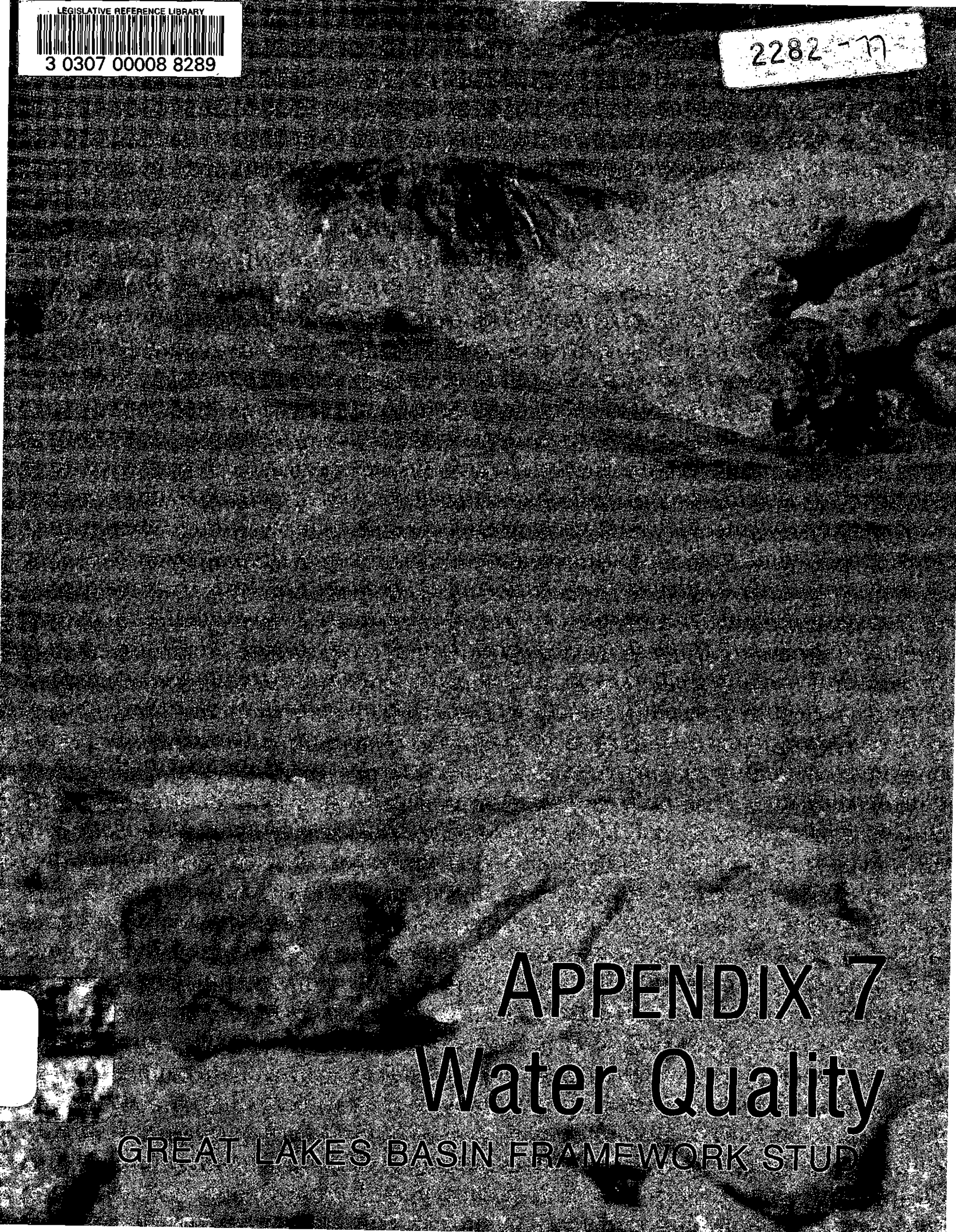

APPENDIX 7
Water Quality

GREAT LAKES BASIN FRAMEWORK STUD

Great Lakes Basin Framework Study

APPENDIX 7

WATER QUALITY

GREAT LAKES BASIN COMMISSION

Prepared by Water Quality Work Group

Sponsored by U.S. Environmental Protection Agency

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This appendix to the *Report* of the *Great Lakes Basin Framework Study* was prepared at field level under the auspices of the Great Lakes Basin Commission to provide data for use in the conduct of the Study and preparation of the *Report*. The conclusions and recommendations herein are those of the group preparing the appendix and not necessarily those of the Basin Commission. The recommendations of the Great Lakes Basin Commission are included in the *Report*.

OUTLINE

SYNOPSIS

Many Federal, State, and local programs exist for the purpose of maintaining or enhancing water quality in the Great Lakes Basin. The Federal programs are primarily the responsibility of the United States Environmental Protection Agency established by Reorganization Plan No. 3, effective December 2, 1970. Principal Federal programs include those relating to comprehensive programs, technical assistance, grant programs, enforcement, Federal installations, Refuse Act permit programs, water hygiene, environmental impacts, pesticide programs, radiation programs, research, and monitoring.

Interstate water quality standards have been adopted by all Great Lakes Basin States. Even though State programs and agencies have been established to bring about control or prevention of water pollution, many water quality problems of varying degrees of severity exist in all of the Lake basins. The number of zones or stream reaches requiring advanced waste treatment varies considerably not only between the major basins but also between river basin groups. A substantial part of the wastewater treatment needs and the resultant investments will occur during the 1970 to 1980 time period, and many of the investment requirements occur in the planning subareas or river basin groups containing large population concentrations or industry.

In addition to municipal and industrial wastewater control problems, other existing and potential problems involve wastes from watercraft, runoff from urban and rural land, including residues from application of chemicals, fertilizers and pesticides, thermal pollution, and disposal of dredged materials.

FOREWORD

Appendix 7, *Water Quality*, was prepared under the general direction of the Water Quality Work Group of the Great Lakes Basin Commission. The work group, consisting of Federal and State representatives, was under the initial chairmanship of Charles R. Ownbey, Chief of the Planning Branch of the Air and Water Programs Division, Region V, United States Environmental Protection Agency. Federal departments or agencies represented included Agriculture, Army, Coast Guard, Interior, and the United States Environmental Protection Agency. States represented were Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin.

In order to facilitate the preparation of the appendix, a group was established for each of the major Lake basins. A leader was appointed for each of the groups as follows:

Lake Superior Basin—Lovell Richie, Minnesota Pollution Control Agency

Lake Michigan Basin—Ralph Purdy, Department of Natural Resources, Michigan Water Resources Commission

Lake Huron Basin — Ralph Purdy, Department of Natural Resources, Michigan Water Resources Commission

Lake Erie Basin—John E. Richards, Ohio Department of Health

Lake Ontario Basin—Russell Mt. Pleasant, State of New York, Department of Environmental Conservation

Preparation of the water quality control needs sections of the appendix was greatly facilitated by the Water Quality Work Group Subcommittee on Methodology under the Chairmanship of L. Robert Carter, Division of Water Pollution Control, Indiana State Board of Health.

Sections of this appendix dealing with water quality control needs in the Lake Ontario basin and Planning Subarea 4.4 were prepared by the Rochester, New York, office of the United States Environmental Protection Agency.

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INTRODUCTION

Purpose

The purpose of this appendix is to examine existing conditions and future prospects for water quality in the Great Lakes Basin as a part of the Great Lakes Basin Commission comprehensive water and related land resources study. The report summarizes water quality conditions and trends in relation to established water use designations and potential future uses. It also identifies the nature, location, and gravity of water quality problems, and defines actions needed to maintain or improve the quality of the waters of the Basin. Also found in the report are general cost estimates for carrying out major components of the required action program.

Scope

This appendix appraises the effectiveness of ongoing programs in the treatment and disposal of waterborne wastes. It translates the economic projections and water use data developed in other appendixes into resulting waste loads, needs for wastewater treatment, and other measures for dealing with waterborne wastes under conditions of development projected for 1980, 2000, and 2020. These data are given for appropriate geographic components of each of the major Lake basins.

Methodology

Methodology was established to project wastewater treatment costs for the 1970 to 1980, 1980 to 2000, and 2000 to 2020 study periods; to identify reaches of streams where advanced waste treatment will be required in each study period; and to identify other water quality control needs.

All projections in this appendix are based on population and industrial growth projections for the defined multicounty planning subareas.

The use of a number of general assumptions was necessary to determine water quality control needs at a framework study level. For example, wastewater discharges are "point" discharges, but some kinds of data may not be available or needed below the planning subarea or river basin group level of plan formulation. Identification of problems for a smaller geographic area such as a river basin or complex sometimes required assumptions about the probable distribution and incidence of water demands, waste flows, and loads.

Additional data and study would be required to document and verify many of the specific problem areas indicated in this study, and one should not attach a higher level of accuracy to the study's findings than that warranted by a framework study.

Basic Treatment

Basic treatment is the combination of secondary or standard biological treatment, which removes 90 percent of the organic constituents as measured by the standard 5-day biochemical oxygen demand, and coagulation and sedimentation with lime, which removes 80 percent of the phosphorus. Basic treatment includes the activated sludge process, effluent chlorination, year-round coagulation and sedimentation with lime, and lime recalcination. Coagulation and sedimentation with lime is included in the basic treatment because the Great Lakes Basin States have agreed upon Basinwide phosphorus removal.

Advanced Waste Treatment

Advanced waste treatment, defined as treatment beyond basic treatment, removes most organic and inorganic contaminants that remain after secondary treatment.

For determining cost estimates in this study, advanced waste treatment is considered to include the granular carbon adsorption and ammonia stripping processes. However, several alternative waste removal methods exist. These include on-land effluent disposal techniques and removal of the effluent from the basin. This appendix does not recommend the method that should be used.

Wastewater Flows

Projections of wastewater flows were made to determine treatment costs and advanced waste treatment needs. Wastewater flows were converted from municipal and industrial water-use figures presented in Appendix 6, *Water Supply—Municipal, Industrial, and Rural*. It was assumed that municipal wastewater flow is equal to municipal water use. For purposes of this study, it was also assumed that industrial processing water is treated by the industries and is not discharged into municipal sewerage systems. To the extent feasible, wastewater treatment requirements and costs were separated into municipal and industrial categories. Only industries that discharge process water with a significant organic loading were included in the industrial category.

Waste Treatment Needs

Advanced waste treatment is considered necessary when the residual biochemical oxygen demand (BOD) loading from a secondary treatment plant depletes the dissolved oxygen in the receiving stream below the level required by State standards for the State minimum flow condition. This is usually the 7-day average low flow expected to recur once in 10 years (7-day 10-year low flow).

One objective of waste-load, treatment-quality studies is to identify stream reaches where advanced waste treatment and/or flow augmentation is needed to meet the water quality standards. Required minimum dissolved oxygen levels are higher for trout streams than for warmwater fisheries.

Because this study does not quantify point discharges, a simplified method was used to identify advanced waste treatment needs. It was assumed that if the 7-day 10-year low flow is eight times the wastewater flow, the dissolved oxygen criteria will be met. The actual required dilution ratio depends on the character of the stream and its assimilative capacity. Lower ratios were used for certain streams when data indicated that a lower ratio would satisfy the oxygen requirements.

To determine advanced waste treatment needs in each planning subarea, judgment was used to apportion the total municipal and industrial wastewater flows to major node points. This discharge was then divided into the 7-day 10-year low flow at the stream's node point. If this ratio is less than eight to one, a need exists for advanced waste treatment, stream-flow augmentation, or a combination of these methods. The amount of augmentation needed was not estimated for this study.

The lake basin groups of the Water Quality Work Group prepared a preliminary list of stream reaches where a potential need for advanced waste treatment or flow augmentation existed. The Surface Water Hydrology Work Group furnished the 7-day 10-year low flows for the places identified.

While it is clear that all the wastewater in a planning subarea does not discharge into a single stream at a single point, this assumption was made to derive total planning subarea treatment costs for areas predominately composed of one or two large municipalities. For areas where the population is fairly evenly distributed among several municipalities, wastewater flows were applied separately for each receiving stream.

Treatment Cost Estimates

The total cost for basic and advanced waste treatment was derived for both municipal and industrial flows. Both capital costs and operating and maintenance costs were derived from two reports prepared by Robert Smith, Federal Water Quality Administration, Division of Research, Cincinnati Water Research Laboratory. The first report, *A Compilation of Cost Information for Conventional and Advanced Wastewater Treatment Plants and Processes*,[3] dated December 1967, includes graphs and tables showing costs for the activated sludge and chlorination processes. The second report, *Cost and Performance Estimates for Tertiary Wastewater Treating Processes*,[4] dated June 1969, includes graphs and tables on costs for the lime clarification, recalcination, ammonia stripping, and granular carbon adsorption processes. Cost data were updated to January 1, 1970, using an annual increase of six percent. These two publications should be consulted for details on unit cost figures. Land costs and the cost of chemicals for the lime clarification processes are not included in these figures.

Estimates of the cost of meeting water quality control needs were determined for each planning subarea. Costs were itemized for the

1970 to 1980, 1980 to 2000, and 2000 to 2020 study periods.

Costs for 1970 to 1980 were determined by State pollution control agencies from existing file data, including construction needs lists. In some cases, additional data compiled by the States were used.

Costs for new plant capacity for the 1980 to 2000 study period were based on increases in water use as determined by the Water Supply Work Group, and on replacement needs. Costs were derived by multiplying the difference in flow between 2000 and 1980 by the unit cost figures for the unit processes described in the Smith reports. Judgment was used to choose unit cost figures based on the variability of community sizes within a planning subarea. New plant capacity costs for the remaining study period were calculated similarly.

Major repairs are generally considered unnecessary for the first 20 years after a plant has been constructed. For recent plant improvement projects, it was assumed that no major repair costs would be required for the 1970 to 1980 period. Repair costs were based on plant capacity determined by using the projected volume of flow at the beginning of the 1980 and 2000 study periods. Repair and replacement costs were derived by assuming that they would equal 50 percent of the total replacement cost. Constant-value 1970 dollars were used.

Recent Developments

The program developed by State and Federal governments in response to the Federal Water Pollution Control Act (P.L. 84-660), as amended in 1970, served as the basis for this appendix. Subsequently a new act was enacted involving a sweeping revision of the entire governmental program for control of water pollution in this country. This new act, the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92–500), proclaims two general goals for the United States:

(1) to achieve wherever possible by July 1, 1983, water that is clean enough for swimming and other recreational uses, and clean enough for the protection of fish, shellfish and wildlife

(2) to have no discharges of pollutants into the nation's waterways by 1985

The new Act is detailed in some areas and deals in broad sweeping concepts in others. The new national water quality goals are to be achieved through a permit program based on effluent limitations as well as water quality standards. All of the elements of the new program are interrelated in a mandatory planning procedure.

The goals of the Act are the groundwork for a series of specific actions aimed at the prevention, reduction, and elimination of water pollution. These actions directly affect the information contained in this appendix:

(1) a review and upgrading of water quality standards in order to accomplish the first goal

(2) stringent new effluent limitations for pollution abatement

(3) increased Federal funding for construction of municipal wastewater treatment facilities

These three elements are based primarily on a set of rigid effluent limitations affecting both municipal and industrial dischargers.

The program of major water quality improvements prescribed in the Act has been divided into two distinct phases. The phase one deadline is July 1, 1977. By this date every industrial discharger must put into practice the "best practicable control technology currently available," and municipal dischargers are required to complete construction of secondary treatment facilities. Both municipalities and industry are required to provide additional treatment, if required to meet stream quality standards.

The second major phase of the Act is directed toward more complete pollution control. By July 1, 1983, industries discharging into the nation's waterways will be required to install the "best available" technology to control their wastes. Municipalities are required to use the "best practicable wastewater treatment technology" for their wastes.

In order to help States successfully carry out their water pollution control programs, Federal funding for construction of municipal waste treatment facilities has been greatly increased. Although the actual amount of Federal funds available will be subject to the limits derived from the overall Federal budget, the total amount of funds available during the 1972-1974 period is nearly three times greater than the amount made available during the previous 15 years.

The Refuse Act permit program, established in 1970 to control the discharge of pollutants into navigable waters, has now been replaced and expanded by the National Pollutant Discharge Elimination System or "Permit Program." Under the NPDES all industries and municipalities must have discharge permits. The Administrator of the Environmental Protection Agency is authorized to issue permits for discharges that meet all applicable effluent limitations and discharge criteria. Specific requirements for each discharger will be spelled out in these permits.

As previously mentioned, the entire program for water quality improvements is coordinated with revised planning procedures. State program plans are continued under the new law in a modified form supplemented by a continuous State planning process, which is now the basic element in the entire water pollution control effort. The Act provides grants to State or interstate planning agencies that develop comprehensive pollution control plans for river basins. Interstate cooperative activities for pollution control are encouraged. The continuous State planning process must cover all navigable waters and must include effluent limitations, applicable portions of areawide planning, daily-waste load limits for streams, procedures for revision, water quality standards compliance schedules, control over residual wastes from water treatment processes, and an inventory and priority ranking of needs for construction of waste treatment works.

Past planning grant provisions have been supplemented by a new areawide planning process. The law provides that "to the extent practicable, waste treatment management shall be on an areawide basis and provide control of all point and non-point sources of pollution . . . ."

The new Act also requires Level B water resource plans by 1980 for all basins in the United States. These Level B studies will be coordinated by the various river basin commissions, with representation from the EPA, the U.S. Departments of Agriculture and the Army, and other Federal agencies.

Because of these and other dramatic changes required by the Act, much of the data supplied in this appendix has been outdated. Specifically, projected wastewater treatment needs and treatment costs are no longer valid. In many cases some incremental higher level treatment will be needed. These data have been included, however, for reference. Revised cost data generated by the 1973 needs survey are included in Appendix 1, *Alternative Frameworks*.

Section 1

FEDERAL PROGRAMS

1.1 Environmental Protection Agency

The first permanent Federal legislation controlling water pollution, passed by Congress in 1956, became Public Law 84-660, the Federal Water Pollution Control Act. It is under this Act, amended in 1961, 1965, 1966, and 1970, that the Federal efforts described in this appendix were directed. Reorganization Plan No. 3, effective December 2, 1970, established the Environmental Protection Agency (EPA) as a new, independent agency within the Executive Branch. The functions carried out by the Federal Water Quality Administration (formerly in the Department of the Interior) and several functions of other Federal agencies were transferred to the Environmental Protection Agency. The principal water-related activities of the Environmental Protection Agency include comprehensive programs, water quality standards, technical assistance, grant programs, enforcement, Federal installations, Refuse Act permit programs, water hygiene, environmental impacts, pesticides programs, radiation programs, research and monitoring, and public information.

1.1.1 Comprehensive Programs

Section 3(a) of the Federal Water Pollution Control Act, as amended, indicates that the administrator of EPA (per Reorganization Plan No. 3) shall, "in cooperation with other Federal Agencies, with State water pollution control agencies and interstate agencies, and with the municipalities and industries involved, prepare or develop comprehensive programs for eliminating or reducing the pollution of interstate and tributaries thereof and improving the sanitary conditions of surface and underground waters."

The activities of the various work groups of the *Great Lakes Basin Framework Study*, in which the EPA is participating, provide an important basis for the continued development and revision of comprehensive programs for water pollution control.

In addition, Section 3(c) of the Federal Water Pollution Control Act, as amended, provides for grants not to exceed 50 percent of the administrative expenses of a planning agency for a period not to exceed three years. Such grants are made at the request of the governor of a State, or a majority of the governors when more than one State is involved. A regional planning agency can qualify for a grant if it provides for adequate representation of appropriate State, interstate, local, or international interests involved. It must be capable of developing an effective comprehensive water quality control and abatement plan for a basin. General provisions of the plans are detailed in the Act.

1.1.2 Water Quality Standards

The Water Quality Act of 1965 amended the Federal Water Pollution Control Act to provide for the establishment of water quality standards for interstate waters. In the absence of State action, such standards were to be adopted by the Secretary of the Interior and later by the Administrator of the Environmental Protection Agency (under Reorganization Plan No. 3). All States elected to draft their own water quality standards, which with minor exceptions were approved by the Federal Agency.

State standards contain three main elements:

(1) the delineation of use, such as swimming, drinking water, industrial use, or a combination of these uses, for each stretch of river, lake, or coastal water

(2) scientific determination of specific characteristics or criteria permitting the appropriate uses agreed on by the State and the Federal government. Limits on such pollutants as bacteria, toxic materials, and taste- and odor-producing substances in the water are set by the standards.

(3) step-by-step plan for construction by cities and industries of waste treatment facilities and use of other measures to meet the water quality requirements

A copy of State standards is available upon request to the appropriate State agency.

1.1.3 Technical Assistance

EPA technical assistance activities include assistance upon request to States, local authorities, industries, and other Federal agencies through the State water pollution control agencies. The program includes maintaining water quality surveillance through a monitoring system. EPA has responsibility for interpreting and evaluating water quality data as they relate to pollution control or quality management.

Technical service and reports on the need for and value of storage for regulation of stream flow are supplied to Federal construction agencies concerned with water quality control.

The EPA research facilities in the Great Lakes Region include a National Water Quality Laboratory at Duluth, Minnesota, which is responsible for developing water quality requirements for all freshwater uses in the United States. Other matters included in the program are lake current, wastes from watercraft, disposal of dredged material, pesticides (see Subsection 1.1.12), and coordination with Canada on solutions to pollution problems.

Knowledge of lake currents is fundamental to understanding the fate of pollutants put into the lake and the effects, both local and widespread, of these pollutants on water quality and associated water uses. This information was gleaned through a study of speed and direction of currents and water temperatures throughout the Great Lakes.

Pollution of Navigable Waters of the United States by Wastes from Watercraft,[6] a report submitted to the Congress on June 30, 1967, proposed legislation based on its findings. It recommended that States adopt uniform requirements controlling the discharge of waste from watercraft and that all marinas and other installations serving watercraft be required to provide the proper disposal facilities. The Water Quality Improvement Act of 1970 incorporated provisions for the control of sewage from vessels. According to the Act, the administrator of the EPA, after consultation with the Secretary of the Department in which the Coast Guard is operating, has to promulgate Federal Standards of performance for marine sanitation devices.

In a joint statement on March 1, 1967, the Department of the Interior (EPA per Reorganization Plan No. 3) and the Corps of Engineers agreed on a program for disposing of polluted material dredged from harbors in the Great Lakes. It was agreed that in order to maintain navigation, the Corps of Engineers would proceed with dredging on 64 channel and harbor projects in the Great Lakes in calendar year 1967. In addition, the Corps initiated a pilot program early in 1967 to develop alternative disposal methods, which would ultimately lead the nationwide effort to improve water quality through prevention, control, and abatement of water pollution by Federal water resources projects. In the fall of 1968 an operational-scaled dike area was started in the Cleveland, Ohio area. It started receiving dredged material from the Cuyahoga River in 1969. A 12-volume report, *Dredging and Water Quality Problems in the Great Lakes*,[5] was completed in 1969.

1.1.4 Grant Programs

EPA grant programs pertaining to water can be categorized as construction grants, program grants, research and demonstration grants, and basin planning grants. On July 2, 1970, amendments to the regulations for grants for construction of treatment works were adopted (Title 18, Chapter V, Part 601), requiring that waste treatment projects assisted with Federal funds be included in an effective basin, metropolitan, or regional plan. These regulations provide for initial certification of regional or metropolitan plans by the governor or his designee and for subsequent consideration as to adequacy by the EPA.

Since passage of the 1956 Act, Federal construction grants have been made in each of the Great Lakes States to help communities build needed sewage treatment facilities. The construction grants section of the Federal Act has been amended three times, each time increasing financial assistance.

Section 7 of the Water Pollution Control Act, as amended, authorizes an appropriation of $10 million annually for fiscal years 1968 through 1971 for grants to State and interstate agencies to assist them in meeting the costs of establishing and maintaining adequate pollution control programs. Each State is allotted $12,000 and the remainder of the funds is distributed on the basis of population, financial need, and the extent of the water pollution problems facing the State.

Section 6 of the Water Pollution Control Act, as amended, authorizes the research and demonstration grants and contracts program. The Act calls for establishing field laboratory and research facilities to conduct research, investigations, experiments, field demonstration and studies, and training related to the prevention and control of water pollution.

1.1.5 Interstate Enforcement Action

Under the provisions of the Federal Water Pollution Control Act, EPA is authorized to call an enforcement conference when requested to do so by the governor of a State, when, on the basis of reports, surveys, or studies, he has reason to believe that pollution of interstate waters subject to abatement under the Act is occurring.

The purpose of the conference is to bring together the State water pollution control agencies, the representatives of the EPA, and other interested parties to review the existing situations and the progress that has been made, to lay a basis for future action, and to give the States, localities, and industries an opportunity to take remedial action under State and local laws.

The Environmental Protection Agency is empowered to seek court action if necessary to carry out its regulatory responsibilities.

The Oil Pollution Act of 1924 prohibited the discharge of oil by vessels in the waters within the United States. As amended, it made unlawful, with some exception, the grossly negligent or willful discharge of oil from vessels into the navigable waters and adjoining shorelines of the United States. Under Presidential directives, a National Multiagency Oil and Hazardous Materials Contingency Plan was developed.[1] Interim multiagency contingency plans for the Great Lakes Region were developed in July 1968 and April 1969. The initial phase of regional contingency planning was conducted on the Federal level to develop a coordinated Federal response to spills of oil or other hazardous material. The Water Quality Improvement Act of 1970 repeats much of what was included in the Oil Pollution Act of 1924, except under this Act the Coast Guard is the primary enforcement agency on the Great Lakes relative to oil pollution by vessels and facilities as defined in the Act. The EPA provides expertise relative to pollution control techniques. See Appendix F20, *Federal Laws, Policies, and Institutional Arrangements*, and Appendix S20, *State Laws, Policies, and Institutional Arrangements*, for further information.

1.1.6 Federal Activities

The Federal government has not overlooked the pollution hazards created by its own activities. On February 4, 1970, President Nixon issued Executive Order 11507, "Prevention Control and Abatement of Air and Water Pollution at Federal Facilities," which states that heads of agencies are to ensure that all facilities under their jurisdiction are designed, operated, and maintained so as to conform to standards pursuant to the Federal Water Pollution Control Act, as amended. Procedures are established for abatement of water pollution at existing facilities, at planned new facilities, and at Federal water resources projects.

Actions necessary to meet the requirements of this order were to be completed or under way no later than December 31, 1972. In cases where an enforcement conference required earlier action, the earlier date was to be applicable.

1.1.7 Refuse Act Permit Program

Executive Order 11574, "Administration of Refuse Act Permit Program," was signed by the President on December 23, 1970. This program is to "regulate the discharge of pollutants and other refuse matter into the navigable waters of the United States or their tributaries and the placing of such matter upon their banks." The Secretary of the Army, after consultation with the administrator of the Environmental Protection Agency respecting water quality matters, is required to issue and amend, as appropriate, regulations, procedures, and instructions for receiving, processing, and evaluating applications for permits pursuant to the authority of the Act of March 3, 1899, c.425.30 Stat. 1152 (33 U.S.C. 407). Relationships with other Federal agencies are described in the Executive Order.

1.1.8 Water Hygiene

The principal water hygiene responsibilities of the EPA include establishing and implementing drinking water standards for systems subject to Federal law and recommending shellfish and recreational water standards through programs of surveillance, research and development, technical assistance, and training.

1.1.9 Environmental Impact

The National Environmental Policy Act of 1969 and Executive Order 11514 on Protection and Enhancement of Environmental Quality require each Federal agency to assess the environmental impact of its activities, whether carried out directly or under grants, contracts, permits, or licenses, with a view toward minimizing adverse environmental effects. Requirements of the NEP Act apply to EPA's construction actions, planning activities, technical studies, and policy statements relative to water quality projection. The EPA has the additional role of assisting other agencies in preparing their environmental statements and reviewing their draft statement.

1.1.10 Research and Monitoring

Research and monitoring activities include, but are not limited to, the development and direction of research programs relative to pollution sources and pollution control.

1.1.11 Public Affairs

EPA's public affairs role involves releasing facts about water pollution control to the news media, interested groups and organizations, and the public. It also serves those who need particular information in order to participate effectively in water pollution control programs.

1.1.12 Pesticides Programs

The pesticide activities of the EPA include establishment of tolerance levels for pesticide residues that occur in or on food, the registration of pesticide uses for protection of man and his environment, and review of pesticide formulations for efficacy and hazard. EPA also regulates sale or use patterns when necessary and checks for compliance with label provisions. It conducts research on effects on human health, non-target fish and wildlife and their environments, and establishes guidelines and standards for analytical methods of residue detection.

1.1.13 Radiation Programs

The Office of Radiation Programs of the EPA is responsible for the radiation activities of the Agency, including the development of radiation protection guidelines and environmental radiation standards. It monitors these guidelines and standards as well as levels of background environmental radiation and evaluates new or proposed Federal or Federally regulated activities. The office also offers technical assistance and training programs, and conducts a research and development program to support the Agency's objectives in radiation protection.

1.2 Department of the Interior

1.2.1 Geological Survey

Both the EPA and the U.S. Geological Survey (USGS) have need for continuing water measurements of a basic type. The USGS has responsibility for meeting the data needs of both agencies. This requires collection of data at fixed points for a period of three years or more. The EPA, other Federal agencies, and State and local cooperators may operate certain stations or perform other test work as an interim measure or a permanent arrangement when this appears to be the most effective course of action.

1.2.2 Bureau of Sport Fisheries and Wildlife

Programs for conservation of fish and wildlife are carried on primarily by the Bureau of Sport Fisheries and Wildlife. For this study the bureau prepared reports on the fish and wildlife aspects of water pollution control in each of the Great Lake basins.

1.2.3 Bureau of Mines

The Secretary of the Interior, through the Fish and Wildlife Service (as modified by Reorganization Plan No. 3) and the Bureau of Mines, is authorized to make such investigations as he deems necessary to determine the effects on wildlife of domestic sewage, mine, petroleum, and industrial wastes, erosion silt, and other polluting substances. He is to report to the Congress concerning such investigation and make recommendations for alleviating dangerous and undesirable effects of such pollution. However, the Bureau of Mines has no statutory authority for the control or use of either water or wastewater disposal by the mineral industry.

1.2.4 Bureau of Outdoor Recreation

Proper water resource use and maintenance or enhancement of high quality recreational opportunities at water recreation areas is of great concern to the Bureau of Outdoor Recreation. As a consequence, the Bureau participates in many water resource studies, either directly through analysis of recreation needs or by review of the analyses of other agencies. The Bureau provides recreation inputs for a variety of water resource research and planning efforts. The Lake Central regional office has produced five Great Lakes water-oriented outdoor recreation studies, which emphasize the impact of water quality on recreation.

The primary mission of the Bureau's water resources program is to guarantee that all types of water recreation areas are free from pollution and unwise development.

1.3 Department of Housing and Urban Development

The Department of Housing and Urban Development is involved in urban planning, which includes water resources programs in the fields of water supply, sewage, and storm drainage. The Department's grant program for basic sewer and water facilities is designed to assist communities finance water and sewer lines that are, or can be, part of an efficient areawide coordinated system with a local program for comprehensive community development. The Department's public facility loans program provides long-term loans for the construction of needed public facilities, such as sewer or water facilities. When aid is available from other Federal agencies, these loans apply to those parts of the project not covered by other Federal programs.

1.4 Department of Agriculture

The Forest Service has responsibility for cooperative State-Federal forestry programs and the administration of the National Forest system. One of the objectives is to reduce erosion and sediment production, and to improve both the water quality and quantity through good management practices on the forested portions of watersheds. When appropriate, the Forest Service conducts water quality monitoring and bacterial sampling in National Forest areas. Other functions include in-depth forestry research, including research on environmentally safe methods of disposing of sewage effluent and sludge on forest land areas.

The Agricultural Stabilization and Conservation Service provides financial and technical assistance to farmers for installing needed soil conservation practices.

The Agricultural Research Service conducts research on many water related matters including practices and systems for preventing or controlling contamination of soil and water resources by agricultural chemicals and farm wastes.

The Farmers Home Administration provides credit and technical and management assistance to rural groups for developing community water supply and sewerage systems, and administers a program of loans for capital improvements and operating costs in connection with water and sewerage facilities, land and water conservation measures, and recreational facilities.

The Soil Conservation Service develops and carries out a national soil and water conservation program. It provides technical aid both to individual landowners and to groups of individuals and organizations who want to conserve land and water resources. These projects can be geared to the abatement of water pollution by retarding the surface runoff and erosion, which contribute pesticides, nutrients, and sediment, and by preventing animal wastes from reaching surface waters through the runoff process.

1.5 Department of Defense

Upon the advice of the EPA administrator, storage to regulate streamflow and improve water quality may be recommended in multipurpose reservoirs, but not as a substitute for adequate local treatment or other methods of controlling wastes at the source.

See Subsection 1.1.7 for the Secretary of the Army's responsibilities with reference to the administration of the Refuse Permit Program. The Secretary of the Army, working with other Federal agencies, also has the basic responsibility for "granting, denying, conditioning, revoking or suspending Refuse Act Permits." The Corps also engages in programs for Pilot Wastewater Management Studies and Urban Studies.

1.6 Department of Transportation

The Department of Transportation Act, Public Law 89–670, (80 Stat. 931) provides for the establishment of a Department of Transportation. The principal agency within this department having responsibilities in the field of water quality control is the Coast Guard.

In accordance with the Water Quality Improvement Act of 1970 the Coast Guard has the major responsibilities when vessels and onshore and offshore facilities, as defined in the Act, pollute with oil. In connection with the National Multiagency Oil and Hazardous Materials Contingency Plan, the Coast Guard provides support in accordance with its responsibilities in the fields of navigation, port safety, security, and maritime law enforcement. The Coast Guard is responsible for promulgation of the Regional Contingency Plan for all coastal regions.

In accordance with the contingency plan, Regional Operations Centers were established at the Ninth Coast Guard District Office in Cleveland and in the Second Coast Guard District Office in St. Louis. The location and circumstances of an oil spill determine which of the two sites is activated. The captain of a port is to act as the on-scene commander when a major pollution spill occurs in the Great Lakes Region. Guidelines entitled "General Patterns of Response Actions" have been prepared.

1.7 Department of Commerce

The National Oceanic and Atmospheric Administration, Department of Commerce, has responsibilities affecting water quality that are assigned to selected elements of the Bureau of Commercial Fisheries. These include economic aspects of fishery operations and the provision of grants for aquatic research.

1.8 Council on Environmental Quality

The Council on Environmental Quality, as created by the National Environmental Quality Act which was approved January 1970, is composed of three members, appointed by the President with the advice and consent of the Senate. Duties and functions of the Council include, but are not limited to, such activities as assisting the President in the preparation of the Environmental Quality Report required by the Act; gathering, analyzing and interpreting trends in the quality of the environment; and developing and recommending to the President national policies to improve environmental quality.

1.9 International Joint Commission

The International Joint Commission, a permanent body of three members from both the U.S. and Canada, was established by the Boundary Waters Treaty of 1909 to administer specific delegated powers and, upon request, to prepare recommendations for action on problems of mutual concern to both countries. It was formed to carry out the purposes of the 1909 treaty which are "to prevent disputes regarding the use of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise . . ."

The United States commissioners are appointed by and serve at the pleasure of the President. The Canadian commissioners are appointed by Order in Council of the Canadian government, and serve at the pleasure of the government.

The treaty gives the IJC responsibilities in two general categories. The first of these is to approve or disapprove all proposals for the use, obstruction, or diversion of boundary waters on either side of the boundary that would affect the natural level or flow of the boundary waters on the other side. Examples in the Great Lakes system include the regulating works at Sault Ste. Marie, and the hydroelectric power developments on the St. Lawrence River.

The second general responsibility of the IJC is to investigate and make recommendations on specific problems referred to it by either or both governments. References (requests for investigation and recommendations) by the two governments have been made on such varied subjects as water pollution, air pollution, regulation of the levels of the Great Lakes, and preservation of the American Falls at Niagara.

The first pollution reference resulted in an investigation in 1913 that covered the entire boundary waters. The final report, published in 1918, was largely concerned with bacterial pollution from municipal sewage. Industrial wastes were of little concern. The extent of sewage pollution at that time resulted in a recommendation that remedial measures be instituted. The outbreak of World War I and subsequent events adversely affected action on these findings.

In 1946, the Commission received a reference concerning pollution of the St. Clair River, Lake St. Clair, and the Detroit River, which was later extended to include the St. Marys and Niagara Rivers. Field surveys were carried out from 1946 to 1949, and the Commission's report was published in 1951. The report concluded that the waters under reference were being polluted contrary to the Treaty. It recommended remedial measures, as well as water quality objectives to protect the waters for the purposes of domestic and industrial water supply, navigation, fish and wildlife, bathing, recreation, agriculture, and other riparian activities.

In 1964, the Commission received a reference concerning pollution of Lake Erie, Lake Ontario, and the international section of the St. Lawrence River. Studies and field surveys were carried out by two advisory boards created for that purpose, and the boards' detailed report was published in 1969.[2] The Commission's report to the governments, published the following year, concluded that the referenced waters "are being seriously polluted on both sides of the boundary to the detriment of both countries, and to an extent which is causing injury to health and property on the other side of the boundary."

The report contained proposed water quality objectives for the lower Lakes, and recommendations that the governments of Canada and the United States agree to specific actions and programs to abate pollution and improve water quality.

Because of these recommendations, the governments entered into negotiation to develop an international agreement for the purpose of water quality management of all boundary waters in the Great Lakes system. The agreement, which was concluded April 15, 1972, greatly expands IJC responsibilities for the coordination and overview of United States and Canadian Great Lakes water pollution control programs, as well as establishing a Water Quality Board to implement the provisions of the agreement.

Accompanying the agreement was a request by the two governments for IJC to make a study of water pollution in Lakes Huron and Superior, and a request for IJC to study pollution of the Great Lakes from the point of view of agriculture, forestry, and other land-use activities.

The staff of the Environmental Protection Agency has been actively participating in the above work.

Section 2

STATE PROGRAMS

2.1 Illinois

The principal State of Illinois agencies concerned with water pollution are the Environmental Protection Agency and the Pollution Control Board.

In 1970, the General Assembly enacted a statute creating the Environmental Protection Agency Act for the control, prevention, and abatement of pollution of the streams, lakes, ponds, and other surface and underground water in the State, and to enhance the quality of the environment in other aspects as well. EPA is designated as the water pollution agency of the State. The Pollution Control Board has the power to decide whether pollution exists in any of the waters of the State. It also sets rules after hearing cases presented to it either by petition or by the Environmental Protection Agency. The Board may also assess penalties and require bonds for performance. Although the area of Illinois that drains into Lake Michigan is relatively small, the Lake is important to the State's economy, and every effort is made to prevent pollution of the waters that are used by the Metropolitan Chicago area for water supply. Additional information is contained in Appendix F20, *Federal Laws, Policies and Institutional Arrangements*, and Appendix S20, *State Laws, Policies, and Institutional Arrangements*.

2.2 Indiana

The Indiana Stream Pollution Control Board has the authority to control and prevent pollution of the surface and ground water of the State. All plans and specifications for waste treatment facilities to prevent, abate, or correct pollution of Indiana waters must be approved by the Board prior to construction.

The Board receives no appropriation. Technical and administrative services are provided by the State Board of Health, Bureau of Engineering.

Chapter 214, Acts of 1943, as amended, provided for the establishment of the Board and outlined its responsibilities and authority for control over the pollution of all waters of the State. Since that time, the Board, with the technical and administrative assistance of the engineering and laboratory staff of the State Board of Health, has pursued programs to maintain and enhance water quality for all water uses, including public and private potable water supply, industrial processing, cooling water, recreation, fish and wildlife, agriculture, and other legitimate uses.

The Board holds regular meetings to consider water pollution control problems and establish policy, initiate enforcement actions, issue abatement orders, approve plans for water pollution treatment and control facilities, establish priorities for State and Federal construction grants to municipalities, and undertake other business necessary to maintain water quality. Board members serve as hearing officers in enforcement actions and participate in the Federal conference on Lake Erie.

The Board adopted water quality standards and plans of implementation for individual basins for all State waters in Fiscal Year 1967. These standards were approved by the Secretary of the Interior, on July 19, 1967. Revised water quality standards were provisionally adopted by the Board on March 17, 1970. The implementation plans for respective basins provide background information, cite pollution sources, enumerate water uses, and provide a timetable for specific municipalities and industries to complete construction of required wastewater treatment facilities. These have been upgraded by means of additions adopted by the Board during the 1970 fiscal year. An anti-degradation policy, regarding existing high quality waters in the State, was adopted by the Board on March 17, 1970.

2.3 Michigan

The objective of the Michigan Water Resources Commission is to bring all existing unlawful pollution under control and prevent the development of unlawful pollution from population growth and increased industrial expansion. Where new sources occur, the Commission is to limit the duration and intensity of the pollution to the fullest extent consistent with requirements of the Water Resources Commission statute.

Where inadequacies in control of waste discharges exist, voluntary corrective action is first suggested. When it appears to the Michigan Water Resources Commission that a voluntary program will not be successful or accomplished within a reasonable time period, statutory procedures are initiated. Orders adopted contain specific effluent restrictions and specific dates for approval of construction plans and specifications. Also included are dates for awarding construction contracts, beginning construction, completing construction, and attaining pollution abatement as required by the order.

Sewerage systems must be developed on the basis of separate sewers for stormwater and sanitary wastewater. When at all feasible, separated sanitary wastewater control facilities must be developed on the combined system to protect present and future water uses of the receiving waters, as stipulated in the Water Resources Commission statute. Problems associated with the overflow of storm and sanitary waste from existing combined sewerage systems to public waters must be corrected on or before June 1, 1977.

Discharges in public waters of nutrients, particularly phosphates, must be controlled. Persons proposing to make new or increased use of State waters for waste disposal purposes are required to use technology and processes known to remove phosphorus compounds. All existing waste dischargers will be required to provide facilities for the removal of phosphorus compounds by June 1, 1977.

The discharge of sanitary waste from recreational watercraft is controlled by rules and regulations adopted by the Water Resources Commission February 22, 1968, with an effective date of January 1, 1970.

The Michigan Water Resources Commission will prevent the development of new problems by continued implementation of Section 8(b) of its statute, which requires the filing of a statement of use by any person proposing to make new or substantial increase in use of State waters. The Commission, upon receipt of a statement, issues an Order stating the minimum restrictions necessary to guard against unlawful uses of State waters.

Water quality standards for water uses of the connecting channels have been adopted. As of June 1, 1972, treatment facilities capable of meeting water quality standards were required on all existing municipal wastewater treatment plants. Secondary treatment is required as a minimum unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with present and future water uses. Exceptions can be granted by the Michigan Water Resources Commission and the Office of Water Programs, U.S. Environmental Protection Agency. Discharges of raw human sewage into public waters was to be corrected by June 1, 1972. Year-round disinfection of all final effluents from municipal sewage treatment plants is required. Industrial waste discharges are to meet the same effluent requirements as required for municipal waste effluent. Industrial waste problems identified in the interstate plan reports were to be cleaned up no later than June 1, 1970.

The Water Resources Commission staff regularly inspects each incipient pollution problem. All orders now adopted by the Commission for both industries and municipalities require routine reports on the quality of wastes discharged to public waters. In addition surface-water quality and waste effluents are monitored in order to identify the need for corrective action to abate existing problems or, if possible, to detect and identify the approach of pollution conditions in time to initiate appropriate corrective action before statutory injury develops. The Water Resources Commission staff reviews and approves or rejects plans for industrial waste treatment or control facilities and counsels management on industrial waste treatment or disposal problems. It develops appropriate restrictions and time schedules for Commission approval to correct or prevent pollution problems, and participates in enforcement procedures initiated by the Commission. It represents the Commission at statutory hearings and presses Commission Orders in court when voluntary compliance is not forthcoming.

The Water Resources Commission has established a branch laboratory at its Pointe Mouillée office and has enlarged its staff so that its greatly expanded surveillance program can maintain a closer watch on waste discharges and evaluate the effect of such discharges on the water quality of the Detroit River and Michigan waters of Lake Erie. The Water Resources Commission's work in this program comprises three major types of activities:

(1) sampling and testing Detroit River and Lake Erie water at 65 locations along seven established river and lake ranges

(2) sampling and testing 75 municipal and industrial waste discharges along the Detroit, Rouge, and Raisin Rivers

(3) noting the general condition of the river and waste discharges during observation runs by boat and helicopter

River range samples are normally tested for phenol, chlorides, sulfates, soluble phosphates, ammonia nitrogen, nitrate nitrogen, iron, cyanide, suspended solids, pH, dissolved oxygen, and total coliform bacteria. Industrial and municipal waste discharges are sampled for the specific pollutional constituents peculiar to the individual waste.

The Department of Public Health, acting through its Division of Engineering, exercises supervisory control over all public sewerage systems. The Director of the Department is required by statute, Act 98, Public Acts of 1913, as amended, to "exercise due care to see that all sewerage systems are properly planned, constructed, and operated so as to prevent unlawful pollution of the streams, lakes, and other water resources of the State." The companion statute, Act 245, Public Acts of 1929, as amended, defines unlawful pollution and authorizes the Water Resources Commission to "establish such pollution standards for lakes, rivers, streams, and other waters of the State in relation to the public use to which they are or may be put, as it shall deem necessary." Such pollution standards and the water quality criteria relating to the public uses currently being promulgated for both interstate and intrastate streams provide the framework decisions and actions concerning the planning, design, construction, and operation of all sewer systems and treatment works. Elements of this supervisory program include the following:

(1) facilities planning and approval

(a) review engineering reports establishing the basis for the design of projects involving collection and treatment of wastewater; consult with the engineers and municipal officials on elements of the proposed design prior to development of plans and specifications; require modification of the proposed design where appropriate and approve it when it is satisfactory

(b) review, approve, or reject, and secure changes in plans and specifications submitted for new municipal systems or for changes in existing collection and treatment systems. No public sewerage system may be built or altered without specific approval by construction permit.

(c) conduct inspections to determine that construction of public sewerage systems conforms to approved plans and specifications

(d) require reduction of overflows from existing combined sewer systems. Adoption of accelerated programs for effective control of overflows from such system is strongly recommended. Progress has been made in several communities by sewer separation.

(e) require municipal rather than private ownership of all sewerage systems serving the public in hopes of assuring more dependable and effective operation and overall pollution control

(f) counsel municipal officials and their consulting engineers as to the need and methods for collecting and treating wastewater

(g) strongly encourage and, where appropriate, require development of multicommunity area planning to provide effective services and pollution control facilities using sound management principles. Many such areas are currently served by an integrated system of sewers, interceptors, and treatment works. Others are being planned in the metropolitan areas of Battle Creek, Benton Harbor, St. Joseph, Grand Rapids, Jackson, Kalamazoo, Muskegon, and Traverse City.

(h) encourage the admission of industrial wastes in municipal sewerage systems where such wastes will not adversely affect the system and its performance in relation to effective pollution control

(i) foster, encourage, and assist communities in the adoption of effective and practical sewer use ordinances for the control of industrial wastes admitted to the sewerage system. In many instances technical assistance and counsel is provided in the location, analyses, and evaluation of wastes, particularly those toxic to biological treatment processes, and in the development of effective corrective measures and controls. Examples are metal plating wastes at Cadillac, Ludington, and Wyoming, which were brought under effective control.

(j) where sufficient information is not available for design purposes, encourage and if appropriate, require communities to conduct pilot or plant scale studies, to provide a dependable basis of design for unusual combinations of industrial and municipal wastes to be treated. Such studies were made at Battle

Creek so that cereal products and paper mill wastes could be treated at the municipal plant. Similarly, require either pilot or plant-scale studies to develop a basis of design where an extremely high degree of treatment is required. Such a study was completed at Jackson.

(k) encourage and assist communities to conduct studies to establish effective methods of phosphate removal from their wastes at existing treatment works. Such studies were made at Lake Odessa and Whitehall.

(l) require new treatment works to remove phosphates as stipulated by the Water Resources Commission

(m) require expansion and improvements of municipal collection and treatment facilities as present capacity is approached instead of waiting until the facilities are overloaded. Approval of sewer extensions can be withheld until an acceptable program for relief is officially adopted if additional loadings would exceed the capacity of the system. "Sewer bans" have been imposed several times in such circumstances. Authority for such action has been tested and upheld in the courts.

(n) order changes in facilities or their operation when requirements of the statutes have not been met. Cases involving deficiency in facilities can be referred to the Water Resources Commission for action.

(o) as agent for the Water Resources Commission, review and approve or reject plans concerning new sewer systems, other than municipal, or for changes in existing ones

(p) assist and encourage local health departments to effectively direct and control the installation of private sewage disposal systems where public sewer systems are not available for connection

(q) require construction of separate sanitary sewers for new community systems

(2) facility operation—supervision, visitation

(a) require the effective operation of all treatment works, pumping stations, and sewer system appurtenances

(b) require all municipalities to submit monthly reports on the operation of treatment works

(c) supervise operation with on-site inspection, instruction, and consultation with plant operating personnel. This requires an average of one visit every three months.

(3) operator certification and training

(a) require all municipalities to employ operators whose competency has been certified

(b) conduct formal group training sessions to impart specific information related to effective operations, to provide opportunity for exchange of information and experience, and to provide incentives for independent study and development

(c) encourage operators to meet on a regular schedule, usually monthly, to exchange information on plant operational problems and experiences, and to invite speakers to discuss selected subjects related to facilities design and maintenance, laboratory equipment, etc.

(4) disinfection policy and practice

(a) require all municipalities to disinfect the plant effluent before discharging it into the surface waters of the State. Virtually all communities in the State are conforming to this policy, which was adopted in January 1967.

(b) require the provision of adequate facilities and their operation, monitoring, and testing in such a manner as to assure continuous effective disinfection

(c) require that department forms concerning chlorine residual readings and related information are filled out regularly. More than 60 communities are performing bacteriological analyses on the chlorinated effluent as a check on the chlorine dosage and residual regimens. Many other small communities are currently planning to apply additional refinements in control this year. Specific abatement programs to correct identified problems are described in tables on municipal and industrial discharges.

2.4 Minnesota

2.4.1 Policy and Purpose

It is Minnesota's policy to prevent, control, and abate pollution in all State waters, so far as feasible and practical, in order to conserve waters and protect the public health, in addition to developing the economic welfare of the State. The State safeguards its waters from pollution by preventing new pollution, and abating existing pollution under a program consistent with its declared policy.

2.4.2 Statutory Authority

Minnesota Statutes Chapters 115 and 116 assign the basic pollution control authority to the Minnesota Pollution Control Agency. All

State departments and agencies are directed to cooperate with the Pollution Control Agency and assist it in the performance of its duties.

2.4.3 Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency which is concerned with water pollution, air pollution, and solid waste programs as specified in the statutes, has the following powers and duties in connection with the Water Pollution Control Program:

> To administer and enforce all laws relating to pollution; to investigate the extent, character, and effect of the pollution of the waters of this State and to gather data and information necessary or desirable in the administration or enforcement of pollution laws, and to make such classification of the waters as it may deem advisable; to establish and alter reasonable orders requiring the discontinuance of pollution discharges in excess of established standards. To require the submission for review and approval of plans for disposal systems and to inspect the construction thereof; to issue, continue in effect or deny permits under such conditions as it may prescribe for the installation and operation of pollution control facilities.

To accomplish these and other functions the Agency has established a professional operating staff with expertise in the air, water, and solid waste fields.

2.4.3.1 Division of Water Quality

The Division of Water Quality is organized into five functional sections as follows:

(1) The Section of Standards and Surveys performs field studies on lakes and streams, compiles basic water quality data from routine water quality monitoring and special studies prerequisite to the development and establishment of water quality standards, prepares such standards and classifications for hearing purposes, and conducts other special purpose studies as required by the Agency.

(2) The Section of Special Services is basically a services support unit providing biological and geological data for special studies or in support of the work of other sections. Groundwater pollution evaluation and pesticide monitoring are performed by the Section.

(3) The Section of Sewage Works receives and reviews plans for municipal sewage works in addition to performing the sewage works operations and operator training functions. It also administers the Federal grant-in-aid programs for municipal treatment works and State grant-in-aid monies, as stipulated in 1969 legislation.

(4) The Section of Industrial and Other Wastes performs a function similar to the Section of Sewage Works except it is concerned with industrial waste sources. It reviews plans and investigates works operations.

(5) The Section of Enforcement maintains the division's basic data pool on compliance status and conducts investigations of complaints of pollution where the source of pollution is not initially known.

2.4.3.2 Special Regulations

(1) Interstate Water Quality Standards (Regulation WPC–15)

These standards were adopted for interstate waters as provided by State law and implementation procedures were established in 1969.

(2) Intrastate Effluent Standards (Regulation WPC–23)

These minimum effluent standards have been adopted for all sources discharging wastes to intrastate waters. This standard requires a high degree of treatment from all sources. For example, an effluent of 25 mg/l five-day biochemical oxygen demand, 30 mg/l total suspended solids, and 1000 MPN per 100 milliliters coliform group organisms requires treatment if the waters into which the wastes are discharged are not otherwise classified by existing standards. The regulation also provides for a determination of classification based on WPC–14 (Intrastate Criteria).

(3) Liquid Storage Regulation (Regulation WPC–4)

This regulation applies to the storage and keeping of oil and liquid substances capable of polluting State waters. It stipulates safeguards for the containment of the liquids.

(4) Wastes from Watercraft (M.S. 361.29, 1961, as amended)

This Act provides for the regulation of marine toilets and the control of waste from watercraft licensed by Minnesota. Under the Act a list of acceptable treatment or storage devices is provided by the Minnesota Pollution Control Agency to the Minnesota Department of Conservation to be used in licensing such vessels. The list contains units of the Masserator-chlorinator type, the incinerator type, and the storage tank type units. While it applies to all waters of Minnesota, it applies only to vessels licensed by Minnesota.

(5) Water Quality Sampling Programs

The Pollution Control Agency has conducted a routine water quality monitoring program on the major rivers and some lakes since 1953. The program has varied over the years depending on needs and resources. Monthly samples are analyzed for 29 physical, chemical, biological, and bacteriological parameters. Twenty-four additional parameters are analyzed annually. This program contains four stations in the Lake Superior Basin.

(6) Pesticide Monitoring Program

In addition to the routine water quality monitoring program above, limited pesticide monitoring is also conducted. Water samples are collected as part of the above program for pesticide analysis and 10 special sampling stations have been established to monitor bottom organisms and fish on a semi-annual basis. None of the special sampling stations are located in the Lake Superior basin.

2.4.4 Other State Agencies

2.4.4.1 Department of Health

This department, through an interdepartmental agreement, conducts certain functions for the Pollution Control Agency. Some services are paid for by the Department, while others involve mutual participation and cooperation. An example of the latter is Agency staff work under the direction of the Department of Health's Engineering Laboratory.

2.4.4.2 State Planning Agency

This agency coordinates State agency water-related activities through a Water Resources Coordinating Committee made up of members from each of the operating State agencies.

2.4.4.3 Department of Conservation

The Department of Conservation has certain responsibilities for the management of game and fish, for the appropriation of ground and surface waters, and for general matters of drainage.

2.5 New York

The Department of Environmental Conservation is New York's principal agency concerned with water pollution control. It was created to consolidate various existing State programs involving environmental quality, water resources planning, and development and management of programs relating to air, land, and water pollution. The functions and duties of the former Water Resources Commission were also transferred to the Department of Environmental Conservation, as were the activities and jurisdiction of the Department of Health in the field of pollution abatement. The Department of Health continues to have primary responsibility for the quality and control of public water supplies and for various aspects of environmental conservation involving public health. Under the legislation that created the new Department, a State Environmental Board within the Department was also created. The Board assists the Commissioner of Environmental Conservation in review and appraisal of programs and activities involving the quality of the environment. It also votes upon standards, criteria, rules, and regulations proposed by the Commissioners of Environmental Conservation.

Under legislation adopted in 1970, the State's Pure Waters Authority was expanded and reconstituted as the Environmental Facilities Corporation. The Corporation is a "Public Benefit Corporation" designed to assist municipalities and State agencies by providing needed facilities to abate air, water, and solid waste pollution. The commissioner of the Department of Environmental Conservation serves as chairman of the Environmental Facilities Corporation.

The legislation creating the Department of Environmental Conservation also created a Council of Environmental Advisers which consists of seven members appointed by the governor. The Council develops guidelines for weighing complex interrelationships between environmental quality, economic development, and population growth, and recommends State environmental policies and legislation.

Other agencies with significant water quality responsibilities include the Office of Parks and Recreation, the Department of Transportation, the Department of Agriculture and Markets, the Department of Law, the Department of Commerce, the Office for Local Government, the Office of Planning Coordination, and the Atomic and Space Development Authority. A detailed description of the above agencies is contained in the State of New

York, Department of Environmental Conservation publication entitled "The Coordinated Program for the Planning and Development of the Water Resources of the State of New York."

2.6 Ohio

Until October 23, 1972, authority for carrying out water pollution abatement programs in Ohio was primarily within various agencies of the Departments of Health and Natural Resources. On that date the Ohio EPA was established to administer water pollution control abatement programs, including those mentioned below, and the Ohio Water Pollution Control Board and the Ohio Water Commission were abolished.

2.6.1 Department of Health

The earliest Ohio statutes for the control of water pollution are contained in Sections 3701.18 through 3701.21 of the Revised Code, which is based on legislation enacted in 1893 and amended in 1925. These statutes mandate approval by the Ohio Department of Health of plans for proposed treatment facilities for municipal or industrial wastes. In addition it authorizes the Department to supervise waste treatment and disposal facilities. It may require the submission of performance records as well as other pertinent information. The last section directs the Department to study the lakes and streams, determine the uses of the waters and causes contributing to their pollution, and determine the practicability of abating and correcting pollution so as to prevent damage to public health and welfare. It also authorizes the Department to adopt and enforce regulations relative to water pollution control. All of the above functions are carried out by personnel of the Division of Engineering. In carrying out these functions, considerable time is spent in developing guidelines for proposed projects with representatives from the municipality or industry. With respect to municipal wastes, the effort includes:

(1) review of engineering reports to determine the design of proposed collection and treatment facilities. Modification may be necessary.

(2) strongly encouraging multicommunity collection and treatment systems and the acceptance of those industrial wastes amenable to conventional treatment processes. Industrial wastes that should be treated prior to their acceptance into the system should be indicated.

(3) periodic visits to all municipal waste treatment facilities. Necessary improvements to the facilities or to their operations should be referred to the proper municipal officials with a request for a program of corrective measures.

(4) preparation of a manual describing possible methods for removing phosphates from municipal wastes in cooperation with a committee composed of consulting engineers, and representatives of OWP, USEPA, and major municipal waste treatment facilities

(5) helping local health departments control the installation of private sewage disposal systems where public sewers are not available

(6) counselling both industrial and municipal officials with respect to the required pretreatment of industrial wastes.

The industrial wastes program is very similar to that for municipal wastes particularly with regard to the first three items. Personnel of the Division of Engineering have been assigned supervision of these programs on an industry by industry basis in order to develop considerable knowledge of the industrial waste problems and their solutions within a particular industry.

All municipal pollution control facilities are required to employ a full-time supervisor certified by the Ohio Department of Health. This mandatory certification is only granted upon the fulfillment of specified education and experience requirements, as well as passing an appropriate written examination. Four grades of certification have been established. The required grade is based on the size and complexity of the treatment facility and the necessary requirements to meet downstream water quality standards. The certification program is also carried out by the Division of Engineering under the direction of an Advisory Board of Examiners.

Sections 6111.09 through 6111.30 of the Revised Code provide that upon proper petition or complaint the Department will investigate, hear cases, and order the correction of water pollution that damages public health or comfort, or pollutes a public water supply. The Act requires proof of unsanitary conditions caused by discharge of sewage or other wastes. Findings and orders of the Director of Health are subject to approval by the Public Health Council. Important legal features of the Act are that an order of the Director of Health is *prima facie* evidence in a law suit resulting from water pollution, and that *mandamus* proceedings in the Ohio Supreme Court have been successful in enforcing compliance with an order of the Director of Health.

The Water Pollution Control Act of Ohio, Sections 6111.01 to 6111.08 of the Revised Code, which became effective September 27, 1951, created a Water Pollution Control Board in the Ohio Department of Health with powers to prevent, control, and abate new and existing pollution of State waters. The Act empowers the board to issue, modify, or revoke orders for the abatement of water pollution; to issue, revoke, modify, or deny permits for the discharge of sewage and industrial wastes into State waters; and to institute proceedings in Common Pleas Court to compel compliance with provisions of the Act or with orders of the Board.

Board permits or orders are designed to bring into compliance, in a logical fashion, a specific cause or causes of water pollution within a specified time period. Where adequate pollution control facilities are provided, the permit will only require evidence of satisfactory maintenance and operation of the facilities. Evidence must show that the effluent is not degrading water quality of the receiving stream below established standards. All industrial permits require information relative to proposed expansions or changes in processes that will result in additional pollution, as well as a proposal for the necessary treatment, reduction or elimination of wastes. Where compliance with the permit conditions is evident, the renewed permit conditions are prepared by the staff of the Division of Engineering, with concurrence from the Board. When compliance with the permit conditions is not obtained without due cause, the matter is brought to the attention of the Board for its recommendations. The permit may be renewed or an order to show cause why the renewal of permit should not be denied may be issued.

To prevent increased pollution from an existing inadequate pollution control facility, the Board has the power to prohibit additional connections to or extension of sewerage system. In a number of cases, this power has been most effective in bringing about the construction of the necessary corrective measures.

The Board also has the power to adopt, amend and repeal standards of quality for State waters. Accordingly, it has held hearings and subsequently adopted stream water quality standards for the interstate waters of Michigan-Ohio, Indiana-Ohio, and Pennsylvania-Ohio in compliance with the Federal Water Quality Act of 1965. The first two interstate streams consist of the Maumee River and some of its tributaries. The Pennsylvania-Ohio streams consist of the Ashtabula River as well as Turkeyfoot and Conneaut Creeks.

During 1967, 1968, and 1969, the Board held hearings and adopted stream water quality standards for the Ohio intrastate tributaries of Lake Erie, using the same format and water quality criteria used for interstate streams.

The Division of Engineering is the technical arm of the Board. The Division makes recommendations on water quality, water use, permit conditions, and pollution abatement orders.

2.6.2 Department of Natural Resources

Section 1501.20 of the Revised Code authorizes the Department of Natural Resources to formulate, maintain, and implement comprehensive plans "for the development, use, and protection of water resources, covering all aspects of water management, including regional water development plans." These plans are coordinated directly with those of the Departments of Development and Health, and indirectly, through joint membership on the Ohio Water Commission and the Ohio Water Pollution Control Board. As a result of this authority the Department has prepared an overall water development program for northwest Ohio and is currently preparing a similar program for northeast Ohio. Much of the information developed for these plans will be pertinent to this report.

The Department, through the Divison of Wildlife, is also responsible for the enforcement of the recently enacted stream littering law.

2.6.3 Ohio Water Development Authority

The primary purpose of the Ohio Water Development Authority, created during 1968 by the Ohio legislature, is to finance the construction of water, sewer, and industrial waste facilities for the abatement of the pollution of State waters. The Authority is empowered to acquire, construct, maintain, and operate such facilities, making them available to anyone, including private and public corporations. These facilities are to be financed through bonds issued by the Authority and payable from the revenues generated by the use of the facilities.

The authorizing legislation (Chapter 6121 of the Revised Code) permits the Authority considerable latitude in financing and operating these facilities. It may operate and maintain its facilities, or it may lease or contract them to private or public corporation. Upon final payment of the bonds for a particular facility, the State may sell the facilities or continue to operate them as a State facility.

2.7 Pennsylvania

The principal legislation used to control water pollution in Pennsylvania is the Clean Stream Law, the Act of June 22, 1937, P.L. 1987, as amended. Other legislation includes the Solid Waste Management Act, the Municipal Sewerage Facilities Act, and the Bituminous Strip Mine Act. Penalties for pollution are also provided in the Pennsylvania Fish Code, which is administered by the Pennsylvania Fish Commission.

The Clean Streams Law which defines the powers of the Department of Environmental Resources to abate pollution, defines pollution as:

> contamination of any waters of the Commonwealth such as will create or is likely to create a nuisance or to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, municipal, commercial, industrial, agricultural, recreational, or other legitimate beneficial use, or to livestock, wild animals, birds, fish or other aquatic life, including but not limited to such contamination by alteration of the physical, chemical or biological properties of such waters, or change in temperature, taste, color or odors thereof, or the discharge of any liquid, gaseous, radioactive, solids, or other substances into such waters. The Board shall determine when a discharge consitutes pollution, as herein defined, and shall establish standards whereby and wherefrom it can be ascertained and determined whether any such discharge does or does not constitute pollution as herein defined.

Waters of the Commonwealth "shall be construed to include any and all rivers, streams, creeks, rivulets, impoundments, ditches, water courses, storm sewers, lakes, dammed water, springs, ponds, and all other bodies of channels of conveyance of surface and underground water or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth."

The Bureau of Water Quality Management in the Pennsylvania Department of Environmental Resources acts as the principal water pollution control agency for the Department and the Environmental Quality Board. It makes inspections, conducts investigations, and does other acts required by the law. It is subject at all times to the rules, regulations, and policies of the Environmental Quality Board. The Department of Environmental Resources issues all orders and permits for water pollution control facilities as well as public water works and public swimming places. It has a water quality laboratory in the City of Erie and a regional water quality office in Meadville, both of which serve the northwestern part of the State, including all of the Lake Erie basin in Pennsylvania. The regional office is responsible for investigations and initiation of enforcement actions.

Among the other agencies with responsibilities relating to water quality are the Environmental Quality Board, the Environmental Hearing Board, and the Citizens Advisory Council.

The Department of Environmental Resources under the provisions of the Clean Streams Law has the duty and responsibility to assure that all sewage discharged into the waters of the Commonwealth receives adequate treatment to meet water quality standards and protect stream uses. A minimal secondary treatment is required for discharge to all streams in the Lake Erie basin. A high degree of treatment is required for certain areas of the Lake Erie basin, and a phosphorus removal requirement is widespread in this basin.

Violations, such as an inadequately treated or unauthorized discharge, are met with an order or a notice of change of treatment requirements, which requires that the violator submit a time schedule and plan to abate the discharge or provide adequate treatment. This must be accomplished within a reasonable time period. Failure to comply with orders or notices results in further enforcement action. The department's authority to direct compliance with provision of the Clean Streams Law has been affirmed by the court in a number of instances.

The Department has the authority to require a municipality to acquire, construct, repair, alter, complete, extend, or operate a sanitary sewer system or treatment plant where it has determined that such action is needed to prevent or eliminate pollution or public health nuisances.

At present, there is a comprehensive water quality management study under way in the

Pennsylvania basin of Lake Erie. This study has received 75 percent funding under Section 15 of the Federal Water Pollution Control Act and is being conducted to prepare a report in compliance with Federal grant regulations relating to water quality management on a basinwide basis.

The Clean Streams Law prohibits the discharge of industrial wastes unless a permit for the discharge has been issued by the Department of Environmental Resources. The Department will not approve discharges that will cause pollution or violate water quality criteria.

The Department has undertaken a pollution incident prevention program, initiated in 1969, that is required of all new permit applicants and high risk permit holders.

This program which requires that the industry establish a program to prevent accidental discharges of polluting materials, considers plant operations, operating procedures, the effects of breakdown by treatment plant equipment, maintenance and inspection, a personnel training program, communications, chain of command for reporting, effects of power failure, procedure for notification of pollution incidents, and clean-up services and equipment. The pollution incident plan program has a high priority for expanded program activities in Pennsylvania.

2.8 Wisconsin

2.8.1 Department of Natural Resources

Responsibility for Wisconsin's water pollution control program is centered in the Department of Natural Resources. The Division of Environmental Protection is the unit within the Department responsible for the protection, maintenance, and improvement of the quality and management of State waters. The Division of Fish, Game, and Enforcement shares related responsibilities. One major responsibility of the Department of Natural Resources is to see that a comprehensive action program is directed at all present and potential sources of water pollution, whether home, farm, recreational, municipal, industrial or commercial, in order to protect human life and health, fish and aquatic life, scenic and ecological values, and domestic, municipal, recreational, industrial, and agricultural uses of water.

2.8.1.1 Action Regarding Inadequacies

Whenever voluntary corrective action fails to achieve adequate control of waste discharges, several alternative actions may be taken.

The Department may issue general orders, and adopt rules applicable throughout the State for the operation of practicable and available systems methods and means for preventing and abating continuing pollution of the waters of the State. Such general orders and rules are issued only after the interested parties have been afforded an opportunity to be heard.

The Department may issue special orders directing particular owners to control continuing pollution of State waters within a specified time. If any order is not complied with within the time period specified, the Department is to immediately notify the Attorney General. The Attorney General may take action within 30 days under Statute 144.536.

The Department may issue temporary emergency orders without prior hearing when it determines that protection of the public health necessitates immediate action.

The Department's conservation wardens are authorized to make arrests under statutes S. 29.288, 29.29(3), 346.94(6) and (6m), and 947.047, which pertain to the intermittent deposition or discharge of wastes on or near waters and highways. Under Section 29.65 the Department is further authorized to take civil action in order to sue for destruction of fish or wildlife.

2.8.1.2 Combined Sewerage Systems

It is departmental policy that new sewage systems must be developed on the basis of separate sewers for storm water and sanitary wastewater. All new plans must be approved according to this policy.

In accordance with the recommendations of the Lake Michigan Enforcement Conference, all existing combined sewerage systems must be corrected on or before October 1, 1977.

2.8.1.3 Policy on Phosphorus Removal from Effluent

Methods exist for substantial removal of phosphorus from sewage and industrial wastes. It is the policy of the Natural Resources Board that the Department of Natural Resources may require any wastewater discharger—regardless of population, volume, or type of waste discharged, or geographic location—to provide for removal of excess amounts of phosphorus where such discharges are causing, or may cause, overfertilization of surface waters.

In conformance with recommendations of the Lake Michigan Enforcement Conference, the Department took the actions necessary to achieve an overall reduction of at least 80 percent of the phosphorus coming from municipal and industrial water treatment facilities located within the Lake Michigan drainage basin by December 31, 1972.

2.8.1.4 Control of New Waste Discharges

Chapter 144.555 requires that:

> any industry which intends to increase the quantity of industrial wastes discharging to the surface waters of the State or to discharge a new waste to said waters or which intends to alter an existing outlet or build a new outlet for industrial wastes shall, before starting such work, advise the Department in writing concerning its intentions and supply the Department with a general report describing steps which shall be taken to protect the surface waters of the State against new pollution or an increase in existing pollution. The report shall be submitted not less than 30 days before approval is desired, and no construction work shall be started until the report has been approved. Variation in or resumption of operation of existing facilities shall not be construed as creating new pollution nor an increase of existing pollution within the meaning of this section.

2.8.1.5 Water Quality Standards

Water quality standards and use designations have been adopted for both the interstate and intrastate waters of Wisconsin.

2.8.1.6 Drainage Basin Surveys

Wisconsin has been divided into 28 major drainage areas. A stream survey program has been devised to study each drainage basin every four years. Stream surveys consist of locating all possible sources, taking appropriate samples, and preparing a formal report to be presented at a public fact-finding hearing.

Typical chemical stream sampling includes pH, temperature, dissolved oxygen, and 5-day BOD. In some instances toxic metals, oils, suspended solids, or nutrients are determined. Bacteriological sampling includes the milipore filter coliform test and fecal coliform counts. Sampling, conducted frequently, covers a wide range of parameters. For example, during 1967–69, the Northeastern Wisconsin Regional Planning Commission conducted tests of over 22,000 water samples taken from 107 stations along 67 streams. It subsequently published a report containing the data.

In addition to samples taken from streams, all waste discharging facilities are studied. An industrial waste census report is made for each industry to determine water usage, type of treatment, and whether an effluent is being discharged into surface water.

A detailed survey is made of major municipal sewage treatment plants and some industrial plants. This survey consists of sampling throughout a 24-hour period to obtain a measure of treatment efficiency and amount of waste discharged during a typical day's operation.

Since 1961, Wisconsin has also had a continuing stream quality monitoring program to determine the water quality of major streams. Samples are taken on a monthly basis in order to evaluate changes in water quality throughout the year. Field tests are made for pH, temperature, and dissolved oxygen at the time of sampling, and laboratory tests are made for biochemical oxygen demand, chlorides, color, hardness, methylene blue, active substances (detergents), pH, and solids. Such information has become increasingly valuable as the length of record increased because it gives long-time averages and shows trends as the characteristics change.

2.8.1.7 Compliance

Most orders are issued on the basis of the comprehensive drainage basin surveys. One of the major responsibilities of the Division of Environmental Protection is to insure that newly constructed and remodeled facilities will provide adequate treatment. This involves reviewing and approving plans for all new facilities before construction begins.

Chapter 144.536 requires that all such orders shall be enforced by the Attorney General and that the County Circuit Court where violation has occurred in whole or in part shall have jurisdiction to enforce the order by injunctional and other appropriate relief.

2.8.1.8 Facility Operation—Supervision, Visitation

In order to insure the effective operation of facilities, the department may investigate, inspect, and require the submission and approval of plans for the installation of systems and devices for handling, treating, or disposing of any wastes.

Section 144.55 requires every owner of an industrial establishment to furnish the Department with all information required in the discharge of its duties under Section 144.025. No member of the Natural Resources Board or any employee of the Department may be denied entrance to an industrial establishment for the purpose of collecting such information.

Wisconsin Administrative Code, Section RD 8.03 (4) states that:

> suitable analyses shall be made and records kept upon approved forms of the operation of all municipal water purification and sewage treatment plants. Reports regarding municipal sewage treatment plants shall be submitted during the month of January for the preceding year and oftener upon written notice of the Department. Similar reports and records may also be required upon refuse disposal plants and privately-owned water purification and sewage treatment plants by written notice from the Department.

2.8.1.9 Operator Certification and Training

Wisconsin Administrative Code, Section 14.01, states that "It is necessary that every waterworks and sewage treatment plant employ an operator who holds a valid certificate. Certification shall be available to all individuals who can meet the qualifications for a given grade." Both municipalities and industries are included under the requirements. In 1968 the Department switched from a voluntary to a mandatory certification program. In a one-year period 659 municipal and 69 industrial wastewater operators were trained and certified.

It is expected that courses will be held annually to train and upgrade operators throughout the State in order to improve plant operating efficiency.

2.8.1.10 Wisconsin's Financial Assistance Program

The Wisconsin Legislature held in Chapter 144.21 that "State financial assistance for the construction and financing of pollution prevention and abatement facilities is a public purpose and a proper State government function in that the State is a trustee of the waters of the State and that such financial assistance is necessary to protect the purity of State waters."

The department may enter into agreement with municipalities to make payments to municipalities from the appropriation made by Section 20.706(1) to pay not less than 25 percent and not more than 30 percent of the estimated reasonable costs of the approved project. These payments shall be in even annual amounts and shall extend for a period of not more than 30 years. The appropriations made by Section 20.706(1) allocated the following amounts for these fiscal years:

1968–1969	$750,000
1969–1970	$1,000,000
1970–1971	$1,625,000

During the spring elections of 1969, the people of Wisconsin voted "yes" in a public referendum to pass Outdoor Recreation Act Program 200 State bonding program. Of the $200,000,000, $144,000,000 would be allocated for water pollution prevention and abatement assistance. After July 1, 1969, the State entered into agreements to pay 25 percent of the cost of eligible construction and to complete payments in stages during construction. Final payment was to be made after audit on completion of the project.

Section 3

WATER QUALITY STANDARDS

3.1 Illinois

Under provisions of the Water Quality Act of 1965, Illinois has adopted water quality standards for its interstate waters. No conflicts exist in the water quality criteria for the interstate waters of Indiana and Illinois.

Revised water quality standards were adopted by the Illinois Pollution Control Board on March 7, 1972. These standards, with the effluent standards adopted on January 6, 1972, provide a consistent and coherent set of regulations concerning water quality criteria, stream-use designations, maximum discharge limits, thermal limits, sewer discharge criteria, and all other provisions necessary for the protection of the State's waters.

The new regulations are based upon the principle that all waters capable of supporting aquatic life, except a few highly industrialized streams around the Chicago area, should be protected to insure that such capability is maintained, and that waters used for public supplies should be preserved.

3.2 Indiana

In accordance with the Water Quality Act of 1965, Indiana water quality standards were revised. Water quality criteria were set according to the use concept, and a plan for implementation was outlined.

After the required public hearings, the criteria and implementation plan were adopted by the Stream Pollution Control Board and together they become known as the "Water Quality Standards." They were approved by the U.S. Department of the Interior in July 1967.

The new standards, which became Stream Pollution Control Board Regulations SPC 1R, 4, 5, 6, 7, 8, 9, and 10, apply to all State waters. However, Regulations SPC 4, 5, 6, 7, 8, 9, and 10 apply only to certain waters in the Lake Michigan basin.

No distinction is made between intrastate and interstate water quality standards.

In general, standards call for secondary treatment, including effluent chlorination, for all municipal wastewater treatment plants. They also require treatment or control of industrial wastewater treatment plants equal to that provided by municipalities on the same stretch. All sewered communities are to have treatment facilities by the end of 1972 and all incorporated communities with public water supplies but no sewers are to have sewers and sewage treatment facilities before the end of 1977. The standards also require advanced waste treatment or provision of low-flow augmentation during the next 10 years or sooner for plants discharging into streams having inadequate assimilative capacity. Prompt and regular submission of monthly operational reports is also required.

3.2.1 Minimum Conditions Applicable to All Waters at All Places and at All Times

All waters should be:

(1) free from substances attributable to municipal, industrial, agricultural, or other discharges that settle and form putrescence or otherwise objectionable deposits

(2) free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, agricultural, or other discharges in amounts sufficient to be unsightly or deleterious

(3) free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, or other conditions in such degree as to create a nuisance

(4) free from substances attributable to municipal, industrial, agricultural, or other discharges in concentrations or combinations that are toxic or harmful to human, animal, plant, or aquatic life

3.2.2 Stream Quality Criteria

3.2.2.1 Public Water Supply and Food Processing Industry

The following criteria are used in the evaluation of stream quality at the point at which water is withdrawn for treatment and distribution as a potable supply:

(1) bacteria: coliform group not to exceed 5,000 per 100 ml as a monthly-average value (either MPN or MF count) nor exceed this number in more than 20 percent of the samples examined during any month nor exceed 20,000 per 100 ml in more than five percent of such samples

(2) threshold-odor number: taste and odor producing substances, other than naturally occurring, shall not interfere with the production of a finished water by conventional treatment consisting of coagulation, sedimentation, filtration, and chlorination. The threshold odor number of the finished water must be three or less.

(3) dissolved solids: other than solids from naturally occurring sources, the concentration should not exceed 500 mg/l as a monthly-average value, or 750 mg/l at any time. The values of specific conductance of 800 and 1,200 micromhos/cm (at 25 degrees C) may be considered equivalent to dissolved-solids concentrations of 500 and 750 mg/l

(4) radioactive substances: gross beta activity (in the known absence of Strontium-90 and alpha emitters) not to exceed 1,000 picocuries per liter at any time

(5) chemical constituents: not to exceed the following specified concentrations at any time:

Constituent	Concentration (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead	0.05
Selenium	0.01
Silver	0.05

3.2.2.2 Industrial Water Supply

The following criteria are applicable to stream water at the point at which the water is withdrawn for use (either with or without treatment) for industrial cooling and processing:

(1) dissolved oxygen: not less than 2.0 mg/l as a daily-average value, nor less than 1.0 mg/l at any time

(2) pH: not less than 5.0 nor greater than 9.0 at any time

(3) temperature: not to exceed 95°F at any time

(4) dissolved solids: other than from naturally occurring sources, concentration should not exceed 750 mg/l as a monthly-average value, nor 1,000 mg/l at any time. The values of specific conductance of 1,200 and 1,600 micromhos/cm (at 25 degrees C) may be considered equivalent to dissolved solids concentrations of 750 and 1,000 mg/l.

3.2.2.3 Aquatic Life

The following criteria are needed to maintain a well-balanced, warmwater fish population. They are applicable to any point in the stream except those areas immediately adjacent to outfalls. In such areas cognizance will be given to opportunities for the admixture of waste effluents with river water.

(1) dissolved oxygen: not less than 5.0 mg/l during at least 16 hours of any 24-hour period, nor less than 3.0 mg/l at any time

(2) pH: no values below 6.0 nor above 9.0 and daily-average (or median) values preferably between 6.5 and 8.5

(3) temperature: not to exceed 93°F at any time during the months of April through November, and not to exceed 60°F at any time during the months of December through March

(4) toxic substances: not to exceed one-tenth of the 96-hour median tolerance limit obtained from continuous flow bioassays where the dilution water and toxicant are continuously renewed. Other application factors may be used in specific cases when justified on the basis of available evidence and approved by the appropriate regulatory agencies.

(5) taste and odor: there shall be no substances that impart unpalatable flavor to food fish, or result in noticeable offensive odors in the vicinity of the water

(6) trout streams: in addition, the following criteria are applicable to those waters designated for put-and-take trout fishing:

(a) dissolved oxygen: not less than 6.0 mg/l as a daily-average value, nor less than 4.0 mg/l at any time

(b) pH: not less than 6.5 nor greater than 8.5 at any time

(c) temperature: not to exceed 65°F. However, slightly higher temperatures may be tolerated with higher dissolved oxygen content than specified.

3.2.2.4 Recreation

The following criteria are used for the evaluation of conditions at any point in waters designated to be used for recreational purposes:

(1) whole body contact: coliform group not to exceed 1,000 per 100 ml as a monthly-average value (either MPN or MF count) during any month of the recreational season. This number should not be exceeded in more than 20 percent of the samples examined during any month of the recreational season, nor should it exceed 2,400 per 100 ml (either MPN or MF count) on any day during the recreational season. The months of April through October, inclusive, are designated as the recreational season.

(2) partial body contact: coliform group not to exceed 5,000 per 100 ml as a monthly-average value (either MPN or MF count). This number should not be exceeded in more than 20 percent of the samples examined during any month, nor exceed 20,000 per 100 ml in more than five percent of such samples.

3.2.2.5 Agricultural or Stock Watering

Criteria for agricultural or stock watering are the same as those for minimum conditions applicable to all waters at all places and at all times. Unless otherwise specified, the term "average" means an arithmetic average.

The analytical procedures used as methods of analyses to determine the chemical, bacteriological, biological, and radiological quality of waters sampled shall be in accordance with the latest edition of *Standard Methods for the Examination of Water and Wastewater* or other methods approved by the Indiana Stream Pollution Control Board and the Environmental Protection Agency.

3.2.3 Proposed Criteria, Implementation, and Enforcement Plan

The Indiana Stream Pollution Control Board, under the present Indiana Stream Pollution Control Law (Chapter 214, Acts of 1943, as amended), has the authority to control and prevent pollution in State waters. All plans and specifications for abatement or correction of any polluted conditions shall be approved by the Stream Pollution Control Board.

The Board adopted the criteria that appear in Appendix 6, *Water Supply—Municipal, Industrial, and Rural,* as standards of water quality for the waters of the Maumee River basin. All waters will be required to meet the standards, as adopted in final form, for the appropriate public and industrial water supply, aquatic life, recreational, and agricultural uses mentioned previously. Compliance with these standards will enhance the quality of waters within this basin. Every effort consistent with the powers granted under the Indiana Act will be made to maintain high quality waters.

The minimum weekly flow over a 10-year period will be used in applying the standards. It is recognized that the all-time minimum flow will be less but will occur only a very small percentage of the time. During these periods, only minimum damage to the stream will result. The board plans to require compliance with the coliform standards for recreation during the recreational season of April through October, inclusive, and year-round for water supply. But it must be recognized that there are uncontrollable sources of coliform pollution other than sewage treatment plant effluents such as stormwater runoff mentioned previously in this report.

Drastic or sudden temperature changes will not be permitted. The Board will insist upon gradual changes in temperature not exceeding a change of 2°F per hour nor more than 9°F in 24 hours, whichever is greater.

The board now conducts approximately 100 stream surveys per year on various waters around the State as part of its data collection program. Similarly, samples are collected biweekly from 71 locations on Indiana streams and lakes. Of the 71 stations, four are located in this basin. These will be increased within budgetary and personnel limitations.

Chapter 273, Acts of 1967, requires the classification of wastewater treatment plants and certification of plant supervisors. Plans for implementing this law, which became effective on July 1, 1968, are now under way. Inspections of wastewater treatment plants by representatives of the Board have been increased and will be further increased to insure compliance with the standards.

The prompt and regular submission of operational monthly reports will be required of the treatment plants to enable evaluations of effluent quality. Where practicable, the board requires the larger treatment facilities to initiate a downstream sampling program.

All those municipalities which have or will be required to have secondary sewage treatment facilities must provide the following removal of BOD:

(1) trickling filter plant—at least 80 percent

(2) activated sludge plant—at least 90 percent

The characteristics of a receiving stream, including low flow, will continue to be used in determining the type of treatment required.

The board requires construction of municipal treatment facilities in accordance with the following timetable:

(1) Effluent chlorination facilities were to be provided by the end of 1968.

(2) Provision of adequate dilution or installation of advanced waste treatment at Auburn, Decatur, Garrett, and Fort Wayne will be required within the next 10 years. Phosphate removal will be required at Fort Wayne as soon as practicable methods are developed.

(3) Installation of sewers and sewage treatment facilities for incorporated communities with public water supplies and no recognized sewage treatment facilities will be required within the next 10 years.

(4) Secondary treatment will be required at all new installations.

All industries will be required to provide a degree of treatment or control that is equivalent to that required of municipalities on the same stretch of the stream. Except in rare instances this will be the equivalent of secondary treatment. Exceptions must be justified to the satisfaction of the Indiana Stream Pollution Control Board and the Federal Water Pollution Control Administration.

The Board notified all municipalities of more than 2,000 population that have discharged significant quantities of phosphate to the Great Lakes Basin that phosphate removal was required before the end of 1972.

With the exception of certain waters in the Lake Michigan basin, all waters of the State must be capable of supporting a well-balanced, warmwater fish population, and all lakes and reservoirs must be maintained for whole body contact recreation, with streams maintained for partial body contact recreation such as boating and fishing.

All waters which are now, or will be in the future, used for public or industrial water supply must meet the criteria whenever used for these purposes.

3.2.4 Summary of Water Uses

(1) All waters in the basin will be required to support a well-balanced, warmwater fish population and must be suitable for agricultural uses.

(2) All waters, where natural temperatures permit, will be required to support put-and-take trout fishing.

(3) All reservoirs and lakes and the St. Joseph River (Allen County) must be maintained for whole body contact recreation and all other streams for partial body contact recreation, such as boating, canoeing, and fishing.

(4) All waters used for public or industrial water supply must meet said criteria.

3.3 Michigan

3.3.1 Michigan Program Description

The Federal Water Quality Act of 1965 (Public Law 89–234) provided that prior to June 30, 1967, the States could adopt water quality criteria applicable to interstate waters and portions thereof within the State, and a plan for implementing and enforcing the criteria.

The Federal Statute (Public Law 89–234) requires that "Standards of quality established . . . shall be such as to protect the public health or welfare, enhance the quality of water and serve the purposes of this Act." The act further requires that in establishing such standards "State authority shall take into consideration [the water's] use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial and other legitimate uses."

On December 17, 1965, Governor George Romney wrote to the Secretary of Health, Education, and Welfare, John Gardner, that it was the intent of the State of Michigan to adopt water quality criteria applicable to interstate waters.

Interstate water quality standards were formally adopted by the Michigan Water Resources Commission on June 28, 1967. Six months later on January 4, 1968, the Commission also adopted water quality standards applicable to the intrastate waters of Michigan.

Michigan's interstate water quality standards have been reviewed and, with the exception of certain temperature criteria for fish and wildlife, have been approved by the Secretary of the Interior.

3.3.1.1 Objectives

The goal of Commission action is the cleanest waters possible for the residents of Michigan. In striving to achieve this goal, two important objectives were incorporated into both the approved interstate and intrastate water quality standards.

> Waters in which the existing quality is better than the established standards on the date when such standards become effective will not be lowered in quality by action of the Water Resources Commission unless and until it has been affirmatively demonstrated to the Michigan Water Resources Commission and the Department of the Interior that the change in quality will not become injurious to the public health, safety, or welfare; or become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being made of such waters; or become injurious to the value or utility of riparian lands; or become injurious to livestock, wild animals, birds, fish, aquatic life or plants, or the growth or propagation thereof be prevented or injuriously affected; or whereby the value of fish and game may be destroyed or impaired, and that such lowering in quality will not be unreasonable and against public interest in view of the existing conditions in any interstate waters of Michigan.
>
> Water which does not meet the standards *will be improved* to meet the standards.

This non-degradation policy was accepted by the Department of the Interior in its approval of Michigan's Interstate Water Quality Standards, making Michigan one of the first States in the nation to include a non-degradation objective in its water quality standards.

3.3.1.2 Developmental Guidelines

The standards' parameters presented are for receiving waters and are designed to be used in conjunction with a system of stream or lake sector designations according to their present or prospective water use. These standards have been designed to both protect the receiving waters of the State for designated use, and to provide maximum protection of the high quality Great Lakes into which they eventually empty.

Several basic premises were used when formulating these standards:

(1) Definite numerical values were used where evidence was adequate to substantiate the value or where a significant possibility of public hazard existed.

(2) The parameters selected to measure water quality are those felt to be significant for all the uses defined in this report. Future research and technological developments may show the need for modification of the standards.

(3) Analysis of the levels of water pollutants will be made according to procedures outlined in *Standard Methods for the Examination of Water, Sewage and Industrial Wastes*, published jointly by the American Public Health Association, American Water Works Association, and the Federation of Sewage and Industrial Wastes Association, or other methods approved by the Michigan Water Resources Commission and the Office of Water Programs, U.S. Environmental Protection Agency.

(4) Application of chemicals for water resource management purposes in accordance with statutory provisions is not subject to the requirements of the standards except in case of water used for public water supply.

(5) The standards apply to stream flows equal to or exceeding the 10-year recurrence of minimum low flow average 7-day duration.

3.3.2 Standards

Michigan's standards use 11 water quality parameters and five major water use categories. Table 7-1 presents the acceptable level of parameters for specific water uses.

3.3.2.1 Public Participation

To assure a maximum of public understanding and to ascertain specific interest viewpoints regarding designated use areas, a series of six public hearings covering interstate waters and five public hearings covering intrastate waters were held throughout the State. The hearings were well attended. In the five intrastate hearings, for example, more than 900 concerned citizens attended with 90 presenting oral testimony in addition to the submission of numerous written statements.

3.3.2.2 Application of Standards

The water-use designations are based on existing water quality and quantity, current

TABLE 7-1 Interstate Water Quality Standards—Michigan

COLIFORM GROUP (organisms per 100 ml or MPN)

Required for WATER SUPPLY (INDUSTRIAL); RECREATION (PARTIAL BODY CONTACT); FISH, WILDLIFE, & OTHER AQUATIC LIFE; AGRICULTURAL; & COMMERCIAL: The average of any series of 10 consecutive samples shall not exceed 5,000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1,000.

Required for WATER SUPPLY (DOMESTIC): For Great Lakes and Connecting Waters--The monthly average shall not exceed 2,000 nor shall 20% of the samples examined exceed 2,000. For Inland Waters--The monthly average shall not exceed 5,000 nor shall 20% of the samples examined exceed 5,000, nor exceed 20,000 in more than 5% of the samples.

Required for RECREATION (TOTAL BODY CONTACT): The average of any series of 10 consecutive samples shall not exceed 1,000 nor shall 20% of the samples examined exceed 5,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 100. See Appendix A, Section B.

DISSOLVED OXYGEN (mg/l)

Required for WATER SUPPLY (DOMESTIC & INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); & COMMERCIAL: Present at all times in sufficient quantities to prevent nuisance.

Required for FISH, WILDLIFE, & OTHER AQUATIC LIFE: Values to be maintained at average 7-day low flow (once/10yrs)--Intolerant Fish: Cold Water; Not <6. Warm Water; Average daily not <5 nor any value <4. Tolerant Fish: Warm Water; Average daily not <4 nor any value <3. Greater values at greater flows.

Required for AGRICULTURAL: Not <3 at any time.

SUSPENDED, COLLOIDAL, & SETTLEABLE MATERIALS

Required for WATER SUPPLY (DOMESTIC & INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); FISH, WILDLIFE, & OTHER AQUATIC LIFE; AGRICULTURAL; & COMMERCIAL: No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with designated use.

RESIDUES (debris & material of unnatural origin, & oils)

Required for WATER SUPPLY (DOMESTIC & INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); FISH, WILDLIFE, & OTHER AQUATIC LIFE; AGRICULTURAL; & COMMERCIAL: Floating Solids--None of unnatural origin. Residues--No evidence of such materials except of natural origin. No visible film of oil, gasoline, or related materials. No globules of grease.

TOXIC & DELETERIOUS SUBSTANCES

Required for WATER SUPPLY (INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); & COMMERCIAL: Limited to concentrations less than those which are or may become injurious to the designated use.

Required for WATER SUPPLY (DOMESTIC): Conform to current USPHS Drinking Water Standards except--Cyanide: Normally not detectable with a maximum upper limit of 0.2 mg/l. Chromium[6]: Normally not detectable with a maximum upper limit of 0.05 mg/l. Phenol: Monthly average concentration less than 0.002 mg/l and maximum concentration limited to 0.005 mg/l for a single sample.

Required for FISH, WILDLIFE, & OTHER AQUATIC LIFE: Not <1/10 of the 96-hr. median tolerance limit obtained from continuous flow bio-assays where dilution water and toxicant are continuously renewed. Other application factors may be used if justified by evidence on hand and approved by appropriate agency.

Required for AGRICULTURAL: Conform to current USPHS Drinking Water Standards as related to toxicants. Toxic & deleterious substances shall be less than those which are or may become injurious to the designated use.

TOTAL DISSOLVED SOLIDS (mg/l)

Required for RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); & COMMERCIAL: Limited to concentrations less than those which are or may become injurious to the designated use.

Required for WATER SUPPLY (DOMESTIC): For Great Lakes & Connecting Waters--Total Dissolved Solids: The maximum shall not exceed 200. Chlorides: The monthly average shall not exceed 50. A monthly average of 10 is a desirable limit where existing conditions are less than 10. For Inland Waters--Total Dissolved Solids: Shall not exceed 500 as a monthly average, nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125.

Required for WATER SUPPLY (INDUSTRIAL): Total Dissolved Solids Shall not exceed 500 as a monthly average nor exceed 750 at any time. Chlorides-- The monthly average shall not exceed 125.

Required for FISH, WILDLIFE, & OTHER AQUATIC LIFE: Standards to be established when information becomes available on deleterious effects.

Required for AGRICULTURE: <700 dissolved minerals. Maximum percentage of sodium 40% as determined by formula (Na x 100/(Na+Ca+Mg+k) when the bases are expressed as milli-equivalents per liter.

NUTRIENTS (Phosphorus, ammonia, nitrates & sugars)

Required for WATER SUPPLY (DOMESTIC & INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); FISH, WILDLIFE, & OTHER AQUATIC LIFE; AGRICULTURAL; & COMMERCIAL: Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds, & slimes which are or may become injurious to the designated use. (AGRICULTURAL: NO_3 concentrations shall conform to USPHS Drinking Water Standards.)

TASTE & ODOR PRODUCING SUBSTANCES

Required for WATER SUPPLY (INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); AGRICULTURAL; & COMMERCIAL: Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.

Required for WATER SUPPLY (DOMESTIC): Same as above with the addition of the following--Monthly average phenol concentration less than 0.002 mg/l & maximum concentration limited to 0.005 mg/l for a single sample.

Required for FISH, WILDLIFE, & OTHER AQUATIC LIFE: Concentration of substances of unnatural origin shall be less than those which are causing or may cause taint in the flesh of fish or game.

TEMPERATURE[1] (°F)

Required for WATER SUPPLY (DOMESTIC & INDUSTRIAL); & COMMERCIAL: The maximum natural water temperature shall not be increased by more than 10°F.

Required for RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT): 90°F maximum.

Required for FISH, WILDLIFE, & OTHER AQUATIC LIFE: See note[2].

Required for AGRICULTURAL: Not applicable.

HYDROGEN ION (pH)

Required for WATER SUPPLY (INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT; & COMMERCIAL: Maintained within the range of 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.

Required for WATER SUPPLY (DOMESTIC); & AGRICULTURAL: pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.

Required for FISH, WILDLIFE, & OTHER AQUATIC LIFE: Maintained between 6.5 & 8.8 with a maximum artifically induced variation of 1.0 unit within this range. Change in the pH of natural waters outside these values must be toward neutrality (7.0).

RADIOACTIVE MATERIALS

Required for WATER SUPPLY (DOMESTIC); & AGRICULTURAL: An upper limit of 1,000 picocuries/liter of gross beta activity (in absence of alpha emitters & Strontium 90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.

Required for WATER SUPPLY (INDUSTRIAL); RECREATION (TOTAL BODY CONTACT & PARTIAL BODY CONTACT); FISH, WILDLIFE, & OTHER AQUATIC LIFE; & COMMERCIAL: Standards to be established when information becomes available on deleterious effects.

[1]For the Great Lakes and connecting waters no heat load in sufficient quantity to create conditions which are or may become injurious to domestic, commercial, industrial, agricultural, recreational, or other uses which are being or may be made of such waters; or which are or may become injurious to the value or utility of riparian lands; or which are or may become injurious to livestock, wild animals, birds, fish, or aquatic life, or the growth or propagation thereof.

[2]Intolerant Fish - Cold Water Species: Ambient--32° to natural maximum; Allowable Increase--10°; Maximum Limit--70°.
Intolerant Fish - Warm Water Species: Ambient--32° to 35°, 36° to natural maximum; Allowable Increase--15°, 10°; Maximum Limit--85°.
Tolerant Fish - Warm Water Species: Ambient--12° to 59°, 60° to natural maximum; Allowable Increase--15°, 10°; Maximum Limit--87°.

water uses, and estimated future uses. A series of 11 water and related land resource inventory reports, six covering interstate waters and five intrastate waters, were compiled by the staff of the Water Resources Commission and were used as background material for determining use designations.

It should be noted, when reviewing the use designations, that in those instances where more than one use is to be protected, the most restrictive use designations shall apply. The standards allow for a mixing zone for entering wastes but in no instance shall the mixing zone act as a barrier to fish migration or interfere unreasonably with designated water uses.

The use of two designations, one for tolerant fish and warmwater species, the other for commercial species and others, applied only until January 1974. By that time the waste disposal situations involved were to be placed before the Water Resources Commission for critical reconsideration with a view toward the application of higher quality use designations. The water quality standards for the designated use areas shall not apply during periods of authorized dredging for navigation purposes and during such periods of time when the after-effects of dredging degrade water quality in areas affected by dredging. However, water quality standards for the designated use shall apply in areas used for the disposal of spoil from dredging operations.

3.3.2.3 Designated Uses

Based on their existing uses and reasonable future uses the waters of Lake Superior, Lake Michigan, Lake Huron, and St. Marys River were classified into designated use areas as described below.

(1) Water Supply

All waters will be protected for domestic and industrial water supply. The individual parameters shall be measured at the point of water withdrawal.

(2) Recreation

All waters will be protected for total body contact recreation, except in the immediate vicinity of enclosed harbor areas and river mouths where partial body contact will apply (Figures 7–1 and 7–2).

(3) Fish, Wildlife, and Other Aquatic Life

All waters will be protected for intolerant fish, warmwater species, and for intolerant fish, coldwater species, where they are naturally suitable for such use.

(4) Agricultural

All waters will be protected for agricultural uses.

(5) Commercial

All waters will be protected for commercial use.

The Water Resources Commission must have discretion in determining the extent of the mixing zone. In general, the Water Resources Commission encourages the use of outfall structures that minimize the extent of the mixing zone.

Based on their existing uses and reasonable future uses the waters of the St. Clair River, Lake St. Clair, Detroit River and Lake Erie will be protected as described below.

(1) Water Supply

All the above named waters will be protected for domestic and industrial water supply, except that portion of the Detroit River from Point Hennepin to the mouth. The individual parameters shall be measured at the point of water withdrawal.

(2) Recreation

Except at the mouths of tributaries and in the immediate vicinity of enclosed harbor areas and wastewater treatment plant outfalls, all of the above named waters will be protected for recreation (total body contact), except during conditions relating to natural causes (Figures 7–3 and 7–4).

(3) Fish, Wildlife, and Other Aquatic Life

All the above named waters will be protected for fish, wildlife, and other aquatic life (warmwater sport fish).

(4) Commercial Navigation

All the above named waters will be protected for commercial navigation in the designated navigation channels as maintained by the Corps of Engineers.

Based on their existing uses and reasonable future uses the Michigan waters of the Maumee River Basin will be protected as described below.

(1) Recreation

All the above waters will be protected for recreation (total body contact), except during conditions relating to natural causes.

(2) Fish, Wildlife, and Other Aquatic Life

All the above named waters will be protected for fish, wildlife, and other aquatic life (warmwater sport fish).

(3) Agricultural

All the above named waters will be protected for agricultural uses.

In general, the designated uses for the interior waters of the Michigan portion of the Lake Huron basin are as follows:

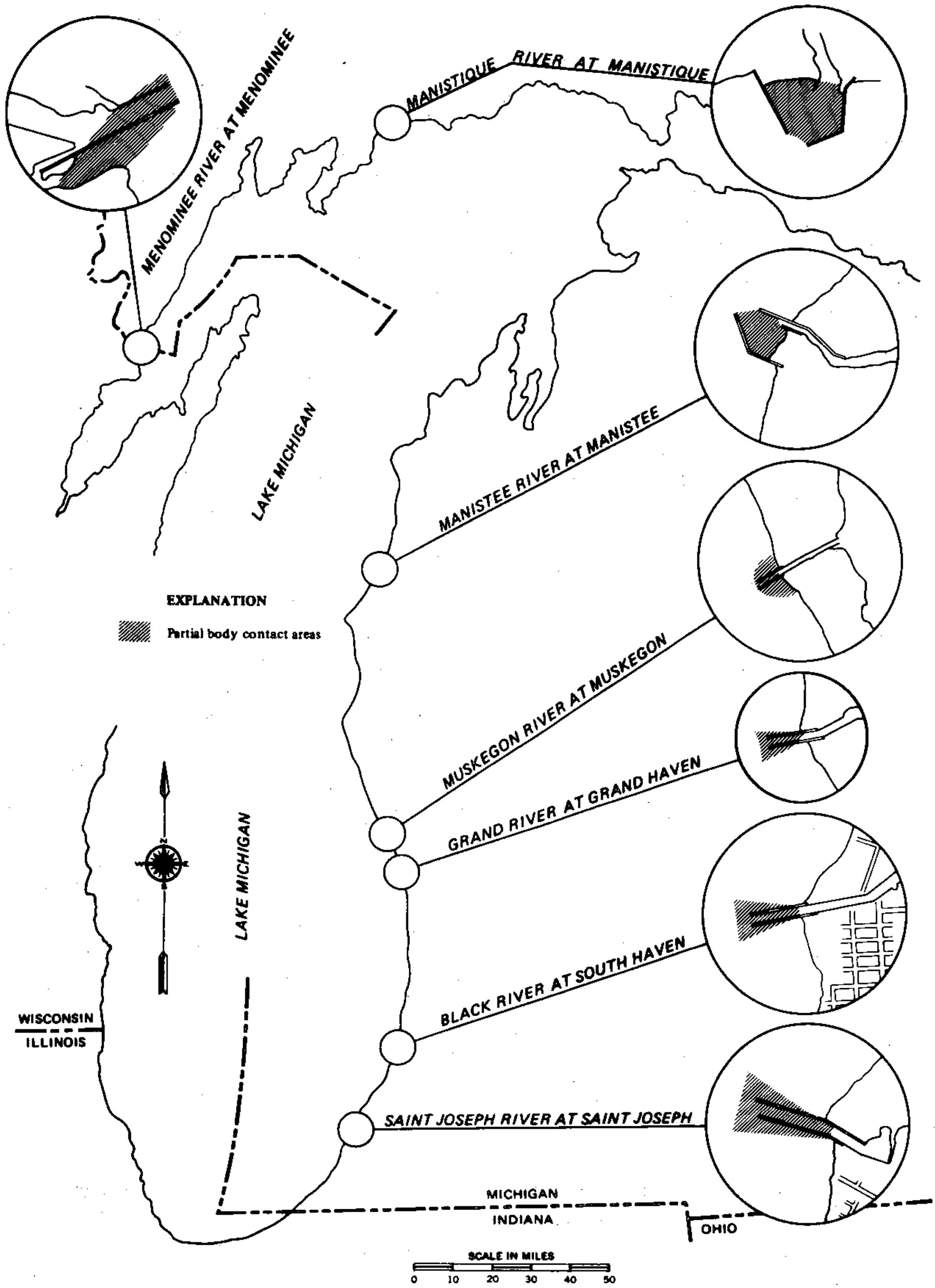


FIGURE 7–1 Lake Michigan Designated Use Areas

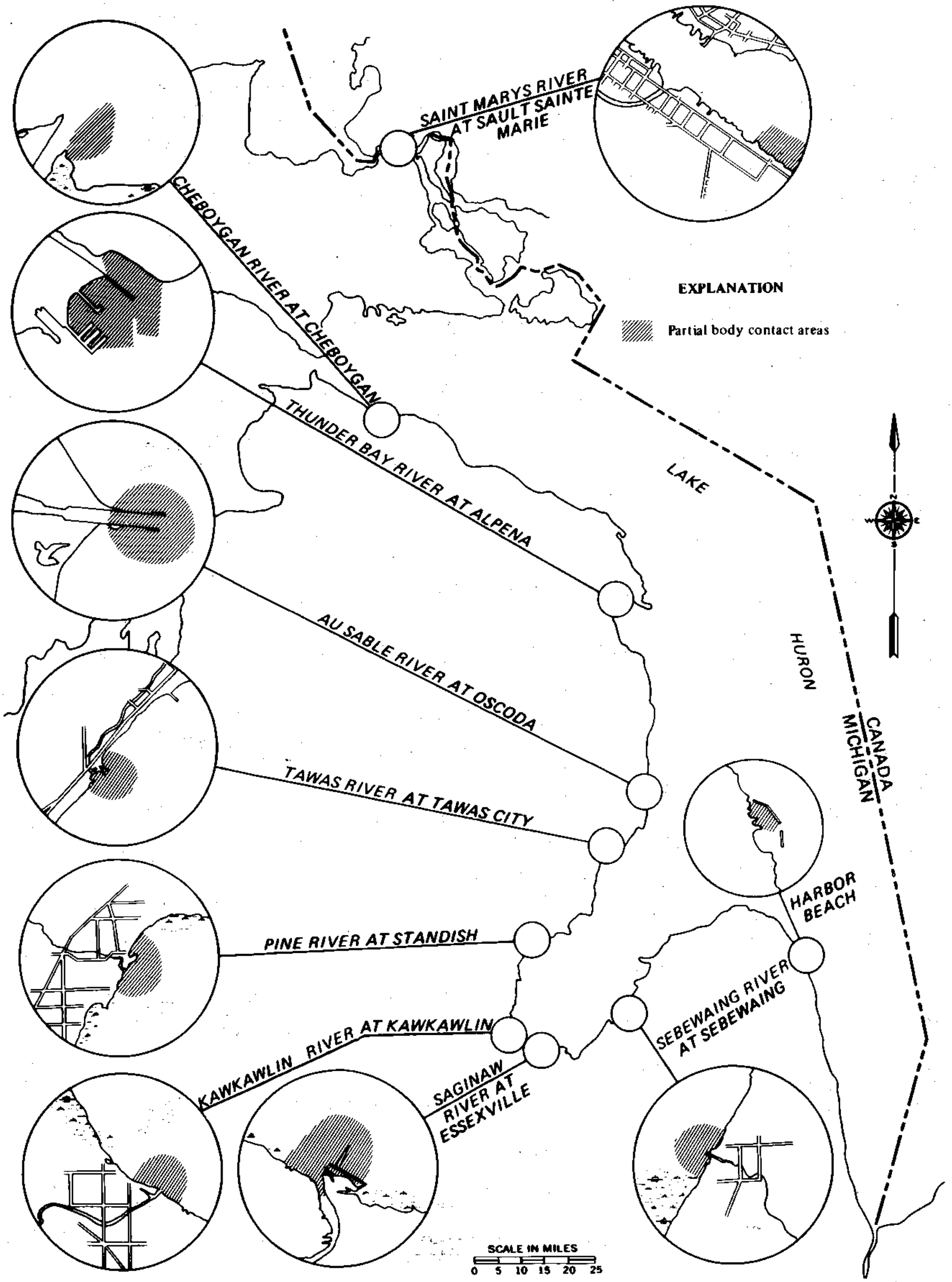


FIGURE 7–2 Lake Huron Designated Use Areas

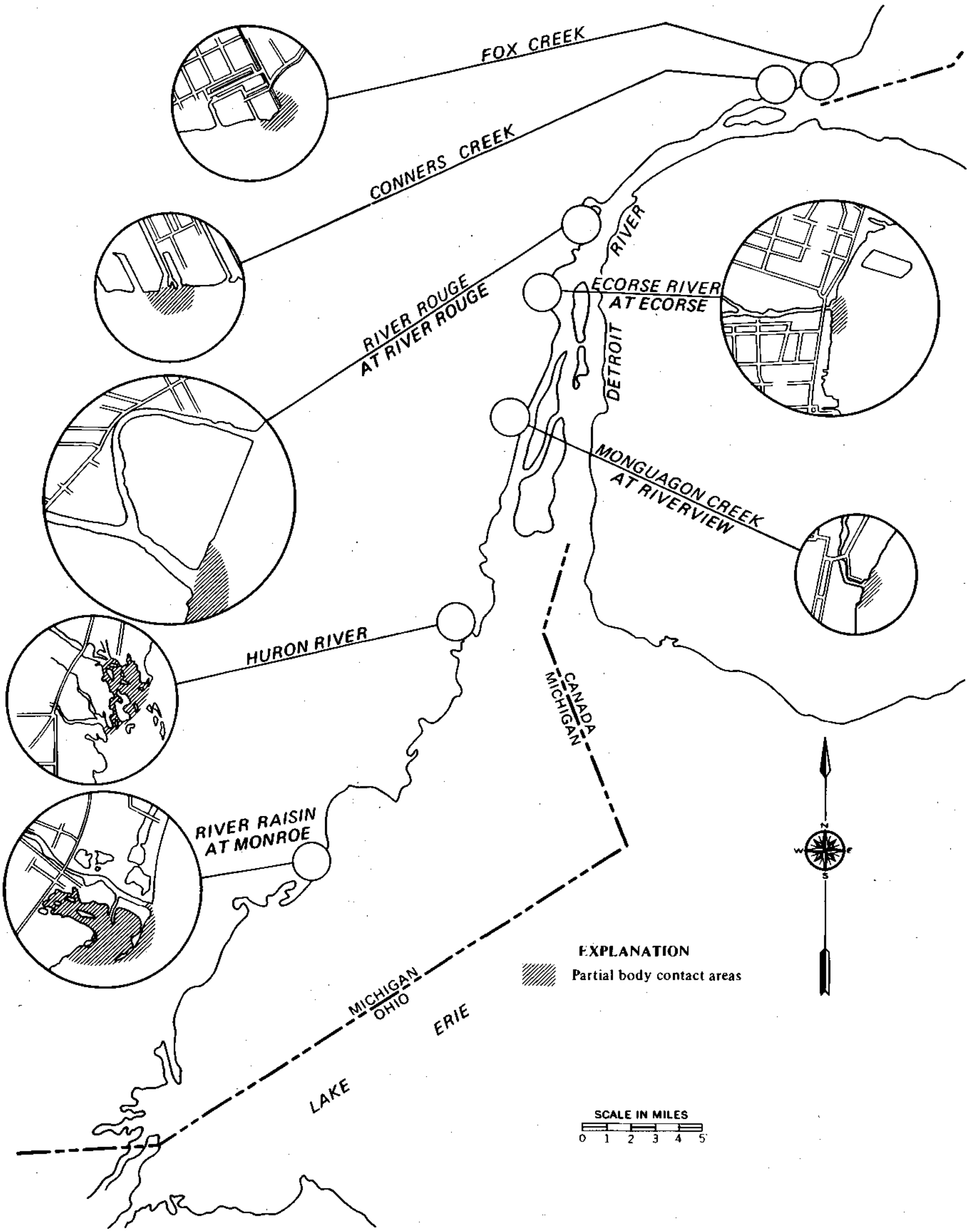


FIGURE 7–3 Detroit River and Lake Erie Designated Use Areas

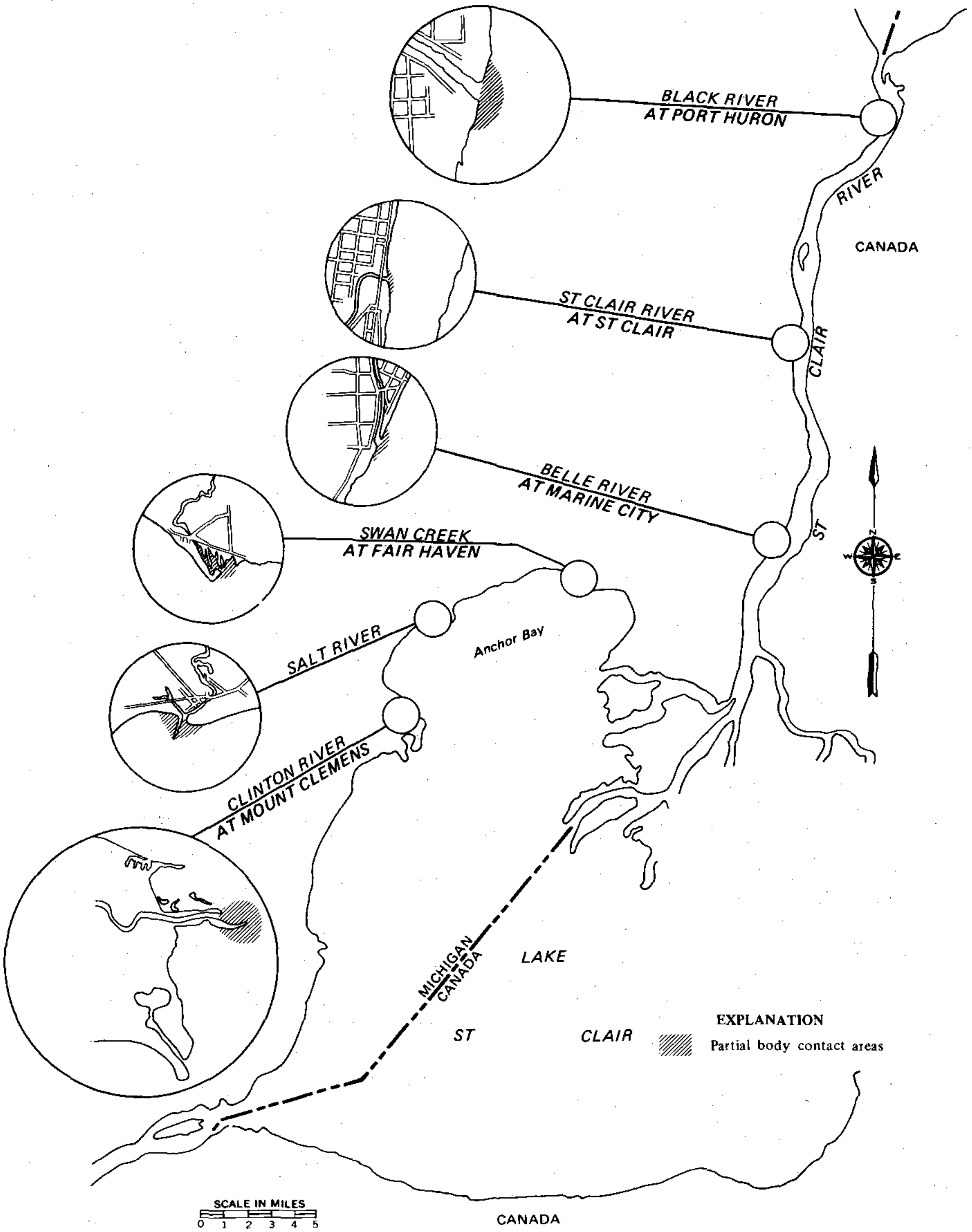


FIGURE 7–4 St. Clair River and Lake St. Clair Designated Use Areas

(1) Water Supply
All existing public water supply intakes in normal daily use are to be protected for domestic water supply. All public waters, with three specified exceptions, are to be protected for industrial water supply.
(2) Recreation
In general, all public waters north of the Saginaw River basin are to be protected for total body contact. All public waters in and south of the Saginaw River basin are to be protected for partial body contact. However, all natural lakes, all artificial lakes on public waters, and specifically designated reservoirs or portions of streams are to be protected for total body contact.
(3) Fish, Wildlife and Other Aquatic Life
In general, most of the waters north of the Saginaw River basin are to be protected for intolerant fish, coldwater species and all streams tributary to the Great Lakes are protected for anadromous fish. In and south of the Saginaw River basin, all waters will be protected for intolerant fish, warmwater species, unless specifically designated for tolerant fish or designated as trout streams (intolerant fish, coldwater species).
(4) Agricultural
All public waters with the exception of two reaches are protected for agricultural use.
(5) Commercial and Other
The reaches not protected for agricultural use are protected for commercial and other uses.

This discussion of designated use areas is intended to provide a broad generalization only. For detailed information on the actual uses designated for specific waters, the following publications of the Michigan Water Resources Commission should be consulted: *Use Designation Areas for Michigan's Intrastate Water Quality Standards,* March 1969, and *Summary of Water Quality Standards for Designated Use Areas in Michigan Interstate Waters*, November 1968.

3.3.3 Standards Implementation

On interstate waters, where noncompliance with the standards exists as the result of a discharge from an existing municipal wastewater treatment plant, treatment facilities adequate for meeting established water quality standards were to be provided no later than June 1, 1972. Secondary treatment is required as a minimum unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with present and future uses. Exception to the requirement for at least secondary treatment must be justified to the satisfaction of the Michigan Water Resources Commission and the Office of Water Programs, U.S. Environmental Protection Agency. Discharges of raw sewage of human origin to public waters were to be corrected by June 1, 1972. Year-round disinfection of all final effluents from municipal sewage treatment plants is required. Industrial waste discharges were to meet the same treatment requirements as municipal waste effluents and industrial waste problems identified in the interstate plan reports must, no later than June 1, 1970, have adequate treatment or control facilities.

3.4 Minnesota

Minnesota has adopted water quality standards for its interstate waters under the provision of the Federal Water Quality Control Act of 1965 (P.L. 89–234). The Interstate Water Quality Standards and Use Classifications were approved by the State of Minnesota in June 1967. These standards, along with the use classifications, were approved by the Secretary of the Interior in November 1969.

The standards contain three major components: a description of water-use classifications, criteria for water quality needed to support the designated uses (Table 7–2), and an implementation plan. Table 7–3 shows the classifications of all the water in the study area.

3.4.1 Criteria and Description of Use

The non-degradation clause contained in WPC–15 is applicable to all waters in the State of Minnesota. It reads as follows:

> Waters which are of quality better than the established standards will be maintained at high quality unless a determination is made by the State that a change is justifiable as a result of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters. Any project or development which would constitute a source of pollution to high quality waters will be required to provide the highest and best practicable treatment to maintain high water quality and keep water pollution at a minimum. In implementing this policy, the Secretary of the Interior will be provided with such information as he requires to discharge his responsibilities under the Federal Water Quality Act, as amended.

In forming the specific standards as they appear in Water Pollution Control Regulations WPC–14, 15, 16, and 17, the following factors were taken into consideration:

(1) size, depth, surface area covered, volume, direction and rate of flow, stream gradient, and temperature of the water

(2) the character of the district bordering the waters and its peculiar suitability for the particular uses, with a view to conserving the value of the district by encouraging the most appropriate use of lands bordering the waters, for residential, agricultural, industrial, or recreational purposes

(3) use the waters for transportation, domestic, and industrial consumption, bathing, fishing and fish culture, fire prevention, the disposal of sewage, industrial wastes, and other wastes, or other uses within this State, and, at the discretion of the agency, any such uses in another State on interstate waters flowing through or originating in this State

(4) the extent of present defilement of fouling of the waters resulting from past discharges

(5) the need for standards for effluent from disposal systems entering waters of the State

(6) other considerations deemed proper by the Agency

Table 7-2 is a summary of values for the parameters used in various classes of interstate waters as they appear in WPC–15, which covers all of the interstate waters in the study area except the Nemadji River basin for which standards are found in WPC–15 and 17.

Standards (criteria) for Minnesota's intrastate waters were approved by the Minnesota Pollution Control Agency in April 1969 (WPC-14) and were established in the same method as the interstate standards.

3.4.2 Designated Uses

Based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, the interstate waters of the State are to be grouped into one or more of the following classes:

(1) domestic consumption (to include all interstate waters that are or may be used as a source of supply for drinking, cooking, food processing, or other domestic purposes, and

TABLE 7–2 Summary of Criteria for Designated Classes of Surface Waters—Minnesota

Water Use Classification	Turbidity Value	Coliform Organisms (MPN/100 ml)	Temp (°F)	Minimum Dissolved Oxygen (mg/l)	Ammonia (mg/l)	Chlorides (mg/l)	Phenol (mg/l)	pH Range	Total Dissolved Solids (mg/l)	Chromium (mg/l)	Copper (mg/l)	Cyanide (mg/l)
1. Domestic Consumption												
A. (Ground Water)	5	1	---	---	---	250	0.001	---	500	0.05	1.0	0.01
B. Surface, High Protection	5	50	---	---	---	250	0.001	---	500	0.05	1.0	0.01
C. Surface, Moderate Protection	25	4000	---	---	---	250	0.001	---	500	0.05	1.0	0.01
D. Surface, Low Protection		4000	---	---	---	250	0.001	---	---	0.05	---	0.2
2. Fisheries & Recreation												
A. Cold Water Fishery and/or Whole Body Contact	10	1000	No incr.	7.0[a] 5.0[b]	Trace	50	Trace	6.5–8.5	---	Trace	Trace	Trace
B. Mixed Fishery and/or Whole Body Contact	25	1000	86[d]	6.0[c] 5.0[b]	1.0		0.01	6.5–9.0	---	1.0	0.2	0.02
C. Resident Fish and/or Partial Body Contact	25	5000	90[d]	5.0[c] 3.0[b]	2.0		---[e]	6.0–9.5	---	1.0	0.2	0.02
3. Industrial Consumption												
A. High Quality, similar to Class 1B	---	5000	75[d]	---	---	50	50	6.5–8.5	---	---	---	---
B. Good Quality, similar to Class 1D	---	5000	86[d]	---	---	100	250 (surface) 350 (ground)	6.0–9.0	---	---	---	---
C. Cooling & Materials Transport	---	5000	90[d]	---	---	250	250	6.0–9.5	---	---	---	---
4. Agriculture & Wildlife												
A. Irrigation	---	5000	---	---	---	---	---	5.0–8.5	700	---	---	---
B. Stock Watering	---	5000	---	---	---	---	---	6.0–9.5	1000	---	---	---
5. Navigation & Waste Disposal	---	5000	---	---	---	---	---	5.5–10.0	---	---	---	---
6. Other uses (provides for conformity with other States and Canada, and applicable Federal requirements. Criteria generally similar to above but may be different if necessary for the stated purpose. For example, some criteria for designated streams may be changed from those given above by the recommendations resulting from the Federal-State enforcement conference of February 28, and March 1 and 20, 1967 on the Mississippi River and Tributaries).												

SOURCE: Abstracted from Criteria for Classification and Establishment of Standards (Regulation WPC-15), not including criteria related only to a single class or use. Shows maximum value or ranges unless otherwise noted. If two or more classes apply, the more stringent value applies.

[a] October through May. [b] Remainder of year. [c] April and May. [d] Summer maximum temperatures. For seasonal ranges, etc., see WPC-15.
[e] None that would impart odor or taste to fish flesh or other fresh water edible products such as clams, crayfish, prawns, etc.

for which quality control is or may be necessary to protect the public health, safety, and welfare)

(2) fisheries and recreation (to include all interstate waters that are or may be used for fishing, fish habitat, bathing, or any other recreational purposes, for which quality control is or may be necessary to protect aquatic or terrestrial life, or the public health, safety, or welfare)

(3) industrial consumption (to include all interstate waters that are or may be used for industrial process or cooling water, or any other industrial or commercial purposes, for which quality control is or may be necessary to protect the public health, safety or welfare)

(4) agriculture and wildlife (to include all interstate waters that are or may be used for any agricultural purposes, including stock watering and irrigation, or by waterfowl or other wildlife, for which quality control is or may be necessary to protect terrestrial life or the public health, safety or welfare)

(5) navigation and waste disposal (to include all interstate waters that are or may be used for any form of water transportation or navigation, disposal of sewage, industrial waste or other waste effluents, or fire prevention, for which quality control is or may be necessary to protect the public health, safety or welfare)

(6) other uses (to include interstate waters that are or may serve the above listed or any other beneficial uses not listed herein, including without limitation such uses in this or any other State, province, or nation which has any interstate waters flowing through or originating in this State, and for which quality control is or may be necessary for the above declared purposes, or to conform with the requirements of the legally constituted State or national agencies having jurisdiction over such interstate waters, or any other considerations the Agency may deem proper)

3.4.3 Implementation

The implementation plans of the State include identification and location of significant sources of waste discharges, waste treatment and control requirements, and a timetable for achieving compliance with the standards. The following is the text of the implementation plan as it was submitted to the Federal Water Pollution Control Administration in June 1967, with revisions made in March 1969 to reflect changes agreed upon in the interim.

TABLE 7–3 Classification of Waters, Planning Subarea 1.1—Minnesota Portion

Waters	Class
RIVERS	
St. Louis River--Seven Beaver Lake outlet to Cloquet	2B, 3B
St. Louis River--Cloquet to Fond du Lac	3B
Red River--source to Wisconsin border	2A, 3B
Little Pokegama River--source to Wisconsin border	2B, 3B
Nemadji River--source to Wisconsin border	See WPC-17
South Fork Nemadji River--source to Wisconsin border	See WPC-17
Clear Creek--source to Wisconsin border	See WPC-17
Mud Creek--source to Wisconsin border	See WPC-17
State Line Creek--source to Wisconsin border	See WPC-16
LAKES	
Pigeon River, Fan Lake, Lily Lake, Moose Lake, North Fowl Lake, South Fowl Lake	1B, 2B, 3A
Watap Lake, Rover Lake, Rose Lake, Rat Lake, South Lake, Mountain Lake, North Lake	1B, 2B
Lake Superior	1B, 2A, 3A
Seven Beaver Lake	2B, 3A
Black Lake	1B, 2B, 3B
St. Louis Bay, Superior Bay	2B, 3B
INTRASTATE WATERS	
All North Shore Streams not included above	See WPC-14

The interstate water quality standards for Minnesota, which include the implementation and enforcement plan, were approved by the Secretary of the Interior on November 26, 1969 (Table 7–3).

MINNESOTA POLLUTION CONTROL AGENCY
Division of Water Quality

Plan for Implementation of Criteria for the Interstate Waters of Minnesota

(1) Conventional sewage or industrial wastes, including but not limited to the attached listing of major sources.

(a) All persons responsible for sources which do not have a valid disposal system operation and/or effluent discharge permit from Agency or do not have an application pending must apply for the same *within one month*.

(b) Persons responsible for any sources of the same must submit to the Agency a report showing the known or estimated quantity and quality of effluents discharged to these waters, together with pertinent operational or other information, unless such a report was filed with the Agency in the preceding month, and in any case not later than July 31, 1967.

(c) All persons operating sewage or waste treatment works, regardless of whether such works are adequate or inadequate, must submit *regular monthly reports* on the operation and the characteristics of the effluents. The measurements, observations, sampling, and analyses done must be sufficient to adequately reflect the condition of the treatment works, the effluent, and the receiving waters.

(d) Where there is compliance at present it shall be maintained and where compliance can be achieved by relatively minor construction or operational improvements, such as chlorination and/or coliform reduction, the improvements, including reporting, shall be made without delay and in any case not later than July 31, 1967.

(e) Where construction or new treatment works or extensive modifications of existing works or costly internal controls may be necessary to achieve compliance it shall be so indicated in the report to be submitted under item (b) above, together with an estimate as to the nature and extent of the needed improvements. The highest practicable degree of treatment will be required, consistent with the nature and the uses of the waters and intent of the applicable statutes. Depending upon the magnitude of the project he may be granted additional time to prepare a Waste Improvement Proposal as outlined in Section 1 of the Enforcement Plan. In any case where voluntary action including adequate reporting for permit purposes, or a satisfactory Waste Improvement Proposal and acceptance of a stipulation incorporating schedules, has not been completed well before the *date of the applicable enforcement hearing* (to be held as shown in the attached Priority Listing of Interstate Water Classification Projects), compulsory action will be taken instead as indicated in steps 4 through 15 of the Enforcement Plan.

(f) Construction of necessary treatment works or modifications thereof ordinarily must be completed and the works in operation before June 30, 1972. [This date may be extended.] This is to be considered a *maximum* time allowance, and extensions will not be granted except for unusually complex projects.

The following periods will usually be considered ample for completion of the indicated project phases (including review and approval of the report, plan and program by the Commission):

Engineering reports	6 months
Construction plans	6 months
Financing program	3 months
Contract bids and awards	3 months
Work construction	2 years

Applications for Federal grants, where eligible, should be made at the earliest possible date. Failure to receive a grant offer will *not* be considered valid reason for delaying a project.

(2) Sewage from storm or combined sewer outlets and/or bypassing of sewage treatment works.

(a) Municipalities with combined sanitary and storm sewer systems, excessive groundwater infiltration or entrance of major amounts of roof or basement drainage, snow melt, storm water or other relatively clean waters into the sanitary sewer system, or other disposal system or maintenance needs such as to cause periodic substantial overflows of untreated or inadequately treated sewage from any part of the system, will be required to report thereon as indicated in Section 1b and may be required to make engineering studies on the problem and submit an improvement proposal for corrective action within not more than two years and in any case *not later than June 30, 1969*. [This date may be extended.]

(b) Following evaluation of the engineering report and improvement proposal, the municipality will be given a variance for a minimum period of time sufficient for construction of separate sewers or other remedial action to prevent pollution from this source. A total of not more than five to ten years, including engineering studies, etc., can be scheduled for this purpose so that the abatement measures *will be* completed by June 30, 1977. [This date may be extended.]

(3) Other wastes including but not limited to the usual dumps, refuse deposits, industrial materials, stock piles, stock feed lots and liquid storage sites of all kinds which are confined to or originate from relatively small areas or point sources and have significant short term pollutional potential.

(a) The permit and reporting requirements of Sections 1a and b apply to all such sources which are located adjacent to or may affect interstate waters.

(b) Waste disposal improvements or safeguards against pollution must be provided in conformance with the schedules outlined in Sections 1d, e and f and in compliance with Regulation WPC–4 and pertinent official recommendations of such matters.

(4) (a) Wherever such areas or sources of substantial magnitude are essentially under the ownership or control of one person or organization (i.e., a legal entity as defined in M.S. Chapter 115) the responsible person must conform with the reporting requirements given in Section 1b, by not later than October 1, 1967.

(b) Following evaluation of the preliminary report a more detailed report on the problem and improvement proposal, together with a subsequent remedial program, may be required based on the schedules given in Sections 2a and b.

(c) Particular attention will be given to known problem areas such as control of siltation from mine spoil banks, accelerated eutrophication of lakes by farm land run-off and detrimental effects on aquatic and other biota by chemical residues. It is recognized that many of the traditional methods of control other than education and publicity are likely to be impractical or unproductive in these fields and considerable modification of the usual approach may be necessary. It is anticipated that the role of the Agency will be largely one of sponsoring research and stimulating action by others, since the main attack on these problems will very likely have to be directed by and through other State, local, or Federal agencies which have more direct jurisdiction as well as proven competence and experience in these fields.

(5) Transient discharges of sewage or episodic losses of pollutional materials from watercraft or other forms of transportation.

(a) Sewage discharges originating on watercraft must be controlled in conformance with water use classification 2A (or 2B) for whole body contact for all Minnesota waters where such discharges are not otherwise prohibited. The discharge of other wastes, as well as sewage effluents, must also be in conformance with the requirements of the agency with which the craft is licensed or registered, or other agency having jurisdiction over such matters (the U.S. Coast Guard, U.S. Corps of Engineers, U.S. Public Health Service, Department of Agriculture, Department of Conservation, Port Authorities, County Sheriffs, etc.).

3.5 New York

A Statewide system of stream classifications to be applied to all waters of the State in conformance with the requirements of the

Water Pollution Control Act was adopted by the former New York State Water Pollution Control Board in 1950 after duly constituted public hearings of the legislative type in seven locations throughout the State. This system established the classification defined in terms of a combination of recognized water usages and also assigns quality standards and criteria specifications consistent with these usages.

Once the classification system was established, all surface waters within New York State boundaries were classified following the recommendations contained in a pre-classification survey report, which was based on evaluation of the physical and hydrologic characteristic of the watershed under consideration, the past, present, and future uses of these waters, and the extent of present defilement resulting from past waste discharges.

After public hearings, these classifications and standards were assigned by the Water Resources Commission, fulfilling the purposes of the Public Health Law in preventing any new pollution and abating the existing pollution. All waters within New York State have been officially classified and assigned quality standards. This establishes the legal baseline for water quality management in New York State.

A minimum of secondary treatment, or its equivalent, is required for waste discharges. The design flow is generally the 7-day 10-year flow with a 30 percent reserve of assimilative capacity being held where the flow available in the stream makes this reasonable. For design purposes, nitrogenous oxygen demand is taken into account in addition to the conventional BOD.

State criteria governing thermal discharges (heated liquids) have also been established. No discharges "alone or in combination with other substances of wastes in sufficient amounts or at temperatures as to be injurious to fish life . . . or impair the waters for any other best usage" are allowed (6 NYCRR 701.3 et seq; details are included in this referenced source).

3.5.1 Water Quality Standards Implementation and Enforcement

Prior to the adoption of the Pure Waters Program, the basic means of abating pollution was through the formal "Comprehensive Plan for the Prevention and Abatement of Pollution," developed on a drainage basin basis following the adoption of stream classifications and standards, and the approval of the abatement plan by the Water Resources Commission as required under the Public Health Law. Such a plan for the Lake Erie drainage basin was developed in 1955. The document outlined the basic steps of enforcing pollution abatement through an initial cooperative phase followed by the enforcement phase. It also included a listing of "polluters" with significant facts concerning pollution.

Since the Pure Waters Program became operative, significant changes in policy have enabled vigorous enforcement of the plan. Hearings in accordance with the prescribed rules and regulations have been held, resulting in issuance of commissioners' orders against all significant polluters. Automatic data processing allowed up-to-date records of polluter status according to schedules set forth in commissioners' orders. The legal and engineering staff have been augmented to carry out the intensified program. The responsibility for evaluating pollution situations and feeding information, such as case reports and lapse of schedules, to the central system was given to the regional offices in cooperation with their jurisdictional local health units.

To date only a small number of hearings have been contested. Timetables for pollution abatement required by the orders range in length from three months for simple problems to five years for the more complex pollutional situations such as those encountered in New York City. Schedules of three to four years for final construction and operation of abatement facilities are the rule, except for extraordinary reasons where the schedules may be extended beyond the four-year period. The typical timetable allows for six months for preliminary plans and report, one year for the submission of final plans, and one to two years for the construction of facilities and completion of all works on or before 1971.

Cases of default or violation of a commissioner's order are referred to the Attorney General, Bureau of Water and Air Resources.

3.5.2 Extent of Interstate Waters

New York State has submitted and received approval for the classifications and water quality standards developed as part of its program. Enforcement and implementation are identical for intra- and interstate waters. Table 7-4 summarizes the New York stream classification system.

TABLE 7-4 Stream Classification of Interstate Waters—New York

Class	Type	pH Range	Minimum Dissolved Oxygen (mg/l) Non-Trout	Trout
AA	Municipal Water Supply (after disinfection)	6.5-8.5	4.0	5.0
AA	Municipal Water Supply (after treatment and disinfection)	6.5-8.5	4.0	5.0
B	Bathing	6.5-8.5	4.0	5.0
C	Fishing	6.5-8.5	4.0	5.0
D	Agricultural, Industrial Water Supply	6.0-9.5	3.0	---

NOTE: Heated liquids, toxic wastes, and other deleterious substances alone or in combination with other substances, or in such amounts or at temperatures to be injurious to fish life or to impair the class are prohibited.

3.6 Ohio

Ohio's interstate waters consist of Lake Erie; tributaries and the main stem of the Maumee River, which flow between Michigan and Ohio as well as Indiana and Ohio; and Turkey Foot Creek, Conneaut Creek, and the Ashtabula River, which flow from Pennsylvania into Ohio. Water quality standards for these waters were adopted after public hearings in accordance with the 1965 Federal Water Quality Act on the following dates: April 11, 1967; January 10, 1967; and June 13, 1967.

On November 14, 1967, standards were adopted for the Lake's north central Ohio tributaries, which include the Portage, Sandusky, Huron, Vermilion, and Black Rivers. Standards for the remaining Ohio tributaries of the Lake, namely, Rocky, Cuyahoga, Chagrin, and Grand Rivers, were adopted April 8, 1969. The procedures and criteria for adopting water quality standards for these intrastate streams were identical to those used for the interstate streams.

With only a few exceptions, the adopted water quality standards call for suitable quality in all waters for the following four basic uses:

(1) full body-contact recreation
(2) the maintenance of well-balanced, warmwater fish population
(3) public water supply
(4) industrial water supply

In addition to the above, standards for a coldwater fishery were adopted for Green Creek and Cold Creek, which are north central Ohio tributaries; Conneaut Creek, Turkey Foot Creek, and the upstream section of the Ashtabula River; and the upstream sections of the Chagrin River. The standards for this use, which are modifications of the aquatic life criteria, calls for a minimum dissolved oxygen value of 6.0 mg/l at anytime and a maximum water temperature of 70°F at any time.

For Lake Erie the existing water quality was adopted as the standard for places where existing quality is considerably better than the criteria for various uses adopted by the Ohio Water Pollution Control Board.

Standards of lesser quality for aquatic life were established for a portion of the navigation channel of the Maumee River, the entire length of the navigation channel of the Cuyahoga River, and several small tributaries of the Cuyahoga River. These channels are large bodies of stagnant water which, even under natural conditions, would not meet the dissolved oxygen requirements for the maintenance of a well-balanced fish population. Since both channel waters receive the treated effluents from major population centers, as well as considerable amounts of heated water, the attainability of dissolved oxygen levels greater than 2.0 mg/l at all times is remote.

A resolution establishing stream water quality criteria for various uses was adopted by the Ohio Water Pollution Control Board on April 14, 1970. These criteria are outlined in the following subsections.

3.6.1 Minimum Conditions

The resolution establishes minimum conditions applicable to all waters at all places at all times. It regulates the substances in State waters that are attributable to municipal, industrial, and other discharges, and agricultural practices. These regulations are outlined below:

(1) Waters should be free from substances that will settle to form putrescent or otherwise objectionable sludge deposits.

(2) Waters should be free from floating debris, oil, scum, and other floating materials in amounts that are unsightly or deleterious.

(3) Waters should be free from materials that produce color, odor, or other conditions in such degree as to create a nuisance.

(4) Waters should be free from substances

in concentrations or combinations that are toxic or harmful to human, animal, plant, and aquatic life.

3.6.2 Protection of High Quality Waters

Waters with existing quality better than the established standards should be maintained at their present high quality. Any industrial, public, or private project or development that would constitute a new source of pollution or an increased source of pollution to these waters is required, as part of the initial project design, to provide for the most effective waste treatment available under existing technology. The Ohio Water Pollution Control Board cooperates with other governmental agencies to enforce this policy.

3.6.3 Water Quality Design Flow

Where applicable for the determination of treatment requirements, the water quality design flow is considered to be the minimum seven consecutive day average that is exceeded in 90 percent of the years.

3.6.4 Stream Quality Criteria

Stream quality criteria were established for public water supply use, industrial water supply use, aquatic life, recreation, and agricultural use and stock watering.

3.6.4.1 Public Water Supply

The following criteria are for evaluation of stream quality at the point at which water is withdrawn for treatment and distribution as a potable supply.

(1) The bacterial criteria require that the coliform group not exceed 5,000 per 100 ml as a monthly average value (either MPN or MF count). The coliform group should not exceed this number in more than 20 percent of the samples examined during any month, nor should it exceed 20,000 per 100 ml in more than five percent of such samples.

(2) The threshold-odor number should not exceed 24 (at 60 degrees C) as a daily average.

(3) Dissolved solids should not exceed 500 mg/l as a monthly average value, and 750 mg/l at any time.

(4) Radioactivity criteria require that the gross beta activity should not exceed 1,000 picocuries per liter (pCi/l). Activity from dissolved strontium-90 should not exceed 10 pCi/l, and activity from dissolved alpha emitters should not exceed 3 pCi/l.

(5) Chemical constituents should not exceed the following concentrations at any time:

Constituent	Concentration (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead	0.05
Selenium	0.01
Silver	0.05

3.6.4.2 Industrial Water Supply

The following criteria are applicable to stream water at the point at which water is withdrawn for use (either with or without treatment) for industrial cooling and processing.

(1) Dissolved oxygen should not be less than 2.0 mg/l as a daily average value, nor less than 1.0 mg/l at any time.

(2) Values for pH should be between 5.0 and 9.0 at all times.

(3) Temperature should not exceed 95° F at any time.

(4) Dissolved solids should not exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time.

3.6.4.3 Aquatic Life

The following criteria are for evaluation of conditions for the maintenance of a well-balanced warmwater fish population. They apply throughout the stream except where waste effluents mix with stream water.

(1) Dissolved oxygen should not be less than an average of 5.0 mg/l per calendar day nor less than 4.0 mg/l at any time.

(2) Values for pH should be between 6.0 and 8.5. Daily fluctuations that exceed the range of pH 6.0 to pH 8.5 and are correlated with photosynthetic activity may be tolerated.

(3) Temperature criteria state that there should be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions. Normal daily and seasonal

temperature fluctuations that existed before the addition of heat due to unnatural causes should be maintained. The maximum temperature rise above natural temperatures should not exceed 5° F at any time or place. In addition, the water temperature should not exceed the maximum limits indicated in degrees Farenheit in the following tabular material.

Month	All Waters Except Ohio River	Ohio River
Jan.	50	50
Feb.	50	50
March	60	60
April	70	70
May	80	80
June	90	87
July	90	89
Aug.	90	89
Sept.	90	87
Oct.	78	78
Nov.	70	70
Dec.	57	57

(4) Toxic substances should not exceed one-tenth of the 48-hour median tolerance limit. When approved by the appropriate regulatory agency, other limiting concentrations may be used in specific cases when justified on the basis of available evidence.

The following criteria are for evaluation of conditions for the maintenance of desirable biological growths and, in limited stretches of a stream, for permitting the passage of fish through the water. They do not apply to areas where effluents mix with stream water.

(1) Dissolved oxygen should not be less than 3.0 mg/l as a daily average value, nor less than 2.0 mg/l at any time.

(2) Values for pH should be between 6.0 and 8.5 at all times.

(3) Temperature should not exceed 95° F at any time.

(4) Toxic substances should not exceed one-tenth of the 48-hour median tolerance limit. When approved by the appropriate regulatory agency, other limiting concentrations may be used in specific cases when justified on the basis of available evidence.

3.6.4.4 Recreation

The following bacterial criterion is for evaluation of conditions in waters designated for recreational use, including total body-contact activities such as swimming and water skiing. The fecal coliform content (either MPN or MF count) should not exceed 200 per 100 ml as a monthly geometric mean based on not less than five samples per month, nor exceed 400 per 100 ml in more than 10 percent of all samples taken during a month.

3.6.4.5 Agricultural Use and Stock Watering

The minimum conditions applicable to all waters, described in Subsection 3.6.1, are also applicable for the evaluation of stream quality at places where water is withdrawn for agricultural use and stock watering.

3.6.5 Implementation and Enforcement Plan

The Ohio Water Pollution Control Board has authority to control, prevent, and abate pollution in the waters of the State. In accordance with this authority the Board adopted the following program and requirements for controlling pollution.

(1) The design flow or critical stream flow should be used in applying stream water quality criteria. For free flowing streams unaffected by significant diversions or regulations, this flow is the annual minimum seven consecutive day warm weather flow that is exceeded in 90 percent of the years. Where low stream flows are affected by regulations or diversion, adjustments to the historical records should be made for these effects.

(2) All plans and proposals for abatement or correction of pollution will be approved by the Ohio Department of Health as required by law. This will constitute approval by the Board.

(3) All sewage and organic industrial wastes should receive not less than secondary treatment (biochemical oxidation), and the facilities to provide this treatment should be constructed and placed in operation without delay.

(4) All effluents should be continuously disinfected, prior to discharge, to meet the criteria for downstream water uses. Facilities to provide this treatment should be constructed and placed in operation without delay.

(5) All inorganic industrial wastes and other pollution constituents should be adequately treated and/or controlled to meet the water quality conditions and criteria. Facilities to provide this treatment should be

constructed and placed in operation without delay.

(6) Local programs should be initiated to control and reduce pollution resulting from bypassing, spillages, and discharges resulting from construction or breakdown.

(7) Necessary studies should be made and, where feasible, plans and construction programs should be developed as rapidly as possible to reduce pollution from existing combined sewer overflows and inadequate sewage collection systems.

(8) Where necessary, supplementary treatment of wastewaters to improve water quality and reduce algal growths should be provided and should be consistent with current research and technological advances.

(9) A comprehensive program for further improvement of the water quality of the Cuyahoga River downstream from Akron by such means and low-flow augmentation with at least 100 cfs, by in-stream aerations, particularly in the navigation channel, or a combination of these or other appropriate means, is part of this plan.

(10) A comprehensive plan is urgently needed for sewerage and sewage treatment for the rapidly growing areas of Cuyahoga and Summit Counties. The plan should provide for the elimination of discharges to the smaller tributary streams.

(11) The portion of the master plan for sewerage in Cleveland calling for the interception of certain urban and industrial drainage streams for treatment is a part of the State plan.

(12) The stream water quality monitoring program should be expanded to assure compliance with these standards.

The Ohio Water Pollution Control Board and the Ohio Department of Health assist other governmental agencies in the implementation of effective soil erosion control programs and programs for the reduction of the runoff of phosphorous, nitrogen compounds, and pesticides.

Enforcement of these requirements should be carried out by means of permits issued to municipalities, counties, industries, and other entities discharging into State waters. Failure to comply with the permit conditions will result in legal action in accordance with the provisions of the law.

3.7 Pennsylvania

Water quality standards were adopted for the interstate waters of Lake Erie and its interstate tributaries by the Sanitary Water Board on June 28, 1967. These standards were adopted after public hearing in accordance with the 1965 Federal Water Quality Act. For the waters affected, the water quality standards replaced the 1944 Stream Classification of the Sanitary Water Board.

The standards were adopted in the following manner:

(1) Water uses that are to be protected were determined at a public hearing. The uses to be protected include all existing uses plus probable uses that could be made of the water. The list of uses to be protected relate only to water quality needs.

(2) Criteria for pertinent water quality indicators were selected to protect the designated uses. Criteria for nutrients were not adopted at that time pending the findings of the Lake Erie Enforcement Conference.

(3) The minimum treatment requirements established for these waters in 1944 by the Sanitary Water Board (Secondary Treatment) was retained in the implementation plan, but each discharge is evaluated on its own to determine if the level of treatment is adequate to achieve the water quality criteria in the receiving waters. Where minimum treatment requirements are inadequate to achieve the criteria, the Sanitary Water Board issues orders that specify the limits on the amount of materials that may be discharged to the receiving waters.

(4) After orders are issued, a schedule of steps to achieve compliance is submitted by the discharger and approved or rejected by the Sanitary Water Board. Compliance is required within as short a time as is technically possible.

Water quality standards have been adopted for only the interstate waters of Pennsylvania's portion of the basin. Plans are being made to adopt water quality standards, using the same procedure, for all waters in the Lake Erie basin.

3.8 Wisconsin

3.8.1 Legislative Directives

In 1965 Federal legislation authorized and required the establishment of interstate water quality standards and State legislation authorized and required intrastate standards. The Federal Water Pollution Control Act

(Public Law 660), as amended by the Water Quality Act of 1965, required that each State file a letter of intent and, after hearings and before June 30, 1967, adopt water quality criteria for interstate waters and a plan for their implementation. These criteria and the plan, if accepted by the U.S. Department of the Interior, would thereafter be the applicable interstate water quality standards.

The Federal act stipulated that the standards of quality "shall be such as to protect the public health or welfare, enhance the quality of water and serve the purposes of this Act. In establishing such standards the Secretary (of the Interior), the Hearing Board, or the appropriate State Authority shall take into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses."

Chapter 614, Wisconsin Laws of 1965, became effective on August 1, 1966, and authorized and directed adoption of rules setting standards of water quality. It recognized that different standards may be required for different waters. The intent is set forth: "standards of quality shall be such as to protect the public interest, which includes the protection of the public health and welfare and the present and prospective future use of such waters for public and private water supplies, propagation of fish and aquatic life and wildlife, domestic and recreational purposes, and agricultural, commercial, indistrial and other legitimate uses. In all cases where the potential uses of water are in conflict, water quality standards shall be interpreted to protect the general public interest."

3.8.2 Official Adoption of Standards

Interstate and intrastate standards were developed separately. Standards were adopted by the Resource Development Board on April 26, 1967, published in the May Register, and became effective on June 1, 1967. These standards and a plan for their implementation were submitted to the Secretary of the Interior and were accepted as Federal interstate standards on January 24, 1968. They were the 14th set accepted by the Federal agency and no changes were required.

Hearings on proposed intrastate water quality standards were held regionally in November 1967. Following review, they were adopted at the final meeting of the Resource Development Board in June 1968, and shortly thereafter by the Natural Resources Board. They became effective on September 1, 1968.

3.8.3 Principles and Guidelines

3.8.3.1 Measurable Characteristics

Water quality standards specify what characteristics must be maintained in a given body of water. They must be based on measurable or observable parameters. The characteristics used in setting Wisconsin water quality standards are: bacterial concentrations, pH, dissolved solids, dissolved oxygen, temperature, and presence of materials that may be unsightly, toxic, harmful to health, or create a nuisance. The U.S. Public Health Service's Drinking Water Standards and the Atomic Energy Commission's limits on the disposal and permissible concentration of radioactive materials were incorporated into the State's water quality criteria.

Standards that must be maintained for a given body of water depend mainly on the designated use of the water. Wisconsin has developed water quality standards for four general types of uses: public water supply, fish and aquatic life, recreation, and industrial and cooling. Those standards for fish and aquatic life are further divided into three categories: trout waters, water where fish reproduction is of primary importance, and waters where fishing is desirable in conjunction with other uses. In addition minimum standards apply to all surface waters of the State establishing a base below which water quality may not be degraded and insuring that present water qualities will not be decreased.

3.8.3.2 Interstate and Intrastate Standards

Wisconsin's water quality standards apply to both interstate and intrastate waters. Water management decisions are now guided by the following standards:

(1) Regardless of the water quality standards and water uses, untreated or inadequately treated wastes may not impair a designated use nor may standards be interpreted to permit a lower quality within a water sector than that now existing or required by outstanding orders. As a result of municipal, industrial, commercial, domestic, agricultural, land development, or other activities, conditions may arise that will be con-

trolled by the following standards:

(a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to create a nuisance.

(b) Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to create a nuisance.

(c) Materials producing color, odor, taste or unsightliness shall not be present in such amouts as to create a nuisance.

(d) Substances in concentrations or combinations toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts that, by bioassay and other appropriate tests, indicate acute or chronic levels harmful to animal, plant, or aquatic life.

(2) The following standards are applicable where surface water is classified for public water supply:

(a) bacteria: coliform number not to exceed 5,000 per 100 ml as a monthly arithmetic average value; nor exceed this value in more than 20 percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than 5 percent of the samples. Counts are expressed as Most Probable Number (MPN) or Membrane Filter Coliform Counts (MFCC).

(b) dissolved solids: not to exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time

(c) pH: a range from 6.0 to 9.0, except in waters naturally having a pH of less than 6.5 or higher than 8.5 where effluent discharges may not reduce the low value or increase the high value of the surface water's pH by more than 0.5 standard units

(d) the intake water supply, by appropriate treatment and adequate safeguards, will meet the Public Health Service Drinking Water Standards, 1962

(e) other: concentrations of other constituents must not be hazardous to health

(3) The following standards are applicable to surface waters where maintenance of fish reproduction is of primary importance to the public interest and natural conditions permit:

(a) dissolved oxygen: not to be lowered to less than 80 percent of saturation or to less than 5 mg/l at any time. There shall be no abrupt change from natural unpolluted background by more than 1 mg/l at any time.

(b) temperature: not to exceed 84°F. No change from natural unpolluted background by more than 5°F at any time nor at a rate in excess of 2°F per hour.

(4) The following standards are applicable to surface waters where fishing is desirable in conjunction with other uses and natural conditions permit:

(a) dissolved oxygen: for a balanced warmwater fishery it should not be less than 5.0 mg/l during 16 hours of any 24-hour period, nor less than 4.0 mg/l at any time

(b) temperature: not to exceed 89° F for warmwater fish. No abrupt change from background by more than 5° F at any time. In addition authorization must be obtained for proposed installations where the discharge of a thermal pollutant may increase the natural maximum temperature of a stream by more than 3° F.

(c) prohibition of unauthorized concentrations of substances that alone or in combination with other materials present are toxic to fish or other aquatic life

(d) prohibition of alteration of streams classified by law as trout waters by effluents that affect the stream environment to such an extent that trout populations are adversely affected in any manner

(5) A sanitary survey and/or evaluation to assure protection from fecal contamination is the chief criterion in determining the suitability of a surface water for recreational use. In addition, the following bacteriological guidelines are set forth:

(a) Water is acceptable for whole body contact if it has an arithmetic average coliform count of 1,000 per 100 ml or less and a maximum not exceeding 2,500 per 100 ml during the recreation season.

(b) Water is acceptable for partial body contact if it has an arithmetic average coliform count of 5,000 per 100 ml or less and with no more than one of the last five samples exceeding 20,000 per 100 ml during the recreation season.

(c) The Membrane Filter Coliform Count (MFCC) is the preferred method for determining coliform density, but the Most Probable Number (MPN) is to be used where turbidity due to algae or other material hinders testing of a sample volume sufficient to produce significant results, or where low coliform estimates may be caused by high number of noncoliforms or the presence of substances toxic to the procedure. The average is based on the last five test results. A more definitive test for fecal pollution is the Membrane Filter Fecal Coliform Count (MFFCC). Tests by this method are acceptable where correlation relating the count to sanitary hazards has been demonstrated. Acceptable values based on MFFCC are not shown, but may be adopted in future revisions.

(5) The following standards are applicable to surface waters designated for industrial processes and cooling purposes:

(a) dissolved oxygen: not less than 2.0 mg/l as a daily average value nor less than 1.0 at any time

(b) dissolved solids: not to exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time

(c) pH: a range from 6.0 to 9.0 except in waters naturally having a pH of less than 6.5 or higher than 8.5 where effluent discharges may not reduce the low value or increase the high value of the surface water's pH by more than 0.5 standards units

(d) temperature: not to exceed 89° F

3.8.3.3 Use Classification

All Wisconsin surface waters have been classified according to these designated uses. Minimum standards apply to all surface waters. Predominant uses of the thousands of lakes and streams are for fish, aquatic life, and recreation. Simplification in establishing intrastate standards was achieved by applying these predominant uses to all waters except those classified for other uses.

The adopted standards do not "lock in" a pollution situation. Rather the goal is to make waters suitable for as many uses as possible. This will be achieved by periodically reviewing all situations that impair quality and by upgrading them as technology permits. Designations for specific waters will be realigned as new information indicates modifications are in the public interest.

3.9 Comparison of State Water Quality Standards

In general, the quality criteria of the States within the Lake Erie drainage basin for various water uses are similar. Some differences occur in the assignment of certain parameters to a particular use, but in most instances this is taken care of in some of the States, by the designation of two or more water uses to a particular body of water.

The following is a brief summary of the criteria for specified uses:

(1) Recreation

Generally the States have comparable standards with respect to control of substances that affect the aesthetic quality of recreational water. These refer to substances that float, settle, or are suspended in water as well as those that impart color or are toxic.

With regard to bacterial levels, four States have adopted a maximum monthly average of 1,000 counts per 100 ml of the coliform group. New York has set no numerical values but does require adequate disinfection of all sewage effluent.

Michigan, Pennsylvania, and New York have also included standards for pH, dissolved oxygen, dissolved solids, temperature, and certain metals. In Ohio and Indiana some of these items are covered by the assignment of the aquatic life use to the same body of water.

(2) Public Water Supply

Generally the States have similar standards with respect to the aesthetic quality of waters used for public water supply. The bacterial standards for inland waters of Michigan, Indiana, Ohio and Pennsylvania all call for a monthly average of 5,000 counts per 100 ml. New York has set no numerical value but instead has called for adequate disinfection of all sewage effluents. For Lake Erie proper, Michigan has established a maximum monthly average of 2,000 counts per 100 ml with no more than 20 percent of the samples exceeding this value. Ohio's standards call for the maintenance of existing quality where it is better than the standard of a monthly average of 5,000 counts per 100 ml. In a number of instances the existing water quality would meet the standards of Michigan. There are, however, areas that are significantly influenced at times by tributary discharges where much higher counts can be expected. Pennsylvania's standards are the same as those it established for recreational uses.

For inland streams the dissolved solids criteria of all States is a monthly average of 500 mg/l with a maximum daily value of 750 mg/l. Ohio has exempted streams in northwestern Ohio that flow through a predominantly limestone area from compliance with this standard. For streams in these areas a monthly average of 750 mg/l with a daily maximum of 1,000 mg/l was established.

Standards for toxic chemical constituents in all the States generally conform to the U.S. Public Health Service's standards for drinking water.

(3) Aquatic Life

For the maintenance of a well-balanced, warmwater fish population in the tributaries, five States have set standards calling for an average dissolved oxygen concentration of 5.0 mg/l and a minimum value of 4.0 mg/l. The minimum value for coldwater fishery is 6.0 mg/l.

For the passage of fish, Ohio has established an average dissolved oxygen level of 3.0 mg/l with a minimum of 2.0 mg/l. This standard is only applied in waters that are essentially stagnant or have other unusual characteristics.

All States use the 0.1–96 hour median tolerance level as a standard for toxic substances.

The maximum summer temperatures for the maintenance of a well-balanced fish population vary from 87 to 90° F. During cold weather, the maximum allowable temperatures vary from 58 to 73° F. There is, however, some difference in the definition of the cold weather period.

(4) Industrial Water Supply

Three States set numerical levels of dissolved solids for industrial water supply while New York and Michigan covered this item in general terms. Standards for pH are essential for the protection of aquatic life. Ohio and Indiana set maximum temperatures at 95° F while Pennsylvania established a maximum temperature of 87° F, 5 degrees above ambient. Michigan's standard permits a 10-degree increase. Indiana and Ohio set an average of dissolved oxygen level of 2.0 mg/l with a minimum value of 1.0. New York established a minimum of 3.0 and Pennsylvania established an average of 5.0 with a minimum of 4.0. Both Ohio and Indiana assign aquatic life use to many of their streams classified for industrial use. In such cases the higher requirements of the aquatic life classification govern. Thus, the apparently wide discrepency between the standards of the States in this matter is, in reality, minimal.

(5) Agricultural Use, Including Livestock Watering, Irrigation, and Spraying

Indiana's and Ohio's standards for agricultural uses are limited to the four items dealing with the aesthetic quality of all water. Pennsylvania, New York, and Michigan have adopted standards calling for water of public water supply quality at least as far as toxic substances, bacteria, and nutrients are concerned. Michigan adopted a dissolved mineral content of 700 mg/l with a sodium ion concentration of not more than 40 percent of the total alkali metal ions.

Section 4

LAKE SUPERIOR

4.1 Introduction

4.1.1 Purpose

This section summarizes water quality conditions and trends in the Lake Superior basin in relation to established water-use designations and potential future uses. It also identifies the nature, location, and gravity of water quality problems and defines actions needed to maintain or improve the quality of the waters of the basin.

4.1.2 Scope

This section covers the United States portion of the Lake Superior basin. For planning purposes, the basin has been divided into two planning subareas. Figures 7-5 and 7-6 show the planning subareas and the counties assigned to each planning subarea.

This section reviews interstate and intrastate water quality standards and designated uses, which have been established by appropriate authorities. Water quality problem areas, defined as areas presently below the quality levels prescribed for the governing water uses, are identified, and major waste sources and corrective programs underway are described in general terms.

For the target years 1980, 2000, and 2020, projections of economic, demographic, and water-use parameters are translated into water loads, and needs for waste treatment and other measures for dealing with waterborne wastes are estimated. Reaches of streams are delineated where increased low flows and decreased waste inputs are indicated for water quality maintenance or improvement.

The information and data contained in this section were provided by representatives from each of the States adjacent to Lake Superior: Minnesota, Wisconsin, and Michigan.

4.1.3 Basin Description

Lake Superior, the largest of the Great Lakes with a surface area of 31,820 square miles, is 350 miles long, 160 miles wide, and 1,333 feet deep at its deepest point. It has a volume of nearly 3,000 cubic miles. Its surface is just over 600 feet above sea level, which is about 20 feet above Lake Huron into which it drains through St. Marys River.

The Lake's entire drainage basin contains 80,511 square miles, of which 23,931 are in Michigan, 8,354 in Minnesota, and 5,656 in Wisconsin. The remaining 42,570 square miles are in Canada.

The average outflow from Lake Superior since 1900 has been 73,400 cfs. This discharge is now regulated by the International Joint Commission.

Lake Superior lies mostly within the Precambrian Canadian Shield. The Precambrian rocks were formed approximately half a billion years ago and are very rich in mineral deposits. This wealth includes iron and copper deposits as well as a limited number of other minerals. The Cambrian era (185 to 500 million years ago) left its mark along the north central and northeastern shore of the Upper Peninsula of Michigan as demonstrated by the sandstones of the Pictured Rocks and the ledge rock of Tahquamenon Falls. The existing Lake Superior basin is of relatively recent origin. It reached its present water level approximately 2,500 years ago.

The outline of Lake Superior is more irregular than that of the other Great Lakes. Except for the eastern Upper Peninsula of Michigan, the Lake is surrounded by escarpment ranging from 400 to 800 feet high.

The United States portion of the basin is sparsely populated with Minnesota accounting for approximately one-half of the approximate total population of 524,000 persons. Table 7-5 lists the major cities with their 1970 populations.

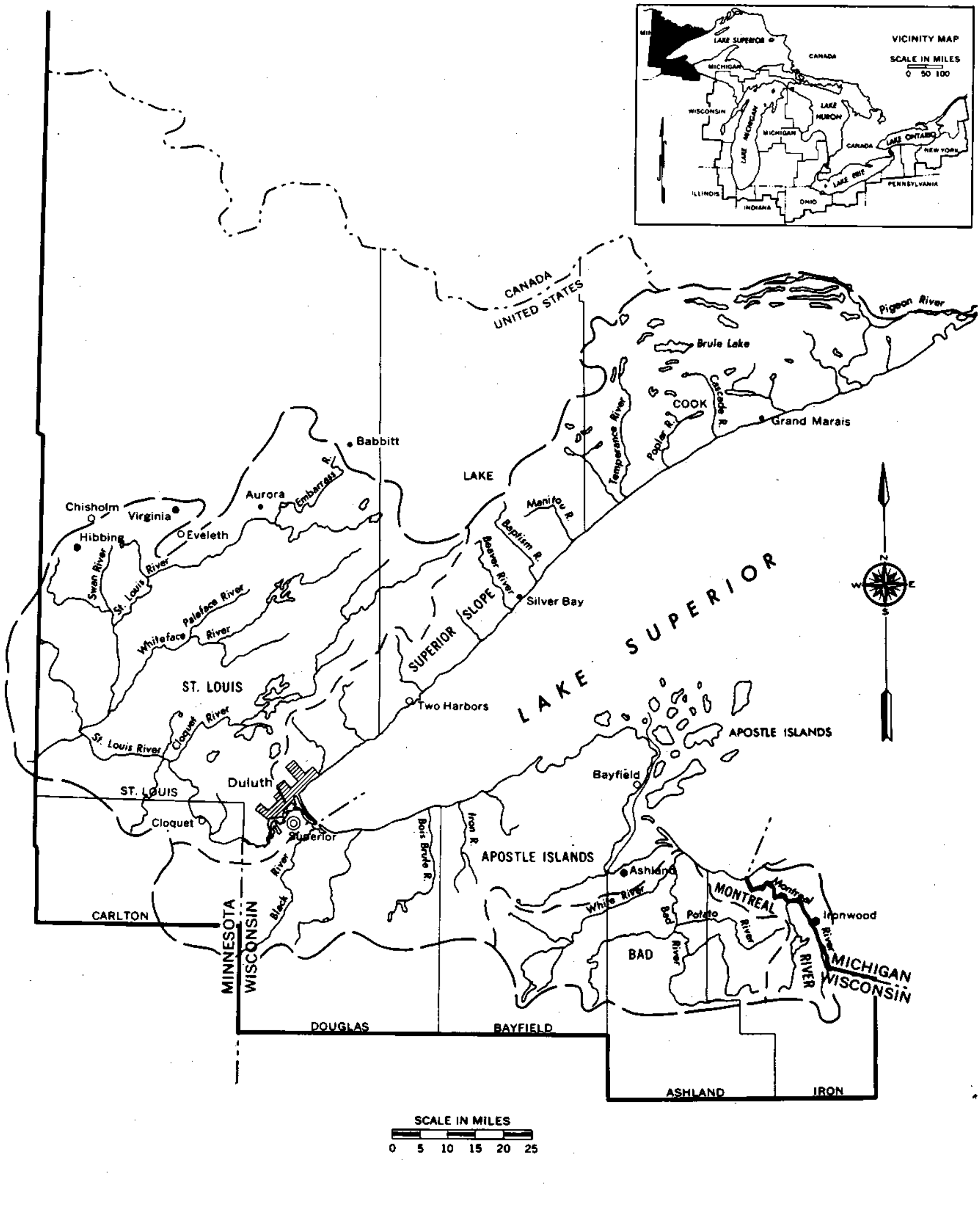


FIGURE 7–5 Lake Superior West, Planning Subarea 1.1

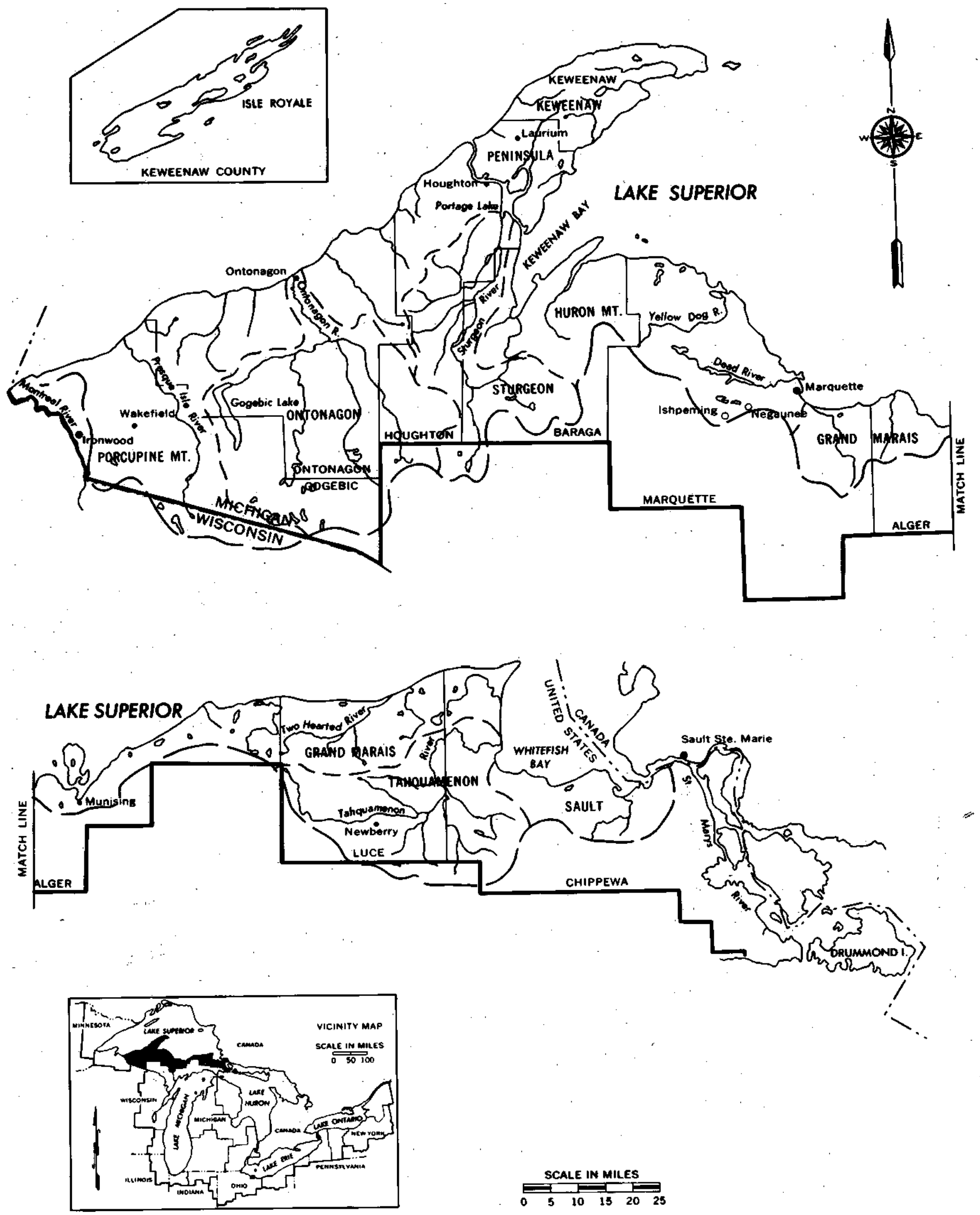


FIGURE 7-6 Lake Superior East, Planning Subarea 1.2

TABLE 7–5 Population of Major U.S. Cities—Lake Superior Basin (1970)

City	State	Population
Duluth	Minnesota	100,578
Hibbing	Minnesota	16,104
Virginia	Minnesota	12,450
Superior	Wisconsin	32,237
Ashland	Wisconsin	9,615
Marquette	Michigan	21,967
Ironwood	Michigan	8,711

4.1.4 Lake Levels

The level of Lake Superior and the discharge of the St. Marys River are maintained by precipitation that falls directly on the lake surface, drainage from the watershed, diversion from the Huron Bay streams, and very limited outseeping of ground water.

Precipitation in the drainage basin is well distributed throughout the year. Most of the precipitation falling during the winter months occurs as snow. The average annual precipitation is approximately 30 inches with extremes being a low of 22.81 inches in 1905 and a high of 38.25 inches in 1951.

Lake Superior also receives water by direct diversion via the Long Lake-Ogoki hydroelectric projects located along the north shore in Canada. This diversion averages nearly 5,000 cfs of water, which formerly flowed north to Hudson Bay. Because of the regulatory work at Sault Ste. Marie, this diversion has not affected the level of Lake Superior.

The level of Lake Superior has varied between a high monthly average elevation of 604.05 feet (August 1876) to a low of 599.88 feet (April 1925), a range of 4.17 feet. It has a 1.2 foot average yearly fluctuation with the low in March and a high in September. It is the function of the International Lake Superior Board of Control, established by the International Joint Commission in 1922, to maintain the level between 600.5 feet and 602.0 feet.

4.1.5 Lake Currents

Current patterns in Lake Superior result primarily from wind action. The wind-driven current is modified by the rotation of the earth, density differences (temperatures in Lake Superior), and the shape of the basin.

Circulation studies of Lake Superior, begun in October 1966 by the Federal Water Pollution Control Administration, indicated that the net circulation of Lake Superior is counterclockwise, with the possibility of large cyclonic eddies occurring in the western arm or Duluth embayment, between Isle Royale and the Keweenaw Peninsula and in the eastern basin (Figure 7–7).

4.2 Water Quality

In general, it may be said that the quality of the Lake Superior Basin water is nearly the highest of any large water body in the nation. There are certain problem areas, however, which are discussed State by State in this section.

4.2.1 Minnesota

The Minnesota portion of Plan Area 1 consists of the drainage basins of the St. Louis River and Superior Slope. A third river basin, the Nemadji, which originates in Minnesota but flows through Wisconsin to Lake Superior, is included in the Apostle Islands drainage basin.

The division into two separate hydrological basins coincides with a hypothetical water quality division. The St. Louis River drainage has industries and communities located throughout its 3,584 square miles, causing some high pollution loads, especially in the lower portions of the St. Louis River. Generally speaking, however, the quality of the waters is quite good. The drainage area of the Superior Slope has only a few industries and a scattering of very small communities. The result is streams of exceptionally high quality.

It is assumed that a combination of factors will probably mean an overall improvement in the quality of the waters within the basin. These factors include but are not limited to the increased importance of recreation in the area's economy, the technological advances in the field of waste treatment, the setting and enforcement of water quality standards in the drainage basin, and the small projected increase in the basin's population.

Waters are used for municipal and industrial water supply, navigation, recreation, commercial fishing, agriculture, and waste disposal.

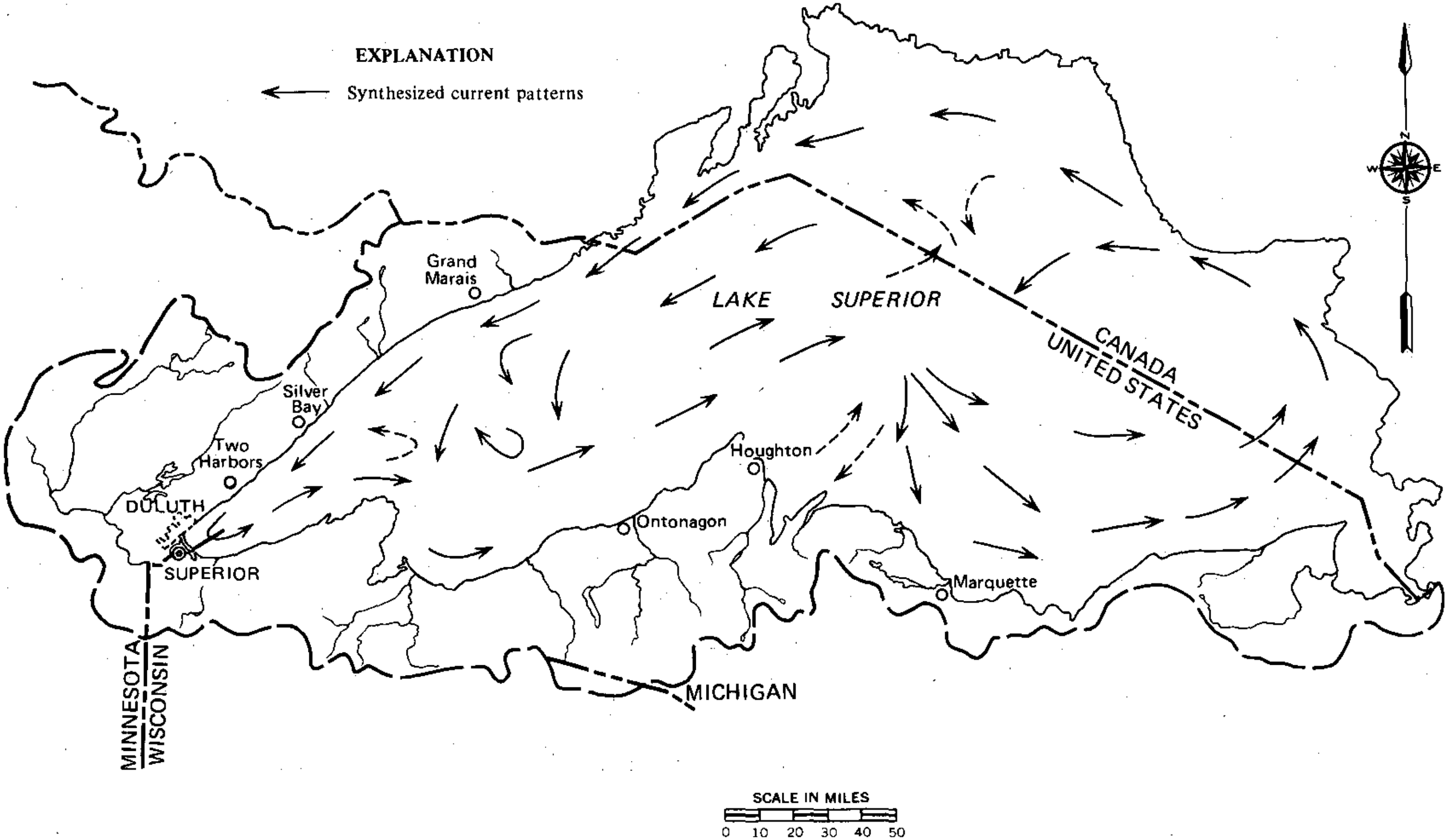


FIGURE 7-7 Lake Superior Water Circulation Patterns

4.2.1.1 Superior Slope Drainage

Four communities use Lake Superior for their municipal water supply. These communities represent approximately 20 percent of the drainage area and have an approximate total population of 25,000. Most of the remaining population derive their supply from private wells, although a few pump from Lake Superior. A summary is given in Table 7-6.

Industrial water use within the drainage is used almost entirely by Reserve Mining's taconite plant located at Silver Bay, which uses 600 million gallons of Lake Superior water per day. This accounts for approximately 95 percent of all the industrial and commercial water used in the drainage.

TABLE 7-6 Municipal Water Use—Superior Slope Drainage

Community	Estimated Pop. Served	Total Water into System (mg/yr)[a]	GPCD[b]
Beaver Bay	285	12	115
Grand Marais	1,300	54	114
Silver Bay	3,725	182	134
Two Harbors	4,695	234	137

[a]Million gallons per year
[b]Gallons per capita per day

Due to the enormous quantity and high quality of the waters in both the Lake and its tributary streams, the drainage has tremendous potential for both municipal and industrial use in the future. It is doubtful, however, that any large increase in water use will take place. The isolation and extreme temperatures of the area make it undesirable for industries other than those exploiting the mineral and timber resources available.

Recreation has the greatest potential in the basin. At present, only moderate demands are being placed on the area's recreational resources. Many factors are cited for this lack of use, including the great distances from major population areas, inaccessibility of many of the recreation areas, and the short tourist season. It has been estimated that the current annual recreation demand will double by the year 2000.

Although there are many types of recreation activities within the drainage, water-related ones account for most recreational usage. The prime trout fishing waters of Minnesota are found in the north shore streams, but many people vacation in the drainage basin just to enjoy the great natural beauty found along Lake Superior.

Commercial fishing has declined steadily since it reached its peak in 1941. The decline can be accredited to both biological and economic factors. The sea lamprey virtually wiped out the lake trout, which was the most valuable and popular fish. Herring catches have also declined significantly and the combination of this with the lake trout decline has resulted in increased activity in fishing for less valuable fish such as chubs and smelt. It is doubtful that catches will ever again equal those of the 1930s and 1940s.

Commercial navigation is related to the taconite industry. The Corps of Engineers has improved the facilities at Grand Marais, Two Harbors, and Knife River, and harbor developments have been authorized for Lutsen and Beaver Bay. Lack of local interest has forestalled the start of the latter two. Two Harbors, Taconite Harbor near Schroeder, and Silver Bay Harbor have been developed by private companies. In 1964 total commerce through harbors in the area was approximately 20,896,000 net tons. All the harbors are capable of supporting more commercial traffic in the future. Their use will be dependent upon the taconite industry and the possible development of other mineral and forestry resources in the subarea.

Studies in the early 1900s by the U.S. Geological Survey and the Corps of Engineers showed that there is a substantial amount of potential hydroelectric power on the north shore streams. The potential has been estimated at an annual figure of 407,300,000 kWh. Development of these streams for power, however, will be dependent on a radical change in the area's economy and would probably be opposed by recreational interests.

Other than significant problems from taconite tailings and asbestos-like fibers, which have not been resolved, there are no known quality problems of any significance in the Superior Slope drainage at this time. It is probably safe to assume that the quality of the waters in this drainage will continue to be excellent.

This assumption is based on the recreationists' desire for high quality water, which will be reinforced by the foreseeable boom in recreation activity, the growing concern over pollution throughout the nation, and the projection of little industry and population growth in the future.

4.2.1.2 St. Louis River Drainage Basin

Municipal and domestic water in the basin is drawn mainly from surface-water supplies. The figures, however, can be misleading. Of the total surface water use of 16.74 million gallons per day, 15.89 of it is used by Duluth, which takes its water from Lake Superior. Aside from Duluth, nearly the entire area derives its supply from ground-water sources. A pipeline conveying water from Lake Superior to Cloquet for domestic and industrial uses was recently completed. The initial capacity of the system is 25 mgd, but it can be expanded to 40 mgd. A breakdown by source is given in Table 7–7.

TABLE 7–7 Domestic Water Use—St. Louis River Drainage Basin

Type of System	Pop. Served	Water Use (MGD)[a]	GPCD[b]	Source Surface Use	Ground (MGD)
Community	186,480	22.78	122	16.74	6.04
Private	38,500	2.27	59	0	2.27
Total	224,980	25.05	181	16.74	8.31

[a]Million gallons per day

[b]Gallons per capita per day

The hydroelectric and steam generating plants are the major water users. In 1961, the total water requirements of these plants were estimated at 7,046 million gallons per day with nearly all of the supply coming from surface sources.

The other major industrial users are the wood industries, which are concentrated around Cloquet, and the U.S. Steel plant at Duluth. Estimated water use by industries for 1961 is given in Table 7–8.

TABLE 7–8 Estimated Industrial Water Use—St. Louis River Drainage Basin

Type	Water Use, MGD			Regional Use[a]	
	Surface	Ground	Total	Northern	Southern
Iron Mining	137	42	179	179	---
Power Plants	7,045	1	7,046	125	6,921
Wood Prods.	36	1	37	---	36
Steel	38	--	38	---	38
Misc.	3	1	4	1	3
Total	7,259	43	7,303	305	6,998

[a]The Whiteface and Savannah Rivers form the dividing line between the Northern and Southern for this table.

The only other important use of the waters is recreation, which, at present, is not highly developed. Above Cloquet the St. Louis River abounds with warmwater species. Many of the storage reservoirs used for hydropower provide excellent walleye and northern pike fishing. Recreational boating can be expected to increase now that the St. Louis River has been designated as a canoe route.

Agricultural water use is minor, with an estimated use of 0.40 million gallons per day, mostly for livestock watering. The possibility of increase in truck farming seems reasonable if the population of the Duluth area increases as projected.

At present the waters in the drainage basin are of good quality with the exception of the St. Louis River from Cloquet to Duluth-Superior harbors. Numerous instances of oxygen depletion have occurred in this stretch and fish kills have been reported. What used to be an excellent walleye and northern pike fishing area has been virtually eliminated by inadequately treated sewage and industrial waste discharges. The effect of these discharges is compounded by the fluctuations in flow caused by the operation of the hydroelectric plant upstream.

Coliform counts in the river from Cloquet to the harbor area have also been excessive with values of 80,000 MPN/100 ml and greater being reported. Another area with coliform problems is the Floodwood River near its junction with the St. Louis River. This is due to a small village's discharge of raw sewage into the river. The approval for construction of a sewage treatment plant, which has been recently approved under Public Law 660, should rectify the problem.

The quality of the lower St. Louis River and the Duluth-Superior Harbor area should improve in the future due to several factors. Foremost among these is the agreement between Conwed Corporation, the Northwest Paper Company, both located at Cloquet, the City of Cloquet, and the Minnesota Pollution Control Agency to upgrade their treatment facilities by 1973. Other factors include orders for improvement of waste treatment facilities issued to industries in the Duluth area and the requirement that municipal sewage facilities must be upgraded to secondary treatment by 1971. The City of Duluth, in addition to upgrading their plant to secondary treatment by 1971, has plans for tertiary treatment at some later date.

4.2.2 Wisconsin

4.2.2.1 Drainage Areas and Uses

Lake Superior drains approximately 3,200 square miles of northern Wisconsin including portions of Douglas, Bayfield, Ashland, and Iron Counties. The drainage area extends between the St. Louis River and the Wisconsin-Minnesota boundary on the west to the Montreal River or the Wisconsin-Michigan boundary on the east, a distance of approximately 100 miles. The area extends inland from Lake Superior an average of approximately 30 miles. Table 7-9 is a table of Wisconsin drainage areas in square miles for river systems tributary to Lake Superior.

TABLE 7-9 Drainage Areas for Wisconsin Tributary Streams

River	Sq.Mi.	River	Sq.Mi.
Amnicon	130	Middle	50
Bad	1,016	Montreal	180
Bois Brule	185	Nemadji	177
Fish	139	Poplar	46
Flag	71	St. Louis	77
Iron	150	Sioux	96
		Siskiwit	31

There are 17 municipal and public institutions (four with secondary and eight with primary treatment, four with septic tanks, and one with no treatment) and 18 industries that use the surface waters of the Lake Superior basin for waste assimilation.

4.2.2.2 Potential Sources of Surface-Water Pollution

The Lake Superior drainage basin in Wisconsin is sparsely populated with relatively little industry. Though surface waters in the basin are generally of good quality, localized problems do exist in the vicinity of some communities and industries. Whenever localized problems do exist, further steps should be taken to protect the surface water resources of the basin.

4.2.2.3 Montreal River Basin

The Montreal River is an interstate stream that forms part of the boundary between Michigan and Wisconsin. The river drains approximately 263 square miles, of which 97 square miles are in Michigan. The river receives the effluent of two communities, both of which have secondary treatment. There are no industrial discharges to the basin's surface waters. One stream reach is of substandard quality due to nutrients originating in a municipal discharge.

4.2.3 Michigan

4.2.3.1 Lake Superior—Inshore Area

Water quality along the Michigan shore of Lake Superior is generally excellent. There is only one small municipal wastewater discharge and one industrial and two electric power generating plants discharging wastewater into Lake Superior. The municipal discharge receives primary treatment. The community responsible is constructing waste treatment lagoons with on-land disposal.

There are four coastal communities with a combined 1960 population of approximately 29,000, that discharge primary treated and chlorinated effluent into intrastate waters. With the exception of minor effects on water quality in the immediate river mouth areas, these discharges do not pollute the waters of Lake Superior, except to add phosphorus nutrients.

Lake Superior river basins are described from east to west.

4.2.3.2 Tahquamenon River Basin

The Tahquamenon River basin has a drainage area of 820 square miles and discharges to Whitefish Bay on Lake Superior. One municipality with primary treatment utilizes the surface waters for waste assimilation. Water quality in the basin is generally excellent. The surface waters are tea-colored because of tannins naturally present in the basin.

4.2.3.3 Grand Marais-Munising Area

This area embraces a number of small streams discharging to Lake Superior including the Shelldrake, Two Hearted, Anna, and Chocolay Rivers. Two municipalities, one with primary and one with no treatment, and one Federal installation discharge waste to the basin's surface waters.

Water quality is generally excellent in the area except along three reaches with substandard quality. One reach of the Au Train River receives a small quantity of raw sewage and displays high coliform levels. The community responsible has engineering studies under way. One reach of the Anna River and one reach of the Chocolay River receive treated wastes and display elevated nutrient levels.

4.2.3.4 Huron Mountains Area

The Huron Mountains area embraces a number of minor streams discharging to Lake Superior and Keweenaw Bay including the Carp, Dead, Yellow Dog, Salmon, Trout, Huron, and Silver Rivers. Five municipalities, two with secondary treatment and three with primary treatment, and three industries discharge waste to the areas surface waters.

The water quality of the streams in the Huron Mountain area is generally excellent although there are three localized reaches of substandard quality on the Carp River, two on the Dead River one each on Linden Creek and Lake Independence. Four of the six substandard quality reaches receive excess nutrients from municipal treatment plants that need nutrient removal facilities. One other reach is affected by untreated wastes from a small food processing industry and exhibits depressed dissolved oxygen levels. The company responsible has completed plans for treatment facilities.

The sixth reach receives the unchlorinated discharge of a community septic tank and exhibits elevated coliform levels.

The final reach of substandard quality is affected by a small amount of oil discharged from an auxiliary electric generating facility. The operators of this facility are investigating ways to eliminate the oil discharge.

There is also some turbidity and discoloration of the Carp River during the spring of the year due to mining operations in the Ishpeming and Negaunee area.

4.2.3.5 Sturgeon River Basin

The Sturgeon River drains an area of 729 square miles and discharges to Portage Lake at Chassell, Michigan. The basin includes the Sturgeon River, the Otter River, and numerous small tributaries. There is only one known source of municipal waste entering this basin. Water quality is generally excellent throughout the basin although there is one minor reach of substandard quality. Untreated municipal wastes degrade one stream reach causing elevated levels of coliforms and suspended solids. The community responsible presently has engineering studies under way.

4.2.3.6 Keweenaw Peninsula Area

The Keweenaw Peninsula area embraces a number of small streams that discharge into Lake Superior, including the Trap Rock, Flint Steel, Firesteel, and Tobacco Rivers, and Portage and Torch Lakes. Some 15 communities and one military establishment discharge wastes to the surface waters of the area. Five of these have primary treatment, two have secondary treatment, and nine have no treatment. There are also three industrial surface-water discharges.

Water quality is generally good throughout the Keweenaw Peninsula area although there are 11 localized reaches of substandard water quality. Nine of the communities responsible have been notified of the need for treatment facilities and the majority are engaged in the necessary engineering studies. One additional reach receives the effluent from a community septic tank without chlorination and displays elevated coliform levels. The final reach receives nutrients from a municipality with secondary treatment.

4.2.3.7 Ontonagon River Basin

The Ontonagon River basin drains an area of 1,390 square miles, of which 1,350 are in Michigan. The remainder is in Wisconsin. Two industries and seven municipalities use the surface waters of the basin for waste assimilation. Two of the seven municipalities provide primary waste treatment and five provide no treatment.

Water quality is generally excellent throughout the basin although the Ontonagon River and tributaries carry a natural silt load because of the character of the clay lands of the basin. The river is commonly muddy and turbid during the spring runoff.

In addition there are six localized reaches of substandard water quality. One reach near the mouth of the river receives both municipal and industrial discharges and exhibits elevated levels of nutrients and suspended solids. There have been occasional instances of a taste and odor problem in the municipal water supply. A corrective program is being pursued with industry involved, and secondary treatment with phosphorus removal is planned by the community.

Five upstream reaches are affected by raw sewage discharges from small basin communities. These reaches display elevated levels of coliforms and suspended solids. Three of the communities involved have waste treatment facilities under construction and the two remaining have plans under way for treatment.

4.2.3.8 Porcupine Mountain Area

The Porcupine Mountain area includes Presque Isle, Black, and Mineral Rivers, and other minor streams discharging to Lake Superior. Five municipalities discharge wastes to the surface waters of the area. Three have secondary treatment and two have no treatment facilities. Water quality is generally excellent throughout the area although there are four localized reaches of substandard water quality. Two reaches are degraded by raw sewage discharges and exhibit elevated levels of coliforms and suspended solids. One of the communities has secondary waste treatment facilities under construction, and a second has plans approved for similar facilities.

A third reach receives the unchlorinated effluent of a secondary treatment plant and exhibits high coliform levels. Construction plans are being prepared to correct this deficiency. The final reach receives nutrients from a secondary treatment plant.

4.3 Water Quality Control Needs

4.3.1 Introduction

Waste load quantities and treatment costs have been estimated for future needs according to the procedures outlined in the Introduction.

4.3.2 Existing Needs

River Basin Groups 1.1 and 1.2 fall under the jurisdiction of the Federal-State Conference on Lake Superior. This conference is a first step in procedures under the Federal Water Pollution Control Act, as amended prior to 1972 (33 U.S.C. 466 et seq.).

The purpose of these procedures is to bring together representatives of the States and the U.S. Environmental Protection Agency to review the existing situation and the progress that has been made, to lay a basis for future action by all parties concerned, and to give the States, localities, and industries an opportunity to take any remedial action that may be indicated under State and local law.

The review reveals that major pollution problems are traceable to effluents from mining and forest products industries, and the lack of tertiary or, in some cases, secondary treatment in both public and private wastewater disposal systems. The upgrading of water quality within the planning subarea will be most effective if wastewater treatment systems causing detriment to the streams and lakes receive adequate attention. A high quality of life, water objectives, financial resources, and the nature and amount of effluent should be the guidelines when setting and enforcing the schedule for corrective action.

Although organic loadings are of primary importance in arriving at projected treatment cost estimates, additional contributing effluent properties such as the amount and nature of effluents with respect to nutrients, heavy and toxic metals, inert solids, thermal properties, various pesticides, and radioactivity, must be considered for any long-term water quality management program. With our present understanding of these factors and their effect on our environment, any one or any combination of these factors may be detrimental to the water quality in River Basin Groups 1.1 and 1.2. Proper consideration must be given to planning and innovative research in the development and design of feasible and effective systems and system approaches in handling a variety of waste discharges.

Tables 7–10 through 7–12 show projected wastewater flows by planning period for Minnesota, Michigan, and Wisconsin. Tables 7–13 to 7–15 refer to projected capital costs and operating and maintenance costs by planning period for the same States. Table 7–16 shows projected advanced waste treatment costs for the Minnesota portion of Planning Subarea 1.1.

The methods used to determine wastewater treatment costs are outlined in the Introduction.

TABLE 7–10 Wastewater Flows (MGD), Planning Subarea 1.1—Minnesota Portion

Year	Flow Municipal	Flow Industrial
1970	23.5	31.5
1980	28.1	23.6
2000	34.2	23.6
2020	42.2	34.9

TABLE 7–11 Wastewater Flows (MGD), Planning Subarea 1.1—Wisconsin Portion

Year	Flow Municipal	Flow Industrial[a]
1970	9.2	---
1980	9.0	---
2000	9.5	---
2020	10.1	---

[a]No industrial flows reported

TABLE 7–12 Wastewater Flows (MGD), Planning Subarea 1.2—Michigan

Year	Flow Municipal	Flow Industrial
1970	12.0	23.7
1980	11.0	20.8
2000	12.2	16.1
2020	15.0	26.1

4.3.3 Wastewater Flows

4.3.3.1 Minnesota

Projections of wastewater flows determined for the four-county Minnesota portion of Planning Subarea 1.1 are presented in Table 7–10.

4.3.3.2 Wisconsin

Planning Subarea 1.1 includes four counties in the State of Wisconsin. Table 7–11 contains projections of municipal wastewater flows.

4.3.3.3 Michigan

Planning Subarea 1.2 comprises nine counties in the northern half of Michigan's Upper Peninsula. The area has been experiencing a decrease in population, and this trend is expected to continue through 1980. Projections of future wastewater flows are presented in Table 7–12.

4.3.4 Treatment Costs

4.3.4.1 Minnesota

Table 7–13 presents cost estimates for capital and operational costs for municipal treatment plants by planning period.

4.3.4.2 Michigan

Table 7–14 presents cost estimates for capital and operating costs for municipal treatment plants by planning period.

TABLE 7–13 Projected Municipal and Industrial Wastewater Treatment Cost Estimates, Planning Subarea 1.1—Minnesota Portion

Planning Period	Municipal Treatment Costs: Capital Costs ($ Million)	Municipal Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)	Industrial Treatment Costs: Capital Costs ($ Million)	Industrial Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)
Present-1980	8.0	1.2	7.0	1.0
1980-2000	3.8	3.9	---	2.4
2000-2020	4.8	4.6	---	2.4

TABLE 7–14 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 1.2—Michigan

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	7.0	0.75
1980–2000	5.5	1.00
2000–2020	7.3	1.25

These estimates exclude costs for separate industrial treatment facilities, sewage collection systems, and stormwater control.

4.3.4.3 Wisconsin

Table 7–15 is an estimate of municipal wastewater treatment costs for the Wisconsin portion of Planning Subarea 1.1

TABLE 7–15 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 1.1—Wisconsin Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	4.8	.45
1980–2000	3.5	.50
2000–2020	4.3	.57

4.3.5 Advanced Waste Treatment Needs

4.3.5.1 Minnesota

Advanced waste treatment of the combined municipal and industrial loadings from Cloquet will be necessary to maintain the required dissolved oxygen content during critical periods.

The 1971 legislature created the Western Lake Superior Sanitary District, which provides the important first step to the realization of a regional approach to the Duluth-Superior area's problems.

The Northeastern Minnesota Development Association had previously proposed a regional treatment system in the Duluth-Superior area, which would have a significant bearing on the advanced waste treatment needs for the Cloquet area. A regional approach will undoubtedly alter these cost projects.

TABLE 7–16 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 1.1 — Minnesota Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	6.9	0.7
1980–2000	---	2.0
2000–2020	---	2.0

4.3.5.2 Michigan and Wisconsin

There are no advanced waste treatment needs anticipated in Planning Subarea 1.2 during the planning period 1970–2020.

4.4 Summary and Conclusions

Lake Superior has a total water surface area of 31,820 square miles, of which approximately two-thirds is in the United States. The total drainage basin (land and water) is 80,511 square miles, of which approximately 47 percent is in the United States.

The population of the United States portion of the basin was 524,000 in 1970, of which approximately 50 percent is in the State of Minnesota, 35 percent in Michigan, and 15 percent in Wisconsin. The basin is divided into two planning subareas. Planning Subarea 1.1, which includes Minnesota and Wisconsin counties, accounts for 63 percent of the total population. Planning Subarea 1.2, which includes nine Michigan counties, accounts for the remainder. Most of the manufacturing activity is in the Duluth-Superior Standard Metropolitan Statistical Area. The mining industry in the basin uses large quantities of water in processing.

Minnesota's major agency concerned with the water pollution control is the Minnesota Pollution Control Agency. Some other involved agencies are the Department of Natural Resources and the Department of Health. The responsibility for Wisconsin's water pollution control program is centered in the Department of Natural Resources. In Michigan the major State agencies are the Michigan Water Resources Commission and the Department of Health.

The principal water activities of the United States Environmental Protection Agency include comprehensive programs, water quality standards, technical assistance, grant programs, enforcement, Federal installations, Refuse Act permit programs, water-hygiene, environmental impacts, pesticides programs, radiation programs and research and monitoring.

Each of the three States in the basin has adopted water quality standards for inter- and intrastate waters. All three have nondegradation clauses for such waters and have classified these waters according to use categories.

4.4.1 Planning Subarea 1.1

Planning Subarea 1.1 (Lake Superior West) includes the following river basins or complexes: Superior Slope Complex; St. Louis River; Apostle Islands Complex; Bad River; and the Montreal River Complex. The drainage area of the Superior Slope has few industries and only a scattering of very small communities. Industrial water use within the Superior Slope is almost entirely that used by Reserve Mining's taconite plant located at Silver Bay. The St. Louis River Basin has a significant number of industries and communities and some high pollution loads, especially in the lower portion of the St. Louis River. Numerous instances of oxygen depletion have occurred in the stretch of the St. Louis River from Cloquet to Duluth-Superior harbors due to both municipal and industrial waste discharges. Present programs are expected to substantially improve water quality. In the Wisconsin portion of the basin 17 municipal and public institutions and 18 industries utilize surface waters for waste assimilation after varying degrees of treatment.

In the Minnesota portion of Planning Subarea 1.1 the total of domestic, commercial, and industrial wastewater to be treated in municipal wastewater treatment facilities is expected to increase from a 1970 base of 23.5 mgd to 28.1 mgd in 1980, and to 42.2 mgd by 2020. In the Wisconsin portion the total of 9.15 mgd in 1970 is not expected to increase significantly in the future planning periods. In the Minnesota portion of this planning subarea, municipal wastewater treatment capital costs are estimated at $8 million in the 1970 to 1980 period and, although capital costs are expected to decline in future planning periods, operation and maintenance costs are projected to increase substantially. In the Wisconsin portion of this planning subarea, capital costs are estimated at $4.8 million in the 1970 to 1980 period, $3.5 million in 1980 to 2000 and $4.3 million in the 2000 to 2020 period.

4.4.2 Planning Subarea 1.2

Planning Subarea 1.2 (Lake Superior East) includes eight Michigan river basins or complexes. Water quality along the Michigan shore of Lake Superior is generally excellent. Within the Grand Marais-Munising area there are three reaches of substandard water quality. Within the Huron Mountains area there are six localized reaches and in the Keweenaw Peninsula Area there are 11 localized reaches of substandard quality. In the Ontonagon River Basin there are six localized reaches of substandard quality in addition to others that exist within the basin. Programs are under way to correct many of the localized water pollution problems.

In Planning Subarea 1.2 projected municipal wastewater treatment capital costs are estimated to be $7 million for the 1970 to 1980 period, $5.5 million for the 1980 to 2000 period, and $7.3 million for the 2000 to 2020 period. Operating and maintenance costs are estimated to be $750,000 in the 1970 to 1980 period, one million dollars in the 1980 to 2000 period, and $1.25 million in the 2000 to 2020 period.

Section 5

LAKE MICHIGAN

5.1 Introduction

5.1.1 Purpose

This section summarizes water quality conditions and trends in Plan Area 2 in relation to established water use designations and potential future uses. It identifies the nature, location, and gravity of water quality problems, and actions needed to maintain or improve the quality of the waters of the basin.

5.1.2 Scope

The section covers the entire 67,860 square miles of the Lake Michigan basin to its outlet at the Straits of Mackinac. The basin has been divided into four planning subareas and river basin groups based on political and hydrologic boundaries. Figure 7–8 shows the planning subareas and Table 7–17 lists the counties assigned to each planning subarea.

The section reviews interstate and intrastate water quality standards and designated uses, which have been established by appropriate authorities. Water quality problem areas, defined as areas presently below the quality levels prescribed for the governing water uses, are identified and major waste sources and corrective programs under way are indicated.

For the target years 1980, 2000, and 2020, projections of economic, demographic, and water-use parameters are translated into waste loads and needs for waste treatment, and other measures for dealing with waterborne wastes are estimated. Stream reaches in need of increased low flows and/or decreased waste inputs for water quality maintenance or improvement are delineated. Anticipated water quality problems in each planning subarea are ranked according to urgency and time of impact, and general cost estimates are given for broad components of the actions needed.

The report generally discusses existing quality conditions, future prospects, and needed actions in accord with Type I comprehensive studies. Existing data were used and no new basic data were secured. The knowledge and judgment of experienced field personnel was relied upon.

5.1.3 Basin Description

The Lake Michigan basin which encompasses an area of 67,860 square miles in four States, is the only one of the Great Lakes to lie entirely within the United States. The

TABLE 7–17 Lake Michigan Basin Counties by Planning Subarea

PSA 2.1	PSA 2.2 (cont.)	PSA 2.3 (cont.)
Michigan	Illinois	Indiana
Dickinson	Cook	Elkhart
Iron	Du Page	Lagrange
Menominee	Kane	Marshall
Wisconsin	Lake	Noble
Brown	McHenry	St. Joseph
Calumet	Will	Steuben
Door	Indiana	PSA 2.4
Florence	Lake	Michigan
Fond du Lac	La Porte	Antrim
Forest	Porter	Benzie
Green Lake	Starke	Charlevoix
Kewaunee		Delta
Langlade	PSA 2.3	Emmet
Manitowoc	Michigan	Grand Traverse
Marinette	Allegan	Kalkaska
Marquette	Barry	Lake
Menominee	Berrien	Leelanau
Oconto	Branch	Mackinac
Outagamie	Calhoun	Manistee
Shawano	Cass	Mason
Sheboygan	Clinton	Mecosta
Waupaca	Eaton	Missaukee
Waushara	Hillsdale	Muskegon
Winnebago	Ingham	Newaygo
	Ionia	Oceana
PSA 2.2	Jackson	Osceola
Wisconsin	Kalamazoo	Roscommon
Kenosha	Kent	Schoolcraft
Milwaukee	Montcalm	Wexford
Ozaukee	Ottawa	
Racine	St. Joseph	
Walworth	Shiawassee	
Washington	Van Buren	
Waukesha		

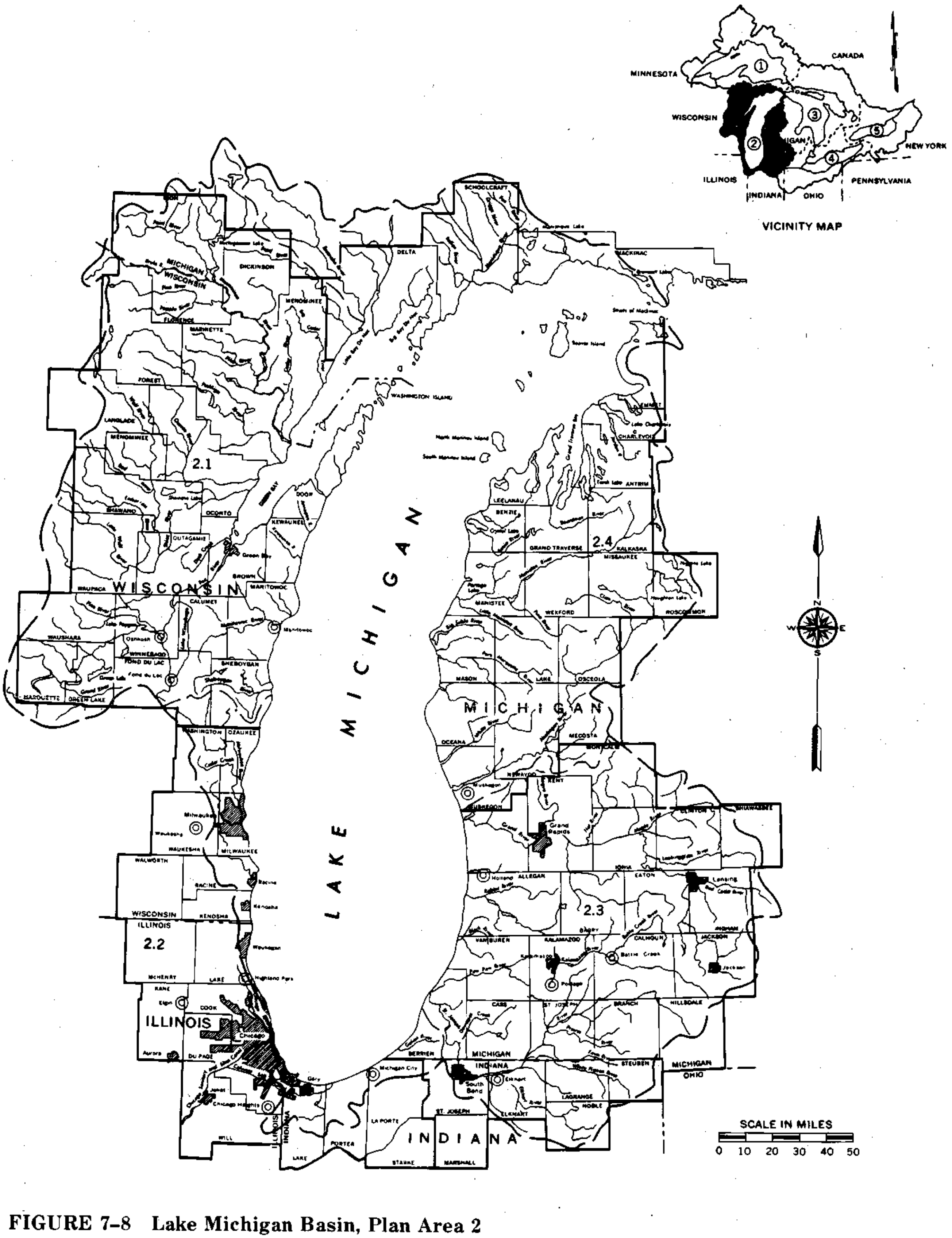


FIGURE 7–8 Lake Michigan Basin, Plan Area 2

total land area in the basin is 45,560 square miles, of which 62.5 percent is in Michigan, 31.9 percent is in Wisconsin, 5.1 percent is in Indiana, and 0.5 percent is in Illinois. The Illinois portion does not include area in the Lake Michigan watershed whose drainage has been diverted to the Illinois River watershed.

Lake Michigan is the sixth largest freshwater lake on earth and the third largest of the Great Lakes. It is approximately 300 miles long and has an average width of 60 miles.

In 1960 approximately 5.5 million people lived within the region's boundaries. Millions more live in nearby areas, including almost seven million in the Chicago metropolitan area. The major metropolitan areas lying entirely or substantially within the watershed are: Milwaukee, Wisconsin; Gary-Hammond-East Chicago, Indiana; and Lansing, Grand Rapids, and Kalamazoo, Michigan.

Most of the major streams (Table 7–18) start with relatively steep gradients at the headwaters that decrease as they approach Lake Michigan. Harbors have been developed at the mouths of most of these rivers. The 20 major streams drain 36,400 square miles or 80 percent of the total land area. Of this, 31,940 square miles or 70 percent of the area is gaged.

5.2 Water Quality

Water quality is examined here with reference to the designated uses established for particular waters and the water quality pa-

TABLE 7–18 Major Tributaries of Lake Michigan

River[a]	Drainage Area Total (sq.mi.)	Drainage Area Gaged (sq.mi.)	Mean Discharge (cfs)	Period of Record
Milwaukee	845	686	381	1914-65
Sheboygan	440	432	232	1916-24, 50-65
Manitowoc	442	0	---	---
Fox-Wolf	6,443	6,150	4,140	1896-1965
Oconto	933	678	569	1906-08, 13-65
Manistique	1,450	1,402[b]	1,699	1938-65
Boardman	347	223	186	1952-65
Manistee	2,010	1,980[b]	2,095	1951-65
Pere Marquette	772	709	608	1939-65
White	480	380	367	1957-65
Muskegon	2,780	2,350	1,889	1909-14, 16-19, 30-65
Grand	5,572	4,900	3,362	1901-05, 06-18, 30-65
Kalamazoo	2,030	1,600	1,296	1929-36, 37-65
St. Joseph	4,590	4,056[c]	3,398	1930-65, 51-65
Burns Ditch	280	160	130	1943-50, 55-65
Peshtigo	1,155	1,124	832	1953-65
Menominee	4,150	3,790	3,098	1907-08, 13-65
Ford	468	450	324	1954-65
Escanaba	920	870	895	1903-12, 50-65
Whitefish	315	0	---	---
Total	36,422	31,940	25,501	

[a]Clockwise from Milwaukee

[b]Total of Indian and Manistique Rivers above confluence

[c]Total of St. Joseph and Paw Paw Rivers above confluence

SOURCE: 1965 Surface Water Records of Indiana, Michigan, and Wisconsin, U.S.G.S.

rameters necessary to protect those uses. Substandard quality reaches used in this discussion are those deficient in one or more parameters. They fail to meet the quality requirements necessary to protect their designated uses.

This review covers water quality conditions as of May 1969. It should be recognized that there are a number of corrective programs in progress that will modify existing water quality conditions in the near future.

5.2.1 Lake Michigan

Lake Michigan has a surface area of 22,400 square miles, an average depth of 276 feet, and a total volume of 1,170 cubic miles. In general the Lake is oriented along the north-south axis, with the northern part of the Lake curving gently to the northeast. The Lake is divided into two areas by two parallel ridges running in an easterly direction from Milwaukee to Grand Haven. The southern area, smaller and shallower than the northern area has a maximum depth of 525 feet. The northern area is longer and narrower. There the Lake's depth reaches 923 feet.

5.2.1.1 Lake Currents

Surface currents are produced mainly by wind and differences in barometric pressure over different parts of the Lake. Brief windstorms may create surface waves that cause strong local currents of short duration. Strong winds of longer duration produce a transfer of water toward the leeward shore and temporary circulation, which is affected by the shape and topography of the Lake basin. Close to shore in shallow water the alongshore drift produced by moderate waves approaching at an oblique angle may reach velocities of one or two miles per hour. Such water movements are of a temporary nature. In addition, there are patterns of permanent, or at least seasonal, circulation involving a slow drift of the water.

There is a southward drift along the western side of the Lake, which continues around the south end and turns northward on the eastern side, where it becomes more pronounced. Around the Beaver Island group in the north and in the major southern basin there are counter-clockwise swirls. Between these swirls the surface water tends to move eastward along lines that are curved with their convex sides to the south.

The prevailing westerly winds, coupled with the flow toward the outlet, are considered the cause of the above flow patterns. Some authorities dispute the counterclockwise swirls described above. Northeasterly winds can alter normal flow patterns so that at times the flow through the Straits of Mackinac is temporarily reversed.

5.2.1.2 Existing Water Quality—Deepwater Region

The deepwater region of Lake Michigan is defined as that portion of the Lake more than 10 miles from shore. The physical, chemical, and biological characteristics of the deepwater region were extensively sampled by the Great Lakes-Illinois River Basin Project of the Federal Water Pollution Control Administration. The project involved a series of seven cruises between May 1962 and November 1963.

The physical and chemical parameters investigated displayed considerable uniformity and there was little or no evidence of water quality deterioration within the deepwater region.

The biota of the deepwater region reflected an unpolluted environment. Free-floating algal population were less than 500 per milliliter. Pollution-sensitive scuds predominated in organism populations on the bottom. Sludgeworm populations were less than 1,000 per square meter and midges were principally of the clean water variety.

5.2.1.3 Existing Water Quality—Inshore Areas (General)

Inshore areas discussed here are those within 10 miles of shore. The Great Lakes-Illinois River Basin Project of the Federal Water Pollution Control Administration also sampled inshore areas during a series of eight cruises from August 1962 to October 1963.

Compared to the deepwater region of Lake Michigan, certain inshore areas have higher concentrations of dissolved substances, much greater variability in water quality parameters, a larger proportion of pollution-tolerant, bottom-dwelling organisms, and increased algal population. In general the largest variations were evident in the vicinity of tributary mouths and harbor areas.

5.2.1.4 Inshore Areas in Michigan

For inshore areas along the Lower and Upper Peninsula of Michigan, with the exception of the Green Bay area, water quality is very good and suitable for all designated water uses.

Phytoplankton populations are generally greater through Michigan's inshore areas, particularly in the southern half of the State. The higher populations can be attributed to the warmer waters of the littoral zone, prevailing westerly winds, lake currents, and the greater availability of nutrients. The Grand, Kalamazoo, and St. Joseph Rivers contribute significant amounts of nutrients to the Lake.

In August of 1966 approximately 60 miles of Lake Michigan shoreline from South Haven north to Pentwater had noticeable accumulations of *Cladophora*. Where the presence of *Cladophora* was not complicated by accompanying growths of *Spirogyra*, the nuisance conditions were not severe. In the north central portion of this area, a 32-mile section of beach had nuisance accumulations of *Spirogyra* and *Cladophora*. In this area, extending from approximately 6½ miles south of Muskegon to Benona, 25 miles north of Muskegon, park managers received complaints that algae stained bathing suits and that conditions were unsuitable for swimming.

Objectionable aquatic growths and shoreline deposition occurred in the west arm of Grand Traverse Bay in the summer of 1964. Under certain wind and current conditions great quantities of aquatic plants and filamentous algae were deposited on the beaches creating a serious nuisance. It is probable that the waters of the Boardman River, enriched by treated waste discharges from the Traverse City area, caused the development of these growths. Actions are under way to resolve this problem.

The Michigan Water Resources Commission conducts a summertime bacteriological sampling program along the shoreline of Lake Michigan. Of the 69 Lower Peninsula locations represented in 1967 and 1968 data, 24 locations had 1968 total coliform levels over 1,000 organisms per 100 milliliters. This represents a 33 percent decrease from 1967 when 36 locations had more than the 1,000 organism limit. Because total coliform counts may be greatly influenced by alewife die-offs and other nondangerous factors, fecal coliform counts are a better index to fecal contamination. The number of locations with fecal coliform levels greater than 100 organisms per 100 milliliters declined from four in 1967 to one in 1968. Along the Upper Peninsula shoreline of Lake Michigan, all 10 stations sampled had coliform levels below the 1,000 organisms per 100 milliliters limit.

5.2.1.5 Green Bay—Michigan Portion

The benthic fauna of the Escanaba River delta area of Little Bay de Noc was investigated in 1963 to determine the effects of wastes from an upstream pulp and paper industry. The study disclosed that the bottom of the bay within a one-half mile radius of the river mouth contained varying amounts of bark, fiber, and organic detritis. There was a noticeable absence of intolerant species in the delta area and sludgeworms were the dominant animal present. Additional waste treatment facilities have been completed.

Further studies have shown depressed dissolved oxygen and elevated nutrient levels in Portage Marsh due to municipal wastes discharged to Portage Creek, which flows into Green Bay. The municipality involved is constructing improved secondary treatment facilities with a deepwater discharge in Green Bay.

5.2.2 Planning Subarea 2.1

5.2.2.1 Michigan Portion

(1) Menominee River Basin

The Menominee River Basin has a total drainage area of 4,186 square miles, of which approximately 2,676 square miles is in Michigan. The Menominee River begins at the confluence of the Brule and Michigamme Rivers and flows southeasterly to Menominee, Michigan, and Marinette, Wisconsin, where it enters Green Bay. In Michigan seven municipalities (four with primary treatment and three with secondary treatment) and eight industries use surface waters of the Menominee River basin for waste assimilation.

Water quality is generally good throughout the basin although there are four reaches of substandard quality. The lower portion of the river receives municipal and industrial waste discharges and displays elevated levels of nutrients, suspended solids, and dissolved solids. The community involved has primary treatment and has recently signed contracts for the construction of phosphate removal facilities and secondary treatment. Two other reaches, one on the mainstem and one on a minor tributary, display elevated nutrient levels. One reach of the Iron River is affected by acid mine water and exhibits elevated levels of suspended and dissolved solids.

(2) Cedar River

The Cedar River, with a drainage area of approximately 400 square miles, discharges to Green Bay at Cedar River, Michigan. Water quality is generally excellent in the basin.

5.2.2.2 Wisconsin Portion

(1) Manitowoc River Basin

The Manitowoc River drains approximately 505 square miles of Calumet, Fond du Lac, Manitowoc, and Brown Counties. There are 12 municipal and public institutions (10 with secondary treatment) and 21 industries that use the surface waters of the Manitowoc River basin for waste assimilation after treatment.

Water quality is variable, but generally good throughout the Manitowoc drainage basin. All intrastate streams and surface waters, with the exception of several small tributaries to the Manitowoc River and Manitowoc River in the City of Manitowoc, meet standards for recreational use and for fish and other aquatic life. Lake Michigan open waters meet the water quality standards and requirements for all uses. Swimming beach waters should meet the standards for body contact recreation, while harbor areas and shoreline sections in the vicinity of pollutional outlets should meet minimum standards and requirements for cooling and industrial water supply.

The rural Manitowoc River drainage basin has numerous small cities and villages scattered through it. The main industries consist of hardware manufacturing and small cheese factories. The greatest problems exist at the municipal sewage treatment plants where inadequate treatment has created objectionable downstream conditions. Steps need to be taken to protect the surface water resources of the basin.

(2) Twin and Kewaunee River Basins

The Twin and Kewaunee Rivers drain approximately 500 square miles of Kewaunee, Manitowoc, and Brown Counties. There are seven municipalities (five with secondary and one with primary treatment) and 10 industries that use the surface waters of the basin for waste assimilation after treatment.

Water quality is generally good and meets the standards for all uses. The Twin and Kewaunee basins are not significantly industrialized and have a comparatively low, stable population. However, localized pollution problems do exist near some communities and industries. Further steps need to be taken in order to protect the basin's water quality.

(3) Door Drainage Basin

The Door drainage basin is located in the northeastern part of Wisconsin. It includes all of Door County, approximately one-fourth of Kewaunee County, and the northeastern corner of Brown County. The Ahnapee River comprises the largest single drainage network in the entire basin, which covers 570 square miles. There are three municipalities (two with secondary and one with primary treatment) and five industries that use the surface waters of the basin for waste assimilation after treatment.

Water quality is generally good and should meet the standards for all uses. Although there are few industries and no large municipalities in the Door drainage basin, there are localized problems near some communities and industries. Further steps need to be taken in order to protect the basin's water quality.

(4) Fox-Wolf River Basin

The Fox-Wolf River drainage basin comprises 6,520 square miles of Marquette, Green Lake, Winnebago, Fond du Lac, Waushara, Calumet, Columbia, Adams, Outagamie, and Brown Counties, and parts of eight other counties. The Fox River drains 2,738 square miles and the Wolf River drains 3,782 square miles. There are 40 municipal and public institutions (31 with secondary and five with primary treatment) and 68 industries that use the surface waters of the Fox River basin for waste assimilation after treatment.

Water quality is variable throughout the Fox River drainage basin. Most of the inland lakes and other intrastate waters are classified for recreational use and fish and other aquatic life. Lake Winnebago will be classified for these uses in addition to those for industrial and cooling water use and public water supply. The waters near Appleton and in Brown County near Green Bay are exceptions and must meet minimum standards.

Green Bay open waters meet water quality standards and requirements for all water uses. Swimming beach waters should meet the standards for body contact recreation. Harbor areas and shoreline sections in the vicinity of pollution outlets and in areas influenced by the discharges of the Oconto, Peshtigo, Menominee and Fox Rivers should meet minimum water quality standards and requirements for cooling and industrial water supply.

The upper Fox River area of the basin has little industry except in a few areas. Municipalities are small and have relatively stable populations. Surface waters are in generally good condition. In contrast, the lower Fox River area has a relatively fast rate of urban and industrial growth. Some municipalities are in need of improved facilities, and industry must reduce its pollution load to alleviate undesirable conditions. Substantial improvements are needed to meet the proposed water quality standards.

(5) Duck Creek and Pensaukee River Basins

The Duck Creek and Pensaukee River drain 470 square miles of Oconto, Shawano, Brown, and Outagamie Counties. There are six municipal or public institutions (three with secondary treatment) and six industries that use the basin's surface waters for waste assimilation after treatment.

Water quality is generally good, with the exception of several localized problems. There are no large municipalities and only a few industries in the Duck and Pensaukee Basins. The section is chiefly devoted to agriculture. Further steps need to be taken to protect the surface water quality of these basins.

(6) Oconto River Basin

The Oconto River drains approximately 966 square miles of Oconto, Menominee, Langlade, Forest, Marinette, and Shawano Counties. There are six municipalities (five with secondary treatment) and three industries that use the surface waters of the basin for waste assimilation after treatment.

Water quality is generally good and meets the standards for recreational use and for fish and other aquatic life, with several exceptions in some locations. The Oconto River drainage basin is predominantly rural with industries in localized areas. The municipalities have stable populations and are relatively small. With proper use and maintenance of existing treatment systems and construction of additional facilities, the water quality within the basin should improve.

(7) Peshtigo River Basin

The Peshtigo River drains approximately 1,131 square miles of Marinette, Forest, Oconto, and Florence Counties. There are seven municipalities and public institutions (seven with secondary treatment) and four industries that use the surface waters of the basin for waste assimilation after treatment.

The Peshtigo River drainage basin is primarily rural with industries in localized areas. Surface water quality in the northern basin is generally good with some streams in the southern basin degraded by industrial and municipal waste discharges. Improvement of industrial treatment facilities should reduce the problems associated with these plants. The major problem with municipal sewage treatment plants is overloading caused by infiltration of clear water into the sanitary sewer lines. Elimination of clear water from the sewerage system will be necessary to improve the effectiveness of the sewage treatment facilities.

(8) Menominee River Basin

The Menominee River drains approximately 4,186 square miles, of which 1,510 square miles is located in Wisconsin. It flows through Marinette, Florence, Forest, and Vilas Counties. There are five municipalities (three with secondary and two with primary treatment) and three industries that use the surface waters of the basin for waste assimilation after treatment.

Water quality is generally good. All waters meet standards for recreational use and for fish and aquatic life. The only exception is on the Menominee River near industries and municipalities.

The Menominee River drainage basin is sparsely populated except for a few areas. The paper industry is the largest loading source with municipal sewerage facilities contributing most of the remainder. Stream conditions have improved below the industries because of improved treatment or deleted processes. Additional improvements may be possible with a continued upgrading of facilities. Primary sewage treatment plants should be replaced by secondary facilities. Infiltration of clear waters into the sanitary sewer should be eliminated to prevent overloading of treatment facilities.

5.2.3 Planning Subarea 2.2

5.2.3.1 Wisconsin Portion

(1) Pike River Basin

The Pike River drains approximately 51 square miles of southeastern Racine County and northeastern Kenosha County. It drains into Lake Michigan approximately 1½ miles north of the Kenosha Harbor. Along its 14 miles, two municipalities (with secondary treatment) and two industries use its surface waters and tributaries for waste assimilation after treatment. There are two municipalities and two industries that discharge treated wastes directly into Lake Michigan.

Water quality is variable throughout the Pike River basin. The Pike River has an extremely variable flow and experiences periods of no flow at times. Lake Michigan open waters meet the water quality standards and requirements for all uses. Special protection must be accorded to waters designated for fish reproduction and trout waters. Swimming beach waters should meet the standards for recreation, while harbor areas and shoreline sections in the vicinity of pollutional outlets should meet minimum standards and the standards for cooling and industrial water supply.

The entire basin is undergoing rapid urbanization and surface waters of the basin are being impaired for general uses. Consequently high degrees of treatment and strict pollution control measures will be necessary to maintain and improve the water quality in the basin.

(2) Root River Basin

The Root River drains 197 square miles of Racine, Milwaukee, Waukesha, and Kenosha Counties. Throughout its length 14 municipalities and governmental institutions (with secondary treatment) and 10 industries use the surface waters of the Root River basin for waste assimilation after treatment. There are three municipalities and two industries that discharge treated wastes directly into Lake Michigan.

Water quality is variable throughout the Root River basin. Dry-weather stream flows in several stretches now consist primarily of treated wastes. Lake Michigan is the only interstate water of the Root River basin. Open waters of the Lake should meet the water quality standards and requirements for all water uses. Swimming beach waters should meet the standards for body contact recreation. Harbor areas and shoreline sections in the vicinity of pollutional outlets should meet minimum water quality standards and requirements for cooling and industrial water supply.

The entire basin is experiencing a rapid increase in population and urbanization. Surface waters within the basin are being impaired for most uses. Higher degrees of treatment, better control of private sewage systems and the continued trend towards suitably situated central treatment systems will be helpful in improving the area's surface water quality.

(3) Milwaukee River Basin

The Milwaukee River drains approximately 790 square miles of Fond du Lac, Sheboygan, Washington, Ozaukee, and Milwaukee Counties. In its 95 miles of length, 19 municipalities (18 with secondary and one with primary treatment) and 15 industries use its surface waters and tributaries for waste assimilation after treatment. There are also private sources that discharge treated wastes directly into Lake Michigan.

Water quality is variable throughout the Milwaukee River basin. Most intrastate waters are classified for recreational use and fish and other aquatic life. However, the waters near and in Milwaukee County approach the minimum requirements for all water uses. Swimming beach waters should meet the standards for body contact recreation. Harbor areas and shoreline sections in the vicinity of pollution outlets should meet minimum water quality standards and requirements for cooling and industrial water supply.

The area in Milwaukee County is highly urbanized, and the area to the north is undergoing rapid urbanization. Waters of the basin are fertile and streams have low dry-weather flow. Certain surface water sectors are being impaired for present and potential uses. Better waste treatment, preferably by suitably situated central systems would be helpful in improving the water quality of the basin.

(4) Sheboygan River Basin

The Sheboygan River drains approximately 720 square miles of Sheboygan, Manitowoc, Calumet, Fond du Lac, and Ozaukee Counties. There are 18 municipal and public institutions (nine with secondary treatment) and 21 industries that utilize the surface waters of the Sheboygan River basin for waste assimilation after treatment. There are five municipal and public institutions (one with secondary and one with primary treatment) and one industry that discharge treated wastes directly into Lake Michigan.

Water quality is variable, but generally good for the entire Sheboygan River basin. Much of the area is devoted to agriculture and is not heavily urbanized or industrialized. Water quality meets most recreational standards. The only major problem occurs in the case of small unincorporated villages and some industries which create unsatisfactory conditions.

5.2.3.2 Illinois Portion

It has been assumed that during the planning periods between 1970 to 2020 there will be no waste discharges to the Lake Michigan drainage area within the Illinois portion of Planning Subarea 2.2. Presently there are cooling water discharges to the Lake from the Zion nuclear power plant, Federal agency waste discharges at Great Lakes and Fort Sheridan, and some industrial discharges from the Lake through the North Shore Sanitary District to the Des Plaines River, an interior stream of Illinois. Some questions still remain as to what will be done about the Federal agency discharges.

5.2.3.3 Indiana Portion

The principal sources of pollution in the basin in Indiana are industrial wastes, municipal sewage, and combined sewer overflows. Other wastes discharges, such as accidental spills from storage tanks and barges, wastes from lake vessels, barge tows, and pleasure craft, and materials from dredging operations, intermittently may have serious local effects or may cause temporary excessive pollution.

All sewered municipalities have some combined sewers, which contribute to pollution during storm periods. Combined sewer overflows contribute gross bacterial pollution, high suspended solids concentrations, and heavy BOD loadings. Industrial wastes in such systems contribute to the pollution problem.

The water quality in the open water of Lake Michigan is excellent except in periods of high threshold odors and increased concentration of ammonia-nitrogen caused by industrial wastes.

Shore water east of the inner harbor basin is generally satisfactory for whole body contact recreation. However, shore water within the inner harbor basin is of poor quality, which is attributed to combined sewer overflows and waste discharges. Combined sewer overflow at times discharges untreated sewage directly to Lake Michigan. In addition storm water overflows to the Grand Calumet River and the Indiana Harbor Canal contribute to the poor water quality. Reduction of storm overflows will be necessary.

The Inner Harbor basin water quality is generally satisfactory, but there are intermittent periods of high threshold odor, ammonia-nitrogen, phenolic material, and coliform bacteria. This pollution is the result of direct discharges to the Lake from sewers and from the Indiana Harbor Canal.

The unsightly waters of the Indiana Harbor Canal and the Grand Calumet River are characterized by floating debris, oil, discoloration, and high suspended solids loading. These waters are composed of industrial process and cooling water, treated and chlorinated effluents from municipal source treatment plants, and combined sewer overflows. Further treatment of industrial wastes is necessary to enhance the water quality and to meet criteria for the Grand Calumet River, Indiana Harbor Canal, and Lake Michigan waters.

The Grand Calumet River flowing west into Illinois is composed primarily of the treated and chlorinated effluent from the Hammond Sanitary District plant. In addition there is combined sewer overflow during storms and discharge from two industries. This stream is of poor quality due to sludge deposits, low dissolved oxygen, and high bacteria counts.

Improved plant operation and reduction or control including disinfection, of storm water overflow are needed to improve water quality in this section of the Grand Calumet River.

The Little Calumet River flowing west into Illinois is of poor quality as a result of combined sewer overflow during storm periods and raw sewage discharges. The effluent from one industry also discharges to this river. Collection of wastes and their discharge to the Hammond Sanitary District for treatment should improve the water quality.

Water quality is generally good in the Little Calumet River-Burns Ditch-Lake Michigan drainage area. Provision of sewage treatment by all sewered municipalities, improved operation of sewage treatment plants, disinfection of effluents, treatment of all industrial wastes, and improved soil conservation measures to reduce pollution from agricultural runoff are needed to meet the proposed water quality criteria. Water quality in Trail Creek is generally poor due to high bacterial counts resulting from combined sewer overflow during storm periods and from the bypassing of raw sewage.

The water quality in the main body of Wolf Lake is generally good and suitable for whole body contact recreation, but improvement in quality is necessary in the channel portion of the lake.

Lake Michigan is the principal source of water both for municipalities and industrial plants. Thirteen municipalities use surface water and six use ground water. All communities get their surface water from Lake Michigan except Valparaiso, which uses Flint Lake. Industrial process and cooling water is obtained from Lake Michigan, the Grand Calumet River, and Indiana Harbor Canal.

There are four thermal electric generating stations located on Lake Michigan. Their capacities are 616 MW, 529 MW, 978 MW and 215 MW. Cooling towers are planned as additions to the Michigan City Plant and the Bailly Nuclear Plant.

Most water withdrawn by municipalities and industries is returned to Lake Michigan via area streams and the Indiana Harbor Canal. The Grand Calumet River west of Indianapolis Boulevard and the Little Calumet River west of Broadway generally discharge out of the Great Lakes Basin. Only very small portions of the treated effluent from the Hammond Sanitary District and storm overflows following rainfall flow west in the Grand Calumet River and Little Calumet River away from Lake Michigan.

Lake Michigan serves the recreational needs of a large metropolitan area. There are many beaches both in Illinois and Indiana. Yachting, boating, water skiing, swimming, and fishing abound in the southern portion of Lake Michigan. Indiana Dunes State Park is located east of Burns Ditch and a national park is being established for much of the area along Lake Michigan from west of Ogden Dunes to and including Dunes State Park. Wolf Lake is used for swimming, water skiing, and fishing. Lake George and the Little Calumet River-East and tributary streams are used for fishing and partial body contact sports. In the eastern section of the basin small natural lakes are sites of much water-based recreation including swimming, water skiing, boating, and fishing.

Agricultural activity is basically limited to the southern and eastern portions of the basin along the Little Calumet River and its tributaries. Livestock watering is the primary water use, but it is expected that irrigation uses will increase. Irrigation, which uses much surface water, could cause a reduction in stream flow and serious problems to all other stream uses.

Lake Michigan open water and inner harbor basin water must be suitable for public and industrial water supply, maintenance of a well-balanced, warmwater fish population, and water-oriented recreation, and must meet the standards set forth in Regulations SPC 4 and SPC 6, respectively.

Lake Michigan shore water (including the three existing bathing beaches located in the inner harbor area) and Wolf Lake must be suitable for maintenance of a well-balanced, warmwater fish population and whole body contact recreation activities. The shore water will also be required to meet the standards set forth in Regulations SPC 5 and SPC 10.

The Grand Calumet River and Indiana Harbor Canal serve as sources of industrial water supplies and must meet the standards set forth in Regulations SPC 7 and SPC 8.

The Little Calumet River flowing west into Illinois and its Indiana tributaries must be suitable for partial body-contact recreation and will be required to meet the standards set forth in Regulation SPC 9.

The Little Calumet River-Burns Ditch and tributaries and other streams flowing to Lake Michigan will be required to support a well-balanced, warmwater fish population, as well as being suitable for partial body-contact recreation and agricultural uses. They must also meet the standards as set forth in Regulation SPC 1R.

All reservoirs and lakes in the basin (other than Lake Michigan and Wolf Lake as provided for under SPC 5 and SPC 10) must be maintained for whole body contact recreation and will be required to meet the standards as set forth in Regulation SPC 1R.

All waters where natural temperatures permit, will be required to support put-and-take trout fishing.

5.2.4 Planning Subarea 2.3

5.2.4.1 Kalamazoo River Basin

The Kalamazoo River basin encompasses 2,080 square miles. Its principal tributaries are the Rabbit River, Swan Creek, Pine Creek, Gun River, Portage Creek, and Rice Creek. It flows in a west-by-northwest direction, discharging into Lake Michigan at Saugatuck, Michigan.

There are 16 municipal wastewater treatment facilities serving approximately 182,000 people that use surface waters of the Kalamazoo River basin for waste assimilation. Four municipal plants provide primary waste treatment with disinfection, and 11 provide secondary treatment. Some municipalities have storm sewers that discharge into the surface waters. In addition 37 industries use the surface waters for waste assimilation. Three localized reaches of substandard water quality occur on the main stem in the lower 40 miles of the Kalamazoo River basin. One reach receives primary treatment plant effluent, discharges of untreated and partially treated sewage, and an industrial discharge. This reach experiences dissolved oxygen depression and excessive levels of coliforms and nutrients. A program underway will eliminate the discharge of untreated and partially treated sewage. A second reach displays substandard bacteria levels because of an industrial discharge. Changes being made in the method of discharge should alleviate this problem. The third reach receives effluent from a primary municipal treatment plant, two industrial discharges, and some uncollected sewage discharges. This reach displays dissolved oxygen depression and excessive levels of coliforms, residues, toxic substances, and nutrients.

Three substandard reaches are located on tributaries in this area. Two are on the Rabbit River and one is on Mann Creek. Two reaches are degraded by untreated and partially treated sewage and both display high coliform densities. Corrective programs are underway in both communities. The third tributary reach receives periodic discharges from a community lagoon and discharges from an industry that has experienced sporadic control failures. This reach displays depressed dissolved oxygen and high coliform densities. The industry responsible has completed additional collection facilities designed to insure more reliable treatment.

An extensive reach of the Kalamazoo River is substandard in quality in and below the City of Kalamazoo for a distance of approximately 20 miles. The greater Kalamazoo area contains a large number of industries including 15 plants that manufacture paper products. Four municipal waste treatment plants discharge into this river reach. Since 1955 organic loads discharged into the river have been curtailed and water quality has substantially improved. The average 1955 total organic load for both municipal and industrial discharges was approximately 98,500 pounds of BOD_5. In 1968 the average total organic load was approximately 28,000 pounds of BOD_5, representing a 70 percent reduction from the 1955 level.

Although water quality has been improved, current waste loads are still too great to maintain acceptable water quality. Throughout the critical 20-mile reach, dissolved oxygen is severely depleted and excessive amounts of suspended solids and nutrients are present. In particular zones excessive levels of coliforms, toxic substances, residues, taste and odor substances, and dissolved solids have been recorded. Portage Creek, a minor tributary which flows through the City of Kalamazoo, receives large amounts of organic wastes and exhibits similar substandard conditions. The industry discharging organic wastes into Portage Creek has an active program under way to substantially reduce discharges to Portage Creek by discharging a portion of their wastes to the Kalamazoo municipal system.

Upstream from Kalamazoo one localized substandard reach occurs below a community that discharges untreated sewage. A corrective program is being implemented.

A reach of substandard quality is located below the City of Battle Creek. Secondary treatment is provided at the Battle Creek waste treatment plant, but operating difficulties have hindered efficiency. Storm sewers containing industrial wastes contribute oils and acids to the river. The river exhibits high nutrient and residue levels and marginally substandard toxic concentrations.

The Battle Creek River joins the Kalamazoo River at Battle Creek. Excessive suspended solids and nutrients are occasionally found in the Battle Creek River within the city. This degradation results from control failures at industrial treatment facilities that normally provide satisfactory control. Three additional substandard reaches occur upstream in the Battle Creek River below small communities. One community has no treatment, one has secondary treatment, and another has a lagoon and some uncollected sewage. All three reaches display elevated nutrients and coliform levels and one reach also exhibits low dissolved oxygen. Corrective programs are under way in two communities.

Above the City of Battle Creek the Kalamazoo River and its tributaries generally exhibit good quality, but localized substandard conditions are found in three main stem reaches. One reach, degraded by untreated and semi-treated sewage discharges, displays high coliform and nutrient levels. A corrective program is under way. Two reaches receive effluents from primary municipal treatment plants and industrial discharges. Both reaches display elevated concentrations of nutrients, residues, suspended solids, and toxic substances. Three industries involved are investigating additional treatment facilities. There is also one short reach of substandard quality on Rice Creek, a tributary of the Kalamazoo River. This reach receives raw sewage discharges and displays high coliform densities. Action has been taken to bring this discharge under control.

5.2.4.2 Black River Basin (Holland)

The Black River flowing through the Holland area exhibits adequate water quality in upstream areas and poorer quality in downstream reaches. One reach of substandard quality occurs in the North Branch where high concentrations of nutrients and dissolved solids are present and dissolved oxygen is marginally substandard. The lower portion of the river forms Lake Macatawa and the water quality reflects the surrounding concentration of population and industry. This reach exhibits dissolved oxygen depression and elevated levels of nutrients, coliforms, suspended and total dissolved solids, toxics and residues. Two industries discharging into Lake Macatawa are designing additional treatment facilities and one company is constructing additional treatment facilities.

5.2.4.3 Black River Basin (South Haven)

The second Black River, flowing through South Haven, is generally of acceptable quality throughout its length, but three minor reaches of substandard quality have been identified. One upstream reach displays elevated nutrient and coliform levels originating from a raw sewage discharge. This community is under orders to construct treatment facilities. A second upstream reach displays excessive concentrations of suspended solids, residues, and toxics which originate in an industrial discharge. Near the mouth a third reach displays high nutrient and coliform levels and, at times, marginal dissolved oxygen concentrations.

5.2.4.4 Paw Paw River Basin

Draining approximately 446 square miles, the Paw Paw River discharges into the St. Joseph River a short distance above its confluence with Lake Michigan. Because of its small size the Paw Paw River exhibits rapid changes in water quality when subjected to man's influences.

Five primary and two secondary municipal treatment plants serving a population of approximately 37,000 (1964 estimate) use surface waters of the basin for waste assimilation. Some municipalities with storm sewer systems discharge into the surface waters. In addition 10 industries use the surface waters for waste assimilation.

Water quality is generally good, particularly in the upper portions of the basin. Five limited reaches of substandard quality have been identified in the basin. All five reaches are located in small communities that provide primary waste treatment and contain some small industrial discharges. Typically the five reaches display elevated levels of nutrients and coliforms and lowered dissolved oxygen concentrations. In some reaches excessive concentrations of toxics, residues, and suspended and dissolved solids also impair water quality.

5.2.4.5 St. Joseph River Basin

The St. Joseph River and its tributaries form a network draining approximately 2,600 square miles of southwestern Michigan and 1,684 square miles of northwestern Indiana. The river originates in southern Michigan, flows southwesterly into Indiana, and then flows northwesterly back through Michigan where it discharges into Lake Michigan approximately 25 miles north of the Indiana State line at Benton Harbor-St. Joseph.

Fourteen municipal and institutional wastewater treatment facilities use surface waters of the St. Joseph River basin for waste assimilation. Seven facilities provide primary waste treatment and seven provide secondary waste treatment. There are also 13 municipalities in the basin with storm sewer systems that discharge into the surface waters. In addition 34 industries use the surface waters for waste assimilation.

The main stem of the St. Joseph River from the Niles Dam downstream to the mouth is of reasonably good water quality. The lower few miles of the river are rendered substandard in quality by treatment plant, industrial, and stormwater discharges. Limited amounts of uncollected sewage and significant amounts of oils pass through storm sewers. This reach exhibits dissolved oxygen depression and elevated levels of coliforms, nutrients, suspended solids, and residues. Ox Creek, a minor tributary, receives uncollected sewage discharges and untreated industrial wastes and displays high residue and coliform levels and depleted dissolved oxygen. This lower portion of the river is also subjected to maintenance dredging which increases turbidity and generally degrades water quality.

Upstream to the Niles Dam, six additional substandard reaches have been identified. Three reaches are located on the main stem and three are on small tributaries. Degraded by untreated and semi-treated sewage discharges, one reach exhibits high coliform densities. Two tributary reaches are located below communities with inadequately treated municipal discharges and one is below an inadequately treated industrial waste discharge. Both reaches display dissolved oxygen depletion and high coliform densities. One reach also displays excessive concentrations of toxics and the other displays marginally substandard residue and toxic concentrations. Three industries that discharge into these two reaches recently added additional waste treatment facilities.

The three main stem reaches each receive effluent from a primary municipal treatment plant, and one reach also receives several industrial discharges. Heavy algae growths in these reaches are caused by enrichment from immediate waste sources, wastes from upstream population centers and from other basin waters. All three reaches display dissolved oxygen depletion and excessive nutrients. In some parts excessive concentrations of residues and suspended solids are present. In accordance with Michigan's interstate water quality standards enforcement programs, the three primary treatment plants discharging into this reach were required to institute secondary treatment with phosphate removal by December 1, 1972. Stipulations incorporating these requirements have been signed by two communities and discussions are continuing with the third community.

Water quality in the Indiana portion of the St. Joseph River basin is generally good. The most urgent problem is bacterial pollution of the St. Joseph River in the Elkhart-South Bend area caused by treated municipal sewage. However, the principal cities causing this condition are now installing or will soon install effluent chlorination facilities which will enable the river to meet the standards.

All but five of the sewered municipalities (representing less than 2 percent of the population) provide sewage treatment facilities.

At present no surface waters are used for public water supplies. One industry uses water from the St. Joseph River in Mishawaka and one industry uses water from the Elkhart River at Elkhart. In addition a 400 megawatt thermal electric generating station uses the St. Joseph River at Mishawaka.

Within the Plan for Implementation, the waters of this basin should be suitable for all uses in the near future except trout fishing.

Upstream from the Indiana-Michigan State line to its headwaters, the St. Joseph River is of good water quality. Nine short main-stem reaches of substandard quality are located in this portion of the basin below the discharge of wastes originating from population centers, industries, and commercial establishments.

Six reaches are near communities that discharge untreated or partially treated sewage resulting in elevated coliform and nutrient levels. Two of the six reaches are also degraded by industrial and commercial waste discharges and may exhibit excessive concentrations of residues, toxics, or suspended solids. Final orders of determination have been adopted for two communities discharging raw sewage and a third community has treatment facilities under construction.

Three other substandard main stem reaches receive effluent from one primary and two secondary municipal treatment plants. Depressed dissolved oxygen and excessive nutrient concentrations are characteristic of these reaches. One reach also displays excessive residue concentrations resulting from stormwater discharges. Stipulations being negotiated require the addition of phosphate removal by all three treatment plants and secondary treatment by two plants.

Water quality is generally very good in the tributaries of the upper St. Joseph River. Seven localized substandard reaches have been identified. Two reaches are located on the Coldwater River and the other reaches are on the White Pigeon River, Fawn River, Portage River, Prairie River, and Swan Creek. All seven reaches are affected by municipal discharges, one of which receives partial treatment only. Five of the seven reaches are also affected by industrial discharges. Nutrient concentrations are high in all seven reaches and dissolved oxygen depression occurs in four reaches. Some reaches exhibit substandard concentrations of toxics, residues, suspended solids, and total dissolved solids. One industry with a polluting discharge recently completed additional treatment facilities, and a second industry is designing additional treatment facilities. One community is under orders to eliminate the discharge of untreated and partially treated sewage. Stipulations requiring phosphate removal are being processed for most communities that discharge into the seven tributary reaches of substandard quality.

5.2.4.6 Grand River

The Grand River basin, draining approximately 5,570 square miles, is the second largest river basin in Michigan. Its major tributaries are the Rogue, Flat, Thornapple, Maple, Looking Glass, and Red Cedar Rivers. The Grand River discharges into Lake Michigan at Grand Haven, Michigan.

Sixty-nine communities with a total population of approximately 685,000 discharge wastes into the basin's waters. Twenty-one communities with approximately 10 percent of the total population served provide primary waste treatment with disinfection and 26 communities with approximately 80 percent of the population served provide some form of secondary waste treatment. Twenty-two communities with 10 percent of the population are unsewered and rely on individual waste disposal systems. Also, there are communities with separate storm sewer systems that discharge into the surface waters, and 60 industrial establishments use the surface waters for waste assimilation.

(1) Main Stem

The water quality of the lower two miles of the Grand River, which receives sewage treatment plant effluents, stormwater overflows, and industrial discharges from the Grand Haven-Spring Lake area, is substandard. The river has high coliform, suspended solids, and nutrient levels. Its dissolved oxygen and residue levels are marginally substandard.

Contracts have been awarded for construction of joint waste treatment facilities with nutrient control to serve two municipalities and some industries.

Upstream from the Grand Haven-Spring Lake area, water quality is generally good with the possible exception of accumulated nutrients from the total watershed. Two substandard reaches are found in Crockery Creek watershed downstream from communities that discharge untreated and partially treated sewage. Both reaches exhibit high levels of coliforms and nutrients. One community is constructing collection and treatment facilities. One reach of Deer Creek is also substandard. This reach, which receives some untreated sewage and the discharge of a secondary treatment plant, experiences very low warm-weather flows and greatly reduced assimilative capacity. The reach exhibits dissolved oxygen depletion and elevated levels of coliforms, nutrients, and suspended solids.

Below the City of Grand Rapids, the Grand River has up to 15 miles of substandard conditions depending on the season and other factors. This reach receives effluents from three municipal treatment plants, industrial discharges, stormwater overflows, and tributary waste loads from the greater Grand Rapids area. The river displays elevated levels of coliforms, nutrients, residues, and taste and odor substances. Dissolved oxygen depletion and toxic concentrations are marginally substandard. A number of small tributary streams receive treated and untreated wastes from outlying communities and townships. Substandard quality areas are found in Rush, Buck, Plaster, Indian Mill, and Mill Creeks. All show high nutrient and coliform levels, and certain reaches experience dissolved oxygen depletion and increases in residues and suspended solids.

Corrective programs are under way in five of these outlying communities. In addition, Grand Rapids, Wyoming, and Grandville plan to improve their collection systems and expand treatment plant capacity. All three cities have initiated steps to provide for phosphate removal.

From the Grand Rapids area upstream to the Grand Ledge area, the Grand River maintains generally good quality with the exception of nutrients. There are two localized reaches of substandard quality. One reach, affected by the seasonal discharge of industrial wastes, experiences high coliform and nutrient levels and lowered dissolved oxygen. The second reach, experiences high coliform and nutrient levels.

An extensive reach of substandard water quality occurs in the Grand River in and below the Lansing area. A short distance above Lansing, the river receives effluent from the Delhi Township treatment plant. Within Lansing, stormwater overflows degrade the Moore's Pare Impoundment and the river with bacteria. Stormwater overflows are a major problem because the Lansing system contains 51 stormwater bypasses. Two steam electric generating stations, located within the city, also limit the thermal load of the river to approximately 15 billion Btu/day during the summer. During warm-weather periods of low flow, the thermal load probably produces substandard river temperature changes.

The Red Cedar River joins the Grand River in Lansing and carries a substantial residual waste load. On the downstream side of Lansing, the river receives secondary effluent from the Lansing sewage treatment plant. This discharge imposes a severe load on the river, and substandard quality conditions prevail for approximately 15 miles downstream. Midway and near the lower end of this reach, additional waste loads are discharged by the Delta Township and Grand Ledge treatment plants. Within this reach the river exhibits dissolved oxygen depletion and high levels of coliforms, nutrients, and suspended and dissolved solids. Very active nitrification exerts more than 75 percent of the total oxygen demand in the reach between Lansing and Grand Ledge.

The City of Lansing has recently expanded treatment plant capacity, increased treatment efficiency, and initiated a small program of sewer separation. To satisfy intrastate water quality standards, a higher degree of waste treatment will be necessary for all major facilities in the Lansing area.

Upstream from Lansing two minor reaches of substandard quality are located on the main stem. Another reach is on Huntoon Creek. These reaches are located below small communities, two of which provide primary treatment and one of which provides no treatment. Elevated coliform and nutrient levels are found in all three reaches. Depleted dissolved oxygen and excessive suspended and dissolved solids appear in two reaches. A program underway will eliminate the one raw sewage discharge.

In the Jackson area the Grand River exhibits substandard quality over a considerable reach. Suburban communities discharging raw and partially treated sewage degrade the river a few miles above the City of Jackson. This reach displays depleted dissolved oxygen and excessive amounts of nutrients, coliforms, residues, and suspended and dissolved solids.

The river receives additional waste loads within Jackson from industrial discharges and stormwater overflows. At the downstream edge of Jackson the river receives the Jackson sewage treatment plant effluent. The City of Jackson is completing construction of additions and improvements to its wastewater treatment plant. The Southern Michigan State Prison is to abandon its existing treatment facilities and connect to the city system upon completion of expansion at the city plant.

Treatment efficiency is very good at both plants. The Jackson plant, for example, removes approximately 92 percent of the suspended solids and 93 percent of the biochemical oxygen demand. Nevertheless, the effluent loads exceed the river's limited waste assimilation capacity during drought flows. The river remains substandard in quality for approximately 13 miles downstream. Sludge deposits and aquatic growths, sometimes unusually heavy, are commonly found in this reach. Dissolved oxygen is severely depleted and excessive amounts of nutrients, coliforms, and suspended and dissolved solids are present.

The City of Jackson has recognized the need for additional treatment and studies are under way. A pilot tertiary treatment plant is in operation. Also, four surrounding townships are evaluating the possibility of joining the Jackson system. The Southern Michigan State Prison is completing construction of a tertiary treatment lagoon which will reduce present waste loads to the river.

(2) Rogue River Basin

The Rogue River maintains acceptable quality throughout most of its drainage area, but three reaches of substandard water quality have been identified. One reach, which is acceptable except for coliform levels, is located below a small community discharging raw sewage into a feeder stream. A final order of determination has been issued against this community. Another reach is affected by oily residues from an industrial operation. Management has undertaken a program to provide adequate treatment. The most serious problem reach is found in the lower part of the basin. This reach receives effluent from a primary sewage treatment plant and discharges from two heavy waste-producing industries. The reach shows depressed dissolved oxygen and high levels of coliforms, nutrients, residues, and suspended solids. Plans are under way to remove the municipal wastes and the wastes of one industry from the basin. The second industry is designing plans for additional treatment facilities utilizing land disposal measures.

(3) Thornapple River Basin

Water quality is generally good throughout the Thornapple River basin, but substandard water quality has been observed in eight short stream reaches. Seven of these stretches are located below small basin communities that discharge raw sewage or sewage that has received only primary treatment (chiefly septic tanks). The principal stream effects are elevated coliform and nutrient levels and, in a few stretches, increased suspended solids and marginal dissolved oxygen concentrations. Corrective programs are under way to eliminate two raw sewage discharges. Jordan Lake has received the secondary effluent from a community of 1,800 people for several years and experiences severe nutrient problems. A program has recently been completed that removes the effluent from the lake and uses land disposal.

(4) Flat River Basin

Throughout the basin water quality is generally good. Three limited stream stretches of substandard quality are located downstream from small basin communities. These areas display elevated coliform and nutrient levels resulting chiefly from combined sewer overflows, uncollected sewage, and lack of nutrient removal facilities.

Some residues and occasional toxic substances of industrial origin are found in two substandard areas. The industries responsible either have inadequate control facilities or an unreliable degree of control protection. These have been identified and remedial control programs are under way.

(5) Maple River Basin

The Maple River maintains good water quality generally. This drainage area includes Fish, Pine, and Stoney Creeks. Nine short reaches of substandard water quality have been identified. Seven reaches are located downstream from small communities that discharge untreated or partially treated sewage. Two reaches are affected by effluent from secondary treatment plants. Milk processing establishments have sporadically degraded certain stream reaches through control failures. Elevated coliform and nutrient levels are present in all nine reaches. Depleted dissolved oxygen appears in half of the reaches, and other parameters are affected in certain reaches. Four communities that discharge raw sewage have construction programs under way or are involved in enforcement proceedings.

(6) Looking Glass River Basin

Low stream velocity and volume during summer periods are characteristic of the Looking Glass River. Three short stream reaches are substandard in water quality. These reaches receive raw or partially treated sewage from small basin communities and one also receives effluent from a small primary treatment plant. Typically the substandard stream reaches have elevated coliform and nutrient levels, low dissolved oxygen concentrations, and in certain reaches, excessive suspended and dissolved solids. There are no apparent problems of industrial origin. Facilities under construction in three communities will process raw or partially treated sewage discharges.

(7) Red Cedar River

Water quality is good throughout most of the Red Cedar River with the exception of the lower reaches, where there are five reaches of substandard quality. The most serious problem occurs in the last few miles of the river below East Lansing. At times effluent from the East Lansing treatment plant constitutes a major portion of the river's flow. This reach exhibits dissolved oxygen depletion, excessive nutrient concentrations, and marginally substandard coliform densities. Heavy aquatic growth, common in this reach, is a result of the nutrient-enriched waters. The city of East Lansing has awarded contracts for construction of wastewater treatment facilities which will enlarge plant capacity and provide tertiary treatment and nutrient control.

The other four substandard reaches located in upstream areas, are of limited extent. Degraded by untreated and partially treated sewage, one reach displays high coliform densities and marginally substandard dissolved oxygen depletion. A second reach receives discharges from a community lagoon and one industry. This reach displays excessive concentrations of nutrients, suspended solids, toxics, and residues. The responsible industry has signed a stipulation to upgrade treatment. A third reach which receives effluent from a primary municipal treatment plant exhibits dissolved oxygen depletion and excessive levels of nutrients and suspended solids. A fourth reach receives the effluent of a secondary municipal treatment plant and is substandard in nutrient concentrations.

5.2.4.7 Minor Drainage Basins

One substandard reach of the Pigeon River is affected by a seasonal lagoon discharge. This reach exhibits high nutrient and lowered dissolved oxygen levels.

Three localized reaches of the Galien River are degraded by the discharge of raw and partially treated sewage from three small communities. Elevated coliform and nutrient levels are the principal water quality effects. A fourth reach receives inadequately treated municipal wastes and exhibits high nutrient and lowered dissolved oxygen levels. Orders to construct treatment facilities have been issued to two townships and two additional communities. Another community has signed a stipulation to upgrade treatment and to institute phosphorus removal.

5.2.5 Planning Subarea 2.4

5.2.5.1 Muskegon River Basin

The Muskegon River, with a drainage area of 2,660 square miles, originates with the discharge from Houghton Lake in Roscommon County. It flows southwesterly and discharges into Lake Michigan at Muskegon, Michigan. Nine municipalities, three providing primary treatment and three providing secondary treatment, and 20 industries use the surface waters of the Muskegon River basin for waste assimilation.

Water quality is generally good throughout the entire reach of the river, but eight reaches of substandard quality have been identified in the basin. Four occur on the main stem of the river and four occur on tributary streams. Construction is under way on a county wastewater system which will remove the existing discharge into the surface waters in the Muskegon metropolitan area and utilize land disposal.

Muskegon Lake, located at the mouth of the Muskegon River, is substandard in quality due to excessive levels of coliforms and nutrients. The lake receives discharges from two municipal primary treatment plants, one power generating station, and ten industries, plus storm water overflows and tributary inflows. The industrial portions of the lakefront also display substandard levels of residues, suspended solids, oil films, and toxics. In the past substantial oil losses from large vessels have degraded the lake. Since 1968, water quality has been upgraded considerably and pollution control activities are under way.

The entire river, except for mixing zones, is protected for total body contact recreational use. For short periods, particularly after rainfalls, localized upstream river reaches below population centers may display coliform levels in excess of that specified by the total body contact standard. Three upstream reaches on the main stem and four reaches on tributaries have been classified as substandard. All three main stem reaches receive effluent from primary municipal treatment facilities, and all three display excessive nutrient concentrations. One of these reaches also displays excessive coliform densities.

The Hersey River, Clam River, Middle Branch River, and Tamarack Creek each have one reach of substandard quality. Degraded by the discharge of untreated sewage, two reaches have high coliform and nutrient levels. One of the communities responsible is completing construction of a lagoon. A third reach is degraded by the discharge of an inadequate municipal treatment plant. This reach displays dissolved oxygen depletion and elevated levels of coliforms, toxics, suspended solids, and nutrients. The fourth reach receives discharges from an industry and exhibits elevated concentrations of toxics and suspended solids.

5.2.5.2 White, Pentwater, and Pere Marquette River Basins

The White River, Pentwater River, Pere Marquette River, and a number of minor streams drain an area along Lake Michigan located between the lower portion of the Muskegon and Manistee River basins.

The White River, draining an area of 526 square miles, flows into White Lake at Montague and Whitehall before discharging into Lake Michigan. Two primary municipal treatment plants and three industries discharge treated waste effluents into the basin's surface waters. Water quality is good throughout the basin with the exception of White Lake. White Lake receives discharges from three industries and one municipality plus stream loadings from upstream areas. The lake exhibits high nutrient levels and depressed dissolved oxygen. Excessive algae and weed growths have impaired certain water uses. Wastewater treatment facilities under construction will remove the existing discharges in the Whitehall-Montague area and use land disposal.

The Pentwater River has a drainage area of 172 square miles and discharges into Lake Michigan through Pentwater Lake at the City of Pentwater. Two municipal waste treatment lagoons discharge into the basin's surface waters. There are no industrial surface water discharges. Water quality is good throughout the basin. A small increase in chloride and nutrient concentrations has been observed in the lower reaches of the river. There are two reaches of marginally substandard water quality, both located below municipal lagoons. Both reaches display elevated nutrient levels during seasonal discharge periods.

Draining an area of 740 square miles, the Pere Marquette River discharges into Lake

Michigan through Pere Marquette Lake at Ludington. The river is currently under study for designation as a wild and scenic river. The general high quality of its water is a major factor in its consideration as a wild river. Two municipalities, one with primary treatment facilities and one with a lagoon, and four industries discharge treated wastes into the basin's surface waters. Water quality is generally good although three reaches of substandard quality have been identified. Pere Marquette Lake receives discharges from two industries and one municipal primary treatment plant, some uncollected wastes discharged through storm sewers, and stream loadings from upstream areas. The lake exhibits elevated levels of coliforms and toxics.

One upstream reach that receives raw sewage discharges from a small community displays elevated levels of coliforms and nutrients. A second upstream reach is affected by the seasonal discharge of a community lagoon and displays marginally substandard nutrient concentrations.

5.2.5.3 Manistee River Basin

The Manistee River draining an area of 2,057 square miles, discharges into Lake Michigan through Manistee Lake at Manistee, Michigan. One municipal primary waste treatment plant and five industries discharge treated wastes into the basin's surface waters. All six waste discharges are located in the lower portion of the basin in the Manistee Lake area.

Water quality is generally excellent in the upstream portions of the basin above Manistee Lake. There is one upstream reach of substandard quality located on a minor tributary. This reach receives discharges of untreated sewage and experiences high coliform levels.

Substandard water quality conditions are found in Manistee Lake. As a result of the salt and chemical brine industries, chloride and other dissolved solids concentrations rise sharply in the Manistee Lake area. Manistee Lake exhibits depressed dissolved oxygen in certain areas and elevated levels of nutrients, suspended solids, and total dissolved solids. One major industry has a corrective program under way.

Ground-water contamination has also been observed in the Manistee area. Studies are under way to determine the source of this contamination, whether man-made or natural, and to devise possible remedial actions.

5.2.5.4 Betsie, Boardman, Elk, and Pine River Basins

The northwestern portion of the Michigan Lower Peninsula, between the Manistee area and the Straits of Mackinac, contains many small streams that discharge directly into Lake Michigan. The principal streams in this region are the Betsie, Boardman, Pine, and Elk Rivers.

Draining 252 square miles, the Betsie River discharges into Lake Michigan at Frankfort, Michigan. Three primary municipal treatment plants and three industries discharge treated wastes into the basin's surface waters. Although water quality is generally very good throughout the basin, Betsie Lake and one upstream reach display substandard quality. The communities and one industry that discharge into the lake have been notified of the need to provide improved waste control facilities.

The Boardman River drains an area of 295 square miles and discharges into Grand Traverse Bay at Traverse City, Michigan. Two municipal treatment plants, one with primary and one with secondary treatment, and four industries discharge treated wastes into the basin's surface waters. Water quality is good throughout the upstream portion of the basin. At Traverse City the river is affected by municipal and industrial discharges and exhibits elevated levels of coliforms and nutrients. The city has recently completed secondary treatment facilities with phosphorus removal.

The Pine River drains an area of 368 square miles. The Jordan and Boyne Rivers meet at Lake Charlevoix to form the Pine River. Three primary municipal treatment plants and three industries discharge treated wastes into the basin's surface waters. Water quality is generally very good in the upper portion of the basin, but there are three areas of substandard quality in the lower portion of the basin. Two sections of Lake Charlevoix contain nutrient concentrations sufficient to stimulate weed growth and both sections display elevated levels of suspended solids of industrial origin. One of the two reaches also experiences lowered dissolved oxygen below Lake Charlevoix. One reach of the Pine River is substandard in quality due to elevated nutrient concentrations.

Draining an area of 452 square miles, the Elk River discharges into Grand Traverse Bay near Elk Rapids, Michigan. The basin contains a number of large, interconnected lakes including Torch, Elk, Bellaire, and Intermediate Lakes. Principal tributary streams include the Intermediate and Rapid Rivers. One municipality and five industries discharge treated wastes into the basin's surface waters. Water quality is good throughout the basin although there are two reaches of substandard quality. One reach near the mouth of the river receives municipal and industrial discharges and displays elevated levels of nutrients and coliforms and depressed dissolved oxygen. One upstream reach that is degraded by the discharge of untreated sewage displays high coliform levels.

5.2.5.5 Manistique River Basin

The Manistique River drains an area of 1,450 square miles and discharges into Lake Michigan at Manistique, Michigan. One municipal primary wastewater treatment plant and one industry, both located a short distance above the mouth of the river, discharge treated wastes into the basin's surface waters. Water quality is generally excellent in the basin although one reach of substandard quality occurs near the mouth of the river. This reach receives municipal and industrial waste discharges and exhibits elevated levels of nutrients, suspended solids, and dissolved solids. The community involved has authorized engineers to prepare construction plans for improved wastewater treatment disposal including secondary treatment and phosphorus removal. The industry is proceeding with its own treatment facilities.

5.2.5.6 Escanaba River Basin

The Escanaba River, draining an area of approximately 923 square miles, terminates at Little Bay de Noc on Lake Michigan. Two municipalities, one with septic tanks and one with waste stabilization lagoons, and two industries, use the basin's surface waters for waste assimilation.

Water quality is generally good throughout the basin although there are two localized reaches of substandard water quality. One reach receives effluents from a community septic tank without chlorination and experiences elevated coliform levels. The second reach is affected by industrial wastes and experiences depressed dissolved oxygen and elevated levels of suspended solids. The industry responsible recently completed secondary treatment facilities.

5.2.5.7 Ford, Days, Rapid, Whitefish, and Sturgeon River Basins

The Ford, Days, Rapid, Whitefish, and Sturgeon Rivers have a combined drainage area of approximately 780 square miles. All flow in a southerly direction and discharge into Green Bay. With one exception in the Rapid River, there are no known sources of pollution in these basins. Water quality is generally excellent with natural conditions prevailing in almost all areas. One reach of the Rapid River is substandard in quality due to the discharge of a small quantity of untreated sewage and septic tank effluents through a storm sewer. This reach exhibits high coliform densities.

5.3 Water Quality Control Needs

Existing water quality conditions in the Lake Michigan basin were reviewed in Subsection 5.2. This subsection is principally concerned with water quality control needs to maintain water quality standards in future years. The primary objectives of this subsection are to:

(1) project waste water treatment costs, including that for phosphorus removal and advanced waste treatment, for the study periods 1970 to 1980, 1980 to 2000, and 2000 to 2020

(2) identify reaches of streams where advanced waste treatment will be required, for each study period

(3) identify other water quality control needs

5.3.1 Advanced Waste Treatment Needs (General)

The methods used in this study to determine the need for advanced waste treatment are described in the Introduction. Considerable data from the Michigan Water Resources Commission were used to augment this methodology to achieve increased accuracy. Of particular importance were the local official pollution control plans submitted by local governments as a requirement for financial assistance under Michigan's Clean Waters Bonding Program. These local plans generally specified expected service areas, waste loads, and other factors for the next 20 to 30 years.

5.3.2 Wastewater Treatment Cost Estimates (General)

The methods used to determine estimates of wastewater treatment costs are summarized in the Introduction. All cost estimates presented in the following sections are order-of-magnitude estimates only and may not be highly accurate.

5.3.3 Planning Subarea 2.1 — Lake Michigan Northwest

Planning Subarea 2.1 embraces three counties in Michigan's Upper Peninsula and 20 counties in northeastern Wisconsin. Projected wastewater volumes, advanced waste treatment needs, and treatment cost estimates are discussed separately for the Michigan and Wisconsin portions of the planning subarea.

5.3.3.1 Michigan Portion

(1) Population and Wastewater Volumes

The Michigan portion of Planning Subarea 2.1 is largely rural with low population density. In recent decades the area's population has declined, but this trend is expected to reverse by 1980 and modest population growth is anticipated through 2020. In 1970 nine municipal sewage treatment plants served approximately 35,600 people or 54 percent of the total population. Projected levels of population, population served, and wastewater volume are presented in Table 7–19.

TABLE 7–19 Projections of Wastewater Flows and Population Served, Planning Subarea 2.1—Michigan Portion

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities
1970	62,153	35,600	4.7	9.0
1980	66,100	39,500	5.2	9.0
2000	74,100	47,500	7.4	8.0
2020	86,100	59,000	9.3	12.0

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

(2) Advanced Waste Treatment Needs

There are no advanced waste treatment needs anticipated in the Michigan portion of Planning Subarea 2.1 in the study period.

(3) Treatment of Cost Estimates

Projections of capital and operating costs for municipal treatment plants by planning period are presented in Table 7–20.

TABLE 7–20 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 2.1—Michigan Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	6.1	0.5
1980–2000	5.2	0.8
2000–2020	6.1	1.0

These estimates exclude the cost of industrial treatment facilities, stormwater control facilities, and sewer collection systems. The estimates in this table are essentially those costs necessary for upgrading existing facilities to full basic treatment (secondary treatment and phosphorus removal generally), for providing adequate treatment facilities to handle future increased wastewater flows, and for meeting treatment facility repair and replacement needs.

5.3.3.2 Wisconsin Portion

(1) Population and Wastewater Volumes

The Wisconsin portion of Planning Subarea 2.1 supported a population of 885,000 in 1970. The population was concentrated in the Green Bay, Menasha, Neenah, Oshkosh, and Fond du Lac area.

Approximately 1,860 manufacturing plants were located in the Wisconsin portion of Planning Subarea 2.1 in 1967. Manufacturing is largely composed of industries involving agricultural and forest products. Both the Fox and Menominee River basins support concentrations of pulp and paper mills.

Population in the Wisconsin portion of Planning Subarea 2.1 is projected to increase nearly two-fold during the next 50 years as shown in Table 7–21.

(2) Advanced Waste Treatment Needs

Advanced waste treatment needs have been identified for three river basins in Planning Subarea 2.1. A water quality problem is identified for the Fox River from Lake Winnebago

TABLE 7-21 Projections of Wastewater Flows and Population Served, Planning Surbarea 2.1—Wisconsin Portion

Year	Subarea Population	Population Served by Municipal Facilities[a]	Wastewater Flows (MGD) Municipal Treatment Facilities[b]	Industrial Treatment Facilities
1970	885,100	509,000	87.7	310.0
1980	1,016,100	640,000	123.2	282.0
2000	1,283,500	907,000	184.9	246.0
2020	1,639,900	1,264,000	270.7	413.0

[a]Assume population served by municipal water supply systems as projected in Appendix 6, Water Supply--Municipal, Industrial, and Rural, equals population served by municipal wastewater treatment facilities.

[b]Total of domestic, commercial, and industrial wastewater estimated to be treated in municipal wastewater treatment facilities. Assume this regards total municipal wastewater as projected in Appendix 6.

to the mouth where several large paper mills and municipal plants are located. Tertiary treatment costs of more than $8 million are estimated for municipal sources. Water quality problems have also been identified for the Oconto and Peshtigo Rivers. Paper mills located at Oconto Falls on the Oconto River and Peshtigo on the Peshtigo River are the source of these problems.

(3) Treatment Cost Estimates

Projections of capital and operating costs for municipal treatment plants by planning periods are presented in Table 7-22.

TABLE 7-22 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 2.1—Wisconsin Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970-1980	66.8	6.9
1980-2000	94.5	9.6
2000-2020	125.8	13.3

These estimates exclude the cost of industrial wastewater treatment facilities, stormwater facilities, and sewer collection systems.

5.3.4 Planning Subarea 2.2—Lake Michigan Southwest

Planning Subarea 2.2 includes seven Wisconsin counties, six Illinois counties, and four Indiana counties. It is among the most heavily populated and industrialized areas in the Great Lakes Basin. In 1970 more than nine million persons resided in Planning Subarea 2.2. More than half the population is concentrated in the Cities of Milwaukee, Chicago, Gary, and Hammond. By 2020 the planning subarea's population is expected to nearly double.

Advanced waste treatment needs and treatment cost estimates are discussed separately by State for Planning Subarea 2.2.

5.3.4.1 Wisconsin Portion

(1) Population and Wastewater Volumes

The Wisconsin portion of Planning Subarea 2.2 comprises seven counties including the Milwaukee metropolitan area and the Cities of Racine and Kenosha. Approximately 1,659,400 people resided in the seven-county area in 1970. By the year 2020 the population is projected to increase by approximately 250 percent to nearly four million. In addition to numerous manufacturing establishments the area also supports substantial dairy activities. Projected levels of population and wastewater volumes are presented in Table 7-23.

TABLE 7-23 Projections of Wastewater Flows and Population Served, Planning Subarea 2.2—Wisconsin Portion

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities
1970	1,659,400	1,501.6	211.1	321.0
1980	2,199,400	1,841.6	329.0	233.0
2000	2,997,000	2,639.2	493.2	265.0
2020	3,992,500	3,634.7	715.2	396.0

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

(2) Advanced Waste Treatment Needs

Advanced waste treatment needs have been identified in three river basins in Planning Subarea 2.2. A water quality problem occurs in the Pike River below Sturtevant where the 7-day 10-year low flow is 0 cfs. Problems are also identified on the Milwaukee River below Cambellsport and Kewaskum, and below West Bend to the mouth of the river. Problems below West Bend will be managed by connections of area communities to the Milwaukee Metropolitan Sewerage District and by elimination of combined sewers or by treatment of combined sewer wastes. A water quality problem also exists below Menominee Falls on the Menominee River.

(3) Treatment Cost Estimates

Projections of capital and operating costs for municipal treatment plants by planning periods are presented in Table 7–24.

TABLE 7–24 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 2.2—Wisconsin Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and maintenance Costs ($ Million)
1970–1980	242.4	8.1
1980–2000	104.0	10.8
2000–2020	139.9	14.1

5.3.4.2 Illinois Portion

It has been assumed that there will be no waste discharges in the Lake Michigan drainage area in the planning periods shown for this report.

5.3.4.3 Indiana Portion

(1) Population and Wastewater Volumes

The Indiana portion of Planning Subarea 2.2 contains the second most populous SMSA in the State. The area is also the most highly industrialized part of the State with five of the nation's major steel plants, four major oil refineries, and other heavy manufacturing and chemical industries. Projected levels of population and wastewater flows for this three-county area are presented in Table 7–25. Hammond and the municipalities it serves are not included in figures for the planning subarea because most of its wastewater flows into the upper Mississippi River drainage basin.

(2) Advanced Waste Treatment Needs

Indiana water quality standards require that the Cities of Gary, East Chicago, and Michigan City provide advanced waste treatment facilities as soon as practical. Crown Point, Hobart, and Valparaiso are to provide these facilities before 1977. Many smaller communities that discharge wastes into low-flow ditches will be expected to provide such facilities in the near future. Portage will probably need these facilities in the 1980 to 2000 period (Tables 7–26 and 7–27).

TABLE 7–25 Projections of Wastewater Flows and Population Served, Planning Surbarea 2.2—Indiana Portion

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD)	
			Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	505,415	341,864	113.6	2,953.0
1980	645,000	482,000	146.2	2,560.0
2000	1,020,000	857,000	202.0	2,420.0
2020	1,460,000	1,297,000	334.0	3,980.0

[a] Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b] Anticipated industrial wastewater discharges; includes both process and cooling water; based on self-supplied industrial water withdrawals less consumption.

NOTE: Does not include population and wastewater flows for Hammond and the communities served by Hammond.

TABLE 7–26 Areas Anticipated to Need Advanced Waste Treatment, Planning Subarea 2.2—Indiana Portion

Stream	Location	Period Required
Grand Calumet River	Gary	1970-1980
Indiana Harbor Ship Canal	East Chicago	1970-1980
Deep River	Crown Point, Hobart	1970-1980
Salt Creek	Valparaiso	1970-1980
Salt Creek	Portage	1980-2000
Trail Creek	Michigan City	1970-1980

TABLE 7–27 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 2.2—Indiana Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970-1980	11.0	2.3
1980-2000	36.3	3.7
2000-2020	65.5	5.0

5.3.5 Planning Subarea 2.3—Lake Michigan Southeast

Planning Subarea 2.3 includes six counties in northeastern Indiana and 19 counties in southwestern Michigan. Advanced waste treatment needs and cost estimates are discussed separately for the Indiana and Michigan portions of the planning subarea.

5.3.5.1 Indiana Portion

(1) Population and Wastewater Volumes

Approximately 20 percent of the planning subarea's total population, slightly less than 500,000 people, resided in the Indiana portion of Planning Subarea 2.3 in 1970. Approximately 1,100 manufacturing plants, concentrated in the vicinity of Elkhart and South Bend, are located in this portion of the planning subarea. Major industries include food processing, paper products, chemicals, metal foundaries and fabrication, and machinery and transportation equipment manufacturing. Projected levels of population and wastewater flows for this six-county area are presented in Table 7-28.

TABLE 7-28 Projections of Wastewater Flows and Population Served, Planning Subarea 2.3—Indiana Portion

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	437,312	248,589	71.9	25.8
1980	518,000	263,000	84.9	23.5
2000	572,000	383,000	106.6	25.8
2020	708,000	519,000	130.4	42.3

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b]Anticipated industrial wastewater discharges; includes both process and cooling water; based on self-supplied industrial water withdrawals less consumption.

(2) Advanced Waste Treatment Needs

Kendallville and Angola now require advanced waste treatment facilities. Kendallville is constructing facilities. Angola is under order to provide AWT facilities and is expected to start construction soon. The Mishawaka-South Bend area is expected to need advanced waste treatment in the 2000 to 2020 period. Smaller communities discharging into low-flow ditches are expected to provide facilities in the near future (Table 7-29).

TABLE 7-29 Areas Anticipated to Need Advanced Waste Treatment, Planning Subarea 2.3—Indiana Portion

Stream	Location	Period Required
St. Joseph River	Mishawaka-South Bend	2000-2020
Henderson Lake Ditch	Kendallville	1970-1980
Mud Creek	Angola	1970-1980

(3) Treatment Cost Estimates

Projected treatment cost estimates for the Indiana portion of Planning Subarea 2.3 are shown in Table 7-30.

TABLE 7-30 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 2.3—Indiana Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970-1980	5.1	1.6
1980-2000	16.1	2.4
2000-2020	22.6	3.1

5.3.5.2 Michigan Portion

(1) Population and Wastewater Volumes

The Michigan portion of Planning Subarea 2.3 supported a population of slightly more than two million in 1970. Population centers include Jackson, Kalamazoo, Lansing, and Grand Rapids. The area contains approximately 3,500 manufacturing plants. Major manufacturing activities include the production of vehicles, furniture, cereal grain and other foods, paper products, and industrial equipment. Population in the Michigan portion of Planning Subarea 2.3 is projected to double in the next 50 years. Projected levels of population and wastewater flows are presented in Table 7-31.

TABLE 7-31 Projections of Wastewater Flows and Population Served, Planning Subarea 2.3—Michigan Portion

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	2,022,240	1,100,000	170	220
1980	2,386,807	1,430,000	240	138
2000	3,136,340	2,180,000	403	115
2020	4,098,081	3,150,000	623	195

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b]Anticipated industrial wastewater discharges; includes both process and cooling water; based on self-supplied industrial water withdrawals less consumption.

(2) Advanced Waste Treatment Needs

Figure 7-9 and Table 7-32 illustrate advanced waste treatment needs in the Michigan portion of Planning Subarea 2.3.

(a) Grand River Basin

Six general areas in the Grand River Basin are expected to require advanced waste treatment before the year 2000.

The greater Grand Rapids area, embracing a large concentration of population and industry, is expected to experience substantial future growth. More than a half million people will be served by area wastewater treatment facilities in the year 2000, according to projections. To meet water quality standards in the Grand River downstream from the Grand Rapids area the major wastewater treatment plants will probably require BOD removal efficiencies in excess of 90 percent by the year 2000. For some plants this need will occur before 2000. Some municipalities are planning facilities to satisfy this need.

A major water quality problem exists in the greater Lansing area which includes East Lansing and DeWitt and adjacent townships in Clinton, Eaton and Ingham Counties. The area supports a large population, but area streams have only modest waste assimilation capacity. Some combination of stream-flow regulation and advanced waste treatment will be required to maintain water quality standards in the Grand River below the Lansing area. Appendix G of the Grand River Basin Comprehensive Study on *Water Use and Stream Quality* evaluated the feasibility of low flow as an alternative method to meet 1980 and 2000 water quality needs for the Grand River downstream from the Lansing area.

(b) St. Joseph River Basin

Two areas in the Michigan portion of the St. Joseph River will probably need advanced waste treatment during the study period. To maintain adequate water quality in the Coldwater River and Chain of Lakes downstream from the City of Coldwater, advanced waste treatment will be needed before 1980. The City of Coldwater is expanding its wastewater treatment facilities with provisions for tertiary treatment by sand filters. This will ensure adequate wastewater treatment levels for expected growth through the year 2000. After that date higher levels of treatment corresponding with population and economic growth may be required.

Hillsdale will also probably need advanced waste treatment by the year 2000 to maintain adequate water quality in downstream reaches of the St. Joseph River.

(c) Kalamazoo River Basin

Advanced waste treatment will be needed at three locations in the Kalamazoo River basin by 1980 and in one additional area by 2020.

In the Kalamazoo area a regional wastewater treatment facility operated by the City of Kalamazoo also serves the Cities of Galesburg and Portage, the Townships of Comstock, Kalamazoo, Oshtemo, Pavilion, and Texas, and a number of area paper industries. More than one-half of the flow currently treated at the Kalamazoo facility is received from the

TABLE 7-32 Areas Anticipated to Need Advanced Waste Treatment, Planning Subarea 2.3—Michigan Portion

Watershed	Area	Planning Period	Waters Affected	Estimated 7-Day-10-Year Low Flow (cfs)
Grand River Basin	Grand Rapids	1980-2000	Grand River	700
Grand River Basin	Lansing	1970-1980	Grand River	72
Grand River Basin	Mason	1970-1980	Sycamore Creek	2-3
Grand River Basin	Williamston	1970-1980	Red Cedar River	5.3
Grand River Basin	Jackson	1970-1980	Grand River	18
Grand River Basin	St. Johns	1970-1980	St. Johns Drain and Hayworth Creek	0
Black River Basin	Zeeland	1980-2000	N. Branch Black River	0.5
Black River Basin	Holland	1970-1980	Lake Macatawa	---
Kalamazoo River Basin	Kalamazoo	1970-1980	Kalamazoo River	235
Kalamazoo River Basin	Battle Creek	1970-1980	Kalamazoo River	180
Kalamazoo River Basin	Albion	2000-2020	Kalamazoo River	31.5
Kalamazoo River Basin	Charlotte	1970-1980	Battle Creek River	4
St. Joseph River Basin	Coldwater	1970-1980	Coldwater River and Chain of Lakes	17.0
St. Joseph River Basin	Hillsdale	1980-2000	St. Joseph River	2

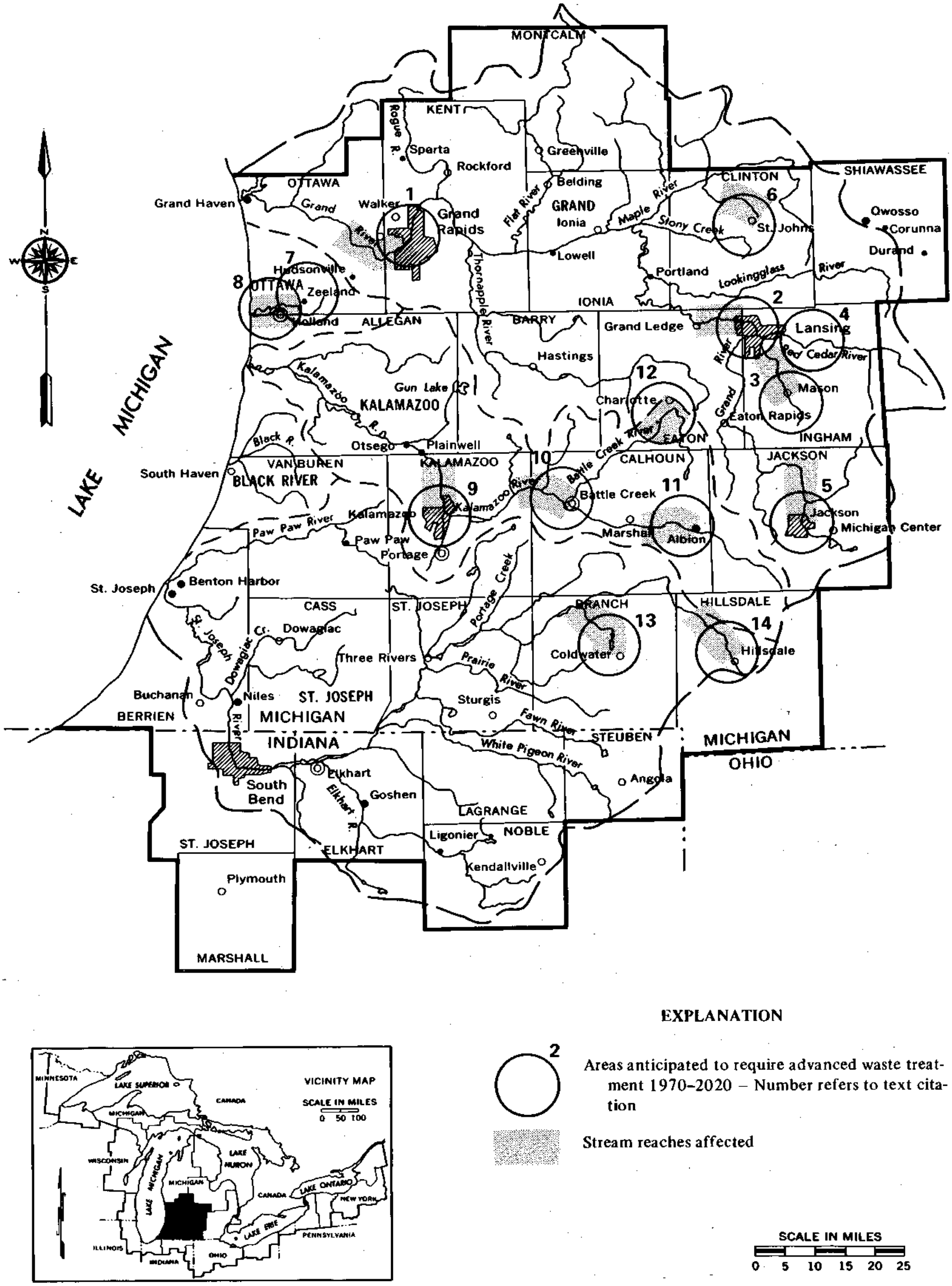


FIGURE 7–9 Planning Subarea 2.3—Michigan Portion, Advanced Waste Treatment Needs

paper industries. The Kalamazoo area will probably require BOD removal efficiencies in excess of 90 percent by the year 1980. As wastewater flows increase after 1980 because of population and industrial growth, additional wastewater treatment will be needed. Higher treatment efficiencies, low flow augmentation, or some combination of these methods will be required to maintain adequate water quality conditions in the Kalamazoo River below the greater Kalamazoo area.

The City of Battle Creek also operated a regional wastewater treatment facility serving the Cities of Battle Creek and Springfield, the Townships of Battle Creek, Bedford, Emmett, and Penfield, and several large industries. To maintain water quality standards in the Kalamazoo River downstream from the greater Battle Creek area, advanced waste treatment will probably be required by the year 1980.

Farther upstream, the Albion area will probably require advanced wastewater treatment sometime during the latter half of the 2000 to 2020 planning period to maintain adequate water quality in the Kalamazoo River downstream from this area. The need for advanced treatment is marginal and Albion's exact future needs will depend upon its rate of growth.

Advanced waste treatment will be required in the Charlotte area by 1980 to meet water quality standards in the Battle Creek River downstream from Charlotte. The Battle Creek River is a major tributary of the Kalamazoo River. The City of Charlotte is improving and enlarging its wastewater treatment facilities and including provisions for tertiary filtering to meet this need.

(d) Minor River Basins

Two areas in the Black River basin (Holland) will require advanced waste treatment during the study period.

Zeeland will probably need advanced waste treatment between 1980 and 2000 to maintain adequate water quality in downstream reaches of the North Branch of the Black River.

Holland will require advanced waste treatment in the current 1970 to 1980 planning period to maintain adequate water quality in Lake Macatawa. Holland is planning to construct the necessary facilities.

(3) Treatment Cost Estimates

Projections of capital and operating costs for municipal treatment facilities in the Michigan portion of Planning Subarea 2.3 are presented in Table 7–33.

TABLE 7–33 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 2.3—Michigan Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	116	12
1980–2000	196	19.5
2000–2020	258	27.5

These estimates exclude the cost of industrial treatment facilities, storm water treatment facilities, and sewer collection systems. These estimates represent the cost of upgrading existing municipal treatment facilities to full basic treatment, generally secondary treatment and phosphorus removal, needed advanced waste treatment facilities, additional facilities to handle projected increases in wastewater volumes, and facility repair and replacement needs.

5.3.6 Planning Subarea 2.4—Lake Michigan Northeast

5.3.6.1 Population and Wastewater Volumes

Planning Subarea 2.4 includes 18 counties in the northeastern portion of Michigan's Lower Peninsula and three counties in the southeastern part of the Upper Peninsula. Basically rural, the planning subarea contains numerous year-round recreational and tourist attractions.

In 1970 Planning Subarea 2.4 had a population of 496,540. Muskegon, the largest city had a 1970 population of just less than 45,000. In 1960 only 44 percent of the total population was classified as urban.

More than 900 manufacturing establishments were found in the planning subarea in 1967, with the majority of these located in the lower Muskegon River basin. Major manufacturing activities include the production of general industrial machinery, paper and paper products, basic and refined chemicals, primary and fabricated metal, furniture and fixtures, lumber, and wood products. The planning subarea also supports a substantial fruit-growing industry.

Projected population levels and wastewater volumes for future planning periods are presented in Table 7–34.

TABLE 7–34 Projections of Wastewater Flows and Population Served, Planning Subarea 2.4—Michigan

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	496,540	195,000	27.0	82.3
1980	546,800	245,000	36.0	68.0
2000	671,400	370,000	56.0	50.0
2020	841,700	540,000	86.0	78.0

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b]Anticipated industrial wastewater discharges; includes both process and cooling water; based on projections of self-supplied industrial water withdrawals less consumption.

5.3.6.2 Advanced Waste Treatment Needs

It is anticipated that the Cadillac area will require advanced waste treatment in the period 1970 to 1980 to meet water quality standards in downstream reaches of the Clam River. The 7-day 10-year low flow in this reach is approximately 1 cfs. No other advanced waste treatment needs are anticipated in Planning Subarea 2.4 in the study period (Figure 7–10).

5.3.6.3 Treatment Cost Estimates

Projections of capital and operating costs for municipal treatment facilities in Planning Subarea 2.4 are presented in Table 7–35.

TABLE 7–35 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 2.4—Michigan

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	66	3.8
1980–2000	39	4.4
2000–2020	49	5.4

These estimates exclude the cost of industrial treatment facilities, storm water treatment facilities, and sewer collection systems. These estimates represent the costs of upgrading existing municipal treatment facilities to full basic treatment, primarily secondary treatment and phosphorus removal, needed advanced waste treatment facilities, additional facilities to handle projected increases in wastewater volumes, and facility repair and replacement needs.

5.3.7 General Water Quality Problems

A number of water quality control problems occur throughout the Lake Michigan basin. Some of these problems are apparent while others are emerging and their potential remains undelineated.

5.3.7.1 Eutrophication

Eutrophication refers to the whole complex of changes that accompany continuing enrichment by plant nutrients. The natural rate of a lake's enrichment can be hastened artificially by adding fertilizing wastes to the lake basin. The rate of natural enrichment and eutrophication in a lake is generally so slow that it can only be measured on a geological time scale. In many of the world's lakes man has drastically shortened the geological time span of enrichment into a few decades.

One major water quality management goal for the Great Lakes is prevention and abatement of nutrient buildup. The progressive changes that accompany accelerated nutrient enrichment include increases in the growth of algae and other plants, general increases in biological productivity, successive changes in the kinds of plants and animals living in the lake, oxygen depletion in deep water during periods of restricted circulation, and decreases in depth caused by accumulating organic sediments.

Major sources of nutrients to the basin's water include sewage, phosphate-based detergents, some industrial wastes, and the drainage and associated accelerated sedimentation from agricultural, urbanized, and natural land. Although a number of nutrients are involved, compounds of phosphorus and nitrogen are the most important. Experience has shown that of these two, phosphorus is most often the controlling nutrient. Control programs have therefore focused on removing a high amount of phosphorus from municipal and industrial wastewaters. Nutrient pollution from agricultural, urban, and natural lands could be reduced by implementing and enforcing erosion and sediment controls, land-use regulations, and flood plain management.

For Lake Michigan eutrophication is now

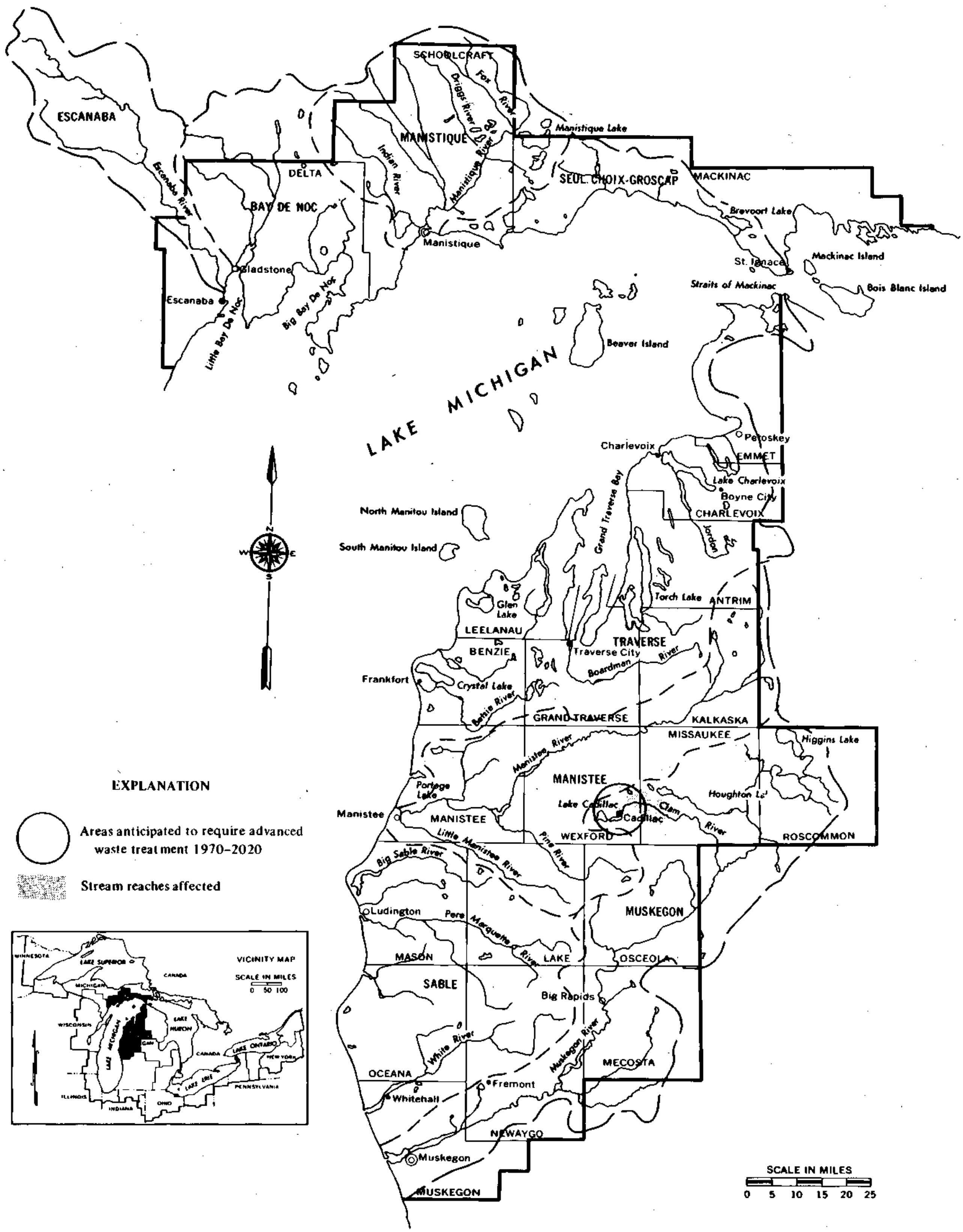


FIGURE 7-10 Planning Subarea 2.4, Advanced Waste Treatment Needs

more a potential threat than an actuality. The discharge of wastewater into the Lake and its tributaries has contributed to the acceleration of the natural aging process. Most biota in the deepwater region reflect an unpolluted environment. Certain inshore areas are characterized by higher concentrations of dissolved substances, greater variability in water quality parameters, increased algal populations, and larger proportions of pollution-tolerant bottom-dwelling organisms. In portions of the southern end of Lake Michigan growths of filamentous green algae have produced nuisance conditions.

It has been estimated that the annual supply of phosphate to Lake Michigan is approximately 15 million pounds. Approximately two-thirds of this amount has been attributed to municipal and industrial wastewater sources. The remaining one-third represents a composite of all non-point sources including natural contributions and contributions resulting from human activities such as agriculture and lawn fertilizing.

A high percentage of the phosphorus in municipal and industrial wastewaters can be removed by treatment facilities. Part of the supply attributed to non-point sources can also be reduced.

The four Lake Michigan States acting through the Lake Michigan Enforcement Conference have instituted a program that required at least an 80 percent reduction of phosphorus from municipal and industrial wastewater discharges by December 1972. This program brought about a substantial reduction in the phosphorus supply to Lake Michigan. Further reduction may be necessary in the future. The effectiveness of current efforts should be evaluated and modified as warranted.

5.3.7.2 Soil Erosion and Sedimentation

Improper land-use practices can cause accelerated erosion and watercourse sedimentation. Major sources of sediment include agricultural lands and lands used for highways, subdivisions, and urban construction projects. Sediment fills stream channels and drains, causing additional expense in the treatment of water supplies. It is harmful to fish and other aquatic life and water-oriented sports and recreation. Sediment is a major pollutant in the Lake Michigan basin, and new programs are needed to abate this problem.

Data on sediment volumes, sources, and control measures are discussed in detail in Appendix 18, *Erosion and Sedimentation.*

5.3.7.3 Combined Sewer Overflows

Combined sewer overflows are major sources of pollutants in some areas. Many large cities in the Lake Michigan basin have combined sewer systems carrying both sewage and surface drainage water. During dry weather the flow is directed through a sewage treatment plant, but during precipitation, combined sewer systems may not be large enough to handle the combined flow of sewage and storm runoff. When this happens the excess flow is discharged into the nearest watercourse without treatment. Such overflows may contribute significant amounts of BOD, bacteria, and nutrients.

As dry weather waste flows receive increased treatment, the attainment and maintenance of water quality standards will require increased efforts to correct combined sewer overflow problems. No new combined sewer systems should be constructed, and existing combined sewer systems should be modified to include storage and/or treatment facilities to handle wet weather flows. The Chicago area, for example, may construct a deep tunnel system to temporarily store wet weather flow until it can be treated. Cost estimates for the Chicago Deep Tunnel Project show that a large investment is needed for these facilities. If funds are approved, this will be the largest deep tunnel project in the Lake Michigan basin.

5.3.7.4 Thermal Discharges

Electric generating facilities and many industries use large amounts of water for cooling. The discharge of these heated waters may add a considerable waste heat load to the receiving waters that may impair water uses. Increasing attention has recently been focused on this issue, particularly through deliberations of the Lake Michigan Enforcement Conference.

Thermal discharges in confined areas or along the shoreline may stimulate algal growth, reduce oxygen levels, and endanger the survival or productivity of fish and other aquatic life.

Because of the availability of large quantities of cooling water, the Great Lakes are an attractive location for industries with large waste heat discharges. The shores of Lake Michigan are a particularly attractive power plant location because of the large power market in the Region.

Considerable growth of power generating facilities in the Lake Michigan basin is projected for the study period. In 1970 the basin supported plants with a total installed generating capacity of 11,332 megawatts. This capacity represented 34 percent of the total installed capacity in the U.S. portion of the Great Lakes Basin. By 2020 the basin's installed capacity is projected to increase to 186,000 megawatts, which would represent approximately 40 percent of the Great Lakes Basin's total projected installed capacity.

A detailed discussion of cooling water needs, alternative cooling techniques, and environmental effects of power generating facilities is presented in Appendix 10, *Power*. The Lake Michigan Enforcement Conference has recommended a control program for waste heat dischargers on Lake Michigan. The conference recommended that all new waste heat dischargers exceeding a daily average of one-half billion Btu/hour be required to use closed cycle cooling facilities, and that certain large waste heat dischargers in existence or under construction be required to modify their facilities to include closed cycle cooling. These recommendations are being acted upon by the four basin States. A Lake Michigan Enforcement Conference session in September 1972 developed additional recommendations.

5.3.7.5 Wastes from Watercraft

Commercial and recreational vessels that ply the waters of Lake Michigan contribute both untreated and inadequately treated wastes to the open lake and harbor areas. Wastes from watercraft include sewage, oil, bilge and ballast waste, compartment washings, and solid refuse. The problem of watercraft pollution is widespread because vessels frequent all navigable waters and may discharge pollutants at any point along their path. The problem is varied because of the assortment of materials that may be spilled or discharged.

New programs have been authorized by the Lake Michigan States and the Federal Government to control pollution from watercraft. The effectiveness of these programs remains to be determined.

5.3.7.6 Oil Pollution

Oil pollution is an ever present threat in the Lake Michigan basin. Lake Michigan serves as a shipping lane for the ore and tanker fleets of the Great Lakes and for international shipping which enters the Great Lakes via the St. Lawrence Seaway. Potential sources of oil include losses resulting from accidental collisions, oil contaminated bilge and ballast pumpings, careless practices in loading and unloading cargos, and discharges from industrial plants and shoreland oil storage facilities.

Oil discharges and spills produce unsightly conditions and degrade beaches and recreational areas. They also contribute to taste, odor, and treatment problems at water treatment plants; coat the hulls of pleasure craft; and in some cases are toxic to desirable fish and aquatic life.

In 1967, the Coast Guard reported 28 oil discharges and spills from outfalls and ships in the Lake Michigan basin. The Calumet area in Illinois and Indiana accounted for most of these spills. The remainder were scattered throughout Lake Michigan.

Both Federal and State contingency plans have been prepared to deal with oil losses. The effectiveness of these plans depends on an adequate surveillance system. Enforcement proceedings against oil dischargers are often impossible because of the difficulty in locating the responsible person, ship, or installation, particularly when such discharges take place in mid-Lake or during darkness.

5.3.7.7 Organic and Inorganic Contaminants

Organic contaminants include the persistent or biochemically resistent compounds found in domestic and industrial wastes, insecticides, herbicides, and other agricultural chemicals. Because of their persistence and toxic nature, often in low concentration, these chemicals pose a continuing threat to the basin's waters.

Many organic contaminants resist conventional water and waste treatment processes and are hard to detect and identify. Because long-term data are not available, it is difficult to assess changes in concentrations in the basin's waters over time.

One organic contaminant, mercury, received considerable attention when it was found in Lake St. Clair and Lake Erie in 1970.

Pesticides are another important group of organic contaminants. Applied throughout the basin in agricultural and forestry operations, pesticides may reach watercourses in a number of ways. These include runoff from treated land areas, aerial spraying, waste discharges containing pesticide residuals from canneries and other industries, and accidental spills.

Some catches of coho salmon from Lake Michigan have contained levels of DDT residuals which exceed the tolerance levels established by the Federal Food and Drug Administration. The FDA therefore banned the interstate shipment and sale of such fish.

There is also evidence of reproductive interference in certain species of birds and fish caused by pesticide residuals.

A special Pesticides Committee was established by the Lake Michigan Enforcement Conference to evaluate the pesticide problem in Lake Michigan. The committee issued a report in November 1968 stating that quantities of insecticides were present in Lake Michigan fish and waters. The committee noted that information was insufficient on most aspects of pesticides in the Lake Michigan watershed and that information was totally lacking in several critical areas.

A pesticide monitoring program was subsequently established with the cooperation of Illinois, Indiana, Michigan, Minnesota, and Wisconsin, and the Federal Environmental Protection Agency. The continuation of this program is in doubt due to financial considerations. This monitoring program warrants sufficient funding to ensure its effective continuation.

Other pesticide control efforts in the basin have also been made. The insecticide DDT has been banned by certain States and the Federal government. Further actions to ensure the proper and limited use of pesticides in the basin should be considered.

More extensive information has been developed by the Governor's Great Lakes Region Interdisciplinary Pesticide Council. Although the information focuses on PCB (polychlorinated biphenyl) problems, it also covers other pesticides.

5.3.7.8 Disposal of Dredged Material

Sedimentation is a problem to some degree at all harbors. As part of its responsibility for maintaining waterways in the United States, the Corps of Engineers conducts dredging activities to insure the maintenance of project depths in harbor areas and connecting channels. In Lake Michigan 27 harbors require some dredging. From 1965 through 1969 an annual average of 1½ million cubic yards of material was removed from these harbors. The dredged material ranges from grossly polluted sludge to clean sand.

In the past most dredge spoil was disposed in authorized dumping grounds in mid-Lake. The Corps of Engineers reversed this practice and now conducts no open lake dumping of polluted dredge spoil. It is still permissible to dispose unpolluted dredge spoil through mid-Lake dumping, but polluted dredge spoil must be placed within diked disposal areas. Twenty-five percent of the cost of such diked disposal areas must be provided by non-Federal parties, although this requirement can be waived if a pollution control plan is being implemented for the harbor area involved.

5.3.7.9 Alewife

Although the massive die-off of alewife in Lake Michigan is probably not caused by pollution, this phenomenon does create a pollution problem. The alewife die-off has become an annual event each spring in Lake Michigan, but it reached catastrophic proportions in 1968. Millions of dead alewife clogged water intakes and fouled beaches in 1968, creating a gigantic clean-up and disposal problem.

The alewife die-off apparently results from an upset in the balance of nature stemming from the alewife invasion into the Great Lakes and the decline in the population of predator fish species. The ultimate solution to this problem is probably the reestablishment of an ecological balance of fish and other aquatic life in Lake Michigan. Such a solution will require time, effort, and funds. As future conditions warrant, interim measures may include offshore skimming of dead alewife, beach clean-up, and proper disposal of the material collected.

5.3.7.10 Recreational Developments

The lakes and streams in the northern portion of the Lake Michigan basin represent prime recreational assets. This area contains a large amount of high quality waters and recreational use is extremely heavy in numerous streams and lakes in the area. Such use reduces the recreational value that initially attracted people to the area. Problems that have emerged include user conflict, sedimentation and erosion, and littering.

The northern area is also experiencing a land boom as increasing numbers of individuals seek recreation opportunities and seasonal houses. Land developments are of increasing size and scope. Initial land clearing and building construction may create erosion and sedimentation. Later septic tanks may add nutrients and bacteria to ground and surface waters. The result may be contaminated waters unsafe for swimming and accelerated eutrophication of once picturesque lakes.

Problems related to recreation also occur in the southern portion of the Lake Michigan basin.

Measures to preserve and restore lakes affected by lakeshore developments are often difficult to implement because of the high cost of necessary sewage collection and treatment systems; the reluctance or inability of seasonal and absentee owners to assume the cost burden involved; and the common lack of adequate housing codes, subdivision ordinances, and zoning controls.

5.4 Summary and Conclusions

The Lake Michigan basin encompasses an area of 67,860 square miles in four States and is the only one of the Great Lakes lying entirely within the United States. The total land area in the basin is 45,560 square miles, with 62.5 percent in Michigan, 31.9 percent in Wisconsin, 5.1 percent in Indiana, and 0.5 percent in Illinois. The Illinois portion does not include the area where drainage has been diverted from the Lake Michigan watershed to the Illinois River watershed. The 20 major streams of the basin drain 36,400 square miles, or 80 percent of the total land area.

The Lake Michigan region had a 1970 population of approximately 13.3 million. The region consists of four planning subareas and the lake proper which are discussed later. Major metropolitan areas include Green Bay and Milwaukee, Wisconsin; Chicago, Illinois; Gary-Hammond-East Chicago and South Bend, Indiana; and Jackson, Kalamazoo, Lansing, and Grand Rapids, Michigan. Manufacturing activity is substantial and widespread with the greatest concentrations in the Milwaukee, Chicago, and Gary-Hammond areas.

The major State agencies concerned with water pollution control are the Michigan Water Resources Commission and the Michigan Department of Public Health in Michigan; the Department of Natural Resources in Wisconsin; the Indiana Stream Pollution Control Board in Indiana; and the State of Illinois Environmental Protection Agency and the Pollution Control Board in Illinois.

The principal water related activities of the United States Environmental Protection Agency include comprehensive programs, water quality standards, technical assistance, grant programs, enforcement, federal installations, Refuse Act permit programs, water hygiene, environmental impacts, pesticides programs, radiation programs, and research and monitoring.

Under provisions of the Water Quality Act of 1965 each State of the Lake Michigan basin has adopted water quality standards for its interstate waters.

There is little evidence of water quality detecrioriation in the deepwater region of Lake Michigan (the portion of the Lake more than 10 miles from shore). In contrast to the deepwater region, some inshore areas are characterized by high concentrations of dissolved substances, much greater variability in water quality parameters, a larger proportion of pollution-tolerant bottom-dwelling organisms, and increased algae populations.

5.4.1 Planning Subarea 2.1

Planning Subarea 2.1 includes three counties in Michigan and 20 counties in Wisconsin. It encompasses eight river basins or complexes.

In the Michigan portion of this planning subarea four stream reaches of substandard quality occur in the Menominee River basin. In the Wisconsin portion of this river basin surface waters are used by municipalities and industries for assimilation of treated wastes. The paper industry is the largest source of loading. Localized pollution problems exist on other tributaries of the planning subarea. The principal concentrations of population and industry are in the Fox River basin, where 40 municipal and public institutions and 68 industries use the basin's surface waters for assimilation of treated wastes. Substantial improvements are needed to meet water quality standards.

In the Michigan portion of Planning Subarea 2.1 the total amount of domestic, commercial, and industrial wastewater treated in municipal wastewater treatment facilities is expected to increase from its 1970 base of 4.7 mgd to 9.3 mgd by the year 2020. There are no advanced waste treatment needs in the Michigan portion of the planning subarea in the study period. Municipal wastewater treatment capital costs are expected to remain relatively constant at approximately six million dollars, but operating and maintenance costs are expected to increase.

In the Wisconsin portion of the planning subarea, wastewater flows processed by municipal treatment facilities are expected to increase substantially from the 1970 base of 88 mgd to 270 mgd by the year 2020. Advanced waste treatment needs have been identified for the river basins in this portion of the planning subarea. A need for tertiary treatment has been identified for the Fox River from Lake Winnebago to the mouth, and treatment costs will be substantial. Municipal wastewater treatment capital costs for the Wisconsin portion of the planning subarea are expected to almost double from 1970 to 2020.

5.4.2 Planning Subarea 2.2

Planning Subarea 2.2 includes the Chicago-Milwaukee complex. The planning subarea encompasses six counties in Illinois comprising the Chicago SMSA, four counties in Indiana, and seven counties in Wisconsin.

The Wisconsin portion of the planning subarea includes the Pike, Root, Milwaukee, and Sheboygan River basins. Surface waters of the Pike River basin are inadequate for general uses. Throughout the Root River basin water quality is variable and dry weather stream flows in several stretches now predominantly consist of treated wastes. Along a 95-mile length of the Milwaukee River 19 municipalities and 15 industries use the surface waters for assimilation of treated wastes. Some stream sectors are unsuitable for present and potential uses. In the Sheboygan River basin water quality is generally good.

In the Wisconsin portion of the planning subarea, wastewater flows processed by municipal treatment plants are expected to more than triple from 1970 to the year 2020. Advanced waste treatment needs have been identified in three river basins. Capital municipal wastewater treatment costs are estimated at $242 million in the 1970 to 1980 period, and are expected to decline significantly in future planning periods.

In the Indiana portion of Planning Subarea 2.2, shore water in the harbor is of poor quality. This is caused by waste discharges and combined sewer overflows that sometimes discharge untreated sewage directly into Lake Michigan. Stormwater overflows discharged into the Grand Calumet River and the Indiana Harbor Canal also contribute to the poor water quality. Waters of the Grand Calumet River and the Indiana Harbor Canal are characterized by floating debris, oil, discoloration, and high suspended solids loading. The Grand Calumet River has low dissolved oxygen and high bacteria counts, and the Little Calumet River flowing west into Illinois is of poor quality.

In the Indiana portion of the planning subarea, wastewater flows to municipal treatment plants are expected to triple from 1970 to 2020. Advanced waste treatment needs have been identified for six streams. Five of the six will occur in the 1970 to 1980 period. Capital municipal wastewater treatment costs are estimated at $11 million in the 1970 to 1980 period, increasing to $65 million in the 2000 to 2020 period.

5.4.3 Planning Subarea 2.3

Planning Subareas 2.3 encompasses 19 counties in southwestern Michigan and six counties in northwestern Indiana. It includes the St. Joseph, Paw Paw, Kalamazoo, Grand, Black (South Haven), and Black (Holland) River basins, and several minor areas draining into Lake Michigan.

The Grand River discharges into Lake Michigan at Grand Haven, Michigan. Twenty-one communities with approximately 10 percent of the total population served provide primary waste treatment with disinfection and 26 communities with approximately 80 percent of the population served provide some form of secondary waste treatment. Twenty-two communities with 10 percent of the population do not have sewers and rely on individual waste disposal systems. Some communities have separate storm sewer systems which discharge into the surface waters, and 60 industrial establishments use the surface waters for waste assimilation.

The St. Joseph River and its tributaries form a network draining approximately 2,600 square miles of southwestern Michigan and 1,684 square miles of northwestern Indiana. The river originates in southern Michigan, flows southwesterly into Indiana, and then flows northwesterly back through Michigan. It discharges into Lake Michigan approximately 25 miles north of the Indiana State line at Benton Harbor-St. Joseph.

Fourteen municipal and institutional wastewater treatment facilities use surface waters in the St. Joseph River basin for waste assimilation. Seven facilities provide primary waste treatment and seven provide secondary waste treatment. There are also 13 municipalities in the basin with storm sewer systems that discharge into the surface waters. In addition 34 industries use the surface waters for waste assimilation.

Water quality in the Indiana portion of the St. Joseph River basin is generally good. The most urgent problem is bacterial pollution in the Elkhart-South Bend area of the river caused by treated municipal sewage. However, the principal cities causing this condition are now installing or will soon install effluent chlorination facilities. This will enable the river to meet water quality standards.

5.4.3.1 Kalamazoo River Basin

The Kalamazoo River basin encompasses 2,060 square miles. Principal tributaries of the Kalamazoo River are the Rabbit River, Swan Creek, Pine Creek, Gun River, Portage Creek, and Rice Creek. Flowing in a west-northwest direction, the Kalamazoo River discharges into Lake Michigan at Saugatuck, Michigan.

Sixteen municipal wastewater treatment facilities serving approximately 182,000 people (1964 estimate) use the basin's surface waters for waste assimilation. Four municipal plants provide primary waste treatment with disinfection and eleven provide secondary treatment. Some municipalities have storm sewers that discharge into the surface waters. In addition 37 industries use the surface waters for waste assimilation.

5.4.3.2 Paw Paw River Basin

The Paw Paw River drains approximately 446 square miles. It discharges into the St. Joseph River a short distance before the St. Joseph River flows into Lake Michigan. Because of its small size, the Paw Paw River exhibits rapid changes in water quality when subjected to man's influence.

Five primary and two secondary municipal treatment plants serving a population of approximately 37,000 (1964 estimate) use the basin's waters for waste assimilation. Some municipalities have storm sewer systems that discharge into the surface waters. In addition 10 industries use the surface waters for waste assimilation.

In the Michigan portion of Planning Subarea 2.3 wastewater flows to municipal treatment plants are expected to increase substantially from the 1970 to 1980 base period to the year 2020. Industrial wastewater flows are expected to decline from the 1970 to 1980 period to the year 2000, and then increase in the 2000 to 2020 period to a level lower than the 1970 to 1980 base.

Advanced waste treatment needs will probably be required for six general areas in the Grand River basin including the Lansing area where a major water quality problem exists. There will probably be a need for advanced waste treatment in three locations in the Kalamazoo River basin by 1980 and in one additional location by 2020. Two areas in the Michigan portion of the St. Joseph River basin and two areas in the Black River basin will also probably require advanced waste treatment.

By the 2000–2020 period both capital and operating municipal wastewater treatment costs are expected to more than double from the 1970 to 1980 base.

In the Indiana portion of Planning Subarea 2.3 wastewater flows to municipal treatment plants are expected to increase from approximately 72 mgd in 1970 to 85 mgd in 1980 and 130 mgd in the year 2020. Industrial wastewater flows treated in industry-owned wastewater treatment facilities are expected to remain relatively constant from 1970 to 2000 at approximately 26 mgd and increase to 42 mgd by the year 2020. Advanced waste treatment needs are expected for three streams and two of these are for the 1970 to 1980 period. Municipal wastewater treatment capital costs are expected to increase from $5.1 million in the 1970 to 1980 period to $16.1 million in the 1980 to 2000 period.

5.4.4 Planning Subarea 2.4

Planning Subarea 2.4 encompasses 18 counties in the northwestern part of Michigan's Lower Peninsula and three counties in the southwestern part of the Upper Peninsula.

The planning subarea includes the Muskegon and the Manistee River basins and two smaller river basins.

In the Muskegon River basin four reaches of substandard water quality occur on the main stem and four occur on tributary streams. Muskegon Lake, located at the mouth of the Muskegon River, is substandard in quality because of excessive levels of coliforms and nutrients. In the Manistee River basin water quality problems occur mainly in the lower portion of the basin in the Manistee Lake area. The Boardman River exhibits elevated levels of coliforms and nutrients at Traverse City. Three areas of substandard quality occur in the lower portion of the Pine River basin. Other reaches of substandard water quality in Planning Subarea 2.4 are described in Subsection 5.2.

Projected municipal wastewater flows are expected to approximately triple from 1970 to 2020. Industrial wastewater flows are expected to decline to the year 2000, but increase to almost their 1980 base level by 2020.

The Cadillac area is expected to require advanced waste treatment in the 1970 to 1980 period. Projected capital municipal wastewater treatment costs in the period from 1980 to 2020 are expected to be less than in the 1970 to 1980 period, but operating costs are expected to be greater.

5.4.5 General Water Quality Problems

General water quality problems include eutrophication, soil erosion and sedimentation, combined sewer overflows, thermal discharges, waste from watercraft, oil pollution, organic contaminants, and disposal of dredged material. These problems were discussed in Subsection 5.3.

Section 6

LAKE HURON

6.1 Introduction

6.1.1 Purpose

This section summarizes water quality conditions and trends in relation to established water use designations and potential future uses. It identifies the nature, location, and gravity of water quality problems and defines actions needed to maintain or improve the quality of waters of the Lake Huron basin.

6.1.2 Scope

This section covers the United States portion of the Lake Huron basin including the St. Marys River drainage area. For planning purposes the basin has been divided into three planning subareas and river basin groups based on political and hydrologic boundaries. Figure 7–11 shows the planning subareas and Table 7–36 lists counties assigned to each planning subarea.

Section 6 reviews interstate and intrastate water quality standards and designated uses established by appropriate authorities. It identifies water quality problem areas, defined as areas presently below the quality levels prescribed for the governing water uses. Major waste sources and corrective programs are indicated in general terms.

For the target years 1980, 2000, and 2020, projections of economic, demographic, and water-use parameters are translated into waste loads. Needs for waste treatment and other measures for dealing with waterborne wastes are estimated. Reaches of streams are deliniated where increased low flows and/or decreased waste inputs are indicated for water quality maintenance or improvement. Anticipated water quality problems in each planning subarea are ranked according to urgency and time of impact, and general cost estimates are given for broad components of the action needed.

This section discusses existing water quality conditions, future prospects, and actions needed in broad terms, as prescribed for Type I (Level A) comprehensive studies. Existing data were used and no new basic data were secured. Reliance was placed on the knowledge and judgment of experienced field personnel.

6.1.3 Basin Description

Lake Huron, the second largest of the Great Lakes and fifth largest lake in the world, has a water surface area of 23,000 square miles and a land drainage area of 51,800 square miles. Of these totals, 9,100 square miles of water surface area and 16,200 square miles of land drainage area are in the United States.

The major sources of flow to Lake Huron, adding runoff from 148,000 square miles, are Lake Superior (via the St. Marys River) and Lake Michigan (via the Straits of Mackinac). Major American tributaries to the Lake are the Cheboygan, Thunder Bay, Au Sable, and Saginaw Rivers.

The Lake Huron basin in Michigan is sparsely populated, with the exception of the Saginaw River basin industrial complexes. Total population in the basin was approximately 1.2 million residents in 1970. The three largest cities are Flint (193,600), Saginaw (90,600), and Bay City (49,100).

The economy of the Michigan portion of the Lake Huron basin varies from the concentrated heavy manufacturing areas of Flint and Saginaw to the remote pulp cutting operations of the northern Lower Peninsula. Most of the manufacturing is concentrated in the urban areas of the southern Lower Peninsula in Genesee, Saginaw, and Bay Counties. The automotive industry of the basin is centered in Flint, home of the Chevrolet and Buick Divisions of General Motors Corporation. Midland County is the center of one of the largest chemical industries in the United States. Most of the remaining counties in the basin are dependent on resource-based activities. Prime croplands are located in the Thumb area as

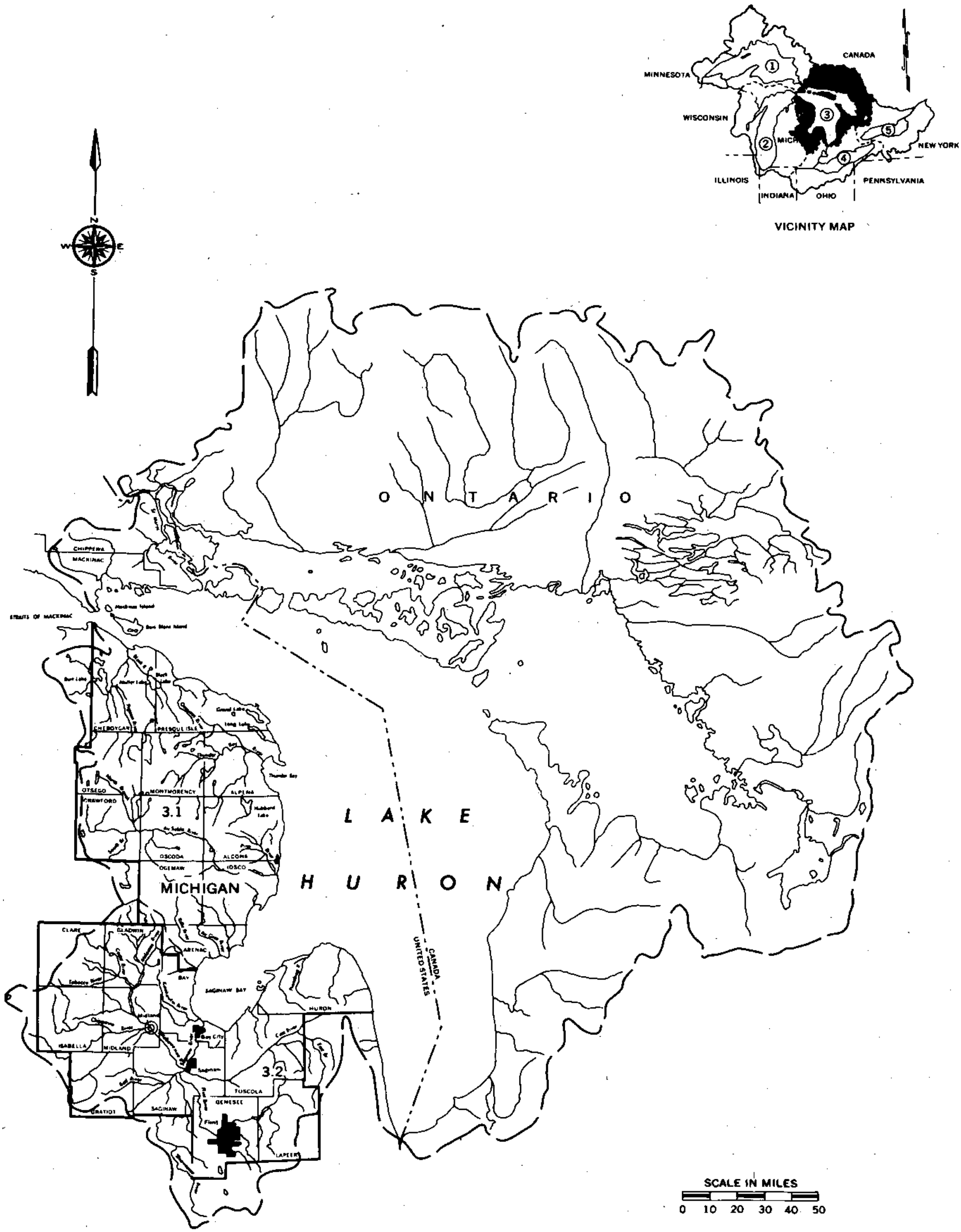


FIGURE 7–11 Lake Huron Basin, Plan Area 3

TABLE 7–36 Lake Huron Basin Counties by Planning Subarea

PSA 3.1	PSA 3.2
Michigan	Michigan
Alcona	Bay
Alpena	Clare
Arenac	Genesee
Cheboygan	Gladwin
Crawford	Gratiot
Iosco	Huron
Montmorency	Isabella
Ogemaw	Lapeer
Oscoda	Midland
Otsego	Saginaw
Presque Isle	Tuscola

well as the central counties of Gratiot and Isabella and other scattered locations. Mining is important in other areas. Alpena County contains the world's largest portland cement manufacturing plant and Presque Isle County has the largest limestone quarry in the world.

6.2 Water Quality

This section reviews existing water quality in the Lake Huron basin. A substandard quality reach is one in which at least one quality parameter is lacking, and therefore the reach fails to meet the requirements necessary for designated uses.

This review covers water quality conditions as of May 1969. A number of corrective programs in various stages of completion will modify existing water quality conditions in the near future (Table 7–36).

6.2.1 Lake Huron

Lake Huron is the second largest of the Great Lakes and the fifth largest lake in the world. It has a length of 200 miles, a width of 100 miles, and a volume of 850 cubic miles. The average depth of Lake Huron is 195 feet, with the greatest recorded depth at 750 feet.

Lake Huron is connected to Lake Michigan by the Straits of Mackinac, to Lake Superior by the St. Marys River, and to Lake St. Clair by the St. Clair River. The long-term average outflow from Lake Huron through the St. Clair River at Port Huron is 176,900 cfs. Major sources of flow to Lake Huron are outflows from Lake Superior and Lake Michigan. The average discharge from Lake Superior is 73,000 cfs and the outward flow from Lake Michigan to Lake Huron is estimated at 40,000 cfs. In addition, annual runoff from the Michigan portion of the Lake Huron basin is approximately 11,000 cfs. Although not precisely determined, contributions from ground water and evaporation-precipitation relationships for the Lake are assumed to be minor (less than 10 percent of the outflow).

Current patterns in Lake Huron are not well understood. Existing data indicate that although a general surface current pattern exists, it is variable. Circulation patterns in the upper and lower portions of the Lake generally have a counterclockwise direction. Figure 7–12 shows the average summer surface currents of Lake Huron.

Four municipalities use Lake Huron for waste assimilation. Three provide primary waste treatment and one has deepwater disposal with no treatment. Three cities use Lake Huron for the discharge of untreated water used to wash their water treatment filters. Six industries, three of which discharge cooling water only, use Lake Huron for waste assimilation.

6.2.1.1 Main Body of Lake Huron

In 1965 the Office of Water Programs, now part of the Environmental Protection Agency, conducted deepwater surveys in Lake Huron from 50 chemical and 40 microbiological stations. The surveys showed that water quality in the main body of Lake Huron is excellent. Lake Huron waters are low in turbidity, moderate in hardness, and generally very clear. Analysis of the parameters reported in the deepwater surveys showed uniform concentrations except in a few localized areas, mainly in harbors and near the mouths of tributaries. Turbidity and hardness increased slightly between the Straits of Mackinac and Port Huron.

6.2.1.2 Saginaw Bay

The waters of Saginaw Bay differ from those of the main body of Lake Huron. Saginaw Bay waters exhibit higher concentrations of calcium, sodium, potassium, chlorides, and sulfates. They also have somewhat greater degree of hardness, higher temperatures, and more turbidity.

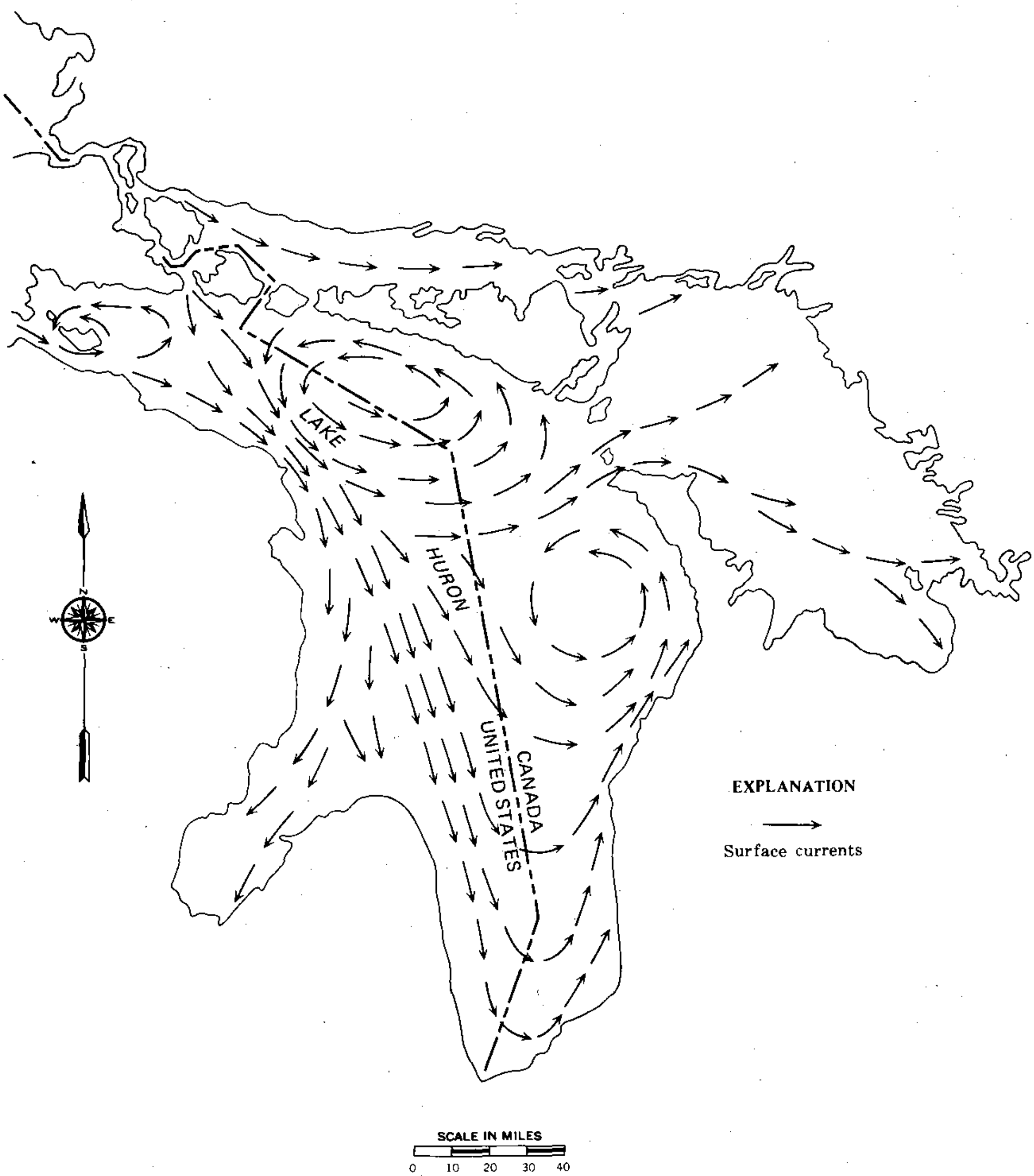


FIGURE 7-12 Surface Currents, Summer Period, Lake Huron

Figures 7–13 through 7–16 graphically present data collected on dissolved oxygen, transparency, and offshore coliform densities.

Studies of currents and water masses in Lake Huron indicate a substantial outward movement of Saginaw Bay water. As these waters mix with the main body of lake water, they lose their identity and little indication of their presence exists at Port Huron.

An extensive sampling program was conducted in the summer of 1965 by the Office of Water Programs (OWP). The Saginaw River, the main source of waste constituents to Saginaw Bay, is the principal influence on water quality in the bay. The data collected by OWP revealed a gradual improvement in water quality from the mouth of the Saginaw River to the mouth of the bay. Total solids decreased from 690 mg/l near the mouth of the river to 130 mg/l toward the mouth of the bay. Suspended solids decreased from 27 to 4 mg/l and BOD_5 average range values declined from 4 to 2 mg/l. Nitrate decreased from 0.7 to 0.1 mg/l.

Dissolved oxygen concentrations were satisfactory throughout the bay. Average values for all samplings ranged from 8.0 to 10.3 mg/l. Averages increased from the Saginaw River toward the mouth of the bay. Low bottom dissolved oxygen values occurred in the inner bay when the bay was relatively calm.

Results of the Michigan Water Resources Commission's beach sampling program show a highly variable bacterial quality in certain beach areas on Saginaw Bay. Annual mean total coliform densities exceed desirable levels at a small number of beaches on the west shore of Saginaw Bay north of Bay City. With the exception of one beach area, however, fecal coliform levels are well within the limits of the standards for total body-contact recreation use.

The Saginaw River discharges large quantities of nutrients from industrial, municipal and agricultural sources into Saginaw Bay. In warm weather these and other sources have contributed to extensive algal blooms in the bay. Property owners along Saginaw Bay have complained occasionally of accumulations of plant debris, but there is no evidence of serious nuisance conditions.

During the summer of 1965 phytoplankton was abundant throughout the central portion of the bay and did not disperse until diluted by water from Lake Huron.

The water quality of Saginaw Bay, which reflects the abundance of waste materials from the Saginaw River and other small tributaries, is adequate to support all but a few designated uses. The waters of the inner bay may exhibit nutrient levels which support extensive algal blooms.

Water quality along the western shore of Saginaw Bay north of Bay City is substandard at a limited number of beaches because of high coliform levels.

6.2.1.3 Other Nearshore Areas

In a number of nearshore areas within harbors and at the mouths of streams, water quality is lower than in Lake Huron proper. These areas include the Straits of Mackinac, Cheboygan Harbor, Rogers City Harbor, Thunder Bay, Harrisville Harbor, Oscoda Harbor, Harbor Beach, and Port Sanilac. These areas generally receive waste loads from tributaries, municipal treatment plants, or industries. They experience slightly lowered levels of dissolved oxygen and slightly increased levels of total solids and other parameters. In almost all cases concentrations of phosphates and/or nitrates are sufficient to support algal growths that could interfere with water uses under proper conditions. The use of one harbor area has already been impaired because of excessive aquatic growths.

6.2.2 Planning Subarea 3.1

Planning Subarea 3.1 covers 11 counties in the northeastern portion of Michigan's Lower Peninsula and part of two counties at the eastern end of the Upper Peninsula (Figure 7–17). Major river basins in this planning subarea are the Au Sable, Thunder Bay, and Cheboygan in the Lower Peninsula and the St. Marys, Carp, Pine, Munuscong, and Waiska in the Upper Peninsula.

6.2.2.1 Pine and Rifle River Basins

The Pine and Rifle River basins have a combined drainage area of approximately 488 square miles. Both streams discharge into the northwest side of Saginaw Bay (Figure 7–17). One municipal primary treatment plant and one industry discharge into the surface waters of the Rifle River basin and one municipal secondary treatment plant discharges into the surface waters of the Pine River basin.

Water quality is generally good throughout

(Continued on page 105)

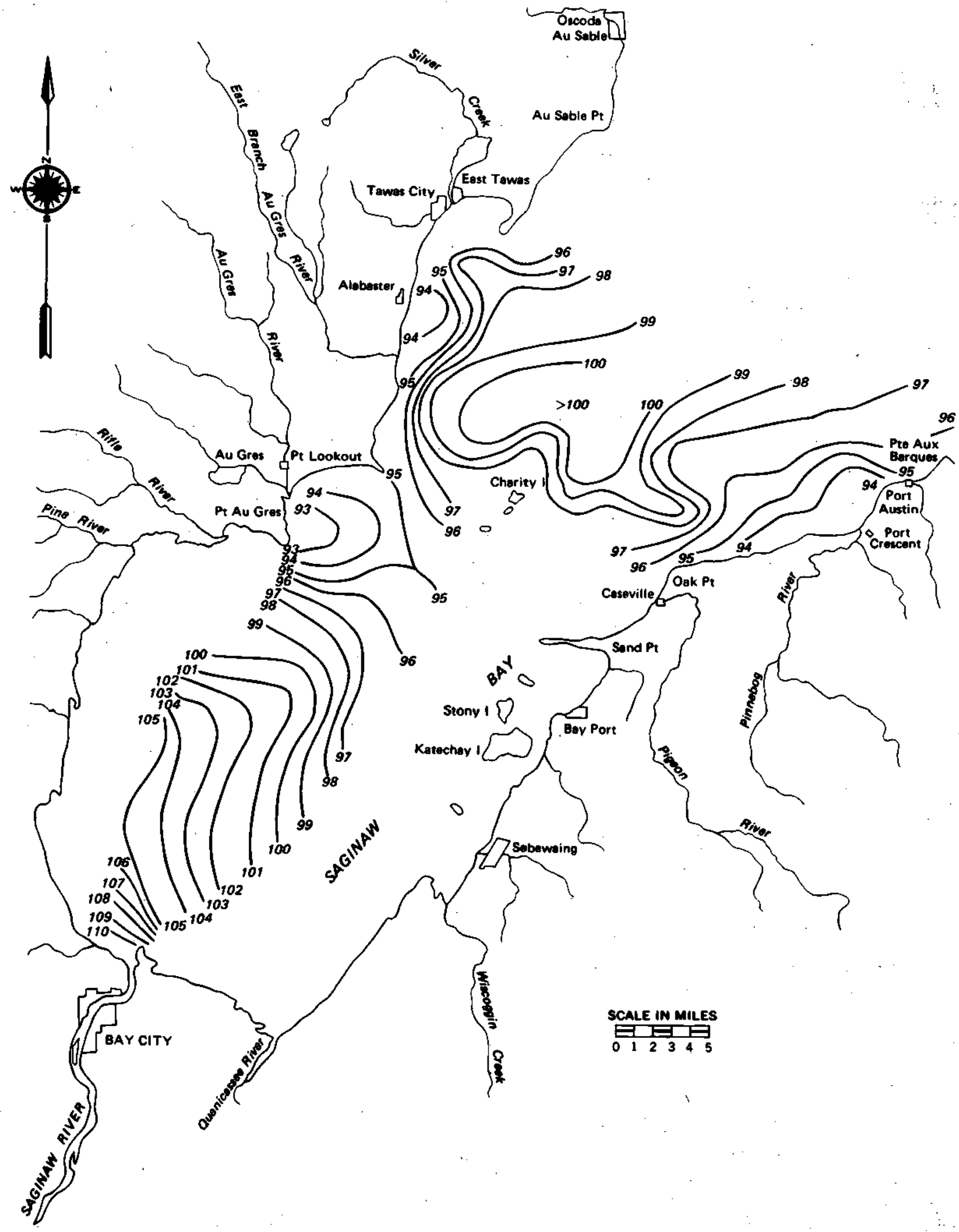


FIGURE 7-13 Mean Surface Dissolved Oxygen Saturation, Saginaw Bay (July-August 1966)

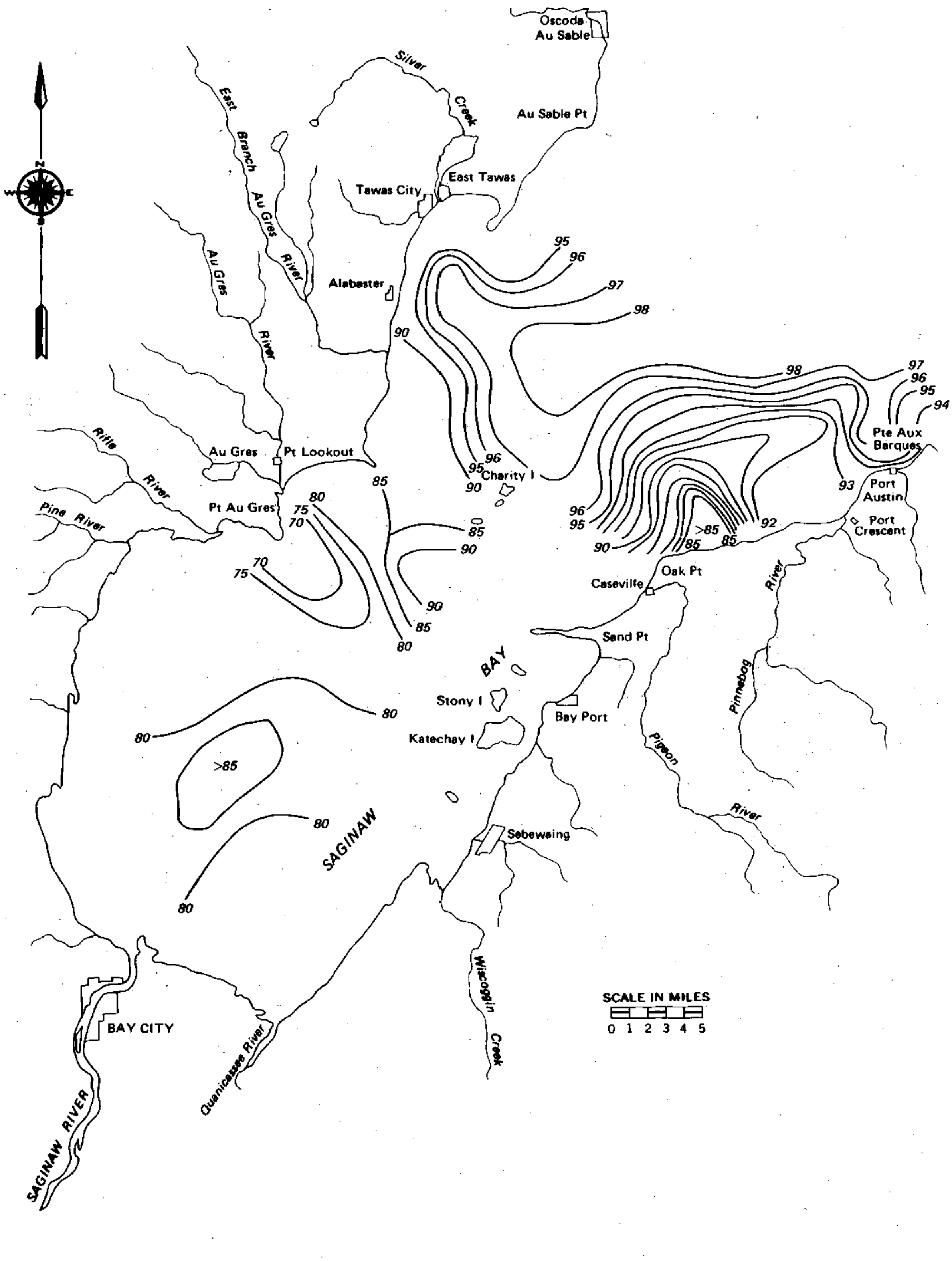


FIGURE 7–14 Mean Bottom Dissolved Oxygen Saturation, Saginaw Bay (July–August 1966)

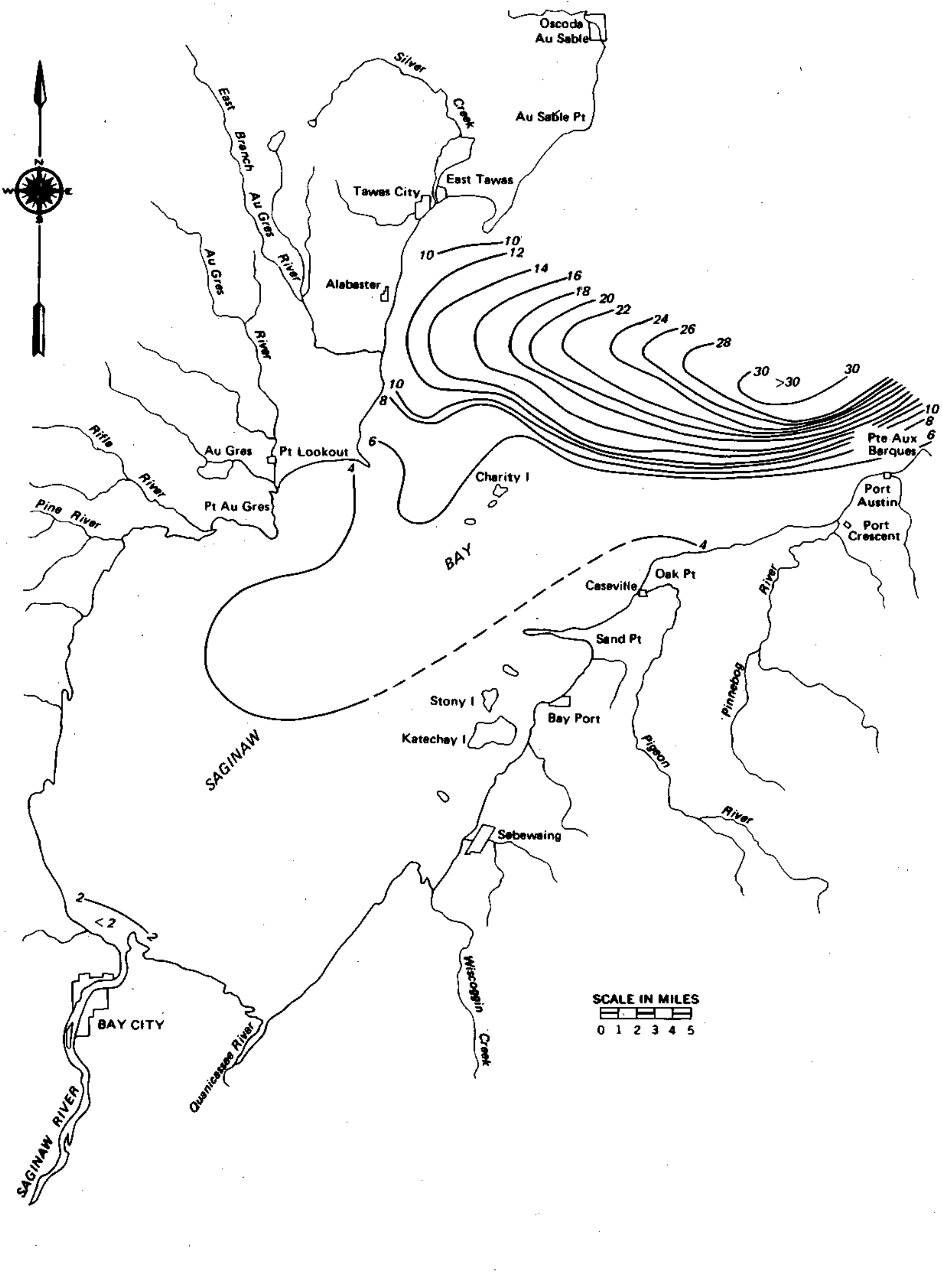


FIGURE 7–15 Mean Transparency, Saginaw Bay (July–August 1966)

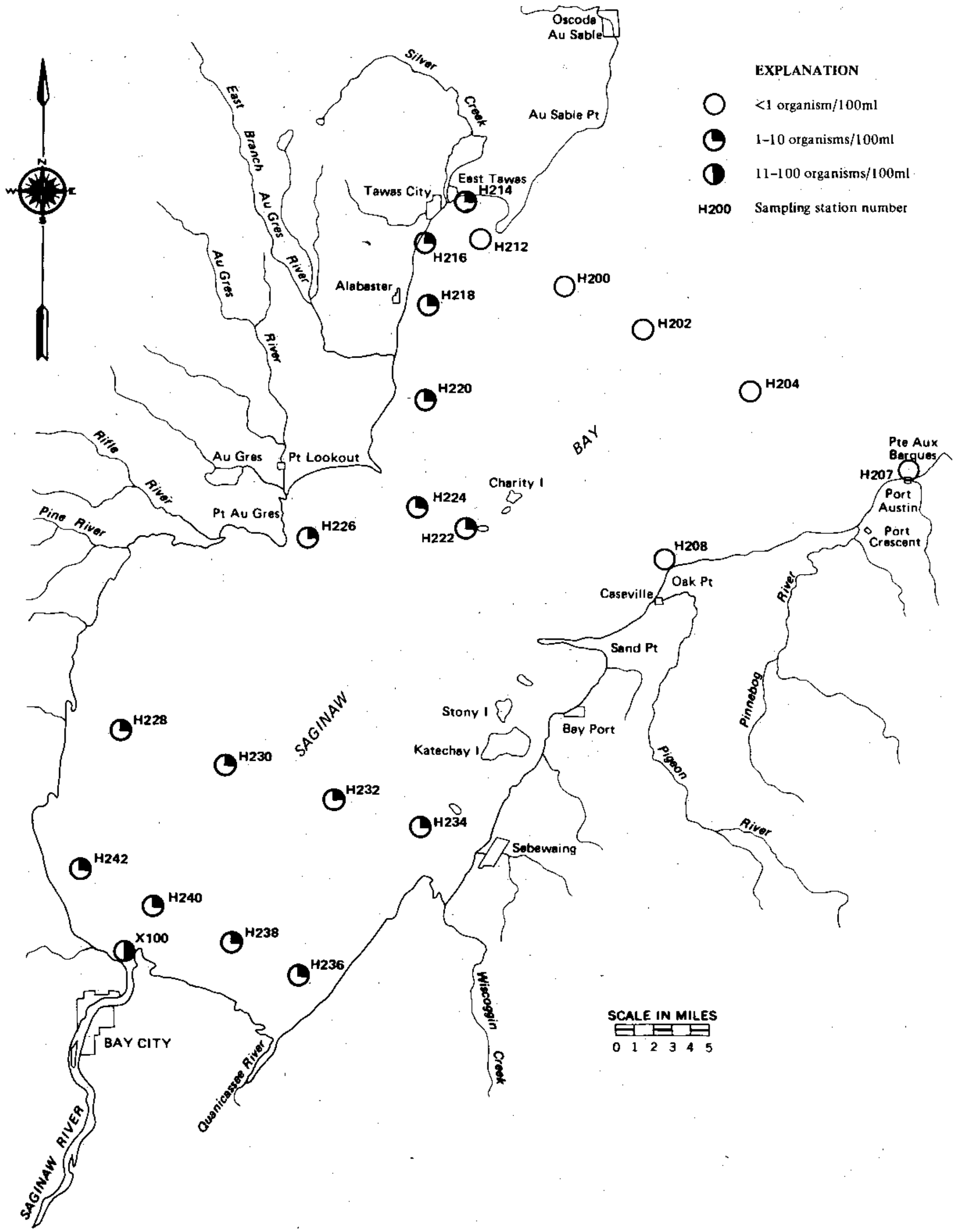


FIGURE 7–16 Median Total Coliform Densities, Saginaw Bay (May–September 1966)

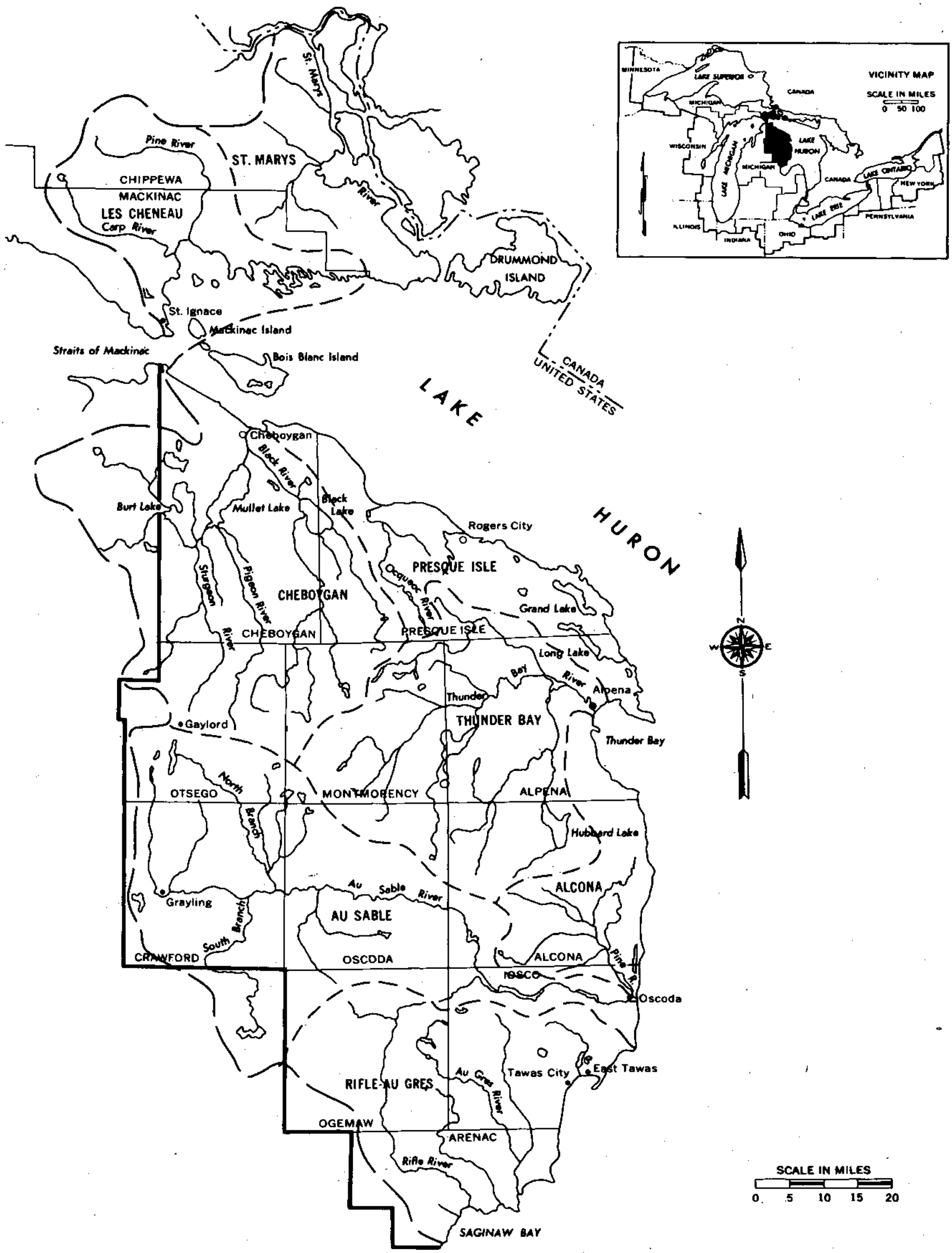


FIGURE 7–17 Planning Subarea 3.1—Lake Huron North

the Rifle River basin, although three localized reaches have substandard water quality. One reach receives the effluent of a primary treatment plant and an industrial discharge. This reach experiences marginally substandard dissolved oxygen depression, high nutrient concentrations, and occasional excessive residue concentrations. The other two reaches of substandard quality are degraded by the discharge of untreated and partially treated sewage. Both reaches exhibit high coliform and nutrient levels and one also experiences dissolved oxygen depression.

The Pine River, which maintains generally good water quality, has two reaches of substandard water quality. Located on the Middle Branch below a municipal secondary treatment plant, one reach exhibits high nutrient levels. Another, located near the mouth of the river, exhibits excessive coliform densities which probably result from rural drainage and individual septic tank systems.

6.2.2.2 Au Gres and Tawas River Basins

The Au Gres and Tawas River basins have a combined drainage area of approximately 540 square miles. One municipal primary treatment plant discharges into the surface waters of the Tawas River basin and one municipal lagoon discharges into the Au Gres River basin. No industrial discharges exist in either basin.

Water quality is good throughout the Au Gres River basin except for localized bacteriological problems. One reach of the Au Gres River and one reach of Cedar Creek are degraded by untreated and partially treated sewage. Both reaches display elevated coliform and nutrient levels.

Good water quality is maintained in the Tawas River basin except in two reaches. One reach of Dead Creek receives the effluent of a primary sewage treatment plant and experiences high nutrient concentrations. A second reach, located in the Tawas area, immediately above the mouth, exhibits elevated coliform densities of unknown origin.

6.2.2.3 Au Sable River Basin

The Au Sable River basin, with a drainage area of 2,350 square miles, flows into Lake Huron at Oscoda, Michigan. Principal tributaries of the Au Sable River are the North Branch, Middle Branch, South Branch, and the Pine River. Three sewage treatment plants, two municipalities, and one Federal installation use surface waters of the Au Sable River basin for waste assimilation. There are no industrial surface water discharges.

Water quality is generally very good throughout the basin although six reaches of substandard quality exist. Two reaches are located downstream from communities which provide primary waste treatment only. Both reaches display elevated coliform densities and nutrient concentrations. Undesirable aquatic growths exist in both reaches.

A third reach of substandard quality, located near the mouth of the river, displays high coliform levels. The privately owned underground septic systems serving this area have failed periodically.

Three reaches of substandard water quality are located on the Pine River. Two reaches are degraded by raw sewage discharges and a third reach has been degraded occasionally by the failure of a municipal septic tank and tile field system. All three reaches exhibit elevated coliform levels.

6.2.2.4 Thunder Bay River Basin

The Thunder Bay River drains an area of approximately 1,250 square miles and flows into Lake Huron at Alpena, Michigan. Principal tributaries are the North Branch, South Branch, and Lower South Branch. Alpena, with a population of 15,000, is the largest community in the sparsely populated basin. A major port on Lake Huron, Alpena is the site of the world's largest portland cement manufacturing center.

One municipal primary treatment plant and two industries use surface waters of the Thunder Bay River basin for waste assimilation.

Water quality is generally very good throughout the basin although two reaches have substandard water quality. One reach, near the mouth of the river in the Alpena area, receives one municipal and two industrial discharges. It exhibits lowered dissolved oxygen concentrations and elevated levels of coliforms, nutrients, suspended solids, and dissolved solids. The City of Alpena has been informed of the need to upgrade treatment. Additional treatment facilities are being constructed by one industry, and studies are under way regarding a second industry.

A second reach of substandard water quality is located in the middle of the basin below a small community discharging raw sewage. This reach exhibits elevated coliform and nutrient levels. A conference has been held with the community involved.

6.2.2.5 Cheboygan River Basin

The Cheboygan River basin, draining an area of approximately 1,460 square miles, empties into Lake Huron at Cheboygan, Michigan. Tributaries of the Cheboygan include the Maple, Pigeon, Sturgeon, and Black Rivers. The basin is sparsely populated, and lakes and swamps occupy 23 percent of the basin's surface area. One municipal primary treatment plant and one industry use the basin's surface waters for waste assimilation.

Water quality is generally very good throughout the basin but two reaches of substandard water quality exist. One reach occurs near the mouth of the river below the discharge of a primary sewage treatment plant. This reach exhibits elevated coliform and nutrient levels. A second reach of substandard quality is located below a small resort community in the middle of the basin. This reach displays marginally substandard coliform densities caused by septic tank seepage into storm sewers.

6.2.2.6 St. Marys River Basin

The St. Marys River basin includes the St. Marys, Waiska, Charlotte, Munuscong, and Gogomain Rivers. The St. Marys River, connecting Lake Superior to Lake Huron, flows easterly for 15½ miles from Whitefish Bay to St. Marys Falls at Sault Ste. Marie, where it drops 22 feet. It continues southeasterly for 49 miles to the De Tour Passage on Lake Huron. The basin is sparsely settled and much of it is in public ownership. In the United States portion of the basin, one municipality, two industries, and one Federal installation use surface waters for waste assimilation.

Water quality in all of the tributaries is good. No known areas of substandard quality exist. The Munuscong River carries a natural silt load which is especially noticeable after rains and during spring runoff.

Water quality of the St. Marys River has improved in recent years because of better treatment by municipal waste treatment plants on both sides of the river and a reduction in industrial effluents from the Michigan side. One reach of substandard quality, below Sault Ste. Marie, Michigan, receives nutrients from the municipal plant and occasionally displays high coliform levels. The community has engaged consultants to evaluate the need for secondary treatment and to design phosphate removal facilities.

During navigation season the St. Marys River is one of the busiest waterways in the world. Due to heavy traffic or fog, vessel traffic occasionally must anchor and await passage through the lock. The anchored vessels deposit waste in the river from pumping bilges and discharging sewage and ballast. Because of the transience of the vessels, these problems are difficult to correct.

6.2.2.7 Carp and Pine River Basins

The Carp and Pine Rivers, with a combined drainage area of approximately 420 square miles, discharge into Lake Huron just east of the Straits of Mackinac in the Upper Peninsula. The two basins are very sparsely populated and much of the area lies within the Marquette National Forest. There are no municipal discharges and only one industrial discharge into the surface waters of these basins. Water quality is generally excellent in these two basins. One school, located to the east of these basins on the Lake Huron shoreline, discharges untreated and semi-treated sewage. This discharge causes elevated coliform densities in a localized area in Lake Huron.

6.2.3 Planning Subarea 3.2

Planning Subarea 3.2 encompasses Michigan's Thumb and the area drained by the Saginaw River and its major tributaries. Eleven Michigan counties are included in the planning subarea (Figure 7–18).

6.2.3.1 Saginaw River System

The Saginaw River system drains an area of approximately 6,200 square miles in the central and eastern portions of the Lower Peninsula. The system consists of the Saginaw River basin itself, which directly drains 246 miles, and the tributary basins of the Cass, Flint, Shiawassee, and Tittabawassee Rivers.

(1) Saginaw River Basin

The Saginaw River is formed by the junction of the Shiawassee and Tittabawassee Rivers. The Cass and Flint Rivers enter the Shiawas-

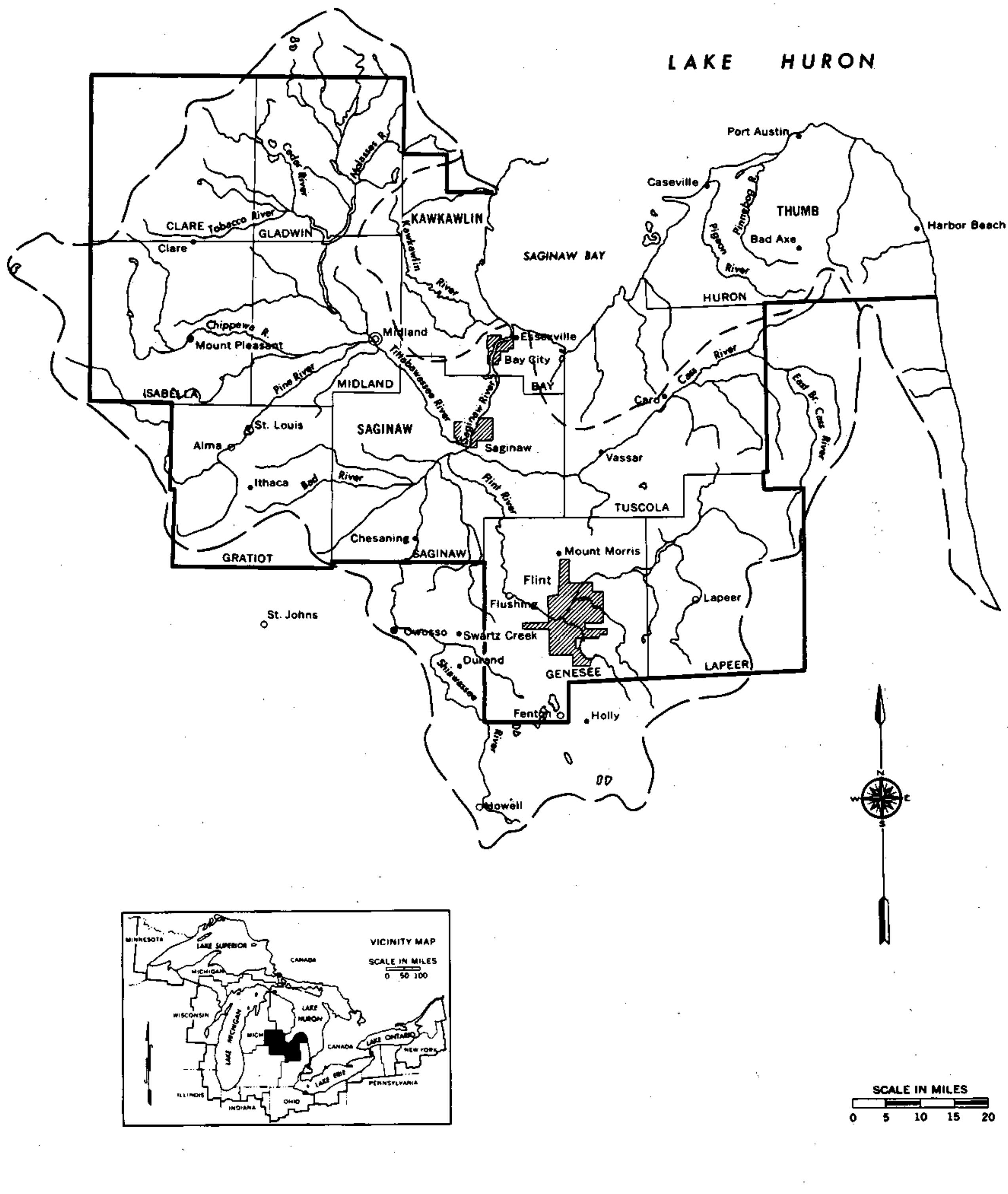


FIGURE 7-18 Planning Subarea 3.2—Lake Huron Central

see slightly above this juncture. Flowing in a north-northeasterly direction for 22 miles, the Saginaw River discharges into Saginaw Bay near Bay City, Michigan. A slow-moving stream, the Saginaw River averages a 2-foot drop throughout its length. The depth, velocity, and discharge of the river are affected by the height of water in Saginaw Bay. A sustained southwest wind lowers the level of Saginaw Bay and temporarily increases river velocity and discharge. A sustained northeast wind causes the opposite result. At times the flow of the river reverses.

Two major and four minor municipal wastewater treatment plants, all providing primary treatment, use the surface waters for waste assimilation. Six major industrial wastewater discharges use the Saginaw River for waste assimilation.

The Saginaw River has substandard quality throughout its entire length. Tributaries contribute sizeable waste loads, especially chlorides and nutrients. Nutrients are present in high concentrations throughout the year. Two distinct dissolved oxygen sags exist in the Saginaw River. The most serious occurs below Saginaw and the other exists below Bay City. The river carries a high suspended sediment load causing extensive sludge deposit areas. High total and fecal coliform concentrations occur below Saginaw, Bay City, and other communities during periods of storm water runoff. Even light rains produce combined sewer overflows.

All six municipalities discharging into the Saginaw River have agreed to upgrade their primary treatment plants by providing secondary treatment with phosphorus removal. This was to have been completed by 1972. Two industries have also agreed to provide additional treatment facilities.

(2) Cass River Basin

Draining approximately 890 square miles, the Cass River is the smallest of the four principal tributaries of the Saginaw River. The basin, which measures approximately 55 miles at its longest point, is a rich farming area without major population centers or industrial complexes.

Seven municipal and institutional wastewater treatment facilities and three industries use surface waters of the Cass River basin for waste assimilation. All seven nonindustrial treatment plants have secondary waste treatment.

Water quality is generally good throughout the basin except for the lower portion of the Cass River. The river is substandard in quality from Frankenmuth to its mouth, a distance of 18 miles (Figure 7–19). The Frankenmuth municipal sewage treatment plant, which processes the wastes of two breweries, imposes a heavy waste load on the river. The larger brewery discharges waste with a population equivalent of approximately 30,000 based on BOD_5. This waste load fluctuates in volume and strength and causes serious operating problems for the municipal treatment plant. In the reach below Frankenmuth the Cass River displays dissolved oxygen depletion and high levels of coliforms, suspended solids and nutrients. Algal blooms cause extreme diurnal dissolved oxygen variations at certain times of year.

In the Cass River basin above Frankenmuth are three main stem and two tributary reaches of substandard quality. One main stem reach receives raw sewage discharges from a small community and exhibits high coliform densities. A second reach, which receives the effluent from an inadequate secondary treatment plant, displays high coliform densities and marginally substandard dissolved oxygen concentrations. Studies are investigating the upgrading of this plant or the securing of other treatment facilities. The third main stem reach, located below Caro, is degraded by the discharge of a large food processing industry at certain times of year. This reach displays depressed dissolved oxygen and excessive levels of coliform, suspended solids, and nutrients.

Two tributary reaches of substandard quality, located on the North Branch and Millington Creek, both receive raw sewage discharges and display high coliform and nutrient concentrations. One community is under orders to provide treatment facilities. One reach, affected by waste from a milk products firm, exhibits substandard dissolved oxygen concentrations.

Sediment loads in the Cass River are high, particularly during spring high water periods, and the river maintains high turbidity. Combined sewers in some basin communities add to the sediment load with stormwater overflows.

(3) Flint River Basin

The Flint River basin has a drainage area of approximately 1,350 square miles. Major tributaries of the Flint River are the North and South Branches, and Farmers, Kearsley, Thread, Swartz, and Mistequay Creeks. Eight municipal and institutional wastewater

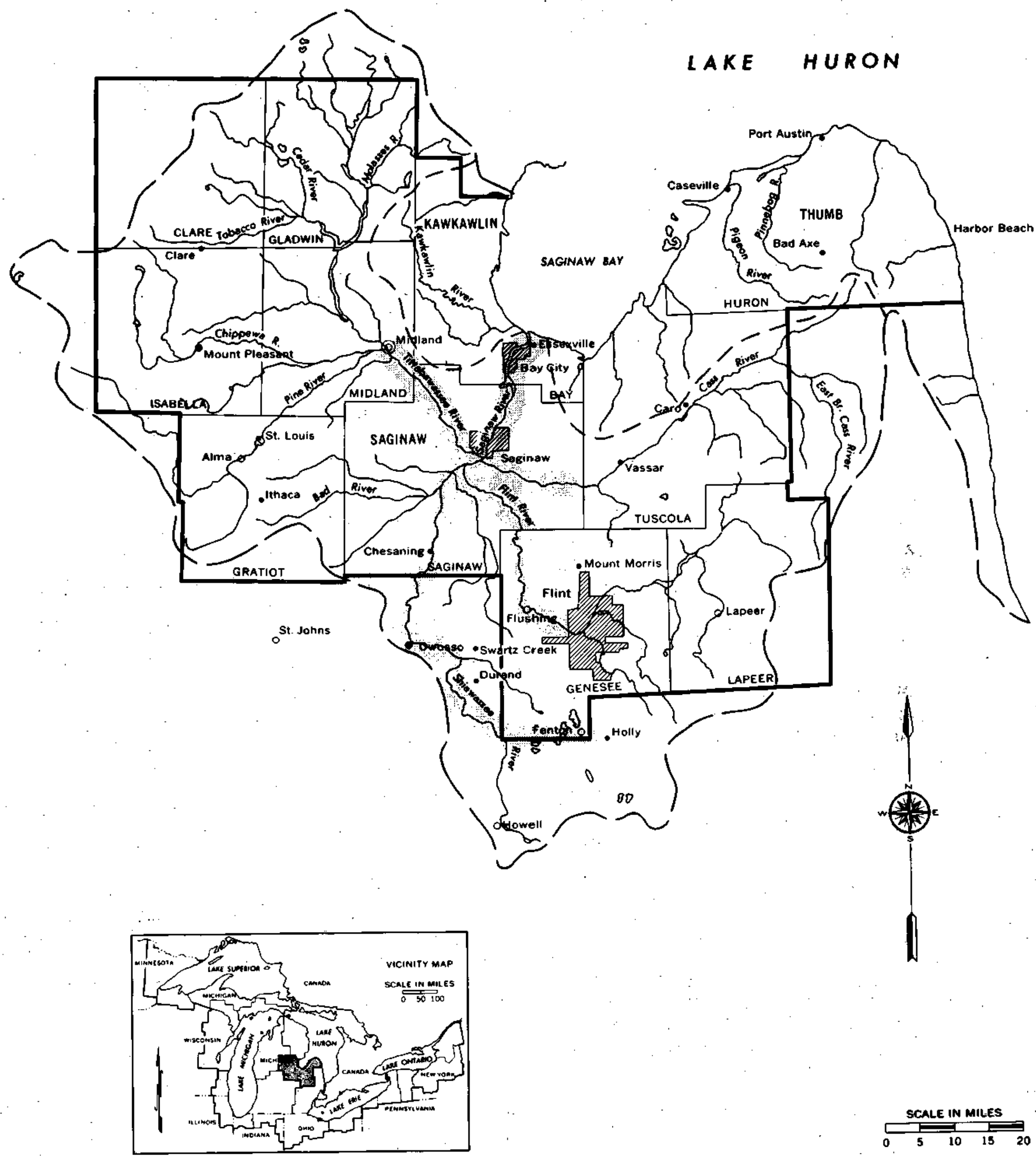


FIGURE 7–19 Planning Subarea 3.2—Major Areas of Substandard Water Quality

treatment facilities and nine industrial establishments use the surface waters for waste assimilation.

Six municipal facilities provide secondary waste treatment and two provide primary treatment. Genesee County's ambitious regional collection, treatment, and disposal system is rapidly becoming a reality. This system of six county districts and a number of independent districts will use the existing secondary plant at Flint, construct certain new plants, and require abandonment of several existing facilities.

The most serious reach of substandard water quality in the Flint River basin occurs in and below Flint. Above the Flint wastewater treatment plant the river is degraded by stormwater overflows, tributary waste loads, and untreated and partially treated sewage discharges from outlying townships. In this reach the river displays dissolved oxygen depression and excessive levels of suspended solids, nutrients, residues, detergents, and substandard pH changes.

Although the Flint wastewater treatment plant is efficient in removing wastes, it still imposes a heavy organic waste load on the river during low flow periods. Dissolved oxygen is severely depleted during these low flow periods and very high nutrient concentrations foster excessive quantities of algae and aquatic weeds. The Flint River contains excessive nutrient concentrations for the entire distance downstream to its confluence with the Saginaw River (Figure 7–18). The Flint River accounts for 40 percent of the annual phosphorus load to the Saginaw River although it contributes only 25 percent of the flow to the Saginaw River.

Waste loads discharged into the river will increase as the area's population increases and the county's system expands. To satisfy intrastate water quality standards, a higher degree of treatment with provision for phosphate removal will be required.

Also in the greater Flint region, untreated raw and partially treated sewage discharges bacteriologically degrade three localized reaches of Kearsley Creek, one reach of Thread Creek, and one reach of Swartz Creek. Two of these areas will soon be served by the county system.

Downstream from Flint one main stem reach receives raw sewage discharges from a small community, causing high coliform levels. The community involved is negotiating with the county for treatment. Two reaches of substandard quality, located on Mistequay Creek, receive raw sewage discharges. One reach also receives treated industrial wastes. Both display high coliform densities and one exhibits depressed dissolved oxygen.

Upstream from Flint water quality is generally good, although one main stem and four tributary reaches exhibit substandard quality. One small main stem community discharges raw sewage which degrades the river and the Holloway Reservoir. The river displays dissolved oxygen depletion and excessive levels of coliforms, suspended solids, and nutrients. Holloway Reservoir has experienced extensive seasonal algal blooms which have resulted in fish kills. This community is under orders to construct treatment facilities.

Two minor reaches of substandard quality are located on Butternut Creek and two other reaches of substandard quality occur in the South Branch. Two reaches are degraded by primary treatment plant effluents, one by a raw sewage discharge, and one by an industrial discharge.

(4) Shiawassee River Basin

The Shiawassee River basin drains an area of 1,200 square miles. North Ore Creek, Bogue Creek, and the Bad River are major tributaries of the Shiawassee River, which is 100 miles long. The basin has an hourglass configuration with a narrow middle portion only a few miles wide.

Ten municipal and institutional wastewater treatment facilities and four industries use surface waters of the Shiawassee River basin for waste assimilation. Seven municipal facilities provide secondary waste treatment and three provide primary treatment.

Because of excessive nutrient concentrations, water quality is substandard along the entire 50-mile stretch from the mouth of the Shiawassee to Corunna, located in the narrow middle portion of the basin. Based on other parameters, substandard water quality exists in six reaches separated by short intervals.

Three reaches, degraded by raw and partially treated sewage discharges, display high coliform densities. One reach also exhibits depressed dissolved oxygen. Abatement orders have been issued against one community, and two communities have been notified that a problem exists.

The other three main stem reaches are degraded by the effluent from inadequate primary treatment plants. All three reaches exhibit dissolved oxygen depression and two display high coliform densities.

The Bad River and Swan Creek, tributaries of the lower basin, each have one reach of substandard quality. Degraded by the discharge of untreated and partially treated sewage, both reaches display high coliform densities. Dissolved oxygen depression and high levels of nutrients and suspended solids are found in one reach.

Water quality is generally better in the upper portion of the basin above Corunna, although five main steam reaches and two tributary reaches of substandard quality exist. Untreated and partially treated sewage degrades three main stem reaches, which display high coliform levels. The other two main stem reaches are affected by effluent from municipal secondary treatment plants. Both reaches exhibit dissolved oxygen depression and high nutrient concentrations.

Bogue Creek and Holly Creek each have one localized reach of substandard quality. Septic tank effluents cause a minor bacteriological problem in one reach. Degraded by the effluent from an overloaded municipal secondary treatment plant, the second reach displays dissolved oxygen depression and high coliform densities. The community responsible for this plant has agreed to a Department of Health stipulation to upgrade the existing treatment plant.

(5) Tittabawassee River Basin

The Tittabawassee River basin encompasses a drainage area of approximately 2,620 square miles. The Tobacco, Salt, Chippewa, and Pine Rivers are major tributaries of the Tittabawassee River. Although the basin is the center of a large chemical complex, developed as a result of underground salt deposits, it is sparsely populated and mostly devoted to rural activities.

Water quality is poor in the lower portion of the Tittabawassee River between Midland and the confluence with the Saginaw River (Figure 7–19). Four reaches of substandard quality exist. Two reaches, degraded by raw sewage discharges, exhibit elevated coliform levels. A third reach, which receives the primary effluent of a municipal treatment plant, exhibits high nutrient levels and marginally substandard dissolved oxygen concentrations.

The most serious reach of substandard quality occurs below the City of Midland. This reach receives the effluent from the Midland wastewater treatment plant and discharges from the Dow Chemical Company complex. Although Dow Chemical has achieved a substantial degree of wastewater treatment, the wastes discharged have a severe impact on water quality. The chloride concentration increases 30-fold below the Midland area. A considerable heat load is also injected to the stream by the use of river water for cooling. Below the Midland are the Tittabawassee River displays lowered dissolved oxygen concentrations and elevated levels of suspended and dissolved solids, conductivity, temperature, pH, and taste and odor producing substances. Due to treatment failure or human error excessive amounts of toxic substances have been released occasionally, causing fish mortality.

Water quality throughout the upper Tittabawassee River basin is generally very good although lower quality exists in reaches below some municipalities. Eight reaches of substandard quality exist in the upper basin.

The Pine River is substandard in quality below the Alma-St. Louis area. This reach receives primary effluents from two municipal treatment plants and discharges from the area's petroleum and chemical industries. The reach exhibits a 14-fold chloride increase, and lesser increases of nutrients, toxics, and suspended solids. Dissolved oxygen is marginally substandard and oil problems have developed occasionally.

One reach of substandard quality, located on the Chippewa River, receives the primary effluent of a municipal treatment plant and an industrial discharge. This reach displays dissolved oxygen depression and high levels of coliforms and suspended solids.

Two localized reaches of substandard quality exist on tributaries of the Salt River. Affected by the discharge of raw and partially treated sewage, both reaches exhibit dissolved oxygen depression and elevated levels of coliform and nutrients. One community is under orders to construct treatment facilities and the second community has been notified that corrective action is necessary.

The Tobacco River also has two localized reaches of substandard quality. Located below municipal secondary treatment plants, both reaches are substandard in nutrient concentrations only.

The principal water quality problem of the Tittabawassee River basin is the amount of dissolved solids, chiefly chlorides, which are discharged from the basin. The Tittabawassee is the major source of discharged chlorides within the entire Michigan drainage area to Lake Huron.

6.2.3.2 Minor Drainage Areas

Minor streams within Planning Subarea 3.2 include the Pinconning and Kawkawlin, which are located to the west of Saginaw Bay, and the Sebewaing, Willow, Pigeon, Pinnebog, and other small streams, which are located south and east of Saginaw Bay (Figure 7–20). These streams generally have a small drainage area of between 50 and 200 square miles. The area is predominately agricultural with little industrial activity. Water quality is generally fair to good except in reaches located below some small communities.

In the lower few miles of the Kawkawlin River near the mouth substandard conditions are caused by septic tank discharges from individual homes and cottages and by one industrial discharge. Elevated coliform and residue levels are the principal in-stream effects.

One reach of the Pinconning River is substandard. This reach receives the secondary effluent of a municipal treatment plant and discharges from two industries. During drought periods river flows are extremely small. This reach experiences dissolved oxygen depression and elevated levels of coliforms and nutrients.

In the Sebewaing River one reach of substandard quality exists near the mouth. This reach receives raw sewage discharges and exhibits depressed dissolved oxygen and high coliform and nutrient levels. The community involved has signed a stipulation to provide waste treatment facilities.

Two reaches of Shibeon Creek and one reach of the Pigeon River exhibit substandard quality due to high coliform densities. All three reaches are degraded by raw sewage discharges and the communities involved have been notified that corrective action is necessary.

Two reaches of substandard quality exist on the Pinnebog River. One reach receives raw sewage discharges from a small community and inadequately treated industrial wastes. This reach experiences depressed dissolved oxygen and excessive levels of coliforms, residues, and suspended solids. The industry involved has signed a stipulation to upgrade treatment facilities and the community has been ordered to abate the discharge of raw sewage. The second reach of substandard quality has been degraded by an industrial discharge, which has experienced past treatment failures. This reach exhibits dissolved oxygen depletion and excessive amounts of suspended solids.

6.3 Water Quality Control Needs

This subsection deals with water quality controls necessary to maintain water quality standards in future years. The primary objectives are to:

(1) project wastewater treatment costs, including that for phosphorus removal and advanced waste treatment, for the study periods 1970 to 1980 to 2000, and 2000 to 2020

(2) identify reaches of streams where advanced waste treatment will be required, for each study period

(3) identify other water quality control needs

6.3.1 Advanced Waste Treatment Needs

The methods used in this study to determine the need for advanced waste treatment are described in the Introduction. Considerable data from the Michigan Water Resources Commission were used to augment this methodology to achieve increased accuracy. Of particular importance were the local official pollution control plans submitted by local governments as a requirement for financial assistance under Michigan's Clean Waters Bonding Program. These local plans generally specified expected service areas, waste loads, and other factors for the next 20 to 30 years.

6.3.2 Wastewater Treatment Cost Estimates

The methods used to determine estimates for wastewater treatment costs are summarized in the Introduction. All cost estimates presented in the following sections are order-of-magnitude estimates only and may not be highly accurate.

6.3.3 Lake Huron North—Planning Subarea 3.1

6.3.3.1 Population and Wastewater Volumes

Planning Subarea 3.1 embraces 11 counties in the northwestern portion of Michigan's Lower Peninsula. It contains no large concentrations of population or industry. In 1970 the municipal sewage treatment plants served approximately 38,000 people, or 27 percent of the planning subarea's total population. The planning subarea is expected to grow consid-

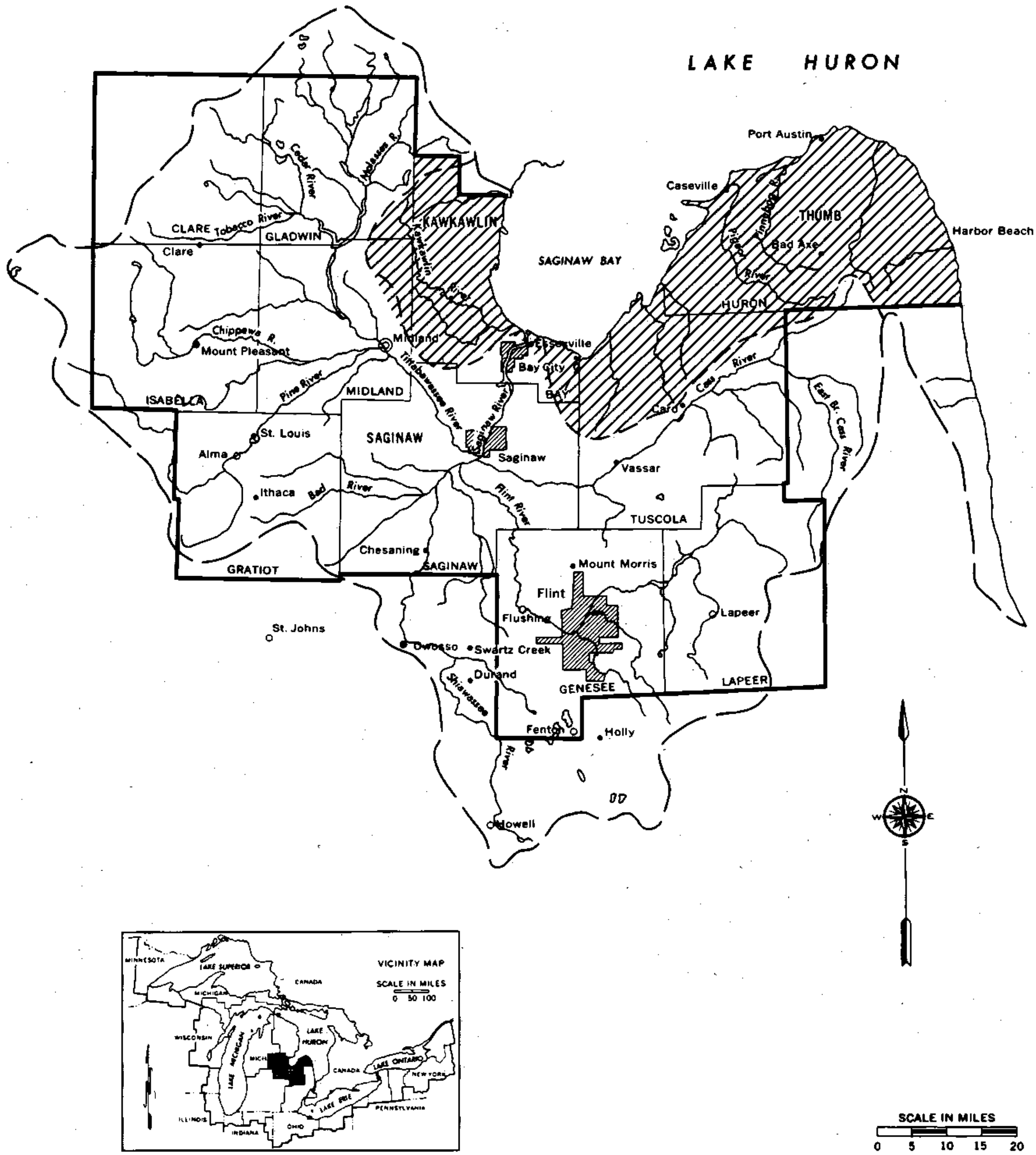


FIGURE 7-20 Planning Subarea 3.2—Minor Drainage Areas

erably in the next 50 years. Projected levels of population and wastewater volumes are shown in Table 7–37.

TABLE 7–37 Projections of Wastewater Flows and Population Served, Planning Subarea 3.1—Michigan

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	142,064	38,000	5.0	12.3
1980	164,300	53,000	7.2	9.7
2000	208,700	85,000	12.0	9.8
2020	267,000	130,000	18.2	17.8

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b]Industrial wastewater anticipated to be treated in industry-owned wastewater treatment facilities.

6.3.3.2 Advanced Waste Treatment Needs

To maintain adequate water quality in the Middle Branch of the Pine River, the Standish area will probably require advanced waste treatment in the 1970 to 1980 period. Facilities are being planned to meet this need. In this reach 7-day 10-year low flows are approximately 1 to 2 cfs (Figure 7–21).

6.3.3.3 Treatment Costs

Table 7–38 presents capital costs and operating and maintenance costs for municipal treatment needs by planning periods.

These figures exclude costs for municipal sewer collection systems, stormwater control facilities, and separate industrial treatment facilities.

6.3.4 Lake Huron Central—Planning Subarea 3.2

6.3.4.1 Population and Wastewater Volumes

Planning Subarea 3.2, which comprises 11 counties in the east-central area of Michigan's Lower Peninsula, is generally coterminous with the Saginaw River basin. In 1970, 36 municipal wastewater treatment facilities served 550,000 people, or approximately half of the area's total population. The average daily flow

TABLE 7–38 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 3.1—Michigan

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	6.05	0.55
1980–2000	8.1	1.0
2000–2020	10.6	1.2

treated by these 36 facilities was 80 million gallons per day.

Total industrial wastewater flows in 1970 were estimated at 473 mgd. Major industrial activities in the planning subarea include chemical companies, refineries, slaughterhouses, food processing operations, and numerous automotive manufacturing facilities. Industrial concentrations are located along the Saginaw River between Bay City and Saginaw, and in the Greater Flint area, Midland, and the Alma-St. Louis area.

Planning Subarea 3.2 is expected to sustain considerable growth through the year 2020. Table 7–39 presents projected levels of population and wastewater flows for target years.

TABLE 7–39 Projections of Wastewater Flows and Population Served, Planning Subarea 3.1—Michigan

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	1,094,201	550,000	80	453
1980	1,246,800	693,000	104	408
2000	1,600,500	1,046,700	163	252
2020	2,057,400	1,503,000	245	346

[a]Total of Domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b]Industrial wastewater anticipated to be treated in industry-owned wastewater treatment facilities.

6.3.4.2 Advanced Waste Treatment Needs

Planners anticipate that 14 areas will require advanced waste treatment in the 1970 to 2020 period. Of these the need for advanced waste treatment in twelve areas falls within the period of 1970 to 1980 and in two areas within the period 2000 to 2020. Advanced waste treatment needs in Planning Subarea 3.2 are discussed by river basins.

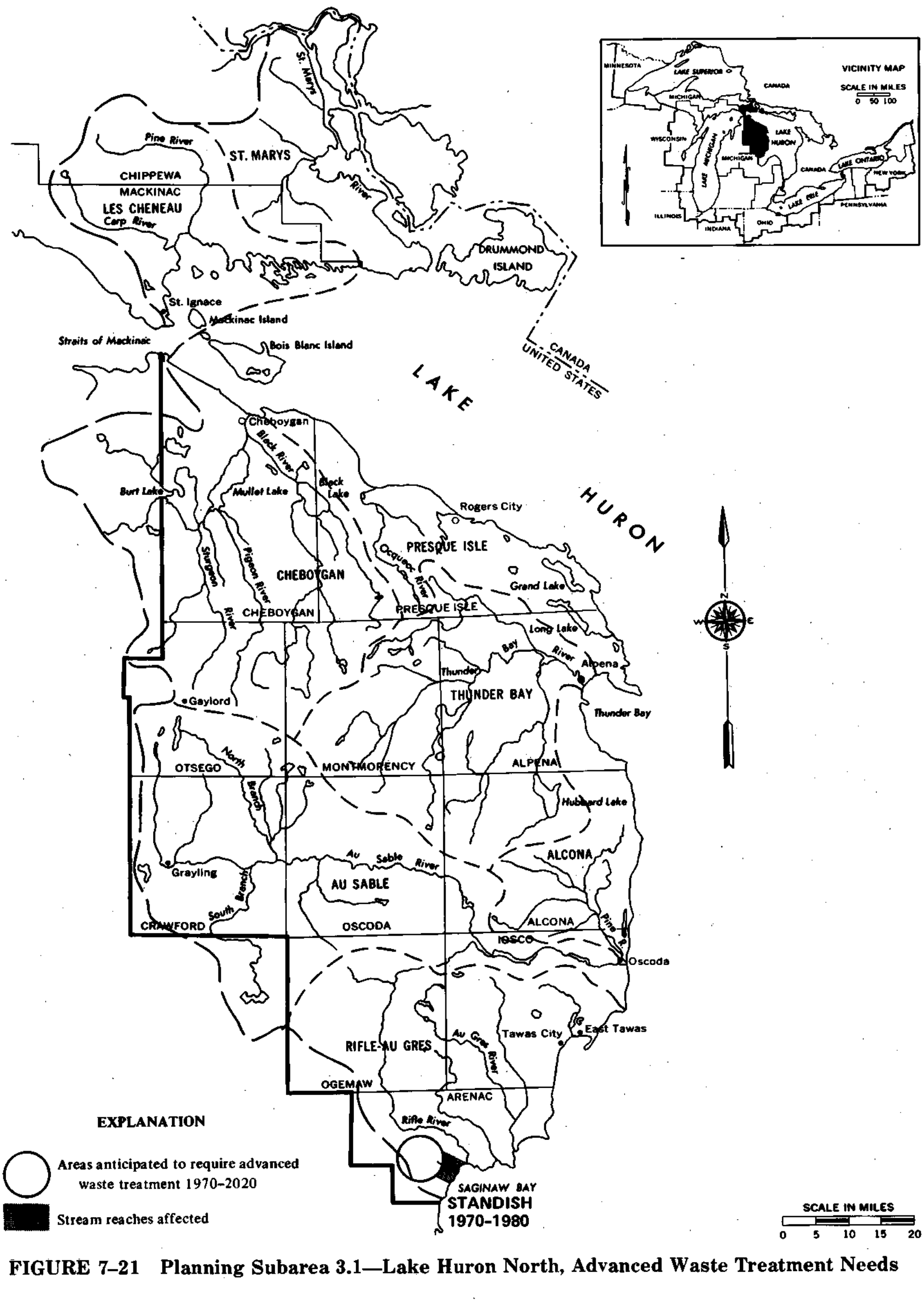


FIGURE 7-21 Planning Subarea 3.1—Lake Huron North, Advanced Waste Treatment Needs

(1) Flint River Basin

In the Flint River basin three areas will probably require advanced waste treatment before 1980. Advanced waste treatment is presently required by the Flint municipal treatment plant to meet water quality standards in the Flint River below the greater Flint area. This plant already removes more than 90 percent of the BOD_5, and additional facilities will provide higher treatment levels.

Planners also anticipate that advanced waste treatment will be needed before 1980 for the treatment plant of Genesee County's Sanitary Sewage Disposal District Number Two. Located near Montrose, Michigan, this plant discharges effluent to the Flint River. District Number Two provides sewer services in the Townships of Flushing, Genesee, Montrose, Mount Morris, Thetford, and Vienna, and the Cities of Mount Morris and Clio.

In the upstream reaches of the Flint River basin advanced waste treatment will be needed at Lapeer before 1980 to maintain water quality standards in the South Branch of the Flint River downstream from the Lapeer area. Facilities are being completed to meet this need. In later planning periods higher levels of treatment will be warranted corresponding with the area's growth.

(2) Shiawassee River Basin

Four areas in the Shiawassee River basin will probably require advanced waste treatment in the current 1970 to 1980 planning period.

The Village of Holly will need advanced waste treatment to meet water quality standards in the Shiawassee River downstream from the Holly area. Facilities are being planned to meet this need. Ultimately it may be possible for Holly to phase out its treatment plant and connect to the Genesee County regional system.

Downstream from Holly near Fenton advanced waste treatment is needed for the treatment facility of Genesee County's Sanitary Sewage Disposal District Number Three. Small drought flows occur in this reach of the Shiawassee River, and extremely high BOD removal is warranted. With future growth in District Number Three increased levels of treatment will be required.

Howell will need advanced waste treatment in the present planning period to protect the waters of the South Branch of the Shiawassee River below Howell. Drought flows in this stream reach are very low, approximately 1 cfs. Howell plans to install tertiary sand filtering equipment to provide the required treatment levels. Substantial growth has been projected for the Howell area and increased levels of waste treatment will probably be needed in future planning periods.

Located in the middle of the basin, the Owosso-Corunna area will require advanced waste treatment in the 1970 to 1980 planning period to protect water quality in the Shiawassee River. Treatment facilities are under consideration in both communities.

(3) Cass River Basin

Advanced waste treatment is now required at Marlette to maintain adequate water quality in Duff Drain, a tributary of the East Branch of the Cass River. Marlette operates tertiary sand filtering facilities as warranted during drought flow periods.

In the lower portion of the basin Frankenmuth needs advanced waste treatment in the present planning period. The Frankenmuth treatment plant handles wastes from two local breweries, which impose a large organic load on the facilities. The city is presently engaged in constructing additional facilities to maintain water quality standards in the Cass River basin downstream from the Frankenmuth area.

(4) Tittabawassee River Basin

Four areas in the Tittabawassee River basin will need advanced waste treatment in the study period.

Advanced waste treatment will be needed at both Alma before 1980 and St. Louis before 2020 to meet water quality standards in the Alma-St. Louis area of the Pine River. In both communities this stream reach receives large discharges of organic industrial wastes. Alma is constructing facilities to meet this need.

Midland will need advanced waste treatment in the present 1970 to 1980 planning period to maintain adequate water quality in the Tittabawassee River below the Midland area. This river reach assimilates a large organic waste load discharged from the Dow Chemical Company complex. Midland plans to install tertiary filtering facilities to meet its effluent requirements.

In the planning period 2000 to 2020 planners anticipate that advanced waste treatment will be needed in the Mt. Pleasant area to maintain adequate water quality in the Chippewa River. The exact timing of this need depends upon future rates of population and economic growth.

(5) Minor Basins

Pinconning will need advanced waste treatment in the current planning period to protect water quality in the Bartlett Drain

TABLE 7–40 Areas Anticipated to Need Advanced Waste Treatment, Planning Subarea 3.2—Michigan

Watershed	Area	Planning Period	Waters Affected	Estimated 7-Day-10-Year Low Flow (cfs)
Flint River	Flint	1970–1980	Flint River	110
Flint River	Genesee County Dist. 3	1970–1980	Flint River	120
Flint River	Lapeer	1970–1980	S. Branch Flint River	3.5
Shiawassee River	Genesee County Dist. 3	1970–1980	Shiawassee River	2.8
Shiawassee River	Owosso-Corunna	1970–1980	Shiawassee River	23
Shiawassee River	Howell	1970–1980	S. Branch Shiawassee River	1
Shiawassee River	Holly	1970–1980	Shiawassee River	2.2
Cass River	Frankenmuth	1970–1980	Cass River	16
Cass River	Marlette	1970–1980	Duff Drain	---
Tittabawassee River	Alma	1970–1980	Pine River	26
Tittabawassee River	St. Louis	2000–2020	Pine River	26
Tittabawassee River	Mt. Pleasant	2000–2020	Chippewa River	65
Tittabawassee River	Midland	1970–1980	Tittabawassee River	242
Pinconning River	Pinconning	1970–1980	Bartlett Drain Pinconning River	0

and Pinconning River. The Pinconning River flows into Saginaw Bay 10 miles north of the mouth of the Saginaw River. In the river reach below Pinconning the river has a drought flow of zero. Pinconning is adding additional facilities, including sand filters and an effluent storage pond, to meet this need.

(6) Summary

Between 1970 and 2020, 14 areas within Planning Subarea 3.2 will probably require advanced waste treatment. Twelve of these needs fall within the current 1970 to 1980 planning period and two within the 2000 to 2020 planning period. Table 7–40 lists these needs, which are shown geographically in Figure 7–22.

6.3.4.3 Treatment Costs

Projections of capital and operating costs for municipal treatment plants by planning period are presented in Table 7–41.

TABLE 7–41 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 3.2—Michigan

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	64	3.6
1980–2000	71	7.3
2000–2020	98	10.2

These estimates exclude the cost of industrial treatment facilities, stormwater control facilities, and sewer collection systems. Estimates shown are essentially those costs necessary for upgrading existing facilities to full basic treatment levels (generally secondary treatment and phosphorus removal), for providing adequate treatment facilities to handle increasing wastewater flows, and for meeting treatment facility repair and replacement needs.

6.3.5 General Water Quality Problems

Water quality control problems exist throughout the Lake Huron basin. Some of these problems are readily apparent, while others are of an emerging nature and their potential remains undelineated.

6.3.5.1 Eutrophication

Eutrophication refers to the whole complex of changes that accompany continuing enrichment by plant nutrients. Further information about eutrophication appears in Subsection 5.3.7.1.

Effects of overenrichment in Lake Huron have been subtle. Only in the shallow confines of a few harbors and bays have man's activities substantially increased the productivity of the lake.

Decreased light penetration, increased nitrogen and phosphorus concentration, and

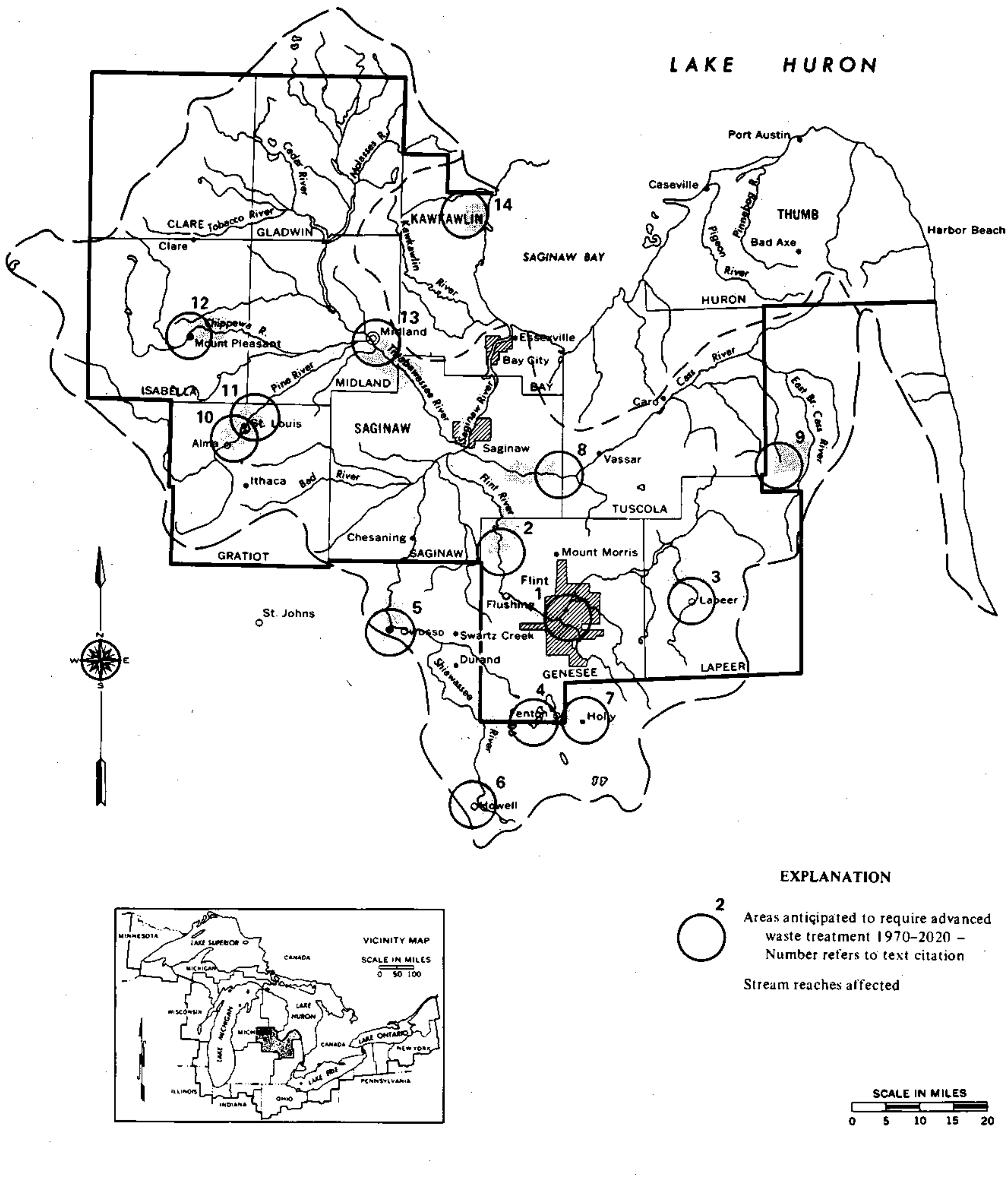


FIGURE 7–22 Planning Subarea 3.2, Advanced Waste Treatment Needs

general algal population increases have occurred in areas such as Saginaw Bay, Thunder Bay, and Harbor Beach. Nuisance growths of algae have occurred on Saginaw Bay beaches.

Increasing levels of pollution control now taking place in the Lake Huron basin will abate the accelerated aging process to an undetermined extent. The effectiveness of current efforts should be evaluated, and augmented or modified as warranted.

6.3.5.2 Soil Erosion and Sedimentation

Improper land-use practices can result in accelerated erosion and watercourse sedimentation. Major sources of sediment include agricultural lands, over-grazed, severely burned, and improperly logged forest lands, and lands used for highways, subdivisions, and other urban construction projects. Sediment fills stream channels and drains, causing additional expense in the treatment of water supplies, and harming fish and other aquatic life and water-oriented sports and recreation. Erosion and sedimentation are discussed in detail in Appendix 18, *Erosion and Sedimentation.*

6.3.5.3 Combined Sewer Overflows

Combined sewer systems are a significant source of pollutants in some areas. During precipitation some systems cannot accommodate the combined flow of wastes and storm runoff. When this occurs the untreated excess flow is discharged to the nearest watercourse. These discharges often contain elevated concentrations of bacterial, biological oxygen demand substances, and suspended solids, chlorides, and nutrients.

Combined sewer systems are common in older, established communities. In the Lake Huron basin serious combined sewer overflow problems have occurred in Bay City, Saginaw, and other communities. As dry weather flows receive increased levels of treatment, the attainment and maintenance of water quality will require that wet weather flows receive adequate treatment. Correction of combined sewer overflow problems will require a considerable investment, but cost estimates are not currently available.

6.3.5.4 Thermal Discharges

Electric generating facilities and many industries use large amounts of water for cooling purposes. When these heated waters are discharged they may add a large heat load to the receiving waters. The issue of thermal pollution has gained increased attention recently, particularly through the deliberations of the Lake Michigan Enforcement Council. The problems associated with thermal discharges were examined in Subsection 5.3.7.4.

To date the development of power generating facilities has not been extensive in the Lake Huron basin. These facilities are expected to grow considerably in the southern portion of the basin in Planning Subarea 3.2 in the next 50 years. In 1970 Planning Subarea 3.2 had approximately 5.2 percent of the total installed capacity in the Great Lakes Basin. According to estimates the area will have 16 percent of the total installed capacity by 2020. Additional discussion of the environmental effects of power generating facilities is contained in Appendix 10, *Power*.

6.3.5.5 Waste from Watercraft

Commercial and recreational vessels that ply the waters of Lake Huron discharge both untreated and inadequately treated wastes into the open lake and harbor areas. Wastes from watercraft include sewage, oil, bilge and ballast waste, compartment washings, and solid refuse. Watercraft pollution is a widespread and varied problem. Vessels frequent all navigable waters and may discharge pollutants anywhere along their path, and an assortment of materials may be spilled or discharged.

New programs have been authorized recently by both Michigan and the Federal government to control pollution from watercraft.

6.3.5.6 Recreational Misuse

Streams in the northern portion of the Lake Huron basin are popular fishing and canoeing areas. The large number of people using these areas reduces their quality for recreational use. The Cheboygan, Thunder Bay, Au Sable, Au Gres, and Rifle Rivers all support large number of recreational users. Typical of recreational problems of these rivers are those facing the Au Sable River, noted for trout fishing and canoeing. The Au Sable's high quality is decreasing because of overcrowding, direct user conflict, and riverside developments. Solving these problems will require the development of new initiatives to bring about remedial and preventive action.

6.3.5.7 Lakeshore Development

Related to problems of recreational overuse is the growth of seasonal or second homes throughout much of the northern portion of Lake Huron basin. Developments are of increasing size and scope. Initial land clearing and building construction may create erosion and sedimentation problems. Later septic tanks add nutrients and possibly coliforms to ground and surface waters. The result may be contaminated waters and accelerated eutrophication of natural and artificial water bodies. The problem is further aggravated by the high cost of remedial utility systems, the reluctance of seasonal and absentee owners to assume this cost burden, and the lack of adequate housing codes, subdivision ordinances, and zoning controls in many areas.

6.3.5.8 Oil Pollution

Lake Huron serves as a shipping lane for both the ore and tanker fleets of the Great Lakes and for international shipping, which enters the Lakes via the St. Lawrence Seaway. These ships constitute a hazard to water quality because of oil-contaminated discharges and catastrophic spills. Bilge and ballast dumpings often contain oil that has dripped or leaked from machinery and other sources.

Tankers holding thousands of gallons of oil are a major potential threat. In an accident this oil could seriously harm miles of shoreline. During the 1966 navigation season more than 700,000 tons of petroleum products were shipped or received at Michigan ports on Lake Huron. Oil pollution potential also exists from shore installations such as storage tanks and pipelines.

Inland oil producing areas and refineries are located in the Lake Huron basin, particularly in the Tittabawassee River watershed. All facets of oil production and transportation represent a potential oil pollution threat to inland waters.

6.3.5.9 Viruses

Little information exists on the presence of viruses in the waters of the Great Lakes Basin. Viruses have been isolated, however, in effluents from sewage treatment plants. Evidence indicates that much sewage treatment is not adequate to control viruses.

To grow and multiply, viruses require living, susceptible cells, but evidence indicates that they can survive outside these cells for long periods. Water must therefore be considered a means of disseminating viral diseases.

One reason for the lack of data on viruses in the Great Lakes is that scientists have not yet found a suitable agent to indicate the presence of viruses. Research in this area is needed.

6.3.5.10 Organic Contaminants

Organic contaminants include the persistent or biochemically resistant compounds found in domestic and industrial wastes, insecticides, herbicides, and other agricultural chemicals. Because of the persistence and toxicity of these chemicals, often in low concentrations, they pose a continuing threat to the basin's waters.

Because they are difficult to detect and identify, many organic contaminants resist conventional water and waste treatment processes. It is difficult to assess changes in the concentrations of these contaminants over time because long-term data are not available.

Mercury, one such organic contaminant, received considerable attention when it was found in Lake St. Clair and Lake Erie in 1970. In the Lake Huron basin one small discharge of mercury was located in a small stream in the Tittabawassee River basin. This discharge was immediately halted and only slight, localized contamination was uncovered. In the extreme southern portion of Lake Huron elevated mercury levels were found in certain species of migratory fish. These fish probably were contaminated in the waters of Lake St. Clair or Lake Erie before they entered Lake Huron. All other Lake Huron water, sediment, and fish samples analyzed showed no elevated levels of mercury residues.

Pesticides are a group of organic contaminants that warrant particular attention. Little data are available on pesticide usage in the Lake Huron basin, although pesticides are applied throughout the basin in agricultural and forestry operations. Ways in which pesticides may reach watercourses include runoff from treated land areas, aerial spraying, waste discharges containing pesticide residuals from canneries and other industries, and accidental spills.

6.4 Summary and Conclusions

Lake Huron contains a water surface area of 23,000 square miles and a land drainage area of 49,600 square miles. Of these totals 9,100 square miles of water surface and 16,200 square miles of land drainage area are in the United States. Major sources of flow to Lake Huron are Lake Superior, via the St. Marys River and Lake Michigan, via the Straits of Mackinac. Major U.S. tributaries to the Lake are the Cheboygan, Thunder Bay, Au Sable, and Saginaw Rivers.

Total population of the basin in 1970 was approximately 1.2 million. The three largest cities and their 1970 populations are Flint (193,600), Saginaw (90,600), and Bay City (49,100). Most manufacturing is concentrated in the southern Lower Peninsula in Genesee, Saginaw, and Bay Counties. Midland County contains a large chemical industry.

Of the four municipalities that use Lake Huron for waste assimilation, three provide primary treatment and one uses deepwater disposal with no treatment. Six industries use the Lake for waste assimilation, including three that discharge cooling water only. Water quality in the main body of Lake Huron is excellent.

Saginaw Bay waters differ from those of Lake Huron's main body in several respects. The bay waters have higher concentrations of calcium, sodium, potassium, chlorides, and sulfates, greater hardness, higher temperatures, and more turbidity. The Saginaw River is the main source of water constituents and the principal influence on water quality in the bay. Water quality gradually improves from the mouth of the Saginaw River to the mouth of the bay. Annual mean total coliform densities exceed desirable levels for a small number of beaches on the west shore of Saginaw Bay north of Bay City. Fecal coliform levels, however, meet the limits of the standards for total body contact recreation except for one beach area. The Saginaw River discharges large quantities of nutrients from industrial, municipal, and agricultural sources into Saginaw Bay. Although these materials produce extensive algal blooms in the bay, evidence of serious nuisance conditions has not been found. With minor exception existing water quality in Saginaw Bay is adequate to support all designated uses. Waters of the inner bay have substandard nutrient levels. Water quality along the western shore of Saginaw Bay, north of Bay City, is substandard at a few beaches because of high coliform levels.

In a number of nearshore areas within harbors and at the mouths of tributary streams water quality is lower than in Lake Huron proper. These areas include the Straits of Mackinac, Cheboygan Harbor, Rogers City Harbor, Thunder Bay, Harrisville Harbor, Oscoda Harbor, Harbor Beach, and Port Sanilac. In general, these areas receive waste loads from tributaries, municipal treatment plants, and industries. Many of these areas exhibit slightly lowered levels of dissolved oxygen and slightly increased levels of total solids and other parameters. In most cases concentrations of phosphates and/or nitrates are sufficient to support algal growths that could interfere with water uses under proper conditions. One harbor area has already experienced impaired water uses because of aquatic growths.

6.4.1 Planning Subarea 3.1

Planning Subarea 3.1 covers 11 counties in the northwestern portion of Michigan's Lower Peninsula and parts of two counties in the eastern end of the Upper Peninsula. Major river basins in this planning subarea are the Au Sable, Thunder Bay, and Cheboygan in the Lower Peninsula, and the St. Marys, Carp, Pine, Munuscong, and Waiska in the Upper Peninsula.

Water quality in seven river basins was described in Subsection 6.2.2.

The total of domestic, commercial, and industrial wastewater treated in municipal wastewater treatment facilities in Planning Subarea 3.1 is expected to increase from a 1970 base of 5.0 mgd to 7.2 mgd in 1980 and 18.2 mgd in 2020. Industrial wastewater processed in industry-owned wastewater treatment facilities is expected to decline from its 1970 base of 12.3 mgd to 9.7 mgd in 1980. It is expected to increase to 17.8 mgd in 2020.

To maintain adequate water quality in the Middle Branch of the Pine River, planners anticipate that the Standish area will require advanced waste treatment in the 1970 to 1980 period. Facilities now planned should meet this need. Seven-day 10-year low flows in this reach are approximately 1 to 2 cfs.

Municipal wastewater treatment capital costs are estimated to be $6.0 million in the

1970 to 1980 planning period, $8.1 million in the 1980 to 2000 period, and $10.6 million in the 2000 to 2020 period. Average annual operating and maintenance costs are estimated at 9 to 12 percent of capital costs.

6.4.2 Planning Subarea 3.2

Planning Subarea 3.2 includes 11 Michigan counties encompassing the State's Thumb area and the Saginaw River basin. Major tributaries of the Saginaw River are the Cass, Flint, Shiawassee, and Tittabawassee Rivers.

The Saginaw River is substandard in quality throughout its length. The most serious dissolved oxygen sag occurs below Saginaw, and another occurs below Bay City. High total and fecal coliform concentrations occur below Saginaw, Bay City, and other communities during periods of stormwater runoff. All six municipalities discharging into the Saginaw River agreed to upgrade their primary treatment plants by providing secondary treatment with phosphorus removal. This was to have been completed by 1972. Two industries also agreed to provide additional treatment facilities.

Water quality is generally good throughout the Cass River basin except for the lower portion of the Cass River. In the Flint River basin water quality problems exist in several locations. The most serious problem occurs in Flint and downstream from the city. In the Shiawassee River basin, a 50-mile stretch from Shiawassee to Corunna including six reaches, is substandard in quality. The most serious substandard reach in the Tittawabassee River basin receives effluents from the Midland wastewater treatment plant and discharges from the Dow Chemical Company complex. Although Dow Chemical Company has achieved a high degree of wastewater treatment, its wastes cause severe damage to the quality of receiving waters. Substandard water quality conditions also exist in several minor drainage area reaches in Planning Subarea 3.2.

In 1970 approximately 36 municipal wastewater treatment facilities served an estimated 550,000 people in Planning Subarea 3.2. The average daily flow treated by these facilities was estimated at 80 mgd, and total industrial wastewater flows were estimated at 473 mgd. Municipal wastewater flows treated at municipal treatment facilities are expected to increase from the 1970 base of 80 mgd to 104 mgd by 1980 and 245 mgd by 2020. Industrial wastewater treated in industry-owned facilities is expected to decrease from the 1970 base of 473 mgd to 408 mgd in 1980 and to 252 mgd in 2000. It is expected to increase to 346 mgd in 2020, an amount lower than the 1970 base. Between 1970 and 2020, 14 areas within Planning Subarea 3.2 will probably require advance waste treatment. Twelve of these needs fall within the current 1970 to 1980 planning period and two fall within the 2000 to 2020 planning period.

Municipal wastewater treatment capital costs are estimated at $64 million in the 1970 to 1980 planning period, $71 million in the 1980 to 2000 period, and $98 million in the 2000 to 2020 period. Average annual and operating and maintenance costs are estimated to range from 6 to 10 percent of capital costs.

6.4.3 General Water Quality and Problems

Water quality problems occur throughout the Lake Huron basin. Some of these are readily apparent while others are still emerging. Decreased light penetration, increased nitrogen and phosphorus concentrations, and general algae population increases have occurred in Saginaw Bay, Thunder Bay and Harbor Beach. Nuisance growths of algae have occurred on Saginaw Bay beaches. Serious combined sewer overflow problems have developed in Bay City, Saginaw, and in other basin communities. The attainment and maintenance of water quality standards in these communities will require that wet weather flows receive adequate treatment. Commercial and recreational vessels contribute both untreated and inadequately treated wastes to the open lake and harbor areas. The high quality of the Au Sable River is diminishing because of recreational overcrowding, direct user conflict, and riverside developments. Oil pollution from tankers and shore installations poses a major threat. Little information exists on the presence of viruses in the basin's waters and long-term data available on organic contaminants are insufficient. Nonpoint sources of pollution also exist. These were indicated where information was available. Such sources may be highly significant and additional study of potential solutions to the problem is necessary.

Section 7

LAKE ERIE

7.1 Introduction

This section describes the programs of interstate, Federal, State, and local agencies engaged in water quality management in the Lake Erie basin. It outlines the water quality standards programs developed by the individual States in conjunction with the Federal government, noting any differences at State boundaries. It reviews existing water quality and its relationship to water use, and it describes the actions needed to improve water quality in the basin.

Water quality information is presented by planning subarea on a State-by-State basis. A further breakdown by major river basins or groups of smaller basins is also included.

Of particular interest are the water quality standards programs developed by the individual States in conjunction with the Federal government. In addition to the interstate programs, the States have also established water quality standards for most intrastate tributaries of the Lake. With minor exceptions the criteria for these standards are identical to those adopted for interstate streams.

Figure 7–23 shows Plan Area 4 and Planning Subareas 4.1, 4.2, 4.3, and 4.4 discussed in this report.

7.2 Water Quality

7.2.1 Planning Subarea 4.1—Michigan

This section summarizes existing water quality in Planning Subarea 4.1, which encompasses the Michigan portion of the Lake Erie basin. Water quality is examined with reference to the designated uses established for particular waters and the water quality parameters necessary to protect those uses. In substandard reaches water quality does not meet the requirements necessary for designated uses.

Planning Subarea 4.1 (Figure 7–24) includes the portion of Lake Erie within Michigan, the Detroit River, Lake St. Clair, the St. Clair River, and their tributaries including the Belle, Black, Clinton, Huron, Raisin, and Rouge Rivers. More than half the people of Michigan reside in this area and it contains a significant portion of the State's industry. This places a heavy demand on the area's surface waters. Degraded water quality in certain sectors has severely impaired water uses. Continued economic and social development of the area will depend on the improvement and preservation of surface water quality.

Water quality conditions are described as of mid-April 1969. Corrective programs both planned and under way, will significantly modify water quality conditions in the immediate future.

7.2.1.1 Lake Erie

Michigan encompasses 105 square miles of the surface area of Lake Erie and approximately 5,800 square miles of land area in the basin. The Michigan portion of Lake Erie receives the full discharge from the Detroit River, the Huron River, and River Raisin, and numerous small tributaries. The inflow from the Detroit River alone represents approximately 93 percent of the total inflow into Lake Erie.

Three industrial and commercial establishments discharge wastes directly into Lake Erie. No municipal treatment plants discharge into the Lake.

Two major zones of substandard water occur in the Michigan portion of Lake Erie, one at the mouth of the Detroit River and another at the mouth of the River Raisin. These waters have high coliform densities and exhibit undesirable concentrations of suspended solids, nutrients, oils, toxic materials, phenols, oxygen consuming substances, and other pollutants. Some small tributary and lakefront locations discharge raw or semi-treated sewage to the Lake causing locally high coliform densities at various beaches. Nutrients are contributing to the accelerated

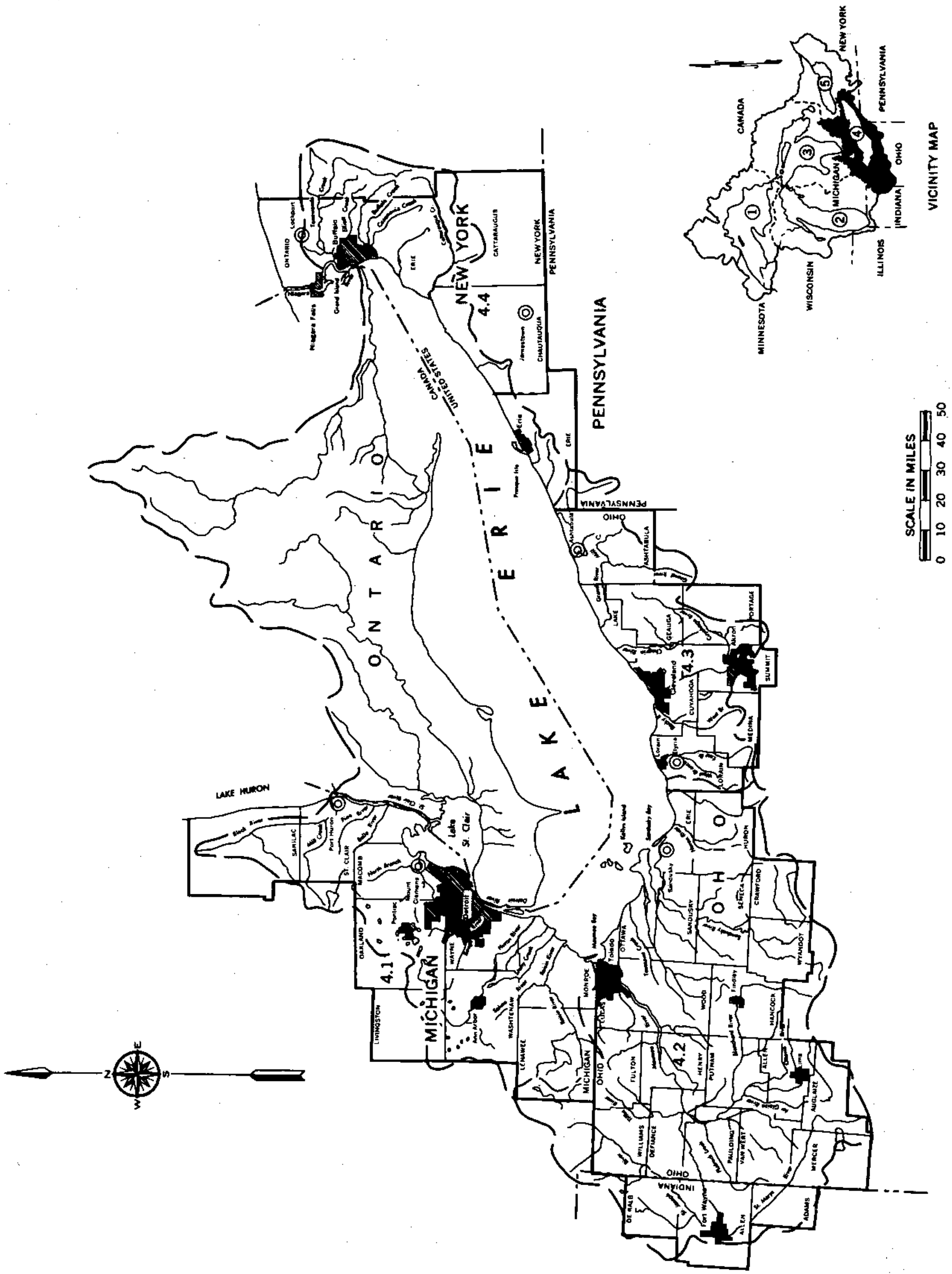


FIGURE 7–23 Lake Erie Basin—Plan Area 4

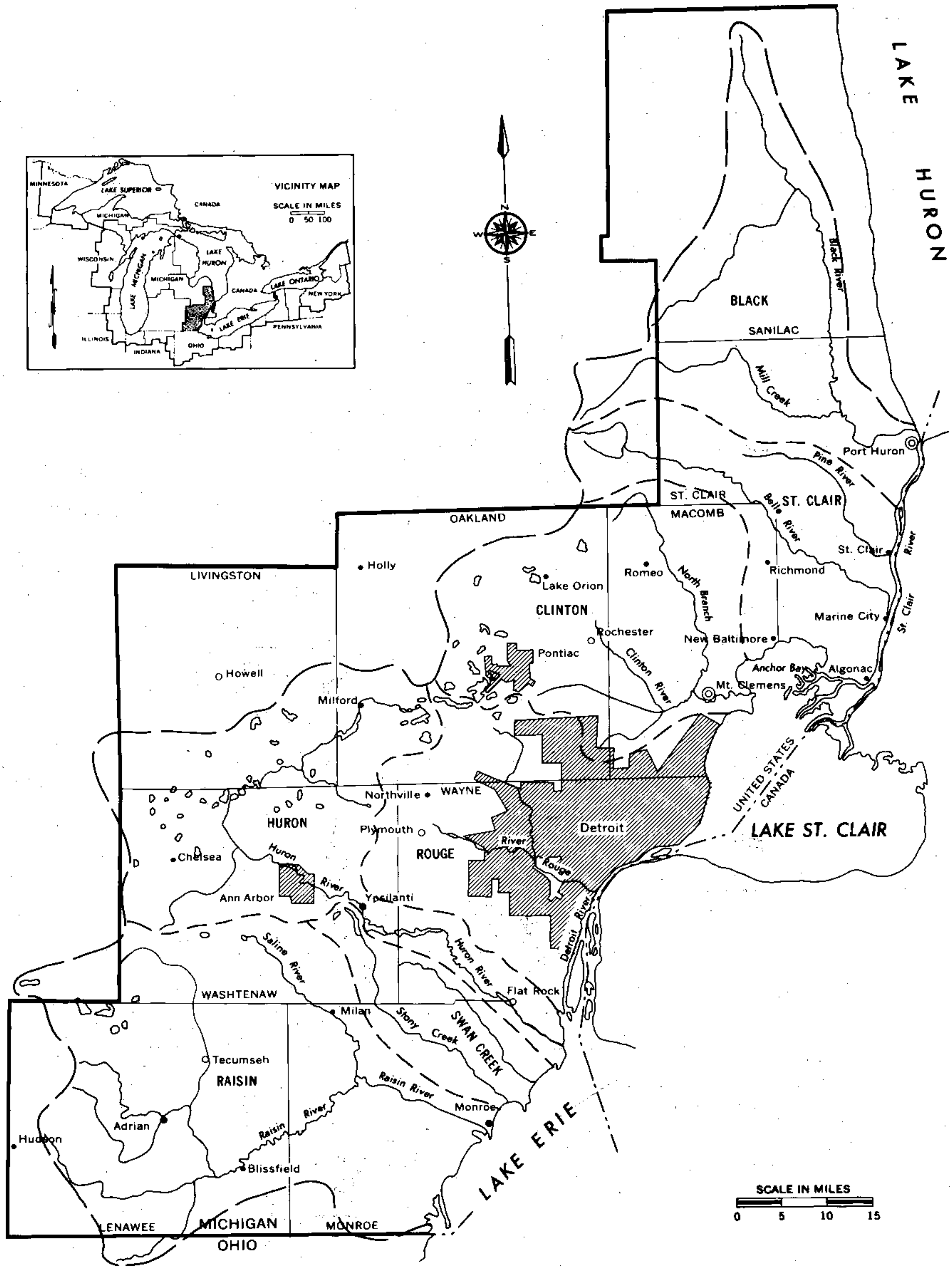


FIGURE 7–24 Planning Subarea 4.1

eutrophication of the Lake, and this in turn causes problems at water supply intakes and affects aquatic life, recreation and other Lake uses.

7.2.1.2 River Raisin

The River Raisin and its tributaries form a network draining approximately 1,070 square miles. It discharges into Lake Erie at Monroe, Michigan.

Surface waters throughout the basin are high in nutrients and dissolved and suspended solids, with concentrations increasing towards the mouth of the river. Nutrient concentrations are high enough to support algal blooms throughout most of the basin.

A major reach of substandard quality is located in the lower three miles of the river (Figure 7–25). This reach exhibits severe oxygen depletion, very high coliform densities, and excessive concentrations of residues, toxicants, nutrients, and suspended and dissolved solids.

Four substandard reaches occur between the Monroe area and Blissfield (Zone 2). Two reaches receive raw sewage discharges from small communities. One reach receives effluent from a primary treatment plant and one receives effluent from a secondary treatment plant. In all four reaches objectionable nutrient levels cause the principal in-stream effect. Coliform densities are excessive in the two reaches that receive raw sewage. Current programs will eliminate the two raw sewage discharges.

From 50 miles upstream on the main stem to the headwaters of the River Raisin (Figure 7–25), five substandard reaches occur because of parameters other than nutrients. Located below small communities that discharge raw sewage, two reaches display excessive coliform densities. Programs are under way to provide treatment for both discharges. The other three reaches are affected by effluents from one primary and two secondary municipal treatment plants. In addition to high nutrient concentrations these three reaches exhibit occasional high coliform densities from stormwater runoff. Two of the five reaches are also degraded by industrial discharges. Both show excessive amounts of residues and one shows excessive toxics.

Two reaches of substandard quality exist in the Saline River drainage area. One upstream reach is affected by industrial discharge and the effluent from a municipal secondary treatment plant. This reach displays marginally substandard dissolved oxygen depletion and excessive levels of residues, toxicants, dissolved solids, and nutrients. Downstream a second reach is degraded by the effluent from a municipal secondary treatment plant. This reach displays depleted dissolved oxygen and high nutrient levels. Nutrients, particularly nitrates and dissolved solids, are found in fairly high concentrations throughout the Saline River drainage area.

One localized reach of Macon Creek is degraded by raw sewage discharges from two townships. Depleted dissolved oxygen and excessive coliform densities occur in this reach.

Three substandard reaches occur in the south branch of the River Raisin. Degraded by communities discharging raw sewage, two upstream reaches display high coliform and nutrient levels. Programs are under way to provide treatment for both discharges. Near its confluence with the main stem, the south branch receives wastes from a small concentration of people and industries in the Adrian area. This reach displays elevated nutrient, toxic, and residue concentrations. Part of the problem results from the discharge of untreated industrial wastes through storm sewers. The zone of degradation extends into the main stem of the river basin.

Two substandard reaches in the Black Creek receive raw sewage discharges and display high coliform and nutrient levels. One is also degraded by an industrial discharge which causes dissolved oxygen depletion, high nutrient concentrations, and substandard pH changes. Additional treatment facilities recently began operating, and a reevaluation of quality conditions will be made in the immediate future.

Swan Creek and Stony Creek, located north of the River Raisin, flow directly into Lake Erie. Both streams have one localized substandard reach, which receives raw sewage discharges and displays elevated nutrient and coliform levels. A corrective program is under way in one community and enforcement proceedings are pending against the second community involved.

7.2.1.3 Huron River

The Huron River basin, draining an area of 890 square miles, flows into Lake Erie at Pointe Mouille. The two major tributaries of the Huron River are the Portage River in the northwestern portion of the basin and Mill

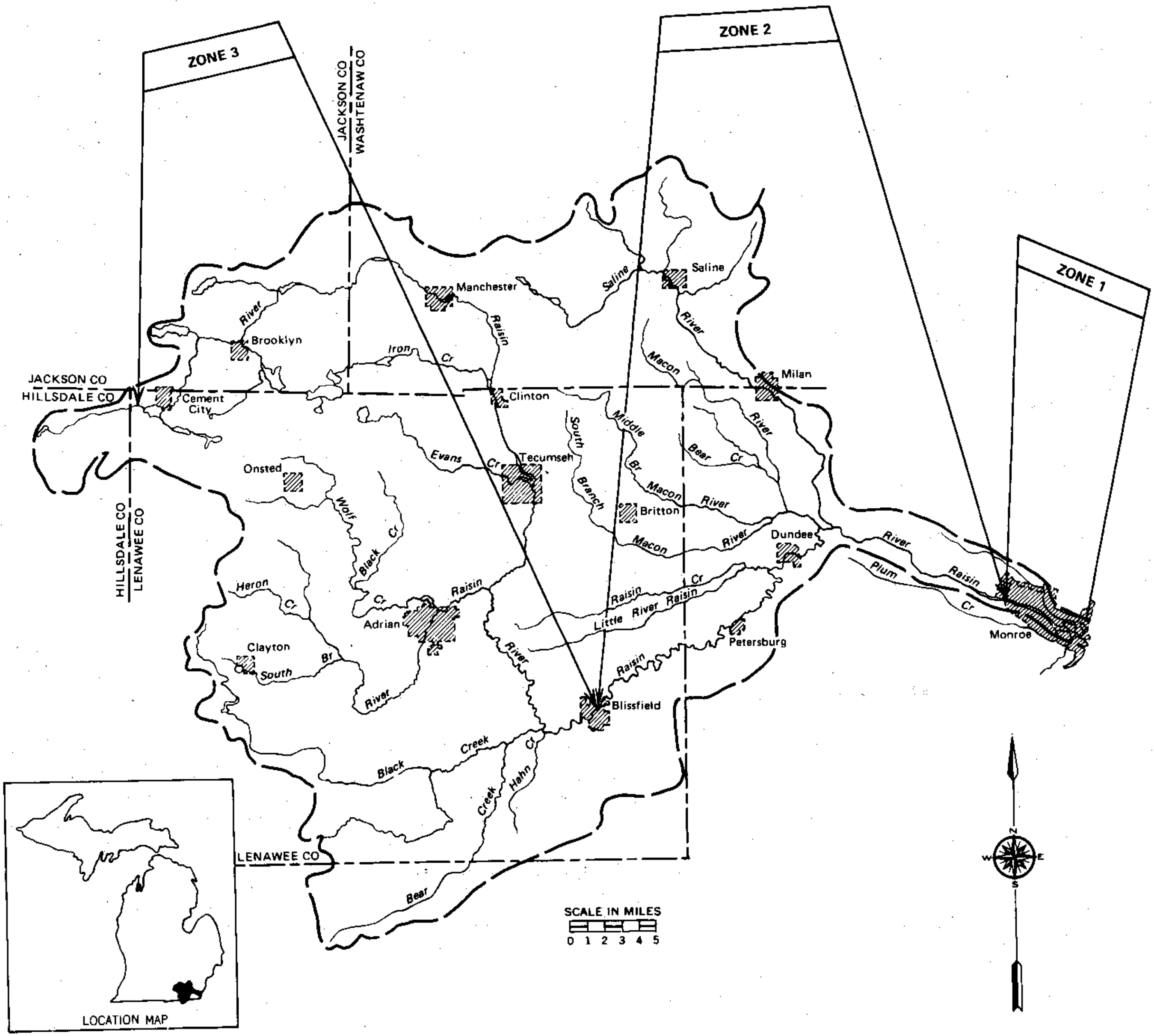


FIGURE 7-25 Raisin River Basin

Creek in the southwestern portion of the basin near Dexter, Michigan.

Suspended solids in the Huron River are lower than in the River Raisin, possibly because of various impoundments that facilitate natural settling. Total dissolved solids and chlorides are moderate, but overenrichment is a widespread problem. In the upper portion of the basin most natural lakes maintain excessive nutrient concentrations. The main stem of the river, from the Ann Arbor treatment plant to the mouth 40 miles downstream, is substandard because of excessive nutrient concentrations. Because of acute algae problems in the middle of the basin, 11 communities accelerated their programs to achieve phosphorus removal by 1970. A total of 13 reaches in the basin are substandard in one or more quality parameters in addition to nutrients.

In the lower 25 miles of the basin four reaches of substandard quality overlap. Two reaches are degraded by raw sewage discharges and one reach is degraded by the effluent from a primary sewage treatment plant. All three reaches display high coliform densities and nutrients. Corrective programs are under way in all these areas. A fourth reach receives the effluent from a primary municipal sewage treatment plant, raw sewage discharges, and an occasional toxic industrial discharge. This reach displays excessive coliform densities and toxic concentrations.

Water quality in the middle portion of the Huron River basin (Figure 7-26) is degraded by treatment plant effluents, industrial discharges, and stormwater overflows from the Ann Arbor-Ypsilanti area. The maximum phosphate concentrations in the Huron River are found here. Two reaches on the main stem and one on Willow Run are substandard in quality parameters other than nutrients. Both main stem reaches display marginally substandard dissolved oxygen concentrations, one exhibits elevated coliform densities, and one displays objectionable residue concentrations. Willow Run exhibits depleted dissolved oxygen and excessive coliforms densities and residue concentrations. Two industrial enterprises plan to remove their wastes from Willow Run. This should alleviate substandard quality conditions.

Above Ann Arbor five localized substandard reaches exist on the main stem and three substandard reaches are located on tributary streams. Three main stem reaches are located below secondary municipal treatment plants, one is below a primary plant, and another is below secondary municipal treatment plants, All five reaches display excessive nutrient concentrations and one reach exhibits high coliform densities.

One tributary reach receives effluent from a secondary municipal treatment plant and displays high nutrient concentrations. Two other tributary reaches are degraded by industrial discharges. One displays dissolved oxygen depletion and excessive concentrations of nutrients and dissolved solids. The second reach displays excessive nutrients, residues and suspended solids. Both industries involved are installing additional treatment facilities.

7.2.1.4 Detroit River

The outlet for Lake St. Clair, the Detroit River, flows in a southerly direction for 32 miles before discharging into Lake Erie. Average discharge of the river is approximately 177,800 cubic feet per second.

Detroit and suburban communities occupy the United States side of the river, and Windsor and smaller communities occupy the Canadian side. On the U.S. side, from Lake St. Clair to above the mouth of the Rouge River, the Detroit River bank is lined with residential and commercial developments and recreation facilities. From there downstream to the mouth the river is lined with heavy industry interspersed with residential and commercial areas.

In 1967 the International Joint Commission reported that water quality in the Detroit River was generally improved over 1966 and 1946 to 1948 quality levels. The upper 10 miles of the river from Lake St. Clair to the junction of the Rouge River is substandard because of high coliform densities and iron concentrations. During dry weather flows this reach is generally of satisfactory quality, but during periods of precipitation combined sewer overflows within Detroit cause excessive coliform densities. The source of iron in this reach has not been found and the iron may be of natural origin. This reach is aesthetically unpleasant because of combined sewer overflows, ship pollution and oil spills, and industrial wastes.

The lower 20 miles of the Detroit River from the junction of the Rouge River to Lake Erie is also substandard in water quality. This reach receives effluents from one Federal and six municipal sewage treatment plants, and 29 industries and commercial enterprises, stormwater overflows and tributary discharges. Located at the confluence of the Detroit and

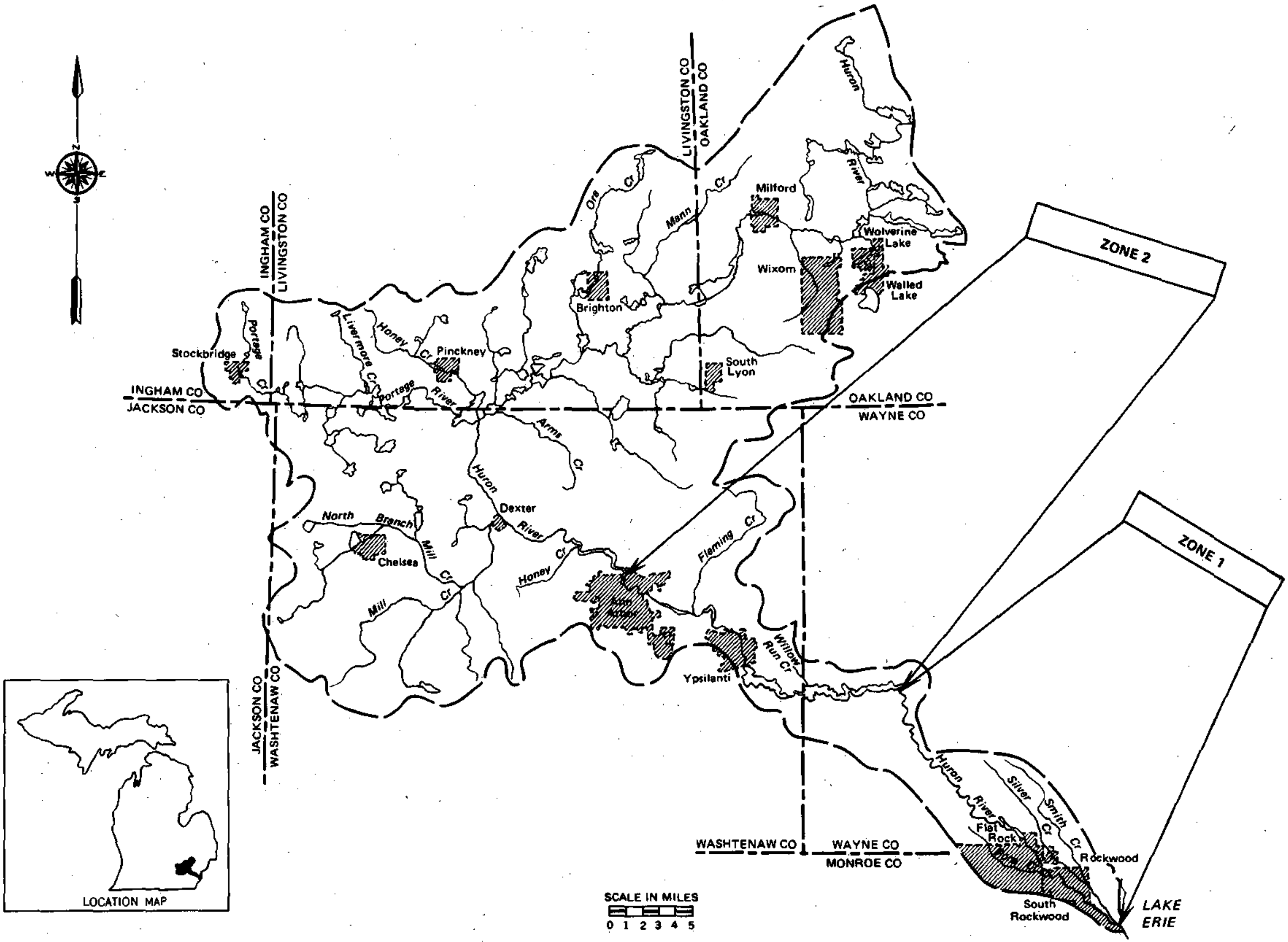


FIGURE 7–26 Huron River Basin

Rouge Rivers, Detroit's main sewage treatment plant serves more than 90 percent of the people in the Detroit area and imposes a tremendous waste load on the river. A large amount of waste is also contributed by the flow of the Rouge River. This reach of the Detroit River displays excessive levels of coliforms, phenols, toxic substances, nutrients, suspended solids, and residues. Objectionable color, oil, and debris are also present.

Detroit River water quality is discussed in detail in the *Report on Pollution of the Detroit River, Michigan Waters of Lake Erie and their Tributaries*, published by the Office of Water Programs, U.S. Environmental Protection Agency. Since completion of that study a massive effort has been under way to abate pollution in the Detroit River. The Michigan Water Resources Commission has obtained stipulations or agreements with 19 municipalities and industries to upgrade the quality of their effluents to recommended levels.

7.2.1.5 River Rouge

The Rouge River basin includes the River Rouge, the upper, middle, and lower Rouge Rivers, and various small tributaries. The River Rouge is located within the intensely urbanized and industrialized Detroit metropolitan area. Twenty-eight industries use the basin's surface waters for waste assimilation, but no municipal treatment plants discharge in the basin.

Except for upstream reaches, the waters of the River Rouge are generally high in coliforms. Suspended solids are moderate, dissolved solids are high, and the basin shows general nutrient enrichment. Many sampling stations exhibit low dissolved oxygen levels and correspondingly high BOD values.

The lower 15 miles of the River Rouge (Figure 7–27), are severely degraded. This reach receives discharges from nine industrial enterprises and combined sewer overflows from Detroit and suburban communities. Dissolved oxygen is severely depleted and coliforms, nutrients, suspended and dissolved solids, and residues all reach excessive levels. Four industries in this reach are constructing additional waste treatment facilities. By May 1, 1969, more than 100,000 pounds of five-day biochemical oxygen demand from industrial sources were removed from the lower portion of the River Rouge.

In the lower River Rouge water quality is substandard for approximately two miles above its confluence with the main stem. Degraded by combined sewer overflows, this reach displays depressed dissolved oxygen and high coliform densities. A second substandard reach, located upstream in the middle of the basin below an industrial discharge, displays excessive residue concentrations. A program now under way will provide additional treatment. Located below an industrial discharge on a headwaters tributary, a third substandard reach displays excessive levels of suspended solids, residues, and toxics. Facilities under construction will provide additional treatment for this discharge.

Water quality of the middle River Rouge, particularly in the lower reaches is seriously degraded. It is substandard in quality from its confluence with the main branch of the River Rouge upstream for a distance of approximately 24 miles. This reach receives effluents from 11 industries and raw sewage and septic tank effluents from two communities. In addition combined sewer overflows during moderately heavy rainfull add substantial loads to the river. Dissolved oxygen is substandard from mile 0 to mile 6 and marginally substandard from mile 6 to mile 15. Total coliform and fecal coliform densities are substandard from mile 0 to mile 6 and are substandard or marginally substandard from mile 6 through mile 24. Nutrients are substandard throughout this entire reach and objectionable growths of algae, weeds, and slimes have occurred. Excessive toxins have been found in one limited reach below an industrial discharge.

High nutrient levels are common in the upper portions of the River Rouge. Several localized reaches are degraded by raw sewage and semi-treated sewage discharges from three townships and one municipality. In addition to nutrients high coliform densities are the principal in-stream effect. Sewer extension programs are under way to correct most of these minor problem areas.

7.2.1.6 Lake St. Clair and St. Clair River

Lying between Lake Huron and Lake Erie, Lake St. Clair is a shallow, heart-shaped body of water 25 miles long and 25 miles wide. Of its surface area of 490 square miles, 190 square miles lie within Michigan. Lake St. Clair is fed by the St. Clair River, which begins at the southern end of Lake Huron. The river flows south 40 miles and has an average discharge of 176,900 cubic feet per second.

On the United States side five primary and

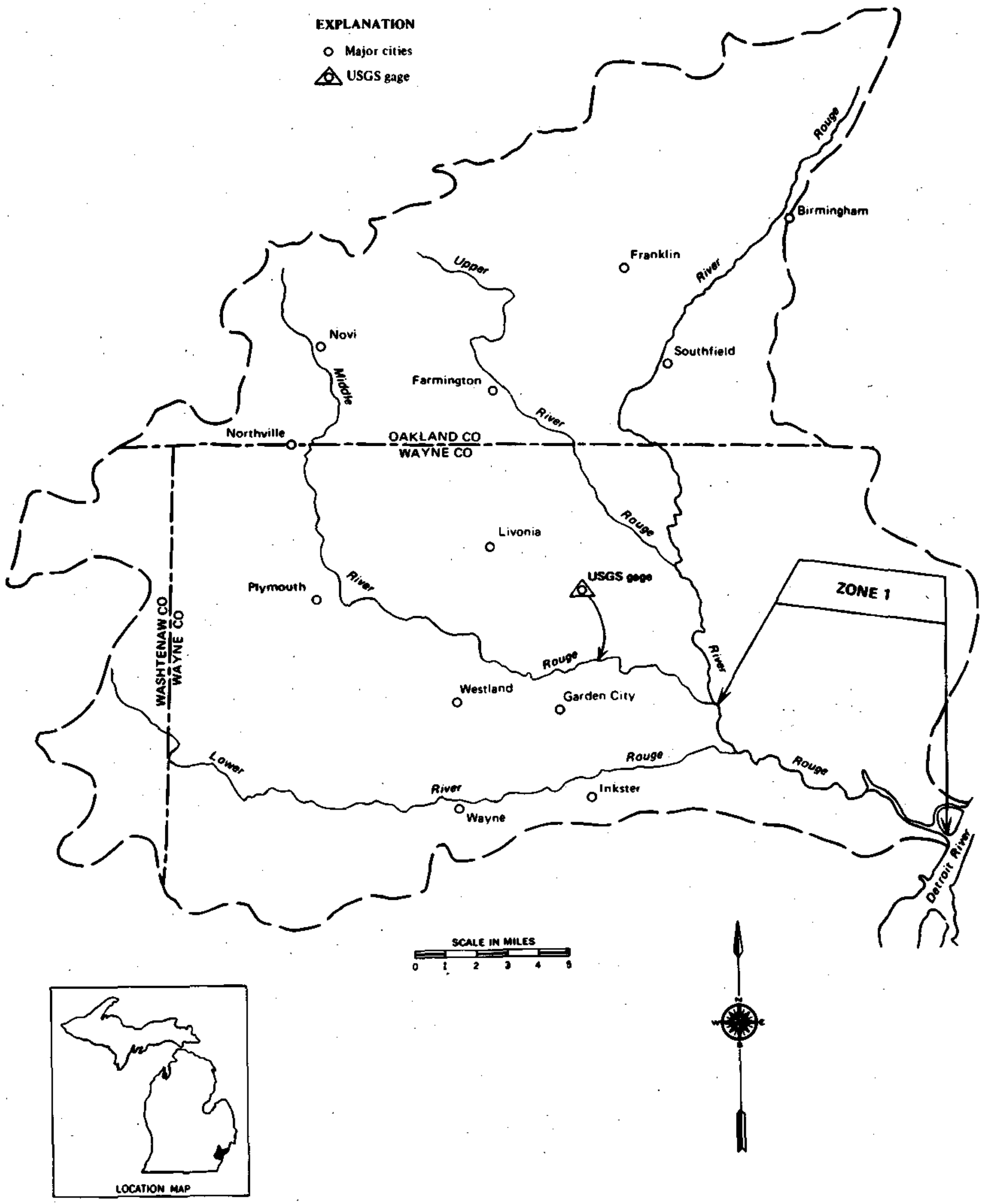


FIGURE 7–27 Rouge River Basin

two secondary municipal treatment plants, four industries, and two electric generating stations use the waters of the St. Clair River and Lake St. Clair for waste assimilation.

Water quality throughout the St. Clair River is generally excellent. Principal tributaries of the St. Clair River in Michigan are the Belle, Black, and Pine Rivers. Some degradation occurs in very localized areas where tributaries join the river, but these effects are not measurable a short distance downstream. Ship pollution occasionally causes oil and aesthetic degradation.

Lake St. Clair receives the full discharge from the St. Clair and Clinton Rivers plus other small tributaries, and its water quality is directly related to these inflows. Water quality is good in the St. Clair River, but the Clinton River is seriously degraded. With the exception of high nutrient and mineral levels, the effects of the Clinton River are largely confined to an area near its mouth. High coliform densities sometimes cause substandard bacterial levels around the mouth of the Clinton River, impairing water uses. A similar problem of less magnitude occurs at the mouth of the Milk River. Corrective programs now under way in the Clinton River basin will greatly reduce the amount of pollutants now discharged into Lake St. Clair.

7.2.1.7 Clinton River

Draining approximately 760 square miles, the Clinton River empties into the western end of Lake St. Clair east of Mt. Clemens. Its major tributaries are the North Branch, Middle Branch, Red Run, Stony Creek, and Paint Creek. During the summer natural streamflow is very small and waste treatment plant effluents constitute a major portion of the flow.

In 1960 wastes from approximately 40 percent of the basin's population were removed from the basin and treated by Detroit Water Services. Twelve secondary sewage treatment plants and eight industries used the basin's surface waters for waste assimilation.

The Clinton River exhibits substandard water quality from its mouth to the confluence Red Run approximately 17 miles upstream (Figure 7–28). This reach receives effluents from four sewage treatment plants and one industry. In addition the flow from Red Run adds a substantial waste load. Dissolved oxygen in this reach is severely depleted and high nutrient concentrations and coliform densities occur. Bottom sludge deposits form in the reach near the mouth of the river, which has been improved for flood control and navigation. Mt. Clemens has been ordered to institute tertiary waste treatment if it continues discharging wastes into Clinton River. It also has the option of joining the Detroit Water Services' metropolitan system. The other three plants now discharging into this reach will be abandoned in favor of the metropolitan system.

Red Run, substandard throughout its length, receives effluents from Warren's treatment plant and combined sewer overflows. At times the Warren plant's effluent constitutes the entire flow of Red Run. The stream displays dissolved oxygen depletion and excessive levels of coliforms, residues, and nutrients. Supersaturated oxygen conditions are common because of extensive algal activity fostered by high nutrient concentrations. The City of Warren will either institute tertiary treatment or join the metropolitan collection and treatment system of Detroit Water Services. Action is also under way to reduce the frequency and magnitude of combined sewer overflows.

From the confluence of Red Run upstream to Pontiac the Clinton River maintains substandard nutrient concentrations. In addition three reaches are substandard in other parameters. One reach receives effluents from the treatment plants of Utica and Sterling Townships and exhibits dissolved oxygen depletion. Both plants will be abandoned in favor of the metropolitan system. Degraded by an industrial discharge, a second reach displays depleted dissolved oxygen and excessive levels of suspended solids and coliforms. The industry has taken steps to improve treatment practices and additional steps are under study. A reach of serious substandard quality below Pontiac receives effluents from two municipal treatment plants and stormwater overflows. Dissolved oxygen is severely depleted and very high nutrient concentrations are present. The City of Pontiac has engaged consultants to study additional treatment needs.

Above Pontiac two minor reaches of substandard quality occur on the main stem. Located below communities which discharge septic tank effluents, both reaches display elevated coliform densities and nutrient concentrations. Both communities will be served by the metropolitan treatment system.

Two localized substandard reaches occur on Paint Creek, two on the North Branch, and one

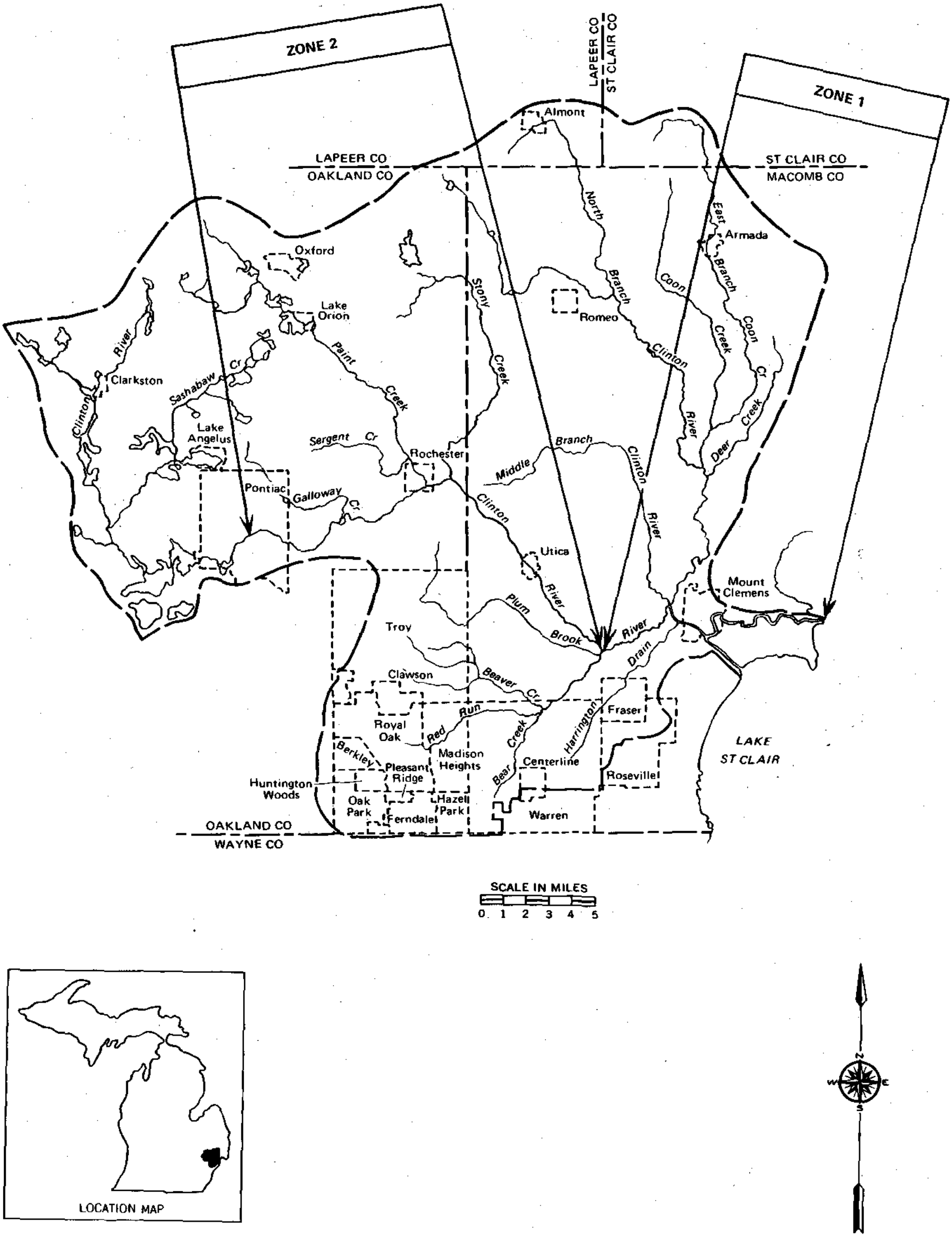


FIGURE 7–28 Clinton River Basin

each on Big Bear Creek and the Middle Branch. Receiving effluent from a secondary treatment plant, one reach displays high nutrient concentrations. The other five reaches are all located below small communities which discharge raw sewage and/or septic tank effluents. Elevated coliform and nutrient levels are the principal effects in all five reaches. Corrective programs or enforcement actions to improve these five reaches are under way.

7.2.1.8 Belle, Black, and Pine Rivers

The Belle, Black, and Pine Rivers together drain approximately 1,100 square miles and empty into the St. Clair River at Marine City, St. Clair, and Port Huron, Michigan. Seven municipal sewage treatment plants and eight industries use surface waters of the three basins for waste assimilation.

Water quality is generally good throughout the Black River basin with some lowering of quality in downstream areas. Three localized reaches of substandard quality occur in the basin. One reach, located at the river's mouth, exhibits depressed dissolved oxygen and increased suspended solids. This reach receives effluents from a municipal sewage treatment plant and one industry, and stormwater overflows. A second substandard reach, located on Mill Creek below a community lagoon, displays elevated nutrient concentrations and marginally substandard coliform densities. A third reach receives effluents from a municipal treatment plant and three food processing industries. This reach exhibits depressed dissolved oxygen and elevated levels of nutrients and dissolved solids, particularly chlorides.

Water quality throughout the Pine River basin is generally good. One short reach of substandard quality occurs near the mouth of the river below a municipal treatment plant and an industrial discharge. This reach displays high chloride concentrations during late spring and early summer. It occasionally displays high coliform densities.

Water quality is also generally good throughout the Belle River basin although there are five localized reaches of substandard quality. Near the mouth of the river one reach displays elevated coliform densities and nutrient concentrations. Dissolved oxygen is also marginally substandard. Two upstream reaches, degraded by food processing discharges, exhibit elevated concentrations of dissolved solids, chiefly chlorides. Located below a community lagoon, a fourth reach displays high nutrient concentrations. The final reach receives septic tank effluents from a small community and displays very high coliform densities.

7.2.2 Planning Subarea 4.2

7.2.2.1 Michigan

Figure 7–29 shows Planning Subarea 4.2, which encompasses parts of Michigan, Indiana, and Ohio.

(1) Maumee River Basin

Small communities and industries and extensive rural areas characterize Michigan's portion of the Maumee River basin. Water supply for all communities in the basin is obtained from groundwater sources.

Water quality in the Michigan tributaries of the Maumee River is generally good. A few tributary reaches, primarily below small rural communities, exhibit high coliform counts because of raw sewage discharges. Waste treatment and chlorination are required.

Because of the low flow in these streams and the general availability of adequate ground water the streams probably will never be used for domestic water supply. The present water quality should not interfere with any other uses.

7.2.2.2 Indiana

(1) Maumee River Basin

There are four water quality monitoring stations in the Indiana area of the Maumee River basin. One station is located on the St. Joseph River approximately eight miles northeast of Fort Wayne at the bridge on Mayhew Road. On the St. Marys River a station is located approximately four miles south of Fort Wayne at the bridge on Anthony Boulevard. Two stations are on the Maumee River. One is approximately one-half mile north of New Haven at the bridge on Landin Road. The other station is lcoated approximately three miles north of Woodburn at the bridge on State Highway 101. This station lies approximately five stream miles west of the Indiana-Ohio State line.

The data shown in Table 7–42 indicate that water quality in the Maumee River basin is generally good. However, during periods of low flow the adverse effect of treated effluent

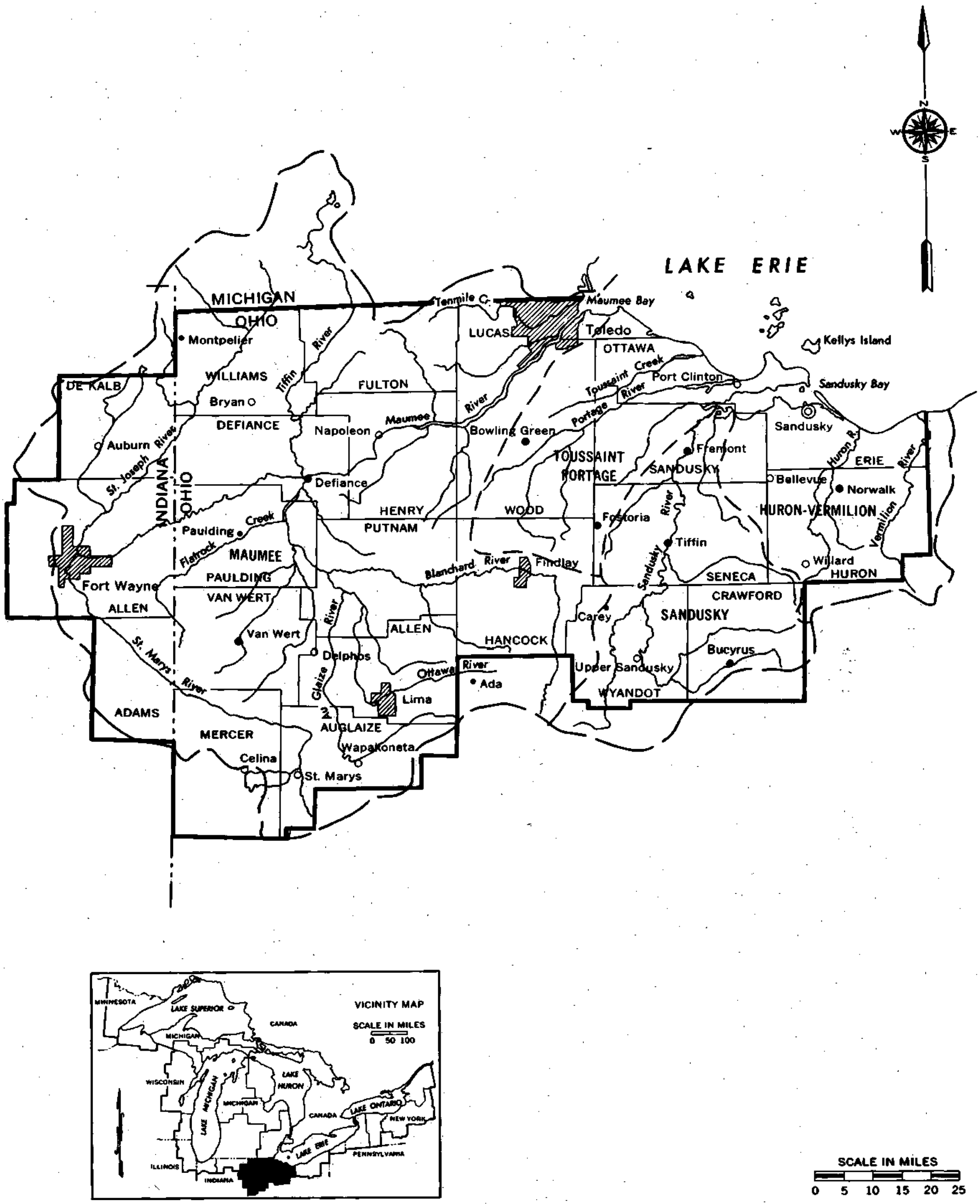


FIGURE 7-29 Planning Subarea 4.2

TABLE 7–42 Summary of Chemical and Bacteriological Data—Maumee River Basin in Indiana (1965)

	DO mg/l	BOD mg/l	SS mg/l	DS mg/l	Cl mg/l	NO_3 mg/l	PO_4 mg/l	pH	Temp. °F	Coliform per/100 ml
St. Joseph River, Fort Wayne										
Maximum	20.6	5.0	816	540	28	7.8	1.0	8.4	82	180,000
Minimum	6.5	1.4	9	190	8	0.0	0.0	7.4	34	100
Average	9.8	2.8	82	400	16	3.0	0.4	7.9	54[c]	6,600[c]
St. Marys River, Fort Wayne										
Maximum	19.5	12.0	1,330	740	108	8.2	3.1	8.8	82	140,000[b]
Minimum	6.7[a]	2.0	12	150	8	0.0	0.3	7.6	32	500
Average	13.0	5.0	149	520	54	3.5	1.0	7.8	54[c]	6,000[c]
Maumee River, New Haven										
Maximum	13.5	19.0	812	560	54	8.2	6.5	8.7	81	720,000
Minimum	5.1	2.5	9	220	10	0.0	0.3	7.6	32	10,000
Average	8.1	5.5	141	420	28	3.7	2.0	7.9	55[c]	80,000[c]
Maumee River, Woodburn										
Maximum	20.1	6.4	744	600	55	7.8	6.9	8.5	81	310,000
Minimum	5.3	2.4	17	220	10	1.9	0.1	7.4	34	2,700
Average	9.3	4.1	88	430	29	3.9	2.0	7.8	55[c]	33,000[c]

LEGEND:
DO Dissolved Oxygen
BOD Biochemical Oxygen Demand
SS Suspended Solids
DS Dissolved Solids
Cl Chlorides
NO_3 Nitrates as Nitrogen
PO_4 Phosphates
pH Below 7--Acid; Above 7--Alkaline

NOTE: DS values were obtained by using specific conductance readings and multiplying by a conversion factor of 0.7.

[a] One sample of 26 samples had DO of 1.5

[b] One sample of 26 samples had coliform of 11,000,000

[c] Median value

can be noted. Although the levels of biochemical oxygen demand (BOD) and dissolved oxygen (DO) are generally satisfactory in the basin, high BODs and low DOs have occurred below the Fort Wayne area. The data also show that a considerable nutrient load is being contributed to the Maumee River from the Fort Wayne area. High coliform values in the Maumee River below Fort Wayne are caused by discharges from Fort Wayne, New Haven, and industrial sewage treatment plants.

7.2.2.3 Ohio

(1) Maumee River Basin

(a) Dissolved Solids

The mean dissolved solids concentrations of the St. Joseph, Tiffin, and Little Auglaize Rivers are generally less than 500 mg/l. Dissolved solids in the Auglaize River above Wapakoneta, the lower Blanchard River, and the Maumee River downstream from Napoleon are also less than 500 mg/l. The mean dissolved solids concentrations of all other streams are less than 540 mg/l except for the Ottawa River below Lima and the Auglaize River below Wapakoneta.

The major constituent of the dissolved solids in most of these streams is calcium carbonate. This salt, prevalent in most area soils, contributes significantly to the total hardness of stream waters. During low flow periods the hardness may range from 300 to 400 mg/l.

No major streams contain concentrations of chlorides or sulfates exceeding 250 mg/l for each ion, the recommended limit for drinking water established by the U.S. Public Health

Service. The concentration of chloride ions is generally less than 100 mg/l, and the concentration of sulfates is generally less than 150 mg/l except in the Ottawa River.

Although dissolved solid concentrations in a few basin streams sometimes exceed the limits established for public water supplies, water quality is generally higher in these streams than in other available water sources.

(b) pH

Because of the buffering action of dissolved solids in the basin's streams, very few stream stretches have pH values higher or lower than 8.5 to 6.5, the preferred limits established as a guide for a well-balanced warmwater fish population. A few low pH values have been observed in the Ottawa River below Lima because of industrial waste discharges. Values approaching 10.0 have been observed in the Maumee River downstream from Waterville. These high values are caused by abundant algae growth in this stretch of the river.

(c) Dissolved Oxygen

The most widespread critical pollution problem in the basin is the low concentration of dissolved oxygen that occurs in many stream stretches. This is caused primarily by the oxygen demand of discharges from municipal waste treatment facilities. In a few areas discharges from organic industrial waste treatment facilities also contribute to this problem.

Long stretches of the Blanchard, Ottawa, Auglaize, and St. Marys Rivers have dissolved oxygen values less than 1.0. Shorter lengths of Town Creek, Swan Creek, and sections of the Maumee River below Fort Wayne, Defiance, and in the Toledo area also have minimum values less than 1.0. The only significant stream stretches where minimum dissolved oxygen concentrations are not below 4.0 mg/l are on the St. Joseph River below Montpelier, the Maumee River from Grand Rapids to Perrysburg, and most of the Auglaize River in Allen County.

In slow-moving river stretches with considerable exposure to sunlight, such as sections of the lower Maumee River, high values of dissolved oxygen occur during the afternoon and lower values occur late at night and during the early morning. Within a 24-hour period dissolved oxygen varies from 6.0 to 13.0 mg/l. At the water surface concentrations of dissolved oxygen as high as 25 mg/l have been observed. In spite of these high concentrations at the surface much lower values may be found near the bottom of the stream.

(d) Bacterial Quality

As may be expected the highest bacterial counts are found immediately downstream from major communities. High bacterial counts in the Maumee River upstream from the Toledo wastewater treatment plant are caused by the seiche or tidal effect of Lake Erie, which sometimes directs plant effluents upstream, and by the discharge of untreated sewage from combined sewers upstream from the treatment plant. Discharges of untreated sewage also contribute to the high counts in Swan Creek.

(e) Nutrients: Ammonia, Nitrates, and Phosphates

Little information is available on the concentrations of ammonia in the basin's streams. It is known, however, that high ammonia concentrations are found in the Lima area of the Ottawa River. The effect of this load extends throughout the entire length of the Ottawa River and into the lower Auglaize River. At times the effect is also noted in the lower Maumee River as far downstream as Waterville. From June through September 1965 the mean concentration of ammonia in the Ottawa River just below Lima was 60 mg/l, decreasing to just below 25 mg/l near its mouth. It further decreased to 12 mg/l in the Auglaize River at Cascade Park, mainly because of dilution. In the Auglaize River above the point of confluence the concentration of ammonia was 1.0 mg/l or less.

In the lower Maumee at Waterville the concentration of ammonia during the same sampling period varied from 1.0 to 1.5 mg/l. Values of 0.0 to 0.2 mg/l were observed in the upper river at Antwerp.

During January and February 1965, a high run-off period, the concentration of ammonia in the Maumee River at Antwerp reached 1.0 mg/l. Concentrations as high as 15 mg/l were observed near Waterville. During the same period mean values for ammonia were 30 mg/l at the mouth of the Ottawa River and 20 mg/l in the Auglaize River at Cascade Park. No detectable amounts were found in the Auglaize River upstream from its confluence with Ottawa River and at the mouth of the Blanchard River.

Significant amounts of nitrates occur in the entire length of the Maumee River and in the Auglaize River and its major tributaries. The January and February 1966 concentrations of nitrates measured milligrams per liter at major sampling points are indicated in Table 7–43.

As an emergency measure nitrates are frequently added to streams heavily loaded with organic matters. In the Ottawa River the dis-

TABLE 7-43 Nitrate Concentration—Maumee River (January-February 1966)

Sampling Stations	Concentration of NO_3 as N-mg/l
Maumee River at Antwerp	1.5-4.0
Mouth of Ottawa River	3.5-8.0
Mouth of Blanchard River	1.0-8.6
Maumee at Defiance	7.0-10.0
Maumee at Napoleon	3.1
Maumee at Waterville	4.0-5.0

charge of nitrates as industrial waste has prevented the river from becoming more seriously polluted by providing a source of readily available oxygen.

The average phosphate concentrations, measured as PO_4, were highest immediately downstream from the major cities located on the basin's tributaries. Concentrations generally ran from 3 to 8 mg/l. A much higher concentration of 17.0 mg/l was observed in Town Creek below Van Wert. Concentrations of less than 1.0 mg/l were observed in nearly the entire lengths of the St. Joseph and St. Marys Rivers and in the main stem of the Maumee River between Napoleon and Toledo. In the upper Maumee and a short stretch in the Toledo area the average concentration varied from 1 to 3 mg/l.

(2) General Observations

Profuse growths of algae, high concentrations of settleable solids, and turbidity cause an unpleasant appearance in most streams in the Maumee River basin. Floating oil and banks blackened with oil deposits are noticeable along the Ottawa and Blanchard Rivers and navigation channel of the Maumee River.

7.2.2.4 Portage, Sandusky, Huron, and Vermilion Rivers

(1) Dissolved Solids

The major dissolved solids are carbonates, sulfates, and chlorides of calcium, magnesium, and sodium. All these constituents are found in the bedrock of the Portage and Sandusky basins. The solids reach the streams when they are leached from the bedrock by ground water. This accounts for the higher dissolved solids in the Portage and Sandusky Rivers as compared with the dissolved solids in the Huron and Vermilion Rivers where the bedrock is mostly shale and sandstone.

(2) Heavy Metals

There are no significant concentrations of heavy metals or cyanides in these four streams.

(3) Dissolved Oxygen

Low concentrations of dissolved oxygen have been found below Bowling Green and Oak Harbor on the Portage River; below Upper Sandusky, Carey, Tiffin, and Fremont on the Sandusky River; and below Willard and Norwalk on the Huron River. Low values have also been found in Mills and Pipe Creeks, which originate in Erie County. In a number of these areas algae contribute to the high values observed during daylight hours, but spot checks indicate that low values occur at night.

(4) Nutrients

High concentrations of ammonia nitrogen, nitrate nitrogen, and phosphates occur in stretches of nearly all other streams of the area. Municipal wastes, certain industrial wastes, and urban and agricultural drainage contribute to these high values.

(5) Bacteria

High concentrations of coliforms and fecal streptococcus have been found in all stream stretches downstream from points of treated and untreated sanitary sewage discharge. The highest counts were found in the Portage and Sandusky Rivers and Pipe Creek.

7.2.3 Planning Subarea 4.3

7.2.3.1 Ohio

Figure 7-30 shows Planning Subarea 4.3, which includes portions of Ohio and Pennsylvania.

(1) Black River

(a) Dissolved Solids

High concentrations of dissolved solids sometimes occur in the Black River upstream from Elyria because of the discharge of oil well brines and industrial wastes.

(b) Heavy Metals

Heavy metals such as chromium, copper, nickel, and zinc are discharged into the Black River from industrial waste outlets and misused storm and combined sewers.

(c) Nutrients

High concentrations of nutrients are found, particularly in the stretch downstream from Elyria.

(d) Bacteria

High bacteria counts exist in all stretches downstream from discharges of untreated and treated sewage.

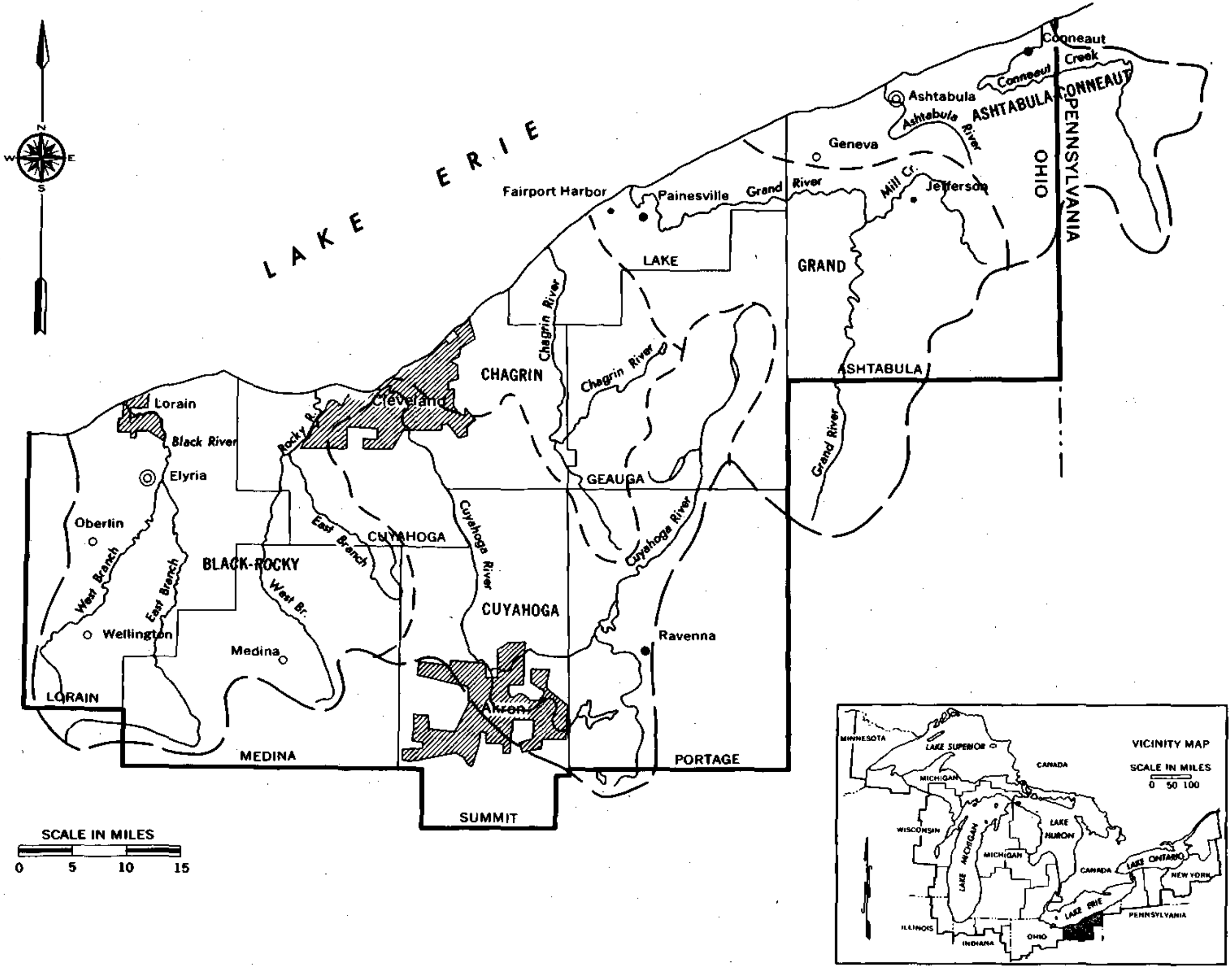


FIGURE 7-30 Planning Subarea 4.3

(2) Rocky River

Data on water quality of the Rocky River represent findings of the Office of Water Programs, U.S. Environmental Protection Agency, at two points on the lower main stem, and results from a limited survey conducted by the Ohio Department of Health on the West and East Branches.

(a) Dissolved Solids

In the main stem just upstream from the Lakewood wastewater treatment plant, as well as in lake water intrusions into the river, dissolved solid concentrations during the summer of 1964 varied from 213 to 830 mg/l. The maximum concentration is considerably higher than any observed in the main stem during a survey by the Ohio Division of Water conducted from 1950 to 1952. The higher concentrations are due mainly to an increase in chlorides which originate in the West Branch near Medina.

(b) Oxygen Demand; Dissolved Oxygen

The biochemical oxygen demand of the river water generally varied from 1.0 to 20.0 mg/l. The maximum concentration indicates large discharges of partially treated municipal wastes which are usually accompanied by low dissolved oxygen levels. Data on chemical oxygen demand, which is limited to the main stem, indicate significant amounts of unoxidized carbonaceous matter.

During the surveys of both the Federal and State agencies low dissolved oxygen values were observed only in the main stem and particularly in the mouth area. Recently a few values less than 3.0 mg/l were found on the West Branch below Medina and the East Branch below Berea. Concentrations in excess of saturation values observed in the mouth area indicate considerable algal activity.

(c) Nutrients

In the river's lower reach the concentration of phosphates varied from 0.1 to 6.4 mg/l near the Hilliard Road bridge and from 0.04 to 14.0 mg/l in the harbor area. Concentrations of ammonia at these respective points varied from 0.2 to 5.7 mg/l and 0.4 to 1.5 mg/l. Phosphate concentrations were generally above the level believed necessary for the encouragement of large algal blooms.

(d) Metals

Analyses made by the Office of Water Programs on samples from the lower reach indicate only trace amounts of such metals as cadmium, chromium, copper, nickel, and zinc. Within the basin the only significant sources of such ions are facilities owned or operated by the Federal government.

(e) Bacteria

Values for total and fecal coliform organisms as well as fecal streptococcus indicate that counts of bacteria of human origin in the mouth area are higher than that usually prescribed for swimming and other water-contact activities. Total coliform counts in both the West and East Branches at State Route 82 also exceed the recommended levels for such use.

(3) Cuyahoga River

(a) Dissolved Solids

Dissolved solid concentrations increase significantly from Lake Rockwell to just downstream from the Akron wastewater treatment facilities. The concentrations then level off from that point to Lake Erie. Average concentrations found during the 1965 low-flow study increased from 190 mg/l at Lake Rockwell Dam to 800 mg/l just upstream from Tinkers Creek. Just downstream from Tinkers Creek concentrations drop to 700 mg/l and then rise to 750 mg/l in the navigation channel. During 1964 the maximum observed concentrations varied from 246 mg/l at Lake Rockwell to approximately 1200 mg/l in the stretch between Akron and Cleveland. In the ship channel the maximum observed value was just less than 1000 mg/l.

The specific conductance of the river water as measured by an automatic monitor located at Independence near Old Rockside Road frequently exceeded 1500 mhos during the summer of 1966. This level is equivalent to 930 mg/l of dissolved solids. Daily variation is often from 900 to more than 1500 mhos and at times from 600 to more than 1500 mhos.

The major increase of dissolved solids in the Akron area is due to an increase in alkalies, particularly chlorides. In the Cleveland area the major increase is due to an increase in sulfates.

(b) pH

Upstream from the greater Cleveland area the pH of the river varied from 6.9 to 8.2. In the lower reach of the river the variation was 5.7 to 8.7 during 1964 and 6.3 to 7.3 during 1965. Individual low values of 5.2 in 1966 and 3.8 in 1967 were recorded on an automatic monitor in the ship channel at West Third Street.

(c) Oxygen Demand

Figure 7–31 shows average values for the chemical and biochemical oxygen demands during the 1965 low-flow period for the stretch downstream from the Little Cuyahoga River. The extremely high values observed just upstream from the navigation channel were

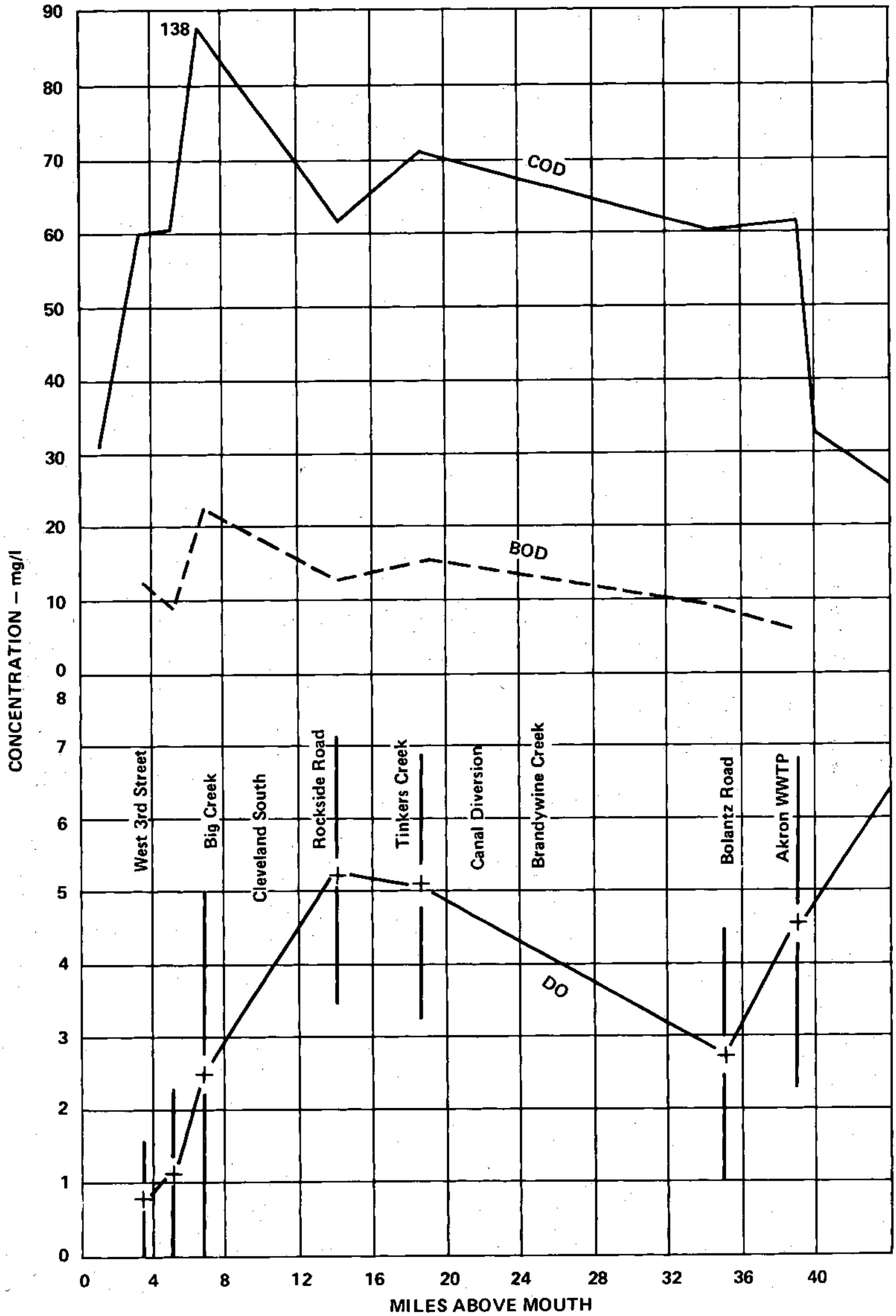


FIGURE 7–31 Profiles of Oxygen Demand and Dissolved Oxygen, Cuyahoga River—Akron to Lake Erie (September 13–22, 1965)

caused by the discharge of raw sewage because of a major break in the Big Creek Interceptor. These chemical oxygen demand values are important because they indicate that the ultimate carbonaceous oxygen demand is approximately three to five times higher than five-day biochemical oxygen demand instead of the usual 1.25 to 1.50 times. This is confirmed by long-term biochemical oxygen demand studies on the Akron wastewater treatment plant effluent as well as by four downstream river samples.

(d) Dissolved Oxygen

Dissolved oxygen concentrations in the Cuyahoga River downstream from its confluence with the Little Cuyahoga River during a 1965 low-flow period are shown in Figure 7–31. Low dissolved oxygen values were observed just downstream from the discharges of the Akron and Cleveland wastewater treatment facilities. Spot checks also indicate a serious depression of dissolved oxygen levels in the pool area immediately upstream from the canal diversion dam.

Typical diurnal fluctuations occurred in the river immediately upstream from the Akron plant and at the two stations near the end of the sampled reach. At the two downstream stations nearest the Akron plant the variation was minor. The latter results indicate possible toxic effects of wastes from Akron on aquatic plants.

Data on daily variations of the dissolved oxygen concentrations in the summer of 1967 were recorded by an automatic monitor in the navigation channel. With the exception of only two days, there was almost no dissolved oxygen concentration during July, August, and September.

(e) Temperature

The maximum water temperature recorded during 1966 and 1967 at Independence was 84°F. At West Third Street the maximum temperature recorded during 1967 was 95°F but this occurred only one day. On three other days the maximum temperature reached 92°F. During 1967 a maximum water temperature of 97°F was observed near Munroe Falls.

(f) Nutrients

The concentration of phosphates during 1964 ranged between 0.02 and 1.65 mg/l upstream from Kent, 0.09 and 16.3 mg/l between Kent and Akron, 0.12 and 8.66 mg/l between Akron and Granger Road in Cleveland, and 0.04 and 3.29 mg/l downstream from Granger Road. Only small amounts of ammonia were found upstream from the confluence of the Little Cuyahoga River. Concentrations between 10 and 15 mg/l were frequently observed downstream from Akron and concentrations of 15 to 20 mg/l were observed in the navigation channel during low flows.

(g) Metals

Toxic metals such as cadmium, chromium, copper, nickel, and zinc were found only in trace to small amounts. Concentrations of iron ranged from 0.18 to 1.9 mg/l upstream from Alexander Road, from 2.1 to 9.1 mg/l in the section between Alexander and Rockside Roads, and from 5.5 to 16.1 mg/l in the navigation channel. Although iron concentrations are undesirable, the higher concentrations in the lower reach cause a positive effect by precipitating most phosphates which were dissolved in upstream channel waters. This reduces the possibility of large algal blooms occurring in the channel and adjacent inner harbor areas. Precipitated phosphates are removed from the channel during dredging.

(h) Bacteria

The median summer bacterial counts are extremely high for all points downstream from Lake Rockwell. When samples were collected the major municipal wastewater treatment facilities were not practicing disinfection. Such facilities now use chlorination disinfection.

(4) Chagrin River

The lower reach of the Chagrin River is of good chemical quality. Concentrations of dissolved solids and metals are well within the limits established by the Ohio Water Pollution Control Board for public water supplies and aquatic life. The ranges of pH, dissolved oxygen, and water temperature are also within the limits established or preferred by the board for maintenance and propagation of warmwater fish.

The density of the bacterial organisms of sanitary significance found during the sampling period, however, exceeded values generally recommended for public water supply or swimming uses.

Immediately downstream from Chagrin Falls values for biochemical oxygen demand and dissolved oxygen during the summer of 1967 ranged between 10 and 20 mg/l and 5.9 and 8.4 mg/l respectively. The maximum water temperature observed during that time was 78°F.

The most serious water quality problem is turbidity from silt caused by erosion of adjacent land areas, particularly upstream from Chagrin Falls. In addition low dissolved oxygen and color problems occur upstream from the falls at Chagrin Falls.

(5) Grand River

The Grand River at State Route 84 and upstream is of good chemical quality and in many ways is similar to that of the Chagrin River. However, downstream from that point river water quality is sharply changed by municipal and industrial waste discharges. The most important changes are in the levels of dissolved solids, chlorides, chemical oxygen demand, and phenols.

At State Route 535 the concentration of dissolved solids varied from 161 to 10,298 mg/l and the average of 43 samples was 4,199 mg/l. During the same period the chlorides concentration varied from 35 to 6,325 mg/l with an average value of 2,490 mg/l. Lower values found at the Coast Guard Station indicate the dilution effect of intruding lake water.

Although the oxygen demand as measured by the biochemical oxygen demand test is low, the chemical oxygen demand indicates the presence of significant amounts of carbonaceous matter.

Dissolved oxygen values at all four sampling stations were greater than 5.0 mg/l at all times during 1964. However, data from an automatic monitor located at State Route 535 indicate the dissolved oxygen in the river was less than 1.0 mg/l at all times during a 12-day period beginning July 16, 1967.

The maximum observed temperature during 1964 at the four stations was 84°F. An instantaneous value of 88°F was recorded by the monitor in August 1967.

Phosphates and ammonia discharged from municipal and industrial sources could create large algal blooms in the Lake and possibly in the river.

Phenol concentrations at State Route 535 varied from 1.1 to 112 parts per billion (ppb) compared with upstream background values of 0.0 to 5.8 ppb.

Median bacterial densities upstream from State Route 84 indicate the stream was reasonably free of sanitary wastes. In contrast total coliform densities were 9,000 counts per 100 ml at U.S. Route 20 and 150,000 counts per 100 ml at State Route 535.

7.2.3.2 Ashtabula River, Conneaut Creek, and Turkey Creek

The present chemical quality of the Ashtabula River at the Main Street bridge is similar to that found during 1951 and 1952. In general the chemical water quality approaches that which would exist under natural conditions. More recent data, however, indicate bacterial counts higher than those acceptable for public water supply and recreational use. In addition phosphate levels may cause large algae blooms.

Water quality of the Ashtabula River at the 6th Street bridge (0.7 mile from the mouth) is affected by the discharge of Fields Brook which contains high concentrations of total dissolved solids and chlorides from industrial wastes. Upstream the river contains much lower concentrations of these constituents. The lower river also contains higher concentrations of ammonia and phenols and lower concentrations of dissolved oxygen. Both the total and fecal coliform bacteria counts in the lower river are much higher than at upstream stations. Water quality of the lower river is degraded by discharges of sewage as well as organic industrial wastes.

Because no significant waste discharges are made into either Conneaut Creek or Turkey Creek within Ohio, the present quality of these streams is essentially that of a natural stream in the area. Some problems are caused by soil erosion and nutrients from land runoff.

7.2.3.3 Lake Erie Shoreline

A total of 23 municipal water treatment plant intakes extend from the Ohio shore into Lake Erie. Pertinent chemical and bacterial quality data for 20 of these intakes during 1965 and 1966 are given in Table 7–43. Considerable variation exists in such indicators as total solids, turbidity, and bacterial counts at each intake. A gradual increase in dissolved solids occurs from west to east. The variations at a particular intake depend on a number of factors including depth of the intake, depth at which water is withdrawn, distance from shore and tributary streams, and water quality in tributary streams. Other factors are current patterns, bottom materials, and water temperature.

In spite of the variations, the chemical quality of Lake Erie at all intakes at all times is well within the criteria limits for public water supplies. Fourteen of the 20 intakes meet all bacterial criteria. Three other intakes had maximum counts exceeding 20,000 per 100 ml in more than 5 percent of the samples for one or two months. These months occurred during winter storm periods when there was considerable rainfall and turbulence in the Lake. High maximum counts which occurred during more than two months of the year were found at the intakes of Elyria and Lorain. High coliform levels at these two intakes are influenced by storm sewer discharges, land runoff, and the Black River. At several intakes in shallow waters debris in the bottom four feet of water contains high coliform counts.

Taste and odor determinations are not generally made on Lake Erie water supplies. However, a good indication of these characteristics is the concentration of activated carbon used by several water treatment plants to control tastes and odors in the summer of 1967. During June and July the monthly average feed of activated carbon was generally less than 2 mg/l, but during August the feed rate was considerably higher, particularly at Lorain and Mentor.

Algae growths were the main cause of taste and odor problems during that summer. Before these problems occurred along the Ohio shoreline they were noted on July 25 at water works in New York and Pennsylvania. Three days later taste and odor problems were noted at Mentor, Ohio, and they occurred later at plants further west.

Water quality of beach areas is influenced by local lake currents, surrounding topography and land use, proximity to tributary streams, and discharges of sanitary sewage, industrial wastes, and storm waters. Table 7–44 shows the minimum and maximum coliform counts and the geometric means found at major bathing beaches during the 1967 season. With only a few exceptions water quality of the beach areas west of Lorain and east of the Chagrin River meets all criteria during the entire bathing season. Water quality of the beaches at Lorain and Huntington Park generally meets all criteria, but coliform concentrations were slightly higher than the maximum limit of 2,400 counts per 100 ml. At beaches in the Cleveland area the coliform concentrations were considerably higher than criteria limits.

In addition to high bacterial counts other objectionable characteristics of some bathing area waters are debris, oils, sediment, color, and algae. Sources of debris include dumps along the shore and tributaries, wash-off from lands stripped for new construction, and careless disposal of food and beverage containers. Sources of oils and greases include municipal and industrial discharges, misused storm sewers, and highway drainage. Wastewater effluents, and land run-off are major sources of solids and sediment and, in a few instances, color. Algae in beach areas are aesthetically objectionable and may become malodorous upon decay.

Many of the above conditions occur at marinas and scenic coves as well as beaches. Such conditions interfere with boating and the aesthetic enjoyment of the Lake. Improved wastewater treatment practices alone will not significantly improve these conditions. The elimination or treatment of combined sewer and stormwater discharges near these areas is required. The need for eliminating shoreline dumps is obvious.

Table 7–45 shows the significant water quality problems caused by the discharge of major Ohio tributaries into Lake Erie and the zones of their influence. Most zones of influence are relatively limited for most constituents. However, because all the tributaries drain areas of limestone formations, they contribute large amounts of dissolved solids to the lake water. From the western to eastern borders of Ohio dissolved solids in the lake water increase to nearly 50 ppm. This represents an average addition of 31,000 tons of dissolved solids per day. More than 70 percent of this amount is discharged by the major Ohio tributaries. The Maumee and Grand Rivers alone contribute nearly 16,000 tons per day. Of the total amount of dissolved solids discharged from Ohio approximately 50 percent occur naturally in tributary waters.

The Maumee, Portage, Sandusky, and Cuyahoga Rivers contribute an average total sediment load of nearly 5,100 tons per day. Almost 65 percent of this load is discharged from the Maumee River.

All the tributaries discharge nutrients into the Lake.

7.2.4 Planning Subarea 4.4

Figure 7–32 shows Planning Subarea 4.4, which includes portions of Pennsylvania and New York.

7.2.4.1 Pennsylvania

(1) Lake Erie Open Waters

Open waters in Lake Erie are generally 200 yards or more offshore except in Erie Harbor and Presque Isle Bay.

The quality of these waters is suitable for water contact sports, navigation, and recreational boating. Following adequate treatment water quality is also suitable for with-

TABLE 7–44 Summary of Lake Erie Water Quality at Municipal Waterworks Intakes (July 1965–June 1966)

	Toledo		Oregon		Port Clinton		Marblehead		Sandusky	
Intake's Distance from shore (ft.)	10,000		5,200		1,000		300		2,500	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Total solids (mg/1)	167	282	128	211	168	282	190	246	193	265
Alkalinity as $CaCO_3$ (mg/1)	72	140	34	166	76	165	89	160	91	113
pH	7.6	8.9	7.9	8.8	7.4	8.4	7.2	8.0	7.7	8.5
Chlorides (mg/1)	15	36	22	23	16	26	22	24	11	21
Turbidity-units	5	148	4	98	25	300	1	160	5	1,560
Nitrates as NO_3 (mg/1)	0.5	1.0	1.5	---	0.1	2.5	0.2	2.0	0	1.5
Hardness as $CaCO_3$ (mg/1)	103	234	108	300	100	306	138	216	138	166
Coliforms/100 ml; daily	10	2,400	12	24,000	280	24,000	314	11,000	14	2,400
Coliforms/100 ml; yearly average[1]	111	---	449	---	2,460	---	1,209	---	160	---
Percent of time monthly coliform average > 5,000/100 ml[1]	0	---	0	---	8.3	---	0	---	0	---
No. days coliforms > 5,000/100 ml	0	---	6	---	37	---	1	---	0	---
No. days coliforms > 20,000/100 ml	0	---	3	---	6	---	0	---	0	---

	Crown		Division		Cleveland Baldwin		Nottingham		Lake Co. West Plant (Mentor)	
Intake's Distance from shore (ft.)	7,800		21,000		21,000		18,000		1,900	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Total solids (mg/1)	170	220	168	212	183	215	187	218	320	384
Alkalinity as $CaCO_3$ (mg/1)	83	104	77	100	87	95	66	98	77	107
pH	7.4	8.6	7.4	8.5	7.5	8.6	7.5	8.4	7.2	8.6
Chlorides (mg/1)	19	28	16	30	21	27	20	28	No data	
Turbidity-units	2	190	1	100	1	76	1	111	4	529
Nitrates as NO_3 (mg/1)	0	0.5	0	0.5	0	1.0	1.0	0.5	No data	
Hardness as $CaCO_3$ (mg/1)	118	133	122	130	120	128	120	132	119	203
Coliforms/100 ml; daily	27	12,000	61	8,200	3	11,000	3	11,000	372	240,000
Coliforms/100 ml; yearly average[1]	563	---	417	---	244	---	202	---	8,020	---
Percent of time monthly coliform average > 5,000/100 ml[1]	0	---	0	---	0	---	0	---	41.7	---
No. days coliforms > 5,000/100 ml	11	---	3	---	1	---	1	---	75	---
No. days coliforms > 20,000/100 ml	0	---	0	---	0	---	0	---	35	---

	Huron		Vermilion		Elyria		Lorain		Avon Lake	
Intake's Distance from shore (ft.)	2,100		1,500		1,200		2,000		1,900	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Total solids (mg/1)	186	245	171	266	168	305	178	286	194	234
Alkalinity as $CaCO_3$ (mg/1)	84	107	90	100	86	108	80	99	80	98
pH	7.7	8.2	7.2	8.4	7.6	8.5	7.8	8.7	7.3	8.4
Chlorides (mg/1)	15	30	15	25	16	17	16	27	21	26
Turbidity-units	5	200	20	100	10	180	1	140	4	130
Nitrates as NO_3 (mg/1)	0	3.0	0	0.7	0.1	0.2	0.1	2.5	0	1.0
Hardness as $CaCO_3$ (mg/1)	114	140	100	150	124	138	116	138	114	146
Coliforms/100 ml; daily	21	2,400	80	4,600	161	24,000	38	110,000	230	27,000
Coliforms/100 ml; yearly average[1]	200	---	876	---	1,416	---	3,673	---	1,897	---
Percent of time monthly coliform average > 5,000/100 ml[1]	0	---	0	---	0	---	33.3	---	8.3	---
No. days coliforms > 5,000/100 ml	0	---	0	---	24	---	43	---	47	---
No. days coliforms > 20,000/100 ml	0	---	0	---	5	---	18	---	2	---

	Painesville		Fairport		Lake Co. East Plant (Madison)		Ashtabula		Conneaut	
Intake's Distance from shore (ft.)	3,800		1,000		2,000		1,500		1,500	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Total solids (mg/1)	214	400	219	274	271	500	192	217	210	230
Alkalinity as $CaCO_3$ (mg/1)	65	106	65	98	60	100	87	110	90	120
pH	7.0	8.8	7.3	9.08	7.2	8.4	7.7	8.2	7.5	7.8
Chlorides (mg/1)	22	43	24	38	25	54	21	30	21	33
Turbidity-units	5	400	10	168	4	250	5	260	3	110
Nitrates as NO_3 (mg/1)	0	1.0	0	3.5	0	2.0	0	1.0	0.2	2.0
Hardness as $CaCO_3$ (mg/1)	116	264	99	162	121	183	130	148	126	134
Coliforms/100 ml; daily	56	110,000	47	11,000	314	24,000	27	9,600	44	24,000
Coliforms/100 ml; yearly average[1]	3,426	---	1,832	---	1,209	---	359	---	620	---
Percent of time monthly coliform average > 5,000/100 ml[1]	16.7	---	8.3	---	0	---	0	---	0	---
No. days coliforms > 5,000/100 ml	42	---	4	---	11	---	3	---	0	---
No. days coliforms > 20,000/100 ml	11	---	0	---	1	---	0	---	0	---

[1]Arithmetical Average

TABLE 7-45 Summary of the Bacterial Quality of the Waters at Beaches Along Lake Erie (1967 Bathing Season)

Beach	Coliforms per 100 ml Minimum Day	Maximum Day	Monthly Avg.
East Harbor	30	24,000	148[a]
Crane Creek	80	724,000	955[b]
Lakeview	40	3,800	1,000
Century	20	3,300	800
Huntington Park	36	4,600	450
Perkins	230	110,000+	16,400
Edgewater	750	110,000+	35,000
White City	2,300	110,000+	45,000
Wildwood	430	110,000+	10,300
Mentor Park	200	1,200	580
Painesville	200	1,300	510
Fairport	200	800	390
Madison	200	1,400	460
Geneva	270	10,000	600
Walnut	20	560	142
Lakeshore	16	630	171

[a] August

[b] 1964 Data

drawal uses such as municipal and industrial water supply. Municipal water use requires coagulation, sedimentation, filtration, and chlorination. Special pretreatment and taste and odor control chemicals are needed at the City of Erie water intake when algal blooms occur and when wastes from the Erie Harbor area are blown westward to the intake. In the 10-mile area on the eastern side of Erie Harbor, the normal downstream area, water intended for municipal use would require this special treatment on a continuous basis.

Water quality of the eastern lake portion is suitable for indigenous and introduced fish including rainbow trout and coho salmon. The western edge of the central lake portion shows severe deoxygenation of waters beneath the thermocline which limits the number and species of fish that can inhabit the area.

The major problems of the open waters are related to eutrophication of the Lake. Eutrophication contributes to deoxygenation of waters trapped below the thermocline, limiting the habitat of desirable fish and aquatic life. Eutrophication also causes frequent algal blooms which interfere with withdrawal uses. Control of eutrophication is the most urgent problem of the open waters. Unless it is corrected as soon as possible it will deteriorate the eastern lake portion and create an irreversible process.

The effects of waste discharges in Erie Harbor are discussed later.

(2) Lake Erie Shoreline Waters

Lake Erie shoreline waters are generally within 200 yards offshore except in Erie Harbor and Presque Isle Bay.

Shoreline water quality is generally poorer than offshore water quality. The water is more turbid because of shoreline erosion and tributary inputs. Total coliform counts are higher than in the open waters because of direct discharges and tributary inputs. Discoloration and foaming are caused by waste discharges from the Hammermill Paper Company.

Detached *Cladophora* wash up on the shore in large amounts, usually during the recreation season. This interferes with swimming, boat launching, and shoreline fishing.

The high turbidity of shoreline waters detracts from the usefulness of these waters for withdrawal uses regardless of other quality considerations. For this reason withdrawal uses are not likely to occur except for those that can stand the high turbidity. Intakes will probably be extended to open waters for the more sensitive uses.

Total coliform levels near the mouths of some tributary streams create a problem since the tributaries provide a natural access corridor to the Lake. With the exception of Presque Isle most natural beach areas on the Pennsylvania shoreline are located at the mouths of tributaries.

Protection of shoreline waters to permit maximum recreational development is needed. Continued protection of the existing Presque Isle beaches is urgent, and restoration of other areas should be undertaken.

(3) Erie Harbor and Presque Isle Bay

The outer Erie Harbor receives the largest waste loads in the area, discharged from the City of Erie and the Hammermill Paper Company. These wastes are mixed in the vortex that exists on the eastern side of Presque Isle. The water is discolored and contains a high biochemical oxygen demand. Foaming occurs frequently and deoxygenation lowers oxygen values to 4 mg/l in the surface waters.

When wind blows from the east or northeast the Lake rises forcing some water into the inner harbor and Presque Isle Bay. Here it mixes with sewage overflows from the City of Erie and with some minor industrial discharges.

The waters of Erie Harbor and Presque Isle Bay are generally unsuitable for water-

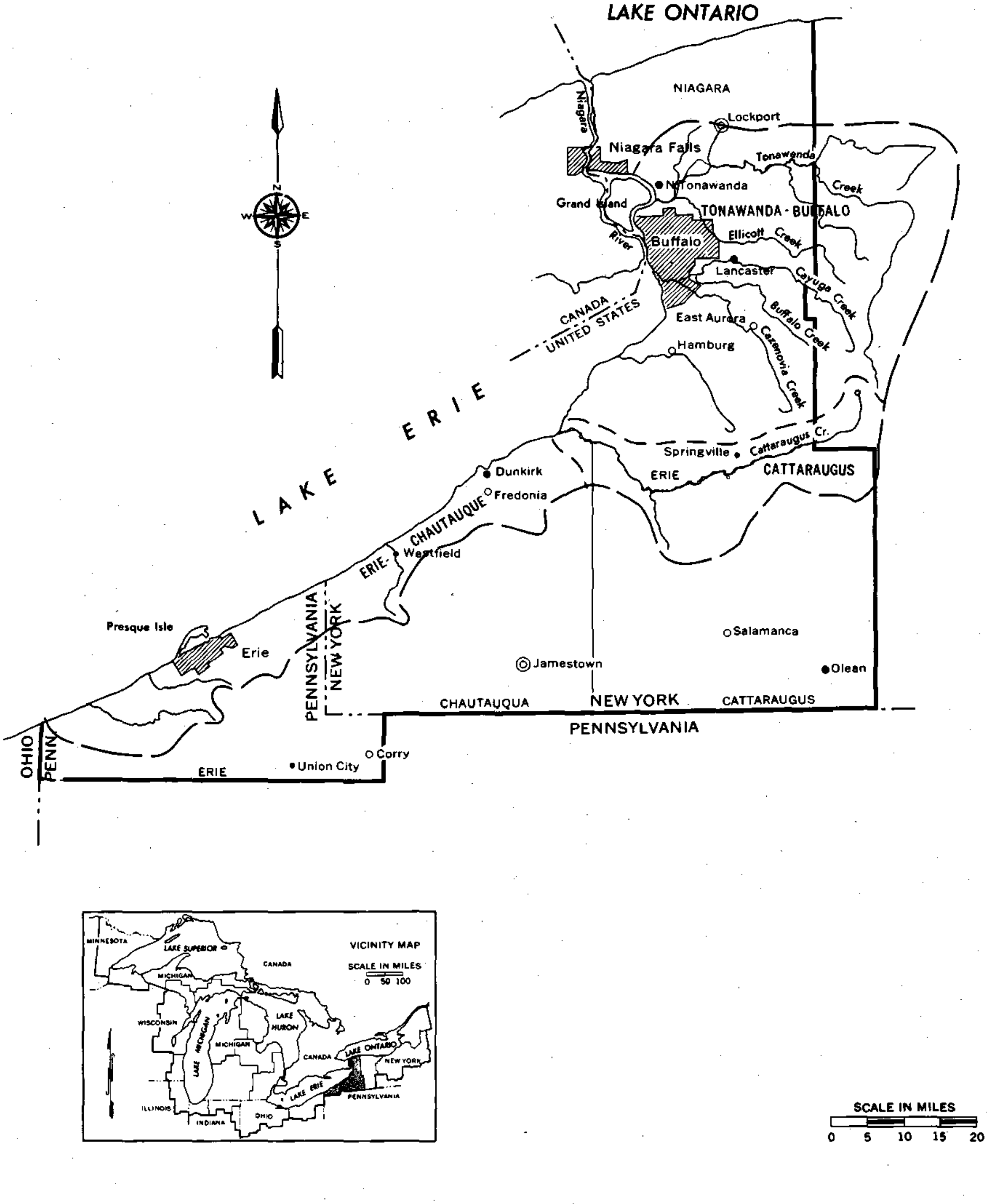


FIGURE 7–32 Planning Subarea 4.4

contact recreation and municipal and industrial supply (except cooling water).

Warmwater species, particularly yellow perch, white bass, largemouth black bass, and pike, abound in the better sections of Presque Isle Bay along the north shore. The bay is protected, and these species provide a popular sport fishery. The bay front area along the south shore provides only marginal fishing and the water is often aesthetically offensive.

Improved water quality in the harbor and bay will enhance recreational and withdrawal uses, particularly along the south shore bay front area of Presque Isle Bay.

(4) Lake Erie Tributaries

The Pennsylvania tributaries of Lake Erie are small. The largest, Conneaut Creek, has a drainage area of only 154 square miles in Pennsylvania. Despite their small size these tributaries play a major role in lake use. Some tributaries carry large numbers of bacteria (total coliforms) into the Lake. This contributes to shoreline contamination, particularly at access areas. These coliforms come from inadequately treated sewage from sewage treatment works, malfunctioning on-lot sewage disposal systems such as septic tanks, and soil erosion.

An environmental survey of Erie County indicated that only two percent of the soils are suitable for on-lot sewage disposal systems. Malfunctioning on-lot disposal systems exist throughout the county. Wastes from one person could contaminate as much as 10 mgd of water, rendering it unsuitable for water contact sports.

Sewerage planning is moving forward rapidly in the suburban Erie municipalities. However, some of these areas are too remote from the City of Erie to make a connection that would be economically feasible at present. Interim planning creates the second problem of the tributaries.

Many Lake Erie tributaries, particularly Godfreys Run, Trout Run, Crooked Creek, Walnut Creek, Sixmile Creek, and Twelvemile Creek, are nursery waters for lake-run rainbow trout and are likely to become important nursery and hatchery waters for coho salmon. The water quality needs for these uses, particularly temperature, dissolved oxygen, and ammonia concentrations, are such that at least a 20:1 dilution of stream water to secondary effluent is needed. Because the available dilution is 4:1 or less for most areas, tertiary treatment or long outfalls to the Lake are necessary. This in turn may make the sewerage projects unfeasible.

There is an urgent need to protect waters suitable for rainbow trout and coho salmon hatcheries because these fish are necessary for a rapid restoration of lake sport fisheries.

Headwater areas of nearly all tributaries are of suitable quality for all uses. Water is unsuitable for water-contact recreation in Elk, Fourmile, and Sixteenmile Creeks near their mouths and in Conneaut Creek below Conneautville. Cascade Creek, Mill Creek, and Garrison Run are generally unsuitable for any uses. The most urgent need for these tributaries is to improve water quality and reduce the adverse effects of tributary waters on the Lake's shoreline areas.

7.2.4.2 New York

The New York State portion of the Lake Erie drainage basin consists of 96 identified tributaries from Tonawanda Creek to Twentymile Creek draining a total area of 1,776 square miles (Table 7–47). Water quality in these streams is a function of stream flow, subsurface geology, land usages, and waste discharges. Several villages and urban townships in the Buffalo area influence water quality. Major cities within the planning subarea are shown in Figure 7–31. Agriculture, the major land usage near the Lake, gives rise to numerous canneries and grape-processing industries.

Most basin streams are not capable of any appreciable sustained flow (Table 7–46). The only exception is Cattaraugus Creek which has a 7-day 10-year low flow of 60 cfs from a drainage area of 428 square miles.

Most inland streams originate in Upper Devonian shale and sandstone formations. Consequently they contain high concentrations of dissolved solids and hardness. Sulfate content is high in areas of gypsum deposits.

Water quality is high in the headwaters upstream from the Buffalo metropolitan area and other population and industrial centers. By far the only significant stream with appreciable flow of high quality water is the Cattaraugus Creek above the Village of Gowanda except for a short reach below the Village of Arcade.

Water quality in Lake Erie is affected by a large steel industry located on its shores near Buffalo where industrial waste discharges contribute to the deteriorated quality. However, the industry plans a sizable construction program to eliminate or reduce wastes.

The remainder of the streams in the watershed suffer from the fertilizing effects of nutrients received from domestic sewage discharges and agricultural runoff. This causes the abundant growth of rooted and floating aquatic weeds and algae. Heavy growths and accumulations of the attached algae, *Cladophora*, have been a nuisance along the Lake Erie waterfront. Tributary waste discharges in Lake Erie cause minimal and mostly localized effects.

The lower five miles of the Buffalo River are severely degraded by four major municipal discharges and five major industrial waste discharges as well as other smaller municipal and industrial wastes. These industries discharge waste process waters originating from

TABLE 7–46 Summary of the Significant Constituents of Ohio Tributaries to Lake Erie and Their Area of Influence

Tributary	Constituents	Area of Influence
Maumee River	Dissolved solids	Maumee Bay
	Sediment + Settleable solids	Toledo Waterworks Intake
	Coliform bacteria	Oregon Waterworks Intake
	Oxygen demand	Reno Beach
	Oil	Michigan Water of Lake Erie
	Color	
Portage River	Bacteria	Port Clinton Waterworks Intake
Black River	Sediment + Settleable solids	Harbor
	Coliform bacteria	Elyria Waterworks Intake
	Oil	Lorain Waterworks Intake
	Color	Lorain Beaches
Rocky River	Sediment	Bay
	Coliform bacteria	Nearby beaches
	Oxygen demand	
Cuyahoga River	Dissolved solids	Harbor
	Sediment + Settleable solids	Nearby beaches
	Coliform bacteria	Cleveland Waterworks Intake
	Oxygen demand	
	Oil	
	Color	
	Taste and odors	
Chagrin River	Sediment	Nearby beaches
	Coliform bacteria	
Grand River	Dissolved solids	Harbor
	Sediment + Settleable solids	Nearby beaches
	Coliform bacteria	Painesville Waterworks Intake
		Fairport Waterworks Intake
Marsh Creek	Coliform bacteria	Bay
	Taste and odors	Nearby beach
		Mentor Waterworks Intake
Ashtabula River	Dissolved solids	Harbor
	Sediment	Beaches
	Coliform bacteria	Ashtabula Waterworks Intake
	Color	

TABLE 7–47 Flow Summary of Lake Erie Tributaries, Planning Subarea 4.4—New York

Stream	Drainage Area Total	Drainage Area Gaged	Streamflow Average	Streamflow MA7CD/10 yr.
Tonawanda Creek	631.0	447.0[a]	NA	NA
Buffalo River	436.0	374.3	413.3	9.4
Buffalo Creek	149.0[b]	145.0	186	4.5
Cayuga Creek	126.0[b]	93.3	12.3	0.4
Cazenovia Creek	138.0[b]	136.0	215	4.5
Smoke Creek	32.9	14.6	18	Trace
Rush Creek	8.6	NA	Intermittent	
Eighteenmile Creek	120.0	119.0	142	2.3
Big Sister Creek	49.2	48.4	60	0.1
Cattaraugus Creek	554.0	428.0	705	66
Silver Creek	51.9	NA	NA	0.3
Canadaway Creek	40.0	NA	NA	2.0+0.5[c]
Chautauqua Creek	36.0	NA	NA	1.4[c]
Twentymile Creek	34.7	NA	NA	NA
Total	1994.3			

[a]Includes Ellicot Creek, Tonawanda Creek, and Little Tonawanda Creek.

[b]Included in Buffalo River totals.

[c]Includes STP Flow.

NA--Not Available.

the manufacture of steel, chemicals, dyes, petroleum products, and the production of coke. Sampling results from the New York State manual sampling stations on the Buffalo River indicate high ammonia, phenol, and chloride concentrations present in the lower Buffalo River. In addition iron and sulfate concentrations are moderately high. Some improvement in water quality has been noted since the Lake Erie cooling water project has been in operation. Effects on Lake Erie water quality are minimal because of the proximity of the Buffalo River to the Niagara River outflow. The project does have an effect on Lake Ontario.

Waste discharges from tannery and glue works in Gowanda seriously degrade water quality in Cattaraugus Creek. Monitoring results show relatively high ammonia, organic nitrogen, and chromium concentrations in the creek below these discharges. Both industries have retained an industrial waste consultant and have conducted pilot plant studies to investigate waste treatment. The New York State Department of Environmental Conservation is awaiting submission of final plans.

Several small streams in Erie and Chautauqua Counties are degraded by the discharge of incompletely treated wastes from canneries and grape processing plants. The municipalities and industries involved are studying the technical and fiscal aspects of their waste problems before proceeding with final design of remedial waste treatment facilities. Preliminary plans call for secondary treatment with phosphorus removal and discharge of effluent through diffusers into Lake Erie.

The water quality problems described above are being alleviated. Basinwide planning has indicated the potential for residential and industrial development and presented long-range economic alternatives consistent with the area's water resources development potential. Engineering studies for individual problem solution are in various stages of completion. Although concern for water quality control needs will continue, significant steps are being taken to solve both immediate and long-range aspects of the problem.

7.3 Water Quality Control Needs

7.3.1 Introduction

Increased municipal and industrial waste loadings on existing wastewater treatment facilities coupled with the limited ability of most receiving streams to assimilate effluents from such facilities has resulted in continued degradation of Lake Erie basin streams. Part of the *Great Lakes Basin Framework Study* is intended to define guidelines for water quality control. This section determines needs and quality control alternatives and establishes the costs of necessary pollution control facilities for the planning subareas in the Lake Erie basin.

7.3.2 Methodology

Methods used to determine waste load projections and treatment requirements are outlined in the Introduction. Municipal and industrial organic waste loads were separated where available data permitted, although some industrial wastes are treated in municipal treatment systems. Estimates of capital and operating and maintenance costs are given by planning periods for planning subareas.

7.3.3 Planning Subarea 4.1—Michigan

7.3.3.1 Population and Wastewater Volumes

Embracing nine counties in southeastern Michigan, Planning Subarea 4.1 is dominated by the Detroit metropolitan area. In 1970 some 4.85 million people resided in the planning subarea. Wayne County, which includes the City of Detroit, accounted for 55 percent of the total 1970 population. Between 1960 and 1970 the planning subarea experienced a 13 percent increase in population. In the next 50 years the population is projected to increase 90 percent to approximately 9.57 million in 2020. Increases in wastewater flows are expected to substantially increase over the period, as shown in Table 7–48.

TABLE 7–48 Projections of Wastewater Flows and Population Served, Planning Subarea 4.1—Michigan

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	4,848,153	4,000,000	897	746
1980	5,799,200	4,950,000	992	504
2000	7,426,400	6,600,000	1,194	247
2020	9,569,600	8,700,000	1,556	255

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b]Industrial wastewater anticipated to be treated in industry-owned wastewater treatment facilities.

7.3.3.2 Advanced Waste Treatment Needs

Numerous reports and plans have been prepared on the water quality control problems and needs of Planning Subarea 4.1. Three such reports are of fundamental importance to this section.

In 1964 two reports were published by the National Sanitation Foundation under auspices of the former Supervisors Inter-County Committee. These reports are entitled *A Report on Sewage Disposal Problems* and *Report on Metropolitan Environmental Study—Sewerage and Drainage Problems, Administrative Affairs.* The reports recommended a plan for interceptor sewers and sewage treatment for the entire metropolitan area.

In October 1970 the Southeast Michigan Council of Governments (SEMCOG) published a report detailing the development of water supply, sanitary sewer and sewage treatment facilities, and storm drainage facilities for the southeastern Michigan region. This report covered six of the nine counties within Planning Subarea 4.1. SEMCOG's report is considered an interim plan with reference to the Department of Housing and Urban Development's *Water and Sewer Facilities Planning Requirements Guide* of January 1966. As such it serves as the basic reference document for review of grant requests for water, sewer, and drainage facilities.

SEMCOG's report essentially reaffirms the regional interceptor and treatment concept recommended in the 1964 reports of the Supervisors Inter-County Committee. The concept is also updated through the incorporation of certain revisions adopted by some counties involved.

In evaluation of advanced waste treatment needs this section adheres to the regional system plan outlined in the SEMCOG report, and summarizes the existing development of the regional system and its future development as presently foreseen. Advanced waste treatment needs are delineated both for areas outside the regional system and for areas within the system but independent of it. This discussion is structured on a county basis.

(1) Wayne County

The major part of Wayne County is served by two independent interceptor and treatment systems operated by the Detroit Metro Water Department and the Wayne County Department of Public Works. Approximately five minor wastewater treatment plants also operate in the county.

Plans call for expansion of existing interceptor systems to serve the entire county. The principal new facilities foreseen include a major interceptor parallelling the Huron River. The Huron River interceptor will serve western Wayne County, central and western Oakland County, and possibly portions of Washtenaw County. Certain minor treatment plants such as those at Flat Rock and Rockwood are programmed for upgrading and operation on an interim basis pending completion of the interceptor system.

Advanced waste treatment needs are not anticipated for Wayne County.

(2) Macomb County

Macomb County has adopted a program to meet its wastewater treatment needs through connection to the Detroit system via a system of interceptors, and the phased elimination of all treatment plants in Macomb County. Portions of the Clinton-Oakland Interceptor System are under construction and will soon provide service to the southern half of the county. As population growth warrants, this system is planned for expansion ultimately to serve the entire county. The ultimate design of the interceptor system as presently foreseen would probably be reached between 1990 and 2000.

There is one possible exception to this general outlook. The City of Warren may elect not to join the Detroit Metro Water Department's regional system. In that event Warren will need to provide advanced waste treatment in the present planning period of 1970 to 1980 to protect water quality in the Red Run Drain and Clinton River. In future planning periods higher treatment levels corresponding with Warren's growth will be needed. Advanced waste treatment at Warren is not an acceptable alternative for State and Federal financial assistance under existing sewage treatment works grant programs.

(3) Oakland County

The southwestern quarter of Oakland County is served by Detroit Metro Water Department. The Clinton-Oakland Interceptor System, portions of which are now under construction, will serve additional areas in the east and central portions of the county. This system will eventually be extended to serve the northeast portion of Oakland County.

The Huron River Interceptor System is planned to serve much of the western portion of Oakland County. Parts of this system are proposed for construction in the immediate future.

By the year 2000 it is anticipated that all but the northwestern part of the county will be served by regional interceptors. Two possible exceptions to this general outlook involve the communities of Pontiac and Rochester.

Pontiac has elected not to join the regional system. It will upgrade its existing two plants to provide advanced waste treatment to meet water quality standards in the Clinton River downstream from the Pontiac area. To complement its advanced waste treatment processes during drought periods, Pontiac will also provide low-flow augmentation using ground-water sources. These actions are required in the present 1970 to 1980 planning period.

Rochester has not announced a decision as to whether it will contract for wastewater treatment services with the Detroit Metro Water Department. If it elects to continue operation of its own facility, advanced waste treatment will be required at Rochester before 1980 to protect water quality in the Clinton River below this area. Advanced waste treatment at Rochester is not an acceptable alternative for State and Federal financial assistance.

Located in the northwestern portion of Oakland County in the Shiawassee River basin, the Village of Holly will need advanced waste treatment before 1980 to meet water quality standards in the Shiawassee River. Holly plans to install facilities to meet this need.

(4) Washtenaw County

In Washtenaw County major water quality problems exist in the Ann Arbor-Ypsilanti area. Future wastewater treatment developments in this area have not been resolved. Two alternatives are open for the Cities of Ann Arbor and Ypsilanti. They can elect to connect to the proposed Huron River Interceptor System and abandon their existing treatment plants, or they can upgrade their existing treatment plants to provide advanced waste treatment. If the second alternative is selected advanced waste treatment will be needed in the present 1970 to 1980 planning period to meet water quality standards in the Huron River downstream from this area.

According to present proposals, waste collection and treatment service for Ypsilanti Township and portions of Superior, Pittsfield, and Augusta Townships would be provided through the Huron River Interceptor and Treatment Plant System. The feasibility and timing of the implementation of these proposals may be affected by the course of action eventually selected by the Cities of Ann Arbor and Ypsilanti.

Upstream in the Huron River basin the Village of Chelsea will require advanced waste treatment in the present 1970 to 1980 planning period to meet water quality standards in Letts Creek. Sometime after the year 2000 Chelsea may be served by the Huron River Interceptor System. This will depend on population growth in the upper Huron watershed and on the emerging design of this interceptor system.

Northfield Township will also require advanced waste treatment in the present 1970 to 1980 planning period to protect water quality in Horseshoe Drain and the Huron River. Northfield Township may also have the option of joining a regional system after 2000.

Two areas in the Saline River basin will also probably require advanced waste treatment. The City of Milan will probably require advanced waste treatment before 1980 to meet water quality standards in the Saline River downstream from Milan. Upstream the City of Saline will probably need advanced waste treatment before 1980 to meet standards in the Saline River downstream from Saline.

(5) Livingston County

Although Livingston County is placed

within the boundaries of Planning Subarea 4.1, only the southern one-third of the county is within the river basin group in this planning subarea. In this part of the county, the City of Brighton will probably need advanced waste treatment within the 1980 to 2000 planning period to protect water quality in Ore Creek and Brighton Lake. According to the Livingston County water and sewer plan, Brighton's treatment plant will eventually provide service for the greater Brighton area.

(6) St. Clair County

The St. Clair County Department of Public Works and various municipalities are engaged in a number of projects to expand and upgrade wastewater treatment facilities to serve the urban eastern portions of the county. In the immediate future a number of existing treatment plants will be upgraded and expanded and additional service areas will be connected. It is planned that three treatment plants will eventually serve the entire eastern portion of the county. Expansion of the existing treatment plants in Port Huron and Algonac has been proposed so that they can handle additional flows, and a new treatment plant is proposed for construction in East China Township. At that time existing treatment plants in Marysville, St. Clair, and Marine City would be phased out.

The City of Yale will probably need advanced waste treatment in the 2000 to 2020 planning period to meet water quality standards in Mill Creek below Yale City. Mill Creek is a major tributary of the Black River.

(7) Lapeer County

A portion of southeastern Lapeer County is within the Belle, Black, and Clinton River basins. Located in this area, Imlay City will probably require advanced waste treatment in the 1980 to 2000 planning period to meet water quality standards in the North Branch of the Belle River downstream from Imlay City.

(8) Sanilac County

At this time there are no regional or areawide wastewater treatment programs planned for Sanilac County.

Advanced waste treatment is required at Sandusky City in the present planning period to protect water quality in the Berry Drain and the Black River. Sandusky operates tertiary filtering facilities during low-flow periods to meet this need.

(9) Monroe County

Monroe County has adopted a long-range plan of waste treatment as part of its "Com-plan 2000," the official planning guideline for the county to the year 2000. The plan recommended the division of the county into three sewage disposal districts. The northeast corner of the county, including the Villages of South Rockwood, Estral Beach, and Carleton, is to be served by the Huron River Interceptor

TABLE 7-49 Areas Anticipated to Need Advanced Waste Treatment, Planning Subarea 4.1—Michigan

County	Area	Planning Period	Waters Affected	Estimated 7-Day-10-Year Low Flow (cfs)
Lapeer	Imlay City	1980-2000	N. Branch Belle River	1-3
Lenawee	Tecumseh	1980-2000	River Raisin	about 15
Lenawee	Adrian	1970-1980	S. Branch Raisin River	15-20
Macomb	Warren	1970-1980	Red Run Drain Clinton River	40-50
Oakland	Holly	1970-1980	Shiawassee River	2.2
Oakland	Pontiac	1970-1980	Clinton River	6
Oakland	Rochester	1970-1980	Clinton River	41
Sanilac	Sandusky	1970-1980	Berry Drain	0
Washtenaw	Ann Arbor	1970-1980	Huron River	53
Washtenaw	Ypsilanti	1970-1980	Huron River	53
Washtenaw	Saline	1970-1980	Saline River	4
Washtenaw	Chelsea	1970-1980	Letts Creek	3.5
Wahstenaw	Milan	1970-1980	Saline River	8
Washtenaw	Northfield Twp.	1970-1980	Horseshoe Drain	0.5
Monroe	Monroe Metro	2000-2020	River Raisin	34
St. Clair	Yale	2000-2020	Mill Creek	about 3
Livingston	Brighton	1980-2000	Ore Creek	about 2

System. The River Raisin basin would be served by the Monroe municipal treatment plant, and the southern portion of the county would be served by the Toledo treatment facilities.

The final implementation of this three-part system is not anticipated until after the year 2000. The county plan outlines a schedule of interceptor construction and expansion of a number of local treatment plants for interim operation.

Only one area in Monroe County may need advanced waste treatment in the study period. The City of Monroe treatment plant presently serves a population of approximately 24,000 and receives large amounts of organic waste from four paper mills. The population of the Monroe metropolitan service district, as presently outlined, would be approximately 370,000 in the year 2000. Assuming the continued operation of the paper mills and rates of population growth as projected in the county plan, advanced waste treatment will be needed in the study period.

The City of Adrian needs advanced waste treatment in the present planning period to meet water quality standards in the River Raisin below the city. Adrian currently achieves treatment performance levels in excess of 90 percent BOD removal. Treatment requirements will increase in future periods corresponding with population and economic growth.

The City of Tecumseh will probably require advanced waste treatment in the 1980 to 2000 planning period to protect water quality in the River Raisin downstream from Tecumseh.

(10) Lenawee County

To date Lenawee County has not been considered in any of the regional treatment system proposals. It is anticipated that two areas will require advanced waste treatment in the study period.

(11) Summary

A total of 17 areas will probably require advanced waste treatment in the 1970 to 2020 period. Advance waste treatment needs for 12 areas fall within the 1970 to 1980 period, for three additional areas in the 1980 to 2000 period, and for two more areas in the 2000 to 2020 period. Table 7–49 presents a list of advanced waste treatment needs in Planning Subarea 4.1 (Figure 7–33).

7.3.3.3 Treatment Costs

Wastewater treatment costs will be substantial in Planning Subarea 4.1 throughout the period from 1970 to 2020. Cost estimates have been prepared for capital costs and operating and maintenance costs. These estimates are presented in Table 7–50.

TABLE 7–50 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 4.1—Michigan

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	700.0	45.0
1980–2000	300.0	55.0
2000–2020	375.0	75.0

These figures represent costs for municipal wastewater treatment facilities only. Costs for separate industrial wastewater treatment facilities and stormwater overflow control are not included. It should be noted, however, that municipal facilities in the planning subarea handle a large volume of industrial wastewater.

7.3.4 Planning Subarea 4.2

7.3.4.1 Ohio

(1) Wastewater Volume and Advanced Waste Treatment Needs

The Ohio portion of Planning Subarea 4.2 consists of 20 northwest Ohio counties. These counties lie within the basins of the Maumee, Portage, Sandusky, Huron, and Vermilion Rivers, all tributaries of Lake Erie.

The Maumee River sytem includes the Tiffin, St. Joseph, St. Marys, Blanchard, Auglaize, and Ottawa Rivers. Seven nodal or reference points (Figure 7–34) were established to define the wastewater treatment needs in this diverse and complex river system. The present wastewater flow is estimated to be 145 mgd including 102 mgd with large organic loads discharged in the Toledo area. The inland wastewater flow of 43 mgd comprises more than one-eighth of the 7-day 10-year low-flow of the tributary streams at each of the established nodal points. It is apparent that on the basis of flow, advanced waste treatment is required throughout the entire basin before 1980.

The extremely low-flow condition in the Maumee River basin has concerned the State

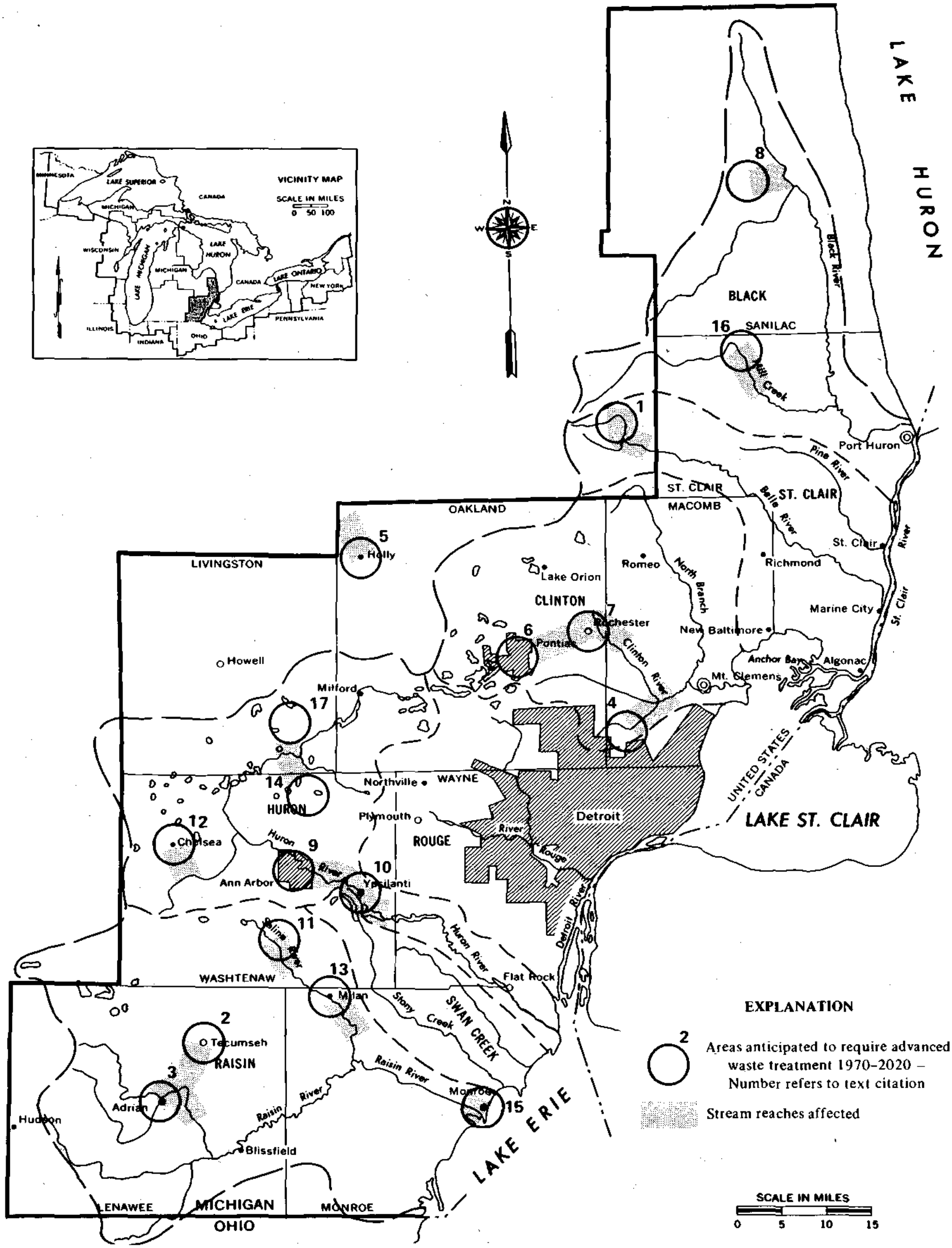


FIGURE 7–33 Planning Subarea 4.1, Advanced Waste Treatment Needs

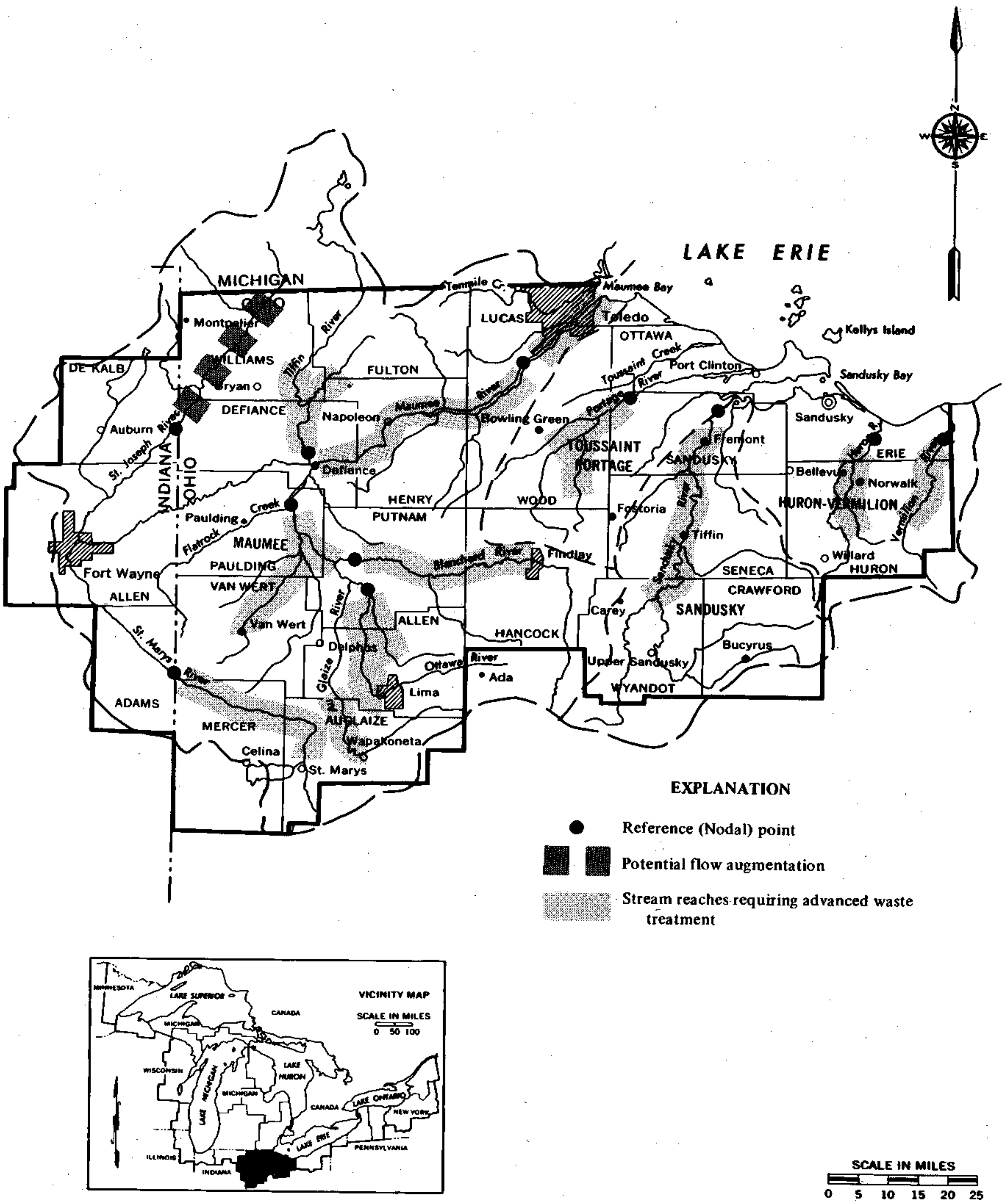


FIGURE 7–34 Planning Subarea 4.2, Wastewater Treatment Needs

of Ohio for some time. The Northwest Ohio Water Development Plan calls for a number of projects to increase the sustained flow throughout a number of basin streams. However, with the exception of the St. Joseph basin, the proposed sustained stream flow program is inadequate to meet the 8:1 dilution requirements established in the methodology for this appendix. Therefore, advanced waste treatment will be essential and should be installed in the first planning period.

Nodal reference points were also established for the Portage, Sandusky, Huron, and Vermilion River basins to investigate the pollutional loads and the effects of proposed projects to enhance stream flows. Agricultural wastes as well as municipal and industrial wastes plague the Portage and Sandusky watersheds. Inadequate treatment facilities for domestic wastes, combined sewer overflows, and large discharges from food processing industries tax the assimilative capacity of the receiving streams. There is little possibility of achieving adequate sustained flow from proposed project development in the Vermilion River basin to satisfy the waste flow projections for the 1970 to 1980 period. Advanced waste treatment is recommended throughout each of the principal basins cited above.

(2) Municipal Wastewater Treatment Costs

A summary of costs by planning periods has been derived following methodology established for this appendix. Capital costs, including new plant and replacement costs and annual operation and maintenance costs, are listed in Table 7–51 for Planning Subarea 4.2 in Ohio.

(3) Industrial Wastewater Requirements and Treatment Costs

Because little information is available on industrial wastewater flows and existing treatment facilities, the discussion of this aspect of the report is limited. However, gross costs were derived following the methodology guidelines by taking into account those industries involved in food processing (SIC 20), pulp and paper (SIC 26), and leather (SIC 31).

7.3.4.2 Indiana

The Indiana portion of Planning Subarea 4.2 contains the State's fourth most populous SMSA, centering around Fort Wayne, the State's second largest city. The diverse manufacturing in this area includes automotive parts, communications equipment, light manufacturing, and food processing. Projected levels of population and wastewater flows for this three-county area are presented in Table 7–52.

TABLE 7–52 Projections of Wastewater Flows and Population Served, Planning Subarea 4.2—Indiana Portion

Year	Subarea Population	Population Served by Municipal Facilities	Wastewater Flows (MGD) Municipal Treatment Facilities[a]	Industrial Treatment Facilities[b]
1970	339,186	226,507	37.3	4.0
1980	384,000	272,000	42.9	4.2
2000	482,000	482,000	54.3	4.2
2020	591,000	581,000	66.5	7.0

[a]Total of domestic, commercial, and industrial wastewater anticipated to be treated in municipal wastewater treatment facilities.

[b]Anticipated industrial wastewater discharges; includes both process and cooling water; based on self-supplied industrial water withdrawals less consumption.

Fort Wayne, Garrett, Auburn, and Decatur have existing needs for advanced waste treatment facilities. Smaller communities discharging wastes into low-flow ditches will be expected to provide facilities in the near future (Table 7–53).

TABLE 7–51 Projected Municipal and Industrial Wastewater Treatment Cost Estimates, Planning Subarea 4.2—Ohio Portion

Planning Period	Municipal Treatment Costs: Capital Costs ($ Million)	Municipal Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)	Industrial Treatment Costs: Capital Costs ($ Million)	Industrial Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)
Present–1980	52.0	6.6	11.0	1.2
1980–2000	96.0	8.6	6.6	1.2
2000–2020	121.0	10.4	10.1	1.4

TABLE 7–53 Areas Anticipated to Need Advanced Waste Treatment, Planning Subarea 4.2—Indiana Portion

Stream	Location	Period Required
Maumee River	Fort Wayne	1970–2020
Cedar Creek	Auburn	1970–2020
St. Marys River	Decatur	1970–2020
Garrett City Ditch	Garrett	1970–2020

Treatment cost estimates for the Indiana portion of Planning Subarea 4.2 are presented in Table 7–54.

TABLE 7–54 Projected Municipal Wastewater Treatment Cost Estimates, Planning Subarea 4.2—Indiana Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1970–1980	2.8	1.0
1980–2000	12.1	1.5
2000–2020	15.3	1.8

7.3.4.3 Michigan

The Michigan portion of Planning Subarea 4.2 contains no significant municipal or industrial wastewater discharges, nor is it likely to contain any within the projection period of this framework study.

7.3.5 Planning Subarea 4.3—Advanced Waste Treatment Needs

The Ohio portion of Planning Subarea 4.3 is composed of eight northeast Ohio counties which include the drainage basins of the Black, Rocky, Cuyahoga, Chagrin, Grand, Ashtabula, and Conneaut Rivers.

Eight nodal or reference points (Figure 7–35) were selected for the investigation of gross wastewater treatment needs in this heavily urbanized and industrialized region. Because program and project development are not as advanced for this planning subarea as in Planning Subarea 4.2, it is not always possible to consider flow augmentation either as a practical alternative to advanced waste treatment or in conjunction with advanced waste treatment.

In the Black and Rocky River basins the discharge of inadequately treated and untreated sewage seriously affects the recovery capabilities of the streams. Although several proposed projects should have marginal effects on water quality directly downstream, advanced waste treatment is required to achieve a satisfactory level of stream water quality.

The headwaters of the Cuyahoga River above Akron generally exhibit good water quality and serve as a source of public water supplies. However, quality degradation is caused by urban development in the Cleveland-Akron area. The river below Akron is seriously polluted. The lower reach serves as a navigation channel through Cleveland and exhibits gross amounts of oils, solids, and oxygen-consuming materials from both municipal and industrial discharges. Advanced waste treatment must be installed in this basin to reach suitable quality standards.

Advanced waste treatment is also necessary in the Chagrin, Grand, Ashtabula, and Conneaut River basins. Water quality in the upper reaches is higher than that in the lower, more densely developed areas. Municipal and industrial discharges in the lower reaches cause waters of diminished quality to reach Lake Erie.

7.3.5.1 Municipal Wastewater Treatment Costs

A summary of municipal wastewater treatment costs has been developed following the methodology established for this appendix. Capital costs, new plant and replacement costs, and annual operation and maintenance costs for Planning Subarea 4.3 in Ohio are presented in Table 7–55.

7.3.5.2 Industrial Wastewater Treatment Costs

Little information is available on the industrial wastewater flows and treatment needs for food processing, pulp and paper, and leather, the SIC categories under consideration. However, guided by the data prepared by the Water Supply Work Group the costs shown in Table 7–55 were developed for treatment of industrial wastewater flows in Planning Subarea 4.3 in Ohio.

There are relatively low investment needs for industrial wastewater treatment because much of the industrial discharge is processed by municipal systems.

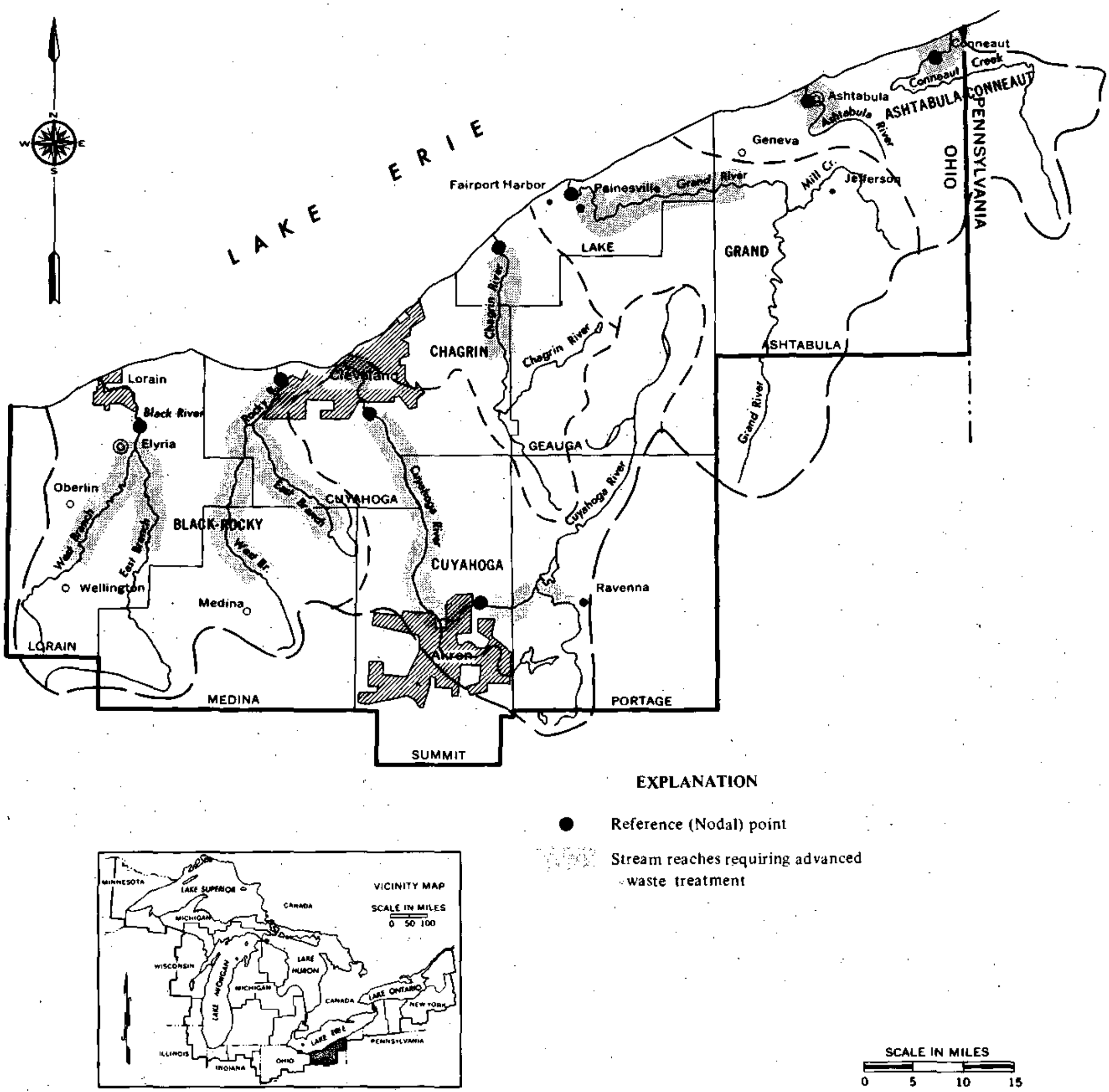


FIGURE 7–35 Planning Subarea 4.3, Wastewater Treatment Needs

TABLE 7–55 Projected Municipal and Industrial Wastewater Treatment Cost Estimates, Planning Subarea 4.3—Ohio

Planning Period	Municipal Treatment Costs: Capital Costs ($ Million)	Municipal Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)	Industrial Treatment Costs: Capital Costs ($ Million)	Industrial Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)
Present-1980	136.0	25.9	7.0	0.7
1980–2000	291.0	36.9	4.0	0.7
2000–2020	352.0	45.6	5.0	0.8

7.3.6 Planning Subarea 4.4

7.3.6.1 Major Streams—Pennsylvania

Pennsylvania streams in the Lake Erie basin are relatively small. Three degraded streams, Cascade Creek, Garrison Run, and Mill Creek, flow through Erie to the harbor and receive the city's combined sewer overflow.

Conneaut, Elk, and Sixteenmile Creeks all suffer from water quality degradation. Elk Creek receives discharges from Lake City, the Borough of Girard, and the Grennison Brothers Tannery. The tannery discharge also affects water quality in Brandy Run. Problems on Conneaut Creek stem principally from municipal waste discharges, and problems on Sixteenmile Creek are caused by both industrial and municipal waste discharges. Other streams are generally of good water quality.

7.3.6.2 Lake Proper

The Hammermill Paper Company and the City of Erie both discharge wastes into Lake Erie along the Pennsylvania shoreline. At least a 10:1 dilution is available in the existing diffuser for the City of Erie. The effect of both discharges on the beaches at Presque Isle State Park varies, depending on prevailing wind conditions. Several other beaches east of Erie are contaminated, and others are of unknown quality. Color, foam, algal problems, and objectional odors all contribute to the beach difficulties.

The waters in New York vary considerably. Some beaches on Lake Erie must be cleaned daily to prevent the accumulation of masses of rotting, foul smelling algae. Although bacterial contamination exists at a number of other bathing areas, some beaches are in fairly good condition.

7.3.6.3 Major Streams—New York

(1) Cattaraugus Creek

Industrial wastes heavy in organic loading from glue and tanning works compose approximately 70 percent of the total waste input in Cattaraugus Creek. The remaining 30 percent consists of municipal wastes. Of these wastes, slightly more than 50 percent receive only primary treatment, a small amount receive secondary treatment, and the rest receive none. The dilution ratio is estimated to be 4.0:1.0.

The last 20 miles of Cattaraugus Creek are grossly polluted. Discharges cause conditions which are in direct violation of New York State stream standards. Present uses include recreation, agriculture, fishing, industrial water supply, and sewage and industrial waste disposal. The most critical requirements for compliance with State stream standards are installation and expansion of municipal treatment facilities along this stream reach as well as upstream, and advanced waste treatment for industrial wastes.

(2) Eighteenmile Creek

There are no significant industrial discharges to Eighteenmile Creek. Most municipal wastes discharged into the stream receive secondary treatment, but these facilities are in need of expansion. Other municipal wastes, comprising approximately 35 percent of the total waste input to the creek, receive no treatment. In the lower reaches, where pollution is greatest, fishing, recreation, and sewage disposal are the present uses. Here the dilution ratio may sink to 1.4:1.0 during critical periods. Above Hamburg present uses include fishing, agriculture, and water supplies. Advanced waste treatment is needed along the entire stream to improve conditions in the lower half.

(3) Buffalo River and Tributaries

There are no significant industrial discharges to Cayuga, Buffalo, and Cazenovia Creeks, which form the Buffalo River. Primary and secondary treatment are provided for most municipal wastes discharged into Cayuga Creek, but these facilities need upgrading. The creek is grossly polluted in its lower reaches where agriculture and waste disposal are the principal uses. Conditions here are in violation of State standards.

Although the Buffalo Creek tributary has an unfavorable dilution ratio, most of its wastes receive adequate treatment. During periods of normal flow its waters may reach compliance with State stream standards for trout above the Town of Elma where agriculture and fishing are principal uses. Below Elma to its confluence with Cayuga Creek, principal uses of Buffalo Creek are bathing, fishing, and agriculture.

Approximately 40 percent of municipal wastes discharged into Cazenovia Creek receive adequate treatment. However, the stream is grossly polluted for much of its length below the confluence of the East and West Branches. Present uses along this reach include sewage disposal, bathing, fishing, and agriculture.

Low-flow dilution ratios may reach 0.2 on Cayuga Creek, 3.3 on Buffalo Creek, and 1.5 to 1.0 on Cazenovia Creek. For all three streams advanced waste treatment is a practical method to achieve satisfactory water quality during critical periods and to bring grossly polluted reaches within stream standards. Low-flow augmentation should also be considered a practical alternative on Cazenovia Creek.

The Buffalo River has only one significant municipal discharge, but its quality reflects the load from its tributaries. The Buffalo River also receives an extremely heavy industrial discharge principally from oil and steel companies. Although most of the load is cooling water, a heavy organic load also exists. Oil films can be observed most of the time, and sewer overflows are a major problem. During critical periods the low-flow dilution ratio may go as low as 0.3:1.0. This includes a 100 mgd flow augmentation by industry during such periods.

Practical solutions to the needs of this basin include municipal advanced waste treatment on the three tributary streams as well as a high degree of industrial advanced waste treatment. These should be combined with present flow augmentation and the elimination of combined sewer discharges on the Buffalo River itself. Increased flow augmentation on the Buffalo River is not a feasible solution. Although the river is basically a small stream, its lower reach has been dredged to such a degree that an impractical amount of flow would have to be added to present augmentation to achieve a beneficial river flow through this slow-moving area. However, flow augmentation is feasible for the tributaries.

(4) Scajaquada Creek

During critical periods the low-flow dilution ratio for Scajaquada Creek may drop to 0.2:1.0. More than 80 percent of its total waste load is municipal wastes. Although almost all these municipal wastes receive secondary treatment, the treatment needs upgrading. Scajaquada Creek exhibits degradation to a variable degree throughout its length, resulting in violation of State stream standards. Its lower reach is augmented by Buffalo city water during low-flow periods, but it remains grossly polluted with periodic oil films. Advanced waste treatment for municipal and industrial wastes is the most critical need in this basin.

(5) Twomile Creek

Industrial, sanitary, and storm wastes cause objectionable conditions throughout Twomile Creek. A large portion runs through an underground conduit, but an open section flows through recreational facilities. Advanced waste treatment is needed for industrial and municipal wastes. The increased diversion of industrial cooling water to the stream would also improve water quality.

(6) Tonawanda and Ellicott Creeks

The discharge of inadequately treated and untreated municipal wastes seriously affects the recovery capabilities of Tonawanda and Ellicott Creeks during periods of low flow. There are no significant industrial discharges to Ellicott Creek and those to Tonawanda Creek amount to only approximately 10 percent of the total waste load. Although most municipal wastes discharged into Tonawanda Creek receive secondary treatment, the treatment facilities should be expanded. Some may require tertiary treatment.

The waste flow dilution ratio on Tonawanda Creek may fall to 0.8:1.0 during critical periods. Critical periods usually occur during navigation season when the New York State Barge Canal is open, diverting the Tonawanda Creek flow from the Niagara River to the canal where it flows east. This may have a marked effect on the quality of the canal's waters.

Tonawanda Creek is polluted to a variable degree throughout most of its length. Principal uses include fishing, recreation, water supply, and sewage disposal. State standards are violated throughout its length except for the reach upstream from the Town of Attica where the stream approaches a natural condition.

Advanced waste treatment is needed for industrial wastes and, more critically, for municipal wastes discharged into this stream.

Most municipal discharges to Ellicott Creek receive secondary treatment but facilities should be expanded or upgraded to include tertiary treatment. A choking stream-flow waste-flow dilution ratio of 0.1:1.0 sometimes occurs during critical conditions. The stream is highly enriched throughout much of its length during normal flow. It begins to approach a natural condition only above the Village of Alden. Principal uses include drainage and sewage disposal in the lower reaches and fishing and recreation upstream where water quality improves. State standards are violated along the entire stream length except for the portion above Alden where present usage is almost optimum.

The poor conditions on the lower reaches of Ellicott Creek are primarily caused by the inadquately treated 8.0 mgd discharge from Amherst's Sewer District 1. This waste load will be transferred to Tonawanda Creek through Amherst Sewer District 16 which will be expanded and upgraded. This project, now partially completed, will remove nearly all municipal discharges from Ellicott Creek within the current planning period. Although major discharges to the creek will be eliminated, the remaining small discharges will cause quality problems during low-flow periods. Flow augmentation is a feasible solution to this problem. Construction of a multipurpose reservoir near Alden has been proposed. The reservoir would control flooding conditions on the heavily populated flood plain and augment stream flow during critical periods. Water in this reservoir would be of relatively good quality because it would come from the headwaters of Ellicott Creek.

(7) Niagara River

More than 1,400 mgd of municipal and industrial wastes are discharged into the Niagara River from both tributary and direct discharges along the United States shore. This figure includes only discharges from the Niagara River portion of Planning Subarea 4.4. It does not include discharges from the Canadian shore and numerous industrial and municipal discharges from the Niagara Falls area.

The Niagara's flow is fairly constant throughout the year. Low flows are approximately 150,000 cfs and maximum flows are 220,000 cfs or more. According to estimates, the 7-day 10-year low flow is approximately 168,000 cfs. This results in a low flow/waste flow dilution ratio of approximately 76:1.

Approximately 35 percent of the total wastes discharged into the river are from the tributaries discussed above. The remainder, and by far the largest percentage, is discharged directly, with industrial wastes composing approximately 80 percent of this direct discharge by volume. Most direct municipal discharges receive only primary treatment. However, nearly all municipalities with only primary treatment are finishing pilot plant studies and preparing final construction plans for secondary treatment with phosphorus removal.

State stream standards are violated in isolated areas by specific discharges throughout the Niagara's length in Planning Subarea 4.4. Areas with oil films, discoloration, and excessive phenols and coliforms occur mainly along the U.S. shore. Uses include public and industrial water supply, municipal and industrial waste disposal, fishing, and navigation.

The few treatment plant projects that have been completed have produced localized improvements in water quality. However, the overall quality of the river water has improved only slightly. A noted improvement in water quality will not occur until most of the planned treatment plants are in operation. Overall improvement is also related to improved conditions on the upper Great Lakes.

7.3.6.4 Waste Loads

It was necessary to compile waste flows for each municipality and industry in the planning subarea to arrive at treatment costs. These values were used in lieu of the water supply reports prepared by the Water Supply Work Group. However, a comparison of data was made for Planning Subarea 4.4 and there was reasonable correlation. In arriving at projected values the relationships established in the water supply report were maintained between present and projected waste loads. (Table 7–56).

TABLE 7–56 Waste Loads (MGD), Planning Subarea 4.4—New York and Pennsylvania

Year	Municipal[1] ($ Million)	Industrial[1] ($ Million)
1970	268	1,067
1980	294	942
2000	359	627
2020	445	767

[1]Estimate was made by the Rochester Field Office of the Environmental Protection Agency.

7.3.6.5 Advanced Waste Treatment Needs

Although advanced waste treatment, low flow augmentation, and the combination of these methods were briefly discussed in preceding paragraphs, this subsection summarizes the more pressing needs. Determination of these needs was based only in part on the dilution ratios which were developed strictly in accordance with procedures outlined in the methodology. The needs were also projected by evaluating existing water quality and present or anticipated water uses as described by stream standards.

Dilution ratios were not altered to reflect variations in stream assimilation capacities or the difference in stream standards. The ratios merely reflect total municipal and industrial organic waste flows at the selected nodal points. However, stream assimilation capacities and differences in stream standards were considered in the final determination of needs. With only a few exceptions, minimum flows used for dilution ratios were roughly approximated. Some minimum average seven-consecutive-day flows with a recurrence interval of once in 50 years were available for different locations on several streams and were used as a check for the rough estimates.

Present and future needs are summarized in Table 7–58. Figure 7–36 shows selected advanced waste treatment nodal points and zones of quality impairment.

7.3.6.6 Treatment Costs

Costs are presented separately for the State of New York and the Commonwealth of Pennsylvania, because the basic assumptions and considerations differ.

All cost estimates for New York State are based on the two reports prepared by Robert Smith of the Federal Water Quality Administration. Basic treatment is considered to include the activated sludge process, effluent chlorination, year-round coagulation and sedimentation with lime, and recalcination of the lime. Advanced waste treatment includes granular carbon adsorption and ammonia stripping processes. Project life is considered to be 25 years. Capital costs also include considerations of salvage value for existing plants and major repair costs. In general these costs are conservative estimates, which do not reflect planning or design costs and possible industrial recirculation cost (Table 7–57).

Industrial costs for the New York portion were prepared only for industries with effluents containing a large organic load. Estimates were also made for industries that now plan to use municipal facilities and for a percentage of industries that will probably use municipal facilities in the middle period. These costs include major industrial wastes from food processing and paper manufacturing. Other industrial wastes costs are not included. (See Tables 7–59 and 7–60.)

TABLE 7–57 Projected Municipal and Industrial Wastewater Treatment Cost Estimates, Planning Subarea 4.4—New York

Planning Period	Municipal Treatment Costs: Capital Costs ($ Million)	Municipal Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)	Industrial Treatment Costs: Capital Costs ($ Million)	Industrial Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)
Present–1980	148	10.5	191	8.3
1980–2000	42	5.6	61	5.6
2000–2020	83	7.2	97	5.2

TABLE 7-58 Present and Future Treatment Needs, Planning Subarea 4.4

Stream	Dilution Ratio	Needs	Other	Remarks
Conneaut Creek (Pa.)	6:1	AWT and LFA Both required	---	Low flow augmentation necessary to control high natural summer temperature and spawning flow for salmon in the fall.
Elk Creek	1:1	AWT and LFA Both required	---	Same as above.
Walnut Creek	5:1	AWT	Phosphorus removal as third stage process should be satisfactory.	It is anticipated discharges will be diverted to regional plant after 1980.
Sixteenmile Creek	0.2:1	AWT	---	Presently set up for regional plant at mouth of stream to provide AWT.
Cattaraugus Creek (N.Y.)	4:1	AWT and LFA	---	Suitable site is available for multi-purpose reservoir development.
Eighteenmile Creek	1:1	AWT	---	Immediate need for almost all dischargers.
Cayuga Creek	0.2:1	AWT	---	Requires upgrading of existing municipal facilities.
Buffalo Creek	3:1	AWT	---	Requires primarily upgrading of existing facilities.
Cazenovia Creek	2:1	AWT and LFA	---	Suitable site is available for multi-purpose reservoir development.
Buffalo River	0.3:1	AWT	Correction of combined sewer overflows, oil, solids, phenols, toxic wastes and color problems, continuation of flow augmentation from Lake Erie by industry.	Improvement also closely related to correction of problems on Cayuga, Buffalo and Cazenovia Creeks.
Scajaquada	0.2:1	AWT	Continue minor augmentation with Buffalo city water.	Immediate need for upgrading of existing treatment.
Twomile Creek	--	AWT	Possibility of improvement through increased diversion of industrial cooling water.	AWT is required for both municipal and industrial waste discharges.
Tonawanda Creek	0.8:1	AWT and LFA Both required	Flows during critical period are supplemented by a diversion from the Niagara River for navigation on the Barge Canal.	Immediate need is for AWT; however, both may be required sometime within the study period. A suitable site is available for reservoir development.
Ellicott Creek	0.1:1	AWT and LFA Both required	Current proposals are to remove waste discharges from Town of Amherst and transfer to Tonawanda Creek.	Low flow augmentation would be useful if for no other reason than to improve the esthetics of the lower reach through a large residential and recreational area. A suitable site is available.
Niagara River	76:1	---	All municipal and industrial wastes should have phosphate removal.	Achievement of secondary treatment or the equivalent for all direct and tributary discharges should resolve water quality problems.

LEGEND: AWT Advanced Wastewater Treatment LFA Low Flow Augmentation

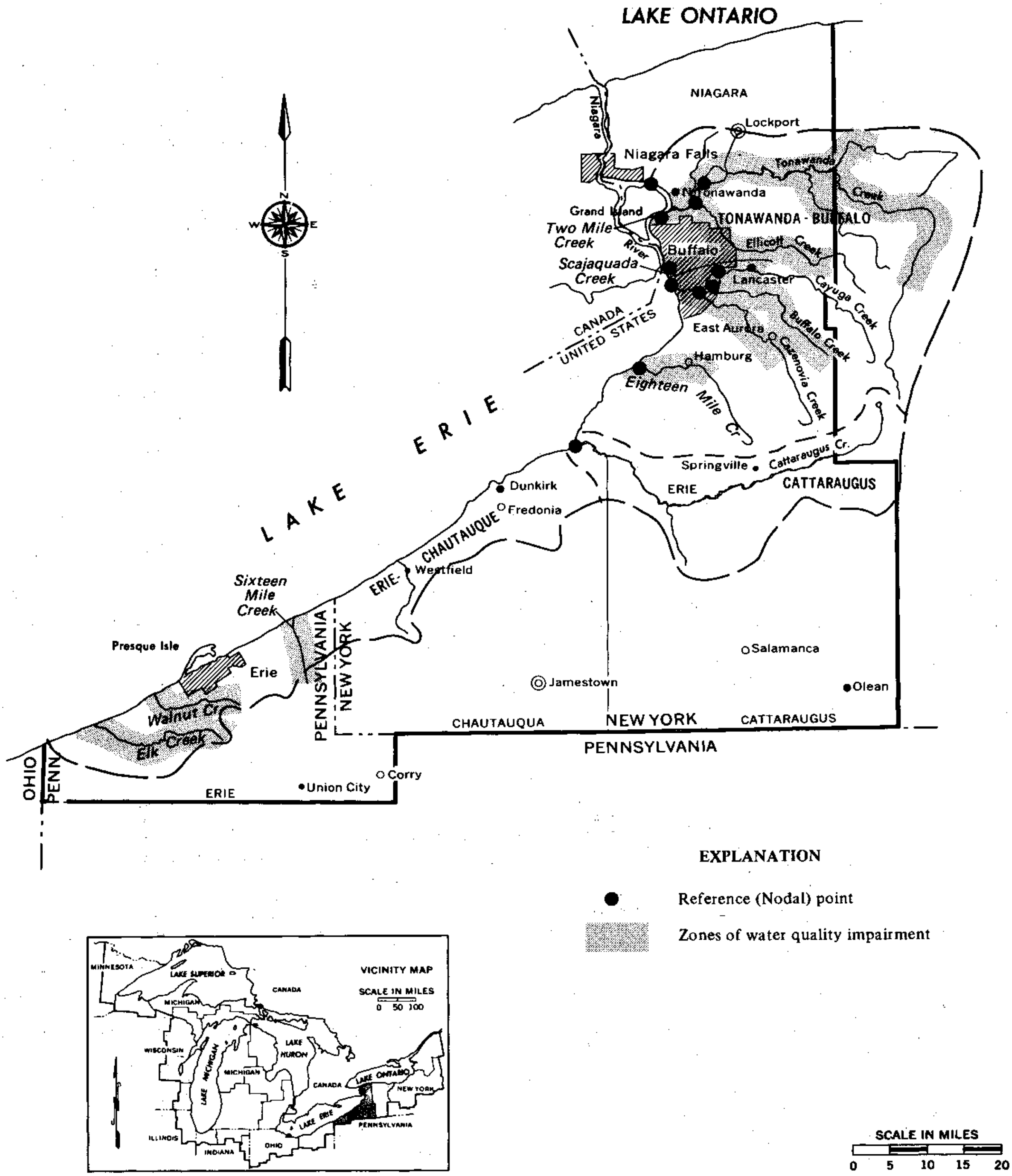


FIGURE 7–36 Planning Subarea 4.4, Wastewater Treatment Needs

TABLE 7-59 Treatment Costs for Stream Discharges, Lake Erie—Pennsylvania Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1980	2.2	0.1
2000[1]	1.3 (4.3)	0.1
2020	---[2]	0.1

[1]Expansion costs only. The $4.3 million would include two deep-water outfalls.

[2]Included in discharge to Lake Erie.

NOTE: Costs do not include value of present facilities.

Total replacement costs. Deep-water outfall not included.

TABLE 7-60 Treatment Costs, Lake Erie—Pennsylvania Portion

Planning Period	Capital ($ Million)	Ave. Annual Operating and Maintenance Costs ($ Million)
1980	22.6	0.8
2000[1]	8.9	1.1
2020	58.5	1.9

[1]Expansion costs only.

NOTE: Costs do not include value of present facilities.

7.3.6.7 General

Considerable time and effort has already been expended on planning solutions to water quality problems within Planning Subarea 4.4. In New York comprehensive county sewage studies are already complete or nearing completion. The State of New York, assisted by several Federal agencies, has completed a comprehensive water resources study, comparable to a Type II study, for almost the entire portion of Planning Subarea 4.4. At a more technical level, pilot plant studies are under way or complete for the major municipalities in New York. As a result of comprehensive planning, numerous regional plants are proposed both in the New York and Pennsylvania portions of the planning subarea.

Work still remains to integrate many of the localized efforts into a realistic and economical plan for solving the long-range problems of the Great Lakes as a whole.

A number of specific proposals directly related to Planning Subarea 4.4 may lead to a resolution of persistent long-range problems and the avoidance of other potential problems.

One proposal calls for strengthening the monitoring and surveillance role of an established international body such as International Joint Commission, or establishing a new body that can achieve prompt and uniform decisions on water quality problems that affect both the Canadian and U.S. shores of Lake Erie and the Niagara River.

Dissolved oxygen and temperature are critical parameters in the upland reaches of many area streams, because standards designate trout fishing as the best usage. Although advanced waste treatment is often adequate further downstream, low-flow augmentation or a combination of methods is often the only solution on these headwater trout streams. Streams with potential development sites were noted in the tables listing needs.

Algal problems plague the planning subarea and extend far beyond its boundaries. A key to resolution of these problems will be the adoption of a uniform phosphorus removal policy at all levels of government. This should include phosphate reductions at treatment plants and elimination of phosphates in widely distributed products such as detergents, which may never pass through treatment plants but reach the lakes directly. The issue of phosphates requires further research. Test results with detergents suggest that nonphosphate detergents can be used in most laundries without noticeable change in consumer satisfaction. Research, however, is necessary to insure that nonphosphate detergents will be as safe for the user and the environment.

An intermediate need is use of onshore diked areas for dredgings.

There is an immediate need for extensive investigation of several present and proposed activities to determine their potential harm to the environment. Two such activities are deepwell injection and oil and gas well drilling in Lake Erie.

7.3.6.8 Other Pollution Sources

Other pollution sources include untreated and inadequately treated wastes from watercraft, including both commercial ships and pleasure boats; runoff from rural and urban land including residues from the application of chemicals, fertilizers, and pesticides; thermal pollution; and disposal of dredged material.

7.4 Summary and Conclusions

Lake Erie has a water surface area of 9,910 square miles including 4,980 square miles in the United States. Lake St. Clair, also within the Lake Erie plan area, has a water surface area of 430 square miles including 162 square miles in the United States. The total drainage basin of Lake Erie, including land and water, is 33,500 square miles, including 23,600 square miles in the United States portion. Except for the 6,586 square-mile Maumee River basin, the tributary system consists of relatively small drainage areas flowing into the Lake system. Major drainage systems are indicated later in the discussion of planning subareas.

The total United States population of the Lake Erie basin was 11.4 million in 1970. There are several large concentrations of population and industry including Detroit, Michigan; Fort Wayne, Indiana; Akron, Cleveland, and Toledo, Ohio; Erie, Pennsylvania; and Buffalo, New York. The chief manufactured products are automobiles, fabricated metals, primary metals, rubber, food, petroleum, chemicals, and paper. Agricultural production is concentrated in the western part of the basin, primarily in Planning Subarea 4.2, which includes the Maumee River basin.

The major State agencies dealing with water quality control are the Water Resources Commission and the Department of Health in Michigan; the Department of Health, the Ohio Environmental Protection Agency, and the Department of Natural Resources in Ohio; the Indiana Stream Pollution Control Board in Indiana; the Sanitary Water Board and the Department of Health in Pennsylvania; and the State Department of Environmental Conservation in New York.

Under provisions of the Water Quality Act of 1965 each State in the Lake Erie basin has adopted water quality standards for its interstate waters.

The two major zones of substandard water quality in the Michigan portion of Lake Erie occur at the mouths of the Detroit and the Raisin Rivers. These waters have high coliform densities and exhibit other undesirable concentrations, including suspended solids, nutrients, oils, toxic materials, and phenols. The chemical quality of Lake Erie at the Ohio water treatment plant intakes is within the criteria limits for public water supplies. Water quality in Ohio beach areas is significantly influenced by local lake currents, surrounding topography and land uses, proximity to tributary streams, and the discharges of sanitary sewage, industrial wastes, and stormwaters. In addition to high bacterial counts, other objectionable characteristics of some bathing areas are debris, oil, sediment, color, and algae. The Pennsylvania Lake Erie open waters are generally 200 yards or more offshore, except for Erie Harbor and Presque Isle Bay.

The quality of these waters is suitable for water contact sports, navigation, recreational boating, and withdrawal uses following adequate treatment. Municipal water use requires coagulation, sedimentation, filtration, and chlorination. The major problems of the open waters are related principally to eutrophication of the Lake. Shoreline water quality is generally poorer than offshore water quality. Total coliform counts are higher than the open waters due to direct discharges and tributary inputs. Most natural beach areas on the Pennsylvania shoreline are located at tributary mouths. Protection of shoreline waters to permit maximum recreational development is needed and continual protection of the existing Presque Isle beaches is urgent. Water quality in Lake Erie is affected by a large steel industry located on its shores near Buffalo, New York. The company is committed to a large construction program for elimination or reduction of wastes. Heavy growths and accumulations of the attached algae *Cladophora* have been a nuisance along the Lake Erie waterfront.

7.4.1 Planning Subarea 4.1

Planning Subarea 4.1 includes the portion of Lake Erie within Michigan, the Detroit River, Lake St. Clair, the St. Clair River, and tributaries, including the Belle, Black, Clinton, Huron, Raisin, and Rouge Rivers. Population of the planning subarea was 4.8 million in 1970, more than half the total population of the State.

The upper 10 miles of the Detroit River, from Lake St. Clair to the junction of the Rouge River, is substandard in quality due to high coliform densities and iron concentrations. The lower 20 miles of the Detroit River, from the junction of the Rouge River to Lake Erie, is even lower in water quality. This reach receives effluents from six municipal and one Federal sewage treatment plants, 29 industries and commercial enterprises, stormwater overflows, and tributary discharges. Detroit's main sewage treatment plant, located at the confluence of the Detroit and Rouge Rivers, serves more than 90 percent of the people in the Detroit area and imposes a tremendous waste load on the river. A substantial amount of waste is also contributed by the flow of the Rouge River. This reach of the Detroit River displays excessive levels of coliforms, phenols, toxic substances, nutrients, suspended solids, and resins. Objectionable color, oil, and debris are also present.

Throughout the Raisin River basin, surface waters are high in nutrients and dissolved and suspended solids, with concentrations increasing towards the mouth of the river. A major substandard reach is located in the lower three miles of the river and there are many other substandard reaches. The river exhibits severe oxygen depletion, very high coliform densities, and excessive concentrations of residues, toxics, nutrients, and suspended and dissolved solids.

The main stem of the Huron River from the Ann Arbor treatment plant 40 miles downstream to the mouth is substandard because of excessive nutrient concentrations. Thirteen reaches in the basin are substandard in one or more quality parameters in addition to nutrients.

The Rouge River is wholly contained within the intensely urbanized and industrialized Detroit metropolitan area. Twenty-eight industries use the basin's surface waters for waste assimilation. There are no municipal treatment plant discharges in the Rouge River basin. The lower 15 miles of the river and middle Rouge River are severely degraded. In upper portions of the Rouge River high nutrient levels are common.

Lake St. Clair receives the full discharge of the St. Clair River, the Clinton River, and other small tributaries, and its water quality is directly related to these inflows. Water quality throughout the St. Clair River is generally excellent. The Clinton River is seriously degraded. During summer natural streamflow is very small and waste treatment plant effluents constitute a major portion of streamflow. Except for nutrients and minerals, the effects of the Clinton River are largely confined to an area near the river's mouth.

Water quality is generally good throughout the Belle, Black, and Pine Rivers, but there are reaches of substandard quality.

Seventeen areas in Planning Subarea 4.1 will probably require advanced waste treatment in the 1970 to 2020 period. Twelve of these needs fall within the 1970 to 1980 period. The total of domestic, commercial, and industrial wastewater treated in municipal wastewater treatment facilities is expected to increase from a 1970 base of 897 mgd to 992 mgd by 1980, and to 1,556 by 2020. Industrial wastewater treated in industry-owned wastewater treatment facilities is expected to decline from a 1970 base of 746 mgd to 504 mgd by 1980, and 255 mgd by 2020. Projected municipal wastewater treatment capital costs are estimated to be $700 million in the 1970 to 1980 period, $300 million in the 1980 to 2000 period, and $375 million in the 2000 to 2020 period. Average annual operating and maintenance costs are expected to increase from $45 million in the 1970 to 1980 period to $70 million in the 2000 to 2020 period.

7.4.2 Planning Subarea 4.2

Planning Subarea 4.2 includes 30 counties in Ohio and three counties in Indiana. (A small part of the State of Michigan is included in the hydrologic area of the Maumee River basin.) The population of the planning subarea was 1.7 million in 1970. The area includes the major population and industrial centers of Toledo, Lima, and Sandusky in Ohio, and Fort Wayne, Indiana. Of the 15 planning subareas in the Great Lakes Basin, the area ranks first in the value of farm products. It also ranks first in the mean average annual rates of gross erosion. The area includes the basins of the Maumee, Toussaint, Portage, Sandusky, and Huron-Vermilion Rivers.

Waters of the Michigan tributaries of the Maumee River are generally of good quality. A considerable nutrient load is contributed to the Maumee River from the Fort Wayne area and coliform counts are high below Fort Wayne. In the Ohio portion of the Maumee low concentrations of dissolved oxygen occur in a number of stream stretches. This is caused primarily by the oxygen demand of the discharge from municipal waste treatment facilities. Bacterial counts are highest downstream from the major communities. They are also high upstream from the Toledo wastewater treatment plant due to the effects of seiches from Lake Erie. Profuse growths of algae, high concentrations of settleable solids, and turbidity give most basin streams an objectionable appearance. Land treatment measures to reduce erosion and sedimentation should be a prime consideration for water quality improvement in this planning subarea.

Low concentrations of dissolved oxygen occur below Bowling Green and Oak Harbor on the Portage River; below Upper Sandusky, Carey, Tiffin, and Fremont on the Sandusky River; below Willard and Norwalk on the Huron River; and at several other locations. The highest bacteria counts occur in the Portage and Sandusky Rivers and in Pipe Creek.

The present wastewater flow of the Maumee River basin is estimated to be 145 mgd including 102 mgd with significant organic loads discharged in the Toledo area. The inland wastewater flow of 43 mgd comprises more than one-eighth of the 7-day 10-year low flow of the tributary streams at each of the established nodal points. On the basis of flow, advanced waste treatment is required throughout the entire basin before 1980. Advanced waste treatment and agricultural pollution control is or will be necessary throughout the Portage, Sandusky, Huron, and Vermilion River basins.

In the Ohio portion of Planning Subarea 4.2 projected municipal wastewater treatment capital costs are estimated at $52 million in the 1970 to 1980 period, $86 million in the 1980 to 2000 period, and $121 million in the 2000 to 2020 period. Average annual operating and maintenance costs are estimated at 13 percent of capital costs in the 1970 to 1980 period and less than 10 percent in the later periods.

In the Indiana portion of Planning Subarea 4.2 projected municipal wastewater treatment capital costs are estimated at $2.8 million in the 1970 to 1980 period, $12.1 million in the 1980 to 2000 period, and $15.3 million in the 2000 to 2020 period. Average annual operation and maintenance costs range from $1.0 million in the 1970 to 1980 period to $1.8 million in the 2000 to 2020 period.

The Michigan portion of Planning Subarea 4.2 contains no significant municipal or industrial wastewater discharges, nor are any considered likely within the projection period of this framework study.

7.4.3 Planning Subarea 4.3

Planning Subarea 4.3, which consists of eight counties in Ohio, had a 1970 population of approximately 3.1 million. The major cities are Cleveland, Akron, and Lorain. Manufacturing is substantial and diverse. There are more than 2,800 manufacturing plants in Cleveland, including large primary steel mills and chemical plants. Rubber and plastic products manufacturing are major industries in Akron. The principal basins are the Black-Rocky, Cuyahoga, Chagrin, Grand, and Ashtabula-Conneaut River basins.

The discharge of inadequately treated and untreated sewage in the Black and Rocky River basins seriously affects the recovery capabilities of these streams. Advanced waste treatment is required to achieve a satisfactory level of stream water quality. The Cuyahoga River below Akron is seriously polluted. The lower region, forming the navigation channel through Cleveland, exhibits gross amounts of oil, solids, and oxygen-consuming materials stemming from municipal and industrial discharges. Advanced waste treatment is necessary in this basin to reach suitable quality standards. Municipal and industrial discharges into the Chagrin, Grand, Ashtabula, and Conneaut River basins result in waters of diminishing quality reaching Lake Erie. Advanced waste treatment is also necessary in these basins.

Projected municipal wastewater treatment capital costs are $136 million in the 1970 to 1980 period, $291 million in the 1980 to 2000 period, and $352 million in the 2000 to 2020 period. Average annual operating costs are estimated at 19 percent of capital costs during the 1970 to 1980 period, and are projected to decline to 13 percent in the later periods.

7.4.4 Planning Subarea 4.4

Planning Subarea 4.4 includes Erie County in Pennsylvania and the New York counties of Cattaraugus, Chautauqua, Erie, and Niagara. In 1970 the population of the planning subarea was approximately 1.8 million. Major industries in the area include food products, basic chemicals and plastics, paper and paperboard, steel and iron, fabricated metals, and general industrial machinery.

The Pennsylvania tributaries are small and the largest, Conneaut Creek, has a drainage area of 154 square miles in Pennsylvania. The New York State portion of the Lake Erie basin has a total drainage area of 1,776 square miles. The three largest tributaries in terms of drainage area and stream flow are the Buffalo River, Tonawanda Creek, and Cattaraugus Creek. Generally streams in the area are not capable of an appreciable sustained flow, but Cattaraugus Creek is a major exception.

The lower five miles of the Buffalo River are severely degraded by major municipal and industrial waste discharges. High ammonia, phenol, and chloride concentrations are present.

The total of domestic, commercial, and industrial wastewater treated in municipal wastewater treatment facilities is expected to increase from a 1970 base of 268 mgd, to 294 mgd by 1980, and 445 mgd by 2020. Industrial wastewater treated in industry-owned wastewater treatment facilities is expected to decline from its 1970 base of 1,067 mgd to 942 mgd by 1980, and 767 mgd by 2020. For the State of New York projected municipal wastewater treatment costs are estimated at $148 million in the 1970 to 1980 period, $42 million in the 1980 to 2000 period, and $83 million in the 2000 to 2020 period.

Section 8

LAKE ONTARIO

8.1 Introduction

8.1.1 Purpose

This section provides a concise description of the present and projected water quality and water usage in the Lake Ontario basin. It also describes the economic alternatives to meet increased demands for water quality.

8.1.2 Scope

This section reviews established water quality standards and appraises the effectiveness of present treatment and disposal practices for waterborne waste. It outlines water quality control needs under existing development, and indicates alternative measures. Economic projections and water-use data are translated into accompanying waste loads to determine needs for waste treatment or other measures, under conditions of development projected for 1980, 2000, 2020. The urgency of water quality problems in each planning subarea is indicated and general cost estimates for broad components of the required actions are given. The section describes stream reaches where increased low flows and/or decreased waste load inputs are needed for water quality improvements.

8.1.3 Basin Description

The study area for the Lake Ontario basin encompasses the United States drainage area of the Lake, including the U.S. portions of the Niagara and St. Lawrence Rivers from Niagara Falls, New York, on the west, to the international boundary line on St. Regis Point (Figure 7-37). Within the Lake Ontario basin are the Niagara, Genesee, Oswego, and Black-St. Lawrence River basins.

Major urban centers, all in New York State, include the Cities of Niagara Falls, Rochester, Syracuse, Geneva, Ithaca, Auburn, Oswego, Watertown, and Ogdensburg.

The 24,700 square miles of drainage area immediately tributary to Lake Ontario is almost equally divided between Canada and the United States. The St. Lawrence River is the natural outlet for the total drainage of the Great Lakes Basin. The river's flow is remarkably steady because of the natural regulatory influence of the Great Lakes.

The mean inflow to the Lake from the Niagara River is 203,000 cfs, and the mean outflow from the Lake to the St. Lawrence River is 241,000 cfs.

Population figures for the Lake Ontario basin in 1970 revealed that 2.5 million persons lived on the United States side of the basin. The greatest population is in an arc at the western end of the Lake from the Niagara Frontier, through the western end of Lake Ontario, to just east of Oshawa, Ontario, Canada.

The United States section of the drainage basin lies almost entirely within the State of New York and contains portions of 21 New York counties.

The New York State portion of the Lake Ontario-St. Lawrence River basin includes 158 tributaries, draining an area of 34,800 square miles. Except for a small portion of the Genesee River basin in Pennsylvania the entire United States part of the basin is located in New York State.

Figure 7-37 indicates boundaries of the Lake Ontario basin.

8.1.4 Water Uses

8.1.4.1 Municipal Water Supply

Municipal water supply systems use approximately 300 million gallons daily (mgd), and serve a population of approximately two million. Lake Ontario is by far the largest source for municipal water supply, with more than 110 million gallons drawn daily, mostly by the

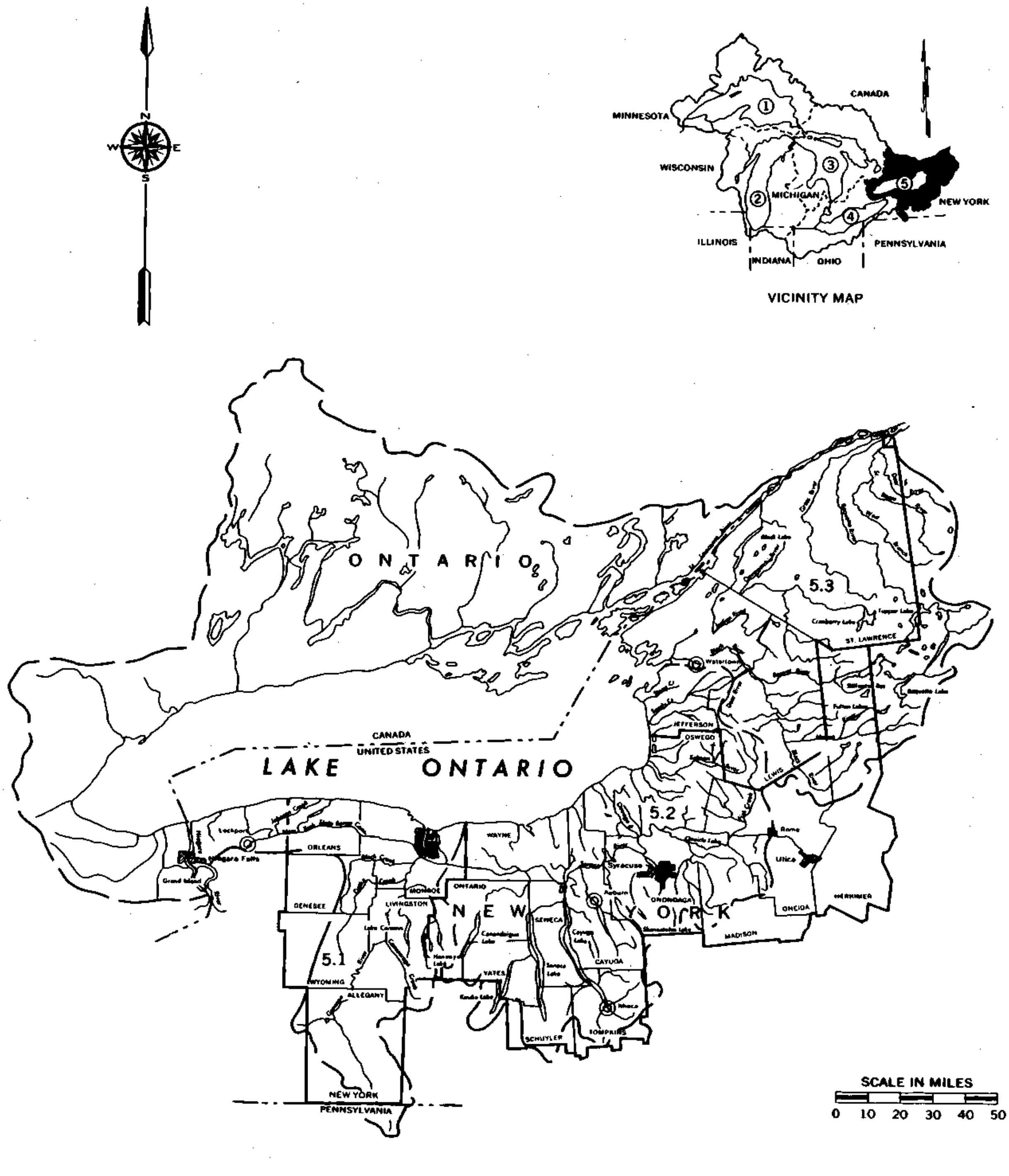


FIGURE 7–37 Lake Ontario Basin—Plan Area 5

Cities of Rochester, Syracuse, and Oswego. The Cities of Niagara Falls and Lockport draw more than 70 mgd from the Niagara River. In addition the Finger Lakes are used extensively for water supply.

8.1.4.2 Industrial Water Supply

The water use by industries with private supplies is estimated to be approximately two billion gallons per day. Of this total approximately 1.5 billion gallons are used by steam generating electric power utilities including 0.3 billion gallons drawn from Lake Ontario. Of the remaining 0.5 billion gallons only 30 mgd are drawn from Lake Ontario. Other industrial water supply sources are the Niagara River (170 mgd, for chemical, paper, and metals producers), Cayuga Lake (270 mgd, mostly for thermal electric generation), Seneca Lake (approximately 200 mgd, for thermal electric generation and salt refining), Onondaga Lake (approximately 100 mgd, for a chemical and steel producer), the Black River (approximately 75 mgd for pulp and paper mills), and the St. Lawrence River (approximately 35 mgd, for a paper mill and three aluminum processing plants).

8.1.4.3 Hydroelectric Power

A total of 88 hydroelectric plants with a capacity of more than 3,600,000 MW are located on streams throughout the Lake Ontario basin. Approximately 85 percent of this total capacity, 3,100,000 MW, is available at the two New York Power Authority sites on the Niagara and St. Lawrence Rivers.

8.1.4.4 Recreation

Natural resources of the Lake Ontario basin and the United States St. Lawrence River basin are excellent for recreational use and development. The area has cool summers, inland lakes, sandy beaches, inland watercourses, glens and waterfalls, mountains and forests, making it one of the most popular outdoor recreation areas of the country. The Adirondacks Preserve, the Barge Canal System, the Finger Lakes region, and the Thousand Islands are all popular recreational areas.

More than one-third of a million acres of water and land are available for outdoor recreation at more than 350 areas in the basin. Approximately 80 percent of these areas have water-dependent facilities.

The Finger Lakes region is the most widely used recreational region in the basin, followed by the area along the Lake Ontario shoreline. There are 130 public and private recreation areas in this region, totaling 121,000 acres. In 1965 there were 2.5 million visitors to the Finger Lakes region. The Finger Lakes offer good fishing for lake trout, rainbow trout, pike, walleye, black bass, and panfish. Naples Creek, a small tributary of Canadaigua Lake, is crowded with fishermen in the spring for the rainbow spawning run. As many as 2,000 fishermen have been seen fishing on the lower two to three miles of this stream at one time. Boating is extremely popular on these lakes, especially Cayuga and Seneca which are linked to the Barge Canal.

The Lake Ontario shoreline, second in recreation demand, will probably serve a large role in future development of recreation facilities in the basin. It has fourteen public beaches located along 150 miles of United States shoreline. The best sand beaches are located on the eastern end of the Lake near Mexico Bay. Numerous bays and coves provide excellent areas for small-boat harbors, fishing, and water skiing.

The St. Lawrence region is also a popular recreation area. Robert Moses State Park had 185,000 visitors in 1965. The St. Lawrence River, especially in the Thousand Islands area, is famous for its muskellunge and northern pike fishing. The Adirondack Forest Preserve encompasses approximately two-thirds of the Black-United States St. Lawrence River basin and contains hundreds of lakes and mountain streams. Fishing, hunting, and hiking are most popular here.

The State Barge Canal system is another of the basin's valuable recreational assets. More than 100 small-boat marinas are established along the canal system. Pleasure boating has more than quadrupled in the last 15 years, as indicated by the number of permits issued for lockage. The State Department of Public Works reported issuing 2,000 such permits in 1952 and more than 10,000 in 1965. An estimated additional 30,000 craft use the canal system between the locks.

8.2 Water Quality

8.2.1 Lake Ontario

Several water quality problems exist in Lake Ontario. Some problems occur throughout the Lake and others occur only in specific portions.

The major and most perplexing water pollution problem in Lake Ontario is the yearly crop of *Cladophora*, a form of filamentous green algae. In a suitable environment these plants attach to any firm object in the water and grow in strings by cell division. The strings vary in length from a fraction of an inch where nutrients are scarce to several feet in nutrient-rich waters. *Cladophora* growth begins with a fringe-like growth in early spring and develops rapidly into strands approximately 15 inches long by late June.

The Niagara River is by far the largest single source of nutrient inputs to Lake Ontario. This reflects the fact that because Lake Ontario is downstream from the other four Great Lakes, it suffers the consequences of what happens above it in the Basin. Fortunately most nutrients flowing into Lake Erie are retained and are not carried out by the Niagara River.

A dramatic example of an upset in the balance of nature is the alewife invasion into the Great Lakes. Alewife die in enormous numbers within a short period each summer and the dead fish drift onto the shores, adding their stench to the windrows of rotting *Cladophora* on beaches.

In addition to the buildup in nutritional compounds, Lake Ontario waters have deteriorated in chemical quality measured by such parameters as the sulfate and chloride ions and total dissolved solids. Data collected at selected points around the Lake in inshore water, such as water intakes, show that chemical quality was changing very gradually during the half-century prior to 1910. Indicative of sharp increases in chemical constituents since that time, the sulfate concentration in deep water sampling has increased from 15 to 30 parts per million (ppm), and chloride from 7 to 26 ppm. The chemical quality of Lake Ontario water is determined mainly by the quality of water from the upstream watershed. The chloride increase in particular has been attributed to a parallel increase in Lake Erie. This in turn is related to several factors including salt mining and related chemical industries on the watershed. These industries are concentrated mainly in the Detroit-Windsor area at the western end of Lake Erie and in northeastern Ohio. Use of chlorides in snow removal and highway ice control has also contributed to the increase in chloride.

Although the threefold chloride increase in Lake Ontario has caused concern, the present concentration level is well below that which would cause significant impairment to water uses. There does not appear to be cause for concern about future increases, but this does not mean that the dumping of chloride or any other substance into these waters should be condoned where reasonable steps can be taken to avoid it.

A classic example of the problems that can arise from the discharge of various substances into a lake is illustrated by the Rochester embayment area. The embayment includes the Monroe County shoreline of Lake Ontario and Irondequoit Bay and Creek.

The problem in this area involves the beaches, sewer outfalls, and water intakes. Both municipal and industrial wastes from a rapidly growing metropolitan area have complicated water uses in the area. However, the major cause of the problems in this area is the discharge of municipal wastes. Partially treated domestic sewage with a population equivalent of more than one million is discharged to the embayment. High bacterial counts from metropolitan sewage have caused the closing of main public beaches in the embayment.

Metropolitan growth and population explosion have engulfed the Irondequoit Bay and Creek basin. The expanding Rochester metropolitan area population with its domestic waste and nutrient load is fast making Irondequoit Bay a highly fertilized waste treatment unit where algal blooms occur. The Villages of East Rochester and Fairport and the Towns of Brighton, Irondequoit, and Penfield discharge waste treatment effluents with an estimated population equivalent of 12,500 to the Irondequoit Creek. This harms water quality in Irondequoit Bay. Good water and adequate flows from the canal protect Irondequoit Creek and its two main tributaries from total deterioration and flush the waste nutrients into the bay. The nutrients become trapped in the bay, deposited on the bottom, or taken up in the life cycles of the biota. Industry also contributes minor amounts of waste to the watershed. A high concentration of nutrients will continue in the bay under conditions of lack of interchange between Lake Ontario and Irondequoit Bay water; minimum flows from Irondequoit Creek; and inefficient removal of nutrients at contributing sewage treatment plants in the Irondequoit basin.

8.2.2 Planning Subarea 4.4

Although most of Planning Subarea 4.4 is included in Lake Erie territory, it is considered in this section because of the Niagara River. Portions of Planning Subarea 5.1 are considered in this section to simplify organization.

8.2.2.1 Niagara River

The Niagara River basin, with the worldrenowned Niagara Falls, separates Lakes Erie and Ontario. Approximately 1.3 million people live in the United States portion of the Buffalo-Niagara area and the area contiguous to the basin. The sewage from this population ends up in the Niagara River, although only a portion of the 1.3 million people actually live in the Niagara River basin. The metropolitan area is highly industrialized and supports the major source of electrical power for the eastern Great Lakes. Less than 10 percent of the area is rural.

The Niagara River has an average flow of approximately 203,000 cfs. Almost all of the flow comes from Lake Erie and the minimal flows from the Buffalo River and Tonawanda Creek have little effect on Niagara River volume. The Tonawanda Creek flow is eliminated when the Barge Canal is in operation. At that time as much as 1,300 cfs of water from the Niagara River and Tonawanda Creek flow east through the canal.

The major pollution load to Niagara River stems from the nutrient-laden waters of Lake Erie, wastes from the heavy industrial complex along the Buffalo River, and direct waste discharges from riparian municipalities and industries.

Because of the large volume of Lake Erie water in the river, the effect of most pollutants in the discharged wastes is masked by the tremendous dilution ratio. However, certain indicators of pollution such as phenols, oil, and coliform bacteria are still evident.

Excessive growths of *Cladophora* in the Niagara River and algae from Lake Erie and the upper Niagara River tributaries form large accumulations below Niagara Falls. The decay of large masses of these plants in the area of the Maid of the Mist docks on the Canadian shore contributes to the obnoxious odor problem in the lower Niagara River.

8.2.2.2 Buffalo River

Pollution from the Buffalo River hugs the east bank of the Niagara River for approximately six miles before mixing throughout the river. The polluted portion of the Niagara River also receives waste from the Buffalo Sewer Authority three miles downstream from the Buffalo River and from Scajaquada Creek, four miles downstream. The Buffalo Sewer Authority discharges approximately 143 mgd of primary-treated waste.

Phenols found in the upper six miles of the Niagara River are associated with waste discharges from a coke plant and a dye plant on the Buffalo River. The oil refinery in the area has achieved substantial compliance with New York State and International Joint Commission requirements for oil and phenol removals. Other industries and the municipal sewage treatment plants discharging oil from facilities on the upper river also add to potential taste and odor problems at municipal water supply intakes on the river. On one occasion in 1967 phenols of 28 micrograms per liter were found at the confluence of the Niagara River and Lake Erie. Although no phenol problems have been reported on the upper Niagara River in the past few years, water is routinely treated for taste and odors caused by phenols at Niagara-on-the-Lake, a Canadian community located near the mouth of the river.

The Buffalo River receives wastes from storm sewer and combined sewer overflows, septic tanks, and sewage treatment plants. These wastes then flow into the Niagara River where they affect the coliform levels on the east shore. The Buffalo Sewer Authority effluent and combined sewer overflow contribute directly to the coliform count in the Niagara River. In 1967, samples collected by the International Joint Commission (IJC) near the east shore indicated median coliform counts were 6700/100 ml approximately two miles downstream on the Buffalo River and 3600/100 ml four miles downstream. Midstream samples at these mile points reflect the maximum levels, and they are high enough to make swimming hazardous in the Grand Island area. This points out the vigilance required by waterworks supply operators to guard against contaminated water.

8.2.2.3 Tonawanda Creek

Tonawanda Creek, more than 100 miles long, has an average flow of approximately 390 cfs, and has 31 tributaries. In comparison to the 203,000 cfs flow of the Niagara River, the creek exerts little pollution pressure on the river. However, when the Barge Canal is open the creek has a marked effect on canal water quality.

The upper reach of the creek above the Barge Canal has relatively good water quality with few exceptions. Waste from Attica Prison, sewage from Attica, toxic waste from the National Lead Company at Batavia, enrichment from the well-operated Batavia sewage treatment plant, and sewage from Akron on

Murder Creek cause polluted conditions for short distances below these outfalls. The creek recovers sufficiently, however, to be in good condition where it reaches the canal.

Near its mouth Tonawanda Creek is joined by Ellicott Creek, a highly enriched stream. The enrichment is caused by sewage from Alden and Erie County Home and Penitentiary, septic tank discharges, and sewage from Amherst. The enrichment causes algal growth and dissolved oxygen depletion in the creek as it passes through Ellicott Creek Park and flows into Tonawanda Creek and the Niagara River.

8.2.2.4 Eighteenmile Creek

Waste loads from the Lockport area pollute Eighteenmile Creek for its entire length. The community of Lockport and nearby industries, including Flintkote Company and United Board and Carton, discharge partially treated waste with a population equivalent of approximately 73,000. Dams on the watercourse place further burdens on the oxygen content of the creek waters, cause nutrient concentrations in the ponded areas, and contribute to algal blooms in the lower reaches. Lessening the flow of canal water into the creek would create a major pollution problem in the creek from the canal to the mouth.

8.2.2.5 Barge Canal

The section of the Barge Canal west of the Genesee River obtains most of its water from Niagara River and Tonawanda Creek and discharges into streams along its 73-mile length. Industries in the western sector, including Upson Company at Lockport, Hunt Foods at Albion, and Duffy-Mott Company, Inc., at Holley, contribute wastes with a population equivalent of 324,000. Several communities also discharge partially treated waste. The industries and communities are steadily degrading canal water because of inadequate treatment.

Good water quality in streams receiving water from the Barge Canal cannot be maintained in some instances without water from the canal. The need for discharges from the canal for flow augmentation is evident. Apportioning the available water in the canal for other purposes may have a serious effect on receiving streams if water for increasing flow-augmentation needs is denied. Better waste treatment facilities on streams receiving canal water will lessen the need for canal water, but will be offset by increased population and industrial growth. Although the Barge Canal is not heavily polluted, it is approaching the stage where continued organic loading will destroy its usefulness as a source of flow augmentation water for the many streams it normally supplies. Such watercourses as Eighteenmile Creek in Planning Subarea 4.4 and the Genesee River and Irondequoit Creek in Planning Subarea 5.1 would suffer. Continued waste loadings will not only result in lowering water quality in the canal itself, but will worsen pollution conditions in most receiving streams.

8.2.2.6 Cayuga Creek

Cayuga Creek in Niagara County is a small stream that drains an area north of Niagara Falls. The main source of pollution is a flow of 80,000 gallons per day from the Niagara Municipal Air Base Group, a Federal installation. Partially treated sewage from the base, the City of Niagara Falls, and the area outside Niagara Falls cause dissolved oxygen depletion, algal growths, and odors in the lower portion of the creek.

8.2.3 Planning Subarea 5.1

Planning Subarea 5.1 is essentially the Genesee River basin. As mentioned before, certain streams in this area were included in Planning Subarea 4.4 for convenience of organization.

8.2.3.1 Genesee River

Major areas of water quality impairment in the Genesee River basin are sectors on the lower and central part of the main stem and on Honeoye, Keshequa, Wolf, Oatka, Black, Wilkins, Conesus, and Canaseraga Creeks.

The Genesee River is most seriously degraded in the lower five to six miles. Studies in the summer and fall of 1965 revealed that the entire lower reach is almost completely depleted of dissolved oxygen. Concurrent biological studies showed the bottom fauna consisted almost exclusively of sludgeworms.

Discharge from the Eastman Kodak Company's primary treatment plant was the principal cause of this condition. Kodak now has secondary treatment facilities in operation which should greatly reduce the effluent loading. Contributing to the poor quality of this lower five to six mile sector are intermittent discharges of untreated wastes from Rochester's 30 combined sewer overflows and the latent oxygen demand of the extensive sludge deposits.

Three other reaches on the main stem display poor water quality. These are below the Village of Avon, below General Foods, Birdseye Division, and below the Gates-Chili-Ogden discharges. At present a joint project involving the Village of Avon and the General Foods Company is the only step towards solving the pollution problem. A secondary plant is now under construction and the plan also calls for industrial pretreatment. State funds totaling $394,026 have been authorized for the project. Pollution from another major source, Curtice Brothers in Leicester, was abated in 1968 by use of spray irrigation.

Among the more seriously degraded reaches on the Genesee River tributaries are Honeoye Creek below Honeoye Falls and Oatka Creek below Warsaw. Stream flow in Honeoye Creek is commonly very low in summer because of limited releases from its three headwater lakes, Honeoye, Canadice, and Hemlock. In addition the Honeoye Falls secondary treatment plant does not sufficiently reduce organic materials. The village is taking measures to reduce its effluent BOD to correct the gross pollution conditions of extremely low dissolved oxygen and high bacterial counts.

8.2.4 Planning Subarea 5.2

Planning Subarea 5.2 covers most of the west central section of New York State. Major areas of concern in this area are found in the Oswego River-Finger Lakes region, Onondaga Lake, and Oneida Lake.

8.2.4.1 Oswego River

The major pollution problems in the Oswego River basin are on Onondaga Lake, the Oswego River near Fulton, the Seneca River in the Waterloo-Seneca Falls area, the Clyde River (Barge Canal) below Newark, and the Finger Lakes outlet.

The Syracuse area is located in the heart of Onondaga County. Most of the river basin's population and approximately 60 major industries are located in the Syracuse metropolitan area. This large concentration of population and industry has given rise to water quality problems in the area. Waste discharges to Onondaga Lake contain large quantities of inorganic and organic materials. Analysis of samples taken from the lake during the summer of 1965 indicated a zone almost devoid of oxygen below the 25-foot depth. Biological investigations in July 1965 revealed that there was little or no bottom fauna, but a large population of pollution-tolerant types of algae ranging up to 100,000 organisms per milliliter.

Lake bottom cores taken in the 1965 investigations revealed layers of sludge and sodium and calcium carbonate deposits. Similar investigations in November 1971 revealed the situation to be largely unchanged. Certain algal species, however, were present in populations well in excess of 100,000 organisms per milliliter. Dominant non-algal benthos were *amphipoda, annelida,* and *diptera.*

Onondaga Lake receives more nutrients than any other lake in the basin. Depite high concentrations of chlorides and suspended solids, algal blooms occur in localized lake areas. Light penetration is less than three feet. All these factors reflect a severely degraded environment.

8.2.4.2 Oneida Lake

Oneida Lake is in a highly advanced state of eutrophication, resulting partly from the input of large quantities of nutrients from poorly treated municipal and industrial wastes. The nutrients along with ideal physiographic features promote prolific algal blooms which decay into foul-smelling masses and eventually wash ashore. These repugnant conditions are a deterrent to most water uses. Major tributaries receiving large waste loads are Chittenango Creek, including Limestone and Butternut Creeks, and Oneida Creek, including Sconondoa and Canaseraga Creeks. A larger portion of the nutrients apparently comes from natural runoff including that from agricultural activity. There are many direct discharges from cottages plus vessel wastes from the Barge Canal traffic and numerous pleasure craft. A small percentage of the total phosphate loading in the basin is the result of municipal and industrial waste discharges made directly to the lake or its tributaries.

8.2.4.3 Finger Lakes Region

Because the Finger Lakes have large volumes and controlled outlet flows, seasonal precipitation variations do not cause a radical effect. The large lake volumes also provide considerable dilution of waste inputs and the eventual assimilation of most wastes. These large natural storage reservoirs permit a gradual release of water to the outlets, preventing extremely low flows in the outlets.

Areas of localized pollution exist at Ithaca, Geneva, and Dresden, and on lake outlets. The two areas of poor quality on Seneca Lake are at Dresden, where the pollution-laden Keuka Outlet adversely affects the lake, and on the north shore at Geneva, where the city has had to restrict swimming. This area is principally affected by the discharge from the city's primary treatment plants, and also by some industrial discharges into tributaries and city storm sewers. At present, Geneva is awaiting approval of plans to provide contact stabilization with an 85 percent reduction of BOD. The design flow is 4.0. The project is eligible for a combined State and Federal grant of more than $3,500,000.

On Cayuga Lake beaches in the Ithaca area have been closed because of bacterial pollution and because dense growths of plankton make the waters hazardous for swimming by limiting transparency.

The two Finger Lakes outlet streams most seriously degraded are Skaneateles Creek and Owasco Outlet. The flow in Owasco Outlet is regulated to preserve the water supply storage in Owasco Lake. Only a nominal amount is allowed for dilution of domestic wastes and odors are common during low flows. Skaneateles Creek is also regulated closely because the lake is the major water supply source for Syracuse. Bacterial contamination exists throughout Skaneateles Creek. In some reaches high pH, turbidity, and color result from poorly treated industrial wastes, especially in and below Skaneateles Falls.

Wineries on both Keuka Inlet and Canandaigua Inlet impose sizeable organic loads on those streams, particularly at Hammondsport on Keuka Inlet. Both chemical and biological data reflect the additional loading imposed by the wineries in the fall.

The Seneca and Cayuga Lake Outlets together form part of the Cayuga-Seneca section of the Barge Canal system and this 13-mile reach is extremely polluted. Many fish-kills have occurred below Waterloo and Seneca Falls and extensive fish-kills were reported in October 1961, September 1962, and October 1963.

Flows from Seneca and Cayuga Lakes are regulated for both hydropower and Barge Canal navigation. Unfortunately other purposes including low-flow augmentation receive only minor consideration. Average 24-hour flows to meet peak power demands have varied from 60 to 1,000 cfs. Because of the wide fluctuation of flows into the Seneca River, Geneva's waste discharges to Seneca Lake occasionally flow directly into the river with little dilution. This is of particular importance to the City of Waterloo with a water supply intake only a short distance downstream. Because of the limited dilution wastes are frequently carried downstream in slugs, contributing to the conditions causing fish kills.

Overfertilization is a problem on the Finger Lakes, as indicated by the aquatic weed problems found primarily on the northern end of Seneca Lake and the substantial plankton blooms which occur at the southern end of Cayuga Lake.

8.2.4.4 Barge Canal

The Barge Canal reach from Newark to Lyons has excessive organic loadings which cause serious depletion on dissolved oxygen. The flow in the canal is diverted to Ganargua Creek above Newark and does not reenter until nine miles downstream at Lyons, complicating the situation.

The Barge Canal in the Newark area is subjected to two large industrial wastes from Perfection Foods and Edgett and Burnham Cannery. These wastes have a combined population equivalent of 28,000. Fish-kills were reported in this area in August 1961, October 1963, and November 1964. A secondary plant began operation at Newark in September 1969, but lack of pretreatment by the Perfection Foods Cannery has hindered its effectiveness.

At Lyons the National Biscuit Company discharges an untreated waste with a population equivalent of more than 20,000 which causes a slight decrease in water quality. At Clyde the canal exhibits moderate deterioration in quality from the village's primary effluent. At the sampling station near Clyde there are high concentrations of dissolved and suspended solids in addition to high bacteria counts.

8.2.4.5 Oswego River

The Oswego River is high in organic loadings at its headwaters. It receives untreated domestic sewage from three communities and untreated industrial wastes from six large industries and many small industries. At Fulton the canal section between two locks is extremely polluted. Just two miles downstream from Fulton, Armstrong Cork formerly added another untreated loading and its discharge created an unsightly delta of deposits in the river below the outfall. Secondary facilities completed by the company in October 1969 relieved this problem. Further downstream bottom deposits are resuspended by passing tugs, making the river a dark unsightly color as it passes Battle Island State Park.

8.2.5 Planning Subarea 5.3

Planning Subarea 5.3 encompasses an area referred to as the Black-U.S. St. Lawrence River basin. Despite the benefits derived from large stream flows and the many headwater lakes that could be regulated for water quality control, this planning subarea has many areas of serious water quality impairment.

The central and lower sections of the Black River are the most seriously affected reaches. Sectors on the upper and lower Oswegatchie River, the lower Grass, and the lower Raquette also have noticeable pollution problems. The St. Lawrence River, in the 114-mile stretch between Lake Ontario and Massena covered in this section, exhibits localized pollution at Ogdensburg and Massena.

Pulp and paper manufacturers contribute more than 90 percent of the total organic loading to the Black-U.S. St. Lawrence River basin in terms of BOD. The total loading has a population equivalent (PE) of 900,000. Waste discharges from aluminum processing plants, dairy products plants, and mining operations are less significant, but still a cause of water quality degradation. Little or no treatment is provided by these industries. Municipalities are also causing pollution problems because of inadequate treatment. A BOD reduction of only 30 percent is provided through existing municipal treatment facilities.

8.2.5.1 St. Lawrence River Basin

The St. Lawrence River, with its enormous flow averaging more than 240,000 cfs, is relatively unaffected by either direct waste inputs or the tributary inputs, but does experience areas of localized pollution. In the approximately 115 miles of river between Lake Ontario and the point above Massena, where the international boundary departs from the river, two locations receive wastes in quantities large enough to cause serious degradation.

At Massena wastes from the General Motors Chevrolet Division aluminum casting plant and the Reynolds metal aluminum reduction plants cause a milky, oily appearance in the river.

At Ogdensburg the Diamond National paper plant discharges raw wastes, including nearly 7,000 pounds per day of five-day BOD, floating fibers, wood chips, and rafts of white foam. An unsightly discoloration is caused along the shoreline despite the paper mill's efforts to trap and remove the larger suspended material with a floating barrier. Diamond National has submitted a final engineering report which has been approved. The company plans to provide chemical coagulation and precipitation. Most municipalities that discharge wastes into the St. Lawrence River provide no waste treatment. The only exceptions are Ogdensburg and Waddington which provide primary treatment.

Data for the past decade reveal little change in quality in the St. Lawrence River.

The major tributaries of the St. Lawrence River, the Raquette, Grass, and Oswegatchie Rivers all have localized areas of pollution. Water quality on the Raquette River in the reach between Potsdam and Raymondsville is often degraded with oxygen deficiencies and gross discoloration. Improper stream-flow regulation by upstream hydropower plants compounds the pollution problems created by industrial and municipal waste discharges. Upstream river flows have been completely interrupted for periods up to 14 hours, preventing any dilution for water quality control.

The only reaches of significantly deteriorated quality on the Grass River are below Canton and Massena. Sources of pollution in the Canton area include untreated discharges by a Kraft Foods cheese plant (approximately 7,500 PE in terms of BOD), several dairies, and poorly treated effluents from the Village of Canton's primary treatment plants. An unsightly milky discoloration often exists in the river in and below Canton. To alleviate this problem the village and Kraft Foods have undertaken a joint water pollution control project. Kraft will also provide pretreatment before discharging wastes to the secondary plant now under construction. The project has been completed. Major sources of the moderate pollution found at Massena are effluents from the

Massena primary treatment plant, serving a population of approximately 16,000 and an industrial waste discharge from an Alcoa plant. The discharge totals 20 mgd from a settling and oil separation lagoon. This occasionally gives an oily appearance to the river and causes a buildup of sludge deposits in the streambed.

In quality the Oswegatchie River is similar to the other major river systems in the St. Lawrence area. Its quality is good except in localized areas that receive untreated or poorly treated municipal and industrial wastes. Erratic and insufficient releases from Cranberry Lake often provide inadequate stream flows for proper water quality control.

In and below Gouverneur the river receives approximately 50,000 PE of organic loading from untreated wastes. The wastes are discharged by Pioneer Ice Cream, Division of Borden (20,000 PE); Groveton Paper (25,000 PE); and the Village of Gouverneur (5,000 PE). Severe discoloration has been observed downstream from the paper mill. Great quantities of fibrous oxygen-consuming sludge deposits have formed on the streambed.

At Heuvelton, approximately 12 miles upstream from where the Oswegatchie River enters the St. Lawrence River, it is again subjected to untreated industrial waste. The Aiello Dairy Farms cheese plant, the major waste contributor, is under order to connect to the Village of Heuvelton system upon its completion. Construction of the village system began July 1, 1969.

8.2.5.2 Black River Basin

The Black River is in a severely polluted condition primarily because of the numerous untreated waste discharges from pulp and paper mills. The area affected covers the lower half of the basin including more than 80 miles of river. The stream sectors below Lyons Falls, Beaver Falls, Carthage, and Watertown are most critically affected.

Pollution in the Black River includes excessive organic loadings and related dissolved oxygen depletions; gross discoloration and a water surface fouled with multicolored foams and floating debris; and the buildup of vast deposits of paper fibers, wood chips, and other oxygen-consuming materials on the streambed. Dissolved oxygen profiles of the Black River made by the National Council for Stream Improvement in 1965 revealed that the entire 40-mile sector from the Georgia Pacific pulp and paper mill at Lyons Falls to Carthage had less than 4 mg/l of dissolved oxygen. One 10-mile reach had less than 2 mg/l. This was at a time when the stream flow was approximately 600 cfs below Lyons Falls, more than three times the critical low flow for this reach.

Another serious problem exists below the Carthage-Deferiet area. St. Regis, Crown Zellerbach, and Carthage Paper Makers were daily discharging untreated wastes containing more than 60,000 pounds of 5-day BOD to this reach in 1965. A major step to eliminate problems in this area is the joint treatment project involving the Villages of Carthage and West Carthage.

Other areas of the Black River and its tributaries, notably below Watertown and Beaver Falls, have serious water pollution problems. The total discharge to the Black River and its tributaries is approximately 700,000 PE from pulp and paper mills and approximately 50,000 PE from municipalities. The City of Watertown, the largest municipality in the basin, has primary treatment for a population of approximately 40,000.

8.2.6 Special Pollution Problems

8.2.6.1 Wastes from Watercraft

Watercraft of all types contribute untreated or inadequately treated wastes to the waters of the Lake Ontario basin. Problem areas include the commercial harbors and small boat marinas off the Lake, the St. Lawrence Seaway, the Barge Canal, and the Finger Lakes area.

Approximately 7,000 commercial ships pass through the St. Lawrence Seaway and across Lake Ontario each year. Approximately 1,000 of these enter New York State's commercial ports from Rochester to Massena. Approximately 750 commercial barges and their tugs use the Barge Canal each season.

Additional watercraft wastes to Lake Ontario and other bodies of water come from pleasure boaters. Approximately 3,100 recreational watercraft can be accommodated at nine recreational harbors constructed by the Corps of Engineers along the lakeshore. It is estimated that private moorings exceed this figure. Widespread distribution of the waste is caused by the freedom of access boats have to most bodies of water in the basin. Approximately 65 publicly operated boat ramps exist in the basin, and many more are under private care. The Barge Canal, for instance, accommodated approximately 30,000 boaters in one season. Oneida Lake accommodates approximately 5,000 boats a day. These high figures are duplicated in many areas of the basin. These numbers alone indicate that boats can create a water pollution problem that upsets nature's balance.

Recognizing the problem of watercraft pollution, New York State passed a law effective March 1, 1970, to deal with sewage and litter. Enforcement began March 1, 1971. Watercraft must have toilets equipped with pollution control devices to prevent discharge of untreated human waste into the water. The Ontario Water Commission of Canada has also enacted a similar law. The Federal Water Pollution Control Administration's report may also require an effective means of controlling pollution from watercraft.

8.2.6.2 Oil Pollution

The oil pollution problem in the Lake Ontario basin is minimal because of the lack of major oil producers or users except in the Niagara area. However, there is always the possibility of a disastrous oil spill because of the major shipping in Lake Ontario and Rochester Harbor, oil transportation on the Barge Canal, oil pipelines crossing the area, and the increasing number of oil storage tank farms along the Barge Canal.

In the last few years minor spills have occurred on the Barge Canal, Genesee River, and Irondequoit Bay. In 1963 the New York State Department of Health observed the harmful effect of oil on wildlife in its study of the St. Lawrence River. The oil came from commercial shipping and recreational boating. In 1961 ballast discharged from tankers in the St. Lawrence Seaway also caused problems along the shore, and on one occasion Grassy Point Beach near the Thousand Island Bridge was temporarily closed.

In the Niagara area a major problem results from the accumulation of oil on the Buffalo River. Flushing action causes the periodical discharge of these heavy accumulations of oil to the Niagara River. Some significant sources of oil to the Niagara River do not immediately appear on the water surface. The oil is first noticed when large oil films collect at protected shore areas such as coves and marinas. In many cases there is no apparent relationship between the location of these oil concentrations and the presence of known oil waste discharges or observable oil films on the water immediately upstream. Municipal waste treatment plants in the area also do not create observable oil films on the streams below their outfalls. However, tests have shown that the quantity of oil and extractables in effluents from the sewage plants discharging directly to the upper Niagara River is more than 32,000 pounds per day.

8.2.6.3 Disposal of Dredged Material

Lake Ontario has three deep-draft harbors that are dredged annually by the Corps of Engineers. These harbors, at Rochester, Great Sodus Bay, and Oswego, accommodate 1,000 ships each year. When the dredged material is deposited in the open area of the embayment over a designated spoil area, aerial photographs show the fine material is not readily settleable and is carried throughout the embayment by current.

8.2.6.4 Pesticides

DDT is one of the best known ingredients in synthetic organic pesticides. It is part of the family of chlorinated hydrocarbon chemicals which are stable, persistent, and travel great distances. Although this type of pesticide has been used extensively only since World War II, its residues have been found in penguins and crab seals as far away as Antarctica.

The danger from such pesticides lies not only in deaths the pesticides cause directly, but in the more indirect effect which may result from pesticide injection into the food chain. Food chains in the aquatic environment are especially vulnerable because they are exposed to pesticides in land runoff in addition to those sprayed directly on water.

Traces of DDT have been found in fish taken from Cayuga and Skaneateles Lakes in the Oswego River basin. The Lake Plain area, which parallels the southern shoreline of Lake Ontario, is an extensive fruit-growing belt where enormous quantities of pesticides are used. In 1965 a pesticide analysis indicated the trace amounts of DDE and both isomers of DDT (chlorinated hydrocarbon pesticides) were present.

On both East Koy and Wiscoy Creeks in the Genesee River basin there have been several large fish-kills attributable to an organic phosphate pesticide commonly used by area potato growers. Sampling results showed the presence of pesticides, with higher concentrations present in bottom samples. This was undoubtedly caused by the two-week time lapse between interjection of the pesticide and sample collection.

Further research is urgently needed on these synthetic pesticides to determine their effects on plants and animals, and their ultimate impact on man. Enough in known, however, to make clear the need for closer control over pesticide usage. An immediate need is a permit and accountability system yielding information on the kinds, amounts, and places of pesticide application.

8.2.6.5 Land Runoff

In addition to pollution from point sources, such as municipal and industrial wastewater discharge points and watercraft, much detrimental material gets into streams and lakes from nonpoint sources. These sources include runoff from rural and urban land; runoff from earth-moving work in the construction of subdivisions and highways; runoff from overgrazed, severly burned, and improperly logged forest lands; and residues from the application of chemicals, fertilizers, pesticides, and deicing compounds used on streets. Runoff water contains both dissolved impurities and suspended particulate matter, and both have detrimental effects on receiving waters.

The chemical effects of sedimentation are not as obvious as physical damage. Unlike the other typical constituents of fertilizer, phosphate compounds are not easily leached out of the soil, but tend to adhere to soil particles. The same is true for many types of pesticides, notably DDT and dieldrin. Thus, pesticides accumulate in stream sediments and are taken up by the bottom-dwelling worms that ingest mud, and from there eventually reach the top of the aquatic food chain in fish. From there the pesticides reach man. This chain of events can be halted by practices that prevent soil erosion.

Although much has been done to improve soil conservation and forestry practices, a more intensified effort is needed. The need is heightened by trends to increase use of fertilizers and pesticides in agriculture.

8.2.6.6 Thermal Pollution

Power plants and industries using large quantities of cooling water are of concern because of the enormous quantities of waste heat they discharge into streams and lakes. Most existing installations discharging large quantities of waste heat are located on Lake Ontario and the inland lakes. Other significant sources of thermal pollution are located on the St. Lawrence, Oswego, Seneca, Genesee, and Niagara Rivers. Three nuclear power plants are now located on Lake Ontario. One plant near Rochester and one near Oswego are in operation. The third, the Fitzpatrick plant at Ninemile Point near Oswego, is nearing completion.

The effects of the present discharge of waste heat to Lakes Ontario, Seneca, and Cuyahoga appear to be minimal. These large bodies of water are better suited than streams for dissipating large quantities of heat.

The selection of sites for future electric power plants is expected to depend heavily not only on a good supply of low-temperature water, but also on the capacity of the receiving stream to dissipate the waste heat generated.

8.3 Water Quality Control Needs

8.3.1 Planning Subarea 5.1

8.3.1.1 Area Boundaries

Planning Subarea 5.1 is composed of the Genesee River basin, a major drainage system that lies wholly within its boundaries. The area also encompasses portions of the lower Niagara River and numerous minor tributaries of Lake Ontario.

8.3.1.2 Water Uses and Related Quality Problems

(1) Genesee River Basin (Main Stem and Major Tributaries)

Although most of the Genesee River basin lies within New York State, the southern tip of the basin is within the Pennsylvania portion of Planning Subarea 5.1. The Pennsylvania portion includes four percent or 96 square miles of the 2,479-square-mile river basin. This rural area, relatively free from pollution, contains the headwaters of the Genesee River.

Following is a basin-by-basin analysis of stream conditions in the New York portion of Planning Subarea 5.1.

In several areas the Genesee River basin surface waters still receive inadequately treated industrial and municipal waste. Consequently, there remain some serious areas of water quality degradation. The most severely impaired areas are the extreme lower sector of the Genesee River and sectors on the central portion of the main stem, Honeoye Creek, Wolf Creek, Oatka Creek, Black Creek, and Canaseraga Creek. However, pollution abatement procedures in many of these areas will restore water quality.

From the Pennsylvania-New York border to the Village of Wellsville the Genesee River continues to display generally good water quality. Its uses include trout fishing and domestic water supply. At Wellsville, however, the river receives untreated industrial waste and inadequately treated municipal waste from the village's overloaded primary treatment plant. As a result the river at Wellsville and immediately downstream suffers moderate pollution, but stream standards are not violated.

The river's relatively swift flow downstream from Wellsville facilitates the recovery and maintenance of good water quality. Significant pollution does not reoccur until just upstream from the Mt. Morris dam. The river section from this point to the Barge Canal crossing is polluted in numerous places. The severity varies directly with stream flow conditions. This 55-mile reach of the stream receives large quantities of high organic waste from canneries at Mt. Morris and Avon. Mt. Morris has a primary sewage treatment plant being expanded for secondary treatment. Avon's new secondary plant is presently adequate, but advanced waste treatment or flow augmentation will probably be required in the future. Water quality occasionally falls below established stream standards in this sector of the river. The most notable problem is at Avon where the river has a C classification. According to standards the best use is fishing, but numerous fish-kills have occurred.

Downstream from Avon, water quality slowly improves until three miles upstream from the Barge Canal junction. Here the river receives a large organic discharge from the Gates-Chili-Ogden primary sewage treatment plant. This plant is being enlarged to include tertiary treatment.

The quality of the river improves downstream from the Barge Canal as it flows over a series of natural falls in Rochester. Although the dissolved oxygen remains high in this section, biological evidence indicates the river is still very polluted.

The last six or seven miles of the Genesee River receive the greatest quantities of inadequately treated wastes and thus exhibit the most severe pollution conditions. Large amounts of industrial waste were discharged into this sector of the river by Eastman Kodak. Total oxygen depletions extended for the rest of the river below Kodak's outfall. Kodak recently installed a secondary treatment plant which should help improve this reach. Stormwater overflows from Rochester still contribute considerable organic loading to this reach. The low-flow/waste-flow dilution ratio at the mouth of the Genesee River can go as low as 0.4:1.

Further complicating the problems of this reach are the large sediment loads transported by the Genesee and deposited in the harbor. This accumulation requires annual dredging by the Corps of Engineers to accommodate deep-draft ships. The highly polluted sludge is dumped into Lake Ontario. Local conservationists have strongly opposed this method and the Corps will probably cease unrestricted dumping into the Lake in the near future. Investigations have begun to obtain a site that can be used for onshore disposal.

The lower portion of the main stem of the Genesee River was recently upgraded to a B classification by the former New York State Department of Health. Ideal uses of Class B water include bathing and recreation. Very high coliform counts and dissolved oxygen measurements consistently below 4.0 mg/l in the lower Genesee are in violation of stream standards.

Wolf Creek is the first significant tributary downstream from the headwaters of the Genesee that suffers substantial water quality degradation. As a result of salt manufacturing by the Morton Salt Company in Silver Springs, this creek has very high concentrations of chlorides and high conductivity. Farther downstream the Village of Castile discharges raw sewage which severely pollutes the stream. High chloride concentrations and conductivity are caused on the main stem of the Genesee at its confluence with this tributary.

Canaseraga Creek receives municipal waste from a primary treatment plant at Dansville and some raw industrial wastes. Farther downstream primary treatment effluent from two small municipalities and wastes from a large milk processing plant further degrade the creek's waters. In addition the primary sewage treatment plant at Mt. Morris discharges into Canaseraga Creek just before its confluence with the Genesee River. As a result of these discharges this tributary is moderately polluted as it empties into the Genesee.

In the past Honeoye Creek discharged moderately polluted water into the main stem of the Genesee River. However, recent construction of tertiary treatment facilities at Honeoye Falls, the creek's major polluter, has done much to alleviate this.

Oatka Creek discharges moderately polluted water into the Genesee. At Warsaw this stream receives industrial wastes and inadequately treated primary treatment plant effluent. Dissolved oxygen measurements of less than 1 mg/l have been recorded downstream from this village. Farther downstream at LeRoy, Oatka Creek receives primary-treated effluent with high organic loadings from several food processors. This seriously lowers water quality in the area. Secondary effluent discharged from Scottsville has a slight additional harmful effect on the creek's water quality. Mild recovery occurs just before the stream's confluence with the main stem of the Genesee River.

In Black Creek pollution first appears near the Village of Bergen. Treated cannery wastes and decaying natural organic vegetation have caused the stream's dissolved oxygen to drop below 3 mg/l. Water quality improves downstream until the creek receives raw domestic sewage at Churchville. These discharges create violation of Black Creek's Class C standards. However, the creek partially recovers before its confluence with the Genesee.

To achieve and maintain satisfactory water quality in the Genesee River basin all municipal treatment facilities must provide a minimum of secondary treatment and maximize reduction of untreated BOD. Industries with separate discharges also must achieve at least this level of treatment for all oxygen-consuming wastes. In general advanced waste treatment is required on the main stem of the Genesee River as far upstream as Avon. Gates-Chili-Ogden and the Village of Avon are the major dischargers that will require advanced waste treatment in the near future. By 1990 the Gates-Chili-Ogden plant will also require low-flow augmentation.

Low-flow augmentation to provide sufficient dilution water for waste loadings is a feasible solution to water quality problems in many other basin areas. A notable exception is the lower Genesee River where the required flow augmentation is too great to be practical with the limited storage available from proposed reservoirs for water quality. However, other portions of the main stem and tributaries apparently will benefit from reservoir sites at Stannards or Portage as well as from a few Soil Conservation Service dams.

(2) Little Finger Lakes

Lying within the Genesee River basin are four small lakes, commonly referred to as the Little Finger Lakes. Rochester has used two of these lakes, Hemlock and Canadice, as a water supply source for the past 100 years. Rochester owns all lakeshore property along both lakes and strictly controls the lakes' watershed areas. As a result water quality in both lakes maintains the State's Class AA rating.

Lakefront property is privately owned along the other two lakes, Conesus and Honeoye. Both lakes are used extensively for recreation, bathing, boating, and fishing. Water quality in both lakes has suffered from leaking septic tanks, oil from power boats, and other causes.

Conesus Lake is also used as a water supply source for the Villages of Avon and Genesee, Lakeville Water District, Conesus Milk Producers Corporation at Lakeville, and numerous private cottages. To maintain acceptable water quality in the lake the Conesus Lake Sewer Project was established. This intermunicipal sewer district is constructing 27 miles of sewer pipe around the lake and a new treatment plant at its north end. The perimeter sewer was scheduled to be in operation by July 1973. The sewer treatment plant was scheduled for operation in August 1972.

(3) Lower Niagara River

The last 20 miles of the Niagara River is included in Planning Subarea 5.1. The rest of the river from Lake Erie to just above Niagara Falls is part of Planning Subarea 4.4.

The Niagara River has a low-flow/waste-flow dilution ratio of approximately 68 to 1 at its mouth. Downstream from the falls industry accounts for 60 percent of the waste discharges. This does not include discharges from the Canadian shore which are minor in comparison. The lower portion of the Niagara River is an area of excessive phenols and coliforms. All New York municipalities on the river plan to add secondary and phosphorus removal facilities. Almost all are preparing final construction plans. The sewer discharge from the upper Niagara River is primarily an industrial discharge and contains some municipal wastes during heavy runoff periods. This causes localized discoloration.

Since early 1970 extensive investigations of mercury discharges have been conducted in the Niagara River basin. The quantity of mercury in discharges will continue to be reduced. Analysis of river water shows no detectable traces of mercury.

Most preliminary plans for municipal and industrial treatment facilities are complete. Overall water quality improvement on the Niagara River will not occur until most of the planned treatment facilities are in operation.

(4) Eighteenmile Creek

Almost the entire length of Eighteenmile Creek is badly polluted. The sector of the creek upstream from Burt Dam is rated Class D. Dissolved oxygen measurements of less than 1.0 mg/l constitute a violation of Class D streams standards. A low-flow/waste-flow dilution ratio of 2.4:1 has been calculated from known discharges at the mouth of this stream, but this ratio is probably even worse during critical periods.

Inadequately treated organic discharges and chemical industrial discharges account for approximately two-thirds of this stream's total waste load. No municipality provides sufficient waste treatment and most provide no treatment at all. Lockport is expanding its primary sewage treatment facilities to include secondary treatment. This plant will also provide treatment for several industrial discharges.

Eighteenmile Creek is grossly polluted and biologically dead. Although some low-flow augmentation is provided by the Barge Canal, alleviation of pollution on Eighteenmile Creek will require advanced waste treatment as far upstream as Lockport.

(5) Johnson Creek

Lyndonville and Middleport are the major municipal dischargers in the Johnson Creek basin. Lyndonville is constructing its first sewage treatment plant and Middleport has adequate secondary sewage treatment facilities. Three industries discharge food and chemical wastes to creek waters in this basin.

Johnson Creek has a low-flow/waste-flow dilution ratio of 21:1 at its mouth. The creek's best use is agriculture. Chemical and biological data indicate no gross pollution conditions now exist on this stream.

In the past, however, Jeddo Creek, a major tributary of Johnson Creek, has been polluted in places. A 1969 survey report prepared by the Environmental Protection Agency's Rochester Field Office stated that the primary source of pollution on this stream was inadequately treated municipal wastes from the Village of Middleport rather than the wastewater discharge from the Food Manufacturing and Chemical Corporation as was previously suspected. The report concluded that the pollution problem of Jeddo Creek would be alleviated if Middleport provided secondary waste treatment facilities. Such facilities are now in operation. The effects of Middleport's secondary sewage treatment plant on the water quality of Jeddo Creek will not be certain until a follow-up survey is conducted.

(6) Sandy Creek

Albion and Holley are the major dischargers to Sandy Creek, a Class C stream. The creek received 0.75 mgd of inadequately treated secondary effluent from the overloaded treatment facilities of these municipalities. Short reaches of the creek below each town are polluted and frequently experience total oxygen depletion.

The stream has a low-flow/waste-flow dilution ratio of 2.2:1 at its mouth. Best uses are primarily fishing and agriculture. Water quality is suitable for recreation, including bathing in three shore reaches of the creek.

(7) Oak Orchard Creek

The low-flow/waste-flow ratio of Oak Orchard Creek is 4.6:1.1. The creek's average flow of 288 cfs can be increased by as much as 225 cfs with water from the Barge Canal. Unfortunately, during periods of low stream flow four Niagara-Mohawk Company power stations on Oak Orchard Creek use this full amount.

Medina, the largest municipal discharger on the creek, provides only primary treatment for its 1.05 mgd discharge. Elba has no treatment facilities, and Oakfield needs to expand its existing secondary treatment facilities. Industrial wastes are discharged to this stream from food processing, tool and die, and paper manufacturing industries.

During periods of low stream flow dissolved oxygen has dipped below 1.0 mg/l. Total coliform counts as high as 44,000/100 ml have been recorded downstream from Medina's sewage treatment plant. High phosphate and nitrate concentrations have caused algal blooms. Other data, however, indicate that the creek's water quality, though still relatively good, is declining.

Best uses for Oak Orchard Creek are fishing and agriculture.

(8) Salmon Creek

Primary treated effluent from the Village of Hilton and an unknown amount of industrial waste from several canneries combine with tributary discharges to make Salmon Creek highly enriched with nutrients. The low-flow/waste-flow ratio at its mouth can dip as low as 0.2:1. Pollution from domestic sewage will be eliminated within 10 years when some wastes are transported to Monroe County's Northwest Quadrant wastewater treatment plant.

Brockport Creek, one major tributary of Salmon Creek, receives a total of 2.18 mgd of municipal wastes from the secondary treatment plants of the Village of Brockport and Town of Sweden. This creek has been the site of several large fish-kills including one as recent as October 1971. These fish-kills have been attributed to cyanide discharges from the Dynacolor Corporation of Brockport. High coliform counts downstream from Brockport also indicate continued sewage pollution.

West Creek, the other major tributary of Salmon Creek, has been polluted primarily by the Duffy-Mott Company in Hamlin. High organic waste discharges from this food processor have been responsible for a total depletion of dissolved oxygen in this stream. Hamlin, the only municipal discharger on West Creek, provides inadequate secondary waste treatment for its population of 400. Hamlin will tie into the Northwest Quadrant wastewater treatment plant when completed.

(9) Slater Creek

Slater Creek receives a waste flow of 163.75 mgd, including 160.0 mgd of cooling water from the Rochester Gas and Electric Corporation. This cooling water discharge contains considerable settleable solids. The Town of Greece discharges 3.75 mgd of effluents containing high phosphate levels from its secondary treatment plant.

The stream's best uses include drainage, agriculture, and sewage disposal. The low-flow/waste-flow ratio at the mouth can go as low as 0.5:1. According to the Monroe County Pure Waters Program, a new 15 mgd tertiary sewage treatment plant will serve this area within 10 years. The Northwest Quadrant sewage treatment plant should alleviate Slater Creek's major pollution problems.

(10) Rochester Embayment

The area of Lake Ontario close to the mouth of the Genesee River is often called the Rochester Embayment.

Partially treated domestic sewage with a population equivalent of more than one million is discharged to the embayment both directly and via the Genesee River. Municipal and industrial wastes from a rapidly growing metropolitan area have complicated water uses in the embayment area.

The worst pollutor of the Rochester Embayment waters is the City of Rochester. Approximately 80 mgd of primary treated waste with a population equivalent of more than 700,000 is discharged through a single 7,000-foot outfall to the embayment. The city's partially treated and chlorinated sewage is discharged offshore from two of the city's major public beaches. Current, wind, and temperature are major factors in the movement of the waste in and around the embayment. The waste is a potential health hazard for the metropolitan drinking water supplies. High bacterial counts have caused closing of the main public beaches on the embayment.

The City of Rochester is constructing a new secondary treatment plant and is placing a 3½ mile outfall into the Lake. This should carry wastes far enough out into Lake Ontario to avoid return of these wastes along the beaches.

(11) Irondequoit Bay

Irondequoit Bay is linked to Lake Ontario by only a shallow channel. The Corps of Engineers has proposed a project to enlarge this connecting channel to allow for greater exchange of bay waters with the Lake. Until this project is accomplished the bay will continue to function as a sink for the various loads discharged to it. Because of its size (1.5 × 6.0 km, area 6.7 km^2, volume 0.046 km^3, maximum depth 23m) Irondequoit Bay displays the limnological characteristics of a small lake. Best use of the bay is general recreation including bathing.

Irondequoit Creek is the major natural tributary of the bay. More than 80 percent of the municipal waste discharged into the stream receives secondary treatment. The stream has a low-flow/waste-flow ratio of less than 1.1:1 at its mouth. The lower portion of Irondequoit Creek is in violation of its present B classification.

Chloride concentrations in Irondequoit Bay are examined in a study by Robert C. Bubeck, a doctoral candidate at the University of Rochester. The study reports that dense saline runoffs from deicing salt used during winter months are responsible for a five-fold increase in the chloride concentration in bay waters during the past two decades. From November 1969 to March 1970 approximately 16,000 tons of salt entered the bay. During the remaining months of the year only 7,000 tons of salt entered the bay. The increased chloride concentrations prevented the bay waters from completely mixing during the spring of 1970, a rare condition for a large, shallow, freshwater lake like Irondequoit Bay. During certain times of year the chloride level exceeds 250 mg/l, the U.S. Public Health Service recommended limit for human consumption. Although not yet critical, the chloride level of the bay's water is rapidly rising and should be carefully monitored.

8.3.1.3 Waste Loads

Table 7-61 indicates waste load totals. For industrial waste loads figures in parentheses indicate totals excluding the 160 mgd cooling water used by Rochester Gas Electric Corporation.

TABLE 7-61 Waste Loads (MGD), Planning Subarea 5.1—New York[a]

Year	Load	
	Municipal	Industrial
1970	225	298 (138)
1980	256	298 (138)
2000	351	377 (174)
2020	464	775 (356)

[a]Also see Annex for more current estimates.

8.3.1.4 Advanced Waste Treatment Needs

Present and future needs are summarized in Table 7-62 and advanced waste treatment nodal points and zones of water quality impairment are shown in Figure 7-38.

8.3.1.5 Treatment Costs

Figures for municipal and industrial treatment costs are presented in Table 7-63.

8.3.1.6 General

To achieve adequate stream restoration in Planning Subarea 5.1, all present and future municipal waste treatment facilities must provide at least secondary treatment. In addition all separately discharging industries must provide at least the equivalent of secondary treatment for all oxygen-consuming wastes.

In recognition of this planning subarea's needs, considerable comprehensive water resources planning has been conducted.

A Type II comprehensive study was conducted under auspices of the U.S. Army Corps of Engineers covering Genesee River basin waters and related land resources. This study was adopted for review by the Great Lakes Basin Commission. The Commission accepted the study, with minor qualifications, as a basis for determining the need for more detailed studies leading to authorization of projects in accordance with the proposed early action plan.

The Genesee Regional Board, during the course of its planning efforts, will investigate all authorities that could assist in implementation of the early action plan. They will also give further consideration to the Lake Plains Service Area which lies adjacent to the Genesee River basin.

In June 1968 the Federal Water Pollution Control Administration (now part of the Environmental Protection Agency) and the State of New York conducted a joint comprehensive study of Lake Ontario and the St. Lawrence River.

Under grants funded by New York State comprehensive sewage studies were conducted in the planning subarea. Monroe County was divided into four separate sections. From these studies the Monroe County Pure Waters Agency developed a "Master Plan" for pollution abatement and recommended methods for implementation.

Construction of new facilities has already begun under the Monroe County plan. In accordance with the plan the county was divided into four drainage basins, each to be served by one large regional secondary treatment plant with phosphorous removal. This will greatly reduce pollution in county waters and the Rochester Embayment area of Lake Ontario.

Other serious water quality problems may not readily be resolved by conventional treatment methods.

Conesus and Honeoye Lakes suffer from an accelerating rate of eutrophication which has already produced some algal blooms. Plans have been drawn up to construct a perimeter sewer around Conesus Lake. The sewer will intercept direct discharges from the tiers of cottages ringing the lake. Results of this effort should be closely observed. If the plan is successful it can be used on Honeoye Lake and elsewhere. Two similar lakes in this basin could serve as control for comparison because their watersheds are protected by the City of Rochester for water supply.

TABLE 7-62 Present and Future Treatment Needs, Planning Subarea 5.1—New York

Stream	Dilution Ratio	Needs	Other	Remarks
Genesee River (lower main stem)	0.4:1	AWT and LFA Both required	Reduction of extremely large sediment loads through erosion control, measures to prevent combined sewer overflows from City of Rochester, phosphate reduction.	AWT and eventual flow augmentation will be needed at Gates-Chili-Ogden Regional STP. Downstream several industrial dischargers will require both. Two main stem reservoir sites (Stannards and Portage) in conjunction with the existing Mt. Morris Dam, could provide some measure of the augmentation requirements after 1990.
Little Finger Lakes (Conesas & Honeoye)	NA	AWT	Elimination of direct discharges from cottages. Measures necessary to correct gasoline and oil problems resulting from multitude of small boats, nutrient removal.	Planning complete for placing a 27-mile perimeter sewer around Conesas Lake.
Lower Niagara River	68:1	AWT	All municipal and industrial discharges should have a high degree of phosphate reduction.	Because of high flows (200,000 cfs), conventional secondary treatment adequate with nutrient removal.
Eighteenmile Creek	2:1	AWT and LFA Both required	---	Barge Canal flow augmentation is essential with eventual AWT for both municipal and industrial wastes.
Johnson Creek	21:1	---	---	Conventional treatment.
Sandy Creek	2:1	AWT	---	Upgrading of existing secondary plants required.
Oak Orchard Creek	5:1	AWT and LFA Both required	Nutrient removal is an important requirement for this creek since it experiences algal blooms.	Augmentation from Barge Canal. Regulation adjustments should be made.
Salmon (plus tributaries Brockport & West Creeks)	0.2:1	AWT	---	AWT needs may be eliminated with the transporting of wastes to N.W. Quad regional treatment.
Slater Creek	0.5:1	---	---	Should have only minor problems. Town of Greece wastes are transferred to the new N.W. Quad plant.
Rochester Embayment	NA	AWT and LFA Both required	Phosphate reduction and extended outfalls with diffusers to carry wastes beyond embayment area.	3-1/2 mile outfall has been constructed for the Durand Eastman Regional Plant.
Irondequoit Bay	NA	AWT and LFA Both required	Nutrient removal. Reduction of deicing salt during winter.	Improve outlet to Lake Ontario to permit greater exchange of waters.
Irondequoit Bay	1:1	AWT and LFA Both required	---	Barge Canal waters supplement flow via siphons and overflow weirs.

LEGEND: AWT Advanced Wastewater Treatment LFA Low Flow Augmentation

NOTE: Annex contains more current data.

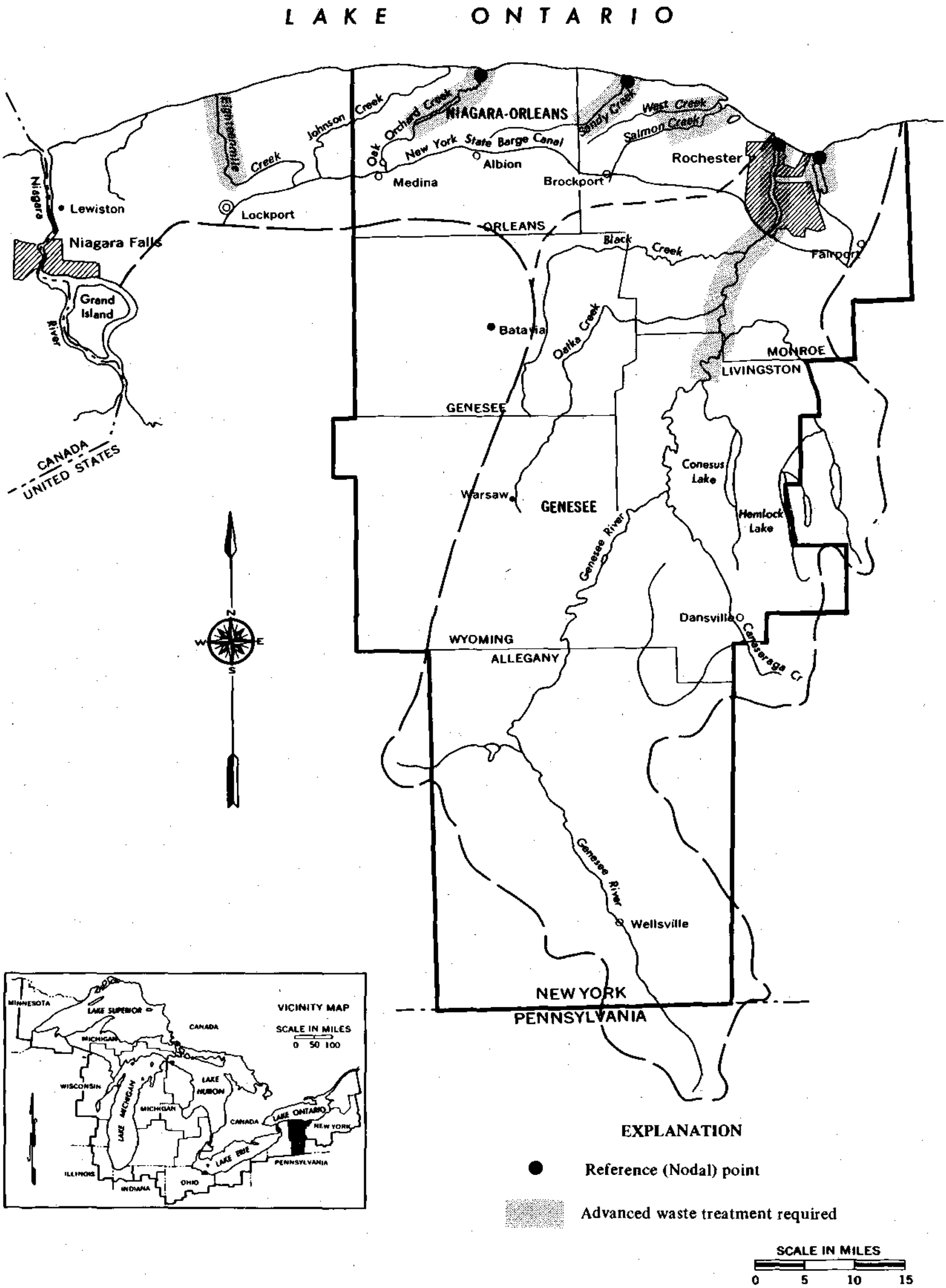


FIGURE 7–38 Lake Ontario West, Planning Subarea 5.1 (Zones of Water Quality Impairment)

TABLE 7-63 Projected Municipal and Industrial Wastewater Treatment Cost Estimates, Planning Subarea 5.1—New York

Planning Period	Municipal Treatment Costs: Capital Costs ($ Million)	Municipal Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)	Industrial Treatment Costs: Capital Costs ($ Million)	Industrial Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)
Present-1980	78	3.1	53	3.4
1980-2000	54	4.2	24	3.5
2000-2020	90	4.4	65	5.4

Because of the rapidly rising chloride level in area waters, the possibility for immediate reduction of salt applied during winter to control road ice should be examined.

Pesticides receive extensive use in fruit belts of the Lake Plain area. Effective January 1, 1971, the State of New York imposed strict regulations on the use of such materials. It is essential that these rules be adequately enforced.

A study should be made to determine what structural methods could be used in agriculture and forestry to reduce the extremely large sediment loads carried by the Genesee River. Most of this load originates from upstream land and sheet erosion. Large quantities of sediment are eventually deposited in the harbor area where they are annually dredged and dumped into Lake Ontario. Erosion control measures such as permanently vegetated filter strips along water courses, drainages, and critical sediment-producing areas may be a practicable solution.

8.3.2 Planning Subarea 5.2

8.3.2.1 Area Characteristics

Although linked by streams and waterways, certain regions within Planning Subarea 5.2 are regarded as distinct from one another because of differences in economic and geographic characteristics. For this reason a departure from the usual format of a stream-by-stream discussion is necessary when considering waste loads and advanced waste treatment needs.

8.3.2.2 Water Uses and Related Quality Problems

(1) The Finger Lakes

The Finger Lakes are a system of six relatively large lakes which occupy large deep valleys in the southwestern corner of Planning Subarea 5.2. Because of their large volume and controlled outlet flows they are not radically affected by seasonal precipitation variations. Each lake provides considerable dilution for waste inputs and eventually assimilates most wastes. The large lake volumes also permit a gradual release of water to the outlets. These lakes provide recreation to millions of upstate New Yorkers and annually attract tourists from many surrounding States and Canada.

In the following discussion inlets and outlets are included under the same heading as the lakes they serve. The condition of each lake warrants a comprehensive limnological study for complete understanding. The following brief descriptions are not intended to give a complete picture but only to serve the ends of this report.

(a) Canandaigua Lake

Naples Creek, the inlet to Canandaigua Lake, fluctuates widely in its flow rates. During summer it exhibits a noticeable decline in dissolved oxygen with a corresponding increase in BOD. This is probably caused by raw waste discharges from the Village of Naples. Faunal analyses do not indicate a critical need for advanced waste treatment, but secondary treatment is needed.

Canandaigua Lake itself receives no large direct waste discharges from municipalities or industries. Its waters retain generally good quality despite the input from Naples Creek and moderate seepage from lakeside cottages. The lake has been assigned an extremely high classification with standards that prohibit direct discharges from even summer cottages. State stream standards are violated in some cases, but pertinent chemical parameters nontheless show some of the lowest values for the Finger Lakes. Uses include public water supply, recreation, fishing and agriculture. High nutrient levels indicate the need for advanced waste treatment. The lake may require a collection system and treatment facility to eliminate discharges by lakeshore cottages.

In the past Canandaigua Outlet received municipal and institutional wastes that caused a serious deterioration in water quality downstream from the City of Canandaigua. The water exhibited organic degradation, high coliform counts, and dissolved oxygen levels often falling below State standards. Secondary treatment facilities have now been installed for the City of Canandaigua and the Veteran's Administration Hospital there. Advanced waste treatment will also eventually be needed, possibly in combination with flow augmentation from the lake during critical periods. Canandaigua Outlet also receives the discharge from Flint Creek which carries untreated municipal and cannery wastes.

(b) Keuka Lake

The quality of Keuka Inlet reflects the heavy organic loading from local winery discharges. This situation is aggravated because peak discharges from the wineries often occur during the low stream flow period in autumn. Untreated municipal wastes are also discharged at Hammondsport. Industrial and municipal advanced water treatment in the form of nutrient removal may eventually be needed on this stream.

Like Canandaigua Lake, Keuka Lake receives no significant direct waste discharges and its high water quality is satisfactory for all uses. Wastes from some shoreline cottages are discharged into the lake but this situation is being remedied by an association of lake property owners. Uses are similar to those of Canandaigua Lake. Possible violations of the lake's very high standards occur primarily in the form of lakeside cottage discharges.

Keuka Outlet receives untreated wastes from the food and grape processing industries and treated wastes from the Village of Penn Yan secondary treatment plant. There wastes apparently cause the high bacterial counts found in the outlet. Waste assimilation studies indicate that even with secondary treatment waste discharges may present a serious problem by 1985. Because Keuka Outlet empties into Seneca Lake the need for industrial and municipal advanced waste treatment on the outlet is important.

(c) Seneca Lake

The second major tributary of Seneca Lake is Catherine Creek which enters the lake at its southern end. The creek's lower reach is classified as a trout stream by New York State, but dissolved solids concentrations are higher than desirable. High sporadic chloride concentrations have also been noted. Benthic analyses at Watkins Glen indicate pollution by organic decomposable wastes which are probably attributable to the Villages of Watkins Glen and Montour Falls. Advanced waste treatment for municipal wastes is needed on this stream to protect troup fishery.

The waters of Seneca Lake exhibit generally high quality, but there are two areas of localized pollution: one along the north shore at Geneva, the other along the west shore at Dresden. Geneva's primary treatment plant discharges wastes totaling 2.0 mgd. Some industrial discharges to tributaries and city storm sewers also add to pollution at Geneva. Periodic closures of north end beaches have resulted from high coliform counts. At Dresden industrial wastes plus the degraded Keuka Outlet enter the lake.

Nutrient concentrations in the lake are not as high as those found in highly eutrophic lakes, but are within the range considered sufficient for stimulating high algal growths. Large areas of troublesome weed beds have developed in recent years.

Chlorides are increasing significantly in the lake and are found in higher concentrations at the north and south ends. The major contribution may be natural, arising from salt beds intercepted by the lake basin, but it is likely that commercial salt plants at the south end of the lake have contributed significant quantities.

Uses of Seneca Lake include public and industrial water supply, bathing, boating, recreation, fishing, transportation, power plant cooling, and waste disposal. Biologically it may be termed moderately productive. It is no longer a "young" lake. Advanced waste treatment for municipal and industrial wastes is needed to retard an accelerated advance toward eutrophication.

Seneca Lake's outlet is the Seneca River which forms the Cayuga-Seneca section of the Barge Canal system. Primarily because of industrial wastes it is grossly polluted along its entire length. Municipal wastes were a problem in the past, but their contribution to the stream's organic load has been considerably lessened with installation of secondary treatment facilities at Waterloo and Seneca Falls. Stream standards are violated by low dissolved oxygen levels, settleable solids, and some toxic wastes. Uses include industrial and municipal water supply and discharge, navigation, and fishing. Flows from Seneca and

Cayuga Lakes are regulated for hydropower and Barge Canal navigation, but low-flow augmentation receives only minor consideration. Flow is controlled by the New York Electric and Gas Corporation for use during peak power production. This results in wide fluctuation of flows into the Seneca River, causing Geneva's waste discharges to Seneca Lake to occasionally flow directly into the river with little dilution. This is of concern to the City of Waterloo which has a water supply intake located only a short distance downstream. Also of concern are local fish populations because these same wastes are often carried downstream in slugs, contributing to conditions causing fish-kills.

Municipal and industrial advanced waste treatment is needed along this stream reach. This should be used in combination with better flow regulation and advanced waste treatment for Geneva's wastes.

(d) Cayuga Lake

The waters of Cayuga Inlet are of generally good quality except near its confluence with Cayuga Lake where the City of Ithaca discharges a secondary effluent totaling 3.5 mgd. Uses of the inlet include fishing, agriculture, and municipal waste disposal.

Except for areas of localized pollution the waters of Cayuga Lake are of satisfactory quality for all uses. Beaches in the Ithaca area have had to be closed primarily because of limited transparency caused by suspended phytoplankton blooms and bacterial pollution. This situation is caused in part by certain natural phenomena in the lake. Although Ithaca's discharge is highly treated and disinfected, and the dominant lake flow is to the north, the flow often reverses, returning wastes to the southern shoreline.

Cayuga Lake is mildly productive, although nutrient levels average slightly above concentrations necessary for large algal growths. The lake exhibits no serious signs of advanced eutrophication.

Chloride levels are similar to those in Seneca Lake. In this lake also the principal contribution may be natural. However, the International Salt Company plant near the south end of the lake discharges a chloride-laden waste.

Pollution stemming from agricultural fertilizers and insecticides is a growing problem which requires further study. Sprayed insecticides, especially DDT, have built up in the food chain of lake trout to the point that these fish are of questionable value for fish hatcheries. It has been estimated that through fertilization of agricultural lands 2 million pounds per year of nitrates and 110,000 pounds per year of phosphorous reach Cayuga Lake. Estimates for Seneca Lake are about half these values.

Use of the lake includes municipal and industrial water supply, recreation, fishing, power plant cooling water, and transportation. A large portion has been assigned extremely high standards by New York State. These standards may be locally and temporarily violated by municipal and industrial discharges. Municipal and industrial advanced waste treatment and improved agricultural and forestry practices are needed to safeguard the lake's present condition.

Because the Seneca River flows into Cayuga Outlet, improvement in the outlet's water quality will come when advanced waste treatment is instituted on the Seneca River. Also, flow regulation from Cayuga Lake must be instituted for other uses in addition to hydropower and Barge Canal navigation.

(e) Owasco Lake

Owasco Inlet exhibits fairly good quality as it reaches the lake. Primary and untreated wastes from Groton and Moravia cause some organic loading, but the stream water recovers, and the wastes have little harmful effect on the lake waters.

Owasco Lake shows little evidence of degradation. Nutrient concentrations sufficient for the support of algal growths are present, but apparently other necessary conditions are not. There are no significant industrial or municipal discharges to the lake. Cottage development, however, is heavy along the shorelines. Although there are direct discharges from septic systems, these discharges apparently do not violate stream standards. Uses include water supply, recreation, and fishing. Advanced waste treatment is not needed, except for possible reductions of nutrient inputs that would be beneficial.

Owasco Outlet below the City of Auburn is grossly polluted. The stream displays high BOD, phosphates, dissolved solids, and chlorides. These characteristics were also found in benthic analyses. The stream receives a heavy organic loading from Auburn's inadequately treated discharge totaling 9.0 mgd, as well as from many unconnected sewers. Coliform counts and settleable and floating solids exceed State standards. Municipal advanced waste treatment is needed on this stream.

(f) Skaneateles Lake

Skaneateles Inlet does not receive significant wastes, and its discharge has no detrimental effect on the lake.

Like other smaller Finger Lakes, Skaneateles Lake does not receive any single large waste discharge. Its water quality is excellent for all uses, despite minor quantities of waste from direct discharges and septic tank seepage from numerous shoreline cottages. Control of algal populations with copper sulfate is practiced by the City of Syracuse which draws its domestic water supply from the lake. Uses include water supply, recreation, and fishing.

Skaneateles Creek, the outlet for the lake, discharges into the Seneca River. Downstream from the Village of Skaneateles at the northern end of the lake, the entire stream is polluted. Primary wastes from Skaneateles and several industrial wastes combine with an untreated discharge from Skaneateles Falls to cause violations of State standards. The stream displays dissolved solids concentrations, low dissolved oxygen levels, toxic waste concentrations, and discoloration. High nitrogen, phosphate, and bacterial levels exist. Although conditions improve downstream, the stream is still polluted as it enters the Seneca River.

(2) New York State Barge Canal

Discussions of the Barge Canal include the reach from Macedon to Three Rivers, excluding the Cayuga-Seneca section discussed under the Finger Lakes region. The Barge Canal east of Three Rivers is covered in the Oneida Lake region.

The prime purpose of the canal is navigation, predominantly merchant shipping, although recreation has assumed a more important role in recent years. Agreements exist between the State of New York Department of Public Works and the New York Electric and Gas Corporation to regulate flows in the upper Seneca River for peak hydroelectric power periods. Flow regulation of Seneca and Cayuga Lakes is geared primarily to navigation and power. Maintenance of adequate depth for navigation and bridge clearance for waterborne traffic on the canal primarily dictate flow regulation from the lakes.

The Barge Canal between Macedon and Newark continues to exhibit the moderate pollution condition common to the entire western section of the canal. Low velocities and artificial controls reduce the canal's assimilative capacity. The sector between Macedon and Newark receives numerous industrial and municipal discharges, both directly and from tributaries, which exert a heavy organic loading. The largest municipal discharges are direct. An untreated effluent of 0.3 mgd is discharged from the Village of Macedon, and a secondary effluent of 0.4 mgd is discharged from the Village of Palmyra. Industrial wastes with little or no treatment are discharged chiefly from food operations such as canning and preserving plants. Many of these wastes are discharged into tributaries, polluting both the tributaries and the canal was well. Peak discharge of food industry wastes comes at a time of year when receiving streams are least able to handle the load. Discoloration, floating and settleable solids, high BODs, and low dissolved oxygen levels characterize the waters of the canal and its tributaries.

Below the Village of Newark the canal is seriously degraded. This is caused chiefly by a lack of industrial waste treatment combined with a lack of appreciable flow between Newark and Lyons. Three miles upstream from Newark the entire canal flow is diverted into lower Ganargua Creek. In effect this leaves a stagnant pool in which a minimal exchange of water takes place only from lockages and leakage. Ganargua Creek parallels the canal to Lyons where it rejoins the canal. On this section of the canal inadequately treated food processing wastes again deliver a heavy organic loading from June through December. During this period dissolved oxygen levels, floating solids, and discoloration are in violation of stream standards. Principal violaters were to tie in with Newark's treatment facilities which discharge to Ganargua Creek. Advanced waste treatment for food processing wastes is needed on this reach along with consideration of flow augmentation below Newark or relocation of discharge.

At Lyons the canal receives a heavy organic loading from the National Biscuit Company. This discharge plus 0.30 mgd of secondary effluents from Lyons cause a slight degradation in quality.

At Clyde further deterioration occurs as a consequence of primary treated wastes from that village combined with an untreated food processing waste.

From the Clyde River confluence to Three Rivers, the canal receives minimal direct waste discharges. However, nutrient levels, BOD, and suspended and dissolved solids concentrations are higher than desirable. A decrease in water quality occurs below the major tributaries of Owasco Outlet and Skaneateles Creek, but the most vivid change occurs below Onondaga Lake Outlet. This reflects the discharge of municipal and industrial wastes by the Syracuse metropolitan area to Onondaga Lake. BOD and concentrations of nutrients, solids, and chlorides are high. Dissolved oxygen levels are low considering the sizeable flows in the canal. The canal partially recovers before reaching Three Rivers. Advanced waste treatment which will benefit this reach of the canal is discussed in the following section.

(3) Syracuse Metropolitan Area

Discussions of the Syracuse metropolitan area include most of Onondaga County except for the Finger Lakes region, the Barge Canal, and the Oneida Lake region, which are discussed separately in this section. Onondaga County is the most significant county within the Oswego River basin and within Planning Subarea 5.2. It has the largest metropolitan population, centered in Syracuse, as well as the largest manufacturing complex, including 135 industrial plants. Because of high municipal and industrial pollution the area contains the largest pollution problem in the planning subarea: the pollution in Onondaga Lake and its tributaries.

(a) Otisco Lake

The quality of water in Otisco Lake compares with that of the Finger Lakes. The chemical quality indicates minimal pollution and the lake exhibits a healthy biological environment. However, shoreline erosion resulting from water supply withdrawals by the Onondaga County Water Authority may be a growing problem. Biological samples in 1965 revealed a bottom composed almost entirely of silt. That same summer the lake displayed drops in elevation as much as 13 feet. Uses of the lake include public water supply, agriculture, fishing, and recreation. State stream standards are not violated.

Ninemile Creek is the outlet from Otisco Lake and a major tributary of Onondaga Lake. As water supply withdrawals from the lake have been increased flows to the creek have been greatly reduced. The creek receives three municipal discharges, only one of which receives secondary treatment; periodic discharges from the State Fair Grounds; four industrial discharges from food processors; and a discharge from Allied Chemical Corporation. Dissolved solids and chlorides increase in marked progression along the entire stream length as do sulphate, calcium, magnesium, sodium, and potassium concentrations. Benthic fauna does not change significantly until the stream reaches the Solvay Process waste beds where calcium compounds and sodium chlorides give the stream a permanent milky color and prohibit benthic growth. These precipitates have also accumulated in a delta at the creek's confluence with Onondaga Lake.

Uses of stream include municipal and industrial waste disposal, industrial water supply, and fishing on its upper reaches. A portion of the stream's municipal discharges now receive secondary treatment. It is expected that the remainder will receive secondary treatment with the formation of the Ninemile Creek Sanitary District. Adequate industrial treatment, however, remains the most critical requirement. Allied Chemical Corporation is working with the Onondaga County Public Works Commission to discharge its wastes to the Syracuse Municipal Plant. This facility is being upgraded to provide secondary treatment, but it will not be completed until 1975 at the earliest.

Although wastes from Allied Chemical Corporation are a significant cause of the degradation of lower Ninemile Creek, these wastes have a more important effect upon Onondaga Lake. The company's role as a polluter of that lake, through discharges to Ninemile Creek and direct discharge as well, will be discussed further in the Onondaga Lake subsection.

(b) Onondaga Lake

Decades of use as a receptacle for all types of untreated wastes has made Onondaga Lake unsuitable for public water supply, recreation, or fishing, and has turned it into one of the most serious pollution problems in New York State. Several immediate needs must be satisfied before an economically feasible long-range plan can be developed to systematically revive the lake. A number of major water quality problems exist.

Raw or partially treated municipal and industrial wastes are discharged directly into the lake and received from tributaries. Major polluters discharging directly to the lake are the Syracuse Metropolitan treatment plant and Crucible Steel. The Solvay Process Plant also discharges large quantities of cooling water directly, in addition to its Ninemile Creek discharge.

The Metropolitan treatment plant provides the equivalent of primary treatment although it possesses the hardware of an intermediate treatment plant. It is hydraulically overloaded because Syracuse has a combined sewer system. Flows often must be bypassed at the plant. There are also numerous other overflow chambers provided in the system. Original plant improvement schedules have been all but forgotten and the anticipated completion date is now set for mid-1975.

Crucible Steel discharges cooling water and process wastes directly to the lake at the rate of 7.2 mgd. These wastes contain pickling washings, acids, and oils. Effects on the lake include a decrease in dissolved oxygen, increases in BOD and suspended solids, turbidity, discoloration, and visible oils and grease. Final plans for process waste abatement facilities have been submitted, but Crucible Steel remains three years behind the implementation schedule imposed by New York State.

Mercury is a source of pollution that has gained considerable attention. Until recently Allied Chemical Corporation was the major source of mercury in this watershed. Action was taken against the corporation and it was placed under a court stipulation by the U.S. Attorney. The corporation has thus far satisfied conditions of the stipulation by reducing its mercury discharge from approximately 24 pounds a day to less than one-half pound a day.

Current proposals are to use the discharge from Allied Chemical Corporation to aid in phosphorus reduction at the Syracuse Metropolitan plant. This would be a major step towards resolving some pollution problems. However, the corporation also has a large cooling water discharge to the lake which must be investigated further to determine the effect of the heat input on the lake environment.

Because of the huge effluent discharges from the Syracuse Metropolitan treatment plant, Crucible Steel, and Allied Chemical Corporation, immediate abatement of any one of these pollution sources by itself would not bring Onondaga Lake into compliance with State stream standards. An effective program to revive the lake should start with the control of all three sources. Wet weather overflows from the city's combined sewer system frequently carry large quantities of untreated sewage to the lake. This is caused by reduction in interceptor capacity and deterioration of overflow chambers through grit buildup. Large deposits of both organic and inorganic sediments have accumulated during the past century in the lake. Cores of these deposits reveal varying layers of black sludge and white clay-like material up to 18 feet thick. This is a result of discharges from the treatment plant and the chemical company. Because of natural hydrologic phenomena, Onondaga Lake, even in its most natural state, would have difficulty assimilating anything but the most highly treated wastes. It is relatively small with a surface area of only approximately 4.5 square miles and depths ranging from 20 to 60 feet. Four small tributaries flow into the lake, thus providing little flushing action. This in turn limits the assimilative capacity of the lake.

The Federal Water Pollution Control Administration conducted a sampling program in the summer of 1965. Results showed high phytoplankton populations in the surface waters, but a complete absence of macroinvertebrates of any kind in the lake bottom. This is caused in part by the long-term accumulation of organic and inorganic waste deposits throughout the lake. The sampling also revealed high concentrations of chlorides, phosphates, calcium, nitrogens, iron, and BOD. Dissolved oxygen was near complete depletion below a depth of 25 feet.

The four streams tributary to Onondaga Lake are Ninemile Creek, which was previously discussed as the outlet for Otisco Lake, and Ley Creek, Onondaga Creek, and Harbor Brook.

Lower reaches of Ley Creek are grossly polluted. Flows are sluggish and stream standards are violated by floating solids and oil. Conditions have recently improved, however, with connection of the Ley Creek treatment plant to the Syracuse Metropolitan plant. The lower reaches of the creek are used chiefly for drainage and the upper reaches for recreation.

Onondaga Creek and Harbor Brook each receive large amounts of untreated sewage from more than 60 combined sewer overflows from the city's two main interceptors which parallel the creeks. State standards are violated on the lower reaches of both streams by high bacterial counts, low dissolved oxygen levels, high organic content, and discoloration. Uses of Onondaga Creek include transportation and industrial process and cooling water on the lower reaches, as well as recreation and fishing upstream. Trout stream standards exist for the uppermost reaches. Uses of Harbor Brook include industrial waste disposal on the lower reaches and recreation and fishing upstream.

(4) Oneida Lake Region

In the Oneida Lake region major water quality problems are found in Oneida Lake and its tributaries to the south. The southern portion of the basin contains the major population concentrations, the most agricultural activity, and the only significant industrial activity in the basin.

(a) Onedia Lake Tributaries

Oneida Lake tributaries are Chittenango Creek and its tributaries, Butternut and Limestone Creeks; Canaseraga Creek; Oneida Creek; Fish Creek, which enters the lake through the Barge Canal; and several minor tributaries.

Water quality on Limestone and Butternut Creeks will soon change with completion of a new regional plant, Meadowbrook-Limestone. This plant will treat wastes from some industries and municipalities which originally discharged to both creeks. Unfortunately the plant will sorely tax the assimilative capacity of Limestone Creek where its effluent will be discharged. Either advanced waste treatment or low-flow augmentation will be required in the immediate future. Uses for Limestone Creek include industrial and municipal water supply, agriculture, and fishing on the upper reaches.

Butternut Creek, which is joined by Limestone Creek near its mouth, is also subjected to several primary or untreated municipal discharges. Plans to eliminate these call for upgrading present plants or creation of a new sanitary district. Grease and oil wastes from a railroad diesel repair facility also are discharged to the lower reaches of the stream. Stream standards are violated by high bacterial counts, dissolved solids concentrations, low dissolved oxygen levels, and floating oil. Uses and needs for municipal and industrial advanced water treatment approximate those of Limestone Creek.

Chittenango Creek receives municipal wastes totaling more than 1 mgd. Half of those wastes are untreated and half receive primary treatment. Chittenango Creek also receives residual wastes from Limestone and Butternut Creeks. The result of these loadings is reflected in the biology of the downstream reaches. Analyses have revealed an abundance of benthic organisms ranging from clean-water to pollution-tolerant types. Luxuriant growths of aquatic vascular plants are found along the entire stream reach in the Bridgeport area. Uses of the creek include agriculture on its lower reaches, public water supply and waste disposal along nearly its entire length, and recreation and fishing on the upper reaches. Muncipal advanced waste treatment in the form of nutrient removal is needed on this stream.

Municipal waste pollution is the main pollution problem in the Canaseraga-Cowaselon-Canastota Creek network. The problem originates on Canastota Creek and reaches Canaseraga Creek via its major tributary, Cowaselon Creek. For decades both of these Canaseraga Creek tributaries have been adversely affected by untreated sewage discharges from the Village of Canastota. Canastota recently introduced secondary treatment facilities for 1.1 mgd of wastes, but treatment has not proven effective and the source remains only partially abated. Water uses in this network include fishing, agriculture, and municipal waste disposal. Municipal advanced waste treatment and nutrient removal are still needed.

Oneida Creek receives several significant municipal discharges. Most of these wastes receive no more than primary treatment. Fishing, agriculture, and municipal waste disposal are its principal uses. The lower reach of the creek is adversely affected by primary effluents totaling more than 2 mgd from the Cities of Oneida and Sherrill. Gross pollution is exhibited in the vicinity of Oneida by an abundance of pollution-tolerant benthic fauna as well as extremely low dissolved oxygen levels which fall far short of State stream standards. In addition the Kenwood plant of Oneida Limited discharges industrial wastes to the creek after treatment for removal of toxic metals, oil, grease, and solids, and after dilution with wash water and cooling water.

Sconondoa Creek, the main tributary of Oneida Creek, receives both municipal and industrial wastes. Moderate pollution exists chiefly from a municipal primary treatment plant. The Sherrill plant of Oneida Limited has a recovery and neutralization system discharge of approximately 1.0 mgd. This has been further improved by expansion of waste treatment capabilities.

Municipal and industrial wastes discharged to Oneida and Sconondoa Creeks, although receiving some degree of treatment, exceed the assimilative capacity of the streams during low-flow periods. Both streams are subject to considerable flow fluctuation because they have no upstream lakes or reservoirs for retention of runoff. As a result critical periods of low flow often occur. Advanced waste treatment for municipal and industrial wastes is needed.

Fish Creek is the only major tributary of Oneida Lake that flows in a southerly direction to the lake, with its watershed north of the lake. There are only a few municipal and industrial waste sources, which exist primarily on the West Branch. This enables the creek to exhibit the best water quality of Oneida's major tributaries. The most significant waste source is at Camden on the West Branch where a primary-treated effluent of approximately 0.25 mgd is discharged. This results in only localized pollution due to the high natural flow and good assimilative capacity of the stream. Camden plans to construct a secondary treatment facility. Fish Creek is used for fishing, recreation, and agriculture. Nutrient removal on the stream would, of course, be beneficial to Oneida Lake, which suffers from large algal blooms.

Oneida Lake has numerous minor tributaries which are polluted by dairy wastes from milk-receiving stations and cheese factories. All these discharges contribute to the overfertilization of the lake.

(b) Oneida Lake

Oneida Lake may have been in an advanced state of eutrophication for some time. Fresh growths of aquatic plants along the shoreline, as documented by early explorers, testify to its high state of natural productivity. This condition has been compounded and its progression accelerated by the input of large quantities of nutrients from poorly treated municipal and industrial wastes. A large portion of these nutrients enters the lake via the tributaries previously discussed, but an even larger portion is apparently caused by natural runoff including the portion attributable to agricultural activity. In addition the lake receives many direct discharges from cottages and vessel wastes from a large number of pleasure craft and from the Barge Canal traffic which crosses it. Extensive blooms of floating algae are seen on the lake. These blooms decay into foul smelling masses that eventually wash ashore, severely limiting recreational uses of the lake waters and shoreline property through much of the summer and fall.

Phosphate levels in the lake are consistently high. Monthly variation of these levels generally reflects the influence of supply waters and the growth cycle of the phytoplankton and algae. For the Oneida Lake basin as a whole, only a small percentage of the total phosphate loading is the result of municipal and industrial discharges made directly into the lake or its tributaries.

Other indications of Oneida's deterioration are its limited transparency and increasing alkalinity. In comparing Oneida Lake to the Finger Lakes and Great Lakes, only Onondaga Lake has an average transparency less than Oneida Lake.

In 1927 the total alkalinity of the north shore of Oneida Lake varied from approximately 10 mg/l to 20 mg/l as calcium carbonate. In 1965 the alkalinity had increased to between 80 and 90 mg/l. This change is directly related to the increase in productivity which reduces the amount of free carbon dioxide and increases the pH.

Certain natural limnologic features such as a warmwater mass, shallow depths, and irregular tributary streams that carry scoured fertilizers and other nutrient-rich material to the lake add to its quality problem. Oneida Lake occupies a shallow depression in the approximate center of its drainage basin. Its maximum depth is only approximately 50 feet and its mean depth is 25 feet.

The lake is used for recreation, fishing, agriculture, navigation, and municipal and industrial waste disposal. It has the largest surface area of all lakes lying wholly within the State of New York. Plants that discharge directly into the lake should be expanded to include advanced waste treatment, and the numerous discharges from shoreline cottages and homes should be eliminated, possibly through the formation of a perimeter sewer district. The Oneida Lake Shore Sewer District is presently in the planning stages, but it will include only the western half of the lake's south shore. Elimination of wastes from Barge Canal traffic and pleasure craft would undoubtedly improve water quality, but the largest source of enrichment to the lake apparently is land runoff. Proper agricultural and forestry practices should reduce the nutrient and sediment loads from land runoff.

The Oneida River, the outlet for Oneida Lake, flows westward to Three Rivers, where it joins the Seneca River to form the Oswego River. It is part of the Barge Canal system and experiences a great seasonal variation in flows which may exceed 8,000 cfs during the spring and drop as low as 100 cfs during periods of low flow. Flows are regulated by a dam at Caughdenoy for navigation in the Canal and recreation on Oneida Lake. The river passes through a region consisting chiefly of woodland, farmland, and swampland, but it is subjected to pollution from Barge Canal traffic in the form of garbage, sewage, and oil. This, combined with the constant stirring of bottom sediment from the passage of boats, gives the river a dirty appearance in places. In addition the Town of Brewerton discharges untreated effluent from a population of approximately 1,000.

Principal uses of the river include fishing, recreation, agriculture, navigation, and waste disposal. There are no violations of stream standards except in localized areas which may have floating oil or solids. Elimination of Barge Canal traffic wastes and occasional oil spills from marinas would contribute to elimination of these localized areas of pollution. Municipal advanced waste treatment is not needed.

(5) Oswego River

Although the Oswego River is only 24 miles long, it receives large volumes of municipal and industrial wastes. Until recently many of these wastes received no treatment.

The river is high in dissolved organics at its headwaters where a dilution ratio of 2.0:1.0 may exist during critical periods. At Phoenix the river exhibits moderate pollution caused by the discharge of primary-treated effluent from the village and a 2.3 mgd paper processing discharge.

At Fulton the canal section between two locks is extremely polluted. Discharges into the river upstream and in this section include 3.4 mgd of primary-treated effluent from the City of Fulton and four relatively large industrial discharges.

Two miles downstream a cork processing plant releases a large discharge which in the past created an unsightly delta of deposits in the river below the outfall. The plant recently installed treatment facilities which should eventually resolve many of the problems in this reach. Farther downstream bottom deposits are resuspended by river traffic, discoloring the river as it flows past a State park. Dissolved oxygen concentrations in this reach are low relative to the large flows.

At Minetto the river receives an untreated municipal discharge from a population of 2,000 as well as a relatively large discharge from a textile works. Before entering Lake Ontario the river flows through the City of Oswego where it receives large volumes of industrial and municipal wastes. On the east side of Oswego construction of a secondary treatment facility was recently completed to serve most of its sewered population of 23,000. The west side is presently served by a primary plant, but final plans have been submitted for a tertiary facility. Several industries presently discharge wastes to the river in this area, but these industries plan to connect to the municipal system.

The placement of a nodal point at the mouth of the Oswego River results in a dilution ratio of approximately 2.0:1.0. Although the river's overall condition has been improved by installation and upgrading of treatment facilities, advanced waste treatment in the form of phosphate reduction would be beneficial.

8.3.2.3 Waste Loads

Waste loads in Planning Subarea 5.2 are listed in Table 7-64. These figures do not include the 259 mgd cooling water discharge from Rochester Gas and Electric Corporation's Ginna nuclear power plant. This plant is located on Lake Ontario approximately five miles west of Sodus Bay in Wayne County and discharges wastes into Lake Ontario.

TABLE 7-64 Waste Loads (MGD), Planning Subarea 5.1—New York[a]

Year	Load	
	Municipal	Industrial
1970	128	188
1980	155	205
2000	216	98
2020	289	209

[a]Also see Annex for more current estimates.

8.3.2.4 Advanced Waste Treatment Needs

Because of the pattern of flows in this planning subarea and the lack of low-flow information which prohibits more localized calculations, it was decided that the nodal point method of recommending treatment could function best by assigning only a minimal number of such points. Flows from the Finger Lakes, Barge Canal, and Onondaga Lake region converge with flows from the Oneida Lake region at Three Rivers (where the Seneca and Oneida River enter the Oswego River). Nodal points have been placed at three Finger Lakes outlets; at the end of the Seneca River System; at the end of the Oneida River system; at the head of the Oswego River below the Seneca-Oneida confluence; and at the confluence of the Oswego River with Lake Ontario.

A strict application of the water quality methodology developed for this appendix results in a stream-flow/waste-flow dilution ratio of 0.9:1 on the Seneca River. In actuality such a ratio must not be regarded as completely accurate, because it includes those wastes discharged far upstream to the Finger Lakes and Barge Canal which are largely assimilated before reaching Three Rivers. Most of the total waste volume calculated in this nodal point is discharged to Onondaga Lake, but the validity of a dilution ratio at Three Rivers is further complicated by the natural hydrologic factors for Onondaga Lake. These factors occasionally cause the reversal of flow in Onondaga Outlet which results in poor flushing action. Many wastes discharged into the lake settle and, therefore, never reach this nodal point.

In short, the problems of the Onondaga Lake region, clearly the most degraded in the planning subarea, have been presented without emphasizing quantification by use of a nodal point ratio. Such a point placed at the end of this system, though it is the only way to apply the methodology with available information, cannot truly represent stream conditions or be used as a basis for accurate advanced waste treatment recommendations.

Nodal point calculations just upstream from Three Rivers on the Oneida River reveal a low stream-flow/waste-flow dilution ratio of approximately 8:1. This barely satisfies the 8:1 guideline ratio which, according to the methodology, prescribes a need for advanced waste treatment. However, the ratio calculated for the Oneida River should not be considered as an accurate measurement of water quality upon which to base recommendations for advanced waste treatment.

Present and future needs are summarized in Table 7–65. Figure 7–39 shows selected advanced waste treatment nodal points and zones of water quality impairment. It should be noted that very few of the listings in Table 7–65 include dilution ratios for the reasons previously indicated.

8.3.2.5 General

In recognition of water quality problems in Planning Subarea 5.2, considerable comprehensive planning has taken place in recent years. (See Table 7–66).

The State of New York, assisted by several Federal agencies, has recently completed three separate comprehensive water resource studies in Planning Subarea 5.2. These studies are under auspices of regional planning boards established by the State. They are similar to a Type II comprehensive study.

Countywide comprehensive sewage studies are complete or nearing completion.

The Environmental Protection Agency (EPA) recently sponsored three studies within the planning subarea. Two research and development grants were given to the Onondaga County Department of Public Works for conducting a study of Onondaga Lake and for investigating solutions to the combined-sewer overflow problems in Syracuse. The third grant was given to Widmer Wineries to resolve some of the related treatment problems which plague the Finger Lakes region.

In June 1968 the Federal Water Pollution Control Administration (now EPA) and the State of New York conducted a comprehensive study of the Lake Ontario and St. Lawrence River basin. This study was entitled *Water Pollution Problems and Improvement Needs.* An unpublished report covering the Oswego River basin was also completed by the Rochester Field Office of EPA. A thorough examination of the findings of such studies is urgently needed. This should be followed by implementation programs that would resolve water quality problems in the most direct and economical manner and serve the best interests of the Great Lakes as a whole. There are several proposals that could alleviate some of the most significant water quality problems in Planning Subarea 5.2.

In the Finger Lakes area, associations of lake property owners have developed in recent years. Consolidation of these groups has been discussed. This would strengthen the associations' efforts to improve water quality and would provide for exchange of information. At Keuka Lake use of a full-time inspector has been extremely successful in resolving many problems. Local inspecting of other lakes is suggested.

High chloride concentrations are present in both Seneca and Cayuga Lakes. Increasing at an alarming rate, these concentrations pose a serious problem. An early solution should be sought.

On Seneca Lake excessive aquatic weeds have caused concern among lakeside residents. The weeds have hampered both boating and water supply intakes for cottages. The situation should be investigated and immediate interim solutions such as chemicals or mechanical harvesters should be considered.

On Cayuga Lake as well as other lakes pesticides have become a serious threat to lake trout. Closer controls for pesticide use are clearly needed.

TABLE 7-65 Present and Future Treatment Needs, Planning Subarea 5.2—New York

Stream	Dilution Ratio	Needs	Other	Remarks
Finger Lakes	NA	AWT	PO_4 reduction, weed and pesticide control, perimeter sewers.	Lakes are not eutrophic but man's inputs have accelerated aging process. Direct inputs from cottages and agricultural runoff are major sources. DDT has built up in food chain of lake trout. Copper sulfate is in use for algae control.
Canandaigua Lake	NA	AWT	---	AWT required with regard to nutrient removal for lake proper.
Canandaigua Lake Inlet (Naples Creek)	--	AWT	---	Provisions of secondary treatment should be adequate through 2000.
Canandaigua Lake Outlet	1:1	---	---	This is a long range need.
Keuka Lake	NA	AWT	---	AWT is in form of nutrient removal.
Keuka Lake Inlet	--	AWT	Immediate PO_4 removal.	Provision of secondary will probably be adequate through 2000.
Keuka Lake Outlet	--	AWT and LFA	Immediate PO_4 removal.	AWT about 1985.
Seneca Lake	NA	AWT	Immediate reduction of nutrients from agricultural runoff and cottages. Aquatic weed control.	High chloride concentrations are steadily increasing and pose a serious problem. Early solution must be sought.
Seneca Lake Inlet (Catherine Creek)	--	AWT	Immediate PO_4 removal.	Will eventually be necessary to protect trout fishery.
Seneca Lake Outlet (Seneca-Cayuga Calan)	--	AWT and LFA	Removal of toxic wastes.	Fish kills have been prevalent.
Cayuga Lake	NA	AWT	Immediate reduction of nutrients and pesticide control.	Investigate sources of high chloride concentrations.
Owasco Lake	NA	AWT	Reduction of nutrient inputs.	---
Owasco Lake Outlet	0.7:1	AWT and LFA Both required	Immediate upgrading of existing treatment and increased flow augmentation.	---
Skaneateles Lake	NA	AWT	Reduction of nutrient inputs.	Copper sulfate used for algae control; partial perimeter sewer proposed North end.
Skaneateles Lake Outlet	--	AWT and LFA	Immediate upgrading to secondary and eventually to tertiary.	Increased water supply withdrawals by Syracuse could substantially complicate this situation.
Barge Canal	0.9:1	---	---	Dilution ratio computed on Seneca River near Three Rivers.
Barge Canal, Newark-Lyons Reach	--	AWT and LFA	Also reduce frequency of oil spills from barge traffic.	---
Otisco Lake[a]	NA	LFA	Has a regulation problem relative to water supply demands.	Lake experiences shoreline erosion. During dry periods water has receded up to 13 feet.
Ninemile Creek[a]	--	AWT and LFA	---	Otisco Lake regulation is a determinant factor.
Onondaga Lake[a]	NA	AWT and LFA Both required	Dredging of salt deltas, phosphate reduction by any direct discharges, further reduction of mercury discharges.	Already partially augmented by water supply withdrawals from Skaneateles and Lake Ontario for the City of Syracuse.

[a]Part of Syracuse Metropolitan Area

TABLE 7–65 (continued) Present and Future Treatment Needs, Planning Subarea 5.2—New York

Stream	Dilution Ratio	Needs	Other	Remarks
Ley Creek Harbor Brook and Onondaga Creek (lower reaches)[a]	--	AWT	Prevent the continuous overflows to Onondaga Creek and Harbor Brook. Reduce leachate from solid waste disposal areas on Ley Creek.	Need immediate provision of secondary treatment for all wastes with eventual AWT for most major discharges.
Oneida Lake[b]	NA	AWT	Elimination of direct cottage discharges and those from Barge Canal traffic.	Lake is experiencing an accelerated rate of eutrophication.
LimeStone Creek[b]	--	AWT and LFA Both required	Phosphate removal for all discharges.	Existing DeRuyter Reservoir may be able to provide some augmentation.
Butternut & Chittenango Creeks[b]	--	AWT and LFA	Phosphate removal for all discharges.	Jamesville and Erieville Reservoirs could not provide sufficient low-flow augmentation.
Oneida & Sconondoa Creeks[b]	--	AWT	Immediate phosphate removal	Eventual AWT for both municipal and industrial.
Canaseraga, Cowaselon & Canastota Creek[b]	--	AWT	Phosphate reduction.	Municipal AWT.
Fish Creek & other small tributaries to Oneida Lake[b]	--	AWT	Immediate phosphate removal from municipal and industrial sources and reduction of nutrients from land runoff.	---
Oneida River[b]	8:1	AWT	Reduction of oil spills.	Provision of secondary treatment will probably alleviate most immediate problems.
Oswego River	2:1	AWT	---	In most cases secondary with nutrient removal for major discharges will satisfy immediate needs.

LEGEND: AWT Advanced Wastewater Treatment LFA Low Flow Augmentation

NOTE: Annex contains more current data.

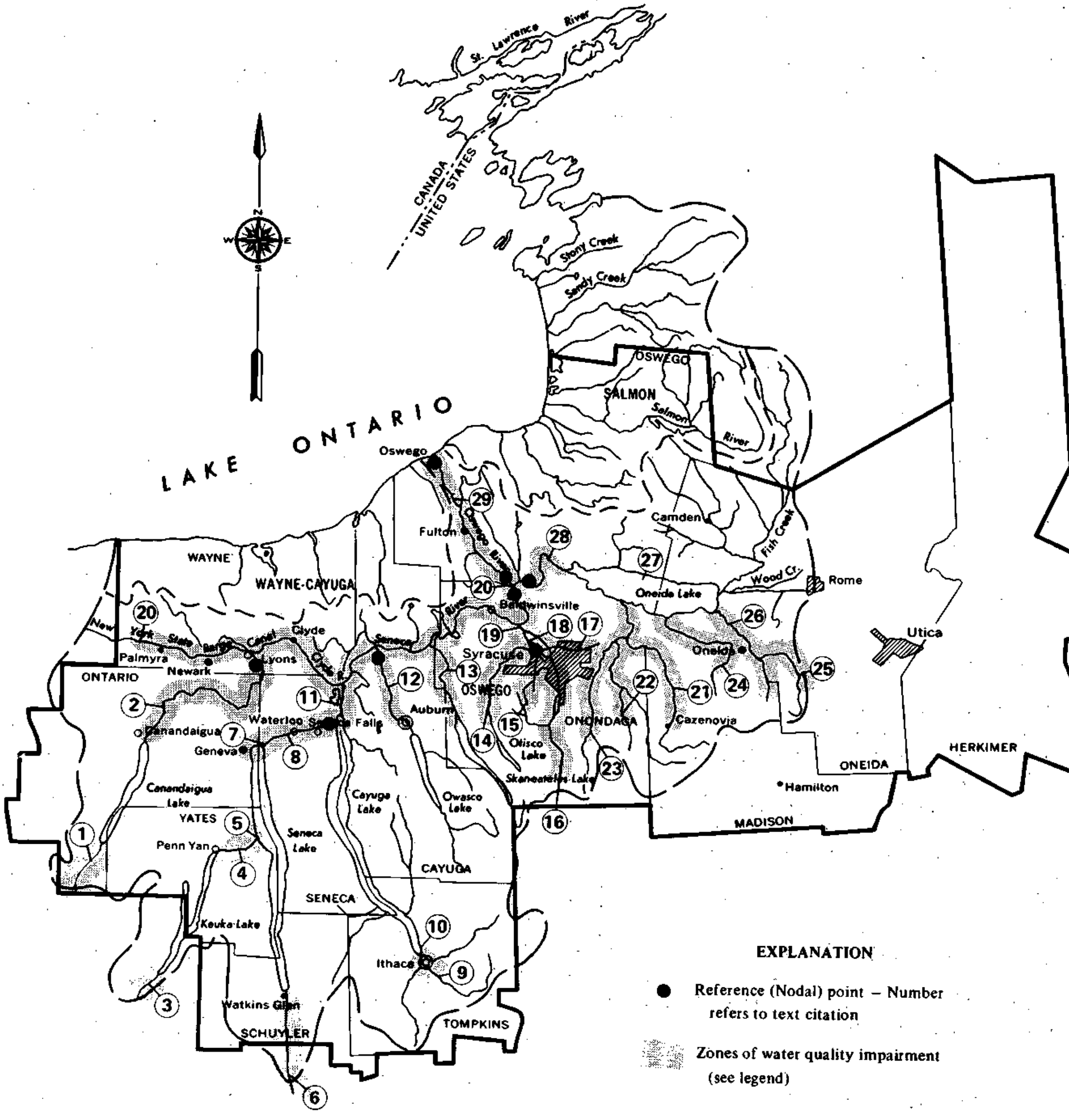
[a]Part of Syracuse Metropolitan Area

[b]Part of Oneida Lake Region

TABLE 7–66 Projected Municipal and Industrial Wastewater Treatment Cost Estimates, Planning Subarea 5.2—New York

Planning Period	Municipal Treatment Costs: Capital Costs ($ Million)	Municipal Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)	Industrial Treatment Costs: Capital Costs ($ Million)	Industrial Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)
Present–1980	35	2.6	61	2.8
1980–2000	22	3.4	24	2.2
2000–2020	50	3.6	84	3.7

NOTE: See Annex for more current estimates



EXPLANATION

● Reference (Nodal) point – Number refers to text citation

Zones of water quality impairment (see legend)

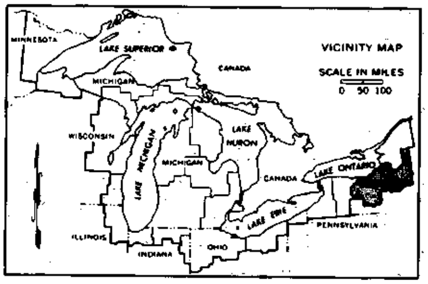


FIGURE 7–39 Planning Subarea 5.2 (Zones of Water Quality Impairment)

Flows from Seneca and Cayuga Lakes are regulated for hydropower, flood control, and navigation. Unfortunately other purposes including low-flow augmentation receive only minor consideration. This policy should be seriously reexamined.

Oneida Lake is in an advanced state of eutrophication resulting partly from the input of large quantities of nutrients. Every attempt should be made to bring about phosphate removal for all municipal and industrial discharges made directly to the lake and via tributaries. Direct discharges from cottages and commercial and pleasure boats should be eliminated. Equally important, a serious effort must be made to reduce nutrient inputs from land runoff, especially that related to agricultural activity, through improved farming and forestry methods.

Signs have been posted on Onondaga Lake warning against eating fish that might be caught, because of mercury contamination. Mercury discharges to the lake must be closely scrutinized to insure that existing stipulations issued by the U.S. Attorney are followed.

Flow augmentation should be given serious consideration on Owasco Outlet and Limestone Creek. Additional sources should be investigated to improve the flushing action of Onondaga Lake.

Several smaller tributaries of Lake Ontario lying within Planning Subarea 5.2 were examined for possible advanced waste treatment needs. Water quality problems were found on Salmon River, Little Salmon River, Red Creek, and the Salmon Creeks in Wayne County. However, the majority of these were localized areas of pollution and the provision of adequate secondary treatment would eliminate the problems.

8.3.3 Planning Subarea 5.3

8.3.3.1 Water Uses and Related Quality Problems

(1) Black River

In the Black River more than 90 percent of the total waste load by volume consists of industrial waste. Most of these industrial wastes come from fiber, paper, and dairy industries, resulting in an extremely heavy organic loading. The larger paper companies use vacuum filtration or sedimentation, but their wastes require further treatment. The largest volume of municipal wastes receive primary treatment with chlorination, but these facilities should be upgraded to include secondary treatment. Estimates show a dilution ratio as low as 7.7:1.0 in the lower reaches of the river during critical periods.

The lower 16 miles of the Black River are grossly polluted. Present uses include industrial and public water supply as well as industrial and sewage waste disposal. High coliform counts and low dissolved oxygen levels resulting from paper mill and sewage plant wastes exceed State stream standards for public water supplies. Eventual industrial and municipal advanced waste treatment is a critical need on this stream reach.

From Black River to Lowville the river is seriously polluted. Present uses include agriculture, fishing, industrial and municipal water supply, and industrial and sewage waste disposal. Degradation occurs through high coliform counts, low dissolved oxygen, foam, fiber, and high BOD, caused by paper mill and sewage plant wastes. These conditions are in violation of stream standards and indicate the need for industrial and municipal advanced waste treatment.

From Lowville to Port Leyden the river is used for fishing, industrial water supply, and waste disposal. Stream standards are violated by high coliform counts, low dissolved oxygen, and high BOD from paper mill and sewage plant wastes. Through this stretch the Black River suffers further from decreased velocity of flows caused by a relatively flat slope and also from wastes from the Moose River which increase the already heavy waste load in this reach. Industrial and municipal advanced waste treatment will be needed eventually. Flow augmentation should also be considered.

In the stretch from Port Leyden to Kayuta Lake the river approaches compliance with stream standards. Use consists primarily of trout fishing. Sewage plants, some small dairies, and farmland runoff contribute to pollution, however, and during low-flow periods dissolved oxygen levels may violate State standards for trout waters. Advanced waste treatment for municipal and dairy wastes is needed to bring about desired conditions on this trout stream.

Because of some small village discharges, the river suffers in water quality above Kayuta Lake, but to a degree compatible with its present usage, fishing. Advanced waste treatment is not needed here.

(2) Oswegatchie River

Variable degrees of degradation are evident throughout the length of the Oswegatchie

River below Cranberry Lake. The degradation is especially concentrated in three generally localized reaches which receive untreated industrial and/or municipal wastes. However, the stream recovers significantly between these reaches due to turbulent flows. On this river, as on the Black River, the largest percentage of the waste load by volume is industrial. Paper mill and dairy wastes combine with municipal wastes to subject the stream to a very heavy organic loading along localized reaches. This, when added to toxic lead smelting and refining wastes, can result in a dilution ratio of 6.0:1.0 in the lower reaches during low-flow periods. These toxic wastes have become a problem of no small consequence in the lower half of the river.

From its mouth to Rensselaer Falls the Oswegatchie River is seriously polluted. Uses include fishing, industrial and municipal water supply, and industrial and sewage waste disposal. Municipal and dairy wastes violate State stream standards because they cause low dissolved oxygen levels and large quantities of floating solids. Advanced waste treatment is critically needed for industrial wastes. Municipal advanced waste treatment will eventually be required.

From Elmdale to Edwards the river again becomes seriously degraded from dairy and municipal wastes and toxic wastes from lead refining processes. Midway along this reach, however, conditions are improved by falls, rapids, and power dams in the vicinity of Gouveneur. Uses approximate those in the lower reach and State standards are violated by low dissolved oxygen levels, discoloration, toxic wastes, settleable solids, and fibrous sludge deposits. Advanced waste treatment will eventually be needed for municipal wastes, but adequate treatment for industrial wastes is the most important need along this reach.

The last polluted reach of the Oswegatchie River extends from Newton Falls to Cranberry Lake. Uses remain the same as on lower sections of the river. Municipal and paper mill wastes cause high BOD. Dissolved oxygen and pH levels, as well as solids, violate State trout stream standards. This situation is complicated by frequent periods of extreme low flow and severe streamflow regulation by the Niagara-Mohawk Power Company at Flat Rock. However, effective flow augmentation is accomplished when needed by the regulation of releases from Cranberry Lake. Industrial and municipal advanced waste treatment will eventually be needed in combination with present flow augmentation to bring this sector into compliance with State standards.

From Wanakena to its headwaters the river is free of pollution. Conditions comply with State standards for trout streams. There is no need for advanced waste treatment.

(3) Grass River

In the lower reaches of the Grass River localized areas of pollution occur below Canton and Massena. A 2.0:1.0 dilution ratio sometimes occurs during critical periods.

The first polluted reach extends from the river's mouth to just below Massena. Major sources are the Massena primary treatment plant with an effluent of 2.5 mgd and an Alcoa Corporation settling and oil separation lagoon with an effluent of 20.5 mgd. These discharges result in low dissolved oxygen levels and high BOD as well as violations of State stream standards in the form of sludge deposits and occasional floating oil. Industrial advanced waste treatment will eventually be needed on this stream reach.

The only other polluted zone lies between the dam at Madrid and the Town of Canton. Once seriously degraded, this reach has recently improved with the installation of secondary sewage treatment facilities in Canton which also serves the Kraft Foods cheese plant. However, untreated discharges by several dairies in the Canton area place an organic loading on the stream, and discoloration and floating solids violate the high State stream standards on this section of the river. Uses along this reach, as well as the lower reach, including fishing, industrial and sewage waste disposal, and industrial and public water supply. Advanced waste treatment is needed for the remaining dairy wastes.

The upper reach of river above Canton exhibits generally high water quality because of the sparse population and turbulent river flow. High State standards for trout streams are not violated. Moderate fluctuations in flows are caused by the few remaining power facilities on the river. Advanced waste treatment is not needed in this area.

(4) Raquette River

Water quality of the Raquette River is generally high except for localized zones of pollution from the mouth to immediately below Potsdam. During periods of low flow a dilution ratio of 22:1 may occur in the lower reaches. However, water quality varies greatly because of the effects of upstream power impoundments, and this ratio may become much worse. There are periods of up to 14 hours when natural river flow below Potsdam is completely cut off. The entire flow during these periods consists of municipal and industrial waste effluents.

Degradation along the last 15 miles of the Raquette River apparently does not result from direct discharges along this reach, but is caused by the continuing oxygen demand from fibrous paper mill discharges upstream. This upstream area which begins at Potsdam, receives a heavy organic loading from paper mills, dairies, and municipalities. Municipal waste pollution, however, has been substantially abated recently with the installation of secondary facilities at Norwood and Potsdam. Violations of State stream standards occur in localized areas and include low dissolved oxygen levels, discoloration, and floating solids. Uses include fishing and municipal and industrial water supply and discharge. Requirements along this reach include industrial and, to a lesser extent, municipal advanced waste treatment in combination with better stream flow regulation from the upstream power impoundments.

The river exhibits generally good quality from Potsdam to its headwaters in spite of some scattered and small municipal discharges. Uses include municipal supply and discharge, fishing, recreation, and power supply. State standards are not violated along this reach. Municipal advanced waste treatment is desirable but not critical.

(5) St. Lawrence River

Although maximum and minimum daily discharges of 350,000 cfs and 139,000 cfs have been recorded on the St. Lawrence River in different years, its flow during a typical water year remains remarkably constant. A 7-day 10-year low flow is estimated at 176,000 cfs. When compared with the waste volume discharged directly and by tributaries, this amount results in a dilution ratio of approximately 1,300:1. This includes only direct and tributary discharges from the St. Lawrence River portion of Planning Subarea 5.3. It does not include discharges from the Canadian shore.

Such a ratio indicates the river's generally good water quality. Some localized zones of pollution do occur, however, and there is evidence of some mercury contamination along its entire length. At Massena poorly treated wastes from the Aluminum Company of America, Reynolds Metals Company, and the Chevrolet Motor Division of General Motors cause violations of State standards in the form of discoloration, floating solids, and floating oil. Added to this are wastes from the Massena primary treatment plant. Generally secondary treatment or its equivalent will be adequate to satisfy treatment needs.

At Ogdensburg the discharge of wastes from the Diamond National Corporation paper plant violates State standards for discoloration, floating solids, and foam. These wastes along with wastes from the primary treatment plant in Ogdensburg also cause a high BOD in this area. Eventual industrial and municipal advanced waste treatment may be needed in this area. Most municipal wastes discharged directly to the river presently receive no treatment or primary treatment at best. Secondary treatment facilities for these municipalities are planned or under construction. The major industries discharging wastes also plan to institute secondary treatment. Water quality should improve by the mid-1970s as these facilities begin operation. This will help to eliminate the gradual increases in chlorides and dissolved solids which have been the only definable changes that indicate a deterioration in the quality of the St. Lawrence River.

8.3.3.2 Waste Loads

In Planning Subarea 5.3 industries using large amounts of water presently receive approximately 29 mgd of the total municipal water supply.

The combined withdrawals of two industry groups, Paper and Allied Products (SIC 26), and Primary Metals Products (SIC 33), account for more than 95 percent of total industrial water use. This and other information was used to derive the waste loads shown in Table 7–67.

TABLE 7–67 Waste Loads (MGD), Planning Subarea 5.3—New York[a]

	Load	
Year	Municipal	Industrial
1970	15	145
1980	16	69
2000	18	15
2020	20	19

[a] Also see Annex for more current estimates.

8.3.3.3 Advanced Waste Treatment Needs

Present and future advanced waste treatment needs are summarized in Table 7–68. Figure 7–40 shows selected advanced waste treatment nodal points and zones of water quality impairment.

Greatly increased recirculation ratios for industrial process water during the second and third planning periods is reflected in substantially reduced capital costs and annual operating and maintenance costs for these periods (Table 7–69).

8.3.3.4 General

Reflecting the awareness of the water pollution elements which threaten optimum use of water resources in Planning Subarea 5.3, several programs have been developed.

Two such programs call for the development of comprehensive water resources plans by the Black River Basin and St. Lawrence-Franklin Regional Water Resources Planning Boards in cooperation with the State of New York.

A water pollution control program has been

TABLE 7–68 Present and Future Treatment Needs, Planning Subarea 5.3—New York

Stream	Dilution Ratio	Needs	Other	Remarks
Black River	7.7:1	AWT and LFA Both required	Industrial and municipal AWT. Flow augmentation.	Heavy organic loading principally from paper and dairy industries. AWT long range need.
Oswegatchie River	6:1	AWT and LFA Both required	AWT with augmentation to offset effects of power impoundment. Minimum of secondary treatment needed immediately for toxic lead smelting and refining wastes.	Zones of localized pollution caused by paper mill, dairy, heavy metal, and sewage wastes. AWT long range need.
Grass River	2:1	AWT	Lower section needs industrial and AWT, eventually.	Localized zones of heavy organic loading in lower reaches.
Raquette River	22:1	AWT and LFA	More effective flow regulation by upstream power impoundments.	AWT for municipal and paper mill discharges; long range need to relieve heavy organic loading on lower reaches.
St. Lawrence River	1300:1	AWT	New York State has advised against consumption of certain species of fish due to mercury contamination. Suspect sources outside immediate subarea also contribute to problem.	Generally good quality with exception of localized zones of pollution. Industrial AWT is a long-range requirement at this point due to minimal progress made by industry. An immediate need for secondary industrial treatment for gradually rising chlorides, mercury, and dissolved solids.

LEGEND: AWT Advanced Wastewater Treatment LFA Low Flow Augmentation

NOTE: Annex contains more current data.

TABLE 7–69 Projected Municipal and Industrial Wastewater Treatment Cost Estimates, Planning Subarea 5.3—New York

Planning Period	Municipal Treatment Costs: Capital Costs ($ Million)	Municipal Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)	Industrial Treatment Costs: Capital Costs ($ Million)	Industrial Treatment Costs: Ave. Annual Operating and Maintenance Costs ($ Million)
Present–1980	7	0.6	50	2.3
1980–2000	5	0.8	9	0.8
2000–2020	7	0.8	15	0.9

NOTE: See Annex for more current estimates

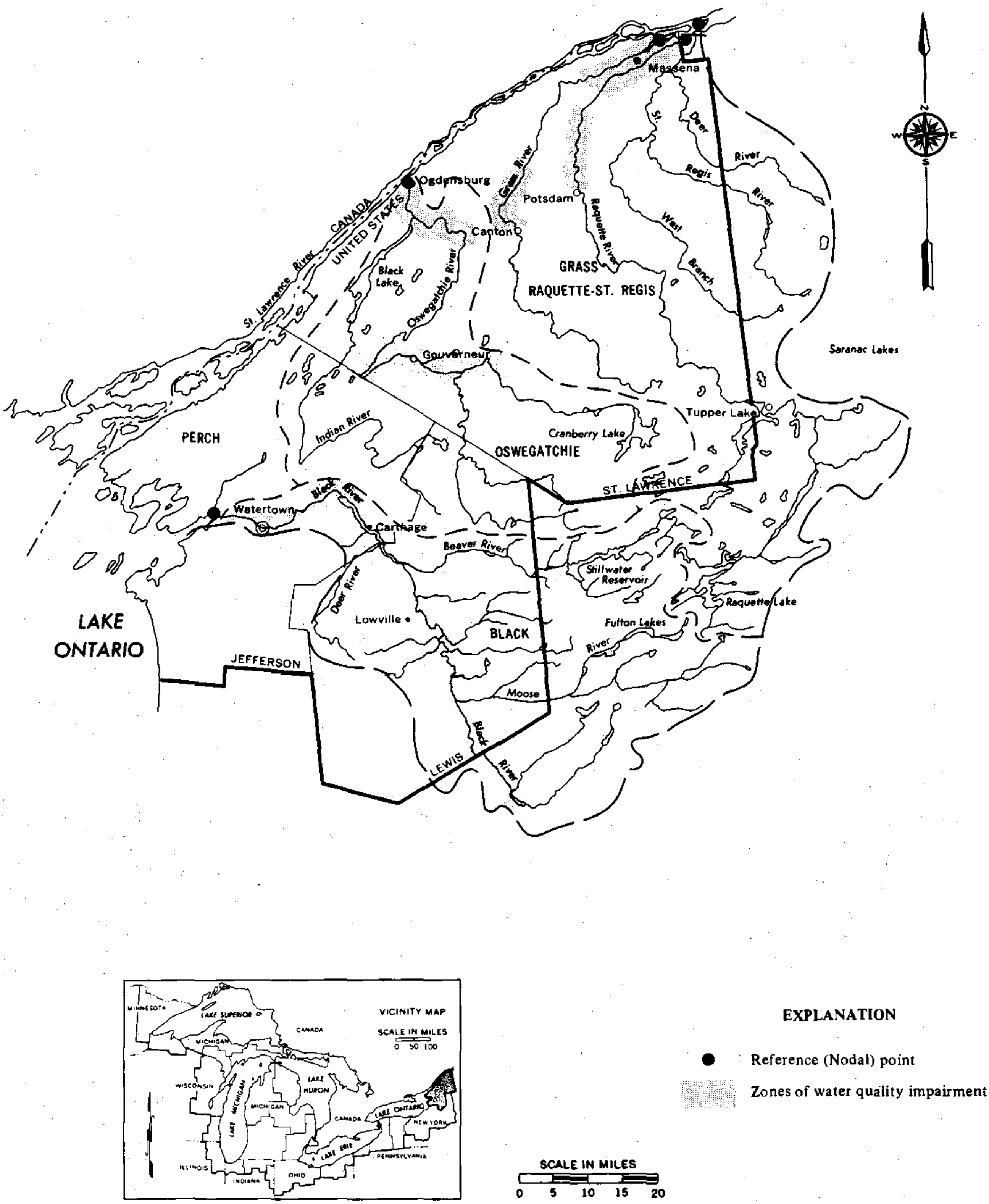


FIGURE 7–40 Planning Subarea 5.3 (Zones of Water Quality Impairment)

established for the Black-U.S. St. Lawrence River basins by the U.S. Department of the Interior and the New York State Department of Health.

Pollution abatement programs for municipal and industrial discharges are in various states of development ranging from preliminary plans to completion of construction.

Although extensive work has been done to satisfy the immediate needs of this area, much remains to be done. Further research is needed in some stream basins. The St. Regis River, for example, requires additional study on a continuing basis to determine its immediate and long-range requirements. A minimum of secondary treatment facilities for all discharges is the most pressing improvement needed to solve the immediate problems in this planning subarea. Although toxic wastes are a growing menace, maximum reduction of untreated BOD from oxygen-consuming wastes is the most critical immediate need. There are also other more specific needs.

More effective stream-flow regulation is required on the Oswegatchie and Raquette Rivers, and timely flow augmentation should be implemented on the upper Black River.

Toxic wastes produced by hard products industries should receive adequate treatment, and acids and alkalies should be neutralized. Mercury contamination has been found in fish throughout the length of the St. Lawrence River. New York State has issued warnings advising against the consumption of certain species of fish caught in that river and in other areas of Planning Subarea 5.3.

Cottage developments around the inland lakes should be connected to shoreline sewer systems to reduce nutrient loadings in those lakes which are valuable recreational resources.

Inconsistencies exist between present uses of some stream reaches and the classifications assigned for the reaches by the State of New York. For example, desired stream classifications of D exist for polluted reaches of the Black River both upstream and downstream from the City of Watertown. However, more stringent Class A standards are needed along the reach of the river flowing through the city because of the present water supply use. Stream quality obviously cannot change from D to A classifications in such a short stretch simply because optimum uses change. The desired classification for a specific stream reach must take into account the optimum standards both upstream and downstream from the reach.

Future requirements in this planning subarea must safeguard high quality waters for recreational use. Planning should be initiated to transport wastes in joint community or master collection systems connected to larger integrated treatment facilities.

Expansion, upgrading, and operating and maintenance costs of treatment facilities installed in the first planning period can be reasonably predicted through the third planning period when these are related to projected industrial and municipal trends. However, a need will exist well before the end of the third planning period to evaluate operations of waste treatment facilities on a frequent basis to predict and provide for needs and trends well into the next century.

8.4 Summary and Conclusions

Lake Ontario has a water surface area of 7,340 square miles and a total drainage basin of 32,100 square miles. Of these totals 3,460 square miles of the water surface and 16,800 square miles of the drainage basin are in the United States. The study area includes the U.S. portions of the Niagara and St. Lawrence Rivers from Buffalo, New York, to the international boundary line at St. Regis Point. Within the Lake Ontario basin are the river basins of the Niagara, Genesee, Oswego, Black, Oswegatchie, and the Grass-Raquette-St. Regis Rivers.

The basin plan area includes three planning subareas which encompass 21 counties, all in the State of New York. The total population was 2.5 million in 1970.

Standard Industrial Classifications used include Food and Kindred Products; Paper and Allied Products; Chemicals and Allied Products; and Scientific Instruments, Photographic, and Optical Goods.

The major New York State agencies concerned with water quality control are the Department of Environmental Conservation and the Department of Health. The Department of Environmental Conservation was created to consolidate various State programs involving the quality of the environment, water resource planning, and development and management of programs relating to air, land, and water pollution. The Department of Health continues to have primary responsibility for the quality and control of public water supplies and for various aspects of environmental conservation involving public health.

New York State has received approval for the classifications and water quality standards developed as part of its program. Enforcement and implementation are identical for intrastate and interstate waters.

The largest single source of nutrient inputs in Lake Ontario is the Niagara River. A major pollution problem in the Lake is the yearly crop of *Cladophora*, a form of filamentous green algae. The alewife die-off during the summer adds to the stench of the windrows of rotting *Cladophora* on beaches.

In addition to the buildup of nutritional compounds, Lake Ontario waters have deteriorated in chemical quality, measured by such parameters as sulfate and chloride ions and dissolved solids. The chloride increase has been attributed to a parallel buildup in Lake Erie. The present level of chlorides in Lake Ontario, however, is well below that which would cause significant water use impairment.

The Rochester Embayment, which includes the Monroe County shoreline of Lake Ontario and Irondequoit Bay Creek, has water pollution problems caused primarily by the discharge of municipal wastes and also by industrial wastes. High bacterial counts from metropolitan sewage have caused the main public beaches in the embayment to be closed.

Although Planning Subarea 4.4 is included in the Lake Erie section, it is briefly considered in this section because of the Niagara River. The nutrient-laden waters of Lake Erie, wastes from the industrial complex along the Buffalo River, and direct waste discharges from municipalities and industries constitute the major pollution load to the Niagara River. Excessive growths of *Cladophora* in the Niagara River and algae from Lake Erie and the upper Niagara River tributaries form large accumulations below Niagara Falls. Pollution problems in tributaries and the Barge Canal were previously described.

8.4.1 Planning Subarea 5.1

Planning Subarea 5.1 includes Allegany, Genesee, Livingston, Monroe, Orleans, and Wyoming Counties. It had a 1970 population of approximately 937,000.

The major areas of water quality impairment in the Genesee River basin are sectors on the lower and central part of the main stem and on Honeoye, Keshqua, Wolf, Oatka, Black, Wilkins, Conesus, and Canaseraga Creeks. In the last five to six miles the Genesee River in its most serious state of degradation. The discharge from the Eastman Kodak's primary treatment plant has been the principal cause of this condition, but Kodak now has secondary treatment facilities in operation. Poor quality of water may also be attributed to intermittent discharges from combined sewer overflows in the City of Rochester and latent oxygen demand of the extensive sludge deposits. Other reaches on the main stem and its tributaries, previously described, exhibit significant impairment of water quality.

In Planning Subarea 5.1 the total amount of domestic, commercial, and industrial wastewater treated in municipal wastewater facilities is expected to increase from a 1970 base of 225 mgd to 256 mgd by 1980 and to 464 mgd by the year 2020.

Present and future advanced waste treatment needs are also indicated in previous subsections. Both nodal points and zones of water quality impairment are shown.

Municipal wastewater treatment capital costs are projected to be $53 million in the 1970 to 1980 planning period, $24 million in the 1980 to 2000 period, and $65 million in the 2000 to 2020 period. Average annual operating and maintenance costs are expected to increase from $6.7 million in the 1970 to 1980 period to $10.8 million in the 2000 to 2020 period.

8.4.2 Planning Subarea 5.2

Planning Subarea 5.2, which includes 12 counties, had a 1970 population of approximately 1,340,000. The major areas of water quality impairment are found in the Oswego River-Finger Lakes region, Onondaga Lake, and Oneida Lake.

A majority of the planning subarea's population and approximately 60 major industries are located in the Syracuse metropolitan area. Waste discharges to Onondaga Lake contain large quantities of inorganic and organic materials. The lake periodically experiences localized algal blooms.

Oneida Lake is in a highly advanced state of eutrophication, resulting partly from the input of large quantities of nutrients from poorly treated municipal and industrial wastes. On Cayuga Lake the beaches in the Ithaca area have had to be closed because of bacterial pollution and dense growths of plankton. The two Finger Lakes outlet streams most seriously degraded are Skaneateles Creek and Owasco Outlet. Several reaches of the Barge Canal have excessive organic loading. The Oswego River is high in dissolved and suspended organics at its headwaters and receives both untreated domestic and industrial wastes from several sources.

In Planning Subarea 5.2 municipal wastewater flows treated at municipal treatment facilities are expected to increase from a 1970 base of 128 mgd to 155 mgd by 1980 and 289 mgd by the year 2020. Industrial wastewater treated in industry-owned wastewater treatment facilities is expected to increase from a 1970 base of 188 mgd to 205 mgd in 1980, and after declining from 1980 to 2000, to increase slightly to 209 mgd by 2020.

Present and future advanced waste treatment needs were discussed previously. Selected advanced waste treatment nodal points and zones of water quality impairment were also discussed.

Projected municipal wastewater treatment capital costs are estimated at $35 million for the 1970 to 1980 period, $22 million for the 1980 to 2000 period, and $50 million for the 2000 to 2020 period. Annual operating and maintenance costs are estimated to increase from $5.2 million in the 1970 to 1980 period to $7.1 million in the 2000 to 2020 period.

8.4.3 Planning Subarea 5.3

Planning Subarea 5.3 includes Jefferson, Lewis, and St. Lawrence Counties, and encompasses an area referred to as the Black-U.S. St. Lawrence basin. It has many areas of serious water quality impairment. The central and lower sections of the Black River are the most seriously affected reaches. In terms of BOD more than 90 percent of the total organic loading of 900,000 PE in the waters of the Black-U.S. St. Lawrence River basin is contributed by pulp and paper manufacturers. Municipalities have inadequate treatment facilities. Several locations of serious water quality degradation also exist on the St. Lawrence River. Two of these areas receive wastes from the aluminum casting plant of the General Motors Chevrolet Division and the Reynolds Metals aluminum reduction plant. The major tributaries of the river all have localized areas of pollution.

In Planning Subarea 5.3 municipal wastewater flows treated at municipal treatment facilities are expected to increase gradually from 15 mgd in 1970 to 20 mgd by the year 2020. Industrial wastewater treated in industry-owned treatment facilities is expected to decline sharply from the 1970 base of 145 mgd to 69 mgd in 1980 and to 19 mgd by the year 2020.

Present and future advanced waste treatment needs were summarized in previous sections. Selected advanced waste treatment nodal points and zones of water quality impairment were also shown.

Projected municipal wastewater treatment capital costs are estimated at $7 million in the 1970 to 1980 period, $5 million in the 1980 to 2000 period, and $7 million in the 2000 to 2020 period. Annual operating and maintenance costs will vary between $1.3 million and $1.7 million during those periods. Industrial wastewater treatment costs are expected to decline substantially from their estimated 1970 to 1980 level of $50 million.

8.4.4 Special Pollution Problems

Special problems include untreated or inadequately treated wastes from commercial ships and pleasure boats; runoff from rural and urban land including residues from the application of chemicals, fertilizers and pesticides; thermal pollution; and disposal of dredged material.

On both East Koy and Wiscoy Creeks in the Genesee River basin there have been several large fish-kills attributable to an organic phosphate pesticide used by area potato growers. A major problem results from the accumulation of oil on the Buffalo River. Flushing action causes these accumulations to be discharged periodically to the Niagara River. Waste heat from power plants and industries using large quantities of cooling water are of considerable concern, especially when located on streams without the capacity possessed by large lakes for dissipating waste heat.

SUMMARY

The large concentrations of people and industry in the Great Lakes Basin, as well as the concentrations of agriculture in some areas of the Basin, have created water quality problems which urgently require coordinated planning for their solution. The Federal, State, and local efforts to remedy existing water pollution problems and prevent future water quality degradation vary within Lake and river basins because of varying situations and varying availability of required resources and technology.

The adoption of water quality standards by all Great Lakes States facilitates the coordinated efforts to attain the water quality needed to meet Framework Study objectives. From time to time it may be necessary to modify such standards to reflect changing conditions, changing information, and changing public wishes as to what constitutes best use of all water related resources.

As the growth of population and industry creates additional pressures on water supply and quality for established uses, further emphasis will have to be placed on identifying areas that require advanced waste treatment. Sufficient funds will be needed for this treatment and other related water quality improvement measures.

In addition to waste treatment problems faced by municipalities and industries other problems will require continued attention and greater resources for their solution. Examples of such problems are soil erosion and sedimentation, combined sewer overflows, thermal discharges, wastes from watercraft, oil pollution, organic contaminants, and dredged material. Non-point pollution sources should receive particular attention in many river basins. Modern agricultural practices, technology, and construction measures can provide a partial solution to this problem.

GLOSSARY

advanced waste treatment (AWT)—the selective application of usually uncommon physical and chemical processes to remove organic and inorganic contaminants that remain after secondary treatment.

algae—simple plants, many microscopic, containing chlorophyll. Most algae are aquatic and may become a nuisance when conditions are suitable for prolific growth.

basic treatment—for the purposes of this study, includes secondary treatment plus effluent chlorination and a minimum of 80 percent phosphorus removal.

biochemical oxygen demand (BOD)—the quantity of oxygen consumed by microbial life while assimilating and oxidizing the organic matter present. It provides an index of the degree of organic pollution of water.

cfs—cubic feet per second.

chemical oxygen demand (COD)—the amount of oxygen required to oxidize organic matter in a sample under specific conditions of oxidizing agent, temperature, and time.

coliform—an organism common to the intestinal tract of man and animals, whose presence in water may be an indicator of pollution.

dilution ratio—the ratio of the rate of flow in a stream to rate of incoming wastewater flow.

dissolved oxygen (DO)—the gaseous oxygen dissolved in water and freely available to aquatic life for respiration. In unpolluted water, oxygen is usually present in amounts of 10 ppm or less. The solubility of oxygen varies inversely with the temperature.

effluent—the treated water discharged by a wastewater treatment plant.

influent—the wastewater, together with its nonwater constituents, entering a treatment plant.

mgd—million gallons per day.

mg/l—milligrams per liter.

municipal waste—includes domestic and commercial wastes and may include industrial wastes if the industries discharge their wastes to municipal systems.

nutrient—a chemical substance (an element or an inorganic compound, e.g., nitrogen or phosphorus) which promotes plant growth.

pH—an expression of hydrogen ion activity. The neutral point between an acid and an alkali is pH7; values below 7 indicate an acid condition, values above 7 indicate an alkaline condition.

population equivalent (PE)—(1) the average number of pounds per day per capita of biochemical oxygen demand (BOD) contributed to a municipal sewer system by the connected population (commonly taken as one-sixth of a pound). (2) For industrial waste, the number of people contributing as many pounds per day of BOD as the industry contributes.

ppm—parts per million by weight. In the small magnitudes commonly found in waters, it may be considered equal to mg/l.

primary treatment—the first major process or group of processes in sewage treatment. It usually consists of screening, shredding, and sedimentation. It is designed to remove a high percentage of suspended matter but little colloidal and dissolved matter. It removes approximately 35 percent of the biochemical oxygen demand (BOD).

process water—all water (liquid or vapor) that comes in contact with a product being manufactured.

secondary treatment—uses biological methods (bacterial action) in addition to primary treatment, removes from 85 to 90 percent of the biochemical oxygen demand in typical municipal wastewaters.

sludge—the residual waste matter normally separated from wastewaters in treatment processes, commonly comprises both solids and concentrated dissolved substances in liquid form, which may or may not be further separated by drying.

LIST OF REFERENCES

1. Council on Environmental Quality, *National Multiagency Oil and Hazardous Materials Contingency Plan*, September 1968.

2. International Lake Erie Water Pollution Board and the International Lake Ontario—St. Lawrence River Water Pollution Board, *Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River*, 1969, 1970, Volumes 1–3.

3. Smith, Robert, *A Compilation of Cost Information for Conventional and Advanced Wastewater Treatment Plants and Processes*, Federal Water Quality Administration, Cincinnati Water Research Laboratory, December 1967.

4. ——————————, *Cost and Performance Estimates for Tertiary Wastewater Treatment Processes*, Federal Water Quality Administration, Cincinnati Water Research Laboratory, June 1969.

5. U.S. Army Corps of Engineers, Buffalo District, *Dredging and Water Quality Problems in the Great Lakes*, 1969.

6. United States Environmental Protection Agency, Region V, *Pollution of Navigable Waters of the United States by Wastes From Watercraft*, (submitted to Congress on June 30, 1967).

BIBLIOGRAPHY

Beeton, Alfred M., "Eutrophication of the St. Lawrence Great Lakes," *Limnology and Oceanography*, Vol. 10, No. 2 (1965), pp. 240–254.

Michigan Water Resources Commission and Michigan Department of Public Health, *Report on Water Pollution Control in the Michigan Portion of the Lake Superior Basin and Its Tributaries*, 1969.

Minnesota Pollution Control Agency, *Progress Report on Long-Range Plan and Program for Water Pollution Control*, 1968.

____________________, *Report on Water Quality and Sources of Wastes in the Lake Superior Basin*, 1969.

____________________, Division of Water Quality, *Wastewater Disposal Facilities Inventory, State of Minnesota*, January 1, 1970.

____________________, Division of Water Quality, *Water Quality Management Plan, Interim, Lake Superior Basin*, July 1971.

Monroe County, Michigan, *Clean Water—Official Plan of Action for Pollution Control and Sewer Collection and Water Supply Submission and Distribution Facilities*, August 1969.

Putnam, H. E. and Olson, T. A., *Studies on the Productivity and Plankton of Lake Superior*, Bloomington, Minnesota, School of Public Health, University of Minnesota, 1961.

Quirk, Lawler, and Matursky, Engineers, New York City, New York, *Systems Analysis of St. Cloud River from Cloquet to Arrowhead Bridge*, Presentation to the Minnesota Water Pollution Control Agency for Establishment of River Classifications, December 12, 1967.

Southeast Michigan Council of Governments, Detroit, Michigan, *Southeast Michigan Regional Water, Sewerage and Drainage Facilities*, October 1970.

United States Environmental Protection Agency, Region V, *An Appraisal of Water Pollution in the Lake Superior Basin*, April 1969.

____________________, *A Comprehensive Water Pollution Control Program, Lake Michigan Basin, Green Bay Area*, June 1966.

____________________, *A Comprehensive Water Pollution Control Program, Lake Michigan Basin, Milwaukee Area*, June 1966.

____________________, *Lake Erie Environmental Summary, 1963–1964*, May 1968.

____________________, *Lake Erie Report, A Plan for Water Pollution Control*, August 1968.

____________________, *Report on Water Pollution in the Lake Erie Basin, Maumee River Area*, August 1966.

____________________, *Water Pollution Problems and Improvement Needs, Lake Ontario and St. Lawrence River Basins*, June 1968.

____________________, *Water Pollution Problems of Lake Michigan and Tributaries*, January 1968.

____________________, *Water Quality Investigations Lake Michigan Basin—Lake Currents*, November 1967.

United States Environmental Protection Agency, Region V, and New York State Department of Health, *A Water Pollution Control Program for Minor Tributary Basins of Lake Ontario*, 1968.

____________________, *A Water Pollution Control Program for the Black and United States St. Lawrence River Basins*, 1968.

____________________, *A Water Pollution Control Program for the Genesee River Basin*, 1968.

———————, *A Water Pollution Control Program for the Oswego River Basin*, 1968.

Wisconsin Committee on Water Pollution, *Report on an Investigation of the Pollution in the Lake Superior Drainage Basin*, 1966.

Wisconsin Department of Natural Resources, *Program for Quality Waters in the Wisconsin Section of the Lake Superior Basin*, 1969.

———————, *Report on the Water Quality Survey in Wisconsin Waters of Lake Superior Made During July 1968*.

ANNEX

This section provides a summary of completed, approved, and pending municipal waste treatment projects for Planning Subareas 5.1, 5.2, and 5.3, as of December 31, 1971 (Tables 7–70 through 7–78). This information is more complete than the generalized information provided for the Lake Ontario basin in preceding pages.

TABLE 7–70 Approved Municipal Wastewater Treatment Projects—RBG 5.1

Project Number	Applicant	County	STP-MGD	Project Cost	Type of Project	Receiving Stream
417	Perry	Wyoming (4)	0.8	1,568,598	---	---
539	Holley	Orleans (3)	0.3	1,316,300	---	---
489	Pittsford	Monroe (3)	0.24	143,000	STP	Barge Canal
375	Rochester	Monroe (3)	100.0	79,040,000	STP,P	Barge Canal
603	Thruway Authority Scottsville Service	Monroe (4)	0.08	103,700	STP	Oatka Creek
293	Scottsville	Monroe (4)	0.65	1,079,389	STP-Init.	Oatka Creek
419	Webster	Monroe (3)	2.5	496,000	STP,P	Mill Creek
359	Lockport	Niagara (3)	22.0	8,468,680	STP,P	Eighteenmile Creek
423	Henrietta	Monroe (3)	---	368,400	INT,PS,FM	Barge Canal
476	Henrietta	Monroe (3)	---	1,698,780	PS,FM,INT	Barge Canal
425	Honeoye Falls	Monroe (4)	0.6	1,195,000	STP	Honeoye Creek
500	Irondequoit Bay	Monroe (3)	---	108,993,500	INT,PS,P	Irondequoit Creek
496	Northwest Quadrant	Monroe (4)	15.0	40,193,000	STP,INT,PS,FM,OS,P	Lake Ontario
261	Pittsford	Monroe (3)	0.4	144,500	STP	Barge Canal
407	Elba	Genesee (3)	0.24	448,237	STP	Oak Orchard Creek
561	Genesee	Livingston (4)	1.7	1,026,040	STP,P	Genesee River
623	Conesus Lake County	Livingston (4)	1.27	5,575,200	STP,PS,FM,INT,OS,P	Conesus Creek
426	Mount Morris	Livingston (4)	0.82	1,298,650	STP	Genesee River
327	Brighton SD #2	Monroe (3)	5.0 & 3.0	4,905,000	STP,P	Allens Creek
626	Churchville	Monroe (4)	0.2	915,200	STP	Black Creek
578	Gates-Chili-Ogden	Monroe (4)	15.0	19,031,000	STP,P	Genesee River
581	Gates-Chili-Ogden	Monroe (4)	---	1,338,400	INT	Genesee River

TABLE 7-71 Completed Municipal Wastewater Treatment Projects—RBG 5.1

Project Number	Applicant	County	STP-MGD	Project Cost	Type of Project	Receiving Stream
199	Batavia	Genesee (4)	2.5	1,429,430	STP,P	Tonawanda Creek
5	Genesee	Livingston (4)	0.75	321,445	STP	Genesee River
36	Brighton	Monroe (3)	---	443,934	STP	Barge Canal
138	Brighton	Monroe (3)	2.0	109,116	STP	Barge Canal
137	Brighton	Monroe (3)	---	135,433	STP	Barge Canal
281	Brighton	Monroe (3)	0.6	752,343	STP	Barge Canal
107	LeRoy	Genesee (4)	0.75	701,981	STP	Oatka Creek
260	Lima	Livingston (4)	0.18	403,337	STP	Spring Brook
240	Brockport	Monroe (3)	1.5	899,397	STP,P	Barge Canal
147	East Rochester	Monroe (3)	1.5	842,338	STP,P	Lake Ontario Irondequoit Bay
81	Fairport	Monroe (3)	0.6	149,897	STP	---
315	Gates-Chili-Ogden	Monroe (4)	4.0	637,990	STP	Genesee River
151	Greece Island Cottage	Monroe (4)	0.4	190,141	STP	Lake Ontario
152	Greece, Latta Road Island Cottage	Monroe (4)	3.5	447,320	STP	Lake Ontario
93	Hamlin	Monroe (3)	0.2	274,980	STP	Tributary to Lake Ontario
202	Henrietta	Monroe (3)	2.0	533,900	STP	Barge Canal
62	Henrietta	Monroe (3)	2.0	379,360	STP	Barge Canal
231	Henrietta	Monroe (3)	---	592,992	STP	Barge Canal
246	Hilton	Monroe (3)	0.4	235,021	STP	Salmon Creek
99	Honeoye Falls	Monroe (4)	0.3	191,159	STP	Honeoye Creek
43	Irondequoit	Monroe (3)	1.0	641,305	STP	Lake Ontario
209	Irondequoit	Monroe (3)	---	79,372	STP	Lake Ontario
235	Irondequoit Bayview SD	Monroe (3)	---	39,900	STP	Lake Ontario
264	Irondequoit	Monroe (3)	---	233,686	STP	Lake Ontario
78	Monroe County	---	---	70,484	STP	Lake Ontario
222	Penfield	Monroe (3)	---	97,913	STP	Irondequoit Creek
233	Penfield	Monroe (3)	0.24	478,115	STP,P	Irondequoit Creek
287	Penfield	Monroe (3)	---	86,377	STP	Irondequoit Creek
270	Perinton	Monroe (3)	0.45	229,627	STP	Irondequoit Creek
5	Pittsford Jefferson Hgts SD	Monroe (3)	---	191,142	STP	Barge Canal
24	Pittsford	Monroe (3)	---	186,800	STP	Barge Canal
6	Rochester	Monroe (3)	---	694,351	STP	Lake Ontario
25	Rochester	Monroe (3)	110.0	928,493	STP	Lake Ontario
56	Rochester	Monroe (3)	---	943,390	STP	Lake Ontario
89	Rochester	Monroe (3)	---	935,280	STP	Lake Ontario
192	Rochester	Monroe (3)	110.0	1,921,030	STP	Lake Ontario
63	Sewer Agency (Gates-Chili-Ogden)	Monroe (4)	2.0	812,170	STP	Genesee River
173	Sewer Agency (Gates-Chili-Ogden)	Monroe (4)	---	84,611	STP	Genesee River
95	Spencerport	Monroe (4)	0.3	120,000	STP	Northrup Creek
125	Sweden	Monroe (3)	0.1	244,040	STP	---
20	Webster	Monroe (3)	2.5	178,500	STP	Mill Creek
110	Webster	Monroe (3)	---	568,000	STP	Mill Creek
249	Webster	Monroe (3)	2.5	701,619	STP	Mill Creek
126	West Webster	Monroe (3)	2.5	86,097	STP	Mill Creek
52	Wilson	Niagara (3)	0.54	118,739	STP	Lake Ontario
77	Albion	Orleans (3)	0.6	99,581	STP	W. Branch Sandy Creek
217	Medina	Orleans (3)	2.4	556,744	STP	Oak Orchard Creek
201	Lockport	Niagara (3)	---	297,600	STP	Eighteenmile Creek
490	Env. Facilities Corp. Wolcott	Wayne (3)	0.25	672,353	STP	Wolcott Creek
487	Lockport SD #3	Niagara (3)	---	255,100	STP	Eighteenmile Creek
382	Middleport	Niagara (3)	0.7	1,046,400	STP	Tributary to Jeddo Creek
383	Spencerport	Monroe (4)	1.0	634,300	STP,P	Northrup Creek
299	Webster	Monroe (3)	2.5	4,019,200	STP,P	Mill Creek
310	Greece	Monroe (4)	---	277,701 Init.	PS,FM,P-Init.	Tributary to Lake Ontario
424	Irondequoit	Monroe (3)	---	127,000	INT,PS	Lake Ontario
314	Avon	Livingston (4)	2.75	1,313,420	STP,P	Genesee River
414	Gates-Chili-Ogden	Monroe (4)	---	2,772,600	INT	Genesee River
329	Greece	Monroe (4)	---	227,800	INT	Tributary to Lake Ontario

TABLE 7–72 Pending Municipal Wastewater Treatment Projects—RBG 5.1

Project Number	Applicant	County	Project Cost	Type of Project	Receiving Stream	Remarks
918	Bergen	Genesee (4)	1,180,000	INT, FM, PS	Barge Canal/Genesee	Awaiting submission of eligibility data; possible treatment at the Churchville Plant.
735	LeRoy	Genesee (4)	2,820,000	STP UP, INT	Oatka Creek	Pilot plant studies again underway; Applic. and Engineering Report under review by NYSDEC: O&M: CO (1).
376	Oakfield	Genesee (3)	912,600	STP	Oak Orchard Creek	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; awaiting submission of Plans and Specs.
683	Dansville	Livingston (4)	2,624,000	STP UP, P	Canaseraga	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing.
919	Genesee	Livingston (4)	810,000	INT	Genesee River	Eligibility meeting held.
326	Nunda	Livingston (4)	1,010,000	STP, INT	Keshequa Creek	Applic. under review by NYSDEC; Engineering Report being revised.
586	Brockport	Monroe (3)	1,627,000	INT, P	Barge Canal	O&M; awaiting submission applic. and Engineering Report.
780	Andover	Allegany (4)	860,000	STP, INT, OS	Genesee River	Applic. under review by NYSDEC; Engineering Report approved. Project defeated by referendum.
702	Canaseraga	Allegany (4)	605,000	STP, INT, OS	Canaseraga Creek	Awaiting submission of applic. and Engineering Report.
752	Cuba	Allegany (4)	54,600	STP ADD	Cuba Lake	Applic. under review by NYSDEC; Engineering Report approved.
575	Wellsville	Allegany (4)	2,000,000	STP, INT, OS, P	Genesee River	Revised applic. and Engineering Report under review by NYSDEC.
652	Adams	Jefferson (3)	678,000	STP, INT, OS	Lake Ontario	CO (2) applic. Plans and Specs under review by NYSDEC; Engineering Report approved.
534	Sackets Harbor	Jefferson (3)	1,799,000	STP, INT, PS, FM	Lake Ontario	Applic. and Priority Certificate returned by WQO.
466	Clayton	Jefferson (3)	940,000	STP, PS, FM, OS	St. Lawrence	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs approved by NYSDEC.
518	Mexico	Oswego (3)	945,000	STP, INT, PS	Little Salmon River	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs approved by NYSDEC.
837	Rochester	Monroe	8,950,000	INT, PS	Lake Ontario	Additional information requested prior to scheduling an eligibility meeting; O&M.
684	State Agricultural and Industrial School, Rush	Monroe (4)	383,300	STP	Honeoye Creek	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; awaiting submission of Plans and Specs.
585	Webster	Monroe (3)	9,198,900	STP ADD, INT, PS, FM	Mill Creek	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs for Contract are under review by NYSDEC.
726	Webster	Monroe (3)	2,000,000	INT	Mill Creek	O&M; awaiting submission applic. and Engineering Report.
922	Barker, Somerset	Niagara (3)	2,560,260	STP, INT, PS, FM, OS	Golden Hill Creek	---
529	Lewiston	Niagara (3)	8,971,300	STP, INT, PS	Niagara River	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs for Contract I under review by NYSDEC.
923	Lockport	Niagara (3)	14,500,000	STP ADD	Eighteenmile Creek	Incinerator and combined sewer separation.
920	Henrietta	Monroe (3)	180,000	INT	Genesee River	Project determined eligible; may be an increase in scope to 36-476; O&M.
717	Irondequoit	Monroe (3)	565,000	INT	Lake Ontario	Awaiting submission of applic.; O&M.
921	Monroe County South Central Section	Monroe (4)	2,400,000	INT, PS, FM	Genesee River	Treatment at Gates-Chili-Ogden STP; Chili (T). O&M.
716	Northwest Quadrant	Monroe (4)	7,680,400	INT	Lake Ontario	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; awaiting submission of Plans and Specs.
838	Perinton	Monroe (3)	175,000	PS, FM	Irondequoit	Project was previously C-328. Bids were rejected and scope of project has been reduced. Eligibility data presently under review WQO, O&M.

TABLE 7–72 (continued) Pending Municipal Wastewater Treatment Projects—RBG 5.1

Project Number	Applicant	County	Project Cost	Type of Project	Receiving Stream	Remarks
867	Oswego	Oswego (3)	1,845,000	INT	Oswego River	---
675	Newfane	Niagara (3)	5,410,000	STP,INT, PS,FM,OS	Eighteenmile Creek	SD formed; Engineering Report under review by NYSDEC; negotiating with EFC; awaiting submission of applic.
924	Royalton, Gasport	Niagara (3)	98,700	PS,FM, INT	Barge Canal	Treatment at Lockport STP; abandon existing STP at Gasport SD.
457	Warsaw	Wyoming (4)	267,300	STP UP, INT,P	Oatka Creek	Applic. returned by WQO for additional information; Plans and Specs under review by NYSDEC.
812	Sodus Point	Wayne (3)	2,320,000	STP,INT, PS,FM,OS	Tributary to Lake Ontario	Applic. and Engineering Report under review by NYSDEC; Municipal-Industrial project; IP.
631	Williamson	Wayne (3)	4,412,200	STP,INT, OS	Tributary to Lake Ontario	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs approved by NYSDEC; project defeated by referendum.
824	Albion	Orleans (3)	3,340,000	STP,INT	W. Branch Sandy Creek	IP Municipal-Industrial project; O&M; supervised schedule.
842	Lyndonville	Orleans (3)	1,580,000	STP,INT	Johnson Creek	Engineering Report not acceptable by NYSDEC; eligibility meeting held; awaiting results of infiltration study; Municipal-Industrial project; CO.
925	Medina	Orleans (3)	1,690,000	STP UP	Oak Orchard Creek	O&M; Basin Plan to WQO.
413	Wayland	Steuben (4)	890,000	STP,INT, OS	---	Applic. and Engineering Report under review by NYSDEC; CO (3).
813	Env. Facilities Corp. Wilson	Niagara (3)	662,000	STP UP	Lake Ontario	O&M; Engineering Report under review by NYSDEC.
485	Ontario	Wayne (3)	3,341,000	STP,INT, PS,FM,OS	Tributary to Lake Ontario	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs under review by NYSDEC.

TABLE 7–73 Completed Municipal Wastewater Treatment Projects—RBG 5.2

Project Number	Applicant	County	STP-MGD	Project Cost	Type of Project	Receiving Stream
263	Port Byron	Cayuga (7)	0.16	349,644	STP	Owasco Outlet
271	Auburn	Cayuga (7)	----	274,497	STP	Owasco Outlet
211	Cayuga	Cayuga (7)	0.0875	154,551	STP	Cayuga Lake
96	Union Springs	Cayuga (7)	1.6	210,543	STP	Cayuga Lake
285	Weedsport	Cayuga (7)	0.3	600,694	STP	North Brook
259	Chittenango	Madison (7)	0.6	477,937	STP	Chittenango Creek
254	Canastota	Madison (7)	----	1,015,280	STP,P	Canastota Creek
70	Baldwinsville	Onondaga (7)	1.8-0.25	197,080	---	Seneca River
303	Camden	Oneida (7)	0.8	58,585	STP	West Branch Fish Creek
174	Oneida	Madison (7)	1.7	609,783	STP	Oneida Creek
90	Sherril	Oneida (7)	0.466	310,776	STP	Oneida Creek
135	Central School District #3 No. Syracuse	Onondaga (7)	0.02	25,591	STP	---
186	Clay	Onondaga (7)	----	41,385	STP	Seneca River
104	Geddes	Onondaga (7)	0.2	234,676	STP	Seneca River
65	Marcellus	Onondaga (7)	----	94,698	STP	Ninemile Creek
103	Minoa	Onondaga (7)	0.5	182,642	STP	LimeStone Creek
308	Onondaga, Manlius	Onondaga (7)	----	87,625	STP	LimeStone Creek
296	Onondaga Jail	Onondaga (7)	0.04	96,937	STP	---
18	Public Works Comm. Metro Syracuse Treatment Plant	Onondaga (7)	50.0	1,807,528	STP	Onondaga Lake
64	Public Works Comm. Morgan Road	Onondaga (7)	0.38	160,190	STP	Seneca River
116	Public Works Comm. Liverpool	Onondaga (7)	----	653,940	STP	Onondaga Lake
251	Salina	Onondaga (7)	----	476,100	STP	Onondaga Lake
73	Skaneateles, Syracuse	Onondaga (7)	0.35	164,449	STP	Skaneateles Creek
225	Central Square	Oswego (7)	0.2	368,607	STP	Little Bay Creek
132	Fulton	Oswego (7)	0.275	1,432,201	STP	Oswego River
141	Phoenix	Oswego (7)	0.29	227,391	STP	Oswego River
224	Ithaca	Tompkins (7)	----	160,249	STP	Tributary to Cayuga Lake
167	Trumansburg	Tompkins (7)	0.3	418,683	STP	Cayuga Lake
55	Ithaca	Tompkins (7)	4.0	882,609	STP,P	Tributary to Cayuga Lake
267	Ithaca	Tompkins (7)	----	302,537	STP	Tributary to Cayuga Lake
144	Groton	Tompkins (7)	0.3	455,220	STP	Owasco Lake Outlet
278	Dryden	Tompkins (7)	0.27	744,405	STP	Virgil Creek
142	Cayuga Heights	Tompkins (7)	0.7	277,001	STP	Cayuga Lake
102	Canandaigua	Ontario (7)	1.5	720,841	STP	Canandaigua Outlet
727	Canandaigua	Ontario (7)	----	-------	---	Canandaigua Outlet
188	East Bloomington, Holcomb	Ontario (7)	0.125	282,830	STP	Tributary to Mud Creek
128	Farmington	Ontario (7)	----	137,511	STP	Mud Creek
177	Farmington	Ontario (7)	----	64,399	STP	Mud Creek
49	Geneva	Ontario (7)	3.38	79,269	STP	Seneca Lake
60	Manchester	Ontario (7)	0.25	10,877	STP	Canandaigua Outlet
157	Phelps	Ontario (7)	0.25	19,769	STP	Canandaigua Outlet
163	Shortsville	Ontario (7)	0.2	14,977	STP	Canandaigua Outlet
273	Victor	Ontario (7)	0.25	582,065	STP	Mud Creek
101	Montour Falls	Schuyler (7)	0.18	229,823	STP	Inlet to Seneca Lake
210	Watkins Glen	Schuyler (7)	0.52	229,000	STP	Inlet to Seneca Lake
16	Newark	Wayne (7)	1.5	6,737	---	Ganargua Creek
252	Newark	Wayne (7)	1.5	152,260	---	Ganargua Creek
91	Palmyra	Wayne (7)	0.75	338,423	---	Barge Canal
145	Penn Yan	Yates (7)	1.5	18,623	STP,P	Keuka Lake Outlet
179	Penn Yan	Yates (7)	----	89,563	STP	---
94	Wayne County Home	Wayne (7)	.02	25,299	STP	---
450	Onondaga, Cicero	Onondaga (7)	----	1,725,556	STP	Seneca River
234	Onondaga, Camillus	Onondaga (7)	0.75	684,925	STP	Ninemile Creek
482	Onondaga, Geddes	Onondaga (7)	----	1,492,663	STP	Seneca River
358	Onondaga, Ley Creek Modification to STP	Onondaga (7)	28.0	3,361,400	STP,P	Onondaga Lake
313	Onondaga, Morgan Road	Onondaga (7)	3.5	3,187,829	STP,P	Seneca River

TABLE 7-73 (continued) Completed Municipal Wastewater Treatment Projects—RBG 5.2

Project Number	Applicant	County	STP-MGD	Project Cost	Type of Project	Receiving Stream
272	Farmington	Ontario (7)	1.0	813,500	STP,P	Mud Creek
330	Ontario County	Ontario (7)	0.03	171,334	---	---
412	Dryden, Varna	Tompkins (7)	----	152,600	PS,FM,INT	Virgil Creek
266	Onondaga	Onondaga (7)	1.7	3,873,000	STP,P	Seneca River
474	Central Square	Oswego (7)	0.2	129,547	STP	Little Bay Creek
484	Clyde	Wayne (7)	1.0	1,185,695	STP	Ganargua Creek
367	Newark	Wayne (7)	3.0	1,550,000	STP,P	Ganargua Creek
312	Dundee	Yates (7)	0.27	486,680	STP	Big Stream-Seneca Lake
332	Jerusalem, Keuka Park	Yates (7)	----	558,270	STP	Keuka Lake
538	Montour Falls	Schuyler (7)	----	231,715	---	---
372	Seneca Falls	Seneca (7)	3.5	2,700,720	STP,P	Seneca River
416	Waterloo	Seneca (7)	0.8	1,109,300	STP	Seneca River
535	Aurora	Cayuga (7)	0.3	1,210,700	STP	Cayuga Lake
319	Camillus	Onondaga (7)	0.15	64,700	STP	Ninemile Creek
467	Marcellus	Onondaga (7)	0.38	381,000	STP	Ninemile Creek

TABLE 7-74 Approved Municipal Wastewater Treatment Projects—RBG 5.2

Project Number	Applicant	County	STP-MGD	Project Cost	Type of Project	Receiving Stream
448	Onondaga Lakeshore	Onondaga (7)	3.0	14,261,000	STP,P	Oneida River
447	Onondaga, Meadow-brook-Limestone	Onondage (7)	7.0	8,777,000	STP,P	LimeStone Creek
459	Env. Facilities Corp. Clifton Springs	Ontario (7)	0.37	1,067,000	STP,INT,OS	Canandaigua Outlet
560	Geneva	Ontario (7)	8.5	6,213,500	STP,P	Seneca Lake
617	Holcomb	Ontario (7)	0.21	606,000	STP	Fish Creek
605	Cayuga Heights	Tompkins (7)	2.0	2,673,800	STP,P	Cayuga Lake
454	Tully	Onondaga (7)	0.25	938,000	STP	Tributary to Oswego River
415	Clyde	Wayne (7)	1.0	1,552,400	STP,P	Barge Canal
422	Lyons	Wayne (7)	0.75	1,082,475	STP	Clyde River
582	Palmyra	Wayne (7)	0.6	553,400	STP	Barge Canal
380	Sodus	Wayne (7)	0.2	811,915	STP	Unnamed tributary to Lake Ontario
483	Auburn	Cayuga (7)	9.3	7,140,676	STP,P	Owasco Outlet
601	Fleming	Cayuga (7)	---	388,000	INT,PS,FM	Owasco Outlet
349	Moravia	Cayuga (7)	0.21	914,505	STP	Owasco Inlet
477	Env. Facilities Corp. Port Byron	Cayuga (7)	0.18	223,400	STP	Seneca River
647	Sennett	Cayuga (7)	---	97,000	INT	Owasco Outlet
462	Fulton	Oswego	3.3	1,163,294	STP,P	Oswego River
386	Oswego	Oswego (7)	3.0	6,100,000	STP,P	Lake Ontario
336	Env. Facilities Corp. Pulaski	Oswego (7)	---	1,074,500	STP UP,PS,INT,FM	Salmon River
449	Env. Facilities Corp. Vernon	Oneida (7)	0.5	1,047,700	STP	Sconondoa Creek
452	Manlius, Fremont	Onondaga (7)	---	253,928	STP	LimeStone Creek
633	Minoa	Onondaga (7)	0.5	661,500	STP	LimeStone Creek
636	Camden	Oneida (7)	0.8	1,146,700	STP	West Branch Fish Creek

TABLE 7-75 Pending Municipal Wastewater Treatment Projects—RBG 5.2

Project Number	Applicant	County	Project Cost	Type of Project	Receiving Stream	Remarks
858	Aurelius	Cayuga (7)	1,050,000	INT;PS, FM	Seneca River	Treatment by Auburn STP (C-36-483); SD defeated.
855	Cato	Cayuga (7)	216,000	STP,INT, OS	Muscrat Creek, Barge Canal	CO (2), project referred to Attorney General for legal action.
804	Cayuga	Cayuga (7)	87,400	STP UP	Seneca River	Awaiting submission of applic.; Engineering Report under review by NYSDEC.
856	Fair Haven	Cayuga (7)	300,000	STP,INT, OS	Lake Ontario (Little Sodus Bay)	CO (2), project referred to Attorney General for legal action.
411	Genoa, King Ferry	Cayuga (7)	372,000	STP,INT, OS	Salmon Creek	---
729	Owasco	Cayuga (7)	2,630,000	INT,PS, FM	Owasco Lake	Transmit to Auburn STP (C-36-483); Owasco IP (2); Engineering Report under review by NYSDEC.
857	Union Springs	Cayuga (7)	2,550,000	STP UP, INT,PS, FM,OS,P	Seneca River	Rehabilitate and upgrade existing Union Springs STP: Union Springs O&M.
654	Cazenovia	Madison (7)	1,869,000	STP UP	Chittenango Creek	Cazenovia CO (2); applic. under review by NYSDEC; Engineering Report approved.
775	Chittenango	Madison (7)	812,000	STP UP	Chittenango Creek	Engineering Report approved; project defeated by referendum.
862	Morrisville	Madison (7)	375,000	STP,INT, OS	---	---
655	Oneida	Madison (7)	2,600,000	STP UP, INT	Oneida Creek	O&M; applic. under review by NYSDEC; Engineering Report approved.
451	East Syracuse	Onondaga (7)	738,000	INT,PS	Onondaga Lake	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs approved by NYSDEC.
805	Jordan	Onondaga (7)	897,900	STP,IS, INT,PS, FM	Seneca River	IP; no schedule; applic. under review by NYSDEC; Engineering Report approved.
731[a]	Onondaga, Clay	Onondaga (7)	14,200,000	STP,INT, PS,FM, OS,P	Seneca River	Eligibility meeting held on change in scope; revised applic. and Engineering Report under review by NYSDEC; special authority given for construction of Contract I, Davis Road, Int. RT.57 Trunk Sewer Plans and Specs under review by NYSDEC.
839	Onondaga, Collomer	Onondaga (7)	1,000,000	INT,PS, FM	Onondaga Lake	Transmit to Ley Creek STP, then to Syracuse Metro STP. Second eligibility meeting needed.
763	Onondaga, Harbor Brook Int & PS	Onondaga (7)	3,600,000	INT,PS	Oneida Lake	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs approved by NYSDEC.
658	Onondaga, Kirkpatrick Street	Onondaga (7)	867,100	PS	Onondaga Lake	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reinbursement of State and local prefinancing; Plans and Specs approved by NYSDEC.
724	Sherrill	Oneida (7)	2,123,000	STP UP, INT	Oneida Creek	Engineering Report approved; applic. Plans and Specs for contract 1A under review by NYSDEC; O&M.
863	Verona	Oneida (7)	1,630,000	STP,OS, INT	Stoney Creek	Engineering Report under review by NYSDEC. Eligibility meeting to be scheduled.
865	Onondaga, Ninemile Creek Service Area	Onondaga (7)	11,120,000	STP ADD, PS,FM, INT,P	Ninemile Creek	Abandon existing Camillus primary STP which is to be converted to PS pump to expanded Ninemile STP; report on formation of SD under review by Camillus County.
596	Onondaga	Onondaga (7)	3,190,239	INT,PS, FM	Onondaga Lake	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs approved by NYSDEC.
864	Onondaga, Skaneateles Service Area	Onondaga (7)	11,100,000	STP,INT, OS,PS, FM,P	Skaneateles Creek	Abandon existing Glen STP; new STP at new site; Skaneateles CO (2); proposed County Sanitary District.
659	Onondaga, Syracuse Metro	Onondaga (7)	65,800,000	STP UP, P	Onondaga Lake	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing; Plans and Specs for Phases 1 and 2 approved by NYSDEC.
806	E. Oneida Lake	Oneida (7)	1,948,000	STP,OS, PS,FM	Oneida Lake	Engineering Report under review by NYSDEC.
762	Onondaga, Baldwinsville-Seneca Knolls	Onondaga (7)	13,302,000	STP,INT, PS,FM, OS	Seneca River	New STP to be built at site of existing Seneca Knoll SD #2 primary STP owned by private sewerage corporation. Abandon existing STP at Van Buren Seneca Knoll SD #1, Baldwinsville North, Baldwinsville South and Geddes SD #4 STP, Van Buren Seneca Knoll SD #1 received O&M.

TABLE 7–75 (continued) Pending Municipal Wastewater Treatment Projects—RBG 5.2

Project Number	Applicant	County	Project Cost	Type of Project	Receiving Stream	Remarks
692	Onondaga, Westside	Onondaga (7)	4,080,000	PS,FM	Onondaga Lake	Applic. withdrawn from EPA/WQO; awaiting resolution of Federal reimbursement of State and local prefinancing. Plans and Specs for FM under review by NYSDEC. Plans and Specs for PS Mod approved by NYSDEC.
815	Onondaga, Meadowbrook	Onondaga (7)	1,000,000	INT	LimeStone Creek	Transmit to Meadowbrook LimeStone STP
453	Onondaga,Southwood	Onondaga (7)	380,000	INT	Onondaga Lake	Applic. withdrawn from EPA/WQO, awaiting resolution of Federal reimbursement of State and local prefinancing. Plans and Specs approved by NYSDEC.
840	Syracuse, Valley Drive	Onondaga (7)	112,500	INT	Onondaga Lake	Valley Drive INT to transmit to Brookside Drive INT then to Syracuse Metro STP. Engineer awaiting City approval to prepare Engineering Report, Syracuse CO (1).
588	NYS Willard State Hospital	Seneca (7)	412,500	STP UP	Seneca Lake	Upgrade existing facilities to tertiary, awaiting submission of applic. and Engineering Report.
926	Bridgeport	Seneca (7)	2,428,000	INT,PS, FM	---	Need referendum, IP.
429	Ovid	Seneca (7)	675,000	STP,INT	Seneca Lake	CO (1), awaiting submission of applic. and revised Engineering Report.
927	Romulus, Varick	Seneca (7)	554,000	PS,FM	Seneca Lake	To Seneca Ordinance Depot for treatment.
816	Canandaigua	Ontario (7)	4,238,000	STP UP & ADD,INT, PS,FM	Canandaigua Lake	Awaiting submission of applic. and Engineering Report.
704	Farmington	Ontario (7)	1,250,000	INT	Mud Creek	Applic. Engineering Report and Plans and Specs under review by NYSDEC, O&M.
765	Geneva	Ontario (7)	820,000	INT,PS FM	Seneca Lake	Applic. Engineering Report and Plans and Specs under review by NYSDEC, S.D. approved.
768	Gorham	Ontario (7)	717,000	STP,INT, OS	Flint Creek	Awaiting submission of applic. and Engineering Report.
682	Rose-North, Rose	Wayne (7)	585,000	STP,INT, PS,FM,OS	Tributary to Lake Ontario	Awaiting submission of applic. and Engineering Report.
685	Env. Facilities Corp. Savannah	Wayne (7)	425,600	STP,INT, OS,PS,FM	Crusoe Creek	IP (4), with supervised schedule, applic. review by NYSDEC, Engineering Report approved.
660	Phoenix	Oswego (7)	461,000	STP UP	Oswego River	O&M, Applic. under review by NYSDEC, Engineering Report approved.
821	Hastings	Oswego (7)	1,121,000	STP,INT, PS,FM,OS	Oneida River	----
732	Minetto	Oswego (7)	987,000	STP,INT, PS,FM,OS	Oswego River	Minetto (H) IP (2); supervised schedule, Municipal-Industrial project; SD approved by Audit and Control.
573[b]	Oswego	Oswego (7)	9,846,000	STP UP, OS,INT, P	Lake Ontario	Upgrade to tertiary. Engineering Report approved; applic. under review by NYSDEC; final design 75% complete.
846	Tompkins, Stage 1	Tompkins (7)	1,680,000	INT	Cayuga Lake	SD will serve portion of Dryden, Ithaca, Cayuga Heights, and Lansing; treatment at Cayuga Heights 2nd eligibility determination conference required. Only R.R. INT to be constructed under Stage 1.
650	Groton	Tompkins (7)	523,000	STP UP	Owasco Inlet Creek	Applic. withdrawn from EPA/WQO, awaiting resolution of Federal reimbursement of State and local prefinancing. Plans and Specs under review by NYSDEC.
786	Watkins Glen	Schuyler (7)	1,616,000	STP UP, ADD	Seneca Lake	O&M, Applic. and Engineering Report under review by NYSDEC.
792	Manchester-Shortsville Joint Sewage Disposal System, Manchester, Shortsville	Ontario (7)	2,420,000	STP,INT, OS	Canandaigua Outlet	Applic. and Engineering Report under review by NYSDEC; existing primary STP's at Manchester and Shortsville to be abandoned; Manchester and Shortsville CO (2).
	Ontario Env. Conservation Agency	Ontario (7)	12,900,000	STP UP & ADD,INT, PS,FM,P	Canandaigua Lake Outlet	Eligibility meeting held.
808	Ontario Env. Conservation Agency, Richmond-Canadice, W.W. District	Ontario (7)	2,330,000	STP,INT, PS,FM,OS	Honeoye Creek	Awaiting submission of applic. and Engineering Report.
740	Macedon	Wayne (7)	515,000	INT	Ganargua Creek	Awaiting submission of applic. and Engineering Report. Sewer District to be formed.
384	Marion	Wayne (7)	908,700	STP,INT, OS	Red Creek	Applic. withdrawn from EPA/WQO, awaiting resolution of Federal reimbursement of State and local prefinancing. Plans and Specs approved by NYSDEC.

[a]STP 8.0 [b]4.1 MGD

TABLE 7–76 Completed Municipal Wastewater Treatment Projects—RBG 5.3

Project Number	Applicant	County	STP-MGD	Project Cost	Type of Project	Receiving Stream
34	Webb	Herkimer (8)	0.4	308,319	STP	Moose River
181	Watertown	Jefferson	8.0	3,424,630	STP	Black River
118	Brasher	St. Lawrence (9)	0.12	168,182	STP	St. Regis River
283	Canton	St. Lawrence (9)		78,353	STP	Grass River
122	Madrid	St. Lawrence (9)	0.12	110,666	STP	Grass River
37	Massena	St. Lawrence (9)	6.0	873,968	STP	Grass River
196	Ogdensburg	St. Lawrence (9)	6.5	3,372,620	STP	Oswegatchie River
32	Malone	Franklin (9)	2.1	323,344	STP	Salmon River
83	Tupper Lake	Franklin (9)	1.1	833,563	STP	Raquette Pond Raquette River
316	Edwards	St. Lawrence (9)	0.08	181,000	INT,STP,OS,PS,FM	Oswegatchie River
444	Fine	St. Lawrence (9)	0.015	103,400	STP,INT,PS,FM	Oswegatchie River
468	Heuvelton	St. Lawrence (9)	0.45	629,000	STP,INT	Oswegatchie River
464	Norwood	St. Lawrence (9)	0.375	892,500	STP,INT	Raquette River
320	Potsdam	St. Lawrence (9)	3.3	3,110,500	STP,FM,PS	Raquette River
501	Stockholm	St. Lawrence (9)		190,624	INT,PS,FM	St. Regis River
369	Canton	St. Lawrence (9)	2.0	2,635,600	STP UP,INT	Grass River
292	Watertown	Jefferson (8)	8.0	1,338,552	STP,P	Black River
491	Env. Facilities Corp. Martinsburg, Glenfield	Lewis (8)	0.05	153,400	STP	Black River
478	Cape Vincent	Jefferson (9)	0.14	422,200	STP	St. Lawrence River
465	Philadelphia	Jefferson (9)	0.1	270,600	STP	Indian River

TABLE 7–77 Approved Municipal Wastewater Treatment Projects—RBG 5.3

Project Number	Applicant	County	STP-MGD	Project Cost	Type of Project	Receiving Stream
556	Brownville	Jefferson (8)	0.6	818,615	STP	Black River
513	Dexter	Jefferson (9)	0.12	140,900	STP	Black River
547	Evans Mills	Jefferson (9)	0.09	238,000	STP	West Creek
595	Orleans, Thousand Island Pk SD	Jefferson (9)	0.25	641,500	STP	Chaumont River
502	Env. Facilities Corp. Carthage, W. Carthage	Jefferson (9)	4.0	4,880,000	STP,P	Black River
653	Alexandria Bay	Jefferson (9)	0.75	1,698,800	STP,INT,PS,FM,OS	St. Lawrence River
435	Waddington	St. Lawrence (9)	0.36	397,250	STP UP,INT	Oswegatchie River
701	Norfolk	St. Lawrence (9)	0.15	449,900	STP UP	Raquette River
584	Potsdam	St. Lawrence (9)	0.14	148,200	STP,INT,OS	Raquette River
520	Colton	St. Lawrence (9)	0.07	363,416	STP,OS,INT,PS,FM	Raquette River
486	DeKalb	St. Lawrence (9)	0.03	198,200	STP,INT	Oswegatchie River
301	Castorland	Lewis (8)	0.019	210,900	STP	Black River
606	Lowville	Lewis (9)	1.0	441,200	STP,P	Mill Creek
515	Boonville	Oneida (8)	0.64	1,016,858	STP	Mill Creek

TABLE 7–78 Pending Municipal Wastewater Treatment Projects—RBG 5.3

Project Number	Applicant	County	Project Cost	Type of Project	Receiving Stream	Remarks
546	Brasher, Helena	St. Lawrence (9)	157,500	STP,INT, OS	St. Regis River	Engineering Report approved, applic. Plans and Specs under review by NYSDEC.
440	Gouverneaur	St. Lawrence (9)	4,160,000	STP,INT, FM,OS,PS	Oswegatchie River	CO (1), Engineering Report approved. Applic. Plans and Specs under review by NYSDEC.
438	Hammond	St. Lawrence (9)	282,000	STP,INT, OS	Indian River	Applic. withdrawn from EPA/WQO, awaiting resolution of Federal reimbursement of State and local prefinancing. Plans and Specs approved by NYSDEC.
439	Hermon	St. Lawrence (9)	329,000	STP,INT, OS	Elm Creek, Grass River	IP (4), supervised schedule Engineering Report approved; applic. under review by NYSDEC.
868	Louisville	St. Lawrence (9)	240,720	INT,PS, FM	Grass River	Transmit to Massena STP for treatment.
661	Massena	St. Lawrence (9)	1,540,000	STP UP	Grass River	Applic. withdrawn from EPA/WQO, awaiting resolution of Federal reimbursement of State and local prefinancing. Plans and Specs approved by NYSDEC.
869	Morristown	St. Lawrence	1,530,000	STP,INT, PS,FM,OS	St. Lawrence	Morristown IP (4) supervised schedule.
710	Norfolk, Raymondville	St. Lawrence (9)	386,000	STP,PS, OS,FM	Raquette River	Engineering Report under review by NYSDEC.
844	Ogdensburg	St. Lawrence (9)	150,000	INT	Oswegatchie River	Treatment at secondary STP under C-36-317, O&M.
860	Webb, Old Forge	Herkimer (8)	300,000	STP UP	Moose River	---
723	Antwerp	Jefferson (9)	537,000	STP,INT, PS,FM,OS	Indian River	IP (3) supervised schedule. Applic. Plans and Specs under review by NYSDEC.
700	Black River	Jefferson (9)	755,205	STP,INT, OS	Black River	Applic. under review by NYSDEC. Engineering Report returned to applicant.
445	Orleans, LaFargeville	Jefferson (9)	1,690,000	STP,INT, OS	Chaumont River	Municipal-Industrial Project.
512	Theresa	Jefferson (9)	435,000	STP,OS, PS,FM	Indian River	NYSDEC & WQO grants withdrawn pending further action by Village.
782	Watertown	Jefferson (8)	6,850,000	STP UP, P	Black River	Engineering Report approved. Applic. under review by NYSDEC. O&M Plans and Specs for Contracts I & II under review by NYSDEC.
548	Copenhagen	Lewis (8)	319,400	STP,INT, PS,FM,OS	Deer River	Project defeated by referendum. Applic. and Engineering Report returned to applicant.
779	Croghan	Lewis (8)	376,000	STP,OS	Beaver River	Engineering Report approved. Applic. Plans and Specs under review by NYSDEC.
510	Harrisville	Lewis (9)	349,300	STP,INT, PS,FM	W. Branch Oswegatchie River	Project defeated by referendum.
861	Port Leydon	Lewis (8)	300,000	STP UP	Black River	---
517	Ogdensburg	St. Lawrence (9)	2,342,000	STP UP	Oswegatchie River	O&M, Engineering Report approved. Applic. under review by NYSDEC.

GREAT LAKES BASIN FRAME-
WORK STUDY - APPENDIX 7

GREAT LAKES BASIN COMMISSION
Frederick O. Rouse, Chairman

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