TECHNICAL REPORT NUMBER 21

SOURCES OF WATER POLLUTION IN SOUTHEASTERN WISCONSIN: 1975

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

COMMISSION MEMBERS

KENOSHA COUNTY
Donald E. Mayew
Francis J. Pitts

RACINE COUNTY
George C. Berteau, Chairman
Raymond J. Moyer
Earl G. Skagen

MILWAUKEE COUNTY
Richard W. Cutler
Evelyn L. Petshek, Vice-Chairman
Harout O. Sanasarian

WALWORTH COUNTY
John D. Ames
Anthony F. Balestrieri, Secretary
Harold H. Kolb

OZAUKEE COUNTY
Thomas H. Buestrin
John P. Dries
Alfred G. Raetz

WASHINGTON COUNTY
Paul F. Quick
Joseph A. Schmitz, Treasurer
Frank F. Uttech

WAUKESHA COUNTY
Charles J. Davis
Robert F. Hamilton
Lyle L. Link

COMMISSION STAFF

Kurt W. Bauer, P.E.	Executive Director
Harlan E. Clinkenbeard	Assistant Director
Philip C. Evenson	Assistant Director
John W. Ernst	Data Processing Manager
Leland H. Kreblin	Chief Planning Illustrator
Donald R. Martinson	Chief Transportation Planner
Thomas D. Patterson	Chief of Planning Research
Bruce P. Rubin	Chief Land Use Planner
Roland O. Tonn	Chief Community Assistance Planner
Lyman F. Wible, P.E.	Chief Environmental Planner
R. William Winnekins	Administrative Officer

Special acknowledgement is due Robert P. Biebel, SEWRPC Senior Engineer; David B. Kendziorski, SEWRPC Water Quality Analyst; and Thomas C. Sweet, SEWRPC Water Quality Management Section Coordinator, for their contributions to this report.

Cover Photos courtesy of University of Wisconsin-Extension Service.

TECHNICAL ADVISORY COMMITTEE ON AREAWIDE WASTEWATER TREATMENT AND WATER QUALITY MANAGEMENT PLANNING

Joel Wesselman, Chairman	Executive Director, Milwaukee-Metropolitan Sewerage Commission
Raymond J. Kipp, Vice-Chairman	Dean, College of Engineering, Marquette University
Lyman F. Wible, Secretary	Chief Environmental Planner, Southeastern Wisconsin Regional Planning Commission
Vinton W. Bacon	Professor, College of Applied Science and Engineering, University of Wisconsin-Milwaukee
Anthony S. Bareta	Director, Milwaukee County Planning Commission
Kurt W. Bauer	Executive Director, Southeastern Wisconsin Regional Planning Commission
Frank R. Boucher	Director, Environmental Department, Wisconsin Electric Power Company
J. R. Castner	Executive Director, Wisconsin Solid Waste Recycling Authority
Frederick H. Chlupp	Land Use and Park Administrator, Washington County
Arnold L. Clement	Planning Director and Zoning Administrator, Racine County
Norbert H. Dettmann	Washington County Board Supervisor
Alvin A. Erdman	District Conservationist, U. S. Soil Conservation Service, Milwaukee and Waukesha Counties
Kent B. Fuller	Chief, Planning Branch, Region V, U. S. Environmental Protection Agency
Herbert A. Goetsch	Commissioner of Public Works, City of Milwaukee
Thomas N. Hentges	Former Racine County Board Supervisor; Former Chairman, Town of Burlington
Lester O. Hoganson	General Manager, Racine Water and Wastewater Utility
Helen M. Jacobs	League of Women Voters
Myron E. Johansen	Former District Conservationist, U. S. Soil Conservation Service, Ozaukee and Washington Counties
Leonard C. Johnson	Research and Development Director, Wisconsin Board of Soil and Water Conservation Districts
Melvin J. Johnson	Chairman, Town of Norway; Racine County Board Supervisor
Elwin G. Leet	Racine County Agricultural Agent
William G. Murphy	Professor, College of Engineering, Marquette University
O. Fred Nelson	Manager, Kenosha Water Utility
Wayne A. Pirsig	District Director, Farmers Home Administration, U. S. Department of Agriculture
Herbert E. Ripley	Health Officer, Waukesha County Department of Health
Donald A. Roensch	Director of Public Works, City of Mequon
Harold F. Ryan	Washington County Board Supervisor
Marvin E. Schroeter	Associated Public Works Contractors of Greater Milwaukee, Inc.; Wisconsin Underground Related Material Suppliers
Bernard G. Schultz	Assistant District Director, Southeast District, Wisconsin Department of Natural Resources
Walter J. Tarmann	Executive Director, Park and Planning Commission, Waukesha County
Rodney M. Vanden Noven	Director of Public Works, City of Waukesha
Emmerich P. Wantschik	Walworth County Planner
Frank A. Wellstein	City Engineer, City of Oak Creek

TECHNICAL REPORT
NUMBER 21

SOURCES OF WATER POLLUTION IN SOUTHEASTERN WISCONSIN: 1975

Prepared by the

Southeastern Wisconsin Regional Planning Commission
P. O. Box 769
Old Courthouse
916 N. East Avenue
Waukesha, Wisconsin 53187

The preparation of this report was financed in part through a planning grant from the U. S. Environmental Protection Agency in cooperation with the Wisconsin Department of Natural Resources under the provisions of Section 208 of the Federal Water Pollution Control Act.

September 1978

Inside Region $15.00
Outside Region $30.00

(This page intentionally left blank)

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

916 NO. EAST AVENUE • P.O. BOX 769 • WAUKESHA, WISCONSIN 53187 • TELEPHONE (414) 547-6721

Serving the Counties of: KENOSHA
MILWAUKEE
OZAUKEE
RACINE
WALWORTH
WASHINGTON
WAUKESHA

September 11, 1978

STATEMENT OF THE EXECUTIVE DIRECTOR

Pursuant to the provisions of Section 208 of the Federal Water Pollution Control Act, the Southeastern Wisconsin Regional Planning Commission on July 1, 1975, undertook an areawide water quality management planning program for the seven-county Southeastern Wisconsin Region. The objective of that program was to identify the most cost-effective means of abating water pollution within the Region and to thereby meet established water use objectives and supporting standards. The formulation of sound recommendations for the abatement of water pollution and the attainment of water use objectives requires, among other things, definitive identification of all sources of water pollution.

Accordingly, the Commission, as a part of its areawide water quality management planning effort, undertook a comprehensive inventory of the sources of water pollution within the Region, an inventory intended to establish the number, type, and location of all significant sources of water pollution in the Region; to establish the type and amount of pollutants contributed by each source to the surface waters of the Region; and to identify the conditions under which the contributions occur. This report sets forth the findings of that inventory.

The information presented in this report provides, together with the information presented in a companion report, SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin, an important basis for the formulation of the areawide water quality management plan presented in SEWRPC Planning Report No. 30, A Water Quality Management Plan for Southeastern Wisconsin. In addition to providing one of the bases for the preparation of an areawide water quality management plan, it is the hope of the Commission staff that this report will provide an important historic benchmark with respect to the sources of water pollution in the Region, a benchmark against which progress in water pollution abatement can be measured over the years ahead.

Respectfully submitted,

Kurt W. Bauer
Executive Director

(This page intentionally left blank)

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

Table		Page
19	Area and Population Served by Existing and Locally Proposed Sanitary Sewerage Systems in the Sauk Creek Subregional Area: 1975	105
20	Selected Characteristics of Existing Public Wastewater Treatment Facilities in the Sauk Creek Subregional Area	106
21	Known Sewage Flow Relief Devices in the Sauk Creek Subregional Area	110
22	Selected Characteristics of Private Wastewater Treatment Facilities in the Sauk Creek Subregional Area: 1975	111
23	Known Point Sources Other than Wastewater Treatment Plants in the Sauk Ceek Subregional Area: 1975	112
24	Existing Urban Development Not Served by Public Sanitary Sewers in the Sauk Creek Subregional Area: 1975	114
25	Area and Population Served by Existing and Locally Proposed Sanitary Sewerage Systems in the Kenosha-Racine Subregional Area: 1975	115
26	Selected Characteristics of Existing Public Wastewater Treatment Facilities in the Kenosha-Racine Subregional Area	116
27	Comparison of Effluent Limitation: Kenosha-Racine Agreement and Regional Sanitary Sewerage System Plan	120
28	Known Sewage Flow Relief Devices in the Kenosha-Racine Subregional Area	130
29	Selected Characteristics of Private Wastewater Treatment Facilities in the Kenosha-Racine Subregional Area: 1975	131
30	Known Point Sources Other than Wastewater Treatment Plants in the Kenosha-Racine Subregional Area: 1975	132
31	Existing Urban Development Not Served by Public Sanitary Sewers in the Kenosha-Racine Subregional Area: 1975	135
32	Area and Population Served by Existing and Locally Proposed Sanitary Sewerage Systems in the Root River Canal Subregional Area: 1975	138
33	Selected Characteristics of Existing Public Wastewater Treatment Facilities in the Root River Canal Subregional Area	138
34	Known Sewage Flow Relief Devices in the Root River Canal Subregional Area	140
35	Selected Characteristics of Private Wastewater Treatment Facilities in the Root River Canal Subregional Area: 1975	141
36	Known Point Sources Other than Wastewater Treatment Plants in the Root River Canal Subregional Area: 1975	142
37	Existing Urban Development Not Served by Public Sanitary Sewers in the Root River Canal Subregional Area: 1975	144
38	Area and Population Served by Existing and Locally Proposed Sanitary Sewerage Systems in the Des Plaines River Subregional Area: 1975	145
39	Selected Characteristics of Existing Public Wastewater Treatment Facilities in the Des Plaines River Subregional Area: 1975	146
40	Known Sewage Flow Relief Devices in the Des Plaines River Subregional Area	154
41	Selected Characteristics of Private Wastewater Treatment Facilities in the Des Plaines River Subregional Area: 1975	155
42	Known Point Sources Other than Wastewater Treatment Plants in the Des Plaines River Subregional Area: 1975	155
43	Existing Urban Development Not Served by Public Sanitary Sewers in the Des Plaines River Subregional Area: 1975	157
44	Area and Population Served by Existing and Locally Proposed Sanitary Sewerage Systems in the Upper Fox River Subregional Area: 1975	159
45	Selected Characteristics of Existing Public Wastewater Treatment Facilities in the Upper Fox River Subregional Area	160
46	Known Sewage Flow Relief Devices in the Upper Fox River Subregional Area	167
47	Selected Characteristics of Private Wastewater Treatment Facilities in the Upper Fox River Subregional Area: 1975	169
48	Known Point Sources Other than Wastewater Treatment Plants in the Upper Fox River Subregional Area: 1975	169
49	Existing Urban Development Not Served by Public Sanitary Sewers in the Upper Fox River Subregional Area: 1975	171
50	Area and Population Served by Existing and Locally Proposed Sanitary Sewerage Systems in the Lower Fox River Subregional Area: 1975	173
51	Selected Characteristics of Existing Public Wastewater Treatment Facilities in the Lower Fox River Subregional Area: 1975	174

Chapter VI

LIST OF FIGURES

Chapter V

Chapter VI

LIST OF MAPS

Chapter IV

Chapter V

Map Page

Chapter I

INTRODUCTION

BACKGROUND

Water is one of the most common, naturally occurring chemical compounds found in the environment, and satisfies the needs for many human uses including domestic and industrial water supply, cooling, waste transport and assimilation, livestock and wildlife watering, irrigation, preservation of aquatic life, recreation, navigation, and aesthetic use. Because of the many important uses of water, it is critically important that the lakes and streams and the ground water reservoirs of southeastern Wisconsin be maintained at a sufficiently high level of quality to support these varied uses and thereby meet the social and economic needs of the resident population of the Region. Good water quality is necessary for a safe and livable environment in which humans can work and recreate. In addition, the evolution of water law in the United States endowed Americans with certain specific rights to water use which would be impaired by degraded water quality. Water quality affects and is affected by regional settlement patterns, and it is important that the water quality of the Region not be a limiting factor in the amounts or locations of desirable urban and rural development. Finally, and most importantly, because he so significantly and directly affects the earth as a habitable environment for all forms of life, man has an obligation to maintain a safe and healthful environment over the long run, not only for the immediate population of the planet, but for the generations of man and other creatures yet to be born.

Pure water in a chemical sense is not known to exist in nature, in that foreign substances originating from the natural environment or from the activities of man will always be present. Water is said to be polluted when those foreign substances are present in such a form and concentration as to render the water unsuitable for any desired beneficial uses. For the purposes of this report, the causes of pollution are considered to be exclusively related to human activity, although there are significant water quality effects from naturally occurring processes as well. Most, if not all, human activities contribute substances to the surface waters of the Region, many of which are pollutants: food production and processing, manufacturing, materials storage and transport, private and public transportation, construction and maintenance of urban housing and other urban activities, and even recreational activities all contribute pollutants of varying types and amounts to the water-courses.

In order to assess the magnitude and relative importance of pollution sources, the Commission in 1976 undertook, as a part of an areawide water quality management planning program, a comprehensive inventory of pollution sources within the Region. The findings of that inventory are presented in this report. The urban and urban-related sources of pollution described include all public sanitary sewerage systems—inclusive of both the sewage collection and the sewage treatment facilities and all known flow relief points on both sanitary and combined sewerage systems; existing privately-owned, on-site sewage disposal systems; and industrial wastewater treatment facilities and discharge points. The urban storm sewerage systems which collect and convey rainfall and snowmelt runoff from areas which contribute pollutants—as diffuse sources—are also presented as urban sources. The pollutant contributions from the land cover types associated with various urban land uses are discussed for areas of residential, commercial, industrial and related activities—inclusive of solid waste disposal, mining, construction, transportation, dredging and channelization, and recreation activities. Air contaminant fallout to the land surface is also considered implicitly under urban sources. The pollutant contributions from cover types associated with various rural land uses are discussed for livestock operations, cropland, orchards, pastures, woodlands and wetlands, and wildlife activities in these associated areas.

Clearly, the inventory recognizes the significance of diffuse pollution sources to surface water quality and considers such sources—which have not been historically considered as primary pollutant sources—together with the sanitary and industrial sewage discharges which have been traditionally considered the principle sources of pollution by practicing sanitary engineers.

The Commission areawide water quality management planning program, under which the inventory of pollution sources was undertaken, is intended to develop a recommended areawide plan for the timely abatement of the most severe forms of pollution within the Region to assure that the intended uses can be made of the Region's surface waters. In order to develop a sound and realistic plan for the abatement of water pollution, it is necessary to obtain definitive data on the number, type, and location of all significant pollution sources, as well as on their direct or indirect contributions of pollutants to the inland lake and stream waters of the Region, and the conditions under which such contributions occur.

These data must be made available for all known "point" sources contributing pollutants to the streams and lakes through clearly identifiable wastewater discharge points—such as sewage treatment plant outfalls, sanitary, and combined sewer flow relief points and industrial wastewater outfalls, and for all known "nonpoint," or diffuse sources which contribute pollutants to the streams and lakes in the form of overland flow, storm sewer discharges, and groundwater inflow. Due to the complexity of the groundwater systems of the Region, it was recognized that the inventory would have to be limited to the consideration of the effects of groundwater quality on surface water quality in those areas in which ground- and surface-water systems interact significantly. This information constitutes a subset of the data which would be needed for a complete groundwater quality management planning program.

The basic data which are necessary for the preparation of an areawide water quality management plan for the Region can be considered in two major sets. The first set consists of those data required to describe definitively the current and historical water quality of the streams and lakes of the Region and the degree to which that water quality meets established standards for existing and proposed water uses. These data are presented in SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams of Southeastern Wisconsin: 1964-1975.

The second set of data needed for the preparation of an areawide water quality management plan consists of those data required to describe definitively the existing sources of water pollution in the Region. This technical report is intended to present those data. As noted above, it describes the nature and location of all known sources of water pollution in the Region in 1975, the base year for the areawide water quality management planning program, including both point—or concentrated—and nonpoint—or diffuse—sources. To the extent possible the contribution of these sources to the total pollution loading of the surface water system is quantified.

Because of the dynamic relationships which exist between the various pollution sources and surface water quality conditions in the Region, this report can provide only a static analysis of the relative importance of the various pollution sources. The more important—and immensely more difficult—task of analyzing the interaction of these sources with the waters of the inland lakes and streams of the Region within a dynamic meteorological, cultural and ecological system is to be presented in SEWRPC Planning Report No. 30, A Water Quality Management Plan for Southeastern Wisconsin.

DATA ORGANIZATION: CATEGORIC, GEOGRAPHIC, AND METEOROLOGIC CONSIDERATIONS

Presentation of information relating to such a pervasive phenomenon as water pollution is difficult because of the interrelated factors which cause pollution. More specifically, a clear and useful presentation of the sources of water pollution, the amounts of pollutants they contribute, and their relative importance is complicated by three factors. First, the pollution sources are difficult to categorize: for example, streets and highways are an integral part of any urban development pattern, but exist in rural areas as well. Pollutants in storm water are contributed by diffuse sources, but may be released to the waterways at a single point, through a storm sewer outfall. Storm water may infiltrate sanitary sewers as groundwater, or may enter directly as inflow from roof drains or flooded manhole covers, surcharging such sewers and causing them to overflow through various levels of flow relief devices. Sanitary sewage may flow into storm sewers if cross-connections have been constructed to relieve excess flow and avoid sanitary sewer surcharging and the attendant health hazard associated with basement flooding. Some residential, commercial and industrial areas may be drained by storm sewers, while others may be drained by surface topography, roadside ditches, and interconnected natural swales and watercourses. As a result of the problems in categorizing pollution sources, it has been imperative in this report to avoid double-accounting of the various sources, and to carefully explain what is and what is not included within each category. Accordingly, the report addresses sanitary sewers, storm sewers, and combined storm and sanitary sewers as separate categories, and explicitly addresses in the discussion of flow relief devices, the information available concerning cross-connections. Storm sewer systems, as discussed in Chapter IV of this report, are assumed to include not only the systems of subsurface conduits, but also any major surface drainageways which may interconnect them as part of a larger system or drain them to the nearest receiving natural watercourse. Where appropriate, the pollutant contributions from urban land surface runoff are presented in association with storm sewer discharges. Finally, for purposes of this discussion, all diffuse sources of pollutants outside urban areas are considered to be related to the storm water runoff from defined watersheds and reflective only of the land cover associated with the land use activities in the tributary watershed area.

The second complicating factor in the presentation of inventory data pertaining to pollution sources is the geographic area of presentation. The area relevant to a specific pollution source may not correlate readily to the affected hydrologic unit—the watershed, subwatershed, or subbasin—within the Region. For example, the storm water runoff from an urban area may be carried by a storm sewer system which serves an area at least roughly congruent with the original natural catchment area, while the sanitary sewage discharges may be carried through a more extensive system of subsurface conduits crossing low-relief natural watershed boundaries several times before draining to the ultimate site of wastewater treatment. A related problem exists when the data related to a diffuse source of pollution are available only by civil division—as opposed to the sanitary sewerage service area or the hydrologic unit.

In order to be useful in subsequent analyses, all of the water pollution sources data must be related to the hydrologic watershed to which they are tributary. Accordingly, the several inventories of pollution sources were conducted in such a manner that the resulting data can always be related to a natural watershed. Moreover, the inventory findings are presented in this report by watershed to the extent practicable. The pertinent data on urban storm sewer systems and on land cover in rural areas are readily presented by watershed. For convenience of presentation, however, the pertinent data on sanitary and combined sewerage systems is presented herein by subregional areas, initially delineated under the regional sanitary sewerage system planning program. These subregional areas have proven to be sound for sanitary sewerage system planning purposes, and can be related to the hydrologic watersheds within which the effluents are ultimately released. The boundaries of these subregional areas were delineated on the basis of the location of major watershed divides, the existing and potential service areas of existing centralized sanitary sewerage systems, and existing and probable future areas of urban development. Because of their past and intended future use for sanitary sewerage system planning, these areas provided the best available basis for organizing the sanitary and combined sewerage system inventory required for the areawide water quality management planning effort. The subregional areas are described in greater detail in Chapter III of this report.

In addition to the organization used to present the pollution source inventory data in this chapter, the data have been reorganized and presented in appendices to this report according to other appropriate geographic units in order to facilitate the review and use of the data not only in the areawide planning process but in plan implementation as well. More specifically, pertinent data on the existing sanitary and combined sewerage systems are summarized in the appendices by civil division; data on the sanitary sewer flow relief devices and combined sewer outfalls are presented by watershed and by civil division; data on the storm sewer systems are presented by civil division; and data on the diffuse sources of pollution are presented by county.

The third factor which complicates the presentation of data on pollution sources in the Region is the effect of meteorological processes on the transport and delivery of pollutants to the streams and inland lakes. The water quality conditions of the surface waters are a function of their capacity to assimilate the amounts of pollutants actually reaching the stream due to storm water flows which carry pollutants from the land surface to the waterways, or due to heavy pollutant build-up washed from the land surface after a long period without precipitation or snowmelt, or due to a combination of these occurrences. The relative importance of the different types of pollution sources and their associated pollutant transport and delivery mechanisms varies with these factors. Because the relationship between precipitation events and pollutant build-up is a random one, except when characterized for many such events and over a long period of time, it is difficult to present a single and universal depiction of the relative importance of the different pollution sources. Therefore, this report includes analytical results intended to demonstrate the pollutant loadings under three conditions: average annual loadings, annual loadings for a year of relatively low amounts of precipitation, and annual loadings for a year of relatively high amounts of precipitation.

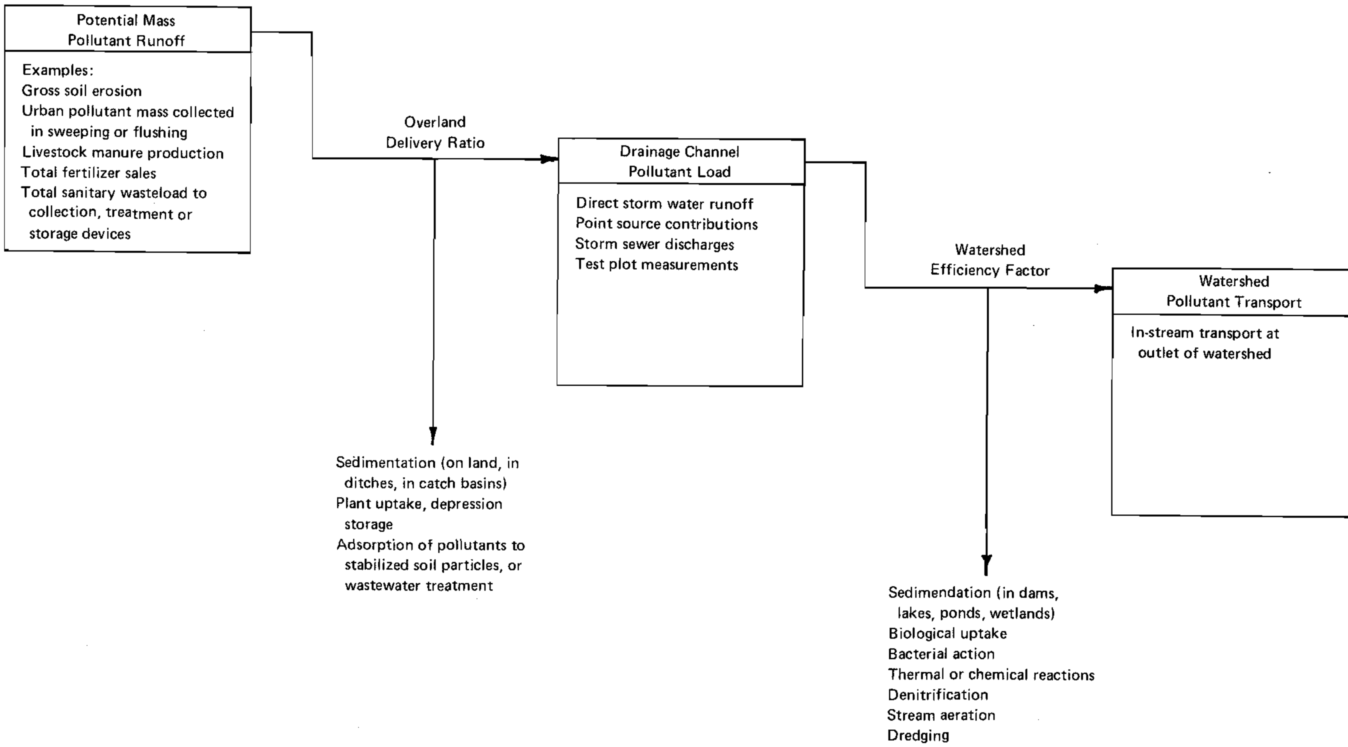
DATA ANALYSIS: POLLUTANT LOADS AND WATERSHED PROCESSES

The estimation of the pollutant loads contributed to lakes and streams by the various pollution sources requires the use of data developed from a number of different research efforts. These efforts have been conducted basically for three different geographic areas and at different levels of detail, with resulting conceptual differences in what the derived quantitative data represent. Conceptually, the data resulting from the research efforts may be thought of as depicted in Figure 1 as representing the "potential mass pollutant runoff"; the "drainage channel pollutant loads"; or the "watershed pollutant transport" depending upon the relative sizes of the areas addressed in the research efforts and, consequently, the geographic locations within the watershed system at which pollutant measurements were made. The three concepts are applied to annual loads in this report, but are applicable to event loads as well. The following comments describe these three types of data. Chapter V, and particularly Table 363 and Table 364, summarize the ranges of the values expected for potential mass pollutant runoff and for drainage channel pollutant loads, respectively, from the indicated categories of pollution sources. Watershed pollutant transport, because it is measured at the outlet of a watershed, cannot be related to specific categories of pollution sources, but can be constructed for specific watersheds and appears in this report as Table 387.

The potential mass pollutant runoff is defined herein as the maximum pollutant mass accumulated on the land surface and potentially available for delivery to the waterways if a complete flushing of the land surface should occur. The potential mass pollutant runoff is expressed as weight per unit area per year, or as weight per unit of pollution source per year. Examples include tons of sediment per acre per year, pounds of nitrogen or phosphorus per acre per year, counts of fecal coliform organisms per acre per year, pounds of nutrient per animal unit per year, pounds of nutrient per resident (served by septic tanks) per year, or counts of fecal coliform per animal unit or

Figure 1

CONCEPTUAL DIAGRAM OF POINTS OF POLLUTANT MEASUREMENTS AND CONVERSION IN TRANSPORT PROCESSES



NOTE: Channel loads are estimated for nitrogen, phosphorus, biochemical oxygen demand, fecal coliform, and sediment in order to identify and quantify significant sources of water pollution. Watershed transport loads are calculated in order to estimate what general portion of the channel loads are transported from the watershed. Watershed transport loads are not calculated for fecal coliform. While this diagram conceptualizes pollutant transport processes as discrete steps, it should be recognized that these processes actually comprise a highly variable, continuous system.

Source: SEWRPC.

per septic system per year. The studies which report data in this form include agricultural research studies which report "gross soil erosion"—the amount of soil which actually moves down the slope of a field as sheet and rill erosion due to storm water runoff—and the urban studies of pollutant mass on the surface of streets or present on lawns or gardens as leaves or fertilizer. Also in this category would be general estimates of total amounts of pet litter or total manure production from livestock feeding operations.

Although the entire pollutant mass represented by the potential pollutant runoff is theoretically available for runoff into the waterway system of a watershed, and, although the entire mass may actually be transported for a brief period of time and over short distances by the overland flow of storm water runoff, only a portion of the potential mass pollutant runoff will normally actually reach an intermittant or continuous stream. The balance of the pollutant mass may simply move a few feet or a few yards across the land surface and remain on a field, or at the foot of a slope, in a floodplain or along a shoreline. The proportion which does reach the waterway system is influenced by many factors including surface topography, land use, vegetative cover, precipitation patterns, soils, and slopes. The degree of potential mass pollutant runoff and its movement to other parts of the land and surface water system can be considered as an aging process and a simplification of the land surface, intimately related to the aging of the waterway system. The natural aging of the landscape is accelerated by human activity, just as the natural eutrophication of a lake is accelerated by pollution. It should be noted that the potential pollutant runoff has no direct significance for point sources of pollution, unless resident population or economic activity—or some other surrogate measure of the raw pollutants in the influent—are used in place of direct point source discharge measurements at outfalls.

The portion of the potential mass pollutant runoff which does reach the waterway system, together with any point source loads or groundwater contributions, becomes the "drainage channel load." Drainage channel loads are thus defined herein as those pollutant loads which are contributed by storm water runoff, by ground water, and by point sources, to a drainage ditch, drainage swale, dry run, intermittent stream, perennial stream, or other component of the drainage system of a watershed. These quantities are also typically reported as a weight per unit area per year, most typically as pounds per acre per year or pounds per square mile per year, or as a number of coliform organisms per acre per year. The drainage channel loads, therefore, are the loads discussed in Chapter V and herein estimated to be contributed to and received by the lakes and streams of the Region. It should be noted that in concept, an "overland delivery ratio" can be developed to represent the proportion of the potential pollutant runoff which actually is transported by overland flow into the stream channel system and, therefore, becomes part of the drainage channel load. It should be further noted that although the drainage channel loads from point and nonpoint sources of pollution both reach perennial or intermittent streams, numerous instream processes may reduce these loads as they move through the channel system.

Although there are research results available that can be used to estimate the channel loads in terms of the five major pollutants considered in this report from urban nonpoint sources, and that can be used to estimate the nutrient loads from agricultural croplands, it was deemed desirable to utilize herein the most detailed inventory data available for sediment from croplands, for pollutants from livestock herds, and for pollutants from septic tank systems. This required the conversion of potential pollutant runoff from these sources into channel loads. Accordingly, the Commission, with the assistance of the members of the Technical Advisory Committee on Areawide Water Quality Management Planning, estimated the channel loadings from these sources, based on available reports on potential pollutant runoff, as well as reports on channel loads. The resulting channel loads, applied in this report, are summarized in Table 364.

Most of the directly useful research which is reported on nonpoint source contributions is reported as drainage channel loads, represented essentially by the downstream measurements obtained for areas of uniform land use. Generally, the Commission review of technical literature indicated that the drainage channel loads are estimated from areas typically less than one square mile in area. The results from studies of areas of this range of sizes are considered the most useful for characterizing pollutant loads to local streams draining subwatersheds of major watersheds of the size found in the Region.

"Watershed pollutant transport" is defined herein as the quantities of pollutants which are estimated to be exported from a watershed on an annual basis. Watershed pollutant transport is typically reported as pounds of pollutant per square mile per year and generally does not address the number of fecal coliform organisms transported annually, since the parameter is characterized by dynamic population phenomena including both growth and die-off rates in the stream system. Like the delivery ratio for pollutants carried from overland flow into the drainage channels, a watershed efficiency factor can be estimated for each pollutant addressed to reflect the proportion of the channel loads which ultimately reaches the outlet of a watershed. Some of the major factors which reduce channel loads to the watershed transport amounts are represented in Figure 1 and include sedimentation, biological uptake by plant and animal organisms, bacterial action to reduce biochemical oxygen demand, and atmospheric release of substances such as free nitrogen. In addition, there are man-made structures and processes which may reduce the channel loads which reach the watershed outlet. Some of these associated processes include instream aeration, treatment in biological ponds, dredging, sedimentation in catch-basins, sedimentation behind dams, or sedimentation in storm water detention basins.

SCHEME OF PRESENTATION

Following this introductory chapter, Chapter II describes the basic distinctions between point and nonpoint sources of pollution, and the general categories of pollution sources by which data are presented in this report. Chapter III presents pertinent data on the sanitary sewerage systems of the Region, including data on the location, configuration, and service areas of these systems; data on the amounts and quality of the effluents and overflows of sewage discharged from these systsms; and data on the location of the points of these discharges. Data are also presented on the estimated amounts and strengths of industrial wastewater discharges, and on the locations of these discharges. Chapter IV presents pertinent data on the existing storm sewer systems within the Region, including data on the location, configuration, and service areas of these systems; on the amounts of the storm water discharged through these systems; and on the location of these discharges. Chapter V presents data on the characteristics of the diffuse sources of pollution within the Southeastern Wisconsin Region, as regards the types of pollutants associated with them and the conditions under which they actively contribute to the streams and lakes. The extent of these diffuse sources of pollution is also set forth by watershed in Chapter V, and includes the enumeration and, to the extent possible, the quantification of the expected annual average contributions from diffuse sources of pollution within each watershed as of 1975, as well as an estimate of the annual loadings of pollutants under wet and dry weather conditions. Chapter VI combines the information developed in the earlier portions of the report, to present an analysis of the relative magnitude of the estimated pollution sources by watershed. Chapter VII concludes the report with a summary description of the sources of pollution of the inland streams and lakes of the Region, and presents conclusions. The information presented in this report will be used in the areawide water quality planning program in order to identify the sources of water quality degradation within the Region, and prepare cost-effective means for their abatement. The information should also be useful for state and local comprehensive functional planning purposes.

This report can only summarize briefly the large volume of information collected on the water pollution sources within the Region under the areawide water quality planning program. Although the reproduction of all of this information in report form is impractical due to the magnitude and complexity of the data collected and analyzed, all of the basic data are on file in the Commission offices in the form of "Areawide Water Quality Plan Development Study Volumes." These Study Volumes are maintained in the Commission offices and are available to member units and agencies of government and to the general public upon specific request. Due to the sheer mass of some of the data, it is necessary that interested parties either review such data items in the Commission offices, or pay the cost of assembly, duplication, and delivery. This report, therefore, serves the additional purpose of indicating the types of pollution source data which are available from the Commission, and which may be of value to local units of government and to private interests within the Region.

Chapter II

TYPES AND EFFECTS OF WATER POLLUTANTS

INTRODUCTION

A complete analysis of water pollution problems must include the identification of not only the location of the pollution sources, but also an estimate of the type, quantity, and characteristics of the pollutants contributed, and of the probable effects of those pollutants on the quality of the receiving waters. The type of pollution sources must be known in order to identify the conditions under which pollutants are released and transported to the lakes and streams. The quantity and character of the pollutants released must be estimated and related to certain natural processes in the lakes and streams, if the transport process and the water quality effects are to be understood. This chapter is intended to identify the water pollution effects which generally can be expected from the several types of pollutants associated with each of the major sources of water pollution in the Region.

Regardless of how pollution sources are categorized—as may be done in various ways for convenience of data presentation or analysis—the most important characteristics of such sources are the amount and type of specific pollutants discharged; the locations of the sources with respect to the surface water system; and the timing or conditions under which the pollutants are discharged to the waterways and thereby released into the aquatic environment. The rate at which a waste stream flows; the size, shape, and slope of the surface over which it flows; the characteristics of the material—soil, vegetation or synthetic surface—upon or through which it flows; the spatial separation of the pollution source from the nearest body of surface water; and the physical or chemical stability of the waste stream as it degrades in the natural environment, all serve to complicate these characteristics. These processes—particularly with respect to diffuse sources—also depend upon the conditions in the entire drainage basin prior to a rainfall or snowmelt runoff event. Each unique combination of pollutant loading and attendant condition of the receiving water body is a function of the events during and preceeding the specific discharge period involved. A clear example of this is the dependence of the concentration of pollutants in a storm washoff event upon the length of time since the last such event. The longer the time period during which the pollutant was able to build up on the earth's surface as a result of dry fallout and of deposition resulting from cultural processes, the more polluted will be the initial flush of storm water runoff. In other words, the occurrence of pollutants and their movement through natural systems, when considered in light of the numerous factors which affect those pollutants within the environment, are not simple deterministic processes which can be readily measured, calculated, and predicted. Rather, such occurrences and movements are highly variable, characterized by probabilities of occurrence, and by expected values as associated with other random processes.

CATEGORIES OF POLLUTION SOURCES

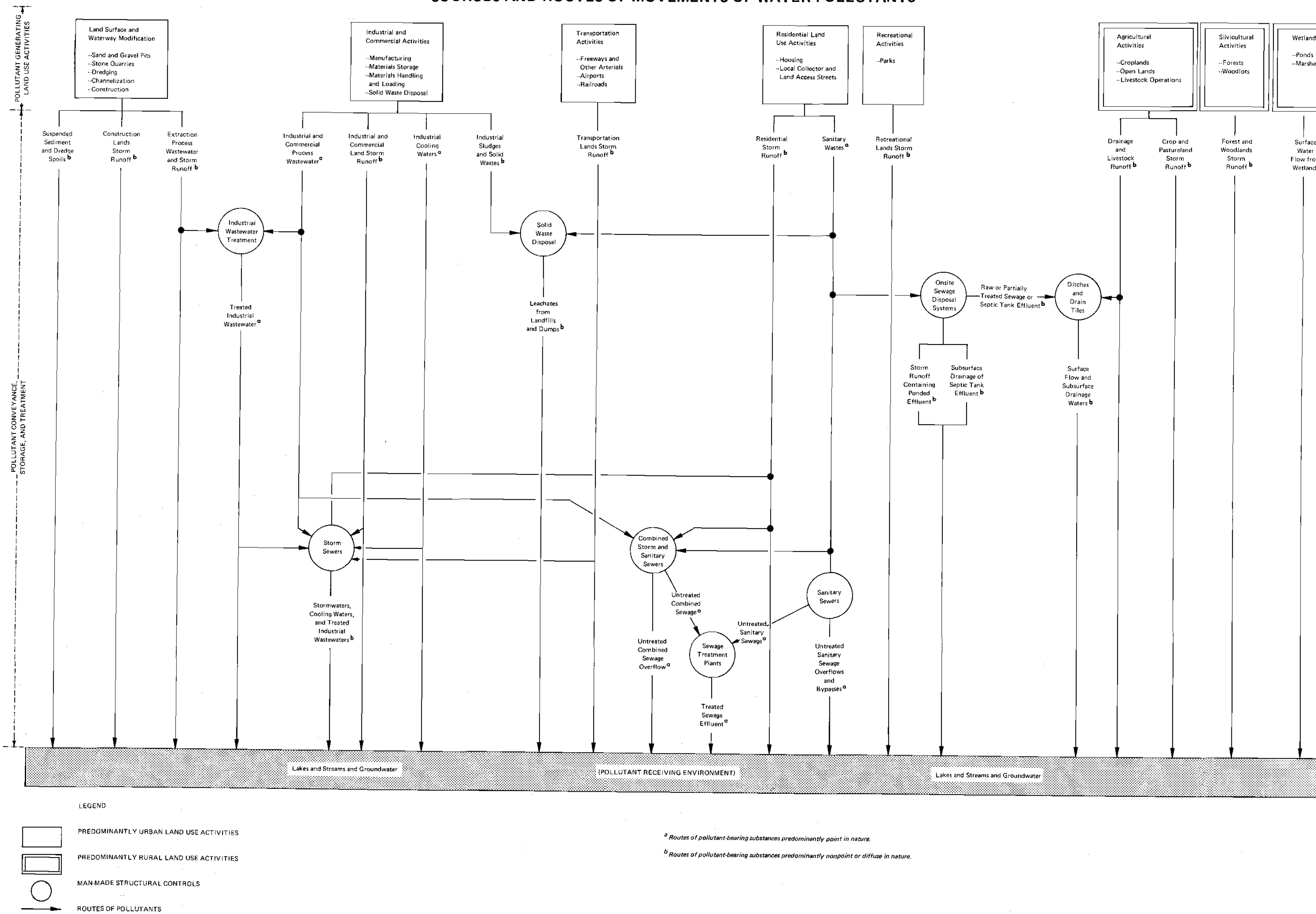
Urban and Rural

For purposes of this report, the major distinction to be made in the categories of pollution sources is the predominantly urban or rural character of each source. This distinction is particularly important in relating pollution problems to alternative solutions and implementation responsibilities. Urban pollution sources are herein defined as those associated with residential land uses having a density of at least 0.2 dwelling units per net acre, together with other land uses which serve and support the residential uses. Specifically, these urban land uses are identified in Figure 2 and include, in addition to residential land uses, industrial and commercial land uses, transportation land uses, recreational land uses, and certain activities related to the modification of the land surface such as earth moving, grading, trenching, clearing, grubbing, dredging or channelization. In addition to storm runoff these urban water pollution sources include sanitary sewage, combined storm and sanitary sewage, effluent from on-site sewage disposal systems, and industrial wastewaters. Rural land uses are herein defined as all of the residual non-urban land uses, including agriculture, silviculture and natural areas of the Region. These rural water pollution sources include the runoff from livestock operations, croplands, pasturelands, unused or open lands, orchards, woodlands, and wetlands.

Because of the complex mix of rural and urban land uses found in the rapidly urbanizing Region, it has been necessary to make somewhat arbitrary distinctions for some pollution sources which may relate to both types of land uses. It is believed, however, that neither the areal extent, nor the pollutant loadings associated with these sources represents a significant proportion of the regional totals. These pollution sources include direct air pollution fallout to water bodies, which is considered herein as a predominantly rural source, since most of the acreage of lakes and streams is located in rural areas of the Region. Included as urban sources are all known residential on-site sewage disposal

Figure 2

SOURCES AND ROUTES OF MOVEMENTS OF WATER POLLUTANTS



[a] *Routes of pollutant-bearing substances predominantly point in nature.*

[b] *Routes of pollutant-bearing substances predominantly nonpoint or diffuse in nature.*

Source: SEWRPC.

systems, sand and gravel pits and stone quarries, solid waste disposal operations, and parks including golf courses. Freeways and other arterial highways are considered as urban sources, but local collector and land access streets serving adjacent land uses are classified with the adjacent urban or rural land uses.

Figure 2 presents a summary diagram of the interrelationships of diffuse sources of pollution and the points at which pollutants are contributed to natural water bodies, as well as major functional routes of the wastewater discharged from municipal and industrial outfalls, combined storm and sanitary sewers, and storm sewers.

Point and Nonpoint

Two other general categories of pollution sources which are sometimes used in considering the effects of human activities on surface water quality are point sources and nonpoint sources. These pollution source categories do not coincide with the urban-rural dichotomy discussed above. Point sources of pollution are defined as concentrated discharges of wastewater emanating from a specific, discrete site. Because point sources discharge collected wastewaters to surface water bodies through a pipe or other identifiable conduit, point sources generally can be more readily eliminated or abated than nonpoint sources. Examples of such discernible confined and discrete sources of pollution include sewerage system flow relief device outfalls, sewate treatment plant outfalls, and industrial waste outfalls.

Nonpoint sources of pollution are defined as diffuse discharges of wastewater which cannot be identified as a point source. Most commonly these consist of stormwater and snowmelt runoff carrying sediment and chemical substances which act as water pollutants. However, the distinction between point and nonpoint sources of pollution is also somewhat arbitrary, and exceedingly difficult to make since diffuse pollution sources associated with urban and rural runoff can be collected, channelized and conveyed to identifiable points of discharge, such as storm sewer outfalls. Thus, for purposes of this report, the pollution sources are not identified primarily as point or nonpoint in nature, but rather are categorized and enumerated in sets which are organized according to the type of land use and the methods by which lands are managed. The categories were also selected to be comprehensive and mutually exclusive in their presentation of the necessary inventory data, given the forms in which the data were available for collection.

Historically, water pollution control efforts have been concentrated on point sources. This emphasis has probably been due to the relative ease with which point sources could be identified, measured, and limitations upon the associated wasteloads established. State and federal laws, and attendant administrative regulations have commonly sought to limit the strength and characteristics of the wastewaters from the different types of point sources, such as municipal sanitary sewage treatment plant and industrial wastewater outfalls. This regulation has generally been based upon the specific process from which a wastewater is generated, as well as the alternative technologies available for treatment of the wastewater prior to discharge. The regulations were commonly interpreted and applied on a case-by-case basis to the individual point sources, using wastewater quality monitoring data collected for this purpose. The resulting regulations—expressed in the form of a discharge permit issued through the Wisconsin Pollutant Discharge Elimination System by the Wisconsin Department of Natural Resources—specify the strength of wastewater or the amounts of the constituent pollutants which may be discharged from each point source. There were 1,173 known point sources of pollution within the Region as of December, 1975. These point sources consisted of 462 sanitary sewer flow relief device outfalls operated by 55 civil divisions; 126 combined storm and sanitary sewer outfalls operated by three civil divisions; 61 public sewage treatment plant outfalls operated by 58 civil divisions; 69 private sewage treatment plant outfalls discharged from 67 facilities, and 455 other point sources including industrial wastewater outfalls discharged from 277 facilities.

The discharge permit program for control of point sources is massive and complex, but it is nevertheless far more simple than an analogous system for diffuse pollutant controls would be. The U.S. Environmental Protection Agency has advanced preliminary proposals for permit procedures for control of feedlot runoff, and storm sewer outfalls. In both cases, the federal agency is currently revising those proposals to focus only on the most readily identifiable sources of these types; generally the larger facilities or those operated by the larger public or private entities, or those most likely to affect water quality.[1] Most livestock operations and most storm

[1] *It should be noted that under the proposed regulations these sources could, conceptually, legally, and administratively, be regarded as "point" rather than "nonpoint" sources. Under current Environmental Protection Agency regulations, an animal feeding operation is considered a "concentrated animal feeding operation" and therefore a point source of pollution and subject to regulation by permit issuance, (a) if more than 1,000 animal units (i.e., 1,000 slaughter and feeder cattle, 700 mature dairy cattle, 500 horses, or 2,500 swine weighing over 55 pounds) are present, or (b) if less than 1,000 but more than 300 animal units are confined (i.e., more than 300 slaughter or feeder cattle, 200 mature dairy cattle, 150 horses, 750 swine weighing more than 55 pounds) and pollutants are discharged directly to navigable waters which pass through the site of animal confinement or to such waters through a ditch or similar man-made device, unless such feeding operation discharges only in the event of a 25-year, 24-hour storm event. An animal feeding facility housing between 300 and 1,000 animal units may only be*

sewer systems in southeastern Wisconsin are smaller than the minimum size operations which are currently being proposed to be included under these permit programs. If indeed a comprehensive permit program were established for the control of diffuse pollution sources of the types discussed in this report, the program would have to address a far more extensive number of sources than does the existing permit program for point source control, and would furthermore require detailed technical specification of the timing and methods of site-specific land management practices, rather than simply an identification of the effluent characteristics. Accordingly, the areawide water quality planning program must develop locally acceptable methods of abating pollution from these sources, as well as the other diffuse sources of pollution.

SOURCES OF POLLUTION

Table 1 sets forth the types of pollutants associated with each of the major categories of pollution sources. These sources are discussed in more detail in Chapter III, with respect to sewage treatment plant outfalls, sanitary and combined sewerage system flow relief devices and industrial wastewater outfalls; in Chapter IV, with respect to storm sewer outfalls; and in Chapter V, with respect to diffuse sources of pollution contributed by storm water runoff from different types of land cover. It is important to note that the storm water runoff and snowmelt which are collected and discharged through storm sewer systems are addressed in two ways; once in the estimation of flows as set forth in Chapter IV, and a second time in the estimation of their constituent pollutants as set forth in Chapters V and VI of this report. In the summary of wasteloads, however, these pollutants have been included only once.

Regardless of source, the pollutants listed in Table 1 may be expected to have the same general effects on the water quality of a stream or lake. The specific effects of the existing and anticipated future pollution sources are considered in SEWRPC Planning Report No. 30, A Water Quality Plan for Southeastern Wisconsin. However, it is possible to characterize the effects of these pollutants on the quality of the streams and lakes in a general way. Accordingly, the following comments describe the general physical, chemical, and biological effects which may be expected of the identified pollutants on surface water quality; the current understanding of the potential for disease associated with the pollutants; and the general levels of the substances as they relate to the currently adopted water quality standards for waters intended for the maintenance of fish and aquatic life, or for recreation—the Congressionally mandated national water use objectives. Both the pollution sources which contribute these substances, and the concentrations and amounts generally contributed are discussed in the chapters which follow.

---

deemed a concentrated feedlot operation however, after on-site inspection has been conducted and has considered the amount of wastes, the location of the feeding operation, the slope, vegetation, rainfall, and other factors relative to the likelihood, frequency or amount of discharge of animal wastes into navigable waters.

As of December, 1975, Environmental Protection Agency Regulations proposed the development of a generalized permit procedure for separate storm sewers—defined as a conveyance or system of conveyances (including but not limited to pipes, conduits, ditches, and channels) located in an urbanized area and primarily operated for the purpose of collecting and conveying stormwater runoff—(40 CFR 124.83), but has limited the program to the urbanized areas as designated by the Bureau of Census pursuant to the criteria set forth in the Federal Register 39 FR 15202 (May 1, 1974). In the Region, this includes areas in and near the Cities of Milwaukee, Kenosha, and Racine, as set forth on Map 1, Chapter III of this report.

EFFECTS OF WATER POLLUTANTS

The various pollution source categories listed in Table 1 contribute subsets of a total of 15 major pollutants. These major pollutants, as noted in Table 1, include suspended solids; dissolved solids; oxygen-demanding, rapidly-degrading, organic substances; slowly degrading or non-degrading organic substances; nitrogen; phosphorus; pathogenic organisms; toxic and hazardous substances; corrosives; grease and oil; dissolved organic substances; detergents; heat; heavy metals; and pesticides. Some of these pollutants can and do interact, thereby causing different environmental hazards: for example, oxygen-demanding substances exert their influence more quickly at higher temperatures, even though warmer water holds less dissolved oxygen than does cooler water. Other pollutants are sensitive to the pH of the aquatic environment. To facilitate understanding, the following descriptions of the effects of the various kinds of pollutants—except as noted—assume a typical water quality condition, in which the subject pollutant is the principle cause of degradation beyond natural conditions and is not affected by the other pollutants present.

Suspended Solids

Soil erosion by wind, rain or other mechanical means destroys the micro-structure of the soil, removing organic, microbial, and inorganic particles which may range in size from very fine clay particles to coarse sand particles. The size and density of the particles, as well as the natural chemical content, determine the pollution effects since the smaller particles present a larger proportion of surface area upon which nutrients and pesticides may be adsorbed. Eroded soil particles may carry with them nitrogen, phosphorus, pesticides, heavy metals, oxygen-demanding substances, and pathogenic organisms. Therefore, eroded soil particles are important transport mechanisms by which pollutants may be moved into and through a stream system. Once they are within an aqueous environment, the soil particles

Table 1

POLLUTANTS ASSOCIATED WITH CATEGORIES OF POLLUTION SOURCES FOUND IN THE REGION

Category of Pollution Source	Principle Associated Substances Containing Pollutants	Specific Pollutants Contributed to Watercourses
Urban Categories:		
Publicly or privately-owned sanitary sewerage system discharges and overflows	Treated and untreated sanitary sewage or combined storm and sanitary sewage	Suspended solids, degradable organic (oxygen-demanding) substances; phosphorus; nitrogen; slowly or non-degradable organic substances; bacteria; viruses; toxic and hazardous substances.
Privately-owned, on-site sewage disposal systems (septic tanks, mound systems)	Surface runoff of effluent from malfunctioning or improperly designed systems	Viruses; bacteria; degradable organic (oxygen-demanding) substances; nitrogen; phosphorus; dissolved organic substances; suspended solids.
Holding tanks	Groundwater discharge of effluent (holding tank wastes, including sanitary and household wastes improperly disposed on land)	Viruses; bacteria; degradable organic (oxygen-demanding) substances; nitrogen; phosphorus; dissolved organic substances; suspended solids.
Industrial wastewater outfalls	Process waters, including wash waters, rinse water, organic wastewaters, chemical wastes, cooling waters	Oxygen-demanding substances; dissolved solids; suspended solids; toxic and hazardous substances; corrosives; oil; grease; detergents; heat.
Storm sewerage systems	Street litter and runoff, pet litter, lawn runoff, and rooftop and parking lot runoff	Oil; grease; suspended solids; dissolved solids; oxygen-demanding substances; phosphorus; nitrogen; pesticides; toxic and hazardous substances; bacteria; viruses.
Storm runoff from residential areas	Lawn runoff, street litter, pet litter, rooftop and parking lot runoff, garbage, degraded surface coatings, vegetation	Oil; grease; suspended solids; dissolved solids; oxygen-demanding substances; phosphorus; nitrogen; pesticides; toxic and hazardous substances; bacteria; viruses.
Storm runoff from commercial areas	Loading dock and work area litter, parking lot runoff, refuse litter, fuels.	Suspended solids; dissolved solids; oxygen-demanding substances; toxic and hazardous substances; phosphorus; nitrogen; bacteria; viruses; grease; oil.
Storm runoff from industrial areas	Loading dock and work area litter, runoff from materials storage, parking lot runoff, refuse litter, fuels, wood, virgin and scrap metals, paper, plastics, salt, sand and gravel, organic deposits, flyash, petroleum and chemical products, corrosives, waste chemicals, brush, garbage, rubber, acids, glass, ceramics, paint, glue, solvents	Suspended solids; dissolved solids; oxygen-demanding substances; toxic and hazardous substances; phosphorus; nitrogen; bacteria; viruses; grease; oil.
Storm runoff from mining areas	Sand, gravel, quarried stone, dust, chemicals, petroleum products	Suspended solids; dissolved solids; grease; oil.
Storm runoff from construction areas	Building materials, pesticides, fertilizers, cement, fuels, petroleum products, soil particles, garbage, litter, chemicals (paints, glues, solvents, acids, concrete curing compounds, lime, flyash, salt)	Eroded soil particles; nitrogen; phosphorus; oxygen-demanding substances; toxic and hazardous substances; grease; oil.
Storm runoff from transportation areas	Fuel, oil, grease, hydraulic fluids, coolants, engine emission particles, rubber particles, litter, brake-linings, pavement particles, paints, vegetation, deicing salts, cinders, spilled materials, chemicals, pesticides, carrion, soil particles	Eroded soil particles; nitrogen; phosphorus; oxygen-demanding substances; toxic and hazardous substances; grease; oil; dissolved solids; suspended solids.
Runoff from dredging and channelization areas	Soil particles, vegetation, sediments, petroleum products, organic deposits	Eroded soil particles; nitrogen; phosphorus; grease and oil; oxygen-demanding substances.
Storm runoff from recreational areas	Vegetation, fertilizers, pesticides, garbage, litter, eroded soil particles, disturbed stream or lake sediments, petroleum products	Suspended solids; dissolved solids; nitrogen; phosphorus; grease and oil; oxygen-demanding substances.
Rural Categories:		
Storm runoff and direct drainage from livestock operations	Manure, bedding, eroded soil particles, pesticides	Suspended solids; dissolved solids; nitrogen; phosphorus; oxygen-demanding substances; pesticides; bacteria; viruses.
Storm runoff from croplands and pasture lands	Eroded soil particles, fertilizers, pesticides, manure, crop residue	Suspended solids; dissolved solids; nitrogen; phosphorus; pesticides; bacteria; viruses.
Storm runoff from orchards	Eroded soil particles, vegetation, prunings, pesticides, fertilizers, mulch	Suspended solids; dissolved solids; pesticides; nitrogen; phosphorus.
Storm runoff from woodlands	Vegetation, pesticides, slashings and logging debris, wood chips, bark, eroded soil particles, leaf leachate, livestock manure, wildlife droppings.	Nitrogen; phosphorus; eroded soil particles; oxygen-demanding substances; pesticides; bacteria; viruses.
Direct fallout of air contaminants and storm runoff from wetlands and surface waters	Air contaminants, (NO_x, Hydrocarbons, sulfur oxides, lead, particulates, organic carbon), smoke, dust, soot, flyash, seeds, fumes, mists, odors, contaminated precipitation, dry fallout, wind-carried soil particles, wildlife droppings, aquatic vegetation, disturbed sediments	Nitrogen; phosphorus; oxygen-demanding substances; heavy metals; inorganic solids.

Source: SEWRPC.

may either be dissolved or suspended in the overland (sheet) flow of water to the nearest stream. The dissolved solids contribute to the hardness of natural waters. The dissolved and suspended solids both may adversely affect fish and aquatic life by reducing oxygen levels, and by adding color and otherwise decreasing the water clarity, thereby interfering with natural feeding patterns. A decrease in clarity can be measured directly by the turbidity of the water, or can be inferred from the levels of total dissolved and suspended solids.

The volatile or organic component of the suspended solids discharged from a sewage treatment plant may produce excessive oxygen demand on the receiving waters, thereby producing fish kills, odors, and generally noxious conditions. Suspended solids in sewage treatment plant effluent and land surface washoff may result in excessive color and turbidity in the receiving stream and may be detrimental to fish by causing abrasive injuries, obstructing respiratory passages, and covering and thereby damaging or destroying eggs in spawning areas.

In streams, the suspended solids drop out of the streamflow when the velocity of movement is reduced sufficiently, and settle to the bed of the stream. This process, referred to as sedimentation, may impair the use of the watercourse by the physical displacement of water. Sediment may plug culverts and road ditches, cause localized flooding as the surface drainage patterns are changed, and interfere with commercial and recreational navigation. Deposited on the bed of a stream or lake, the particles create an aesthetic nuisance and may cover benthic organisms, shutting off the supplies of light and flowing water needed for life, and thereby making these organisms inaccessible as food sources for the other, more mobile creatures in the aquatic system.

As sediment, the soil particles also function as a storage site for the chemical pollutants they carry with them. Nitrogen, phosphorus, pesticides, heavy metals, and some organic matter and pathogenic organisms may be present, and released by desorption under various conditions not well understood at the present time. It is known that phosphorus in sediment is more readily released under anaerobic conditions, where ferric iron may be changed to ferrous iron, and form ferrous phosphate, which is highly soluble. Similarly, it is known that changes in the pH of water can affect the solubility of phosphorus compounds with calcium, magnesium, iron, and aluminum. Temperature is also thought to be an important variable in these processes. As noted below, nitrogen, phosphorus, pesticides, heavy metals, and organic substances each constitute water pollutants with their own attendant hazards and adverse effects.

Federal recommendations relating to the preservation of fish and other aquatic life call for suspended solids in natural waters to be present at levels which will not reduce by more than 10 percent, the seasonal depth to the effective limits of photosynthetic activity. Localized concentrations of 80 mg/l of inert suspended solids have been shown to cause 60 percent density reductions in the populations of macroinvertebrates, while sediment accumulation as a result of any significant concentration in the overlying waters has been shown to cause 60 percent reductions in benthic invertebrate populations.

Dissolved Solids

The dissolved solids content of water consists of all of the inorganic and organic substances that occur dissolved in the water regardless of source. Excluded by this definition are suspended organic or inorganic materials, floating organisms, and dissolved gases.

The dissolved solids content of surface and ground water has a major bearing upon its suitability for various water uses. Dissolved solids content affects the required treatment of waters used for industrial and domestic purposes. The availability of many plant nutrients increases with increased dissolved solids. In addition, livestock and poultry may be injured by drinking water that contains dissolved solids in excess of 500 mg/l. Dissolved solids may also influence the toxicity of heavy metals and organic compounds to fish and other aquatic life. Dissolved organic solids may add to the demand on dissolved oxygen, with an attendant suppression or depletion of the dissolved oxygen content of the stream or lake. Dissolved solids in water supplies have been shown to be detectable by taste in the range of 400 to 800 mg/l. Public Health Service Drinking Water Standards recommended maximum levels of 500 mg/l, with a range of 20 to 270 mg/l of sodium—a dominant cation—recommended as maximum for persons on a restricted sodium diet. Several common freshwater species of fish have been found able to tolerate up to 10,000 mg/l dissolved solids.

Oxygen Demanding (Degradable Organic) Substances

One especially offensive type of pollution occurs when relatively large amounts of putrescible organic materials, which require oxygen for their decomposition, are introduced into waters. The biodegradation, or oxidation, of carbonaceous or nitrogenous materials by bacteria and microorganisms depends on the dissolved oxygen already present in the receiving waters, oxygen entering from the atmosphere, and oxygen released by photosynthetic processes. When the rate of oxidation is greater than the rate of oxygen replenishment, the concentration of dissolved oxygen in receiving waters declines. In addition, algae and other aquatic plants may cause large daily fluctuations in the dissolved oxygen concentrations of surface waters, as these plants produce oxygen through photosynthesis during the daylight hours and consume oxygen by respiration at night. Such diurnal dissolved oxygen variations often produce unfavorable conditions for the maintenance of desirable forms of aquatic animal life during the low phase of the diurnal cycle. Low dissolved oxygen concentrations in surface waters create an unsuitable environment for fish and other desirable forms of aquatic life, and the absence of dissolved oxygen leads to a septic or anaerobic condition with its associated foul odors and unpleasant appearance. Anaerobic conditions also affect the release rate of toxic materials and nutrients from sediments and increase denitrification rates. The state and federally adopted water quality standards call for 5.0 mg/l of dissolved oxygen for the protection and propagation of fish and other aquatic life, except that 6.0 mg/l is recommended for trout streams, with 7.0 mg/l specified for trout spawning periods.

The five-day biochemical oxygen demand (BOD_5) is a measure of the oxygen used over a five-day period at 20°C in the aerobic bacterial decomposition of the organic wastes in a water sample. Thus, BOD_5 is a frequently-used measure of the concentration of decomposable organic substances. It should be noted that BOD_5 is not a pollutant, the reason being that it is not a specific chemical substance, physical property, organism or group of organisms; it is measurable only in the presence of aerobic decay bacteria under a set of controlled test conditions that do not prevail in nature. BOD_5 determinations are important in water quality studies because they indicate levels of organic pollution and the attendant potential decrease in dissolved oxygen concentration. Without the knowledge of the reaeration characteristics of a stream, BOD_5 values cannot be used, except in a very general way, to determine where dissolved oxygen concentrations may reach critically low levels for the preservation of fish life. However, for the purposes of this report, BOD_5 is regarded as a pollutant load which aids in prediction, analysis, and planning.

Slowly Degradable or Non-Degradable Organic Matter

Non-degradable or slowly degradable organics, such as lignin or synthetic detergents, while not significantly contributing to oxygen demand, may nevertheless have an adverse effect on water quality. These organics can cause taste and odor problems in downstream watercourses, and also impart color to a water, sometimes making it unsuitable for certain direct reuse applications or aesthetically unacceptable for recreation. In some cases, the organic matter may cause an objectionable taste in fish residing in the receiving watercourse. There are no known recommended levels for this category of pollutants as such.

Nitrogen

Nitrogen is a nutrient essential for plant growth, and, along with phosphorus, is often cited as causing problems of overfertilization in surface waters. The derivatives of nitrogen are important water quality parameters because of the significance of nitrogen as a nutrient in the life processes of all plants and animals. The amount of plant growth may be limited by nitrogen concentration, provided all other required nutrients are present and above the critical concentrations.

Nitrogen may occur in water and wastewater in the form of nitrates, nitrites, ammonia, and organic nitrogen. Excessive growth of algae and other aquatic plants may occur from excessive quantities of nitrates to the streams and lakes of the Region, giving rise to unsightly scum and unpleasant odors, when nitrate is present along with phosphate in water above a minimum level. In spite of having many sources, nitrates are seldom abundant in natural surface waters, for they serve as an essential nutrient for all types of plants, from phytoplankton to trees. Photosynthetic action constantly utilizes nitrates and converts them to organic nitrogen in plant cells. Methemoglobinemia, a serious or even fatal disease in infants under three months of age, characterized by displacement of oxygen by nitrite in the hemoglobin in blood, is generally held to be caused by nitrate concentrations above 10 mg/l in drinking water.

Nitrite occurs in nature as a chemically unstable substance readily oxidized to nitrate, and for this reason is normally present in very low concentrations in surface waters. Nitrites are often byproducts of bacteriological action upon ammonia and nitrogenous substances. Nitrites are toxic, but rarely occur in large enough concentrations to cause a health hazard. The brewing and dairy industries require that water contain no nitrites. In association with ammonia and nitrate, nitrites in water are often indicative of pollution.

Ammonia is the chief decomposition product from plant and animal proteins and is used as chemical evidence of sanitary pollution. In the presence of oxygen, however, ammonia is transformed by the nitrifying bacteria into nitrate. Ammonia may also result from the discharge of industrial wastes or from scouring and cleaning operations where ammonia water is used. Streams and lakes known to be unpolluted have very low ammonia concentrations, generally less than 0.2 mg/l expressed as nitrogen. In groundwater, however, ammonia generally occurs in higher concentrations as a result of natural reduction processes. High concentrations of ammonia, particularly in the presence of high pH levels, can be toxic to aquatic animals. Algae which live on high nitrate concentrations appear to be harmed or inhibited when nitrogen is in the form of ammonia.

The organic nitrogen content of a water is contributed by amino acids, proteins, and polypeptides—all products of biological processes. Increase in the organic nitrogen content may often be related to the sewage or industrial waste pollution of a given water supply. In water treatment plants practicing chlorination, the presence of organic nitrogen and ammonia increases the amount of chlorine required, since additional chlorine is used in the chemical formation of chloramines by the reaction of chlorine with organic nitrogen or ammonia. Organic nitrogen also exerts a certain amount of chemical oxygen demand, since the oxidation of organic nitrogen takes up the oxygen present in the surface water, reducing the dissolved oxygen concentrations vital for aquatic life.

Concentrations of 0.02 mg/l is the EPA-recommended level for un-ionized ammonia in freshwater streams to avoid conditions toxic to freshwater fish. There are no state or federally recommended levels for concentrations of nitrate, nitrite or organic nitrogen forms in lakes or streams, since the hazardous or toxic levels are very unlikely to occur. Studies[2] have indicated that the approximate threshold concentration for algae growth in lakes is 0.1 mg/l[3] nitrate-nitrogen. Nitrate-nitrogen concentrations below 0.1 mg/l, however, can be supplemented by nitrogen fixation from atmospheric sources which occurs in blue-green algae.[4,5] Blooms by non-nitrogen fixing algae can be anticipated in lakes when the inorganic nitrogen[6] concentrations exceed 0.3 mg/l[7] if the phosphate-phosphorus exceeds 0.01 mg/l.

Phosphorus

With respect to controlling algae and aquatic plant growths in surface waters by limiting the influx of a critical nutrient, contemporary water resources management places emphasis on phosphorus control rather than on the control of nitrogen or other necessary elements which are generally more readily available in the natural environment.

High phosphate concentrations in water are associated with excessive algae or other aquatic plants growths. Algae have been frequently cited as responsible for unpleasant taste and odor in drinking water supplies. Algae growths can impart color and turbidity to water. Algae also interfere with the water treatment processes of filtration and disinfection, and reduce the useful capacity of reservoirs by concentrating at certain depths in the water or along the shallow margins or bottom. Other problems caused by algae in domestic water supplies include clogging of intake screens and reduction of flow capacity. Algae are also undesirable in water for a variety of industrial uses, including cooling towers, paper manufacture, laundry, photography, and chemical industries. Algae can cause heavy fish mortality through direct poisoning or by the depletion of oxygen as a result of the death and decay of excessive growths. Algae, both fresh and decaying, have also been reported to be toxic to livestock and wildlife. Deaths of a variety of animals, after drinking water containing high concentrations of blue-green algae such as Aphanizomenon, Anabaena and Anacystis, have been reported from many parts of the world if not specifically from southeastern Wisconsin. Excessive growths of algae destroy recreational and aesthetic values of lakes and also cause inconvenience to the recreational users. Wave action may concentrate a large amount of algae on shore. If not removed immediately, the algae will cause foul odors and an offensive appearance during decomposition.

Aquatic fertilization can also induce heavy growth of large, rooted, aquatic plants or macrophytes. Aesthetic and chemical problems of plant overgrowth from macrophytes is similar to that associated with algae. Macrophytes may provide some aquatic wildlife habitat; in extremely heavy growths, they may reduce shore erosion from wave action, and may even improve water quality by nutrient uptake or by encouraging the settling of suspended solids. The largest and most hardy macrophytes, however, do present an impediment to desirable water use, because of their durable, specialized fibrous tissues. The snarling of propellers, water skis, and fishing tackle, and documented cases of entanglement and resultant drowning of swimmers have caused public objection to macrophyte overgrowth. The ameliorative measures of chemical treatment or weed harvesting have caused increasing levels of local expenditures to control this water quality problem.

Studies[8] have indicated that 0.01 mg/l phosphate-phosphorus is the approximate threshold concentration for algae growth in lakes if sufficient nitrogen is also available, along with other necessary conditions such as temperature, incident sunlight, or the presence of essential elements like boron. Federal reports on water quality criteria[9,10] con-

---

[2] *State of California Publication No. 34, Eutrophication—A Review, State Water Quality Control Board, 1967, p. 30.*

[3] *P. Fay et al, "Is the Heterocyst the Site of Nitrogen-Fixation in Blue-Green Algae?" Nature, 220:810, 1968.*

[4] *P. Fay et al, op. cit.*

[5] *W. G. W. Kurz and T. A. LaRue, "Nitrogenase in Anabaera flos-aquae Filaments Lacking Heterocysts," Naturwissenschatten, 58:417, 1971.*

[6] *Inorganic nitrogen includes the nitrate-nitrogen, nitrite-nitrogen and ammonia-nitrogen concentrations collectively.*

[7] *C. N. Sawyer, "Fertilization of Lakes by Agricultural and Urban Drainage," Journal New England Water Works Association, Vol. 61, 1947.*

[8] *State of California Publication No. 34, Eutrophication—A Review, State Water Quality Control Board, 1967, p. 30.*

[9] *Water Quality Criteria, Report of the National Technical Advisory Committee, p. 34.*

[10] *U.S. Environmental Protection Agency Water Quality Criteria, Ecological Research Series, March, 1973, p. 81.*

tain guideline values of a maximum of 0.10 mg/l total phosphorus in flowing streams and 0.05 mg/l in streams entering lakes or reservoirs to prevent nuisance growth of aquatic plants.

Pathogenic Organisms

Because they can cause serious illness in animals and in man, bacteria and viruses are among the most important of the pollutants which can impair water use in southeastern Wisconsin. These are insidious pollutants because they can be detected only with sophisticated laboratory procedures. A simplified indicator of the bacteriological safety of water is the test for "coliform bacteria": a group of bacteria which are rod shaped, aerobic and facultative anaerobic, Gram-negative, non-spore-forming and which ferment lactose with gas formation within 48 hours after incubation at 35°C. This combination of structural and physiological characters exists in the genera Escherichia, Erwinia, Salmonella, Shigella, Serratia, and Enterobacter, a large and ecologically somewhat diverse group.

The number of coliform bacteria in water is the most widely-used indicator of the possible presence of disease-producing organisms. Coliform bacteria are easily detected and apparently harmless microorganisms which occur in extremely large concentrations in the intestinal tracts of man and warm-blooded animals, along with the pathogenic—or disease-producing—bacteria. Therefore, the presence of large numbers of coliform bacteria in a water is used as an indicator of the possible presence of enteric pathogens in that water, while the absence of coliform bacteria is used as an indicator of the probable absence of pathogenic bacteria. Coliform bacteria are also present in the soil, however, and therefore may originate from sources other than the human intestinal tract, so a high coliform count is not necessarily indicative of fecal pollution. Tests have been developed to determine the number of actual fecal coliform organisms present in water, and such tests are considered a better indicator of the probable presence of disease-producing organisms than total coliform tests.

The genera Salmonella and Shigella include most of the important causative agents of intestinal disease in man; the agents of bacilliary dysentery, infectious hepatitis, typhoid and paratyphoid fevers, and the most common and serious kind of food poisoning. These pathogens are transmitted almost exclusively by the fecal contamination of water, food and milk. Transmission through water is by far the greatest source of infection and has been invariably the source of mass epidemics. Today, typhoid fever is a very rare disease in most civilized countries, and its disappearance has been achieved largely by the sanitary control of water supplies. It is seldom possible to isolate intestinal pathogens directly from water that has undergone fecal contamination, unless the water has been recently and massively contaminated. However, any water supply that is contaminated with fecal matter is a potential source of disease, and hence the recognition of such contamination is essential to sanitary control.

The drinking water standards established in 1974 by the Wisconsin Department of Natural Resources limit the mean total coliform concentration in treated drinking water to one colony per 100 ml by the membrane filter coliform count (MFCC) method. In water used for the maintenance of fish and other aquatic life and for recreational purposes, State of Wisconsin standards specify a monthly geometric mean membrane filter fecal coliform count (MFFCC), based on a minimum of five samples per month of not more than 200 colonies per 100 ml, and a maximum count not exceeding 400 colonies per 100 ml for more than 10 percent of the samples during any month.

Although enteric viruses are found in relatively small numbers in polluted waters, their occurrence could be hazardous since the minimum infective dose for humans has not been firmly established.[11] Viruses are submicroscopic infective agents so small as to be regarded either as the simplest of microorganisms or as extremely complex molecules, containing a protein coat surrounding a core of genetic material. They are capable of growth and multiplication only within living cells. Viruses are the causes of various important diseases in man, lower plants and animals. Viruses can be transmitted by water and infect human populations by contaminating drinking water, food and milk, swimming areas, or other media to which humans are exposed. Although there are means of immobilizing or inactivating viruses, there is no consistently available and predictably effective general virucidal technique. Although some viruses have been found to be more susceptible to inactivation by chlorine, others are typically more resistant to chlorine than are coliform bacteria. Standard analyses for bacteria cannot satisfactorily predict the presence of viruses, since viral strains are significantly smaller than bacteria, and their survival and growth rates differ widely within as well as between the two categories. No single indicator organism has found favor or primary use in the water chemistry profession to identify or indicate the presence of viruses. To a large degree, the sanitary engineering profession has relied upon the use of fecal coliform bacteria and other bacterial indicators as surrogates for the presence of human waste and potential viral contamination.

In addition to a wide range of moderately hazardous or disabling diseases such as influenza or measles, viruses have also been shown to be responsible for such diseases as viral carditis, chicken pox, hemorrhagic fever, infectious and serum hepatitis, infectious mononucleosis, mumps, rabies, rubella,

---

[11] *U.S. EPA Quality Criteria for Water, Ecological Research Series, EPA-440/9-76-023, 1976.*

smallpox, and poliomyelitis.[12] Accordingly, there is no single or generally recommended level of a single indicator virus for use in the analysis of potential viral health hazards, and indeed little or no viral sampling is available for the natural waters of the lakes and streams of southeastern Wisconsin.

Toxic and Hazardous Materials

The general category of toxic and hazardous materials consists of heavy metals, pesticides, and polychlorinated biphenyls (PCB's) which accumulate in nature after their initial production as a result of man's activities. The development and production of industrial chemicals, and their ultimate disposal in the environment have presented the ecological systems of the streams and lakes with a complex array of new chemical species. Such chemicals have essentially unpredictable individual or joint impacts on the biological processes occurring in waterways. Heavy metals, pesticides, and PCB's are transported into the surface waters of the Region via several sources of entry, including discharges from sewage treatment plants; industrial wastewater discharges; stormwater runoff from urban and rural streets, and highways, rooftops, lawns, and other pervious and impervious surfaces; application of wastewater sludge residuals to land surfaces; applications of organic and inorganic fertilizers for agricultural purposes; and the repeated spraying or spreading of pesticides, particularly the persistent chlorinated hydrocarbons.

Heavy metals, pesticides, PCB's and other toxic and hazardous substances generally do not present the gross, aesthetic or olfactory offense of some other water pollutants, but do present an unseen health hazard to animal and human populations. Not only are these toxic and hazardous materials taken up by rooted plants, but they have the inert ability to enter the food chain at the lowest levels of vegetative growth and thereby gradually move up the food chain and accumulate in fish which, in turn, are available for human consumption. In addition, other carnivores such as predatory birds may be adversely affected by toxic materials. Populations of peregrine falcons and bald eagles have been decimated by the effects of pesticides.

Heavy metals such as cadmium, chromium, cobalt, copper, lead, mercury, nickel, and zinc are those which have a specific gravity greater than four, have several oxidation states, and readily form complex ions. The toxic effects of heavy metals in the aquatic system vary greatly and are thought to be dependent upon such factors as concentration, hardness, pH, and temperature of the receiving waters, and the presence of other compounds with which the heavy metals may react—although the specific toxic effects of each metal on each potentially affected species of plant or animal are not uniformly and readily documentable. Concentrations of heavy metals which are toxic to many forms of aquatic life may not be harmful to man. However, this is not always the case, as numerous incidents of poisoning have been reported following human consumption of fish that had accumulated large concentrations of organic mercury in their flesh as a result of ingesting lower aquatic forms which had assimilated the mercury directly from the water.[13] The 1967 discovery of this problem in Japan, after scientific studies of the so-called "Minamata Disease," prompted the recent increase in research and regulation pertaining to these materials. Even in Wisconsin, unacceptable levels of mercury and PCB's in fish flesh have caused the Wisconsin Department of Natural Resources to recommend limiting human consumption of sport fish from stretches of the Wisconsin River, and from Lake Michigan. In addition, the commercial fisheries of Lakes Michigan and Superior have been severely constrained by these same findings. The specific effects of heavy metals on man and other forms of life are many and varied. For example, excessive concentrations of cadmium are associated with liver and kidney disorders in man, and are toxic to fish in their food sources. Chromium can be toxic—particularly in its hexavalent form—and is also a possible carcinogen, in addition to being toxic to fish and aquatic life. Although trace elements of copper are essential to man, large quantities may cause liver damage. Lead and mercury attack the nervous system and can be toxic to humans as well as to fish and other aquatic life.[14]

Organic pesticides are chemicals used by man to control or destroy undesirable forms of plant and animal life. Pesticides encompass all forms of insecticides, herbicides, fungicides, fumigants, nematocides, algacides, and rodenticides. Pesticides and their residues may enter the surface waters via surface and groundwater runoff from both urban and rural land uses. Some pesticides, such as herbicides used for aquatic weed control, are applied directly to surface waters. Pesticides, like heavy metals, may accumulate in the tissues of living organisms with their concentration increasing up the food chain and thus presenting a potential threat to human population.

Pesticides can be generally classified into four groups: chlorinated hydrocarbon insecticides, organophosphorus insecticides, carbamate insecticides, and chlorophenoxy herbicides. The chlorinated hydrocarbons, which include DDT, DDD, DDE, Aldrin, Dieldrin, Chlordane, Heptachlor, and Lindane, are synthetic organic insecticides that are

---

[12] *Environmental Engineers Handbook, edited by Bella G. Liptak, Vol. 1, Water Pollution, Chilton Book Company, 1974, pp. 427-430.*

[13] *U.S. EPA Quality Criteria for Water, Ecological Research Series, EPA-440/9-76-023, 1976.*

[14] *Ibid.*

very stable in the environment, and are not easily broken down in the bodies of man and animals. These poisons affect the nervous system—particularly the brain—and in very severe poisonings, may cause death. The organophosphorus insecticides include approximately 30 types, of which Parathion is potentially the most dangerous to man. These synthetic organic compounds may affect the nervous system in man by inhibiting certain enzymatic reactions necessary for proper neural functions. The carbamate insecticides such as Aminocarb, Bayer, Baygon, Carboryl, and Zectian are very similar to the organophosphorus insecticides in their toxic mechanisms. The chlorophenoxy herbicides have been widely used to control both aquatic and terrestrial vegetation. Experiments have generally indicated ambiguous toxic effects from chlorophenoxy herbicides.[15] Because of their slow degradation rate, the adverse and toxic effects of pesticides may continue long after the sources have been discontinued.

Polychlorinated biphenyls (PCB's) are a class of compounds produced by the chlorination of biphenyls and are registered in the United States under the trade name Aroclor. The degree of chlorination determines the chemical properties, and generally the composition can be identified by the numerical nomenclature; e.g., Aroclor 1242. The first two digits represent the molecular type and the last two digits the average percentage—by weight—of chlorine. Identification of PCB's in the presence of organochlorine pesticides such as DDT and DDE has been difficult in the past because of their similar chromotographic characteristics. PCB compounds are slightly soluble in water, soluble in lipids (which are compounds that, with proteins and carbohydrates, constitute the principal structural components of living cells—i.e., fats, waxes), oil, organic solvents, and are resistant to both heat and biological degradation. PCB's are relatively nonflammable, have useful heat exchange and dielectric properties and are used principally in the electrical industry in capacitors and transformers, as well as in the production of papers used for printed self-copying forms not requiring carbon paper. Parallel to heavy metals and organic pesticides, PCB's are also capable of being taken up at the lowest vegetative food chain and thereby accumulating in the fleshy tissues of fish and eventually the human population that consumes the fish—the amounts accumulated are directly related to the amount of fish eaten over a long period of time.

Persistent levels of PCB's have been continually measured in the effluents of municipal wastewater treatment plants, industrial discharges, iron, steel, and especially aluminum foundries, pulp and paper mills, electrical industries; traces of PCB's have been found in snow samples, indicating deposition from the contaminated atmosphere. Polychlorinated biphenyls' entry into the atmosphere may be expected to occur at locations where papers are incinerated, at foundries where imported casting waxes containing PCB's are heated to high temperatures, and in manufacturing facilities. PCB's adsorbed in fine particulate matter may also be entering the air as windblown dust.

Exposure to high levels of PCB's is known to cause skin lesions[16] and to increase liver enzyme production with potential secondary effects on reproductive processes.[17] It is not clear whether the effects are due to the PCB's or to contaminants (e.g., chlorinated dibenzofurans) present in the PCB's which are highly toxic. While chlorinated dibenzofurans are a byproduct of PCB production, it is not known whether they are also produced by the degradation of PCB's.[18]

Although a great deal of research remains to identify definitively the appropriate acceptable levels of these highly dangerous materials, and although new chemicals continue to be put on the market and find their way into the environment, available data concerning the federally recommended acceptable levels of these materials are presented in Table 2.

<u>Corrosives</u>

Corrosive pollutants in the form of acids can interfere with the natural biochemical processes of aquatic organisms and may accelerate the degradation of metals, concrete, asphalt, and wood. In a strict sense, alkaline or basic substances are also corrosive, and may have an adverse effect on natural waters. The pH, a measure of the acid-base equilibrium, serves as the commonly-used water quality indicator related to the effects of corrosives on water quality. The value assigned for pH units is equal to the logarithm of the reciprocal of the hydrogen ion concentration. Thus, a pH value of 7.0 implies a hydrogen ion concentration of 0.1 mg/l. The pH scale ranges from 0 to 14, with 7.0 marking the neutral point. Acids have values of less than 7.0; bases have values of more than 7.0. Most natural waters have a pH in the range of 5 to 9 units, and most sanitary wastewaters have neutral or slightly alkaline (higher) pH values. Many industrial wastes, on the other hand, can either

---

[15] *Ibid.*

[16] *L. Schwartz and S. M. Peck, "Occupational Acme," New York State Medical Society, 43:1711, 1943.*

[17] *M. Wasman, et al, "The Effect of Organochlorine Insecticides on Serum Chlorosterol Level in People Occupationally Exposed to Pollutants," Bulletin of Environmental Contamination and Toxicology, 5:368, 1970.*

[18] *National Academy of Sciences, National Academy of Engineering, Water Quality Criteria, U.S. Government Printing Office, Washington, D.C., 1972.*

Table 2

RECOMMENDED MAXIMUM LEVELS OF TOXIC AND HAZARDOUS SUBSTANCES IN NATURAL WATERS INTENDED FOR THE PRESERVATION OF FISH AND OTHER AQUATIC LIFE

Name of Substance	Recommended[a] Level in Micrograms per Liter (μg/l)
Cadmium	12[b]
Chromium	100[b]
Cobalt	--c
Copper	50[c,d]
Lead	4,800[d]
Mercury	0.05[b]
Nickel	100[d]
Zinc	350[d]
Polychlorinated biphenyls (PCB or "Aroclor")	0.001[b]
DDT (DDD, DDE)	0.001[b,e]
Aldrin (or Aldrin/Dieldrin)	0.003[b,e]
Benzidine	0.1[e]
Dieldrin	0.003[b,e]
Chlordane	0.01[b]
Endrin	0.004[e]
Heptachlor	0.001[b]
Lindane	0.01[b]
Parathion	0.04[b]
Malathion	0.1[b]
Methoxychlor	0.03[b]
Toxaphene	0.005[e]
Aminocarb	Not Available
Bayer	Not Available
Baygon	Not Available
Carbaryl	--c
Zectian	Not Available

[a] *For further discussion of these substances, see Appendix A, "Toxic and Hazardous Substances" of SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975.*

[b] *Quality Criteria for Water, 1976, U.S. Environmental Protection Agency.*

[c] *Recommended level has not been established, but substance is discussed in Appendix D, Part II, "Parameter Handbook," in the Areawide Assessment Procedures Manual, Volume III, Municipal Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.*

[d] *District staff of Wisconsin Department of Natural Resources, and SEWRPC, based on a generally accepted procedure of applying a factor of 0.01 to the "96-hour-lethal concentration (LC50)" based on 50 percent die-off of daphnia resident species within a 96-hour period as stated in Quality Criteria for Water (see above) which reports bioassay results.*

[e] *"Toxic Pollutant Effluent Standards" in Chapter I of Title 40, Code of Federal Regulations, Part 129, Sub part A, "Toxic Pollutant Effluent Standards and Prohibitions," published in Federal Register, Vol. 42, No. 8, Wednesday, January 12, 1977.*

Source: SEWRPC.

be strongly alkaline or acidic, and therefore highly corrosive. Although they attack organic matter, alkaline substances in water do reduce the corrosion of metals in contact with the water. Among the acid wastes may be included tan liquors, acid dyes, coal mine drainage, sulphite waste liquors, pickling liquors, and some brewery wastes.

High dissolved oxygen concentrations in industrial waste supplies may also increase corrosion, especially in waters used for cooling. Corrosion of metals used in water-handling systems has been reported at 45-50 mg/l of chlorides. More than 50 mg/l of sodium and potassium in the presence of suspended matter causes foaming, which in turn accelerates scale formation and corrosion in boilers. Sodium and potassium carbonate in circulating cooling water can cause deterioration of wood in cooling towers.

It has been found that direct lethal effects of pH on aquatic life are not produced within the range of 6.5 to 9.0 units. The permissible range of pH for fish and other aquatic organisms depends upon many other factors such as temperature, dissolved oxygen, prior acclimation, and the presence of various anions and cations. The toxicity of the compounds present in water may also vary with the change in the pH value. The pH may affect swimming and other recreational uses of streams and lakes. The number of cases of eye irritation among swimmers in a controlled pool has been observed to increase when the pH of the water decreased from 8 to 7 units. Federally recommended water quality criteria[19] identify a pH between 6.5 and 9.0 as providing adequate protection for life of freshwater fish and bottom dwelling organisms on which fish may feed, and currently adopted Wisconsin water quality standards call for pH values to range between 6.0 and 9.0.

Oil and Grease

Oil, grease, and other petroleum products can cause both physical and chemical pollution in natural waters. These substances may form a film on the water surface, be dispersed into droplets or particles, sorb onto solids with which they come in contact, be soluble, or be incorporated into sediments. They may be volatile or non-volatile; may be persistent or easily degraded. Because of the variable nature of petroleum products, their specific effects on the aquatic environment are difficult to predict.

Field and laboratory evidence have demonstrated both acute and chronic toxicity of oils to aquatic organisms. The lethal concentrations of oil vary greatly with the type of organisms and the specific oil product. Concentrations as low as 0.1 mg/l of soluble hydrocarbons, fuel oil, and fresh crude oil have been found to be toxic to aquatic larvae and

[19] *U.S. Environmental Protection Agency, Quality Criteria for Water, EPA-440/9-76-023, 1976.*

eggs; benthic organisms are sensitive to concentrations of 1.0 mg/1 of oil products; and freshwater fish are adversely affected by concentrations as low as 10 mg/1.[20] Concentrations of 200 mg/l have been shown to be toxic to aquatic plants. Most lethal and sublethal effects on mammals and birds are caused by physical coating, entanglement, ingestion of fine oil droplets, or incorporation of hyrdocarbons through food chains. Sublethal effects on aquatic organisms may be caused by petroleum product concentrations as low as 0.01 mg/1, and may include disruption of cellular, physiological, reproductive, and development processes.

Oil pollutants may be incorporated into sediments. There is evidence that once this occurs in those sediments below the aerobic surface layer, oil can remain unchanged and toxic for long periods of time, since its rate of bacterial degradation is slow. The persistence of oil within the sediments could have long-term effects on the structure of the benthic community, or cause demise of certain sensitive species. For example, approximately 33 x 10^5 milligrams of oxygen are required for the complete oxidation of one liter of mineral oil.[21] This oxygen demand from one liter of degradable oil would completely deplete the oxygen content of 6,600,000 liters of water at an oxygen concentration of 5 mg/l. Fortunately, the rate of this form of oxygen demand is so slow that adverse dissolved oxygen effects have never been the major water quality problem associated with grease and oil. Rather, the above-described physical effects of these substances on aquatic life have always been the primary concern. Over longer time periods, however, the cumulative effects of grease and oil on dissolved oxygen could prove to be very important to the maintenance of a safe and healthy aquatic environment.

State water quality standards, as well as federally recommended water levels, call for natural waters to be virtually free of grease and oil, the attendant aesthetic or functional impairment of public rights to water use, and the impairment of biotic stability. Numeric criteria are not set forth except in the federal recommendations, where the concentrations are suggested to be limited to a factor of 0.01 of the 96-hour concentration lethal to 50 percent of a species.

Dissolved Organic Substances

Dissolved organic substances will exert much the same influence on surface waters as organic substances which are nonsoluble. The presence or the introduction of dissolved organic substances generally increases the bacterial activity in the stream or lake and decreases the concentration of dissolved oxygen. The decrease of dissolved oxygen concentration in the water causes many problems. Depressed concentrations of dissolved oxygen in a stream or lake contribute to an unfavorable environment for fish and other aquatic life. Where natural waters contain no dissolved oxygen, decay of organic wastes is carried on by anaerobic bacteria causing putrefication. Organic acids and foul odors are the end products of this anaerobic decay. Life forms—such as the Tubifex, or sludge worm—that inhabit streams under this condition of deoxygenation are useless to man and aesthetically unpleasant. Dissolved organic substances, like soluble nutrients, are impossible to control or remove once they are in the waters except by full treatment of the water itself. Non-degradable dissolved organic substances may create a foul odor and taste and be aesthetically unpleasing. There are no numeric criteria for instream levels of these substances as a category.

Detergents

Domestic and industrial detergents in lakes and streams present several difficult water quality management problems. Detergents may cause taste and odor problems on bathing beaches, and an aesthetic nuisance due to deposits of a slimy scum or a foam. The waste also causes difficulties in sewage treatment plants because of the thick scum on tank surfaces and the clogging of filters. The high phosphate content of the detergents can increase the algal production in waterways, and thereby deteriorate water quality. The currently adopted state standards address the detectable presence of detergents as an unacceptable aesthetic offense. There are no known federally recommended levels of detergents in natural waters.

Heat

Heat, as a pollutant, is important for many reasons. It affects the palatability of water drawn from surface and ground water sources for human consumption, and determines the value of water for certain industrial uses, including cooling. More importantly, however, aerobic and anaerobic biochemical processes in surface waters are temperature-dependent, since reaction rates approximately double with each 20°F rise in temperature within the temperature range normally encountered. Furthermore, the aerobic natural self-purification processes are partly a function of the dissolved oxygen levels. In turn, dissolved oxygen level are a function of oxygen solubility in water which is highly dependent on temperature. Extremely high temperatures or rapid fluctuations in temperature can be detrimental to fish and aquatic life by causing severe biological stress on the individual aquatic organisms.

Increased water temperature stimulates growth of taste- and odor-producing organisms. Higher temperatures diminish the solubility of dissolved oxygen,

[20] *Ibid.*

[21] *Ronald Stewart and Alex Muratori, Jr., "Outboard Motor Fuel Discharge: A Source of Water Pollution, A Method of Control;" presented at the University of Wisconsin Engine Exhaust Institute, Kenosha, Wisconsin, October 20, 1967.*

as noted above, and thus decrease the availability of this essential gas in stream and lake water. Elevated temperatures increase the metabolism and respiration of fish and other aquatic life, approximately doubling the respiration for a 20°F rise in temperature. Hence, the demand for oxygen is increased at higher temperatures under conditions where the oxygen supply is low because of decreased solubility of this gas. Many toxic substances such as cyanide phenol, xylene, and zinc exhibit increased toxicity at elevated temperatures. Even with adequate dissolved oxygen and absence of any toxic substances, there is a maximum temperature that each species of fish or aquatic organism can tolerate; the exposure of an organism to temperature in excess of this maximum usually results in death of the organism within 24 hours or less. For each organism there is not only a thermal death point, but also a range of temperature for optimum growth. Thus, temperature is one of the most important environmental factors determining which organisms will thrive and which will diminish in number and size. A 1967 publication of the FWPCA describes temperature as "a catalyst, a depressant, an activator, a restrictor, a stimulator, a controller, a killer . . . " Increased temperature, however, may be beneficial to the recreational use of a stream or lake by lengthening the swimming period. Conversely, elevated temperatures stimulate the decomposition of sludge, multiplication of bacteria and fungi, and the consumption of oxygen by the decomposition of organic materials, thus affecting the aesthetic value of the watercourse.

Currently adopted state standards call for maximum water temperature in inland lakes or in streams to be 89°F, with maximum increases of 3°F and 5°F respectively, and with no artificial temperature increase in waters intended to protect trout reproduction.

SUMMARY

A large variety of pollutants are discharged to lakes and streams in southeastern Wisconsin. These pollutants can alter the biological, physical, and chemical characteristics of the watercourses, impair the utility of the water for human use, and impose on the creatures which dwell within the waters undue suffering and even death. The sources of these pollutants must be identified, characterized, and quantified; the effects of specific pollutants described; and pollutant transport, dispersion, release and accumulation mechanisms understood to ascertain the pollutants' effects on water quality in order to develop appropriate water quality management plans.

Pollutant sources can be divided into two major groups—urban and rural. Urban related pollution sources are associated with residential areas having a density of at least 0.2 dwelling units per net acre, or together with other land uses which serve the residential areas. These sources include sanitary sewerage systems; combined storm and sanitary sewerage systems; storm sewerage systems; on-site sewage disposal systems; industrial wastewater discharges; stormwater runoff from residential, commercial, and industrial related lands; runoff from mining, construction, transportation and recreational lands; and dredging and channelization activities. Rural related pollution sources include runoff from livestock operations, croplands, pastures, orchards, woodlands, and wetlands. The pollutant amounts associated with these major pollution sources are discussed in Chapter III, regarding industrial and sanitary wastewaters; Chapter IV, regarding storm sewer discharges; and Chapter V, regarding diffuse sources of pollution. The relative magnitude of these pollution sources and the specific substances which they contribute to the inland lakes and streams are compared in Chapter VI in the development of estimated pollutant load for the twelve major watersheds within the Southeastern Wisconsin Region, and are summarized in Chapter VII.

The effects of pollutants are many, varied and include direct and indirect adverse affects on aquatic organisms, destruction of habitat, human sickness and death, aesthetic degradation, production of unpleasant odor and taste, recreational impairment, the imposition of increased costs of production in economic activities, and the degradation through sedimentation and accelerated eutrophication of the lake or stream itself as a natural entity. For many pollutants present within the waters of southeastern Wisconsin, the state and federal agencies have identified the levels producing no significant adverse effects, according to current scientific knowledge. Major pollutants which have significant effects on the water quality and are released in southeastern Wisconsin in sufficient amounts to have an important impact on water quality include suspended solids, dissolved solids, oxygen-demanding substances, slowly degrading or non-degrading organic matter, nitrogen, phosphorus, pathogenic organisms inclusive of bacteria and viruses, corrosives, oil and grease, dissolved organic substances, detergents, and heat. Also present in the environment and presenting potential hazards to the health and safety of the aquatic environment are numerous toxic and hazardous substances inclusive of cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc, polychlorinated biphenyls, DDT, DDD, DDE, Aldrin, Dieldrin, Chlordane, Heptachlor, Lindane, Parathion, Malathion, Methoxyclor, Aminocarb, Bayer, Baygon, Carboryl, and Zectian. Each of the detailed pollutants has varying effects on the physical, chemical, and biological properties of the lakes and streams of the Region and may have a significant potential for the introduction or transmission of human sickness and disease and for adverse effects on aquatic life.

From this plethora of pollutants, a select few have been historically identified and studied both as predominant pollutants and as principal indicators of the presence of other more specific substances. The specific water chemistry parameters which are utilized in the balance of this report include total nitrogen, total phosphorus, carbonaceous five-day biochemical oxygen demand, suspended solids, and fecal coliform. In the balance of this report, the Commission has assembled the known information on the waste loading rates associated with each of the pollution sources within the Region, their relative contributions of the specific indicator substances noted here, and an estimate of the effects of annual precipitation cycles on these contributions.

(This page intentionally left blank)

Chapter III

EXISTING SANITARY SEWERAGE SYSTEMS

INTRODUCTION

Sanitary sewage[1] is among the most obnoxious and hazardous by-products of an urban society. Its safe collection, treatment, and disposal should always be a matter of public concern. Improperly conveyed, treated, and disposed of, sanitary sewage can:

1. Spread disease among men and animals.[2]

2. Increase the cost and complexity of purifying water supplies. Waters containing sewage can stain, foul, and corrode transportation vehicles and industrial structures and equipment, and reduce the efficiency of manufacturing equipment and operations through sludge formation, scale deposits, foaming, and organic growths.

3. Contribute to stream and lake sedimentation and fertilization, causing accompanying noxious algal and weed growths.

4. Destroy the ability of receiving waters to support fish and other desirable aquatic life.

5. Destroy opportunities for swimming, boating, fishing, and other forms of water-based recreation.

6. Reduce property values and create severe aesthetic nuisances.

Although not the only source of water pollution, sanitary sewage if improperly treated and disposed of can cause virtually all of the harmful effects of water pollution. Because of the hazardous nature of sanitary sewage, its safe collection, treatment, and disposal is critical in the interests of maintaining a safe, healthful environment and avoiding severe public health problems and property value deterioration. Sanitary sewerage facilities can also have a major impact on land use development, and, therefore, on the social and economic as well as physical development of an area.

A large network of sanitary sewers consisting of many individual systems presently exists within the Region to serve existing urban land use development. This network has been under continuous development over a period of about 130 years, ever since construction of the first sewer within the Region was begun within the City of Milwaukee in the late 1840's. In the 1850's and 1860's small networks of combined sanitary and storm sewers were constructed to serve the Cities of Milwaukee, Racine, and Kenosha. By the mid-1920's, the last extensions of these combined sewer systems were made, and since then all sewers constructed to serve developing areas of the Region have been constructed as separate sewers.

Because of the direct relationships which exist between water quality and sanitary sewerage, any water quality management planning effort must include an evaluation of the network of sewers within the planning area. Such an evaluation requires an inventory of the location, capacity, service areas, and performance of the existing sanitary sewerage facilities. The capabilities of these existing systems to be expanded and thereby meet future needs, as well as any deficiencies of these existing systems to meet present needs, may thereby be identified and an important step toward both the identification of water pollution sources and the synthesis of plans to abate such sources achieved. Accordingly, one of the initial steps in the areawide water quality management planning program was to update the inventory of all existing sanitary and combined sewerage systems within the Region which had been conducted by the Commission in or as part of its regional sanitary sewerage systems planning program.

This chapter presents the results of this inventory of existing public sanitary sewerage systems and of a companion inventory of locally prepared sanitary sewerage system plans. Included in this chapter are descriptive analyses of all existing public sanitary

---

[1] *The term "sewage" is defined as the spent water or wastewater of a community consisting of a combination of the liquid and water-carried solid wastes from streets and other open areas, residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present.*

[2] *The fact that sanitary sewage can transmit certain serious human diseases has been recognized since before the turn of the century. These diseases include cholera, typhoid, dysentery, and certain virus-produced diseases such as hepatitis. High concentrations of nitrates in water supplies, which can result from sanitary sewage entering the water supply, may cause infant death by depleting the oxygen in the bloodstream through biochemical reduction. Although direct health hazards associated with the pollution of water by sanitary sewage are known, the latent effects of such pollution are still largely unknown.*

and combined sewerage systems and of all other wastewater treatment facilities serving industrial, commercial, institutional or recreational land use development within the Region. In addition, significant concentrations of existing urban development not currently served by public sanitary sewerage facilities are identified and described. Finally, all known point sources of wastewater other than wastewater treatment plants are identified, including industrial wastewater outfalls discharging industrial process wastes or cooling waters directly to streams and lakes.

Since stream and lake water quality management problems are interrelated with and partially determined by waste discharges to natural drainage systems, the inventory data presented in this chapter have been organized on a subregional basis, with the subregions approximating natural watershed boundaries, but recognizing other factors such as the location and extent of existing and probable future urban land use development and the service areas of the existing and proposed sanitary sewerage systems. Tabulations of the inventory data organized on a county basis and on a watershed basis which parallel those included in this chapter on a subregional basis are presented in Appendices A and B, respectively. The presentation of the data on a county basis, in Appendix A, was provided because most local officials and interested citizens are more familiar with political boundaries than with watershed or subregional area boundaries. The presentation of the data on a watershed basis, in Appendix B, was provided in order to facilitate the analyses of the effects on water quality of both the existing and probable future waste loadings from the various sanitary sewerage systems and related sources of pollution. Although some sanitary systems serve multiple communities and provide sewer service to areas which may lie in different watersheds, the flow relief devices located within these systems discharge to the stream systems of specific watersheds. Therefore, a complete analysis of pollution sources within a watershed must include an enumeration of, and loading estimate for, flow relief devices, regardless of the more distant location of the intended point of sewage treatment and discharge during normal, dry-weather operating conditions.

The planning and design of sanitary sewerage systems involve careful consideration of many factors, including existing and probable future service areas; existing and probable future land use development patterns; existing and probable future population levels, densities, characteristics, and distributions; and the anticipated physical life of the various components of the total system. Of particular importance among these considerations are the characteristics of the wastewater to be collected and treated, including the rate and volume of flow and the concentrations of contaminants. Since municipal wastewater is commonly a mixture of domestic and industrial wastes, wastewater flows and strengths vary with the land use pattern and population characteristics of the service area. The presence of certain types of industrial land uses particularly may affect wastewater flows and strengths. The characteristics of the sewerage system itself may also affect wastewater flows and strengths.

Wastewater flow rates are used to determine the size of sewers, lift and pumping stations, and wastewater treatment plants. Flow volumes and wastewater strengths are used to establish the type and level of treatment required to meet established stream and lake water use objectives and supporting water quality standards.

The cost of wastewater treatment will be determined, in part, by wastewater strength characteristics and the degree of treatment required before discharge to the receiving environment. High-strength or low-strength wastewater may require the use of different types of treatment processes than those normally used for treating more common medium-strength wastewater. Unless the wastewater effluent is to be discharged to the land either through seepage ponds or irrigation, the type and degree of treatment is largely determined by the volume and quality of the receiving waters, the desired or prescribed use of the receiving waters, and the volume and strength of the raw wastewater. Thus, the costs of wastewater treatment will be determined by both wastewater flow and strength characteristics, while the costs of wastewater conveyance facilities will be largely determined by flow characteristics together with the land use, topographic, and soil conditions in the service area.

This chapter describes the results of investigations that were made under the areawide water quality planning and management program to determine the flow and strength characteristics of wastewater generated within the Region for regional sanitary sewerage system planning purposes. Such characteristics will then be utilized together with accepted engineering standards as the basis for the selection of the sewerage system design criteria to be utilized in SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin.

Description of Subregional Areas

Sanitary sewerage system planning, like water quality management planning, must be done on a regional basis. Land use patterns, which determine the amount and spatial distribution of the hydraulic and pollution loadings to be accommodated by the sanitary sewerage system, develop over an entire urban region in response to basic social and economic forces and to the operation of the urban land market, without regard to artificial corporate limit lines or natural watershed boundaries. The sanitary sewerage facilities, in turn, determine to a considerable extent the use to which land areas may be put. These facilities often cross not only corporate limits but also watershed boundaries. Thus, sanitary sewerage facility planning cannot be accomplished successfully within the context of a single municipality or county, if the municipality or county is part of a large urban complex. Nor can such planning be accomplished successfully solely within natural watershed areas.

Sanitary sewerage facilities, however, need not form a single integrated system over an entire urbanizing region. Sanitary sewerage facilities may form subsystems related to existing urban concentrations. Although sanitary sewerage facilities may cross watershed boundaries, the location of the major watershed divides must be recognized as an important influence on the development of areawide sanitary sewerage systems. This is true because sanitary sewerage facilities should be developed, to the maximum extent possible, as gravity drainage systems; because treated wastes are often discharged to surface streams; and because legal considerations may prohibit or constrain the transfer of water and sewage across major watershed boundaries. Existing urban concentrations with well-developed sewerage systems must also be recognized as an important influence on the development of areawide sanitary sewerage systems. This is necessary if maximum use is to be made of the capacity of these systems and the public capital invested in them, and if proper recognition is to be given to the placement of new land use development within or near such concentrations and systems.

The urbanizing region must then form the basic geographic unit for the analysis of sanitary sewerage systems to assure coordination of related subsystems. But the planning effort must recognize the existence of subregional planning areas relating both to existing urban concentrations and natural watershed boundaries. The need to coordinate sanitary sewerage system development in an urbanizing region to effect economies in providing such facilities, to guide land use development, and to protect the natural resource base may dictate the need to adjust and change the delineation of such subregional areas for a more efficient overall system.

The Commission, as part of its regional sanitary sewerage system planning program, delineated geographic subareas of the Region which comprised rational sewerage system planning areas. The boundaries of these eleven areas were delineated based upon consideration of major natural watershed divides, the exterior boundaries of the Region, the existing and potential service areas of existing centralized sanitary sewerage systems, and existing and probable future areas of urban development. Because of their use for previous sanitary sewerage system planning, these areas provided the best available basis for organizing the sanitary sewerage system inventory required for the areawide water quality management planning effort. The eleven subregional areas are shown on Map 1, and are described here.

1. The Milwaukee-Metropolitan subregional area consists of all of Milwaukee County and those portions of Ozaukee, Racine, Waukesha, and Washington Counties which either presently contract, or are proposed to contract, with the Milwaukee-Metropolitan Sewerage Commissions for sewage treatment services.

2. The Upper Milwaukee River subregional area consists of all of the Milwaukee River watershed within the Region north of the northern limits of the City of Mequon.

3. The Sauk Creek subregional area consists of all of the Sauk Creek watershed, that portion of the Sheboygan River watershed lying within the Region, and minor tributary areas which drain directly to Lake Michigan lying generally north of the City of Port Washington.

4. The Racine-Kenosha subregional area consists of all that area of Racine and Kenosha Counties lying east of IH 94 except the Caddy Vista Sanitary District and that portion within the Des Plaines River watershed lying west of the subcontinental divide.

5. The Root River Canal subregional area consists of all that part of the Root River watershed in Racine County west of IH 94 which generally drains northward toward Milwaukee County and the main stem of the Root River at the Milwaukee-Racine County line.

6. The Des Plaines River subregional area consists of all of the Des Plaines River watershed within the Region.

7. The Upper Fox River subregional area consists of nearly all of the Fox River watershed north of the Vernon Marsh in Waukesha County.

8. The Lower Fox River subregional area consists of all of the Fox River watershed within the Region south of the Vernon Marsh, except the urban concentrations at the west end of Geneva Lake in Walworth County.

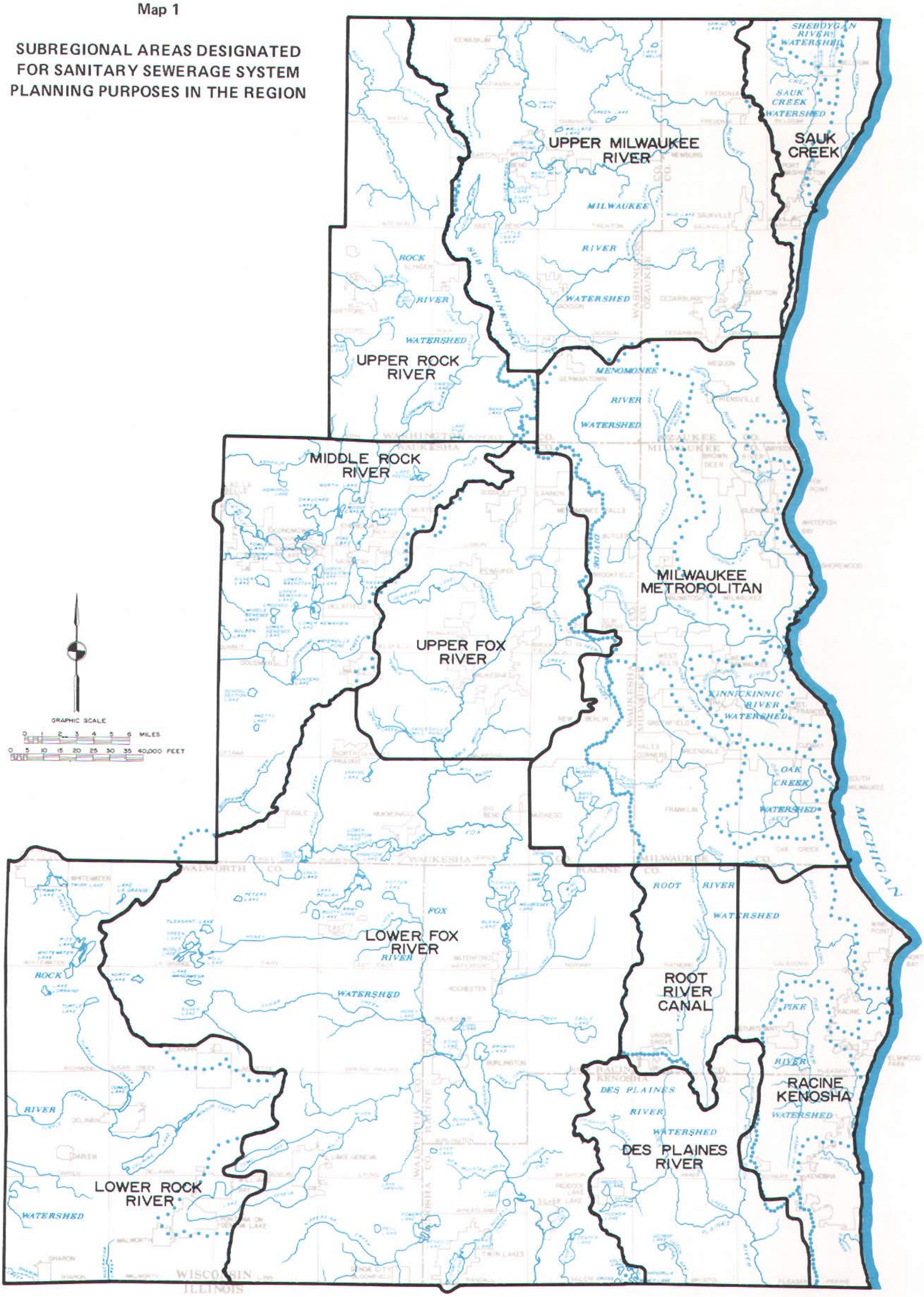
9. The Upper Rock River subregional area consists of all that area of the Rock River watershed lying within Washington County.

10. The Middle Rock River subregional area consists of all that area of the Rock River watershed lying within Waukesha County.

11. The Lower Rock River subregional area consists of all that area of the Rock River watershed lying within Walworth County and the urban concentrations in the Fox River watershed at the western end of Geneva Lake.

Map 1

SUBREGIONAL AREAS DESIGNATED FOR SANITARY SEWERAGE SYSTEM PLANNING PURPOSES IN THE REGION



Eleven distinct subregional areas were identified for sanitary sewerage system planning purposes within the Region. The boundaries of these 11 areas were delineated on the basis of natural major watershed divides, existing and potential service areas of existing centralized sanitary sewerage systems, and existing and probable future areas of urban concentration as recommended in the adopted regional land use plan. In determining the boundaries of the subregional areas, natural watershed divides were crossed only where necessary to recognize the effects of potential urban development and attendant sewerage facilities which crossed such divides.

Source: SEWRPC.

The boundaries of these eleven subregional areas generally follow natural major watershed divides. Such natural watershed divides were crossed only where necessary to provide a more rational planning area or a more convenient method of presenting the alternative plans considered in the development of the regional sanitary sewerage system plan. In general, it was possible to consider in that effort all of the plan alternatives within the various subregional areas, although in a few instances it became necessary to consider—at least in the preliminary analysis—additional alternatives which transcended even the subregional area boundaries.

Inventory Procedures

Two separate but related sanitary sewerage inventories were conducted under the areawide wastewater treatment and water quality management planning program: an existing sanitary sewerage facilities inventory and a local sanitary sewerage system plans inventory. The inventory of existing sanitary sewerage facilities was designed to update an extensive inventory of such facilities conducted by the Commission in 1972 as part of the regional sanitary sewerage system planning effort. Under that inventory, all existing sanitary sewerage systems were mapped on a uniform basis by county, at a scale of 1″=2,000′. The sizes of all trunk sewers and of all combined sewers were recorded on the maps; if available from local records, sewer slopes and invert elevations were shown at critical points in the system. In addition, existing and committed future service areas were determined and mapped along with combined sewer service areas. Individual subsystem plans were also acquired at various larger map scales from the individual cities, villages, and special purpose sewerage districts in the Region. These subsystem maps indicate the location of all existing sanitary sewers, sewage pumping and lift stations, and sewage treatment plants, together with other pertinent data.

In addition to the mapped sewerage system data, certain additional data pertaining to the existing sanitary sewerage systems were acquired and tabulated under both original inventory and the update. These data included: name of operating agency; community served; area served; treatment levels and type of treatment units provided; type of sludge treatment, handling, and disposal unit processes utilized; sludge characteristics and quantities; location of disposal of treatment plant effluent; date of original construction of sewage treatment plant and of major additions; treatment plant design capacities and loadings; population served; average per capita flow; population equivalent served; and reserve hydraulic capacity of the treatment plant. Data were also collected on the location of known sewage overflow points and the location and capacity of sewage pumping and lift stations.

Where available, specific local studies, Wisconsin Pollutant Discharge Elimination System (WPDES) reports, facilities planning analyses and reports of flow relief quantities and strengths were used to prepare estimates of flow relief loads from such devices in the Region. Generally, the available data on 157 relief devices in seven different sanitary sewerage systems indicates that the discharge amounts are widely variable, as was expected, due to differences in age, condition and design of the systems, as well as soils and tributary land uses served. The data were analyzed for possible relationships between the annual flow relief quantities and the annual average wastewater flow in the entire sewer system, or the tributary sanitary sewer service area or the size of the flow relief devices. However, no such relationships were evident. Where locally measured or estimated flow relief quantities were not available, 2 million gallons per year was the average discharge assumed for each flow relief device based upon an average annual discharge calculated using the mean value estimated for 157 devices which had available, annual discharge data. When specific data was available for a flow relief device indicating the discharge frequency or the quantity bypassed per event, this data was utilized to adjust the average values. Some specific data was available for about half of the known flow relief devices within the Region.

Review of the limited data[3] on the quality of overflows and bypasses resulted in assumed wastewater characteristics of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus, 100,000 fecal coliform organisms per 100 ml, and 3.0 mg/l of total nitrogen. Similarly, the data available from WPDES monitoring reports and from other reports[4] pertaining to the quantity and quality of combined sewer overflows were utilized to estimate the average annual discharge from the reported combined sewer overflows in the Kenosha, Milwaukee, and Racine areas, respectively. Assumed quality characteristics

---

[3]*Available data included that contained in SEWRPC Planning Report No. 26, A Comprehensive Plan for the Menomonee River Watershed, 1976; sampling data obtained in 1975 by the City of Milwaukee under the WPDES program; and dilution ratios applied to raw wastewater characteristics included in SEWRPC Technical Report No. 18—Volume I, State of the Art of Water Pollution Control For Southeastern Wisconsin: Point Sources.*

[4]*Stevens, Thompson, and Runyon Inc. for the Metropolitan Sewerage District of the County of Milwaukee, Combined Sewer Overflow Pollution Abatement—A Critique of System Components, A Working Document, April, 1976;*

Consoer, Townsend, and Associates for the City of Milwaukee, Wisconsin and the U.S. Environmental Protection Agency, Humboldt Avenue Pollution Abatement Demonstration Project, September, 1974;

(Footnote 4 continued on next page)

were 100 mg/l of BOD_5, 300 mg/l suspended solids, 10.0 mg/l total nitrogen, 5.0 mg/l total phosphorus, and 700,000 fecal coliform organisms per 100 ml.

The Commission's previous inventories of sanitary sewerage systems and the update of that inventory under the areawide water quality management planning program, were designed to make full use of all existing and available surveys, studies, reports, and other pertinent data. An example of this was the interpretation and integration of all available data sources to provide a complete and consistent inventory of other known point sources of water pollution, inclusive of industrial wastewater discharges. Additional data collection activities were limited to those essential to developing the information base necessary to the preparation of a sound water quality management plan for the Region. Among the special inventory activities was the development of the estimated numbers of privately-owned, on-site sewage disposal systems in each unsewered U.S. Public Land Survey quarter section. Low-flight photographs at a scale of 1"=400', taken in May, 1975, were used to update the Commission file of housing unit counts by quarter section, and these were subsequently converted to the estimates of the number of private, on-site disposal systems. The records of county sanitarians, and planning and zoning agencies, as well as the records of the Wisconsin Department of Health and Social Services were reviewed to inventory the locations of the known holding tanks and mound systems in the Region.

With respect to the inventory of hydraulic and pollutant strength loadings at the sewage treatment plants, investigations were made as to the specific components of sewage flow, including spent municipal and private water supply, groundwater infiltration and storm water inflow as well as the waste strength characteristics of the flow.

While the sheer magnitude and complexity of the foregoing data preclude full presentation in published form for each individual sanitary sewerage system in the Region, the descriptive analyses presented in this chapter do include the following:

1. The location, configuration, and size of major trunk sewers and force mains serving a given area through which other service areas may be connected to a treatment facility to form an areawide system, and the location and capacity of appurtenant pumping and lift stations.
2. The location of all points of sanitary sewage flow relief, including permanent relief pumping stations, portable relief pumping stations, crossovers, bypasses, and combined sewer outfalls, and an estimate of the amounts of sewage contributed at these points.
3. The location, type, and level of treatment capacity, hydraulic and organic loading, and means of effluent and sludge disposal for all public and private sewage treatment plants serving centralized sanitary sewerage systems.
4. The size and extent of existing, committed, and proposed future sewer service areas and the estimated populations served in such areas.
5. The administrative structure and financing arrangements for each municipal sanitary sewerage system.
6. An identification of all local sewerage system and facilities planning programs including infiltration and inflow studies and analyses.
7. Effluent limitations for each wastewater treatment facility as established under the Wisconsin Pollution Discharge Elimination System.
8. All known existing point sources of wastes other than sewage treatment plants, consisting primarily of industrial cooling and wash water outfalls but including some industrial process wastewater outfalls.
9. The number and locations of all known sewage holding tanks and mound-type septic systems, and the number and spatial distribution of all traditional onsite sewage disposal systems known as of 1975.
10. The identification of influent wastewater flow components and waste strengths for the municipal wastewater treatment plants in the Region.

A major portion of the inventory data on the existing sanitary sewerage facilities was obtained through the cooperation of the operators and administrators of each system, who responded to formal letters, telephone surveys, and in some cases, site visits conducted by the SEWRPC staff.

(Footnote 4 continued)

Envirex for the City of Kenosha and the U.S. Environmental Protection Agency, Biological Treatment of Combined Sewer Overflows at Kenosha, Wisconsin, 1975;

Donahue and Associates for the City of Racine, Sewer System Evaluation—Phase I, Infiltration/Inflow Analysis, Racine Sewerage Service Area, 1975;

SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, December, 1970.

In addition, a significant amount of information was obtained through the Wisconsin Department of Natural Resources and the Wisconsin Public Service Commission.

The inventory of locally prepared sanitary sewerage system plans was conducted by contacting each municipality in the Region and requesting that copies of such plans be provided to the Commission. It should be understood that, in many cases, local sanitary sewerage system plans consist of engineering reports prepared by consulting engineers and submitted to the governing body of the municipality. As such, these reports are rarely formally adopted by either a local plan commission or a local governing body. In most cases, however, such reports do represent at least the informal long-range plan for sanitary sewerage system development for a given municipality. If a community did not have a formally documented plan or engineering report available, it was assumed that no long-range sanitary sewerage system plan existed for the area. Subsequent to the 1975 inventory of such locally prepared sanitary sewerage system plans, the Commission received a number of locally proposed sanitary sewerage system improvement projects under its areawide planning review and clearinghouse function carried out pursuant to U.S. Office of Management and Budget Circular A-95. While these projects were submitted during 1976 and 1977, and thus reflect local sewerage system planning carried out subsequent to the base year of the areawide wastewater treatment and water quality management plan, the system plans on which these projects are based have been included in this chapter because of the obvious need to consider the proposed projects in the development of an areawide water quality management plan.

Definition of Terms

In order to facilitate understanding of the inventory findings of existing sanitary sewerage systems and local sanitary sewerage system plans, it is desirable to define certain terms used in the inventory presentations. Accordingly, the definitions of all sanitary sewerage system-related terms used in the inventories are set forth in Appendix C.

INVENTORY FINDINGS MILWAUKEE METROPOLITAN SUBREGIONAL AREA

The Milwaukee metropolitan subregional area consists of all of Milwaukee County and those portions of Ozaukee, Racine, Washington, and Waukesha Counties which contract, or are proposed to contract, with the Milwaukee-Metropolitan Sewerage Commissions for wastewater treatment services. The Milwaukee metropolitan subregional area is comprised of all of the Menomonee, Kinnickinnic, and Oak Creek watersheds; major portions of the Milwaukee and Root River watersheds; a minor portion of the Fox River watershed in the Muskego Lakes areas; and minor areas which drain directly to Lake Michigan. This area contains by far the largest single concentration of urban development within the Southeastern Wisconsin Region.

Existing Public Sanitary Sewerage Systems

Sanitary sewer service in the Milwaukee metropolitan subregional area is provided by a combination of a metropolitan and a number of local sewerage systems. There are a total of 32 existing public sanitary sewerage systems including those operated by the Cities of Brookfield, Cudahy, Franklin, Glendale, Greenfield, Mequon, Milwaukee, Muskego, New Berlin, Oak Creek, South Milwaukee, St. Francis, Wauwatosa, and West Allis; the Villages of Bayside, Brown Deer, Butler, Elm Grove, Fox Point, Germantown, Greendale, Hales Corners, Menomonee Falls, River Hills, Shorewood, Thiensville, West Milwaukee, and Whitefish Bay; the Caddy Vista Sanitary District; and the Rawson Homes Sewer and Water Trust. With the exception of the City of South Milwaukee, these systems are all planned to be connected to the wastewater treatment and conveyance facilities of the Metropolitan Sewerage Commission of the County of Milwaukee and the Sewerage Commission of the City of Milwaukee. In 1975, these 32 systems served a total area of approximately 230.8 square miles; or approximately 54 percent of the total area of the subregional area, and a total population of approximately 1,093,200 people, or nearly 96 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described briefly in the following paragraphs. Pertinent characteristics of each system are presented in Tables 3, 4, and 5.

Milwaukee-Metropolitan Sewerage Commissions: The Sewerage Commission of the City of Milwaukee, which was established pursuant to Chapter 608, Laws of Wisconsin 1913, and the Metropolitan Sewerage Commission of the County of Milwaukee, which was established pursuant to the provisions of Section 59.96 of the Wisconsin Statutes, together act as agents for the Metropolitan Sewerage District of the County of Milwaukee.[5] This District, as a special purpose areawide unit of government, was established pursuant to and operates under the provisions of Section 59.96 of the Wisconsin Statutes. The Metropolitan Sewerage Commission has the power to plan and construct main sewers; pumping and temporary disposal facilities for the collection and transmission of domestic, industrial, and other sanitary sewage to and into the intercepting sewers of the District; and to improve any watercourse within the District by deepening, widening, or otherwise changing the same where, in the judgment of the Commission, it may be necessary in order to

[5] *For a brief summary of the historical development of the Milwaukee-Metropolitan sewerage system, see SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volume One, Inventory Findings and Forecasts, December 1970, pp. 215-218.*

Table 3

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population[b] Served	Arrangement for Treatment of Sewage (See Table 4)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
City of Brookfield—Area Connected to Milwaukee-Metropolitan System	6,950	10.86	448	0.70	16,300	Contracts with Milwaukee-Metropolitan Sewerage Commissions
City of Cudahy	3,036	4.74	--	--	21,700	Part of Milwaukee-Metropolitan Sewerage District
City of Franklin	3,814	5.96	14,598	22.81	8,800	Part of Milwaukee-Metropolitan Sewerage District
City of Glendale	3,821	5.97	--	--	13,500	Part of Milwaukee-Metropolitan Sewerage District
City of Greenfield	5,542	8.66	1,613	2.52	29,900	Part of Milwaukee-Metropolitan Sewerage District
City of Mequon	5,901	9.22	8,231	12.86	9,500	Contracts with Milwaukee-Metropolitan Sewerage Commissions
City of Milwaukee	57,152	89.30	4,685	7.34	670,100	Part of Milwaukee-Metropolitan Sewerage District
City of Muskego	3,040	4.75	6,272	9.80	10,200	Operates temporary facilities
City of New Berlin—Area Connected to Milwaukee Metropolitan System . .	3,219	5.03	10,931	17.08	12,500	Contracts with Milwaukee-Metropolitan Sewerage Commissions
Regal Manors Subdivision	344	0.54	147	0.23	1,100	Operates a temporary facility
City of Oak Creek	7,738	12.09	10,445	16.32	14,400	Part of Milwaukee-Metropolitan Sewerage District
City of South Milwaukee	3,110	4.86	--	--	23,400	Operates a facility
City of St. Francis	1,638	2.56	--	--	9,900	Part of Milwaukee-Metropolitan Sewerage District
City of Wauwatosa	8,499	13.28	--	--	55,700	Part of Milwaukee-Metropolitan Sewerage District
City of West Allis	7,284	11.38	--	--	69,000	Part of Milwaukee-Metropolitan Sewerage District
Village of Bayside	1,536	2.40	--	--	4,400	Part of Milwaukee-Metropolitan Sewerage District

Table 3 (continued)

Name of Public Sanitary Sewerage System	Estimated Service Area				Population Served[b]	Arrangement for Treatment of Sewage (See Table 4)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Village of Brown Deer	2,788	4.36	--	--	13,600	Part of Milwaukee-Metropolitan Sewerage District
Village of Butler	499	0.78	--	--	2,100	Contracts with Milwaukee-Metropolitan Sewerage Commissions[c]
Village of Elm Grove						
Sanitary District 1	1,139	1.78	--	--	4,100	Contracts with Milwaukee-Metropolitan Sewerage Commissions
Sanitary District 2	941	1.47	--	--	2,900	
Village of Fox Point	1,844	2.88	--	--	7,900	Part of Milwaukee-Metropolitan Sewerage District
Village of Germantown	1,203	1.88	2,003	3.13	4,600	Operates a temporary facility
Village of Greendale	3,200	5.00	365	0.57	16,800	Part of Milwaukee-Metropolitan Sewerage District
Village of Hales Corners	1,914	2.99	115	0.18	8,800	Part of Milwaukee-Metropolitan Sewerage District
Village of Menomonee Falls	3,949	6.17	7,763	12.13	20,400	Operates temporary facilities and Contracts with the Milwaukee-Metropolitan Sewerage Commissions
Village of River Hills	3,405	5.32	--	--	1,500	Part of Milwaukee-Metropolitan Sewerage District
Village of Shorewood	1,085	1.70	--	--	14,300	Part of Milwaukee-Metropolitan Sewerage District
Village of Thiensville	742	1.16	--	--	4,200	Operates a temporary facility
Village of West Milwaukee	710	1.11	--	--	3,800	Part of Milwaukee-Metropolitan Sewerage District
Village of Whitefish Bay	1,362	2.13	--	--	16,200	Part of Milwaukee-Metropolitan Sewerage District
Caddy Vista Sanitary District	186	0.29	--	--	1,000	Operates a temporary facility
Rawson Homes Sewer and Water Trust	102	0.16	--	--	600	Operates a temporary facility[d]
Proposed Systems						
None						
Subregional Area Total	147,693	230.78	67,616	105.67	1,093,200	

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U. S. Public Land Survey quarter section.*

[c] *Pending completion of trunk sewer construction, sewage flow from the Village of Butler to the Milwaukee-Metropolitan sewerage system is limited to 400,000 gallons per day. Any flow in excess of this amount is bypassed through a chlorination tank to the Menomonee River.*

[d] *The Rawson Homes Sewer and Water Trust treatment facility was abandoned in 1977 and the tributary sewer system was connected to The City of Franklin System which is part of the Milwaukee Metropolitan Sewerage District.*

Source: SEWRPC.

Table 4

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes				Level of Treatment Provided			Disposal of Effluent	Sludge Handling and Disposal Unit Processes					
				Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary		Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
Milwaukee Metropolitan Sewerage District--																	
Jones Island Plant . .	207.98	1,018,900	1925, 1935, 1969, 1970	No	Yes	Yes	Yes	Yes	Yes	Yes	Lake Michigan	No	Yes	No	Yes	Yes	No
South Shore Plant . .			1969, 1974	No	Yes	Yes	Yes	Yes	Yes	Yes	Lake Michigan	No	Yes	No	No	Yes	Yes
Hales Corners Plant .	2.99	8,800	1942, 1957	Yes	No	No	Yes	Yes	No	Yes	Root River	No	Yes	Yes	No	Yes	No
City of Muskego -- Big Muskego Plant . .	2.15	4,200	1967, 1970	No		No[b]	Yes	Yes	No	Yes	Big Muskego Lake	No	No	No	No	Yes	No
Northeast District Plant	2.60	6,000	1972	No	Yes	Yes	Yes	Yes	Yes	Yes	Tess Corners Creek	Yes	No	Yes	No	Yes	No
City of New Berlin -- Regal Manors	0.54	1,100	1970	No	Yes	No	Yes	Yes	No	Yes	Deer Creek	Yes	No	Yes	No	Yes	No
City of South Milwaukee	4.86	23,400	1937, 1952, 1962, 1972	No	Yes	Yes	Yes	Yes	Yes	Yes	Lake Michigan	No	Yes	Yes	No	Yes	Yes
Village of Germantown	1.88	4,600	1956, 1973	No	Yes	Yes	Yes	Yes	Yes	Yes	Menomonee River	Yes	No	No	No	Yes	Yes
Village of Menomonee Falls -- Pilgrim Road Plant	6.17	20,400	1954, 1961 1973, 1975	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Menomonee River	Yes	Yes	Yes	No	Yes	Yes
Lilly Road Plant . . .			1969, 1973	No	Yes	Yes	Yes	Yes	Yes	Yes	Menomonee River	Yes	No	No	No	Yes	Yes
Village of Thiensville	1.16	4,200	1951, 1963	No	Yes	Yes	Yes	Yes	Yes	Yes	Milwaukee River	No	Yes	Yes	No	Yes	No
Caddy Vista Sanitary District	0.29	1,000	1956	Yes	No	No	No	Yes	No	No	Root River	No	Yes	Yes	No	Yes	No
Rawson Homes Sewer and Water Trust . . .	0.16	600	1954	No	Yes	No	Yes	Yes	No	Yes	Minor Tributary of Root River	Yes	No	No	No	Yes	No

Table 4 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975: Annual Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Hydraulic Per Capita (GPD)	Existing Loading - 1975: Maximum Monthly Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Organic (pounds BOD_5/day)	Existing Loading - 1975: Average Annual Organic Per Capita (pounds BOD_5/day)	Existing Loading - 1975: Maximum Monthly Average Organic (pounds BOD_5/day)	Wastewater Strength in Influent Sewage[b]: BOD_5 (mg/l)	Wastewater Strength in Influent Sewage[b]: Suspended Solids (mg/l)	Wastewater Strength in Influent Sewage[b]: Total Phosphorus (mg/l)	Wastewater Strength in Influent Sewage[b]: Organic Nitrogen-N (mg/l)	Wastewater Strength in Influent Sewage[b]: Ammonia Nitrogen-N (mg/l)	Design Capacity: Population[c]	Design Capacity: Average Hydraulic (MGD)	Design Capacity: Peak Hydraulic (MGD)	Design Capacity: Average Organic (pounds BOD_5/day)	Design Capacity: Average Organic Population[c] Equivalent	Industrial Flows: Design Average Daily Flow (MGD)	Industrial Flows: Estimated Daily Flow 1975 (MGD)	Industrial Flows: Reserve[d] Hydraulic Capacity (MGD)
Milwaukee-Metropolitan Sewerage District --																			
Jones Island Plant	137.10	207	151.40	485,140	0.66	561,697	426	377	6.5[e]	N/A	N/A	N/A	200.0	300.0	422,000	2,009,520	N/A	N/A	48.6
South Shore Plant	73.70		93.90	184,419		216,717	308	437	N/A	N/A	N/A	N/A	120.0	320.0	N/A	N/A	N/A	N/A	26.1
Hales Corners Plant	0.52	59	0.69	749	0.09	1,111	174	174	7.1[f]	8.1[f]	15.0[f]	9,000	0.9	N/A	1,333	6,350	N/A	N/A	0.21
City of Muskego -- Big Muskego Plant	0.58	138	0.88	518	0.12	707	110	122	24.7[g]	N/A	N/A	6,000	0.7	1.3	1,400	6,670	N/A	N/A	None
Northeast District Plant . . .	0.34	57	0.51	424	0.07	555	153	136	8.7[h]	N/A	N/A	5,000	0.5	1.0	1,000	4,760	N/A	N/A	None
City of New Berlin -- Regal Manors	0.12	109	0.13	215	0.20	301	209	160	5.0	N/A	N/A	N/A	0.3[i]	N/A	500[k]	2,380	N/A	N/A	0.2
City of South Milwaukee . . .	2.67	114	3.54	3,489	0.15	4,071	161	166	5.6[j]	10.5[j]	15.0[g]	32,000	6.0	12.0	12,510	59,570	1.07	2.2	2.5
Village of Germantown	0.80	174	1.06	204	0.04	1,146	29	28	12.9[k]	10.9[k]	12.4[k]	10,000	1.0	3.0	1,700	8,100	N/A	0.2	None
Village of Menomonee Falls --																			
Pilgrim Road Plant	1.40	107	1.79	821	0.07	1,023	71	146	4.9[j]	3.4[j]	10.0[j]	N/A	1.9	2.5	935	4,450	N/A	N/A	0.1
Lilly Road Plant	0.78		1.02	637		1,063	99	247	5.5[j]	6.9[j]	11.0[j]	N/A	1.0	2.0	1,700	8,100	N/A	N/A	None
Village of Thiensville	0.57	136	1.02	330	0.08	634	70	83	4.8[l]	10.1[m]	10.3[m]	3,000	0.24	0.36	N/A	N/A	N/A	N/A	None
Caddy Vista Sanitary District	0.09	30	0.12	142	0.14	199	215	163	N/A	N/A	N/A	N/A	0.25	0.40	N/A	N/A	N/A	N/A	0.1
Rawson Homes Sewer and Water Trust	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	402	0.04	N/A	67	320	N/A	N/A	N/A

Table 4 (continued)

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]												Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Date	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values			
	BOD_5 (mg/l)		Suspended Solids (mg/l)		Total Phosphorus (mg/l)		Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l)		Fecal Coliform (number per 100 ml)				BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average			Minimum Monthly Average	Maximum Monthly Average	Average Annual	Maximum Monthly Average						
Milwaukee-Metropolitan Sewerage District-- Jones Island Plant	29	55	50	122	0.8	1.7	N/A	N/A	2.0	2.4	384	1,100	N/A	6-30-77	30	30	1	200
South Shore Plant	28	51	71	129	3.9	6.1	N/A	N/A	1.6	2.1	80	195	N/A	6-30-77	30	30	1	200
Hales Corners Plant	35	42	53	66	N/A	N/A	4.5[b]	9.0[b]	N/A	N/A	50	239	N/A	6-30-77	50	50	–	200
City of Muskego -- Big Muskego Plant	9	19	21	43	6.5	9.6	N/A	N/A	0.5	0.6	N/A	N/A	N/A	3-31-79	30	30	1	200
Northeast District Plant . .	11	14	20	28	3.1	4.7	1.0[b]	0.5[b]	0.5	0.6	N/A	N/A	None	3-31-79	30	30	1	200
City of New Berlin -- Regal Manors	83	145	39	96	0.7[l]	N/A	N/A	N/A	0.4	0.6	N/A	N/A	N/A	3-31-77	30	30	–	200
City of South Milwaukee . .	12	27	11	18	1.1	1.8	N/A	N/A	0.5	0.6[j]	N/A	N/A	2	6-30-79	30	30	1	200
Village of Germantown . . .	10	14	8	27	2.3	4.7	N/A	N/A	0.1	1.4	N/A	N/A	None	6-30-77	20	20	1	200
Village of Menomonee Falls-- Pilgrim Road Plant	13	17	23	33	3.8	6.0	N/A	N/A	0.3	0.7	N/A	N/A	N/A	6-30-77	40	40	5	200
Lilly Road Plant	8	18	20	86	2.5	10.4	N/A	N/A	0.3	0.5	N/A	N/A	N/A	6-30-77	30	30	2	200
Village of Thiensville	20	28	15	27	0.5	0.8	3.2[n]	8.8[n]	0.3	0.5	N/A	N/A	105	6-30-77	30	30	1	200
Caddy Vista Sanitary District	62	83	19	26	6.0[f]	N/A	2.3[f]	3.1[f]	N/A	N/A	N/A	N/A	N/A	6-30-77	70	70	–	200
Rawson Homes Sewer and Water Trust	62	N/A	12	N/A	13.3	N/A	2.4[o]	3.0[o]	N/A	N/A	N/A	N/A	N/A	6-30-77	140	140	–	200

NOTE: N/A indicates data not available

[a] *Average and maximum of the monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The Big Muskego wastewater treatment plant incorporates a three step aerated lagoon treatment system. Advanced waste treatment for phosphorus removal added in 1976.*

[c] *The population design capacity for a given sewage treatment facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[d] *Difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

[e] *Data obtained from 1976 survey by the Wisconsin Department of Natural Resources.*

[f] *Data obtained from a 1976 3-hour survey by the Wisconsin Department of Natural Resources.*

[g] *Data obtained from 1973 survey by the Wisconsin Department of Natural Resources.*

[h] *Data obtained from 1975 two-month average.*

[i] *Data obtained from the report, Facilities Plan for Treatment Plant Expansion, dated October, 1975 by Howard, Needles, Tammen, and Bergendoff.*

[j] *Data obtained from 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[k] *Data obtained from a September, 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[l] *Data obtained from a 1973 eight month average.*

[m] *Data obtained from 1974 24-hour survey by the Wisconsin Department of Natural Resources.*

[n] *Data obtained from August, 1974 sample survey by the Wisconsin Department of Natural Resources.*

[o] *Data obtained from a sample reported in the Wisconsin Department of Natural Resources Report, Southeastern Wisconsin River Basins, A Drainage Basin Report, dated November, 1976.*

SOURCE: Wisconsin Department of Natural Resources and SEWRPC.

Table 5

SERVICE AREA, POPULATION, AND WASTEWATER FLOW CHARACTERISTICS OF THE MILWAUKEE-METROPOLITAN SEWERAGE SYSTEM BY CIVIL DIVISION: 1975

Civil Division	Total Area[a] Planned for Service by Milwaukee-Metropolitan Sewerage System (square miles)	Area Currently Served (square miles)			Population Currently Served[b]			Average Hydraulic Loading (mgd)			Area Locally Proposed for Sewer Service[c] (square miles)
		By Milwaukee-Metropolitan Sewerage System	By Other Public Sewerage System	Total	By Milwaukee-Metropolitan Sewerage System	By Other Public Sewerage System	Total	On the Milwaukee-Metropolitan Sewerage System	On Other Public Sewerage System	Total	
In Metropolitan Sewerage District of the County of Milwaukee											
City of Cudahy	4.74	4.74	--	4.74	21,700	--	21,700	6.30	--	6.30	--
City of Franklin	34.69	5.96	0.16	6.12	8,800	600	9,400	0.80	--	0.80	22.81
City of Glendale	5.97	5.97	--	5.97	13,500	--	13,500	3.00	--	3.00	--
City of Greenfield	11.63	8.66	--	8.66	29,900	--	29,900	3.30	--	3.30	2.52
City of Milwaukee	96.62	89.30	--	89.30	670,100	--	670,100	139.90	--	139.90	7.32
City of Oak Creek	28.41	12.09	--	12.09	14,400	--	14,400	5.30	--	5.30	16.32
City of St. Francis	2.56	2.56	--	2.56	9,900	--	9,900	1.90	--	1.90	--
City of Wauwatosa	13.28	13.28	--	13.28	55,700	--	55,700	8.20	--	8.20	--
City of West Allis	11.38	11.38	--	11.38	69,000	--	69,000	11.70	--	11.70	--
Village of Bayside	2.31	2.31	--	2.31	4,400	--	4,400	0.60	--	0.60	--
Village of Brown Deer	4.36	4.36	--	4.36	13,600	--	13,600	1.50	--	1.50	--
Village of Fox Point	2.88	2.88	--	2.88	7,900	--	7,900	1.30	--	1.30	--
Village of Greendale	5.57	5.00	--	5.00	16,800	--	16,800	1.80	--	1.80	0.57
Village of Hales Corners	3.17	2.99	--	2.99	8,800	--	8,800	0.80	--	0.80	0.18
Village of River Hills	5.32	5.32	--	5.32	1,500	--	1,500	0.50	--	0.50	--
Village of Shorewood	1.70	1.70	--	1.70	14,300	--	14,300	2.10	--	2.10	--
Village of West Milwaukee	1.11	1.11	--	1.11	3,800	--	3,800	5.00	--	5.00	--
Village of Whitefish Bay	2.13	2.13	--	2.13	16,200	--	16,200	2.00	--	2.00	--
Subtotal	237.83	181.74	0.16	181.90	380,300	600	980,900	196.00	--	196.00	49.72
In Existing Contract Service Area											
City of Brookfield	14.20	10.86	--	10.86	16,300	--	16,300	1.90	--	1.90	0.70
City of Mequon	47.03	9.22	--	9.22	9,500	--	9,500	1.20	--	1.20	12.86
City of Muskego	28.80	--	4.75	4.75	--	10,200	10,200	--	0.92	0.92	9.80
City of New Berlin	25.30	5.03	0.54	5.57	12,500	1,100	13,600	1.40	--	1.40	17.31
Village of Bayside	0.09	0.09	--	0.09	--[d]	--	--	0.02	--	0.02	--
Village of Butler	0.78	0.78	--	0.78	2,100	--	2,100	0.40	--	0.40	--
Village of Elm Grove	3.25	3.25	--	3.25	7,000	--	7,000	1.10	--	1.10	--
Village of Menomonee Falls	18.30	--	6.17	6.17	--	20,400	20,400	0.08	2.18	2.26	12.13
Subtotal	137.75	29.23	11.46	40.69	47,400	31,700	79,100	6.10	3.10	9.20	52.80
In Proposed Contract Service Area											
City of Milwaukee	0.02	--	--	--	--	--	--	--	--	--	0.02
Village of Germantown	34.31	--	1.88	1.88	--	4,600	4,600	--	0.80	0.80	3.13
Village of Thiensville	1.03	--	1.16	1.16	--	4,200	4,200	--	0.57	0.57	--
Town of Caledonia	0.50	--	0.29	0.29	--	1,000	1,000	--	0.09	0.09	--
Town of Raymond	4.20	--	--	--	--	--	--	--	--	--	--
Subtotal	40.06	--	3.33	3.33	--	9,800	9,800	--	1.36	1.46	3.15
Total	415.64	210.97	14.95	225.92	1,027,700	42,100	1,069,800	202.10[e]	4.68	206.66	105.67

NOTE: N/A indicates data not available.

[a] *The local facilities planning program being conducted by the Milwaukee Metropolitan Sewerage District during 1978 will refine the limits of the sewer service area proposed to be tributary to the Milwaukee Metropolitan Sewerage System.*

[b] *Based upon an approximation of the existing sewer service area by U. S. Public Land Survey quarter section.*

[c] *As identified in locally prepared plans and engineering reports. These areas, when summed with the existing sewer service areas, do not necessarily correspond to the total areas planned for service by the Milwaukee-Metropolitan Sewerage Commissions, since some communities do not plan to serve all the area permitted to be served under contracts with the joint Commissions.*

[d] *The population residing in the area is included in the estimated population served for that portion of the Village of Bayside in Milwaukee County.*

[e] *The average hydraulic loading during 1975 on the three sewage treatment facilities operated by the Milwaukee-Metropolitan Sewage District — Jones Island, South Shore, and Hales Corners — was 211.32 mgd. In addition to the 202.10 mgd derived from the municipalities in the Milwaukee-Metropolitan Sewerage District and in the existing contract service area, an additional 9.22 mgd was processed through the plants from miscellaneous sources, including hauled sewage from holding tanks; sewage from federal government installations and county parks; and, most significantly, plant cooling and wash water.*

Source: SEWRPC

carry off surface or drainage waters. The Metropolitan Sewerage Commission, however, may only exercise its powers within the District and outside of the City of Milwaukee. The Sewerage Commission of the City of Milwaukee, on the other hand, is empowered to construct, operate, and maintain treatment facilities and main and intercepting sewers within its jurisdictional area, which is the City of Milwaukee. The Sewerage Commission of the City of Milwaukee also may improve watercourses within the City of Milwaukee.

In order to coordinate the activities of the two Commissions, the Wisconsin Statutes provide that the Metropolitan Sewerage Commission must secure the approval of the Sewerage Commission of the City of Milwaukee before it is empowered to engage in any work and, when it has completed the work it proposes to do, it then conveys title to the facilities to the Sewerage Commission of the City of Milwaukee for operation and maintenance. In addition, the Rules of the Sewerage Commissions adopted pursuant to State Statutes further require that all towns, cities, and villages lying within the District or under service agreements with the District submit local sewerage system and construction plans to the Sewerage Commission of the City of Milwaukee for approval before connections to the main and intercepting sewers owned by the District may be made. The two Commissions have the power to promulgate and enforce reasonable rules for the supervision, protection, management, and utilization of the entire sewerage system. For the purposes of this report, the Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee will be hereinafter referred to as the "Milwaukee-Metropolitan Sewerage Commissions," and the Metropolitan Sewerage District of the County of Milwaukee will be referred to as the "Milwaukee-Metropolitan Sewerage District."

As noted above, the Milwaukee-Metropolitan Sewerage Commissions jointly act as agent for the special purpose unit of government known as the Metropolitan Sewerage District of the County of Milwaukee. This District at the present time includes all of the area of Milwaukee County except the City of South Milwaukee, which has elected not to become part of the District. The District, through the Milwaukee-Metropolitan Sewerage Commissions, may enter into contracts with municipalities in the same general drainage area and adjacent to the District to accept sewage for transmission and treatment from those municipalities. The term, "same general drainage area," has been defined by the Milwaukee-Metropolitan Sewerage Commissions to include all of the Kinnickinnic, Menomonee, and Milwaukee River watersheds, the Oak Creek watershed, and those portions of the Root River watershed draining into Milwaukee County.

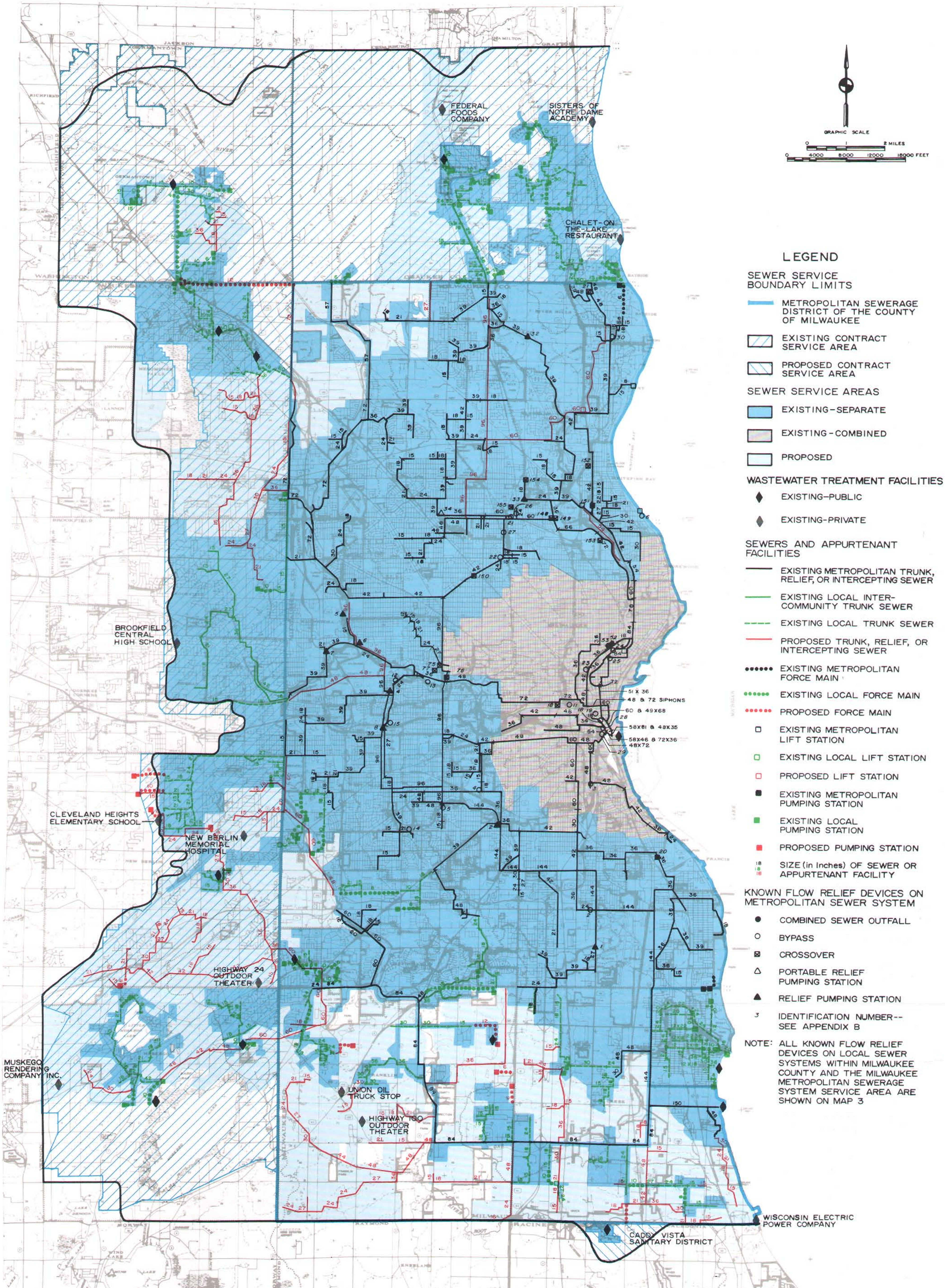
The centralized sanitary sewerage system developed and operated by the Milwaukee-Metropolitan Sewerage Commissions is by far the largest sewerage system in the Southeastern Wisconsin Region[6]. As shown on Map 2, the existing service area of this system is comprised of portions of the Milwaukee-Metropolitan Sewerage District and portions of the existing contract service area in Ozaukee and Waukesha Counties outside of the District. This area totals about 211.0 square miles, of which 181.7 square miles represent the area now served within the Metropolitan Sewerage District and 29.3 square miles represent the area now served within the existing contract service area. About 1,027,700 persons are now served by the Milwaukee-Metropolitan sanitary sewerage system, including 980,300 persons who reside within the Metropolitan Sewerage District and 47,400 persons who reside within the existing contract service area. In addition, it should be noted that the remaining sewer service area of the Milwaukee Metropolitan subregional area consisting of about 14.9 square miles and serving about 42,100 persons who reside within either the Metropolitan Sewerage District or the existing contract service area are currently provided with public sanitary sewer service. Wastewater treatment for such areas is provided by temporary wastewater treatment facilities pending connection to the centralized system. With respect to the District, these areas lie within the City of Franklin; with respect to the existing contract service area, these areas lie within the Cities of Muskego and New Berlin, the Villages of Germantown, Menomonee Falls, and Thiensville; and the Caddy Vista Sanitary District (see Map 2). All of these service areas will eventually be connected to the Milwaukee-Metropolitan centralized sewerage system as trunk sewer service and capacity become available. The service area and population characteristics of the Milwaukee-Metropolitan sewerage system are summarized in Table 5.

---

[6] *The statutes authorizing the creation of the Metropolitan Sewerage District of the County of Milwaukee and granting it authority to contract with municipalities outside of the District for sewage treatment apply only to counties in Wisconsin having a population of 500,000 or more. Since, at the present time, no other county even approaches this population size, this legislation is, as a practical matter, uniquely designed for Milwaukee County. There are, however, other areawide sanitary sewerage systems in the Region, as described in other sections of this chapter. Two other formal metropolitan sewerage districts—the Western Racine County Sewerage District and the Walworth County Metropolitan Sewerage District—exist in the Region. In addition, other cities, such as the City of Kenosha and the City of Racine, operate sanitary sewerage systems which, while not organized under statutes specifically creating special-purpose districts, are areawide or metropolitan sewerage systems through the operation of intergovernmental contracts and agreements.*

Map 2

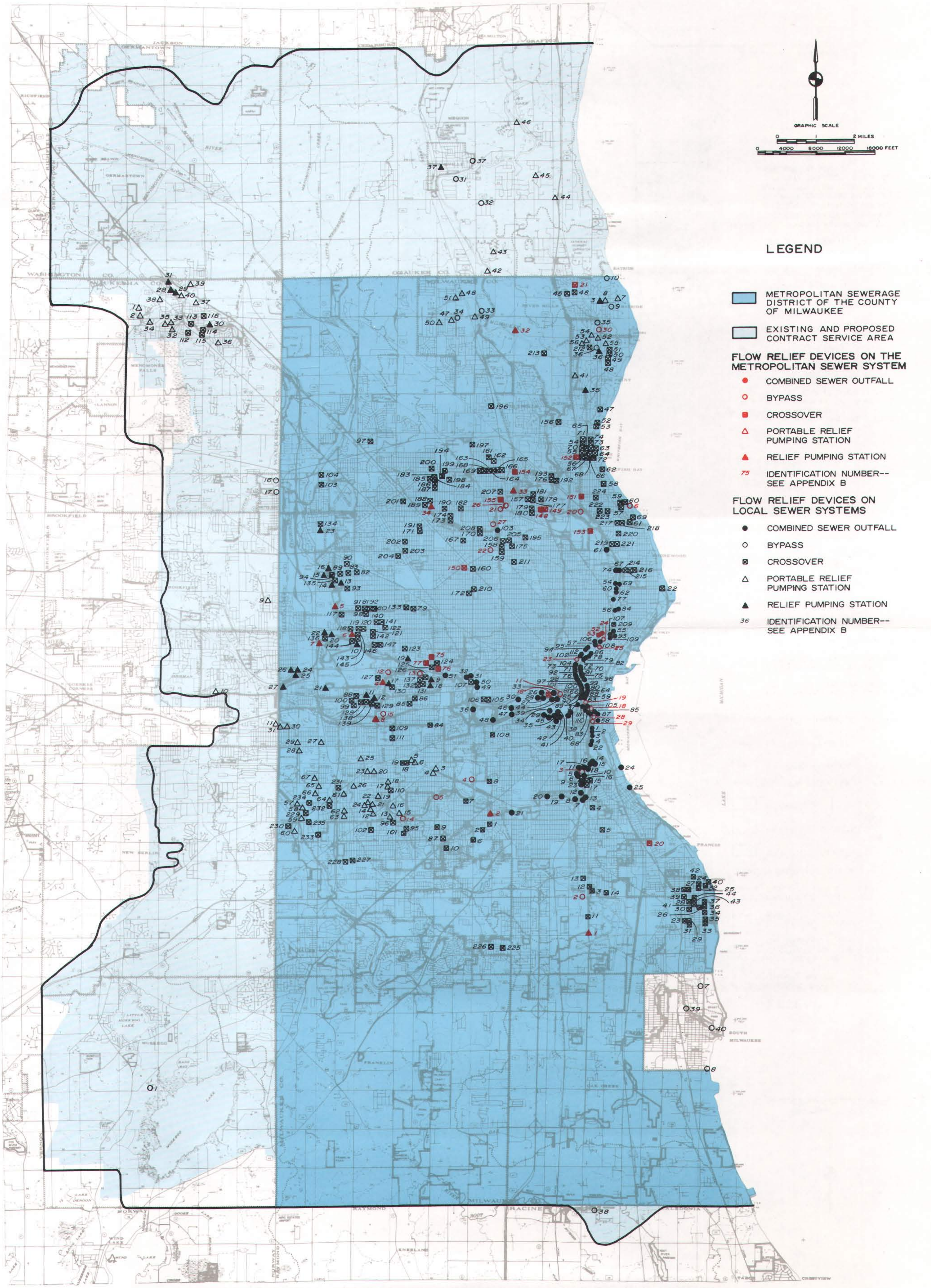
EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA: 1975



Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 3

KNOWN FLOW RELIEF DEVICES IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA AND THE MILWAUKEE-METROPOLITAN SEWERAGE SYSTEM CONTRACT SERVICE AREA: 1975



Source: *Wisconsin Department of Natural Resources and SEWRPC.*

The area presently planned for future sanitary sewer service in the plans of the Milwaukee-Metropolitan Sewerage Commissions and the communities which contract or have agreed to contract with the Commission for wastewater treatment service are also shown on Map 2. This includes all of the currently unserved area within the Milwaukee-Metropolitan Sewerage District, totaling about 55.9 square miles. In addition, this area includes all of the unsewered areas currently under contract for future sanitary sewer service in Ozaukee and Waukesha Counties, such areas lying within the Cities of Brookfield, Mequon, Muskego, and New Berlin, and the Village of Menomonee Falls, and totaling about 97.1 square miles. Finally, this area includes proposed future contract service areas within the Villages of Germantown and Thiensville and the Towns of Caledonia and Raymond, totaling about 36.7 square miles. The foregoing planned future sewer service areas, totaling about 189.7 square miles, reflect the total area planned for ultimate service by the Milwaukee-Metropolitan Sewerage Commissions. Local facility planning being conducted in 1978 by the Metropolitan Sewerage District is expected to refine the limits of the area proposed for sewer service through the Milwaukee Metropolitan sewerage system. Of this total, about 105.6 square miles are actually planned for sewer service by the local communities served by the metropolitan system (see Map 2 and Table 5). It should be noted, in this respect, that provision of sewer service to portions of the Town of Caledonia and Raymond was recommended in the Root River watershed plan, to the Village of Thiensville in the Milwaukee River watershed plan and to the Villages of Menomonee Falls and Germantown in the Menomonee River watershed plan, as such plans were prepared and adopted by the Southeastern Wisconsin Regional Planning Commission. The plans also recommend abandonment of the existing Caddy Vista wastewater treatment plant in the Town of Caledonia and the existing Village of Thiensville wastewater treatment plant.

The location and configuration of existing and locally proposed major trunk, relief, and intercepting sewers, pumping and lift stations, and related force mains included in the Milwaukee-Metropolitan centralized sewerage system are shown on Map 2. This major sewer system serves both the combined sewer areas in parts of the City of Milwaukee and the Village of Shorewood and the separate sewer areas in the remainder of the District and the existing contract areas. As shown on Map 3, there are 49 known points of sewage flow relief in the Milwaukee-Metropolitan sewerage system, including 14 crossovers, 23 bypasses, 10 relief pumping stations, and two combined sewer overflows.

The intercepting sewers contained in the Milwaukee-Metropolitan sewerage system are generally designed to carry all the dry weather sanitary flow from the combined sewers and, through control devices, a portion of the wet weather flow, with the remaining wet weather flow discharged directly to the streams in the District or to Lake Michigan. These combined sewer outfalls are described later in this chapter.

Proposed additions to the major trunk, relief, and intercepting sewer system in the Milwaukee-Metropolitan Sewerage District are shown on Map 2. These proposed system additions are part of a long-range trunk and relief sewer construction plan adopted by the Milwaukee-Metropolitan Sewerage Commissions Task Force in 1959. It is expected that the sewer system plan will be refined by the local facility planning program being conducted by the Milwaukee Metropolitan Sewerage District.

A comprehensive facility plan which provides the framework for the Metropolitan Sewerage District's proposed sewerage system improvements has been completed and conditionally approved by the U.S. Environmental Protection Agency. The conditional approval is contingent upon completion of all requirements of the federal regulations governing facilities planning under the Federal Water Pollution Control Act Amendments of 1972. For individual projects, an environmental assessment report including a section on justification for proceeding with the project without a completed facilities plan has been prepared. Projects for which such an environmental assessment has been prepared include Additional Filters and Support Equipment and Additional Dryers and Dryer House—Jones Island Wastewater Treatment Plant; the Hales Corners Interceptor; the North East Side Relief Sewer System; the Root River Interceptor; and the Menomonee Falls-Germantown Interceptor. These projects are now in various stages of development.

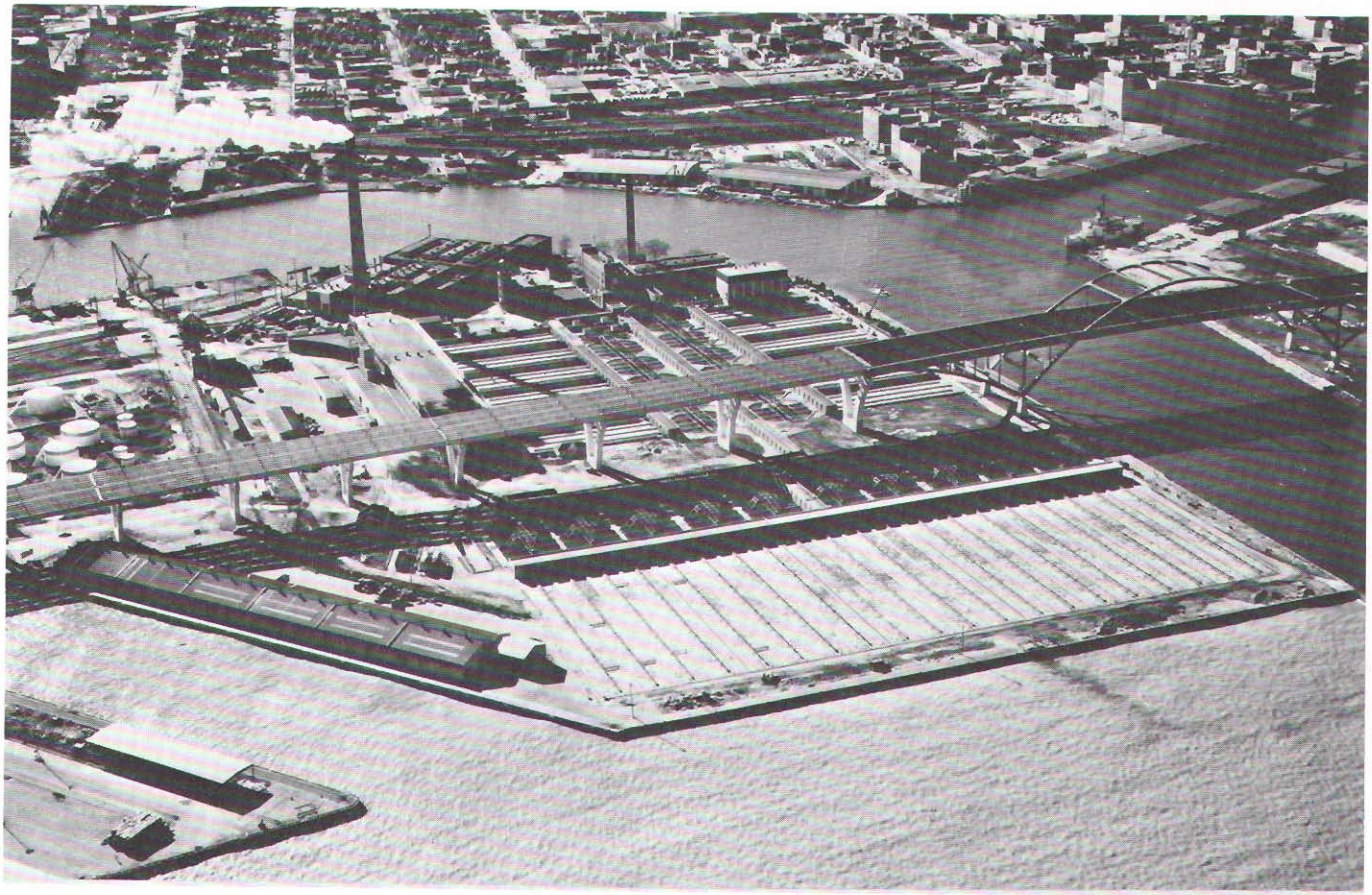
Wastewater from the Milwaukee-Metropolitan centralized sewerage system is treated at two large permanent wastewater treatment plants and one small interim wastewater treatment plant. The older of the two permanent plants, known as the Jones Island wastewater treatment plant, was put into operation in 1925. It is located in the City of Milwaukee on the Lake Michigan shoreline just south of the Milwaukee harbor entrance (see Figure 3). Major expansions to this plant were completed in 1935, 1969, and 1970.

The Jones Island plant has a site area of about 60 acres, all of which are currently utilized. The plant site is bounded by the Kinnickinnic River and the Ferry Terminal of the Chesapeake and Ohio Railroad on the west; by the Milwaukee harbor entrance on the north; the outer harbor on the east; and by railroad yards, petroleum products storage areas, and related port facilities on the south. Effluent disposal is directly to the Milwaukee harbor at the treatment plant site.

The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfec-

Figure 3

MILWAUKEE-METROPOLITAN SEWERAGE COMMISSIONS JONES ISLAND WASTEWATER TREATMENT PLANT



Source: Karl W. Emrich and Ching-Chi Wu.

tion. Wastewater treatment unit processes incorporated into the plant include primary treatment utilizing rotating drum fine screening, activated sludge, final clarification, chemical treatment for phosphorus removal, and effluent chlorination. The solids removed by the coarse and fine screening systems and the grit chambers are incinerated on the plant site. Approximately 60 wet tons of this material are incinerated each day. Sludge solids removed from the activated sludge system are thickened and then chemically conditioned prior to being fed to a vacuum filtration system and then to a heated rotating drum drying system. The dried sludge is then transported to the fertilizer storage building. Approximately 75,000 tons are bagged annually as a commercial fertilizer under the trade name of "Milorganite" which contains approximately 6 percent nitrogen, 2 percent available phosphoric acid (P_2O_5), 0.4 percent potash (K_2O), and a variety of trace elements. Generally used as a lawn fertilizer, it is distributed commercially throughout North America. The plant has an average hydraulic design capacity of 200.0 mgd, with a peak hydraulic design capacity of 300.0 mgd and an organic design capacity of 422,000 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 137.1 and 151.4 mgd, respectively, while an average annual and maximum monthly organic loading were reported to be 485,140 and 561,697 pounds of BOD_5 per day, thus indicating that while the plant has adequate hydraulic capacity to treat loadings from the existing sewer service area, it is operating above its organic design capacity.

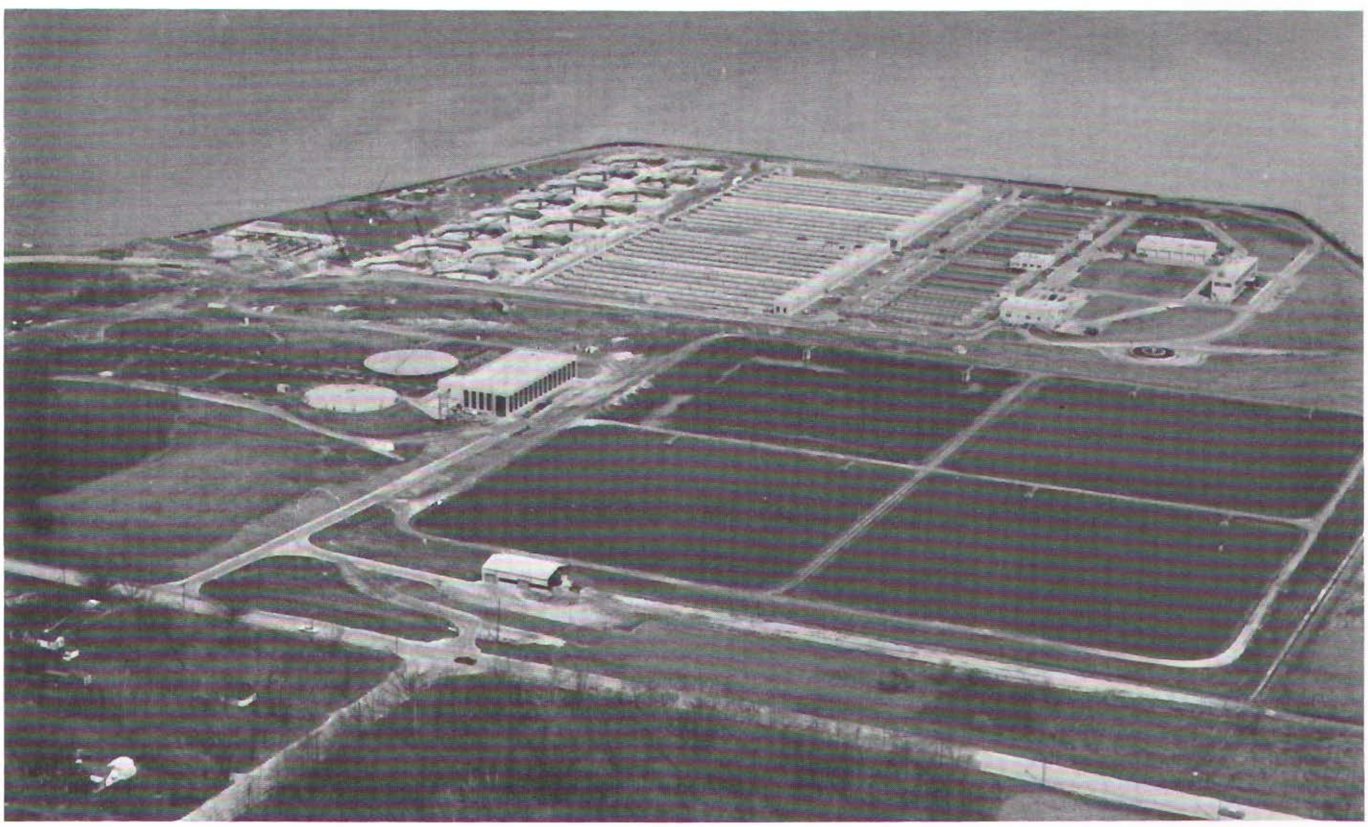
During 1975, treatment effluent was reported to contain average concentrations of 29 mg/l of BOD_5, 50 mg/l of suspended solids, 0.76 mg/l of phosphorus, and an average fecal coliform count of 384 per 100 ml. Maximum monthly average effluent concentrations of 55 mg/l of BOD_5, 122 mg/l of suspended solids, 1.7 mg/l of phosphorus, as well as a maximum monthly average fecal coliform count of 1,100 per 100 ml were reported in 1975. The wastewater treatment plant WPDES permit established monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The second of the two permanent plants, known as the South Shore wastewater treatment plant, is located on fill land built out from the Lake Michigan shoreline in the City of Oak Creek. The plant was put into operation in 1969 and modified in 1974 to include secondary treatment (see Figure 4). The South Shore plant has a site area of about 150 acres, of which about 110 acres are currently utilized, leaving about 40 acres available for future use. The plant site is bounded by Lake Michigan on the east, residential development on the north, industrial development on the south, and by 5th Avenue and residential development on the west. Effluent disposal is through a 1,930 foot outfall sewer to Lake Michigan. The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and effluent chlorination. Solids removed in the screening process are ground up and returned to the sewage flow. Upon completion of incineration facilities under construction, the coarse screening will be incinerated. Grit removed from the sewage is trucked to the Jones Island plant for incineration. Sludge solids removed from the wastewater treatment systems are thickened, fed to an anaerobic digestion system and then to sludge lagoons for partial drying prior to being hauled by tank truck to agricultural land application sites. The plant has an average hydraulic design capacity of 120.0 mgd, with a peak hydraulic design capacity of 320.0 mgd. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 73.7 and 93.9 mgd respectively, thus indicating that the plant has adequate hydraulic treatment capacity to treat the loading from the existing sewer service area.

During 1975, treatment plant effluent was reported to contain average concentrations of 28 mg/l of BOD_5, 71 mg/l of suspended solids, 3.9 mg/l of phosphorus, and a fecal coliform count of 80 per 100 ml. Maximum monthly concentrations of 51 mg/l of BOD_5, 129 mg/l of suspended solids, 6.1 mg/l of phosphorus, and an average fecal coliform count of 195 per 100 ml were reported in 1975. The wastewater treatment plant WPDES permit established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended

Figure 4

MILWAUKEE-METROPOLITAN SEWERAGE COMMISSIONS SOUTH SHORE WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The results of a pending settlement of a lawsuit brought by the State of Illinois may affect the future treatment requirements for the Jones Island and South Shore wastewater treatment plants. The proceedings from the hearing of the case, People of the State of Illinois vs. The City of Milwaukee et al., held before The Honorable John F. Grady, beginning on January 11, 1977, and ending on July 29, 1977, indicated that sewerage facility improvements for the two Milwaukee-Metropolitan wastewater treatment plants may be required in order to meet standards which are more stringent than recommended in the regional sanitary sewerage system plan. The transcript of the court decision indicated that the Milwaukee plants should install tertiary waste treatment. Based upon the hearing findings, the treatment requirements are noted to consist of coagulation and sand or multimedia filtration, and the effluent standards that should be met are specified as 5.0 mg/l of BOD_5 and 5 mg/l of suspended solids. Presently, the settlement of the lawsuit is not yet finalized and the above-noted effluent standards may be modified prior to the settlement.

The temporary treatment facility operated by the Milwaukee-Metropolitan Sewerage Commission serves only the Village of Hales Corners. This facility, discharges its effluent to the Root River (see Figure 5), and is scheduled to be abandoned

Figure 5

MILWAUKEE-METROPOLITAN SEWERAGE COMMISSIONS
HALES CORNERS WASTEWATER TREATMENT PLANT

Source: Karl W. Emrich and Ching-Chi Wu.

upon completion of a metropolitan trunk sewer in 1978. The plant was constructed in 1942 and modified in 1957 by the addition of trickling filters and anaerobic digesters. The Hales Corners plant has a site area of approximately three acres, of which approximately two acres are currently utilized. The plant site is bounded by a commercial facility to the north, residential development to the west and recreation lands to the south and east. The treatment plant incorporates primary and secondary treatment processes and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filters, final clarification, and effluent chlorination. Sludge solids removed from the wastewater treatment systems are fed to anaerobic digesters and then to drying beds where they are available for citizen pickup. The plant has an average hydraulic design capacity of 0.90 mgd, with an organic design capacity of 1,333 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.52 and 0.69 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 749 and 1,111 pounds of BOD_5 per day, thus indicating that the plant has adequate capacity to treat wastewater from the existing sewer service area.

During 1975, treatment plant effluent was reported to contain average concentrations of 35 mg/l of BOD_5 and 53 mg/l of suspended solids, and a fecal coliform count of 50 per 100 ml. Maximum monthly average effluent concentrations of 42 mg/l of BOD_5 and 66 mg/l of suspended solids and a maximum monthly average fecal coliform count of 239 per 100 ml were reported during 1975. The wastewater treatment plant WPDES permit established maximum monthly average effluent concentration limits of 50 mg/l of BOD_5, 50 mg/l of suspended solids and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

Management of the Milwaukee-Metropolitan sewerage system is, as noted above, under the direction of both the Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee. These two Commissions act jointly in all matters affecting the Milwaukee-Metropolitan Sewerage District. The Sewerage Commission of the City of Milwaukee consists of five members who are appointed by the Mayor, subject to confirmation by the Common Council. The Metropolitan Sewerage Commission of the County of Milwaukee consists of three members, all appointed by the Governor. One member is certified to the Governor by the Sewerage Commission of the City of Milwaukee and one member is certified to the Governor by the Wisconsin Department of Natural Resources. The Governor appoints the third member on his own motion, with the limitation that the member be a resident within the drainage area of Milwaukee County but outside of the City of Milwaukee. Day-to-day administration of the Milwaukee-Metropolitan sanitary sewerage system is provided by a joint staff headed by a Chief Engineer and General Manager.

The capital improvements budget for the Milwaukee-Metropolitan Sewerage District is adopted on an annual basis jointly by the Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee. The amount of the capital improvements budget is then adjusted downward to reflect capital receipts from contract service areas. This reduced budget is then forwarded to the Milwaukee County Board of Supervisors. The Board then determines the amount of the proposed budget which will be raised by the selling of general obligation bonds for the forthcoming year and the amount which will be raised by a tax levy upon all taxable property within the District. Thus, all capital improvements, including sewage treatment facilities, main sewers, relief sewers, intercepting sewers, and appurtenant facilities that are part of the Milwaukee-Metropolitan sewerage system are paid for by the taxpayers of the entire District as well as by the contract service communities through direct charges, whether these facilities are constructed within the City of Milwaukee or within any of the other 17 municipalities in Milwaukee County which belong to the Milwaukee-Metropolitan Sewerage District.

The portion of the cost of operating and maintaining the Milwaukee-Metropolitan sewerage system attributed to communities in the Milwaukee-Metropolitan Sewerage District is allocated based upon the relative amount of sewage each of the 18 communities in the District contributes to the total sewage flow. This cost is determined each year and the 18 communities in effect receive a bill directly from the Sewerage Commission of the City of Milwaukee for operation and maintenance services. Each local governing body then must provide for the billed amount through the use of service charges, taxes, or other means.

The communities within the contract service area outside of the Milwaukee-Metropolitan Sewerage District are billed each year by the Milwaukee-Metropolitan Sewerage Commission on a fixed charge per million gallons of metered wastewater. Such fixed charge is adjusted at five-year intervals. In fiscal year 1975, each of the service contracts provided that the fixed service charge, which was $330.00 per million gallons of sewage, be based on the following three components:

1. A depreciation component based on 2 percent of the total investment for permanent assets.

2. A fair-return-on-capital component based on 6 percent of the depreciated value of the system components.

3. An annual operations and maintenance component based on metered sewage flow.

The total expenditures in 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Milwaukee-Metropolitan sanitary sewerage system approximated $23,342,156, or about $23.00 per capita, the per capita cost being based upon the total estimated population served of 1,027,700. Of this total cost, $9,703,000, or about $9.50 per capita, was expended on operational maintenance, and $13,639,156, or about $13.50 per capita was expended for capital improvements. The foregoing expenditure data include all costs associated with the operation and maintenance of the Jones Island, South Shore, and Hales Corners sewage treatment plants; with maintenance of the Milwaukee-Metropolitan trunk sewer and storm water drainage systems; and with capital improvements to the entire system—treatment plants, trunk sewers, and watercourse improvements—attributable to the year 1975.

Because most of the capital cost attributable to 1975 consists of debt retirement on bonds sold in previous years to finance both sanitary sewer and storm water drainage improvements, it was not possible to determine precisely how much of the total 1975 capital improvement cost was due to sanitary sewerage improvements and how much was due to watercourse improvements. However, the capital budgets prepared and adopted by the joint Milwaukee-Metropolitan Sewerage Commissions historically have included only a relatively small percent of the capital expenditures for watercourse improvements, with the majority of the expenditures directed at sanitary sewerage improvements. The estimate for operation and maintenance also includes costs attributable to the maintenance of storm water drainage channels. These costs, however, are negligible and do not affect the validity of comparing the per capita operation and maintenance cost of the Milwaukee-Metropolitan sewerage system with other systems.

The total expenditures noted above for the Milwaukee-Metropolitan sanitary sewerage system during 1975 have been apportioned to the 18 municipalities in the Milwaukee Metropolitan Sewerage District in the ensuing portion of this chapter in order that such costs may be summed with any applicable local sewerage expenditures to effect the true per capita cost of providing sewer service within each community in the District. The capital improvement costs have been prorated to the communities based upon equalized assessed valuation. The operation and maintenance costs have been prorated to the communities based upon wastewater flow. Thus, any total and per capita costs attributed to communities in the Milwaukee-Metropolitan Sewerage District include that community's share of constructing, operating, and maintaining the metropolitan sewerage system. Such prorated costs are, however, subject to the same qualification noted above relating to the inclusion of certain relatively minor storm water drainage improvements in the capital cost component.

City of Brookfield: The City of Brookfield sanitary sewerage system consists of two separate parts. One serves urban development located in the City generally east of the subcontinental divide which traverses the Southeastern Wisconsin Region and will be described here. The other serves urban development generally located in the Fox River watershed west of the subcontinental divide, and will be described under the Upper Fox River subregional area section. The existing service areas of each of these sanitary sewerage systems are shown on Map 2. Together, these areas total about 19.4 square miles and have a resident population of about 32,500 persons. Both areas are served by separate sanitary sewer systems.

The City of Brookfield contracts with the Milwaukee-Metropolitan Sewerage Commissions for treatment of wastewater generated in the area east of the subcontinental divide. This area totals about 10.9 square miles and has a resident population of about 16,300 persons. The average hydraulic loading on the Milwaukee-Metropolitan sewerage system from the City of Brookfield in 1975 was estimated at 1.90 mgd.

The location and configuration of the major trunk sewers and pumping and lift stations and related force mains included in the City of Brookfield sanitary sewerage system east of the subcontinental divide is shown on Map 2. There are three known points of sewage flow relief in this portion of the City of Brookfield sanitary sewerage system, all of which are portable pumping stations (see Map 3). The planned future service area in this portion of the City of Brookfield, which includes all of the unserved sections of the City generally east of the subcontinental divide, totaling about 0.7 square mile, together with locally proposed trunk sewers to serve this area, are also shown on Map 2.

Management of the City of Brookfield sanitary sewerage system is under the direction of a five-member sewer utility board including the Mayor and Public Works Director, along with a four-member Underwood Creek Sewer Commission, a joint commission with the Village of Elm Grove. Day-to-day administration of the system is provided by the Director of Public Works and the utility superintendent. Financing of the system is provided through both a sewer service charge and general property taxes.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement for the entire City of Brookfield sanitary sewerage system (including that portion of the City that lies in the Upper Fox River subregional area) and including its share of the costs of constructing, operating, and maintaining the Milwaukee-Metropolitan sewerage system, approximated $2,273,600, or about $70.00 per capita. Of this total, $482,900 or about $15.00 per capita, was expended for operation and maintenance, and $1,790,700 or about $55.00 per capita, was expended for capital improvements.

City of Cudahy: The existing service area of the City of Cudahy sanitary sewerage system, an area which encompasses the entire city, is shown on Map 2. This area totals about 4.7 square miles and has a resident population of about 21,700 persons. The entire area is served by a separate sanitary sewer system, the city having completed in 1966 a program of separating all existing combined sewers.

Since the City of Cudahy is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the City is treated in the South Shore and Jones Island wastewater treatment plants operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of Cudahy in 1975 was 6.30 mgd.

The location and configuration of the major trunk sewers serving the City of Cudahy are shown on Map 2. There are 22 known points of sewage flow relief in the City of Cudahy sanitary sewerage system, all of which are crossovers (see Map 3).

Management of the City of Cudahy sanitary sewerage system is under the direction of a ten-member Board of Public Works. This Board is composed of all ten of the City's aldermen. Day-to-day administration of the system is provided by the Director of Public Works. Financing of the system is provided through the general property tax. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement for the City of Cudahy sanitary sewerage system and including its share of costs for constructing, operating, and maintaining the metropolitan sewerage system approximated $701,231, or about $32.00 per capita. Of this total, $334,163, or about $15.00 per capita, was expended for local operation and maintenance, and $367,068, or about $17.00 per capita, was expended for capital improvements.

City of Franklin: The existing service area of the City of Franklin sanitary sewerage system is shown on Map 2. This area totals about 6.0 square miles and has a resident population of about 8,800 persons. The entire area is served by a separate sanitary sewer system. This area does not include portions of the City of Franklin served by private water and sewer trust described later in this chapter.

Since the City of Franklin is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the City is treated in the South Shore wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of Franklin in 1975 was 0.80 mgd.

The location and configuration of all major trunk sewers and pumping stations included in the City of Franklin sanitary sewerage system are shown on Map 2. There are no known points of sewage flow relief in the City of Franklin sanitary sewerage system. The planned future service area of the City of Franklin, which includes the entire developable area within the City and totaling about 22.8 square miles, together with locally proposed trunk sewers to serve this area are also shown on Map 2.

Management of the City of Franklin sanitary sewerage system is under the direction of the Committee of the Whole of the City Council. Day-to-day administration of the system is provided by the City Engineer. Financing of the system is provided through special assessments and a sewer service charge for each residential sewer connection, with special flat fees and quantity-of-flow charges for nonresidential connections.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Franklin sanitary sewerage system and including its share of the cost of constructing, operating, and maintaining the metropolitan sewerage system, approximated $1,900,028, or about $216.00 per capita. Of this total, $47,736, or about $5.50 per capita, was expended for operation and maintenance, and $1,852,292, or about $210.50 per capita, was expended for capital improvements.

City of Glendale: The existing service area of the City of Glendale sanitary sewerage system, an area which encompasses the entire City, is shown on Map 2. This area totals about 6.0 square miles and has a resident population of about 13,500 persons. The entire area is served by a separate sanitary sewer system.

Since the City of Glendale is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the City is treated in the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of Glendale in 1975 was 3.00 mgd.

There are two known points of sewage flow relief in the City of Glendale sanitary sewerage system including one crossover and one portable pumping station (see Map 3). The location and configuration of the major trunk sewers and pumping station serving the City of Glendale are shown on Map 2.

Management of the City of Glendale sanitary sewerage system is under the direction of the City Council. Day-to-day administration of the system is provided by the Superintendent of Public Works. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Glendale sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $761,916, or about $56.50 per capita. Of this total, $186,338, or about $14.00 per capita, was expended for operation and maintenance, and $575,578, or about $42.50 per capita, was expended for capital improvements.

City of Greenfield: The existing service area of the City of Greenfield sanitary sewerage system is shown on Map 2. This area totals about 8.7 square miles and has a resident population of about 29,900 persons. The entire area is served by a separate sanitary sewer system.

Since the City of Greenfield is a part of the Milwaukee-Metropolitan Sewerage District, wastewater from the City is treated in the Jones Island and South Shore wastewater treatment plants operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of Greenfield in 1975 was 3.30 mgd.

The location and configuration of the major trunk sewers serving the City of Greenfield are shown on Map 2. There are no known points of sewage flow relief in the City of Greenfield sanitary sewerage system. The planned future service area of the City of Greenfield, which includes all developable areas of the City not now served and totaling about 2.5 square miles together with locally proposed trunk sewers, is also shown on Map 2.

Management of the City of Greenfield sanitary sewerage system is under the direction of the City Council. Day-to-day administration of the system is provided by the Superintendent of Public Works. Financing of the system is provided through the general property tax and sewer service charges.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Greenfield sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $1,286,916, or about $43.00 per capita. Of this total, $210,257, or about $7.00 per capita, was expended for operation and maintenance, and $1,076,659, or about $36.00 per capita, was expended for capital improvements.

City of Mequon: The existing service area of the City of Mequon sanitary sewerage system is shown on Map 2. This area totals about 9.2 square miles and has a resident population of about 9,500 persons. The entire area is served by a separate sanitary sewer system.

The City of Mequon contracts with the Milwaukee-Metropolitan Sewerage Commissions for sewage treatment. The wastewater from the City is treated in the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of Mequon in 1975 was 1.20 mgd.

The locations and configuration of the major trunk sewers, lift and pumping stations, and related force mains included within the City of Mequon sanitary sewerage system are shown on Map 2. There are seven known points of sewage flow relief in the City of Mequon sanitary sewerage system including two bypasses and five fortable pumping stations (see Map 3). Although additional future service areas are planned in the City of Mequon, no specific locally proposed future sewer service areas were identified in the inventory. However, the City in conjunction with the Village of Thiensville has initiated a facilities planning program to evaluate sewerage system alternate plans for connection to the Metropolitan Sewerage Commission sanitary sewerage system.

Management of the City of Mequon sanitary sewerage system is under the direction of the City Council. Day-to-day administration of this system is provided by the Director of Public Works. Financing of the system is provided through a sewer service charge, and a special assessment for each connection. Total expenditures during 1975 for operation, maintenance, and capital improvement, including debt retirement, for the City of Mequon sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $1,548,047, or about $163.00 per capita. Of this total, $149,034, or about $16.00 per capita, was expended for operation and maintenance and $1,399,013, or about $147.00 per capita, was expended for capital improvements.

City of Milwaukee: The existing service area of the City of Milwaukee sanitary sewerage system is shown on Map 2. This area totals about 89.3 square miles and has a resident population of about 670,100 persons. About 67.8 square miles containing about 376,100 persons, or about 76 percent of the area served and 56 percent of the population served in the City, are served by a separate sewer system, and about 21.57[7] square miles containing about 294,000 persons, or about 24 percent of the area served and 44 percent of the population served, are served by a combined sewer system.

Since the City of Milwaukee is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the city is treated at both the Jones Island South Shore wastewater treatment plants operated by the Milwaukee-Metropolitan Sewerage Commissions. Since wastewater is metered from all other municipalities contributing sewage to the Milwaukee-Metropolitan sewerage system, wastewater from the City of Milwaukee is estimated as the residual after subtracting all of the measured wastewater from the total wastewater treated. The average daily flow from the City of Milwaukee in 1975 was estimated at 139.90 mgd.

The location and configuration of the major trunk sewers including lift stations and related force mains included in the City of Milwaukee sanitary sewerage system are shown on Map 2. There are 217 known points of sewage flow relief in the City of Milwaukee sanitary sewerage system, including 107 crossovers and 110 combined sewer outfalls (see Map 3). As noted earlier in this chapter, the intercepting sewers of the Milwaukee-Metropolitan sewerage system convey all of the dry weather wastewater flow and a portion of the wet weather wastewater flow from the combined sewer area of the City of Milwaukee to the wastewater treatment plants. The remaining wet weather flow from the combined sewer area is discharged directly to the streams in the City or to Lake Michigan.

It should be noted that the City of Milwaukee is continuing to improve its sanitary sewer system by the construction of additional relief sewers and a corresponding elimination of existing flow relief devices.

The City intends to provide sewer service to the remaining areas of the City not now served. As shown on Map 2, these areas are concentrated in the northwestern portion of the City in the former Town of Granville.

General policy relating to the City of Milwaukee sanitary sewerage system is under the direction of the Common Council of the City of Milwaukee. Day-to-day administration of the system is provided by the Commissioner of Public Works. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Milwaukee sanitary sewerage system, including its share of the costs

---

[7] *The combined sewer area of the City of Milwaukee and the Village of Shorewood is estimated to be 22.4 square miles of which about 96 percent or 21.5 square miles is located in the City of Milwaukee. This estimate is based upon reported information in Metropolitan Sewerage District Report prepared by Stevens, Thompson and Runyon, Inc., and entitled Technical Analysis of Conveyance—Storage—Treatment Concept, A Working Document, Combined Sewer Overflow Pollution Abatement, July, 1976. The combined sewer service area was estimated to be 17,200 acres in SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, 1971 and in SEWRPC Planning Report No. 16, A Regional Sanitary Sewage System Plan for Southeastern Wisconsin, 1974. The Stevens, Thompson and Runyon report attributed the difference in combined sewer areas to 2,450 acres of separated areas within the limits of the 17,200 acre combined sewer area and 400 acres to minor variations in boundaries and beach areas that drain to Lake Michigan via overland runoff.*

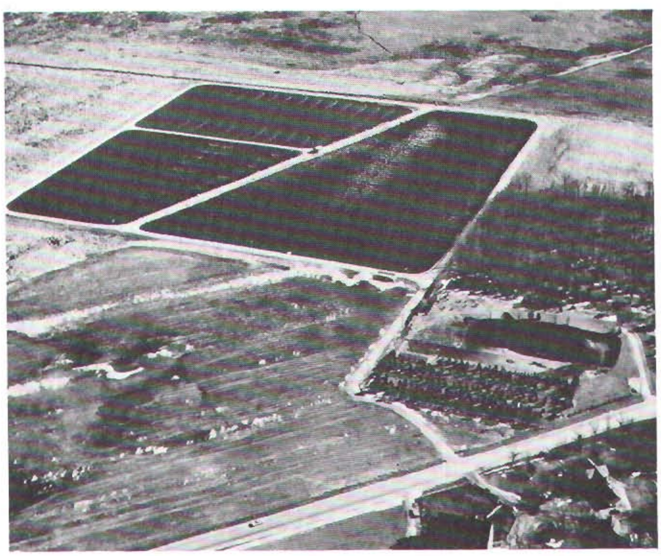
of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $22,870,847, or about $34.00 per capita. Of this total, $8,655,940, or about $13.00 per capita, was expended for operation and maintenance, and $14,214,907, or approximately $21.00 per capita, was expended for capital improvements.

City of Muskego: The existing service area of the City of Muskego sanitary sewerage system is shown on Map 2. This area totals about 4.8 square miles and has a resident population of about 10,200 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the northwestern portion of the City of Muskego is temporarily being treated at a wastewater treatment lagoon located near Big Muskego Lake, to which effluent is discharged (see Figure 6). The existing lagoon site accommodates three lagoons and is about 21 acres in size. It is bounded by agricultural land uses on all sides. The facility was constructed in 1967 and reconstructed in 1970. The facility incorporates secondary treatment process with auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the facility include primary sedimentation and aerated stabilization—both in the lagoons—and effluent chlorination. Chemical treatment for phosphorus removal was added in 1976. Sludge solids when occasionally removed from the lagoons are applied to agricultural lands. The facility has an average hydraulic design capacity of 0.70 mgd, with a peak hydraulic capacity of 1.30 mgd and an organic design capacity of 1,400 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.58 and 0.88 mgd respectively, while the average annual and maximum monthly loadings were reported to be 518 and 707 pounds of BOD_5 per day, thus indicating that the facility has adequate capacity to treat the loading from the existing sewer service area.

Figure 6

CITY OF MUSKEGO
BIG MUSKEGO WASTEWATER TREATMENT PLANT



Source: Karl W. Emrich and Ching-Chi Wu.

During 1975, treatment facility effluent was reported to contain average concentrations of 9 mg/l of BOD_5, 19 mg/l of suspended solids, and 6.5 mg/l of phosphorus. Maximum monthly average effluent concentrations of 19 mg/l of BOD_5, 43 mg/l of suspended solids, and 9.6 mg/l of phosphorus were reported in 1975. Data on effluent fecal coliform counts were not routinely reported in 1975; however, a monthly average chlorine residual which varied from 0.5 mg/l to 0.6 mg/l was reported. The wastewater treatment facility WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through March 31, 1979.

Wastewater from the northeastern portion of the City of Muskego is treated at a wastewater treatment plant located on a tributary of the Root River, Tess Corners Creek, to which effluent is discharged (see Figure 7). The plant has a site area of approximately 25 acres. The plant, which was constructed in 1972, is bounded by agricultural lands on the south and east, open lands on the north and west. The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification flow-through lagoon, chemical treatment for phosphorus removal, and effluent chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.50 mgd, with a peak hydraulic design capacity of 1.00 mgd and an organic design capacity of 1,000 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.34 and 0.51 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 424 and 555 pounds of $CBOD_5$ per day, thus indicating that the plant has adequate organic treatment capacity to treat the loading from the existing sewer service area. During 1975, treatment plant effluent was reported to contain average concentrations of 11 mg/l of BOD_5, 20 mg/l of suspended solids, and 3.1 mg/l of phosphorus. Maximum monthly average effluent concentrations of 14 mg/l of BOD_5, 28 mg/l of suspended solids, and 4.7 mg/l of phosphorus were reported during 1975. Data on effluent fecal coliform counts were not routinely reported in 1975; however, a monthly average chlorine residual which varied from 0.5

Figure 7

CITY OF MUSKEGO NORTHEAST DISTRICT WASTEWATER TREATMENT PLANT

Source: Karl W. Emrich and Ching-Chi Wu.

mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through March 31, 1979.

Both of the City of Muskego wastewater treatment facilities are scheduled to be abandoned upon completion of a major trunk sewer by the Milwaukee-Metropolitan Sewerage Commissions to the Milwaukee-Waukesha County Line. The City of Muskego is committed by contract to abandon its temporary wastewater treatment facilities and connect to the Milwaukee-Metropolitan sewerage system as soon as the trunk sewer capacity becomes available. During 1976 the City of Muskego initiated facilities planning studies for major trunk sewers to connect the City's sewer system to the Milwaukee-Metropolitan Sewerage Commission's system.

Although nearly the entire City of Muskego lies within the contract service area of the Milwaukee-Metropolitan Sewerage Commission, the locally proposed plans of the City of Muskego indicate providing sewer service to an additional 9.8 square mile area, as shown on Map 2. Locally proposed trunk sewers to serve this area and to enable abandonment of the existing sewage treatment plants are also shown on Map 2.

The location and configuration of all existing major trunk sewers, pumping stations, and related force mains included in the City of Muskego sanitary system are shown on Map 2. There is one known point of sewage flow relief in the City of Muskego sanitary sewerage system, a bypass at the wastewater treatment plant.

Management of the City of Muskego sanitary sewerage system is under the direction of the Mayor and Common Council. Day-to-day administration of the system is provided by the City Engineer. Financing of the system is provided through the general property tax and a sewer service charge. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Muskego sanitary sewerage system, approximated $255,939, or about $25.00 per capita.

Of this total, $95,939, or about $9.50 per capita, was expended for operation and maintenance, and $160,000, or $15.50 per capita, was expended for capital improvements.

City of New Berlin: The existing service area of the City of New Berlin sanitary sewerage system is shown on Map 2. This area totals about 5.6 square miles and has a resident population of about 13,600 persons. The entire area is served by a separate sanitary sewer system. All of the area lies east of the subcontinental divide traversing the Southeastern Wisconsin Region. Of the total area served, about 5.0 square miles having a resident population of about 12,500 persons are served directly through the Milwaukee-Metropolitan sewerage system, and about 0.5 square miles having a resident population of about 1,100 persons is served directly by the City of New Berlin through a small sewage treatment plant.

The City of New Berlin has a contract with the Milwaukee-Metropolitan Sewerage Commissions for transmission and treatment of wastewater generated in the area of the City east of the subcontinental divide. The average hydraulic loading on the Milwaukee-Metropolitan sewerage system from the City of New Berlin in 1975 was estimated at 1.40 mgd.

The City of New Berlin placed into operation during 1970 on a limited use basis, a temporary wastewater treatment plant designed to serve the Eisenhower High School and the Regal Manors Subdivision (see Figure 8). The treatment plant incorporates secondary treatment processes and provides for auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification flow-through lagoon and effluent chlorination. Tertiary sand filters were added to the plant in 1977. Sludge solids removed from the treatment system are fed to an aerobic digestion system and then to drying beds prior to being hauled to the City of Brookfield wastewater treatment plant for incineration or alternatively to agricultural land application sites.

The location and configuration of all major trunk sewers and pumping and lift stations and related force mains including the City of New Berlin sanitary sewerage system are shown on Map 2. There are no known points of sewer overflow or bypassing in the City of New Berlin sanitary sewerage system. The inventory revealed that the City had a documented plan to provide sewer service to the entire area of the City lying within the contract limits of the Milwaukee-Metropolitan Sewerage commissions, an

Figure 8

CITY OF NEW BERLIN WASTEWATER TREATMENT PLANT

Source: Karl W. Emrich and Ching-Chi Wu.

area generally corresponding to the area lying east of the subcontinental divide. This proposed future sewer service area, which approximates 17.31 square miles, is shown on Map 2.

Management of the City of New Berlin sanitary sewerage system is under the direction of the Common Council. Day-to-day administration of this system is provided by the Director of Public Works. Financing of the system is provided through a quarterly sewer service charge which varies from $18.15 for a residential connection to $54.40 plus commodity over 100,000 gallons for industrial connections based upon waster usage connection. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of New Berlin sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $895,862, or about $66.00 per capita. Of this total, $130,412, or about $9.50 per capita, was expended for operation and maintenance, and $765,450, or about $56.50 per capita, was expended for capital improvements.

City of Oak Creek: The existing service area of the City of Oak Creek sanitary sewerage system is shown on Map 2. This area totals about 12.1 square miles and has a resident population of about 14,400 persons. The entire area is served by a separate sanitary sewer system.

Since the City of Oak Creek is part of the Milwaukee-Metropolitan Sewerage District, all wastewater from the city is treated at the South Shore wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of Oak Creek into the Milwaukee-Metropolitan sewerage system during 1975 was 5.30 mgd.

The location and configuration of all major trunk sewers, pumping stations and related force mains included in the City of Oak Creek sanitary sewerage system are shown on Map 2. There are no known points of sewage flow relief in the City of Oak Creek sanitary sewerage system. The planned future service area of the City of Oak Creek which includes all developable areas within the City not now served, together with locally proposed trunk sewers, are also shown on Map 2.

Management of the City of Oak Creek sewerage system is under the direction of a five-member Board of Water Works and Sewer Commissioners. Board members are appointed by the Mayor, subject to fonfirmation by the Common Council. Day-to-day administration of the system is provided by the waste and sewer utility manager. Financing of the system is provided through the general property tax and assessments, and a sewer service charge. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Oak Creek sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage system, approximated $1,090,719, or about $76.00 per capita. Of this total, $472,552, or about $33.00 per capita, was expended for operation and maintenance, and $618,167, or about $43.00 per capita, was expended for capital improvements.

City of South Milwaukee: The existing service area of the City of South Milwaukee sanitary sewerage system, an area which includes all but a very small portion of the entire City, is shown on Map 2. The area served totals about 4.9 square miles and has a resident population of about 23,400 persons. The entire area is served by a separate sanitary sewer system.

As noted earlier in this chapter, the City of South Milwaukee is the only municipality in Milwaukee County which has elected not to become part of the Milwaukee-Metropolitan Sewerage District. Wastewater from the City of South Milwaukee is treated at a wastewater treatment plant located on the Lake Michigan shoreline about one mile north of the South Shore wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions (see Figure 9). The plant has a site area of about ten acres, of which six acres are currently utilized, leaving four acres available for future use. The plant site is bounded by industrial land uses on the north, Lake Michigan on the east, vacant lands on the south, and residential land uses on the west. This plant was initially placed into operation in 1937 with major modifications in 1952, 1962, and 1972.

The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and effluent chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system prior to being fed to a wet air oxidation unit or being hauled by tank truck to land application or landfill sites. A small portion of the sludge is dried on drying beds. Recently the City has instituted a program of polymer addition in the anaerobic digestion system which results in a better separation of solids in the digestion system and generally results in the wet air oxidation unit having adequate capacity to handle all sludge solids. The plant has an average hydraulic design capacity of 6.00 mgd, with a peak hydraulic design capacity of 12.00 mgd and an organic design capacity of 12,510 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 2.67 and 3.54 mgd respectively, while the

Figure 9

CITY OF SOUTH MILWAUKEE WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

average annual and maximum monthly organic loadings were reported to be 3,489 and 4,071 pounds of BOD_5 per day, thus indicating that the plant has adequate hydraulic and organic treatment capacity to treat the loading from the existing service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 12 mg/l of BOD_5, 11 mg/l of suspended solids, and 1.13 mg/l of phosphorus. Maximum monthly average effluent concentrations of 27 mg/l of BOD_5, 18 mg/l of suspended solids, and 1.82 mg/l of phosphorus were reported in 1975. Data on effluent fecal coliform counts was not routinely reported during 1975; however, a monthly average chlorine residual which varied from 0.5 mg/l to 0.9 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml effective through the period to June 30, 1979.

The results of a settlement of a lawsuit brought by the State of Illinois will affect future treatment requirements for the South Milwaukee wastewater treatment plant. Officials of the City of South Milwaukee signed a settlement to a Lake Michigan pollution law suit brought by the State of Illinois which would commit the City to provide higher levels of waste treatment at their sewage treatment facility. The agreement, which is binding on South Milwaukee only if all necessary federal and state funds are made available, require effluent limitations of 10 mg/l of BOD_5, 10 mg/l of suspended solids, and 1.0 mg/l of phosphorus.

In 1977, the City initiated a facilities planning project to evaluate wastewater treatment and conveyance needs. This project was directed principally to infiltration and inflow analyses.

The location and configuration of all trunk sewers and lift and pumping stations and related force mains included in the City of South Milwaukee sanitary sewerage system are shown on Map 2. There are four known points of sewage flow relief in the City of South Milwaukee sanitary sewerage system, all of which are bypasses including one at the wastewater treatment plant (see Map 2).

Management of the City of South Milwaukee sanitary sewerage system is under the direction of a five-member Sewerage Commission elected by the City Council. Day-to-day administration of the system is provided by the Superintendent of the wastewater treatment plant. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of South Milwaukee sanitary sewerage system approximated $346,125, or about $15.00 per capita. Of this total, $316,600, or about $13.50 per capita, was expended for operation and maintenance, and $29,525, or about $1.50 per capita, was expended for capital improvements.

City of St. Francis: The existing service area of the City of St. Francis sanitary sewerage system, an area which encompasses the entire City, is shown on Map 2. This area totals about 2.6 square miles and has a resident population of about 9,900 persons. The entire area is served by a separate sanitary sewer system.

Since the City of St. Francis is a part of the Milwaukee-Metropolitan Sewerage District, wastewater from the City is treated in the Jones Island and South Shore wastewater treatment plants operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of St. Francis in 1975 was 1.90 mgd.

The location and configuration of all major trunk sewers serving the City of St. Francis are shown on Map 2. There are no known points of sewage flow relief in the City of St. Francis sanitary sewerage system.

Management of the City of St. Francis sanitary sewerage system is under the direction of the City Council. Day-to-day administration of the system is provided by the City Engineer. Financing of the system is provided through the general property tax. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of St. Francis sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $203,275, or about $20.50, per capita. Of this total, $92,525, or about $9.50 per capita, was expended for operation and maintenance, and $110,750, or about $11.00 per capita, was expended for capital improvements.

City of Wauwatosa: The existing service area of the City of Wauwatosa sanitary sewerage system, an area which encompasses the entire city, is shown on Map 2. This area totals about 13.3 square miles and has a resident population of about 55,700 persons. The entire area is served by a separate sanitary sewer system.

Since the City of Wauwatosa is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the City is treated in the Jones Island and South Shore wastewater treatment plants operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of Wauwatosa in 1975 was 8.20 mgd.

The location and configuration of all major trunk sewers serving the City of Wauwatosa are shown on Map 2. There are 50 known points of sewage flow relief in the City of Wauwatosa sanitary sewerage system, including 31 crossovers and 19 relief pumping stations (see Map 3).

Management of the City of Wauwatosa sanitary sewerage system is under the direction of a Board of Public Works. Day-to-day administration of the system is provided by the Operations Administrator of the Public Works Department under the general supervision of the City Administrator. Financing of the system is provided through the general property tax and federal revenue sharing funds.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Wauwatosa sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $1,726,420, or about $31.00 per capita. Of this total, $469,468, or about $8.50 per capita, was expended for operation and maintenance, and $1,256,952, or about $22.50 per capita, was expended for capital improvements.

City of West Allis: The existing service area of the City of West Allis sanitary sewerage system, an area which encompasses the entire City, is shown on Map 2. This area totals about 11.4 square miles and has a resident population of about 69,000 persons. The entire area is served by a separate sanitary sewer system.

Since the City of West Allis is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the City is treated in the Jones Island and South Shore wastewater treatment plants operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the City of West Allis in 1975 was 11.70 mgd.

The location and configuration of all major trunk sewers and one pumping station with related force mains included in the City of West Allis sanitary sewerage system are shown on Map 2. There are 47 known points of sewage flow relief in the City of West Allis sanitary sewerage system, including 12 crossovers and 35 portable pumping stations (see Map 3).

Management of the City of West Allis sanitary sewerage system is under the direction of the Board of Public Works. Day-to-day administration of the system is provided by the Director of Public Works. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of West Allis sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $2,549,765, or about $37.00 per capita. Of this total, $646,809, or about $9.50 per capita, was expended for operation and maintenance, and $1,902,956, or about $27.50 per capita, was expended for capital improvements.

Village of Bayside: The existing service area of the Village of Bayside sanitary sewerage system, an area which encompasses the entire village, is shown on Map 2. This area totals about 2.3 square miles and has a resident population of about 4,400 persons. The entire area is served by a separate sanitary sewer system.

The Village of Bayside is located partly within the Milwaukee-Metropolitan Sewerage District, and partly within the contract service area. All of the wastewater from the Village, however, is treated in the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of Bayside in 1975 was 0.60 mgd.

The location and configuration of all major trunk sewers, pumping station and related force mains included in the Village of Bayside sanitary sewerage system are shown on Map 2. There are seven known points of sewage flow relief in the Village of Bayside sanitary sewer system including two crossovers, two bypasses, one relief pumping station and two portable pumping stations (see Map 3).

Management of the Village of Bayside sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Manager. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Bayside sanitary sewerage system, and including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $153,046, or about $35.00 per capita. Of this total, $41,516, or about $9.50 per capita, was expended for operation and maintenance, and $111,530, or about $25.50 per capita, was expended for capital improvements.

Village of Brown Deer: The existing service area of the Village of Brown Deer sanitary sewerage system, an area which encompasses the entire village, is shown on Map 2. This area totals about 4.4 square miles and has a resident population of about 13,600 persons. The entire area is served by a separate sanitary sewer system.

Since the Village of Brown Deer is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the Village is treated in the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of Brown Deer in 1975 was 1.50 mgd.

The location and configuration of all major trunk sewers serving the Village of Brown Deer are shown on Map 2. There are seven known points of sewage flow relief in the Village of Brown Deer sanitary sewerage system, including two bypasses, and five portable pumping stations (see Map 3).

Management of the Village of Brown Deer sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Manager. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Brown Deer sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $321,198, or about $24.00 per capita. Of this total, $105,836, or about $8.00 per capita, was expended for operation and maintenance, and $215,362, or about $16.00 per capita, was expended for capital improvements.

Village of Butler: The existing service area of the Village of Butler sanitary sewerage system, an area which encompasses the entire Village, is shown on Map 2. This area totals about 0.8 square miles and has a resident population of about 2,100 persons. The entire area is served by a separate sanitary sewer system.

The Village of Butler contracts with the Milwaukee-Metropolitan Sewerage Commissions for wastewater treatment. The average hydraulic loading on the Milwaukee-Metropolitan sewerage system from the Village of Butler in 1975 was estimated at 0.40 mgd. Pending completion of trunk sewer construction, sewage flow from the village to the Milwaukee-Metropolitan sewerage system is limited to 400,000 gallons per day. Any flow in excess of this amount is bypassed through a chlorination tank and discharged to the Menomonee River.

The location and configuration of the major trunk sewers, a pumping station and related force mains included in the Village of Butler sanitary sewerage system are shown on Map 2. There are two known points of sewage flow relief in the Village's sanitary sewerage system, both of which are bypasses (see Map 3).

Management of the Village of Butler sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Water and Sewer Superintendent. Financing of the system is provided through a sewer service charge based upon the quarterly water billings.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Butler sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $76,774, or about $36.50 per capita. Of this total, $27,605, or about $13.00 per capita, was expended for operation and maintenance, and $49,169, or about $23.50 per capita, was expended for capital improvements.

Village of Elm Grove: The existing service area of the Village of Elm Grove sanitary sewerage system is shown on Map 2. This area, which encompasses the entire village, totals about 3.3 square miles and has a resident population of about 7,000 persons. Of this total, about 1.8 square miles with a resident population of about 4,100 persons consists of the Village of Elm Grove Sanitary District No. 1. The remaining 1.5 square miles with a resident population of about 2,900 persons constitutes the Village of Elm Grove Sanitary District No. 2. The entire village is served by a separate sanitary sewer system.

The Village of Elm Grove contracts with the Milwaukee-Metropolitan Sewerage Commissions for wastewater treatment. The average daily wastewater loading on the Milwaukee-Metropolitan sewerage system from the Village of Elm Grove in 1975 was estimated at 1.10 mgd.

The location and configuration of the major trunk sewers serving the Village of Elm Grove are shown on Map 2. There are no known points of sewage flow relief in the Village of Elm Grove sewerage system.

Management of the Village of Elm Grove Sanitary District No. 1 sewerage system is under the direction of a three-member commission. Management of the Village of Elm Grove Sewerage District No. 2 sanitary sewerage system is also under the direction of a three-member commission. Day-to-day administration of both systems is provided by the Village Manager. Financing of both systems is provided through the general property tax and a sewer service charge for each connection.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for both Village of Elm Grove Sanitary Districts, including their share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $236,271, or about $33.50 per capita. Of this total, $87,585, or about $12.50 per capita, was expended for operation and maintenance, and $148,686, or about $21.00 per capita, was expended for capital improvements.

Village of Fox Point: The existing service area of the Village of Fox Point sanitary sewerage system, an area which encompasses the entire Village, is shown on Map 2. This area totals about 2.9 square miles and has a resident population of about 7,900 persons. The entire area is served by a separate sanitary sewer system.

Since the Village of Fox Point is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the village is treated in the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of Fox Point in 1975 was 1.30 mgd.

The location and configuration of the major trunk sewers, lift stations and pumping stations with related force mains, included in the Village of Fox Point sanitary sewerage system are shown on Map 2. There are 17 known points of sewage flow relief in the Village of Fox Point sanitary sewerage system, including eight crossovers, two bypasses, two relief pumping stations, and five portable pumping stations (see Map 3).

Management of the Village of Fox Point sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Manager. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Fox Point sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $241,721, or about $30.50 per capita. Of this total, $68,504, or about $8.50 per capita was expended for operation and maintenance, and $173,217 or about $22.00 per capita, was expended for capital improvements.

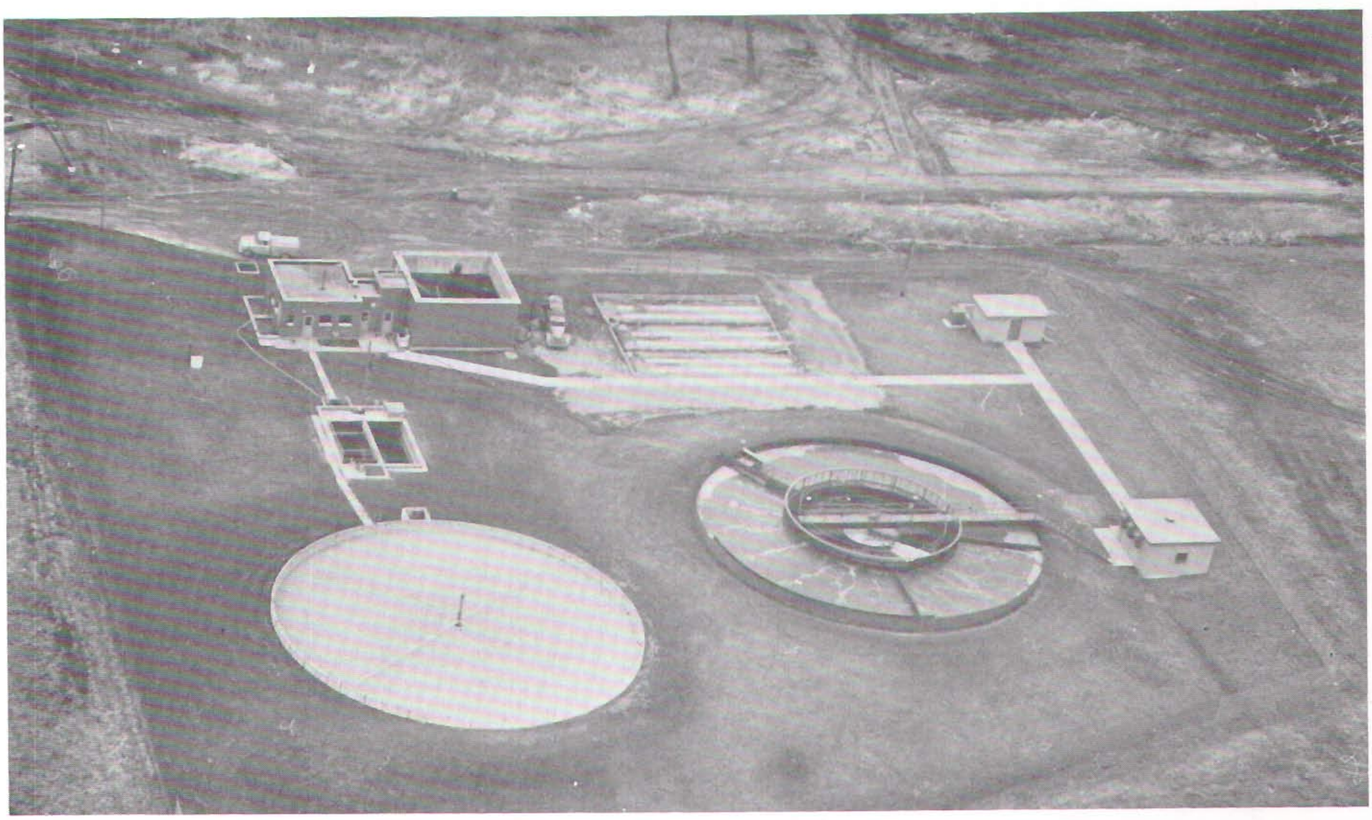
Village of Germantown: The existing service area of the Village of Germantown sanitary sewerage system is shown on Map 2. This area totals approximately 1.9 square miles and has a resident population of about 4,600 persons. The entire area is served by a separate sanitary sewer system. The location of trunk sewers and pumping and lifting stations with related force mains are found on Map 2.

Wastewater from the Village of Germantown is treated at a wastewater treatment plant located on a minor tributary of the Menomonee River, to which effluent is discharged (see Figure 10). The plant's site area of approximately five acres is currently being fully utilized. The plant site is bounded by open and unused lands on the south and agricultural lands on the north, east, and west. The plant was constructed in 1956 and modified in 1973 with the addition of phosphorus removal. The treatment plant incorporates primary and secondary treatment processes, provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filter, contact stabilization, final clarification, chemical treatment for phosphorus removal, and effluent chlorination. Sludge solids removed from the wastewater treatment systems are fed to an aerobic digestion system prior to final disposal to landfill or application on agricultural lands. The plant has an average hydraulic design capacity of 1.00 mgd, with a peak hydraulic design capacity of 3.00 mgd and an organic design capacity of 1,700 pounds of BOD_5 per day. During hydraulic loadings to the plant were reported to be 0.80 and 1.06 mgd, respectively, while the average annual and maximum monthly organic loadings were reported to be 204 and 1,146 pounds of BOD_5 per day, thus indicating that while the plant has adequate organic treatment capacity and it is operating near its hydraulic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 10 mg/l of BOD_5, 8 mg/l of suspended solids, and 2.3 mg/l of phosphorus. Maximum monthly average effluent concentrations of 14 mg/l of BOD_5, 27 mg/l of suspended solids, and 4.7 mg/l of phosphorus were reported in 1975. Data on effluent fecal coliform counts was not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.1 mg/l to 1.4 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 20 mg/l of BOD_5, 20 mg/l of suspended solids, 1 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through March 31, 1977.

Figure 10

VILLAGE OF GERMANTOWN WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

The Menomonee River watershed plan recommends that this plant be abandoned and its sewer service area connected to the Milwaukee Metropolitan sewerage system. The Village of Germantown and the Milwaukee-Metropolitan Sewerage Commissions have agreed in principle to the future connection of the Germantown sewer service area to the Milwaukee-Metropolitan sewerage system for sewage treatment purposes. At the present time, trunk sewer service from the Milwaukee-Metropolitan sewerage system to the Village of Germantown is not available. Until such time, the Village of Germantown is continuing to operate its treatment plant. When trunk sewer service becomes available from the Milwaukee-Metropolitan sewerage system, the Village intends to construct a series of force mains and pumping stations to connect the existing sewerage system to the Milwaukee-Metropolitan system. It is anticipated that this connection will serve the needs of the Village of Germantown through the plan design year 2000. Eventually, gravity trunk sewers will be extended to serve the Village of Germantown. The proposed force main sewer connection, together with the area proposed in the documented plan of the Village of Germantown for future sanitary sewer service, which area totals about 3.13 square miles, is shown on Map 2. There are no known points of sewage flow relief in the Village of Germantown sanitary sewerage system.

Management of the Village of Germantown sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Engineer. Financing of the system is provided through the general property tax and a sewer service charge based on a flat quarterly rate to residences and a volumetric rate to commercial users.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Germantown sanitary sewerage system were not available.

Village of Greendale: The existing service area of the Village of Greendale sanitary sewerage system is shown on Map 2. This area totals about 5.0 square miles and has a resident population of about 16,800 persons. The entire area is served by a separate sanitary sewer system.

Since the Village of Greendale is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the village is treated at the South Shore wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of Greendale in 1975 was 1.80 mgd.

The location and configuration of the major trunk sewers serving the Village of Greendale are shown on Map 2. There are no known points of sewage flow relief in the Village of Greendale sanitary sewerage system.

Management of the Village of Greendale sanitary sewerage system is under the direction of the Sewerage Committee of the Village Board. Day-to-day administration of the system is provided by the Village Manager. Financing of the system is provided through the general property tax and a sewer service charge equal to 48 percent of the water bill.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Greendale sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $556,617, or about $33.00 per capita. Of this total, $143,132, or about $8.50 per capita, was expended for operation and maintenance, and $413,485, or about $24.50 per capita, was expended for capital improvements.

Village of Hales Corners: The existing service area of the Village of Hales Corners sanitary sewerage system is shown on Map 2. This area totals about 3.0 square miles and has a resident population of about 8,800 persons. The entire area is served by a separate sanitary sewer system.

As discussed earlier in this chapter, all wastewater from the Village of Hales Corners is treated at a temporary facility operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of Hales Corners in 1975 was 0.90 mgd.

The location and configuration of the major trunk sewers serving the Village of Hales Corners are shown on Map 2. There are no known points of sewage flow relief in the Village of Hales Corners sanitary sewerage system.

Management of the Village of Hales Corners sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Commissioner of Public Works. Financing of the system is provided through special assessments, the general tax, and a sewer service charge of $9.00 per quarter per residence.

Total expenditures during 1975 for operation, maintenance and capital improvements, including debt retirement, for the Village of Hales Corners sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $309,485, or about $35.00 per capita. Of this total, $56,862, or about $6.50 per capita, was expended for operation and maintenance, and $252,623, or about $28.50 per capita, was expended for capital improvements.

Village of Menomonee Falls: The existing service area of the Village of Menomonee Falls sanitary sewerage system is shown on Map 2. This area totals about 6.2 square miles and has a resident population of about 20,400 persons. The entire area is served by a separate sanitary sewer system.

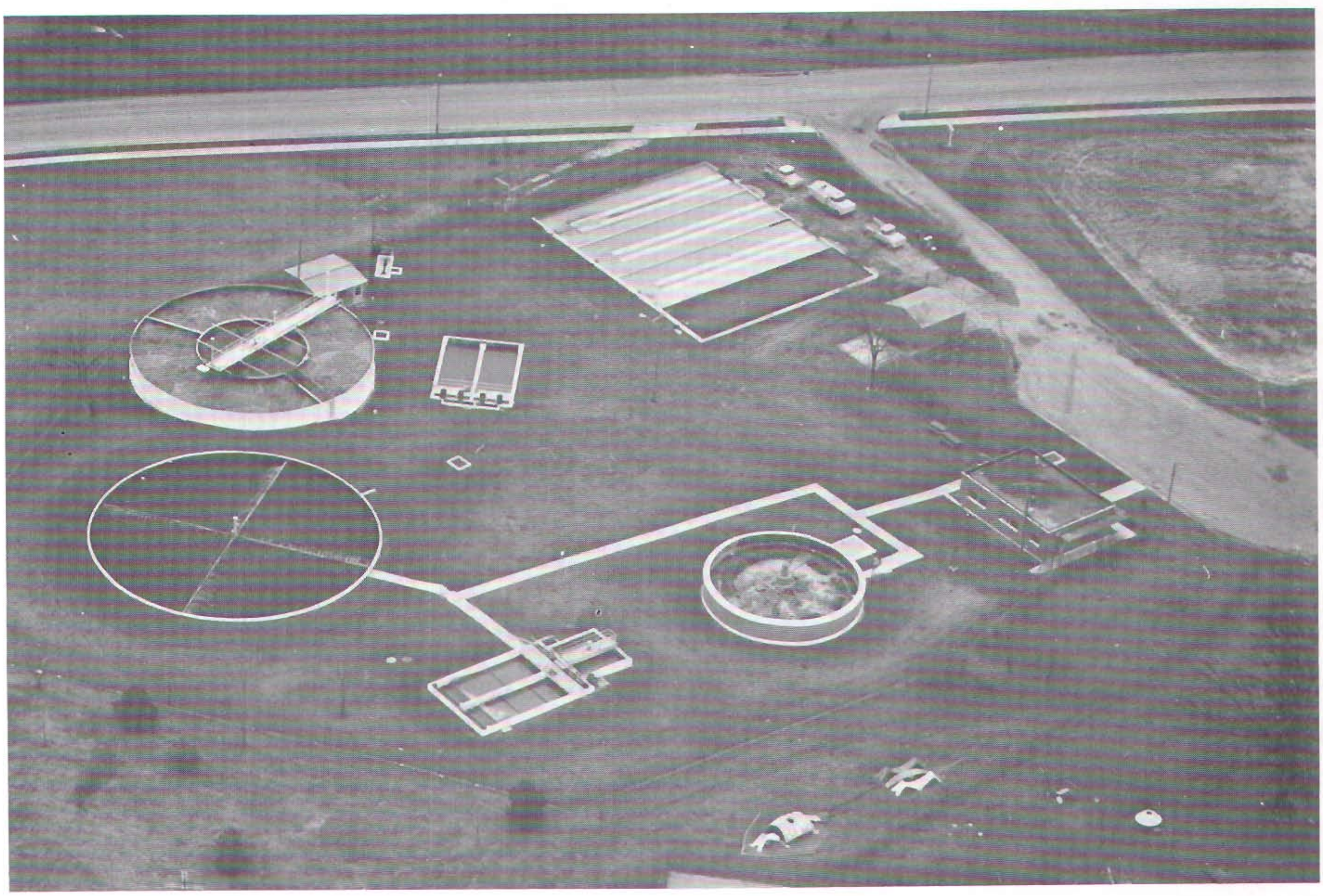
Wastewater from the Village of Menomonee Falls is currently treated at two temporary wastewater treatment facilities located on the Menomonee River, to which effluent is discharged (see Figures 11 and 12). The first plant, located near the Pilgrim Road crossing of the Menomonee River, has a site area of about four acres of which about two acres are utilized. The plant site is bounded by Village streets on the east and south and by commercial and other urban land uses on the west and north. The original plant, a trickling filter type, was constructed in 1954. In 1962 a new activated sludge plant was constructed to operate in parallel with the trickling filter plant.

The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, trickling filter, final clarification, chemical treatment for phosphorus removal, and effluent chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system and may be dried on sand beds prior to application on Village-owned land or disposal in a landfill. The plant has an average hydraulic design capacity of 1.90 mgd with a peak hydraulic design capacity of 2.50 mgd and an organic design capacity of 935 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.4 and 1.8 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 821 and 1,023 pounds of BOD_5 per day, indicating that the plant has adequate hydraulic and organic design capacity to treat the load from the existing service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 13 mg/l of BOD_5, 23 mg/l of suspended solids, and 3.8 mg/l of phosphorus. Maximum monthly average effluent concentrations of 17 mg/l of BOD_5, 33 mg/l of suspended solids, and 6.0 mg/l of phosphorus were reported in 1975. Data on effluent fecal coliform counts were not routinely reported during 1975. However, a monthly average chlorine residual which

Figure 11

VILLAGE OF MENOMONEE FALLS PILGRIM ROAD WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

varied from 0.3 mg/l to 0.7 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 40 mg/l of BOD_5, 40 mg/l of suspended solids, 5.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The second plant, located about one mile downstream from the first plant, has a site area of about 25 acres of which 14 acres are utilized. The plant site is bounded by residential land uses on three sides and a golf course on the east. The plant was constructed in 1969.

The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chemical treatment for phosphorus removal, and effluent chlorination. Sludge solids removed from the wastewater treatment systems are fed to an aerobic digestion system prior to application on Village-owned lands or disposal in a landfill. The plant has an average hydraulic design capacity of 1.00 mgd, with a peak hydraulic design capacity of 2.00 mgd and an organic design capacity of 1,700 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly average hydraulic loadings to the plant were reported to be 0.78 and 1.02 mgd respectively, while the average annual and maximum monthly average organic loadings were reported to be 637 and 1,063 pounds of BOD_5 per day, thus indicating that the plant has adequate organic treatment capacity but is operating near its hydraulic design capacity.

During 1975, treatment plant effluent was reported to contain average concentrations of 8 mg/l of BOD_5, 20 mg/l of suspended solids and 2.5 mg/l of phosphorus. Maximum monthly average effluent

Figure 12

VILLAGE OF MENOMONEE FALLS LILY ROAD WASTEWATER TREATMENT PLANT

Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

concentrations of 18 mg/l of BOD_5, 86 mg/l of suspended solids and 10.4 mg/l of phosphorus were reported in 1975. Data on effluent fecal coliform counts was not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.3 mg/l to 0.5 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977. It should be noted that the Menomonee Falls sewer system can be controlled to divide the flows between the plants.

The Menomonee River watershed plan recommends that the Menomonee Falls treatment plants be abandoned with their sewer service area connected to the Milwaukee-Metropolitan sewerage system. Both of the Village of Menomonee Falls treatment facilities are scheduled to be abandoned upon completion of a major trunk sewer by the Milwaukee-Metropolitan Sewerage Commissions to the Milwaukee-Waukesha County line at STH 45. The Village of Menomonee Falls is committed by contract to abandon its temporary sewage treatment facilities and connect to the Milwaukee-Metropolitan sewerage system as soon as the trunk sewer capacity becomes available. At the present time it is anticipated that this trunk sewer will be in place in 1979. During 1975, however, raw sewage flows averaging 0.10 mgd have been conveyed during off-peak hours through existing smaller connections from the sanitary sewerage systems of the Village of Menomonee Falls to the trunk sewer system of the Milwaukee-Metropolitan sewerage system.

All of the Village of Menomonee Falls lying east of the subcontinental divide which traverses the Southeastern Wisconsin Region lies within the contract service area of the Milwaukee-Metropolitan Sewerage Commissions. This future sewer service area approximates 12.1 square miles and is in addition to the area already served at the temporary sewage treatment facilities. Locally proposed trunk sewers to serve this area and to enable abandonment of the existing sewage treatment plants are shown on Map 2.

The location and configuration of all existing major trunk sewers and pumping stations with related force mains included in the Village of Menomonee Falls sanitary sewerage system are shown on Map 2. There are 20 known points of sewage flow relief in the Village of Menomonee Falls sanitary sewerage system, five crossovers, four relief pumping stations, and 11 portable pumping stations (see Map 3).

Management of the Village of Menomonee Falls sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Public Works Director. Financing of the system is provided through the general property tax, a special property tax levy specifically for trunk sewer construction, and a sewer service charge based upon a percent of the water bill.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Menomonee Falls sanitary sewerage system were not available.

Village of River Hills: The existing service area of the Village of River Hills sanitary sewerage system, an area which encompasses the entire Village, is shown on Map 2. This area totals about 5.3 square miles and has a resident population of about 1,500 persons. The entire area is served by a separate sanitary sewer system.

Since the Village of River Hills is a part of the Milwaukee-Metropolitan Sewerage District, sewage from the village is treated in the Jones Island sewage treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of River Hills in 1975 was 0.50 mgd.

The location and configuration of the major trunk sewers serving the Village of River Hills are shown on Map 2. There is one known point of sewage flow relief in the Village of River Hills sanitary sewerage system which is a crossover (see Map 3).

Management of the Village of River Hills sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Manager. Financing of the system is provided through the general property tax, special assessment, and sewer service charge of $5.00 per month per residential connection.

Total expenditures during 1970 for operation, maintenance, and capital improvements, including debt retirement, for the Village of River Hills sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $228,051, or about $152.00 per capita. Of this total, $29,115, or about $19.50 per capita, was expended for operation and maintenance, and $198,936, or about $132.50 per capita, was expended for capital improvements.

Village of Shorewood: The existing service area of the Village of Shorewood sanitary sewerage system is shown on Map 2. This area totals about 1.7 square miles and has a resident population of about 14,300 persons. About 0.8 square miles containing about 6,600 persons, or about 47 percent of the area served and 46 percent of the population served in the Village, are served by a separate sewer system, and about 0.9 square miles containing about 7,700 persons, or about 53 percent of the area served and about 54 percent of the population served, are served by a combined sewer system.

Since the Village of Shorewood is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the Village is treated at the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of Shorewood in 1975 was 2.10 mgd.

The location and configuration of the major trunk sewers serving the Village of Shorewood are shown on Map 2. There are eight known points of sewage flow relief in the Village of Shorewood sanitary sewerage system, all of which are crossovers (see Map 3). As noted earlier in this chapter, the intercepting sewers of the Milwaukee-Metropolitan sewerage system convey all of the dry weather wastewater flow and a portion of the wet weather wastewater flow from the combined sewer area of the Village of Shorewood to the sewage treatment plant. The remaining wet weather flow for the combined sewer area is discharged directly to the Milwaukee River.

Management of the Village of Shorewood sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Manager. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Shorewood sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated $344,923, or about $24.00 per capita. Of this total, $122,742, or about $8.50 per capita, was expended for operation and maintenance, and $222,181, or about $15.50 per capita, was expended for capital improvements.

Village of Thiensville: The existing service area of the Village of Thiensville sanitary sewerage system, an area which encompasses nearly the entire Village, is shown on Map 2. This area totals about 1.2 square miles and has a resident population of about 4,200 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Thiensville is treated in a wastewater treatment plant located at the northwesterly Village limits on Pigeon Creek, a tributary of the Milwaukee River, into which effluent is discharged (see Figure 13). The plant has a site area of about three acres of which one acre is currently utilized leaving two acres for future use. The plant was initially constructed in 1951 and was extensively modified in 1963.

The treatment plant incorporates primary and secondary treatment processes, provides advanced waste treatment for phosphorus removal, and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and effluent chlorination. Sludge solids removed from the wastewater treatment systems are fed to an aerobic and anaerobic digestion system then to drying beds prior to final disposal on agricultural lands. The plant has an average hydraulic design capacity of 0.24 mgd, with a peak hydraulic design capacity of 0.36 mgd. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.57 and 1.02 mgd respectively, thus indicating that the plant is operating well above the average hydraulic design capacity.

During 1975, treatment plant effluent was reported to contain average concentrations of 20 mg/l of BOD_5, 15 mg/l of suspended solids, and 0.5 mg/l of phosphorus. Maximum monthly average effluent concentrations of 28 mg/l of BOD_5, 27 mg/l of suspended solids, and 0.8 mg/l of phosphorus were reported during 1975. Data on effluent fecal coliform counts were not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.3 mg/l to 0.5 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

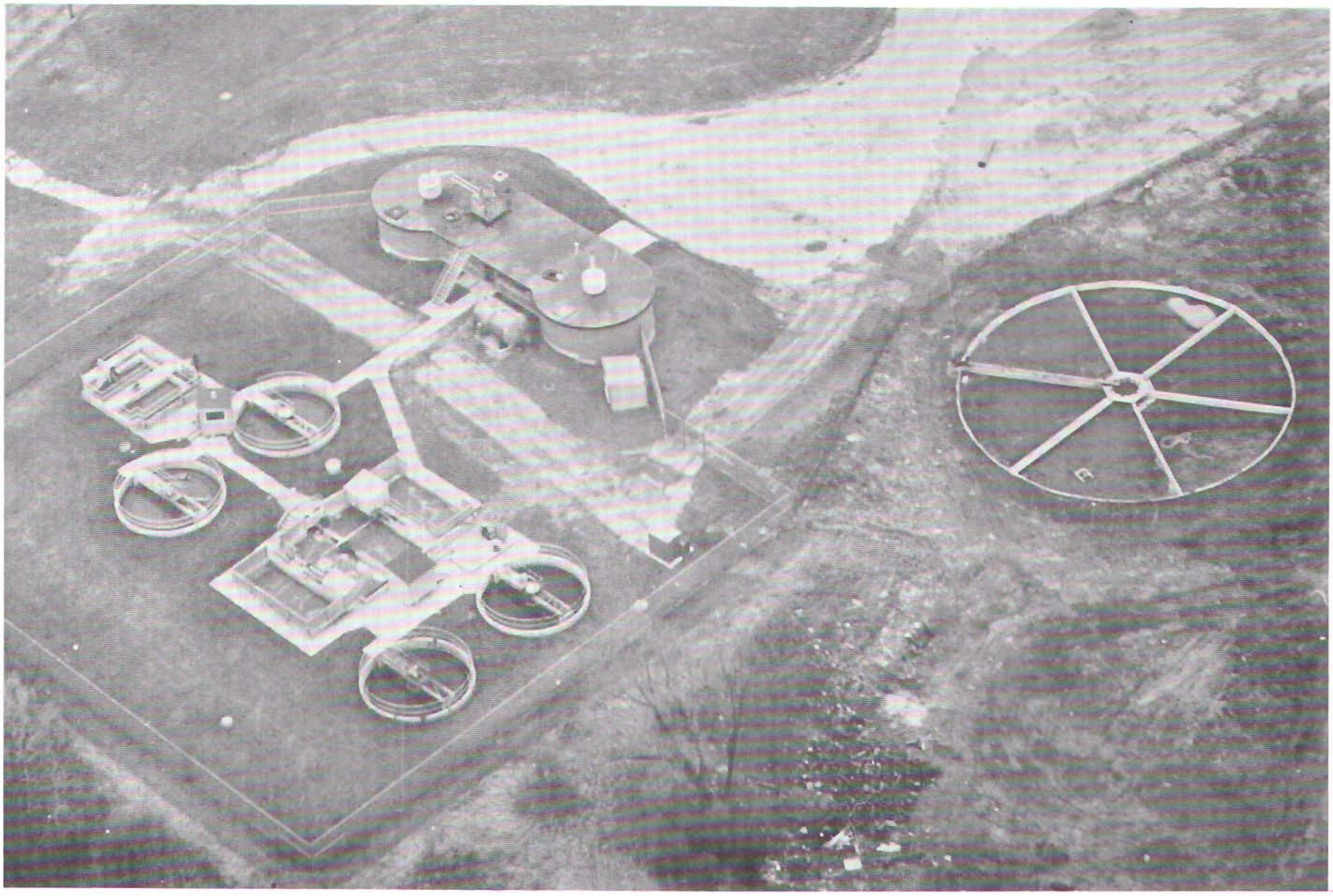
The Milwaukee River watershed plan recommends that this treatment plant be abandoned and its service area connected to the Milwaukee-Metropolitan sewerage system. Major trunk sewer construction to accomplish this has been initiated in the development of plans for a trunk sewer on the northeast side of the City of Milwaukee. The Village, in conjunction with the City of Mequon, has initiated a facilities planning project to evaluate wastewater treatment and conveyance needs.

The location and configuration of all major trunk sewers comprising the Village of Thiensville sanitary sewerage system are shown on Map 2. There are two known points of sewage flow relief in the Village of Thiensville sanitary sewerage system; including one bypass and one relief pumping station which permit bypassing of the sewage treatment plant (see Map 3).

Management of the Village of Thiensville sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Administrator. Financing of the system is provided through the general property tax, and a sewer service charge of $4.50 per month per connection.

Figure 13

VILLAGE OF THIENSVILLE WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Thiensville sanitary sewerage system approximated $79,805, or about $19.00 per capita. Of this total, $68,855, or about $16.00 per capita, was expended for operation and maintenance, and $10,950, or about $3.00 per capita, was expended for capital improvements.

Village of West Milwaukee: The existing service area of the Village of West Milwaukee sanitary sewerage system, an area which encompasses the entire Village, is shown on Map 2. This area totals about 1.1 square miles and has a resident population of about 3,800 persons. The entire area is served by a separate sanitary sewer system.

Since the Village of West Milwaukee is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the village is treated in the Jones Island and South Shore wastewater treatment plants operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of West Milwaukee in 1975 was 5.00 mgd.

The location and configuration of the trunk sewers serving the Village of West Milwaukee are shown on Map 2. There are no known points of sewage flow relief in the Village of West Milwaukee sanitary sewerage system.

Management of the Village of West Milwaukee sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Superintendent of Public Works. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of West Milwaukee sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated \$591,700, or about \$156.00 per capita. Of this total, \$264,689, or about \$70.00 per capita, was expended for operation and maintenance, and \$327,011, or about \$86.00 per capita, was expended for capital improvements.

Village of Whitefish Bay: The existing service area of the Village of Whitefish Bay sanitary sewerage system, an area which encompasses the entire Village, is shown on Map 2. This area totals about 2.1 square miles and has a resident population of about 16,200 persons. The entire area is served by a separate sanitary sewer system.

Since the Village of Whitefish Bay is part of the Milwaukee-Metropolitan Sewerage District, wastewater from the Village is treated in the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. The average daily flow from the Village of Whitefish Bay in 1975 was 2.00 mgd.

The location and configuration of the major trunk sewers and one lift station serving the Village of Whitefish Bay are shown on Map 2. There are 24 known points of sewage flow relief in the Village of Whitefish Bay sanitary sewerage system, all of which are crossovers (see Map 3).

Management of the Village of Whitefish Bay sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Manager. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Whitefish Bay sanitary sewerage system, including its share of the costs of constructing, operating, and maintaining the metropolitan sewerage systems, approximated \$382,871, or about \$24.00 per capita. Of this total, \$99,177, or about \$6.00 per capita, was expended for operation and maintenance, and \$283,694, or \$18.00 per capita, was expended for capital improvements.

Caddy Vista Sanitary District: The existing sewer service area of the Caddy Vista Sanitary District in the Town of Caledonia is shown on Map 2. This area, which consists of the Caddy Vista Subdivision, totals about 0.3 square miles and has a resident population of about 1,000 persons. The entire area is served by a separate sanitary sewerage system. It should be noted that the Caddy Vista Sanitary District extends into the City of Oak Creek in Milwaukee County. No development, however, has taken place in this area.

Wastewater from the Caddy Vista Sanitary District is treated at a wastewater treatment plant located on the Root River, to which effluent is discharged (see Figure 14). The plant has a site area of about six acres. The site is bounded by the Root River on the north, and by agricultural, open and unused lands on the south, east, and west. The plant was constructed in 1956 and modified in 1965. The treatment plant incorporates primary and secondary treatment processes. Wastewater treatment unit processes incorporated into the plant include primary clarification trickling filter, and final clarification. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system then to drying beds where they are available for citizen use as fertilizer. The plant has an average hydraulic design capacity of 0.25 mgd with a peak hydraulic design capacity of 0.40 mgd.

During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.09 and 0.12 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 142 and 199 pounds of BOD_5 per day, thus indicating that the plant has adequate average hydraulic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 62 mg/l of BOD_5 and 19 mg/l of suspended solids. Maximum monthly average effluent concentrations of 83 mg/l of BOD_5 and 26 mg/l of suspended solids were reported in 1975, while data on effluent phosphorus concentration, fecal coliform counts, and chlorine residual were not routinely reported during 1975. The wastewater treatment plant WPDES permit has

Figure 14

CADDY VISTA SANITARY DISTRICT
WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

established maximum monthly average effluent limits of 70 mg/l of BOD_5, 70 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977. The adopted Root River watershed plan recommends abandonment of the Caddy Vista Plant and connection of its service area to the Milwaukee-Metropolitan sewerage system.

The location and configuration of the trunk sewers serving the Caddy Vista Sanitary District are shown on Map 2. The only known point of sewage flow relief in the Caddy Vista Sanitary District sanitary sewerage system is a bypass located at the treatment plant. The inventory revealed that the sanitary district had no documented plan for extension of the sewers into the undeveloped portion of the district located in the City of Oak Creek.

Management of the Caddy Vista Sanitary District sanitary sewerage system is under the direction of a three-member commission. Day-to-day administration of the system is provided by the treatment plant superintendent. Financing of the system is provided both through a sewer service charge of $6.00 per quarter per sewer connection and through a general property tax levy.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Caddy Vista Sanitary District sanitary sewerage system approximated $21,062, or about $21.00 per capita. Of this total, $14,862, or about $15.00 per capita, was expended for operation and maintenance and $6,200, or about $6.00 per capita, was expended for capital improvements.

Rawson Homes Sewer and Water Trust: The existing sewer service area of the Rawson Homes Sewer and Water Trust sanitary sewerage system in the City of Franklin is shown on Map 2. This area totals about 0.2 square mile and has a resident population of about 600 persons. The system serves the Rawson Homes Subdivision located in the northeasterly portion of the City of Franklin.

Wastewater from the Rawson Homes Sewer and Water Trust service area is treated in an activated sludge type sewage treatment plant discharging its effluent to a tributary of the Root River (see Figure 15). The plant was constructed in 1954 and has an average hydraulic design capacity of 0.04 mgd. The average hydraulic loading on the plant in 1975 was not available. The treatment processes provided at the plant are classified as secondary level. The plant was constructed as a temporary wastewater treatment facility and is scheduled to be abandoned as soon as local trunk sewer service from the City of Franklin is made available.

Management of the Rawson Homes Sewer and Water Trust is under the direction of a 10-member Board of Trustees. Day-to-day administration of the system is provided by the President of the Board. Financing of the system is provided through a sewer service charge of $8.00 per month per residential connection. Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Rawson Homes Sewer and Water Trust sanitary sewerage system were not available. The treatment facility serving this service area was abandoned in 1977 and the sewer system connected to the City of Franklin system which is part of the Milwaukee Metropolitan Sewerage District.

Proposed Public Sanitary Sewerage Systems

The inventory revealed that as of 1975 there were no new proposed public sanitary sewerage systems for Milwaukee-Metropolitan subregional area. All areas not now provided with public sanitary sewer service are scheduled to be provided with such service through the orderly extension of the trunk sewer systems of both the local communities and the Milwaukee-Metropolitan Sewerage Commissions. However, the provision of public sanitary sewers to portions of the subregional area is not expected to take place until after the year 2000.

Flow Relief Devices

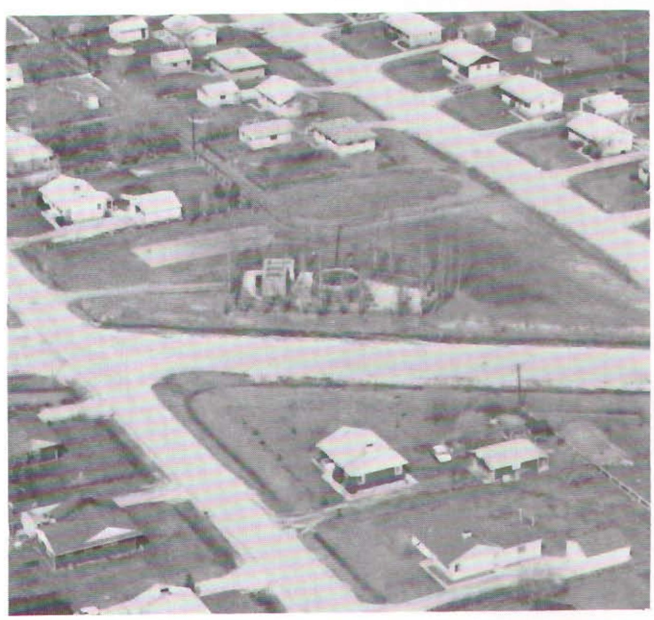
As noted above on an individual community basis, there are 491 sewage flow relief devices in the sanitary sewerage systems located in the Milwaukee-Metropolitan subregional area. Table 6 indicates the number and type of flow relief devices as well as an estimate of the total average annual discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 3.

Other Wastewater Treatment Facilities

In addition to the 31 publicly-owned sanitary sewerage systems discussed above, there are a total of 11 privately-owned or semi-privately-owned wastewater

Figure 15

RAWSON HOMES SEWER AND WATER TRUST
WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

Table 6

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in the Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices Million Gallons (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
FOX RIVER WATERSHED								
City of Muskego	Yes, Bypass	--	--	--	--	--	--	-[b]
Village of Menomonee Falls	No plant	--	--	--	2	--	2	-[b]
Watershed Subtotal	1-Bypass	--	--	--	2	--	2	-[b]
KINNICKINNIC RIVER WATERSHED								
Milwaukee-Metropolitan Sewerage Commissions	No plant	--	4	2	--	--	6	6.0
City of Milwaukee	No plant	17	--	--	--	23	40	531.0[c]
City of West Allis	No plant	2	--	--	4	--	6	2.0
Watershed Subtotal	None	19	4	2	4	23	52	539.0
LAKE MICHIGAN WATERSHED								
Milwaukee-Metropolitan Sewerage Commissions	No	2	1	--	--	--	3	6.0
City of Cudahy	No plant	22	--	--	--	--	22	44.0
City of Milwaukee	No plant	1	--	--	--	2	3	202.0[d]
City of South Milwaukee	Yes-Bypass	--	1	--	--	--	1	4.0
Village of Bayside	No plant	2	2	1	2	--	7	9.0
Village of Fox Point	No plant	7	--	--	--	--	7	17.0
Village of Whitefish Bay	No plant	21	--	--	--	--	21	42.0
Watershed Subtotal	1-Bypass	55	4	1	2	2	64	324.0[e]
MENOMONEE RIVER WATERSHED								
Milwaukee-Metropolitan Sewerage Commissions	No plant	4	5	5	--	--	14	16.0
City of Brookfield	No plant	--	--	--	3	--	3	8.0
Milwaukee	No plant	30	--	--	--	26	56	1,357.0[f]
Wauwatosa	No plant	31	--	19	--	--	50	42.0
West Allis	No plant	3	--	--	20	--	23	20.0
Village of Butler	No plant	--	2	--	--	--	2	116.0
Menomonee Falls	None	5	--	4	9	--	18	35.0
Watershed Subtotal	None	73	7	28	32	26	166	1,594.0
MILWAUKEE RIVER WATERSHED								
Milwaukee-Metropolitan Sewerage Commissions	No plant	8	13	3	--	2	26	115.0[g]
City of Glendale	No plant	1	--	--	1	--	2	4.0
City of Mequon	No plant	--	2	--	5	--	7	12.0
City of Milwaukee	No plant	55	--	--	--	59	114	1,382.0[h]
Village of Brown Deer	No plant	--	2	--	5	--	7	37.0
Village of Fox Point	No plant	1	2	2	5	--	10	19.0
Village of River Hills	No plant	1	--	--	--	--	1	5.0
Village of Shorewood	No plant	8	--	--	--	--	8	16.0
Village of Thiensville	None	--	1	1	--	--	2	4.0
Village of Whitefish Bay	No plant	3	--	--	--	--	3	6.0
Watershed Subtotal	None	77	20	6	16	61	180	1,600.0
OAK CREEK WATERSHED								
City of South Milwaukee	No plant	--	2	--	--	--	2	--[b]
Watershed Subtotal	None	--	2	--	--	--	2	--
ROOT RIVER WATERSHED								
City of Milwaukee	No plant	4	--	--	--	--	4	4.0
City of West Allis	No plant	7	--	--	11	--	18	18.0
Caddy Vista Sanitary District	Yes-Bypass	--	--	--	--	--	--	2.0
Watershed Subtotal	1-Bypass	11	--	--	11	--	22	24.0
SUBREGIONAL AREA TOTAL	3-Bypasses	235	37	37	67	112	488	4,081.0

[a] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.*

[b] *The annual contribution from flow relief devices is less than 1.0 mg.*

[c] *Includes an annual estimated contribution of 516 mg from combined sewer overflows and 15 mg from other flow relief devices.*

[d] *Includes an annual estimated contribution of 200 mg from combined sewer overflows and 2 mg from the other flow relief devices.*

[e] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.*

[f] *Includes an annual estimated contribution of 1,316 mg from combined sewer overflows and 41 mg from other flow relief devices.*

[g] *Includes an annual estimated contribution of 71 mg from combined sewer overflows and 44 mg from other flow relief devices.*

[h] *Includes an annual estimated contribution of 1,240 mg from combined sewer overflows and 142 mg from other flow relief devices.*

Source: SEWRPC.

treatment facilities in the Milwaukee-Metropolitan subregional area which, in general, serve single, isolated enclaves of residential land and treat wastes which can be considered for inclusion in areawide wastewater treatment systems utilizing domestic wastewater treatment processes. Of these 11 privately-owned wastewater treatment facilities, four serve commercial facilities. These plants provide sanitary wastewater treatment for Chalet on the Lake Restaurant in the City of Mequon, the Highway 100 Drive-In Theater in the City of Franklin, the Highway 24 Drive-In Theatre in the City of New Berlin, and Union Oil Highway 100 Milwaukee Beltline Truck Stop in the City of Franklin. Four of the facilities serve institutions including Brookfield Central High School in the City of Brookfield, Cleveland Heights Grade School in the City of New Berlin, New Berlin Memorial Hospital in the City of New Berlin, and the Sisters of Notre Dame Academy in the City of Mequon. Two of the facilities serve industries including Federal Foods Company in the City of Mequon, a food processor, and Muskego Rendering Company which processes animal carcasses and wastes, in the City of Muskego. The final wastewater treatment facility serves a utility, the Wisconsin Electric Power Company in the City of Oak Creek, with normal sanitary wastewater treatment. The facilities serving the Highway 24 Drive In and Federal Foods Company are reported to be abandoned with portions of each facility serving only as a holding tank for storage of wastewater prior to collection by a private waste hauler. Pertinent characteristics of these facilities are presented in Table 7 and their location is shown on Map 2.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage overflow points on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, process, rinse, and wash waters, which are discharged without treatment or following treatment directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued and reports filed under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of 163 such known point sources of industrial wastewater were identified in the Milwaukee-Metropolitan subregional area. The characteristics of these 163 waste sources are identified in Table 8 and their location is shown on Map 4.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Milwaukee-Metropolitan subregional area serve a total area of about 230.8 square miles, or 54 percent of the total area of the subregional area, and a total population of about 1,093,200, or nearly 96 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban, while quarter sections with between 6 and 31 housing units or one housing unit for every 5 to 27 gross acres, was classified as rural-urban. Quarter sections with 5 or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas to remain unsewered as they relate to treatment facility requirements for septage and holding tank disposal, and as they represent a potential diffuse source of water pollution.

Together these unsewered areas total about 194.4 square miles, or 46 percent of the total area of the subregional area, and contain a total population of about 46,600, or 4 percent of the total population of the subregional area. Of that total, about 22.1 square miles, or 5 percent of the total area of the subregional area containing a total population of 30,000 or 3 percent of the total population of the subregional area are classified as urban nonsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into 27 named major urban concentrations which are shown on Map 4. The estimated population and urban development areas of each of these major concentrations are shown in Table 9.

The most common method of providing for wastewater disposal for those approximately 46,600 people not served by public sanitary sewers within the Milwaukee-Metropolitan subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of sewage disposal utilized in the area consists of sewage holding tanks which are emptied

Table 7

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (Gallons/Day)	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)
FOX RIVER WATERSHED													
Waukesha County													
Brookfield Central High School	City of Brookfield	Institutional	Sanitary	Septic Tank, Sand Filter and Lagoon	Soil Absorption		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cleveland Heights Elementary Schools	City of New Berlin	Institutional	Sanitary	Septic Tank, Sand Filter and Lagoon	Tributary of Poplar Creek	N/A	5,000	7,000	N/A	N/A	N/A	N/A	N/A
Muskego Rendering Company, Inc.	City of Muskego	Industrial	Process	Trap Skimmer, Aeration and Lagoon	Soil Absorption	N/A	N/A	10,000	N/A	N/A	N/A	N/A	N/A
LAKE MICHIGAN WATERSHED													
Milwaukee County													
Wisconsin Electric Power Company-Oak Creek Plant	City of Oak Creek	Utility	Sanitary	Activated Sludge	Lake Michigan	40,000	30,000	40,000	N/A	N/A	N/A	N/A	400
Ozaukee County													
Chalet on the Lake Restaurant	City of Mequon	Commercial	Sanitary	Sedimentation	Lake Michigan	50,000	N/A	N/A	130	130	N/A	N/A	200
Sisters of Notre Dame Academy	City of Mequon	Institutional	Sanitary	Activated Sludge	Lake Michigan	40,000	20,000	20,000	2.0	2.0	N/A	N/A	N/A
MILWAUKEE RIVER WATERSHED													
Ozaukee County													
Federal Foods Company[b]	City of Mequon	Industrial	Process	Septic Tank, Lagoon	Soil Absorption		N/A	N/A	N/A	N/A	N/A	N/A	N/A
ROOT RIVER WATERSHED													
Milwaukee County													
Highway 100 Drive-In Theater	City of Franklin	Commercial	Sanitary	Sand Filter, Septic Tank and Lagoon	Soil Absorption	6,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Union Oil Truck Stop	City of Franklin	Commercial	Sanitary	Extended Aeration	Root River	10,000	N/A	N/A	23[c]	30[c]	7.0[c]	10.4[c]	3,300
Waukesha County													
Highway 24 Outdoor Theater[b]	City of New Berlin	Commercial	Sanitary	Septic Tank and Lagoon	Soil Absorption	intermittent	N/A	intermittent	N/A	N/A	N/A	N/A	N/A
New Berlin Memorial Hospital	City of New Berlin	Institutional	Sanitary	Activated Sludge and Lagoon	Root River via Drainage Ditch	19,000	26,000	37,000	21[c]	32[c]	7.2[c]	26.5[c]	2,500

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System, questionnaire data obtained by SEWRPC, reports filed under Section NR 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the data as reported in or requirements of the permit itself.*

[b] *The facilities operated by Federal Foods Company and The Highway 24 Outdoor Theater have been abandoned with only portions of the units being used as holding tanks.*

[c] *Data obtained from 1973 samples reported in the Wisconsin Department of Natural Resources report, Southeastern Wisconsin River Basins, A Drainage Basin Report, dated November 1976.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 8

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	FOX RIVER WATERSHED Waukesha County																
1	General Electric Company-Medical System Division	--	City of New Berlin	Cooling	None	1	Deer Creek via storm sewer	2,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
2	Huber Supreme Metal Treating Co.	--	City of New Berlin	Cooling	None	1	Deer Creek	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
3	State Sand & Gravel	--	City of Muskego	Process	Seepage Lagoon	1	Muskego Lake	N/A	N/A	20.0	N/A	N/A	N/A	N/A	N/A	No	--
	KINNICKINNIC RIVER WATERSHED Milwaukee County																
4	Allied Smelting Corporation	3341	City of West Allis	Process and Cooling	None	1	Kinnickinnic River via storm sewer	121,000	144,000	1.0	N/A	N/A	N/A	N/A	8.9	Yes	Oils, Fats & Grease
5	Badger Die Casting Corp.	3369	City of Milwaukee	Cooling	None	--	Kinnickinnic River via storm sewer	43,500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
6	Briggs and Stratton Corporation	3714	City of West Allis	Cooling	None	1	Kinnickinnic River via storm sewer	1,026,00	1,026,000	158.4	332.7	0.024	1.629	N/A	30.2	Yes	Oils, Fats, & Grease
				Cooling	None	3	Kinnickinnic River storm sewer	308,000	308,000	158.4	332.7	0.024	1.629	N/A	N/A	Yes	Oils, Fats & Grease
				Cooling	None	4	Kinnickinnic River via storm sewer	20,000	108,000	158.4	17.7	0.024	1.629	N/A	N/A	Yes	Oils, Fats & Grease
				Cooling	None	5	Kinnickinnic River via storm sewer	25,000	25,000	158.4	322.7	0.024	1.629	N/A	N/A	Yes	Oils, Fats & Grease
				Cooling	None	6	Kinnickinnic River via storm sewer	99,000	99,000	158.4	322.7	0.024	1.629	N/A	N/A	Yes	Oils, Fats & Grease
7	Caterpillar Tractor Company	3531	City of Milwaukee	Cooling	None	5	Kinnickinnic River via storm sewer	1,000	2,400	2.6	8.5	1.12	3.272	N/A	27.2	Yes	--
				Process	None	6	Kinnickinnic River via storm sewer	1,900	4,800	2.6 2.6	8.5 8.5	1.12	3.272	N/A	N/A	Yes	--
				Cooling	None	13	Kinnickinnic River via storm sewer	4,300	5,300	2.6	8.5	1.12	3.272	N/A	N/A	Yes	--
				Process	None	16	Kinnickinnic River via storm sewer	600	1,200	2.6	8.5	1.12	3.272	N/A	N/A	Yes	--
8	Eaton Corporation	3462	City of West Allis	Process, Cooling, and Boiler Blowdown	Oil Separator	1	Kinnickinnic River via storm sewer and drainage ditch	128,800	233,500	16.5	12.2	2.33	0.0	N/A	25.8	Yes	--
				Process, Cooling and Boiler Blowdown	None	2	Kinnickinnic River via storm sewer and drainage ditch	2,800	3,200	N/A	N/A	N/A	N/A	N/A	N/A	No	--
9	Froedtert Malt Corporation	2083	Village of West Milwaukee	Cooling	None	1	Kinnickinnic River via storm sewer	19,900	36,200	N/A	N/A	N/A	N/A	N/A	13.7	No	--
10	General Electric Company — Dishwasher and Disposal Products Department	3639	Village of West Milwaukee	Cooling	None	1	Kinnickinnic River via storm sewer and drainage ditch	72,000	N/A	1.2	6.7	N/A	N/A	N/A	17.1	Yes	--
				Cooling	None	2	Kinnickinnic River via storm sewer and drainage ditch	34,000	N/A	1.2	6.7	N/A	N/A	N/A	14.7	Yes	--
				Cooling	None	3	Kinnickinnic River via storm sewer and drainage ditch	2,000	N/A	1.2	6.7	N/A	N/A	N/A	25.4	Yes	--
				Cooling	None	4	Kinnickinnic River via storm sewer and drainage ditch	1,000	N/A	1.2	6.7	N/A	N/A	N/A	15.8	Yes	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
11	General Electric Company – Medical Systems Division	3829	City of Milwaukee	Cooling and Cooling Tower Blowdown	None	1	43 Street ditch	475,700	967,600	N/A	N/A	N/A	N/A	N/A	13.2	Yes	--
12	General Electric Company – West Edgerton		City of Milwaukee	Cooling	None	1	Holmes Ave Creek	300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
13	Heil company Bulk Trailer Division	3713	City of Milwaukee	Test and Cooling	None	1	Kinnickinnic River via storm sewer	10,800	20,400	163	25.5	88.5	1.14	N/A	16.8	Yes	--
				Test and Cooling	None	2	Kinnickinnic River via storm sewer	300	300	163	167	27.2	1.14	N/A	10.5	Yes	--
14	Heil Company – Solid Waste System and Truck Equipment Division	3713	City of Milwaukee	Cooling	None	1	Kinnickinnic River	82,400	120,500	0.0	3.0	0.0	0.14	N/A	14.9	Yes	--
				Cooling	None	14	Kinnickinnic River	1,000	5,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
15	Howmet Turbine Components Corporation	3324	City of Milwaukee	Cooling	None	1	Kinnickinnic River	323,900	481,000	2.0	23.0	0.0	0.1	N/A	26.6	Yes	--
				Cooling and Process	None	2	Kinnickinnic River	201,400	258,400	2.0	4.5	0.0	0.1	N/A	28.1	Yes	--
				Process	Settling Pond	3	Kinnickinnic River	111,500	176,000	2.0	12.9	0.0	0.1	N/A	12.8	Yes	--
16	Kurth Malting Corporation – Plant No. 1	2083	Village of West Milwaukee	Cooling	None	3	43 Street ditch	20,000	30,000	N/A	N/A	N/A	N/A	N/A	14.8	No	--
				Cooling	None	4	43 Street ditch	130,000	450,000	N/A	N/A	N/A	N/A	N/A	10.7	No	--
17	Ladish Company	3462	City of Cudahy	Cooling	N/A	2	Wilson Park Creek via drainage ditch	176,600	246,200	0.85	6.94	0.13	0.44	N/A	13.4	Yes	--
				Cooling	N/A	3		288,900	465,000	0.85	6.94	0.13	0.44	N/A	13.3	Yes	--
18	Maynard Steel Casting Company	3325	City of Milwaukee	Process and Cooling	Settling Basin, Lagoon and Chemical Precipitation	1	Kinnickinnic River	110,400	123,400	6.0	24.8	0.1	0.51	N/A	15.6	No	--
19	Milwaukee County Park Commission – Holler Park	7999	City of Milwaukee	Swimming Pool Over Flow and Drainage	None		Holmes Ave Creek via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
20	Milwaukee County Park Commission – Jackson Park	7999	City of Milwaukee	Swimming Pool Over Flow and Drainage	None		Kinnickinnic River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
21	Milwaukee County Park Commission – Kosciusko Park	7999	City of Milwaukee	Swimming Pool Over Flow and Drainage	None		Kinnickinnic River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
22	Milwaukee County Park Commission – Wilson Park	7999	City of Milwaukee	Swimming Pool Over Flow and Drainage	None		Wilson Park Creek via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
23	Milwaukee Solvay Coke Company	3312	City of Milwaukee	Cooling, Process and Boiler Blowdown	None	1	Kinnickinnic River	2,120,800	3,158,100	2.7	64	0.3	0.5	N/A	26.9	Yes	--
				Cooling, Process and Boiler Blowdown	None	2	Kinnickinnic River	2,700,00	2,700,000	N/A	64	0.3	0.5	N/A	19.8	Yes	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a] BOD5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
24	Milwaukee Spring Company		City of Milwaukee	Cooling	N/A		Kinnickinnic River via storm sewer	78,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NO	--
25	Milwaukee Waterworks Howard Ave. Plant	4941	City of Milwaukee	Filter Backwash	None	1	Kinnickinnic River	415,800	430,000	N/A	4352.0	N/A	N/A	N/A	N/A	No	--
26	Murphy Diesel Company	3519	City of West Allis	Cooling	None	1	43rd Street Ditch via Storm sewer	5,500	5,800	N/A	N/A	N/A	N/A	N/A	28.4	No	--
				Cooling	None	2	43rd Street Ditch via Storm sewer	8,900	15,100	N/A	N/A	N/A	N/A	N/A	19.2	No	--
				Cooling	None	3	43rd Street Ditch via Storm sewer	6,200	12,400	N/A	N/A	N/A	N/A	N/A	20.8	No	--
				Cooling	None	4	43rd Street Ditch via Storm sewer	19,600	30,300	N/A	N/A	N/A	N/A	N/A	36.6	No	--
27	Oil Gear Company	3661	City of West Allis	Cooling	None	1	Kinnickinnic River via storm sewer	1,000	2,000	N/A	N/A	N/A	N/A	N/A	13.9	Yes	--
28	Pelton Casteel, Inc.	3325	City of Milwaukee	Process and Cooling	Settling Basin, Oil Separator and pH Adjustment	1	Kinnickinnic River via drainage ditch	79,800	92,600	22.9	10.9	0.38	3.9	N/A	19.6	Yes	--
29	Perfex, Inc.	3433	City of Milwaukee	Cooling, and Test	None	1	Kinnickinnic River via storm sewer	130,000	140,000	3.3	7.2	0.38	1.103	N/A	5.5	Yes	--
30	Rexnord, Inc. – Nordberg Machinery Group	3532	City of Milwaukee	Cooling, Process and Boiler Blowdown	None	1	Kinnickinnic River via storm sewer	145,500	220,000	4.0	160.9	5.4	1.37	N/A	13.4	Yes	--
				Cooling and Process	None	2	Kinnickinnic River via storm sewer	246,600	300,000	4.0	75.0	5.4	1.37	N/A	16.6	Yes	--
				Process	None	3	Kinnickinnic River via storm sewer	4,000	10,000	4.0	20.0	5.4	1.37	N/A	12.0	Yes	--
				Cooling and Process	None	4	Kinnickinnic River via storm sewer	52,700	77,500	4.0	643.0	5.4	1.37	N/A	11.1	Yes	--
31	Teledyne Wisconsin Motor	3519	City of West Allis	Cooling and Process	None	1	43rd Street Ditch via Storm sewer	3,800	5,500	11.7	13.5	0.01	1.86	N/A	15.6	Yes	--
				Process and Cooling	None	2	43rd Street Ditch via Storm sewer	22,500	30,000	11.7	10.25	0.1	1.86	N/A	N/A	Yes	--
				Process and Cooling	None	4	43rd Street Ditch via Storm sewer	1,200	1,500	11.7	8.5	0.025	1.86	N/A	N/A	Yes	--
				Process and Cooling	None	5	43rd Street Ditch via Storm sewer	8,500	14,000	11.7	37.25	0.0425	1.86	N/A	N/A	Yes	--
32	Union Oil of California – Mitchell Field	5170	City of Milwaukee	Oil Contaminated Stormwater	Oil-Water Separator	1	Wilson Park Creek via storm sewer	Intermittent	Intermittent	N/A	30.0	N/A	N/A	N/A	N/A	No	--
33	Wehr Steel Company	3325	City of West Allis	Cooling	N/A	2	43rd Street Ditch via Storm sewer	182,000	239,000	0.0	0.0	0.011	0.0	N/A	26.6	No	--
				Cooling	N/A	3	43rd Street Ditch via Storm sewer	23,000	20,000	0.0	0.0	0.011	0.0	N/A	N/A	No	--
				Process	N/A	6	43rd Street Ditch via Storm sewer	31,000	50,000	0.0	0.0	0.011	0.0	N/A	N/A	No	--
				Cooling	N/A	7	43rd Street Ditch via Storm sewer	17,000	49,000	0.0	0.0	0.011	0.0	N/A	N/A	No	--
	LAKE MICHIGAN WATERSHED Milwaukee County																
34	Advance Boiler and Tank Company	3324	City of Milwaukee	Hydrostatic Test Water	None		Lake Michigan	40	40	N/A	N/A	N/A	N/A	N/A	N/A	No	--
35	Allis-Chalmers Corporation	3523	City of Oak Creek	Process and Cooling	Oil Separator	1	Lake Michigan via storm sewer	4,900	12,500	5.7	8.3	0.23	1.851	N/A	26.4	Yes	--
				Process and Cooling	None	2	Lake Michigan via storm sewer	4,800	5,000	5.7	8.3	0.23	1.851	N/A	N/A	Yes	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
36	American Motors Corporation – Services & Distribution Division	3711	City of Milwaukee	Cooling	None	1	Lake Michigan via storm sewers	75,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	
37	Bucyrus Erie Company	3532	City of South Milwaukee	Cooling	None	6	Tributary of Lake Michigan via drainage ditch and storm sewer	17,300	27,500	10	77.4	0.27	1.5	N/A	N/A	Yes	oils, fats, & grease
38	EZ Paintr Corporation	3991	City of St. Francis	Cooling	None	1	Lake Michigan via drainage ditch and storm sewer	16,000	75,000	N/A	N/A	N/A	N/A	N/A	13.9	No	--
				Cooling	None	2	Lake Michigan via drainage ditch and storm sewer	19,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
				Cooling	None	3	Lake Michigan via drainage ditch and storm sewer	14,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
39	James Manufacturing, Inc.– Froemming Cast Products Division	3462	City of Oak Creek	Process and Cooling	None	1	Lake Michigan via drainage ditch and storm sewer	36,300	N/A	N/A	20.0	N/A	N/A	N/A	N/A	No	--
40	Ladish Company – Cudahy	3462	City of Cudahy	Cooling	None	4	Lake Michigan via storm sewer	535,000	690,000	0.85	6.94	0.13	0.44	N/A	18.2	Yes	--
				Cooling	None	5	Lake Michigan via storm sewer	44,000	57,000	0.85	6.94	0.13	0.44	N/A	14.5	Yes	--
				Cooling	None	6	Lake Michigan via storm sewer	11,000	14,000	0.85	6.94	0.13	0.44	N/A	N/A	Yes	--
				Cooling	None	7	Lake Michigan via storm sewer	200	200	0.85	6.94	0.13	0.44	N/A	N/A	Yes	--
				Cooling	None	8	Lake Michigan via storm sewer	52,000	67,400	0.85	6.94	0.13	0.44	N/A	19.5	Yes	--
				Cooling	None	9	Lake Michigan via storm sewer	3,400	4,400	0.85	6.94	0.13	0.44	N/A	N/A	Yes	--
				Cooling	None	10	Lake Michigan via storm sewer	62,000	80,000	0.85	6.94	0.13	0.44	N/A	11.9	Yes	--
				Cooling	None	11	Lake Michigan via storm sewer	200	400	0.85	6.94	0.13	0.44	N/A	N/A	Yes	--
				Cooling	None	13	Lake Michigan via storm sewer	200	200	0.85	6.94	0.13	0.44	N/A	N/A	Yes	--
41	Mobil Oil Corporation – Milwaukee Terminal	2992	City of Milwaukee	Runoff	Oil and Water Separator	1	Lake Michigan	4,600	N/A	17.7	33.3	0.78	4.65	N/A	21.1	Yes	--
42	Milwaukee County Park Commission Swimming Pool Sheridan Park		City of Cudahy	Swimming Pool Overflow and Drainage	None		Lake Michigan via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
43	Milwaukee Oceanic Terminal, Division of Optics for Industry	4225	City of Milwaukee	Cooling	None		Lake Michigan	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
44	Milwaukee Waterworks Linwood Ave. Plant	4941	City of Milwaukee	Filter Backwash	None	1	Lake Michigan	1,013,300	1,411,900	N/A	4193.8	N/A	N/A	N/A	N/A	No	--
45	Oak Creek Water Filtration Plant		City of Oak Creek		None	2	Lake Michigan	611,600	1,993,800	N/A	6141.6	N/A	N/A	N/A	N/A	No	--
46	Patrick Cudahy, Inc.	2011	City of Cudahy	Cooling	N/A		Lake Michigan via storm sewer	72,000	79,000	5.0	16.7	N/A	N/A	N/A	N/A	No	--
47	Peter Cooper Corporations United States Glue & Gelation Division	2891	City of Oak Creek	Process and Cooling	None	1	Lake Michigan via storm sewer	3,204,600	4,195,800	3.18	43.2	0.4	11.6	N/A	26.2	Yes	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
48	Phillips Petroleum Company	5171	City of Milwaukee	Runoff	Oil and Water Separator		Lake Michigan	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
49	Shell Oil Company	5171	City of Milwaukee	Runoff	Oil and Water Separator		Lake Michigan	1,200	5,200	15.0	11.9	0.96	13.15	N/A	N/A	No	--
50	Texaco Inc.	5171	City of Milwaukee	Runoff	Oil Separator		Lake Michigan	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
51	University of Wisconsin – Milwaukee, Physical Plant	8221	City of Milwaukee	Cooling	N/A		Lake Michigan	9,000,000	12,000,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
52	Wire and Metal Specialties Company	3350	City of St. Francis	Cooling	None		Lake Michigan via storm sewer	1,500	N/A	N/A	N/A	N/A	N/A	N/A	15.6	No	--
53	Wisconsin Electric Power Company – Lakeside Power Plant	4911	City of St. Francis	Cooling, Boiler Blowdown, and Drainage	Chlorination	1	Lake Michigan	111,566,500	144,237,900	0.0015	0.016	0.001	0.0015	N/A	13.5	Yes	--
				Deicing Line (winter use only)	N/A	2	Lake Michigan	84,295,500	92,180,000	0.0015	0.016	0.001	0.0015	N/A	10.6	Yes	--
				Boiler Cleaning Water and Drainage	Settling Pond	3	Lake Michigan	139,600	264,500	0.0015	16.5	0.001	0.0015	N/A	N/A	Yes	--
				Deicing Line (winter use only)	N/A	4	Lake Michigan	19,680,500	20,240,000	0.0015	0.016	0.001	0.0015	N/A	10.6	Yes	--
				Cooling, Boiler Blowdown and Drainage		5	Lake Michigan	115,453,300	127,694,700	0.0015	0.016	0.001	0.0015	N/A	14.3	Yes	--
54	Wisconsin Electric Power Company – Oak Creek Plant	4911	City of Oak Creek	Deicing Line (winter use only)	N/A	1	Lake Michigan via storm sewer	301,682,500	441,887,400	0.02	0.18	0.0002	0.005	N/A	10.2	No	--
				Cooling, Boiler Blowdown, and Process	Chlorination	2	Lake Michigan via storm sewer	351,974,600	511,296,800	0.02	0.18	0.0002	0.005	N/A	12.8	No	--
				Cooling, Boiler Blowdown, and Process	Chlorination	3	Lake Michigan via storm sewer	251,683,400	275,386,200	0.02	0.18	0.0002	0.005	N/A	12.0	No	--
				Cooling, Boiler Blowdown	Chlorination	4	Lake Michigan via storm sewer	257,543,800	273,700,000	0.02	0.18	0.0002	0.005	N/A	11.8	No	--
				Cooling and Boiler Blowdown	Chlorination	5	Lake Michigan via storm sewer	239,362,400	257,774,200	0.02	0.18	0.0002	0.005	N/A	13.7	No	--
				Cooling and Boiler Blowdown	Chlorination	6	Lake Michigan via storm sewer	248,014,100	261,596,800	0.02	0.18	0.0002	0.005	N/A	16.0	No	--
				Process and Drainage	Ash Settling Basins	7	Lake Michigan via storm sewer	4,076,000	6,471,000	0.02	42.4	0.0002	0.005	N/A	N/A	No	--
				Process and Drainage	Activated Sludge Plant	8	Lake Michigan via storm sewer	153,000	864,000	0.02	92.5	0.0002	0.005	N/A	N/A	No	--
				Drainage	N/A	9	Lake Michigan via storm sewer	Intermittent	Intermittent	0.02	0.18	0.0002	0.005	N/A	N/A	No	--
				Drainage	N/A	10	Lake Michigan via storm sewer	Intermittent	Intermittent	0.02	0.18	0.0002	0.005	N/A	N/A	No	--
				Process	N/A	11	Lake Michigan via storm sewer	Intermittent	Intermittent	0.02	0.18	0.0002	0.005	N/A	N/A	No	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a] BOD$_5$ (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	MENOMONEE RIVER WATERSHED Milwaukee County																
55	Allis Chalmers Corp.	3523	City of West Allis	Process		1	Menomonee River via storm sewer	70,000	70,000	3.0	23.8	0.3	6.53	N/A	N/A	No	--
56	AMF, Inc. – Harley Davidson Motor Company	3751	City of Wauwatosa	Cooling and Process	Settling Pond, Oil Separator, Oil Skimmer and pH Adjustment	2	Tributary of Menomonee River	40,000	50,000	26.7	18.6	0.3	8.4	N/A	17.1	No	--
57	Babcock and Wilcox – Tubular Products Division	3312	Village of West Milwaukee	Cooling	Oil Separator	1	Menomonee River via storm sewer	825,000	900,000	20.0	24.0	0.0	0.0	N/A	19.9	Yes	Oils, Fats and Grease
58	Briggs and Stratton Corporation	3519	City of Wauwatosa	Cooling	Settling Basin and Oil Separator	1	Menomonee River via storm sewer	25,000	25,000	21.7	3.5	0.153	0.573	N/A	21.7	Yes	Oils, Fats and Grease
59	Butler Lime and Cement Company	3273	City of Milwaukee	Process	Settling Basin and pH Adjustment	1	Menomonee River via storm sewer	1,700	2,300	2.0	6.4	0.05	0.4	N/A	N/A	No	--
60	Center Fuel Company	2911	City of Milwaukee	Runoff	Oil and Water Separator	1	Little Menomonee River via storm sewer	Intermittent	Intermittent	N/A	30.0	N/A	N/A	N/A	N/A	No	--
61	Chicago, Milwaukee, St. Paul & Pacific Railroad Company	4013	City of Milwaukee	Process	Oil Separator	1	Menomonee River via drainage ditch	316,800	418,500	309.0	59.7	2.95	5.64	N/A	15.6	Yes	Oils, Fats and Grease
				Process	Oil Separator	2	Menomonee River via drainage ditch	3,000	7,000	309.0	21.2	2.95	5.64	N/A	N/A	Yes	Oils, Fats and Grease
62	Chicago and Northwestern Railway	4013	Village of Butler	Process	Oil and Water Separator	1	Menomonee River via drainage ditch	300	7,500	1.36	30.8	0.01	1.7	12	N/A	Yes	--
63	Chris Hanson's Laboratory, Inc.	2869	City of West Allis	Cooling	None	1	Honey Creek via storm sewer	50,000	63,000	22.0	13.0	3.7	6.61	N/A	15.6	Yes	--
64	Falk Corporation – Research and Development	3566	City of Milwaukee	Cooling	None	3	Menomonee River	30,000	33,000	1.8	8.0	N/A	N/A	N/A	23.3	No	--
				Cooling and Process	None	4	Menomonee River	8,000	11,000	1.8	8.0	N/A	N/A	N/A	N/A	No	--
				Cooling	None	5	Menomonee River	17,000	20,000	1.8	8.0	N/A	N/A	N/A	N/A	No	--
65	Falk Corporation – Plant No. 1	3566	City of Milwaukee	Cooling and Process	N/A	1	Menomonee River	121,100	126,000	1.0	33.4	2.98	2.3	N/A	18.5	No	--
				Cooling and Process	N/A	3	Menomonee River	23,000	36,000	1.0	74.0	2.98	2.3	N/A	17.6	No	--
				Cooling and Process	N/A	4	Menomonee River	41,000	80,000	1.0	28.2	2.98	2.3	N/A	16.3	No	--
				Cooling and Process		5	Menomonee River	243,000	270,000	1.0	858.0	2.98	2.3	N/A	14.2	No	--
66	Falk Corporation – Plant No. 2	3566	City of Wauwatosa	Cooling	None	1	Tributary of Menomonee River	21,000	26,000	1.1	1.1	1.0	N/A	N/A	17.0	Yes	--
				Cooling	None	2	Tributary of Menomonee River	4,000	4,000	1.1	1.1	1.0	N/A	N/A	N/A	Yes	--
67	Federal Malleable Company	3322	City of West Allis	Cooling	None	1	Honey Creek via storm sewer	9,500	11,500	0.0	12.0	2.03	0.0	N/A	18.3	Yes	--
				Cooling and Boiler Blowdown	None	2	Honey Creek via storm sewer	26,600	40,300	0.0	12.0	2.03	0.0	N/A	N/A	Yes	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
68	Grede Foundries, Inc. — Liberty Foundry	3321	City of Wauwatosa	Cooling	None	1	Menomonee River via storm sewer	45,000	53,000	N/A	N/A	N/A	N/A	N/A	26.1	No	--
				Cooling	None	2	Menomonee River via storm sewer	15,000	18,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
69	Grey Iron Foundry, Inc.	3321	City of West Allis	Cooling and Process	None	1	Honey Creek	370,000	391,000	8.4	55.7	0.0045	0.422	N/A	25.9	No.	Oils, Fats and Grease
				Cooling	None	2	Honey Creek	52,000	56,000	8.4	55.7	0.0045	0.422	N/A	N/A	No	Oils, Fats, and Grease
				Cooling	None	3	Honey Creek	52,000	56,000	8.4	55.7	0.0045	0.422	N/A	N/A	No	Oils, Fats, and Grease
70	Harnischfeger Corporation	3536	City of Milwaukee	Cooling and Process	None	1	Menomonee River via storm sewer	360,000	441,000	0.0	9.0	1.02	0.29	N/A	N/A	Yes	--
				Cooling	None	2	Menomonee River via storm sewer	6,000	10,000	0.0	9.0	1.02	0.29	N/A	N/A	Yes	--
				Process	None	3	Menomonee River via storm sewer	14,000	14,000	0.0	9.0	1.02	0.29	N/A	N/A	Yes	--
71	Hentzen Chemical Coatings, Inc.	2851	City of Milwaukee	Cooling	None	1	Little Menomonee River via storm sewer	49,000	49,000	0.0	8.3	N/A	N/A	N/A	57.9	Yes	--
				Cooling	None	2	Little Menomonee River via storm sewer	5,000	5,000	0.0	8.3	N/A	N/A	N/A	54.7	Yes	--
72	Inryco, Inc.	3444	City of Milwaukee	Cooling	N/A	3	Menomonee River via storm sewer	211,000	211,000	3.0	1.6	N/A	N/A	N/A	16.4	No	--
73	Kearney and Trecker Corporation	3540	City of West Allis	Cooling	None	1	Underwood Creek via storm sewer	121,900	127,000	N/A	N/A	N/A	N/A	N/A	15.5	No	--
74	Marquette University	8221	City of Milwaukee	Cooling and Steam Condensate	None	1	North Menomonee Canal via storm sewer	56,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
75	Miller Brewing Company	2082	City of Milwaukee	Cooling and Drainage	None	1	Menomonee River via storm sewer	7,100	7,200	7.7	1.4	0.2	1.6	5357	17.5	Yes	--
				Cooling	None	2	Menomonee River via storm sewer	86,400	86,400	1.0	3.0	0.2	1.6	N/A	21.5	Yes	--
				Cooling	None	3	Menomonee River via storm sewer	31,000	31,000	7.7	1.4	0.2	1.6	N/A	13.6	Yes	--
				Cooling and Drainage	None	4	Menomonee River via storm sewer	1,328,400	1,420,800	7.7	1.4	0.2	1.6	349	28.6	Yes	--
				Cooling	None	5	Menomonee River via storm sewer	224,00	346,000	1.0	12.0	0.2	1.6	N/A	N/A	Yes	--
76	Milwaukee County Institutions Power Plant	4911	City of Wauwatosa	Cooling and Process	None	1	Menomone River via drainage ditch	67,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
77	Milwaukee County Park Commission—Greenfield Park	7999	City of West Allis	Swimming Pool Overflow and Drainage	None	1	South Branch of Underwood Creek via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
78	Milwaukee County Park Commission — Hoyt Park	7999	City of Wauwatosa	Swimming Pool Overflow and Drainage	None	1	Menomonee River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
79	Milwaukee County Park Commission — Madison Park	7999	City of Wauwatosa	Swimming Pool Overflow and Drainage	None	1	Menomonee River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
80	Milwaukee County Park Commission McCarty Park	7999	City of West Allis	Swimming Pool Overflow and Drainage	None	1	Honey Creek via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
81	Milwaukee County Park Commission – Washington Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	1	Menomonee River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
82	Milwaukee Marble Company	3281	City of Milwaukee	Process	Setting Basin	1	Menomonee Canal via storm sewer	1,900	1,900	14.0	2960.0	0.074	1.53	N/A	N/A	No	--
				Process	None	2	Menomonee Canal via storm sewer	1,800	1,800	14.0	2960.0	0.074	1.53	N/A	N/A	No	--
				Process	None	3	Menomonee Canal via storm sewer	1,800	1,800	14.0	2960.0	0.074	1.53	N/A	N/A	No	--
83	Mobil Oil Corporation – Lubrication Plant	2992	City of Milwaukee	Cooling	Oil and Water Separator	1	Menomonee River via storm sewer	4,600	N/A	17.7	33.3	0.78	4.65	N/A	21.1	Yes	--
84	Motor Casting Plant No. 1	3321	City of West Allis	Cooling	None	1	Woods Creek via storm sewer	119,000	120,000	2.0	60.0	0.07	13.88	N/A	23.4	Yes	--
				Cooling	None	2	Woods Creek via storm sewer	101,000	101,000	2.0	60.0	0.07	13.88	N/A	N/A	Yes	--
85	Motor Casting Plant No. 2	3321	City of Milwaukee	Cooling	None	1	Honey Creek via storm sewer	18,000	20,000	60.0	2.0	0.03	0.73	N/A	29.1	Yes	--
86	Perlick Company, Inc.	3585	City of Milwaukee	Cooling	None	1	Little Menomonee River via storm sewer	1,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
87	Rexnord, Inc. – West Milwaukee Facility	3566	Village of West Milwaukee	Process	None	1	Woods Creek via storm sewer	21,000	26,000	11.0	5.0	0.1	0.35	N/A	9.3	Yes	--
				Cooling and Process	None	2	Woods Creek via storm sewer	159,000	180,000	11.0	5.0	0.1	0.35	N/A	23.4	Yes	--
				Cooling and Process	None	3	Woods Creek via storm sewer	6,600	7,300	11.0	5.0	0.1	0.35	N/A	11.2	Yes	--
				Cooling	None	4	Woods Creek via storm sewer	29,800	36,200	11.0	5.0	0.1	0.35	N/A	13.4	Yes	--
				Cooling	None	5	Woods Creek via storm sewer	3,500	4,000	11.0	5.0	0.1	0.35	N/A	11.5	Yes	--
				Cooling	None	6	Woods Creek via storm sewer	1,700	2,100	11.0	5.0	0.1	0.35	N/A	12.7	Yes	--
				Cooling and Process	None	7	Woods Creek via storm sewer	18,200	20,000	11.0	5.0	0.1	0.35	N/A	10.7	Yes	--
				Cooling	None	8	Woods Creek via storm sewer	24,800	27,000	11.0	5.0	0.1	0.35	N/A	10.0	Yes	--
				Cooling and Process	None	9	Woods Creek via storm sewer	11,000	12,000	11.0	5.0	0.1	0.35	N/A	12.7	Yes	--
88	Robert A. Johnston Company	2066	City of Milwaukee	Cooling	None	3	Menomonee River via storm sewer	511,600	650,400	N/A	N/A	N/A	N/A	N/A	27.7	No	--
89	Safeway Wash-A-Car, Inc.	7542	City of West Allis	Process	Catch Basin	1	Honey Creek via storm sewer	1,000	1,900	N/A	30.0	N/A	N/A	N/A	N/A	No	--
90	Seven-Up Milwaukee, Inc.	2086	City of West Allis	Process Wash Water	None	1	South Branch of Underwood Creek	7,000	10,000	4.0	4.0	0.29	0.8	N/A	22.8	No	--
91	Union Oil of California – N. 107th St.	2911	City of Milwaukee	Runoff	Oil and Water Separator	1	Little Menomonee River via drainage ditch	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
92	Western Metal Specialty – Division of Western Industries Inc.	3449	City of Wauwatosa	Cooling	None	1	Menomonee River via storm sewer	10,000 to 50,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a] BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
93	West Shore Pipe Line Company		City of Milwaukee	Process	Oil and Water Separator	1	Menomonee River	4,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
94	Wisconsin Electric Power Company—Heating Steam System	4961	City of Milwaukee	Steam Condensate and Seepage	None	1	Menomonee River	62,000	80,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
95	Wisconsin Electric Power Company — Valley Plant	4911	City of Milwaukee	Cooling, Boiler Blowdown and Drainage Ditch	Chlorination	1	South Menomonee Canal	73,510,100	78,467,700	0.002	4.73	0.009	0.0013	N/A	27.0	Yes	--
				Cooling, Boiler Blowdown and Drainage Ditch	Chlorination	2	South Menomonee Canal	69,288,400	77,351,600	0.002	4.73	0.009	0.0013	N/A	25.3	Yes	--
	Washington County																
96	Gehl Guernsey Farms, Inc.	2026	Village of Germantown	Cooling	None	1	Menomonee River via storm sewer	190,000	210,000	8.5	8.0	0.165	4.49	N/A	19.7	Yes	--
	Waukesha County																
97	Best Block Company	3271	Village of Menomonee Falls	Process	Ridge and Furrow	1	Soil Absorption	9,200	12,400	N/A	N/A	N/A	N/A	N/A	N/A	No	--
98	Carnation Company — Can Division	3411	Village of Menomonee Falls	Cooling	None	1	Menomonee River via storm sewer	48,300	64,500	43.4	13.7	0.18	2.99	N/A	23.1	No	--
99	Menomonee Falls Water Utility	4941	Village of Menomonee Falls	Filter Backwash	None	1	Menomonee River	162,900	173,200	N/A	25.1	N/A	N/A	N/A	N/A	No	--
100	Molded Rubber and Plastics Corporation	3069	Village of Butler	Cooling	None	1	Menomonee River via storm sewer	33,100	50,000	N/A	N/A	N/A	N/A	N/A	17.6	No	--
101	SEFO, Inc. D/B/A Safer Cleaning Center	7216	City of Brookfield	Cooling	None	1	Menomonee River via storm sewer	1,000 to 1,500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
102	W. A. Krueger Company, Inc.	2752	City of Brookfield	Cooling	None	1	Underwood Creek	10,000	32,000	1.54	119.0	0.75	0.31	N/A	21.1	Yes	--
103	Western States Envelope	2642	Village of Butler	Cooling	None	1	Menomonee River via storm sewer	15,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
	MILWAUKEE RIVER WATERSHED Milwaukee County																
104	A. F. Gallun & Sons Corporation	3111	City of Milwaukee	Cooling	None	2	Milwaukee River via storm sewer	2,800	3,500	N/A	N/A	N/A	N/A	N/A	17.2	No	--
				Cooling	None	3	Milwaukee River via storm sewer	1,500	1,800	N/A	N/A	N/A	N/A	N/A	N/A	No	--
				Cooling	None	4	Milwaukee River via storm sewer	1,100	1,300	N/A	N/A	N/A	N/A	N/A	N/A	No	--
105	American Can Company	3411	City of Milwaukee	Cooling	Settling Basin, Screening and pH Adjustment	1	Lincoln Creek via storm sewer	30,000	40,000	7.12	5.7	0.01	4.5	N/A	14.7	Yes	--
106	American Motors Corporation — Body Plant	3711	City of Milwaukee	Cooling	None	1	Milwaukee River via storm sewer	470,400	632,100	0.0	2.8	N/A	0.01	N/A	20.2	Yes	--
				Cooling	None	2	Milwaukee River via storm sewer	20,000	37,000	0.0	0.6	N/A	0.01	N/A	19.5	Yes	--
				Cooling	None	3	Milwaukee River via storm sewer	25,000	47,300	0.0	1.0	N/A	0.01	N/A	19.4	Yes	--
				Cooling	None	4	Milwaukee River via storm sewer	14,700	21,300	0.0	0.6	N/A	0.01	N/A	9.1	Yes	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
107	A. O. Smith Corporation -- Automotive Division	3714	City of Milwaukee	Cooling	Settling Basin and Oil Separator	1	Lincoln Creek via storm sewer	1,094,900	1,235,900	0.93	8.1	0.003	0.282	N/A	17.8	Yes	--
				Cooling	Settling Basin and Oil Separator	2	Lincoln Creek via storm sewer	591,000	661,000	0.93	12.0	0.003	0.282	N/A	N/A	Yes	--
108	Aqua-Chem, Inc. -- North Plant No. 1	3829	City of Milwaukee	Cooling and Process	None	2	Lincoln Creek via storm sewer	11,600	178,500	2.5	9.5	0.9	7.9	N/A	27.1	Yes	--
109	Aqua-Chem, Inc. -- North Plant No. 2	3829	City of Glendale	Cooling Process and Boiler Blowdown	None	2	Lincoln Creek via storm sewer	37,500	58,800	2.8	78.9	1.15	5.4	N/A	20.7	Yes	--
110	Badger Meter, Inc.	3824	Village of Brown Deer	Cooling	None	2	Milwaukee River via storm sewer	7,000	14,000	1.0	1.0	0.014	0.64	N/A	3.9	Yes	--
111	Beatrice Foods Company	3027	City of Milwaukee	Cooling	None	1	Milwaukee River via storm sewer	51,000	51,000	N/A	N/A	N/A	N/A	N/A	14.4	No	--
112	Briggs and Stratton Corporation	3499	City of Milwaukee	Cooling	Lagoon	1	Brown Deer Park Creek	5,000	5,000	1.06	0.0	0.0074	0.204	N/A	15.6	Yes	--
113	Continental Can Company	3551	City of Milwaukee	Cooling	None	1	Milwaukee River via storm sewer	340,000	500,000	N/A	N/A	N/A	N/A	N/A	20.2	No	--
114	Continental Equipment	3551	City of Milwaukee	Cooling	None	1	Lincoln Creek via storm sewer and drainage ditch	N/A	1,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
115	Cutler Hammer Inc. -- Industrial System Division	3622	City of Milwaukee	Cooling	None	2	Lincoln Creek via storm sewer	80,000	100,000	N/A	N/A	N/A	N/A	N/A	8.9	No	--
				Cooling	None	3	Lincoln Creek via storm sewer	50,000	60,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
				Cooling	None	4	Lincoln Creek via storm sewer	15,000	20,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
116	First Wisconsin National Bank	6025	City of Milwaukee	Cooling	None	1	Milwaukee River	660,000	660,000	0.0	5.0	0.0	0.0	N/A	24.0	No	--
117	Florence Eiseman, Inc.	2339	City of Milwaukee	Cooling and Boiler Blowdown	None	1	Milwaukee River	100	N/A	48.0	60.0	N/A	N/A	N/A	51.6	Yes	--
118	Fred Usinger, Inc.	2013	City of Milwaukee	Cooling	None	1	Milwaukee River	45,000	50,000	N/A	N/A	N/A	N/A	N/A	17.1	No	--
119	Gimbels Midwest, Inc.	5311	City of Milwaukee	Cooling	None	1	Milwaukee River	1,470,000	3,370,000	N/A	1.6	0.04	0.164	N/A	25.8	Yes	--
				Cooling	None	2	Milwaukee River	47,000	73,000	N/A	1.6	0.04	0.164	N/A	N/A	Yes	--
				Process	None	3	Milwaukee River	200	5,000	N/A	1.6	0.04	0.164	N/A	N/A	Yes	--
				Process	None	4	Milwaukee River	2,000	2,500	N/A	1.6	0.04	0.164	N/A	N/A	Yes	--
120	Gimbels Midwest, Inc. -- Warehouse	5311	City of Milwaukee	Boiler Blowdown	None	1	Milwaukee River	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
121	Globe Union, Inc. -- Administration and Research Park	3691	City of Glendale	Cooling	Cooling Lagoon	1	Lincoln Creek via storm sewer	7,100	17,000	N/A	N/A	N/A	N/A	N/A	12.9	No	--
122	Globe Union, Inc. -- Central Lab Division	3671	City of Milwaukee	Cooling	None	1	Lincoln Creek via storm sewer	60,000	80,000	2.5	11.5	N/A	N/A	N/A	27.6	No	--
				Cooling	None	2	Lincoln Creek via storm sewer	60,000	70,000	2.5	11.5	N/A	N/A	N/A	N/A	No	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a] BOD$_5$ (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
123	Hoerner Waldorf Corporation	2653	City of Milwaukee	Cooling and Boiler Blowdown	None	1	Milwaukee River via storm sewer	1,200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
124	Inland Ryerson Construction Products Company	3444	City of Milwaukee	Cooling	None	1	Lincoln Creek via storm sewer	1,100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
125	Interstate Drop Forge Company	3462	City of Milwaukee	Cooling	None	1	Lincoln Creek via storm sewer	60,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
126	Joseph Schlitz Brewing Company	2082	City of Milwaukee	Cooling	None	1	Milwaukee River via storm sewer	2,274,800	4,110,000	4.4	5.0	0.07	0.85	N/A	22.4	Yes	--
				Cooling	None	2	Milwaukee River via storm sewer	2,364,000	3,068,000	3.6	5.0	0.07	0.85	N/A	27.8	Yes	--
				Cooling	None	3	Milwaukee River via storm sewer	6,276,500	14,950,800	2.0	5.0	0.07	0.85	N/A	20.8	Yes	--
127	Kurth Malting Corporation – Plant No. 2	2083	City of Milwaukee	Cooling	None	4	Milwaukee River	46,783,300	54,000,000	N/A	N/A	N/A	N/A	N/A	15.0	No	--
128	Longview Fibre Company – Downing Box Division	2653	City of Milwaukee	Cooling	None	17	Milwaukee River via storm sewer	4,800	4,800	3.5	16.5	1.69	1.41	N/A	51.7	Yes	--
129	Milprint, Inc.	2649	City of Milwaukee	Cooling	None	1	Milwaukee River via storm sewer	202,000	259,400	N/A	N/A	N/A	N/A	N/A	15.0	No	--
				Cooling	None	2	Milwaukee River via storm sewer	86,700	111,000	N/A	N/A	N/A	N/A	N/A	15.1	No	--
130	Milwaukee Country Club	7999	City of Milwaukee	Cooling	None	1	Milwaukee River via storm sewer	17,600	50,500	N/A	N/A	N/A	N/A	N/A	15.6	No	--
				Cooling	None	2	Milwaukee River via storm sewer	100	300	N/A	N/A	N/A	N/A	N/A	N/A	No	--
131	Milwaukee County Park Commission – Carver Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None		Milwaukee River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
132	Milwaukee County Park Commission – Gordon Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	--	Milwaukee River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
133	Milwaukee County Park Commission – Lincoln Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	--	Milwaukee River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
134	Milwaukee County Park Commission – McGovern Park	7999	City of Milwaukee	Swimming Pool Overflow and Drainage	None	--	Lincoln Creek via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
135	Milwaukee Die Casting Company	3361	City of Milwaukee	Cooling	None	1	Milwaukee River via storm sewer	11,000	15,000	0.0	14.8	0.19	0.0	N/A	14.0	No	--
136	North Milwaukee Lime and Cement Company	3273	City of Milwaukee	Process	Settling Pond and Ph Adjustment	1	Lincoln Creek via storm sewer	2,000	2,500	5.0	8.1	0.05	0.53	N/A	N/A	No	--
137	Oster Corporation	3634	City of Milwaukee	Cooling	None	3	Milwaukee River via storm sewer	8,000	13,000	12.0	35.0	0.1	0.42	N/A	20.0	Yes	--
				Cooling	None	4	Milwaukee River via storm sewer	33,000	72,000	12.0	35.0	0.1	0.42	N/A	N/A	Yes	--
138	Outboard Marine Corporation – Evinrude Foundry	3519	City of Milwaukee	Cooling	None	1	Lincoln Creek via storm sewer	901,300	1,123,500	N/A	N/A	N/A	N/A	N/A	12.3	No	--
				Cooling	None	2	Lincoln Creek via storm sewer	85,200	179,800	N/A	N/A	N/A	N/A	N/A	17.0	No	--
				Cooling	None	3	Lincoln Creek via storm sewer	107,000	170,000	N/A	N/A	N/A	N/A	N/A	11.4	No	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
139	Outboard Marine Corporation – Plant No. 1 Research Annex	3519	City of Milwaukee	Cooling	None	1	Lincoln Creek via storm sewer	262,200	313,800	N/A	N/A	N/A	N/A	N/A	11.1	No	--
140	Square D Company	3622	City of Glendale	Cooling	None	1	Milwaukee River via storm sewer	2,600	3,500	5.1	6.0	0.25	1.66	N/A	14.9	Yes	--
				Cooling	None	2	Milwaukee River via storm sewer	36,600	62,500	5.1	6.0	0.25	1.66	N/A	17.6	Yes	--
				Cooling	None	3	Milwaukee River via storm sewer	88,800	153,000	5.1	6.0	0.25	1.66	N/A	25.2	Yes	--
141	Stainless Foundry and Engineering Company	3325	City of Milwaukee	Cooling	N/A	2	Lincoln Creek via storm sewer	110,000	121,000	2.0	11.0	0.03	1.16	N/A	21.1	No	--
				Cooling	N/A	3	Lincoln Creek via storm sewer	20,000	22,000	2.0	11.0	0.03	1.16	N/A	N/A	No	--
142	Treat All Metals, Inc.	3398	City of Milwaukee	Cooling	N/A	1	Milwaukee River via storm sewer	200,000	200,000	4.0	6.0	0.13	1.31	N/A	17.9	Yes	--
143	Western Electric Company, Inc. – Wisconsin Service Center	7629	City of Milwaukee	Cooling	N/A	1	Milwaukee River via storm sewer	1,000	2,400	4.0	2.7	N/A	N/A	N/A	24.4	Yes	--
144	W. H. Brady Company Florist Avenue Plant	2641	City of Glendale	Cooling	N/A	1	Milwaukee River via storm sewer	29,000	52,000	6.0	4.0	0.56	0.36	N/A	13.9	Yes	--
145	Wisconsin Bridge and Iron Company	3441	City of Milwaukee	Cooling and Drainage	None	1	Lincoln Creek via storm sewer	5,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
146	Wisconsin Cuneo Press	2752	City of Milwaukee	Cooling and Process	None	1	Lincoln Creek via storm sewer	135,000	148,000	3.0	5.0	0.063	0.535	N/A	10.6	No	--
147	Wisconsin Electric Power Company (Commerce Street)	4911	City of Milwaukee	Boiler Blowdown	None	1	Milwaukee River	200,000	200,000	0.003	1.0	0.002	0.0022	N/A	98.9	Yes	--
				Cooling Process and Boiler Blowdown	None	4	Milwaukee River	46,521,200	51,887,100	0.003	0.003	0.002	0.0022	N/A	13.8	Yes	--
148	Wisconsin Electric Power Company (Wells Street)	4911	City of Milwaukee	Boiler Blowdown	None	1	Milwaukee River	600	700	N/A	N/A	N/A	N/A	N/A	50.4	No	--
				Drainage	None	2	Milwaukee River	200	250	N/A	N/A	N/A	N/A	N/A	20.1	No	--
				Drainage	None	3	Milwaukee River	400	500	N/A	N/A	N/A	N/A	N/A	20.1	No	--
				Boiler Blowdown	None	4	Milwaukee River	24,200	25,000	N/A	316.4	0.09	0.0301	N/A	29.2	No	--
				Boiler Blowdown	N/A	5	Milwaukee River	7,000	8,700	N/A	N/A	N/A	N/A	N/A	50.4	No	--
				Drainage and Boiler Blowdown	N/A	6	Milwaukee River	20	25	N/A	N/A	N/A	N/A	N/A	N/A	No	--
				Boiler Blowdown	N/A	7	Milwaukee River	1,200	1,500	N/A	N/A	N/A	N/A	N/A	50.4	No	--
				Boiler Blowdown	N/A	8	Milwaukee River	1,200	3,000	N/A	11.0	N/A	N/A	N/A	50.4	No	--
				Drainage	N/A	9	Milwaukee River	20	25	N/A	N/A	N/A	N/A	N/A	20.1	No	--
				Drainage	N/A	10	Milwaukee River	20	25	N/A	N/A	N/A	N/A	N/A	20.1	No	--
				Drainage	N/A	11	Milwaukee River	100,000	125,000	N/A	N/A	N/A	N/A	N/A	20.1	No	--
				Tank Overflow	N/A	12	Milwaukee River	100	125	N/A	N/A	N/A	N/A	N/A	50.2	No	--
				Cooling, Boiler Blowdown and Drainage	N/A	13	Milwaukee River	889,500	909,300	N/A	1.06	0.00	0.0301	N/A	26.5	No	--
149	Wisconsin Electric Power Company – Heating Steam System	3585	City of Milwaukee	Steam Condensate and Groundwater	None	2	Milwaukee River	300	72,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--

Table 8 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (Gallons/Day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (Gallons/Day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	Milwaukee County (cont)																
150	Wright Metal Processors, Inc.	3479	City of Milwaukee	Cooling	None	1	Lincoln Creek via storm sewer	3,000	4,000	0.11	3.4	7.5	N/A	N/A	14.2	No	--
	OAK CREEK WATERSHED Milwaukee County																
151	Appleton Electric Company -- Lighting Products Division	3643	City of South Milwaukee	Process	None	1	Oak Creek via storm sewer	22,600	28,800	98.4	4.9	0.9	4.17	N/A	16.0	Yes	Oil and Grease
				Process	None	3	Oak Creek via storm sewer	11,500	14,000	98.4	1.1	0.9	4.17	N/A	20.0	Yes	Oil and Grease
152	Appleton Electric Company -- Foundry Division	3679	City of South Milwaukee	Cooling	None	1	Oak Creek	66,000	84,000	0.1	0.6	N/A	N/A	N/A	0.78	Yes	--
153	Bucyrus Erie Company	3532	City of South Milwaukee	Cooling	None	1	Oak Creek	42,200	78,000	10.0	81.3	0.27	1.5	N/A	20.0	Yes	Oil, Fats & Grease
				Cooling	None	2	Oak Creek	117,000	162,500	10.0	13.4	0.27	1.5	N/A	N/A	Yes	Oils, Fats & Grease
				Cooling and Process	None	3	Oak Creek	136,600	300,000	10.0	189.8	0.27	1.5	N/A	N/A	Yes	Oils, Fats & Grease
				Cooling and Process	None	5	Oak Creek	468,400	590,000	10.0	7.8	0.27	1.5	N/A	N/A	Yes	Oils, Fats & Grease
154	Harley-Davidson Motor Company	3751	City of Oak Creek	Cooling	N/A	1	North Branch Oak Creek via storm sewer	4,400	7,500	0.0	0.0	N/A	N/A	N/A	20.0	No	--
155	Industrial Fuel, Inc.	5093	City of Oak Creek	Process	Holding Pond	1	North Branch Oak Creek via storm sewer	600	600	N/A	30.0	N/A	N/A	N/A	N/A	No	--
156	Ladish Company	3462	City of Cudahy	Cooling	N/A	1	Oak Creek via storm sewer	585,000	1,585,000	1.0	6.9	0.1	0.4	N/A	21.0	Yes	--
				Cooling	N/A	12	Oak Creek	171,000	1,013,000	1.0	6.9	0.1	0.4	N/A	21.0	Yes	--
157	Milwaukee County Park Commission Oak Creek Park	7032	City of South Milwaukee	Swimming Pool Overflow	None	1	Oak Creek via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
158	Union Oil Truck Stop	5541	City of Oak Creek	Runoff	Oil Separator	1	Oak Creek	Intermittent	Intermittent	30.0	30.0	N/A	N/A	200	N/A	No	--
	ROOT RIVER WATERSHED Milwaukee County																
159	Fruehauf Corporation	7539	City of West Allis	Cooling and Process	None	1	Root River via storm sewer and drainage ditch	3,200	4,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
160	Milwaukee County Park Commission -- Hales Corners Park	7999	Village of Hales Corners	Swimming Pool Overflow and Drainage	None		Root River via storm sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
161	P.P.G. Industries, Inc.	2851	City of Oak Creek	Cooling, Boiler and Cooling Tower Blowdown	None	1	Root River via drainage ditch	4,000	6,600	0.0	18.0	0.85	3.40	N/A	17.8	Yes	--
162	Union Oil Milwaukee Truck Stop	5541	City of Franklin	Runoff	Oil Separator	1	Tributary of Root River	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
163	Vulcan Materials Company	1422	City of Franklin	Runoff	Settling Pond	1	Root River	321,000	1,260,000	2.0	2.6	0.0	5.6	N/A	N/A	No	--

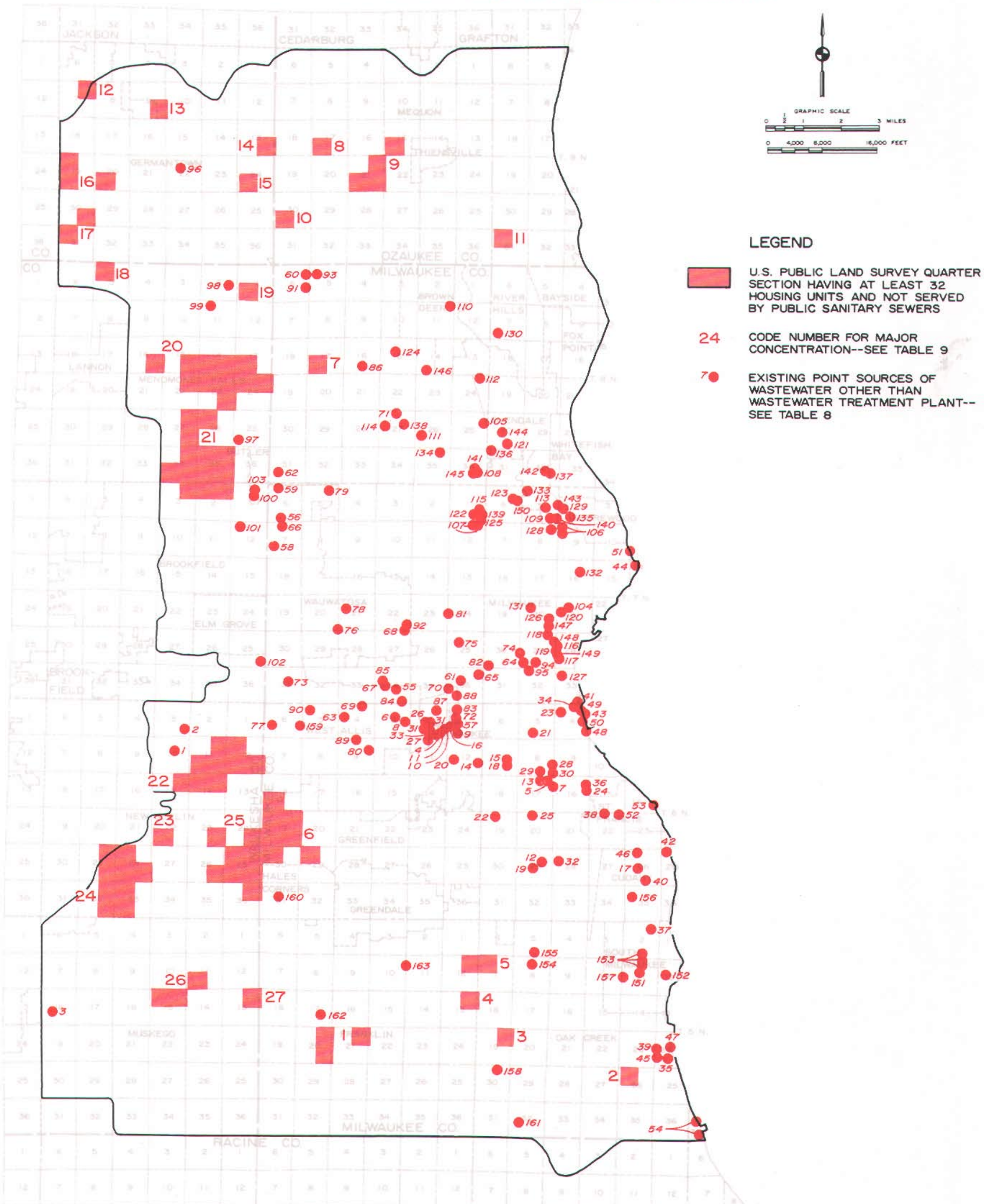
Note: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wiscon sin Pollutant Discharge Elimination System or under Section NR 101 of the Wisconsin Administrative Code of from the Wisconsin Pollutant Discharge Elimination System permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in or requirements of the permit. In some cases when wastewater characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 4

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA: 1975



Significant concentrations of unsewered urban development in the Milwaukee Metropolitan subregional area are found within the Cities of Brookfield, Franklin, Greenfield, Mequon, Muskego, New Berlin, and Oak Creek; the Villages of Germantown, and Menomonee Falls; and the Town of Germantown. Such areas are mainly representative of both typical septic tank subdivision development of the 1950's and the early 1960's and the new leap frogging development which has occurred in the subregional area since the mid 1960's. There are also 163 existing (1975) known point sources of wastewater other than wastewater treatment facilities in the Milwaukee Metropolitan subregional area. Such waste sources are most prevalent in the industrial land use concentrations of the major cities of the subregional area.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 9

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS
IN THE MILWAUKEE-METROPOLITAN SUBREGIONAL AREA: 1975

Major Urban Concentration[a] Number[b]	Major Urban Concentration[a] Name	Estimated Resident Population	Developed Urban Quarter Section Area (acres)
	Milwaukee County		
1	City of Franklin-Sections 20 & 21	1,500	475
2	City of Oak Creek-Section 26	200	159
3	City of Oak Creek-Section 19	200	163
4	City of Franklin-Section 13	300	162
5	Cities of Franklin & Oak Creek-Sections 12 & 7	300	311
6	City of Greenfield-West	1,300	1,052
7	City of Milwaukee-Section 17 (0821)	200	167
	Ozaukee County		
8	City of Mequon-Section 17	100	159
9	City of Mequon-Sections 15 & 21	1,300	644
10	City of Mequon-Section 30	200	171
11	City of Mequon-Section 31	200	165
	Washington County		
12	Village of Germantown-Section 7	100	157
13	Dheinsville-Rockfield	100	159
14	Village of Germantown-Section 13	100	163
15	Village of Germantown-Section 24	200	164
16	Village of Germantown-Sections 19 & 20	600	477
17	Willow Creek	300	314
	Waukesha County		
18	Village of Menomonee Falls-Section 5	500	162
19	Village of Menomonee Falls-Section 1	100	165
20	Village of Menomonee Falls-East	4,200	1,962
21	Village of Menomonee Falls-South	5,600	2,137
22	City of New Berlin-North	5,500	1,464
23	City of New Berlin-Section 22	500	159
24	City of New Berlin-Southwest	2,500	1,438
25	City of New Berlin-Southeast	3,900	1,290
26	Bass Bay	500	479
27	City of Muskego-Section 13	100	163
Total		30,000	14,157

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U. S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b] *See Map 4.*

Source: SEWRPC

on a regular basis and transported to a centralized disposal site. A second alternative, using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system," is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through 1975, there were 86 sewage holding tank installations, and four mound systems existing in the Milwaukee-Metropolitan subregional area. Thirty-five of the holding tanks served residential homes, while 49 were used by commercial establishments, and two were used by industrial establishments. All the mound systems were used to dispose of sanitary sewage from residences. The location of these systems is indicated on Map 4.

Concluding Remarks—Milwaukee-Metropolitan Subregional Area

Inventories conducted under the areawide water quality management planning program indicated that in 1975 there existed in the Milwaukee-Metropolitan subregional area a total of 32 public sanitary sewerage systems, which include 491 sewage flow relief devices and which serve a total area of about 230.8 square miles, or about 54 percent of the total area of the subregional area, and a total of about 1,093,200 persons, or about 96 percent of the total population of the subregional area. Seven of the sanitary sewerage systems including the three plants operated by the Milwaukee-Metropolitan Sewerage Commissions operates its own wastewater treatment facility. In addition to the 32 publicly-owned sanitary sewerage systems, 11 privately-owned wastewater treatment facilities serving isolated industrial, commercial, institutional and utility development were found in the inventory. The inventory indicated that as of 1975 there were no proposed new public sanitary sewerage systems in the area. There were also 163 point sources of wastewater other than wastewater treatment plants identified in the subregional area consisting primarily of industrial cooling, process, rinse and wash waters. Finally, in 1975 there were an estimated 30,000 persons residing in scattered enclaves of urban development in the Milwaukee-Metropolitan subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about 22.1 square miles. In the areas of the Milwaukee-Metropolitan subregional area not served by sanitary sewers, it is estimated that approximately 194.4 square miles and 46,600 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, 86 holding tanks and four "mound systems" are also used for sewage disposal within the subregional area.

INVENTORY FINDINGS UPPER MILWAUKEE RIVER SUBREGIONAL AREA

The Upper Milwaukee River subregional area consists of all of the Milwaukee River watershed within the Southeastern Wisconsin Region north of the northern limits of the City of Mequon. This area has been subject in recent years to relatively rapid urbanization, particularly in the Cedarburg, Grafton, Jackson, Saukville, and West Bend areas.

Existing Public Sanitary Sewerage Systems

There are a total of eight existing public sanitary sewerage systems in the Upper Milwaukee subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the Cities of Cedarburg, and West Bend, and the Villages of Fredonia, Grafton, Jackson, Kewaskum, Newburg, and Saukville. These eight systems serve a total area of approximately 13.4 square miles, or approximately 4 percent of the total area of the subregional area, and a total population of approximately 48,600 people, or approximately 64 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 10 and 11.

City of Cedarburg: The existing service area of the City of Cedarburg sanitary sewerage system is shown on Map 5. This area totals about 2.6 square miles and has a resident population of about 10,400 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Cedarburg is treated at a wastewater treatment plant located at the eastern City limits on Cedar Creek, a tributary of the Milwaukee River, to which effluent is discharged (see Figure 16). The plant has a site area of about five acres, of which approximately three acres are currently utilized, leaving two acres available for future treatment plant use. The plant site is bounded by residential development on the northwest and northeast, by cemetery lands on the southwest, and by agricultural and open lands on the southeast. The plant was initially constructed in 1925 and underwent modifications in 1935, 1960, and 1973. The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, trickling filter, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the activated sludge system are thickened and then combined with solids removed from the primary sedimentation units prior to being transferred to an anaerobic digestion system followed by application as a liquid on agri-

Table 10

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE UPPER MILWAUKEE SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area: Existing Acres	Existing Square Miles	Proposed[a] Acres	Proposed[a] Square Miles	Population[b] Served	Arrangement for Treatment of Sewage (See Table 11)
Existing Systems						
City of Cedarburg	1,652	2.58	--	--	10,400	Operates a facility
City of West Bend	4,021	6.28	3,388	5.29	21,000	Operates a facility
Village of Fredonia	422	0.66	--	--	1,500	Operates a facility
Village of Grafton	1,377	2.15	193	0.30	8,800	Operates a facility
Village of Jackson	275	0.43	--	--	2,000	Operates a facility
Village of Kewaskum	415	0.65	376	0.59	2,000	Operates a facility
Village of Newburg	119	0.19	395	0.62	600	Operates a facility
Village of Saukville	275	0.43	1,845	2.88	2,300	Operates a facility
Proposed Systems						
Tri-Lakes	--	--	--[c]	--[c]		--
Wallace Lake	--	--	--[d]	--[d]		--
Subregional Area Total	8,556	13.37	6,197	9.68	48,600	--

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U. S. Public Land Survey quarter section.*

[c] *The proposed Tri-Lakes area service area totals about 1,698 acres, or 2.66 square miles, and has been included in the proposed service area of the City of West Bend.*

[d] *The proposed Wallace Lake service area totals about 138 acres, or 0.21 square miles, and has been included in the proposed service area of the City of West Bend.*

Source: SEWRPC.

cultural lands. A portion of the digested sludge is conveyed to sludge drying beds and to a sludge lagoon for further dewatering prior to land application. The plant has an average hydraulic design capacity of 3.00 mgd, with a peak hydraulic capacity of 6.00 mgd and an organic design capacity of 5,000 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.41 and 2.10 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 1,340 and 1,660 pounds of BOD_5 per day respectively, indicating that the plant has adequate capacity to treat the wastewater loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain an average concentration of 11 mg/l of BOD_5, 24 mg/l of suspended solids and 2.6 mg/l of phosphorus and an average fecal coliform count of 67 per 100 ml. Maximum monthly average effluent concentrations of 29 mg/l of BOD_5, 82 mg/l of suspended solids and 3.3 mg/l of phosphorus, as well as a maximum monthly average fecal coliform count of 355 per 100 ml were reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus, and fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of all major trunk sewers, pumping stations, and related force mains serving the City of Cedarburg are shown on Map 5. As shown on Map 5, there are two known sewage flow relief devices in the City of Cedarburg sanitary sewerage system, both of which are bypasses.

Management of the City of Cedarburg sanitary sewerage system is under the direction of a five-member Board of Public Works. Day-to-day administration of the system is provided by the Superintendent of the wastewater treatment plant. Financing of the system is provided through general property tax for some capital improvements and a sewer service charge levied quarterly. The four equal quarterly charges are set equal to the public water supply charge during the winter quarter of the year.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Cedarburg sanitary sewerage system approximated $304,254, or about $30.00 per capita. Of this total, $154,721, or about $15.00 per capita, was expended for operation and maintenance, and $149,533, or about $15.00 per capita, was expended for capital improvements.

City of West Bend: The existing service area of the City of West Bend sanitary sewerage system is shown on Map 5. This area totals about 6.3 square miles and has a resident population of about 21,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of West Bend is treated at a wastewater treatment plant located on the Milwaukee River, to which effluent is discharged (see Figure 17). The plant has a site area of about 38 acres, of which 14 acres are currently utilized, leaving 24 acres available for future use. The plant site, which is partially located in the floodlands of the Milwaukee River, is bounded by agricultural lands on the north and the main stem of the Milwaukee River on the south, west and east. The plant was constructed in 1967 and upgraded in 1973, replacing an older treatment plant constructed in 1936 on a site about two miles upstream of the present plant site. The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system prior to application as a liquid on agricultural lands. The plant has an average hydraulic design capacity of 2.50 mgd, with a peak hydraulic design capacity of 10.00 mgd and an organic design capacity of 4,300 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly average hydraulic loadings to the plant were reported to be 3.70 and 4.20 mgd respectively, while the average annual and maximum monthly average organic loading were reported to be 3,200 and 3,600 pounds of BOD_5 per day, indicating that while the plant has adequate organic treatment capacity to serve the existing sewer service area, it is operating above the average hydraulic design capacity.

During 1975, treatment plant effluent was reported to contain sewage concentrations of 9 mg/l of BOD_5, 17 mg/l of suspended solids and 1.24 mg/l of phosphorus. Maximum monthly average effluent concentrations of 15 mg/l of BOD_5, 22 mg/l of suspended solids and 1.8 mg/l of phosphorus were reported during 1975. Data on effluent fecal coliform counts were not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.3 mg/l to 0.4 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 10 mg/l BOD_5, 20 mg/l of suspended solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1979.

Table 11

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes				Level of Treatment Provided			Disposal of Effluent	Sludge Handling and Disposal Unit Processes					
				Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary		Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Land fill
City of Cedarburg . . .	2.58	10,400	1925, 1935 1960, 1973	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Cedar Creek	No	Yes	Yes	No	Yes	No
City of West Bend . . .	6.28	21,000	1967, 1973	No	Yes	Yes	Yes	Yes	Yes	Yes	Milwaukee River	No	Yes	No	No	Yes	No
Village of Fredonia . .	0.66	1,500	1939, 1962	No	Yes	No	Yes	Yes	No	Yes	Milwaukee River	No	Yes	Yes	No	Yes	No
Village of Grafton . . .	2.15	8,800	1934, 1960, 1970	No	Yes	Yes	Yes	Yes	Yes	Yes	Milwaukee River	Yes	Yes	No	No	Yes	No
Village of Jackson . . .	0.43	2,000	1939	Yes	No	No	Yes	Yes	No	Yes	Cedar Creek	No	Yes	Yes	No	Yes	No
Village of Kewaskum .	0.65	2,000	1955, 1972	No	Yes	Yes	Yes	Yes	Yes	Yes	Milwaukee River	Yes	No	No	Yes	Yes	Yes
Village of Newburg . .	0.19	600	1964	No	Yes	No	Yes	Yes	No	Yes	Milwaukee River	Yes	No	No	No	Yes	No
Village of Saukville . .	0.43	2,300	1959	Yes	No	No	Yes	Yes	No	Yes	Milwaukee River	No	Yes	Yes	No	Yes	No

Table 11 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975						Wastewater Strength Parameters in Influent Sewage[a]					Design Capacity					Industrial Flows		
	Annual Average Hydraulic (MGD)	Average Annual Hydraulic Per Capita (GPD)	Maximum Monthly Average Hydraulic (MGD)	Average Annual Organic (pounds BOD_5/day)	Average Annual Organic Per Capita (pounds BOD_5/day)	Maximum Monthly Average Organic (pounds BOD_5/day)	BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Organic Nitrogen-N (mg/l)	Ammonia Nitrogen-N (mg/l)	Population[b]	Average Hydraulic (MGD)	Peak Hydraulic (MGD)	Average Organic (pounds BOD_5/day)	Average Organic Population[b] Equivalent	Design Average Daily Flow (MGD)	Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
City of Cedarburg	1.41	136	2.10	1,340	0.13	1,660	121	154	4.0[d]	7.6[d]	7.4[d]	20,000	3.00	6.00	5,000	23,800	N/A	0.25	0.90
City of West Bend	3.70	176	4.20	3,210	0.15	3,570	106	259	12.8[e]	11.0[e]	10.0[e]	25,000	2.50	10.00	4,250	20,240	0.50	1.00	None
Village of Fredonia	0.28	187	0.37	310	0.21	460	132	141	9.0[f]	12.9[f]	N/A	1,200	0.12	0.25	200	950	N/A	N/A	None
Village of Grafton	0.88	100	1.05	1,020	0.12	1,210	138	258	16.6[d]	9.8[d]	16.7[d]	9,400	1.00	2.50	1,880	8,950	0.05	0.23	None
Village of Jackson	0.26	130	0.28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	250	0.03	0.05	40	190	None	0.03	None
Village of Kewaskum	0.32	160	0.47	970	0.49	1,610	362	454	20.7[g]	19.0[g]	17.0[g]	5,000	1.00	1.50	1,800	8,570	0.70	0.30	0.53
Village of Newburg	0.07	117	0.07	150	0.25	160	246	372	7.6[d]	4.8[d]	24.4[d]	800	0.05	0.10	136	650	N/A	N/A	None
Village of Saukville	0.29	126	0.42	310	0.13	490	129	139	5.7[h]	5.4[h]	15.0[h]	1,400	0.28	0.46	430	2,050	0.10	0.05	None

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]												Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Date	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values			
	BOD_5 (mg/l) Average Annual	BOD_5 (mg/l) Maximum Monthly Average	Suspended Solids (mg/l) Average Annual	Suspended Solids (mg/l) Maximum Monthly Average	Total Phosphorus (mg/l) Average Annual	Total Phosphorus (mg/l) Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l) Minimum Monthly Average	Chlorine Residual (mg/l) Maximum Monthly Average	Fecal Coliform (Number per 100 ml) Average Annual	Fecal Coliform (Number per 100 ml) Maximum Monthly Average			BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (Number per 100 ml)
City of Cedarburg	11	29	24	82	2.60	3.30	N/A	N/A	0.26	0.38	66.7	355	0	6-30-77	30	30	1.0	200
City of West Bend	9	15	17	22	1.24	1.80	1.4[e]	5.8[e]	0.30	0.40	N/A	N/A	0	4-30-79	10	20	1.0	200
Village of Fredonia	35	54	43	57	N/A	N/A	N/A	N/A	0.50	0.67	N/A	N/A	N/A	6-30-77	60	60	--	200
Village of Grafton	9	15	16	20	N/A	N/A	N/A	N/A	0.42	0.61	N/A	N/A	0	4-30-79	30	30	15% of Influent	200
Village of Jackson	140	215	91	110	N/A	N/A	N/A	N/A	N/A	N/A	4.8×10^6	6.6×10^6	N/A	6-30-77	120	120	--	200
Village of Kewaskum	9	20	8	19	1.77	3.70	1.3[g]	0.2[g]	0.56	0.59	N/A	N/A	0	6-30-77	30	30	2.0	200
Village of Newburg	75	117	54	67	N/A	N/A	N/A	N/A	0.49	0.50	N/A	N/A	0	6-30-77	30	30	--	200
Village of Saukville	36	55	39	54	5.2[h]	N/A	6.0[h]	15.0[h]	1.06	7.53	N/A	N/A	3	6-30-77	60	60	--	200

NOTE: N/A indicates data not available.

[a] *Average maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant operating personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

[d] *Data obtained from a 1974 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from a September 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[f] *Data obtained from a 1971 24-hour survey by the Wisconsin Department of Natural Resources.*

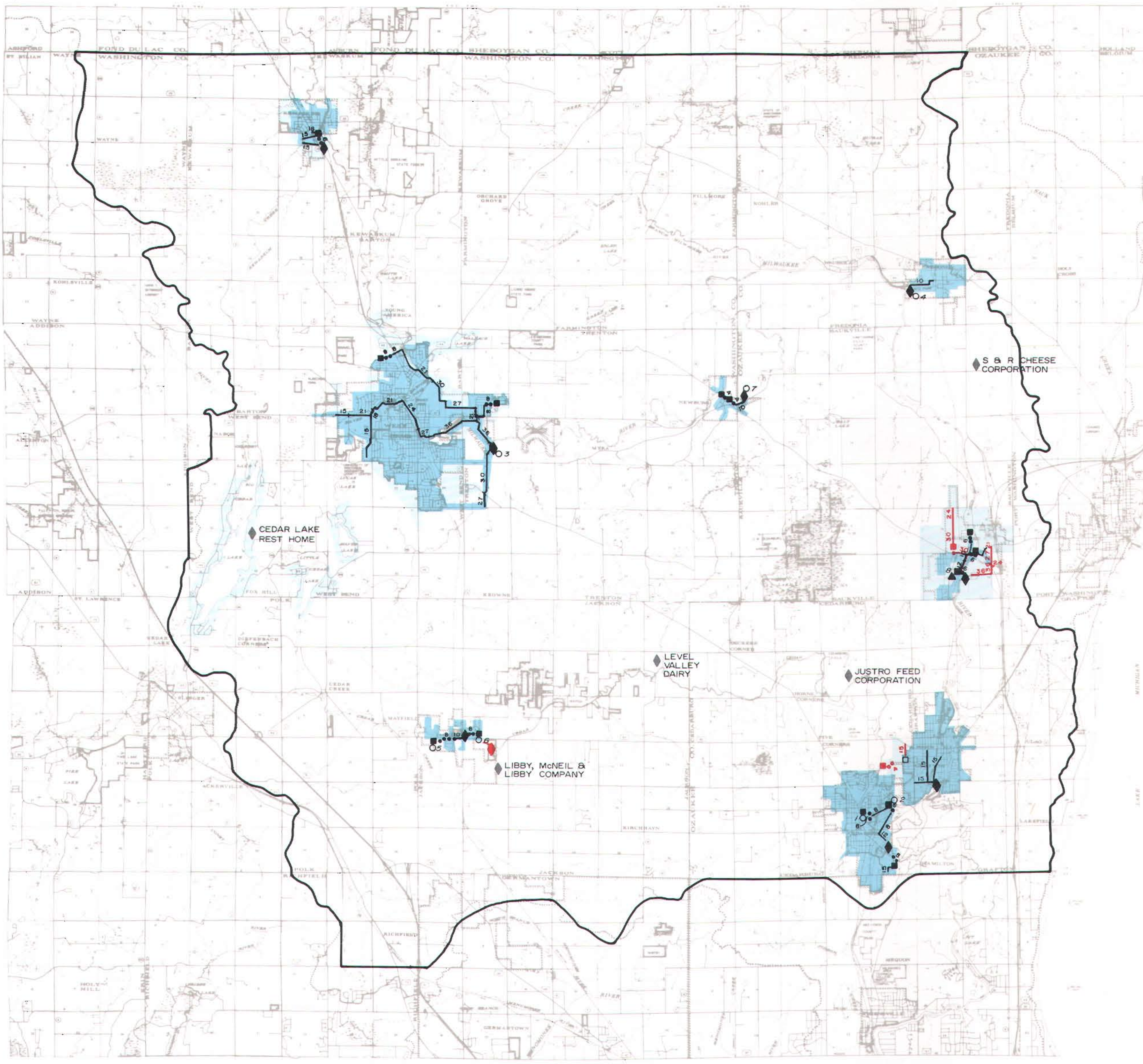
[g] *Data obtained from a November 1974 24-hour survey by the Wisconsin Department of Natural Resources.*

[h] *Data obtained from a February 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 5

EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975



LEGEND

SEWER SERVICE AREA

- EXISTING
- PROPOSED

WASTEWATER TREATMENT FACILITIES

- EXISTING-PUBLIC
- PROPOSED-PUBLIC
- EXISTING-PRIVATE

SEWERS AND APPURTENANT FACILITIES

- EXISTING MAJOR TRUNK, RELIEF, OR INTERCEPTING SEWER
- EXISTING FORCE MAIN
- PROPOSED FORCE MAIN
- EXISTING LIFT STATION
- EXISTING PUMPING STATION
- PROPOSED PUMPING STATION
- 15 / 15 SIZE (in Inches) OF SEWER OR APPURTENANT FACILITY

KNOWN FLOW RELIEF DEVICES

- BYPASS
- RELIEF PUMPING STATION
- 2 IDENTIFICATION NUMBER-- SEE APPENDIX B

GRAPHIC SCALE

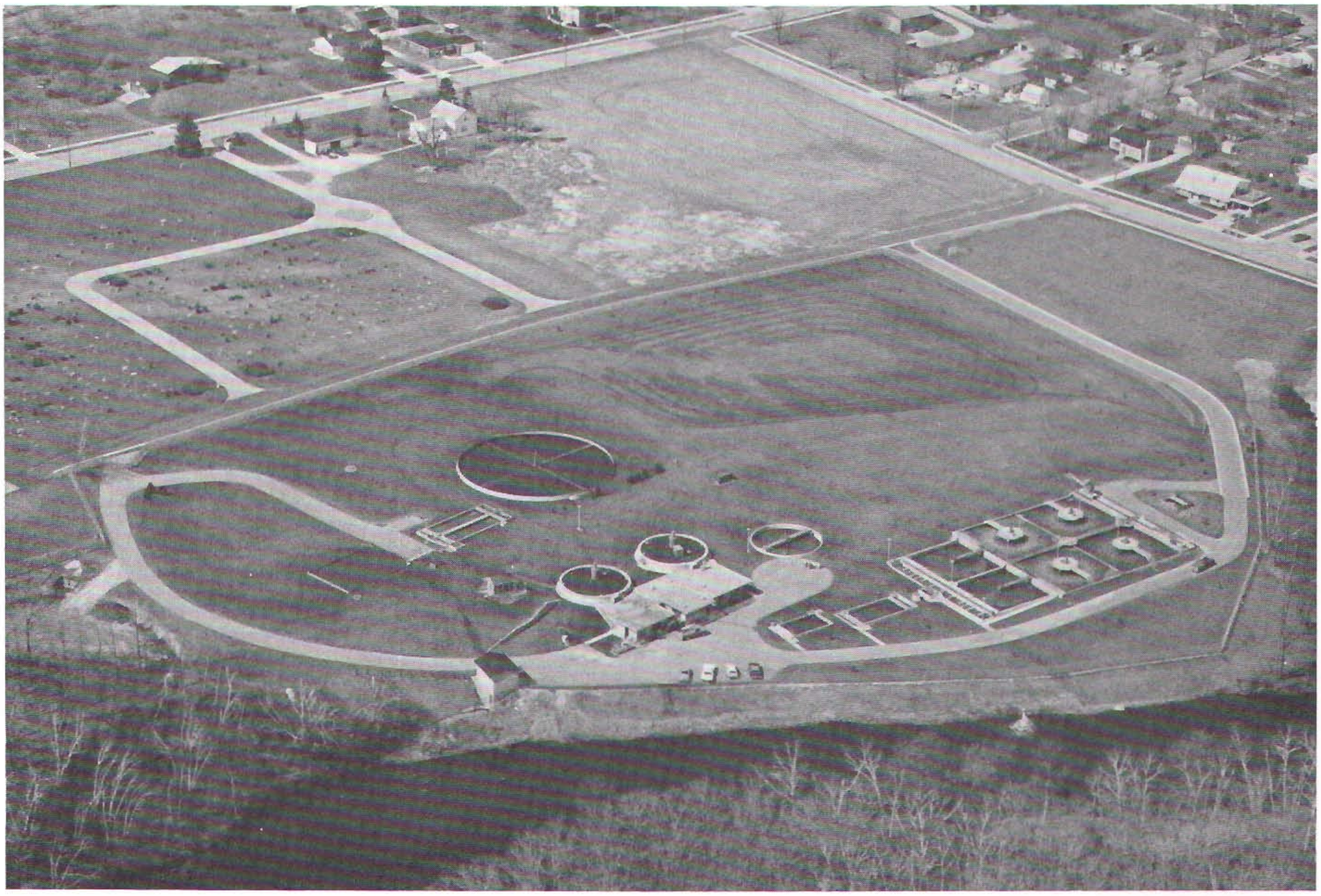
0 1 2 MILES

0 4000 8000 12000 16000 FEET

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 16

CITY OF CEDARBURG WASTEWATER TREATMENT PLANT



Source: SEWRPC.

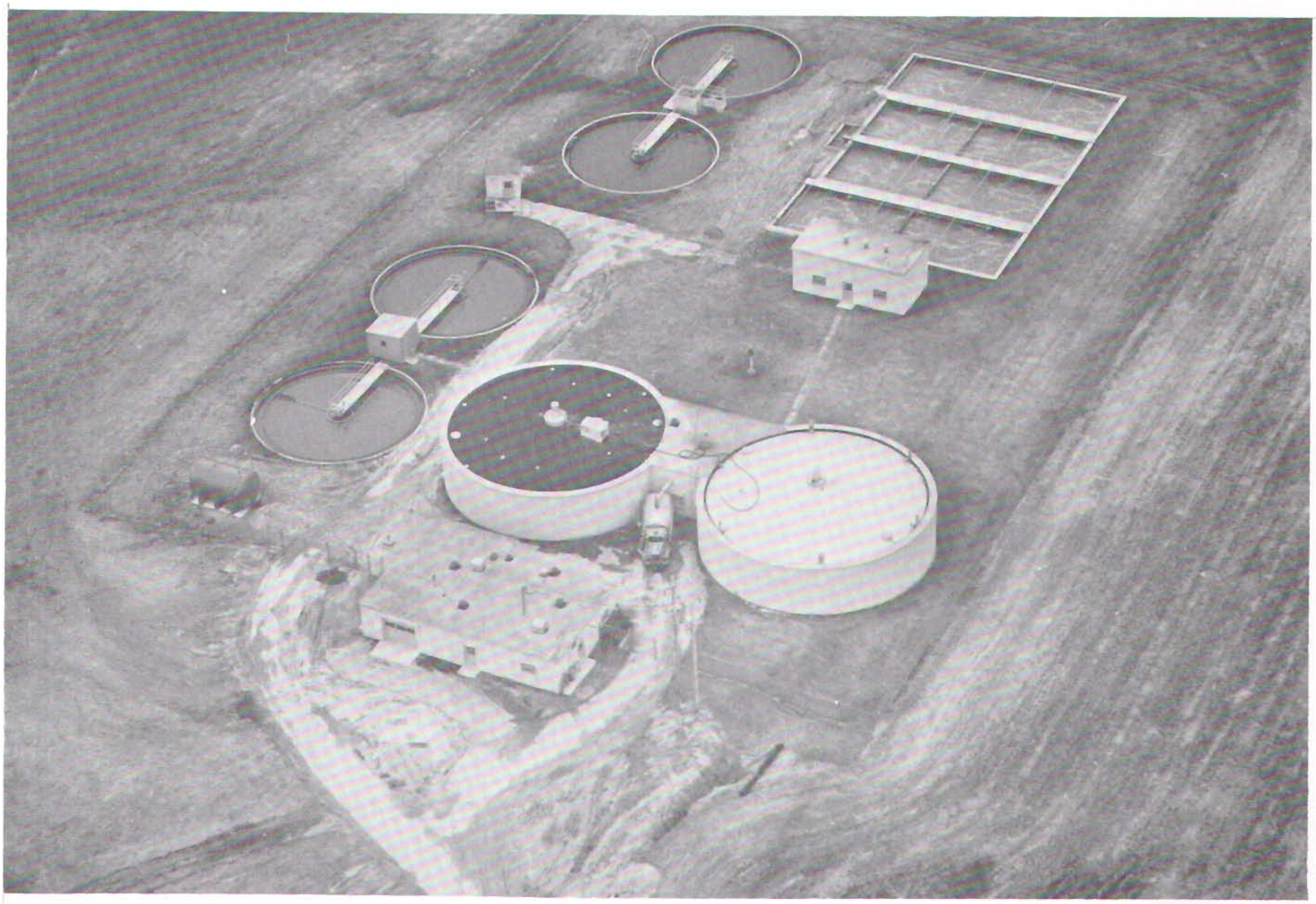
During 1975, the City of West Bend completed facilities planning for the expansion of the sewage treatment plant in order to correct existing deficiencies and provide adequate capacity to accommodate future growth in the City, as well as service to the Tri-Lakes area of Washington County. The facilities plan indicates that the proposed improvements will include provisions to remove the treatment plant site from the floodlands of the Milwaukee River through construction of a dike. The average hydraulic design capacity of the new plant is proposed to be 9.00 mgd, with a peak hydraulic design capacity of 28.00 mgd and an organic design capacity of 13,000 pounds of BOD_5 per day. The new plant is planned to incorporate primary and secondary treatment processes as well as advanced waste treatment for nitrification and phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes planned to be incorporated into the plant include primary sedimentation, synthetic media trickling filters followed by sedimentation, activated sludge nitrification followed by final sedimentation, chemical treatment for phosphorus removal, dual media filtration and chlorination.

The location and configuration of all major trunk sewers, pumping and lift stations, and related force mains included in the City of West Bend sanitary sewerage system are shown on Map 5. There is only one known point of sewage flow relief in the City of West Bend sanitary sewerage system, a bypass located at the sewage treatment plant. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 5.3 square mile area, which area is shown on Map 5.

Management of the City of West Bend sanitary sewerage system is under the direction of the Mayor and Common Council. Day-to-day administration of the system is provided by the Water and Sewer Department of the City, headed by the City Engineer.

Figure 17

CITY OF WEST BEND WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

Financing of the system is provided through a sewer service charge related to water consumption. Residential water consumers pay a sewer service charge equal to 75 percent of the water consumption charge. A residential sewer service user not served by the municipal water system is charged $32.00 per year for sewer service. All industries pay a sewer service charge equivalent to 100 percent of the water supply charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of West Bend sanitary sewerage system approximated $449,017, or about $21.00 per capita. Of this total, $200,242, or about $9.00 per capita, was expended for operation and maintenance, and $248,775, or about $12.00 per capita, was expended for capital improvements.

Village of Fredonia: The existing service area of the Village of Fredonia sanitary sewerage system is shown on Map 5. This area totals about 0.7 square miles and has a resident population of about 1,500 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Fredonia is treated at a wastewater treatment plant located at the southwesterly Village limits on the Milwaukee River, to which effluent is discharged (see Figure 18). The plant has a site area of about three acres, of which about one acre is currently utilized, leaving two acres available for future use. The plant site is bounded by agricultural and open lands on all sides. The plant was constructed in 1939 and was modified in 1962. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, and chlorination. Sludge solids removed from the treatment process are fed to an anaerobic digestion system and then to sludge drying beds prior to

Figure 18

VILLAGE OF FREDONIA WASTEWATER TREATMENT PLANT

Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

application on agricultural land. The plant has an average hydraulic design capacity of 0.12 mgd, with a peak hydraulic design capacity of 0.25 mgd, and an organic design capacity of 200 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.28 and 0.37 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 310 and 460 pounds of BOD_5 per day, indicating that the plant is operating above its hydraulic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 35 mg/l BOD_5 and 43 mg/l of suspended solids. Maximum monthly effluent concentrations of 54 mg/l of BOD_5 and 57 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not reported routinely during 1975. However, a monthly average effluent chlorine residual which varied from 0.5 mg/l to 0.7 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 60 mg/l of BOD_5, 60 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers serving the Village of Fredonia are shown on Map 5. The only known point of sewage flow relief in the Village of Fredonia sanitary sewerage system is a bypass located at the wastewater treatment plant. The inventory also indicated that the Village is in the early stages of preparing a facilities plan pertaining to expansion of its wastewater treatment facilities. The facilities planning program study area includes the unincorporated Village of Waubeka located immediately to the west of Fredonia, indicating that the facilities plan will evaluate providing public sanitary sewerage service to the Waubeka area.

Management of the Village of Fredonia sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Clerk of the Sewer and Water Commission. Financing of the system is provided through the general property tax and a sewer service charge equal to the bill for public water service.

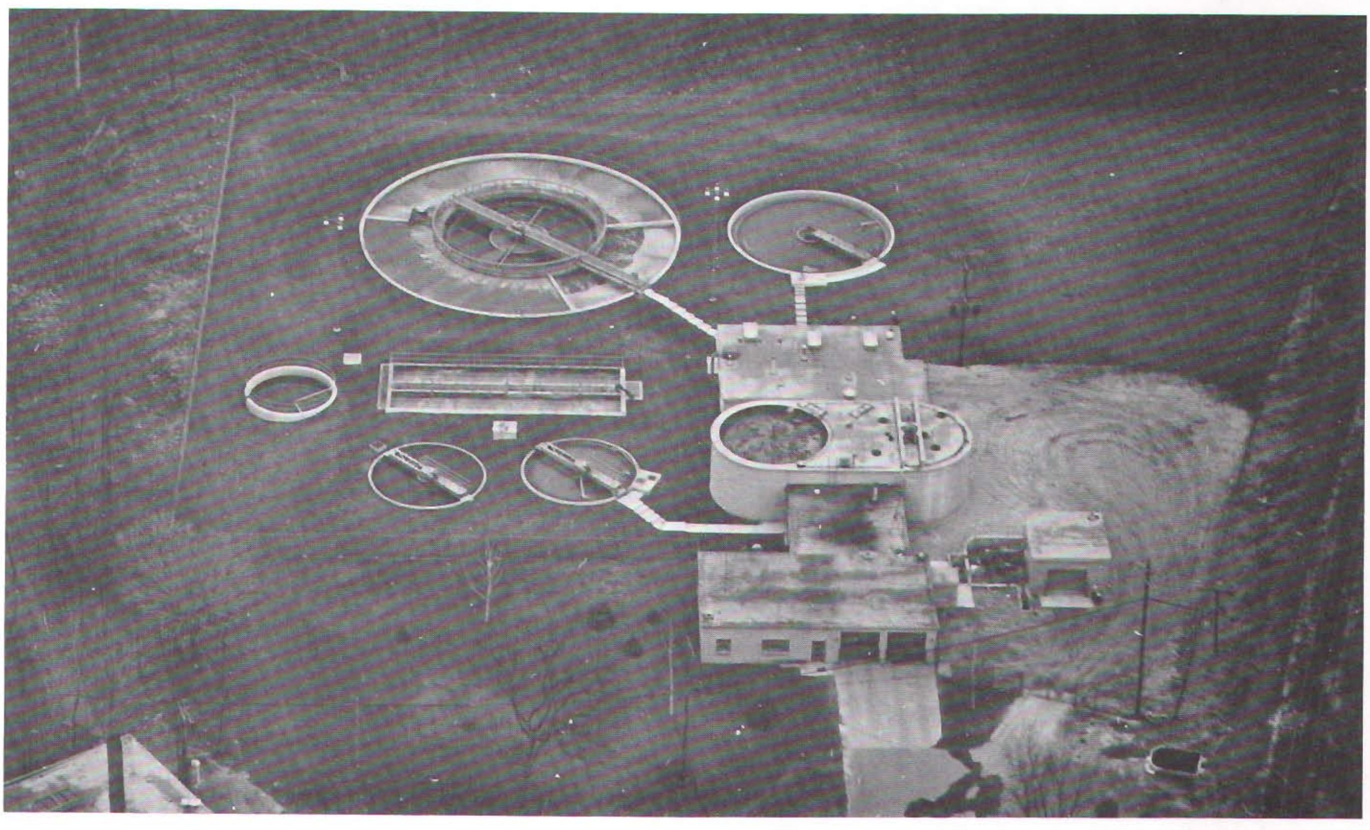
Total expenditures during 1974 for operation and maintenance and capital improvements at the sewerage system including the treatment plant are estimated to be $25,084, or about $17.00 per capita. Of this total, $16,084, or about $11.00 per capita, was expended for operation and maintenance, and $9,000, or about $6.00 per capita, was expended for capital improvements.

Village of Grafton: The existing service area of the Village of Grafton sanitary sewerage system is shown on Map 5. This area totals about 2.2 square miles and has a resident population of about 8,800 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Grafton is treated at a wastewater treatment plant located at the southern Village limits on the Milwaukee River, to which effluent is discharged (see Figure 19). The plant has a site area of about two acres, all of which is currently utilized. The plant site is bounded by open and wooded lands on the south, railroad right-of-way on the west, commercial land use on the north, and Green Bay Road on the east. The plant was constructed in 1959-1960, replacing an earlier plant constructed at the same site in 1934, and underwent additions in 1970. The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the wastewater are divided and fed to either an anaerobic or aerobic digestion system prior to application on agricultural lands. The plant has an average hydraulic design capacity of 1.00 mgd, with a peak hydraulic design capacity of 2.50 mgd and an average organic design capacity of 1,880 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.88 and 1.05 mgd respectively, while the average annual and maximum

Figure 19

VILLAGE OF GRAFTON WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

monthly organic loadings were reported to be 1,020 and 1,210 pounds of BOD_5 respectively, indicating that the plant is operating near its hydraulic design capacity, but below its organic design capacity.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 9 mg/l of BOD_5 and 16 mg/l of suspended solids. Maximum monthly average effluent concentrations of 15 mg/l of BOD_5 and 20 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not reported routinely during 1975. However, a monthly average effluent chlorine residual which varied from 0.4 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, membrane filter fecal coliform counts of 200 per 100 ml, and 15 percent of the raw wastewater influent phosphorus concentration, effective through April 30, 1979.

The location and configuration of the major trunk sewers serving the Village of Grafton are shown on Map 5. There are no known points of sewage flow relief in the system. The inventory revealed that the Village had a documented plan for the provision of sewer service to an additional 0.3 square mile area, which area is shown on Map 5. Those locally proposed trunk sewers to serve this area are identified on Map 5.

Management of the Village of Grafton sanitary sewerage system is under the direction of a five-member Water and Wastewater Commission. Day-to-day administration of this system is provided by the staff of the Commission. Financing of the system is provided through a sewer service charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Grafton sanitary sewerage system approximated $212,765, or about $24.00 per capita. Of this total, $175,430, or about $20.00 per capita, was expended for operation and maintenance, and $37,335, or about $4.00 per capita, was expended for capital improvements.

Village of Jackson: The existing sewer service area of the Village of Jackson sanitary sewerage system is shown on Map 5. This area totals about 0.4 square mile and has a resident population of about 2,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Jackson is treated at a wastewater treatment plant located at the eastern Village limits. Effluent is discharged through an outfall sewer to Cedar Creek (see Figure 20). The plant has a site area of about one acre. The plant site is bounded by residential land use on the north, east, and south and agricultural land use on the west. The plant was constructed in 1939, and incorporates primary and secondary treatment processes and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filter, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are processed by anaerobic digestion followed by sludge drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.03 mgd, with a peak hydraulic design capacity of 0.05 mgd and an organic design capacity of 40 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.26 and 0.28 mgd respectively, indicating that the plant does not have adequate capacity to treat the average daily flow from the sewer service area.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 140 mg/l of BOD_5 and 91 mg/l of suspended solids and an average fecal coliform count of 4,800,000 per 100 ml. Maximum monthly average effluent concentrations

Figure 20

VILLAGE OF JACKSON WASTEWATER TREATMENT PLANT

Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

of 215 mg/l of BOD_5 and 110 mg/l of suspended solids as well as a maximum monthly average fecal coliform count of 6,600,000 per 100 ml were reported during 1975. Data on effluent phosphorus concentrations were not reported routinely in 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 120 mg/l of BOD_5, 120 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

It should be noted that the Village of Jackson is in the final stages of the facilities planning process relating to construction of a new wastewater treatment plant to be located southeast of the Village on Cedar Creek, to which effluent would continue to be discharged. The proposed wastewater treatment facility would discharge to Cedar Creek at a point adjacent to the existing outfall and is proposed to have an average hydraulic design capacity of 0.87 mgd, a peak hydraulic design capacity of 1.38 mgd, and an organic design capacity of 1,700 pounds of BOD_5 per day. The new plant is proposed to serve, in addition to the Village of Jackson, the Libby, McNeil and Libby, Inc. canning plant located in the Town of Jackson. The canning plant will contribute about 30 percent of the total annual BOD_5 loading to the new plant. The proposed new plant is planned to provide secondary waste treatment, advanced wastewater treatment for nitrification and phosphorus removal, and auxiliary waste treatment for effluent disinfection.

The location and configuration of all major trunk sewers, pumping stations, and related force mains serving the Village of Jackson are shown on Map 5. As shown on Map 5, there are two known points of sewage flow relief in the Village of Jackson sanitary sewerage system both of which are bypasses. The inventory revealed that the Village of Jackson has no documented plan for the provision of additional sewer service.

Management of the Village of Jackson sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Superintendent of the treatment plant.

Financing of the system is provided through the general property tax. Total expenditures during 1975 for operation, maintenance, and capital improvements for the Village of Jackson sanitary sewerage system approximated $35,890, or about $18.00 per capita. Of this total, $9,138, or about $4.50 per capita, was expended for operation and maintenance, and $26,752, or about $13.50 per capita was expended for capital improvements.

Village of Kewaskum: The existing sewer service area of the Village of Kewaskum sanitary sewerage system is shown on Map 5. This area totals about 0.6 square mile and has a resident population of about 2,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Kewaskum is treated at a wastewater treatment plant located on the Milwaukee River, to which effluent is discharged (see Figure 21). The plant has a site area of about six acres, of which two acres are currently utilized, leaving four acres available for future use. The plant site is bounded by open lands on the north, residential land uses on the south, STH 45 on the west, and the Chicago and Northwestern Railroad on the east. The plant was constructed in 1955 and underwent extensive modifications in 1972.

The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes include raw primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an aerobic digestion system and through a vacuum filter to reduce moisture prior to final disposal on agricultural lands. The plant has an average hydraulic design capacity of 1.00 mgd, with a peak hydraulic design capacity of 1.50 mgd and an organic design capacity of 1,800 pounds of BOD per day.

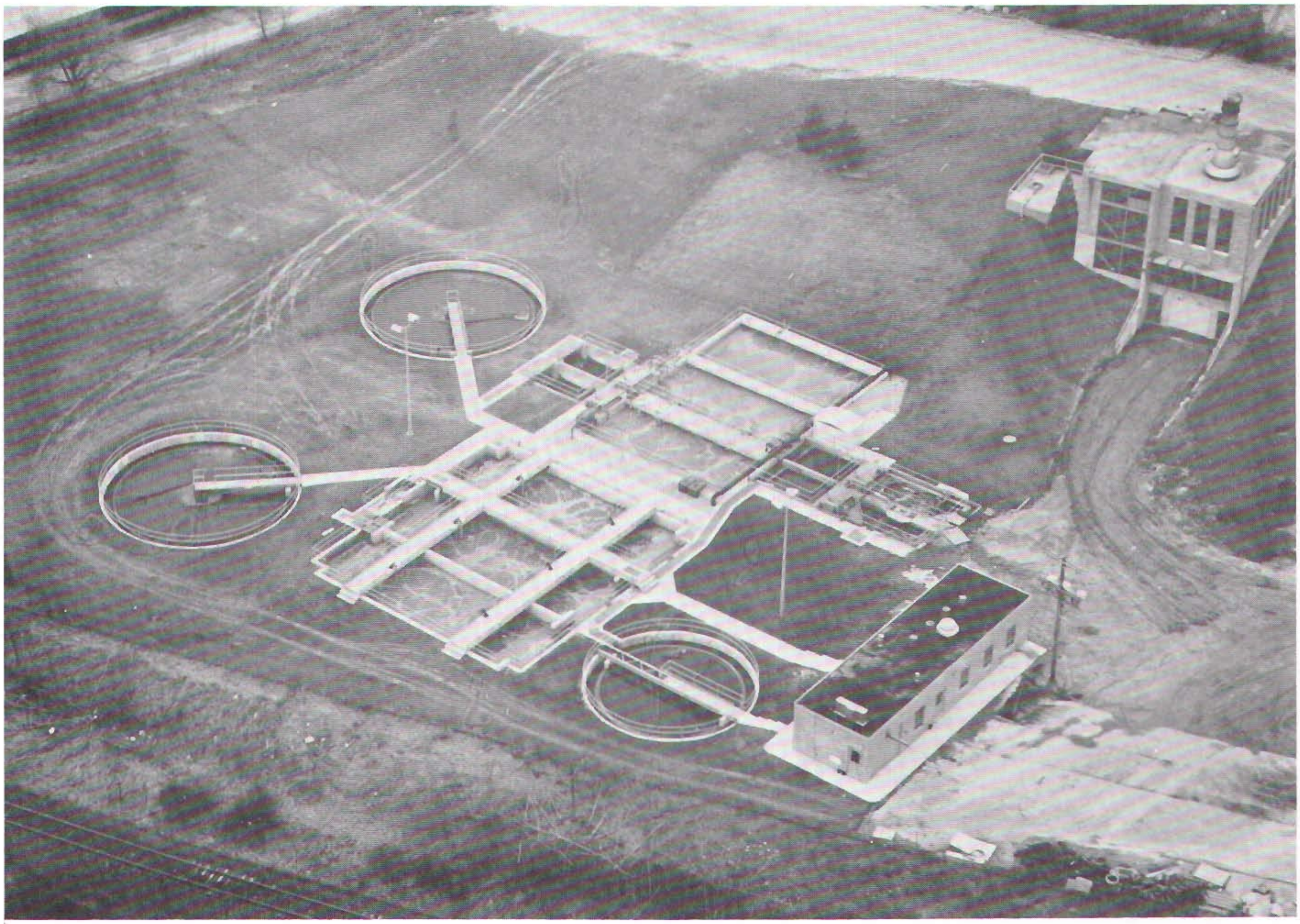
During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.32 and 0.47 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 970 and 1,610 pounds of BOD_5 respectively, indicating that the plant has adequate capacity to treat the hydraulic and organic loading from the existing sewer service area.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 9 mg/l of BOD_5, 8 mg/l of suspended solids, and 1.8 mg/l of phosphorus. Maximum monthly average effluent concentrations of 20 mg/l of BOD_5, 19 mg/l of suspended solids, and 3.7 mg/l of phosphorus were reported during 1975. Data on effluent fecal coliform counts were not reported routinely during 1975. However, a monthly average effluent chlorine residual which varied from 0.5 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 2 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping stations, and related force mains included on the Village of Kewaskum sanitary

Figure 21

VILLAGE OF KEWASKUM WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

sewerage system are shown on Map 5. There are no known points of sewer overflow or bypassing in the Village of Kewaskum sanitary sewerage system.

Management of the Village of Kewaskum sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Superintendent of the treatment plant.

Financing of the system is provided through a sewer charge. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Kewaskum sanitary sewerage system approximated $102,722, or about $51.00 per capita. Of this total, $84,961, or about $42.00 per capita, was expended for operation and maintenance, and $17,761, or about $9.00 per capita, was expended for capital improvements.

Village of Newburg: The existing service area of the Village of Newburg sanitary sewerage system, located in the Town of Trenton, Washington County, and the Town of Saukville, Ozaukee County, is shown on Map 5. This area totals about 0.2 square mile and has a resident population of about 600 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Newburg is treated at a wastewater treatment plant located on the Milwaukee River, to which effluent is discharged (see Figure 22). The plant has a site area of about 17 acres, of which about nine acres are currently utilized, leaving eight acres available for future use. The plant site is bounded by open land uses on all sides. The plant site was constructed in 1964. The treatment plant provides secondary waste treat-

Figure 22

VILLAGE OF NEWBURG
WASTEWATER TREATMENT PLANT

Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

ment and auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an aerobic digestion system and then are applied to agricultural lands.

The plant has an average hydraulic design capacity of 0.05 mgd, with an estimated peak hydraulic design capacity of about 0.10 mgd, and an organic design capacity of 136 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loading to the plant were both reported to be approximately 0.07 mgd, while the average annual and maximum monthly organic loadings were reported to be approximately 150 and 160 pounds of BOD_5, respectively, indicating that the plant is operating over its hydraulic capacity.

During 1975, the wastewater treatment plant effluent contained average concentrations of 75 mg/l of BOD_5 and 54 mg/l of suspended solids. Data on effluent phosphorus concentrations and fecal coliform counts were not reported routinely in 1975. However, an average effluent chlorine residual of 0.5 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids and membrane filter fecal coliform counts of 200 per 100 ml, effective through March 31, 1976.

The location and configuration of all major trunk sewers serving the Village of Newburg are shown on Map 5. As shown on Map 5, there is one known point of sewage flow relief in the Village of Newburg sanitary sewerage system, a bypass at the sewage treatment plant. The inventory indicated that the Village had no documented plan for the expansion of its sanitary sewerage system.

Management of the Village of Newburg sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by a part-time, certified Plant Operator and Sanitary Engineer. Financing of the system is provided through a sewer service charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Newburg sanitary sewerage system approximated \$23,110, or about \$38.50 per capita. Of this total, \$13,345, or about \$22.00 per capita, was expended for operation and maintenance, and \$9,765, or about \$16.50 per capita, was expended for capital improvements.

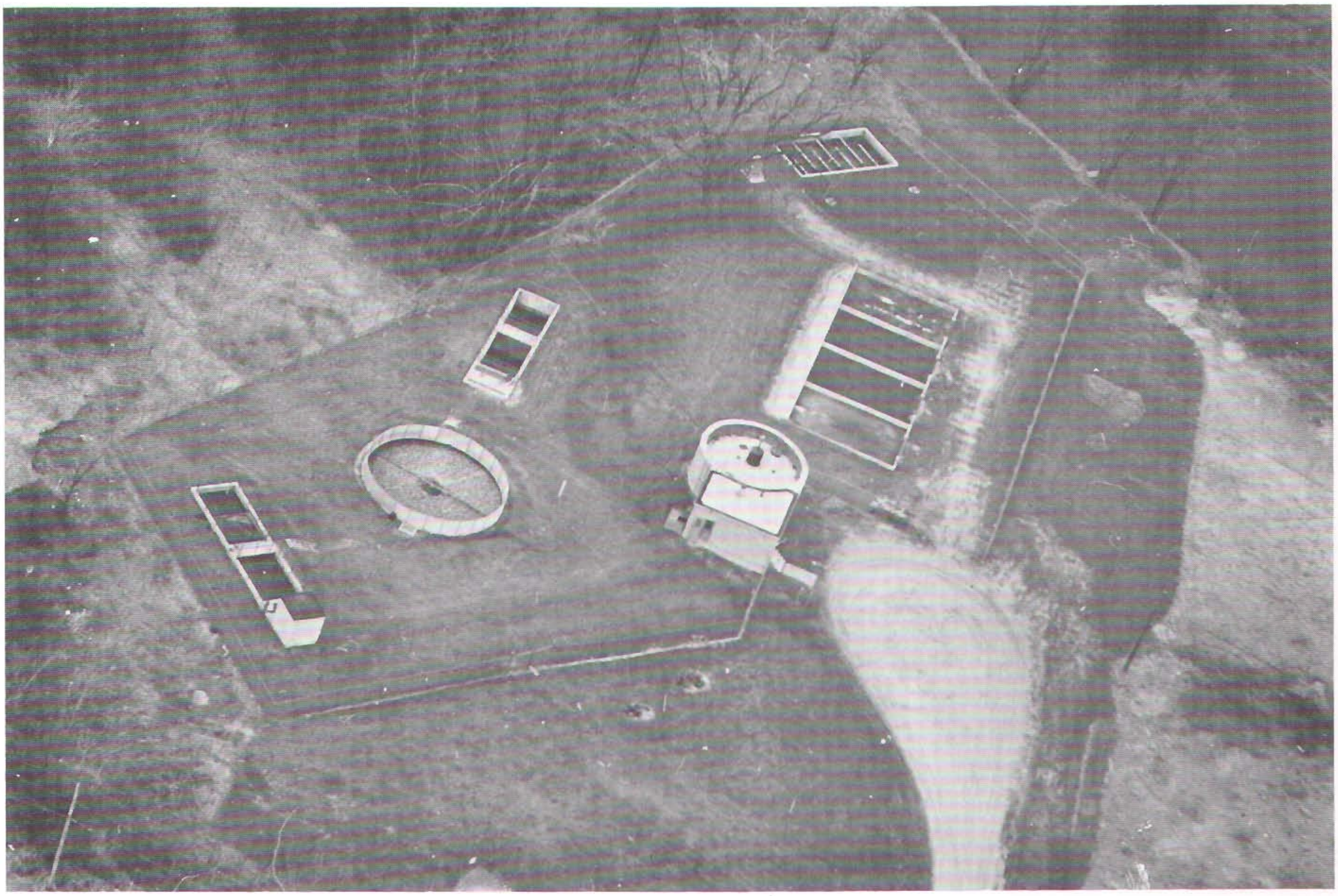
Village of Saukville: The existing service area of the Village of Saukville sanitary sewerage system is shown on Map 5. This area totals about 0.4 square mile and has a resident population of about 2,300 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Saukville is treated at a wastewater treatment plant located at the southeasterly Village limits on the Milwaukee River, to which effluent is discharged (see Figure 23). The plant has a site area of about three acres, of which about two acres are currently utilized, leaving about one acre available for future use. The plant site is bounded by the Milwaukee River on the west and by agricultural and open lands on the north, south, and east. The plant was constructed in 1959.

The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filter, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system and sludge drying beds prior to final land disposal. The plant has an average hydraulic capacity of 0.28 mgd, with a peak hydraulic capacity of 0.46 mgd, and an organic design capacity of 430 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.29 and 0.42 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 310 and 490 pounds of BOD_5 respectively, indicating that the plant is operating near its design hydraulic capacity.

Figure 23

VILLAGE OF SAUKVILLE WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 36 mg/l of BOD_5 and 39 mg/l of suspended solids. Maximum monthly average effluent concentrations of 55 mg/l of BOD_5 and 54 mg/l of suspended solids were reported for 1975. Data on effluent fecal coliform counts were not reported during 1975. However, a monthly average effluent chlorine residual which varied from 1.0 mg/l to 8.0 mg/l was reported.

The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 60 mg/l of BOD_5, 60 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of all major trunk sewers serving the Village of Saukville are shown on Map 5. As shown on Map 5, there is one sewage flow relief device in the Village of Saukville sanitary sewerage system, which is a relief pumping station.

Early in 1977, the Village of Saukville completed a facility plan for the expansion of the existing wastewater treatment plant in order to correct existing deficiencies and provide adequate capacity to accommodate future growth. The facility plan report proposes to expand the plant to an average hydraulic capacity of 1.00 mgd and an organic design capacity of 1,670 pounds of BOD_5 per day. The proposed new plant is planned to provide secondary waste treatment, advanced waste treatment for phosphorus removal, and auxiliary waste treatment for effluent disinfection.

Management of the Village of Saukville sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Utility Committee of the Board and the Commissioner of Public Works.

Financing of the system is provided through a sewer service charge based upon water consumption. Total expenditures during 1970 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Saukville sanitary sewerage system approximated $74,576, or about $32.50 per capita. Of this total, $52,045, or about $22.50 per capita, was expended for operation and maintenance, and $22,531, or about $10.00 per capita, was expended for capital improvements.

Proposed Public Sanitary Sewerage Systems

The Commission sewer service inventory indicated that, as of 1975, proposals had been made for the construction of two new public sanitary sewerage systems in the Upper Milwaukee River subregional area. One of these two systems would serve the Tri-Lakes area in Washington County, consisting of urban development along the shorelines of Big Cedar Lake, Little Cedar Lake, and Silver Lake, located southwest of the City of West Bend. The other would serve urban development along the shoreline of Wallace Lake in the Towns of Barton and Trenton. Sewage collected by these systems is proposed to be treated at the City of West Bend treatment plant. Both of these proposed sanitary sewerage systems were recommended in the adopted comprehensive plan for the Milwaukee River watershed. Together these two proposed systems would serve a total area of about 2.9 square miles, or about 1 percent of the subregional area, and a total seasonal resident population of about 4,000. Both of these proposed sewer service areas have been included in the facility plan for the City of West Bend.

In addition to the two proposed public sanitary sewerage systems noted above, the adopted Milwaukee River watershed plan initially recommended that a centralized sanitary sewerage system be provided in the Town of Farmington to serve existing urban development, including campgrounds on the shoreline of Green Lake. The record of the public hearing with respect to the Milwaukee River watershed plan reveals no opposition to or comment on the plan recommendation at that time. Accordingly, this recommendation was carried over into the preparation of the preliminary regional sanitary sewerage system plan. At the public hearing on the preliminary plan, both the Town of Farmington and the Washington County Park and Planning Commission requested this recommendation be deleted from the plan. The local officials expressed concern that the establishment of such a system would serve to induce further urban development and destroy the generally rural character of the surrounding area. Furthermore, they indicated steps would be taken with respect to the enactment of sound zoning and other land use control ordinances to ensure that urban development would not take place in this area. Finally, they indicated that alternative solutions to any existing problems, perhaps including the installation of holding tanks where necessary, would be superior to the establishment of a new sewerage system that would be costly to the small number of permanent residents on the lake. After careful consideration of the information presented by the local public officials in this area, the Commission determined to delete from the recommended regional sanitary sewerage system plan the proposal to provide for a new centralized sanitary sewer system to serve urban development on the shorelines of Green Lake. At the same time, the Commission noted that should problems related to the handling of sanitary wastes in the Green Lake area become more severe at some future date, a recommendation to provide a centralized sanitary sewerage service could be reconsidered.

Each of the two proposed public sanitary sewer systems is described in the following paragraphs.

Tri-Lakes Sanitary Sewerage Systems: As noted above, the Tri-Lakes sanitary sewerage system would serve existing urban development along Big Cedar, Little Cedar and Silver Lakes. After careful consideration of alternative ways of providing centralized sanitary sewer service to the major lakes area, the comprehensive plan for the Milwaukee River watershed and the adopted regional sanitary sewerage system plan recommended that service be provided through the City of West Bend sanitary sewerage system. To date, the Common Council of the City of West Bend has agreed in principle to the provision of such service, and has completed facilities planning studies designed to expand the existing West Bend wastewater treatment plant, in part to accommodate the anticipated sewage flow from the Tri-Lakes area. The individual sanitary districts already formed around the three lake areas have not acted to date to adopt the plan recommendations. The proposed service area of the Tri-Lakes sanitary sewerage system is shown on Map 5. This area totals about 2.7 square miles and has a current seasonal resident population of about 2,400 persons. Detailed lake water quality management reports are presently being prepared for Big Cedar, Little Cedar, and Silver Lakes under the areawide water quality management planning program. These reports will further evaluate the need for the timing of providing public sanitary sewer service to the Tri Lakes area.

Wallace Lake Sanitary Sewerage System: The proposed sanitary sewerage system for Wallace Lake, which lake is located adjacent to the northeast limits of the City of West Bend, is recommended to be connected to the City of West Bend sanitary sewerage system for sewage treatment purposes. The Wallace Lake area is included in the future planned service area incorporated into the facilities planning studies designed to expand the West Bend sewage treatment plant. The proposed service area, as shown on Map 5, totals about 0.2 square miles and has a current resident population of about 200 persons.

Flow Relief Devices

As noted above on an individual community basis, there are eight sewage flow relief devices located in the sanitary sewerage system located in the Upper Milwaukee River subregional area. Table 12 indicates the number and type of flow relief devices as well as an estimate of the total average annual discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 5.

Table 12

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in the Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer *Outfalls*	Total	
City of Cedarburg	No	--	2	--	--	--	2	--[b]
City of West Bend	Yes-Bypass	--	--	--	--	--	--	--[b]
Village of Fredonia	Yes-Bypass	--	--	--	--	--	--	2.0
Village of Grafton	No	--	--	--	--	--	--	--
Village of Jackson	No	--	2	--	--	--	2	4.0
Village of Kewaskum	No	--	--	--	--	--	--	--
Village of Newburg	Yes-Bypass	--	--	--	--	--	--	--[b]
Village of Saukville	No	--	--	1	--	--	1	--[b]
Total	3-Bypasses	--	4	1	--	--	5	6.0

[a] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.*

[b] *The annual contribution from the relief devices is less than 1.0 mg.*

Source: SEWRPC.

Other Wastewater Treatment Facilities

In addition to the eight publicity-owned sanitary sewerage systems discussed above, there are a total of five privately-owned wastewater treatment facilities in the Upper Milwaukee River subregional area which in general serve single, isolated, urban land use enclaves and generally treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. Four of these facilities are industrial waste treatment plants directly related to the agricultural industry. These industrial waste treatment plants serve the Justro Feed Corporation plant in the Town of Cedarburg; the Libby, McNeil and Libby, Inc. canning plant in the Town of Jackson; the Level Valley Dairy creamery in the Town of Jackson; and the S & R Cheese Corporation cheese manufacturing plant in the Town of Saukville. The fifth facility is the Cedar Lake Rest Home which treats domestic wastes. Pertinent characteristics of these facilities are presented in Table 13 and their location is shown on Map 5. It should be noted that the Libby, McNeil and Libby, Inc. facility in the Town of Jackson is proposed to be connected to the new Village of Jackson wastewater treatment facility.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage overflow points on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, rinse, and wash waters, which are discharged without treatment or following treatment directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Wisconsin Department of Natural Resources, permits issued under the Wisconsin Pollutant Discharge Elimination System, and the portion of the effluent reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters, and records of municipal public works departments. A total of 21 such known point sources of industrial wastewater were identified in the Upper Milwaukee River subregional area. The characteristics of these 21 waste sources are identified in Table 14 and the location of these 21 point sources is shown on Map 6.

Point Sources of Wastewater Outside the Region

With respect to that portion of the Milwaukee River watershed lying in Fond du Lac and Sheboygan Counties, north of the boundaries of the Upper Milwaukee River subregional area, four wastewater

Table 13

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Average Hydraulic Design Capacity (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
MILWAUKEE RIVER WATERSHED													
Ozaukee County													
Justro Feed Corporation (Not in Operation)	Town of Cedarburg	Industrial	Process	Lagoon	Soil Absorption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
S & R Cheese Corporation	Town of Fredonia	Industrial	Process	Septic Tank and Lagoon	Soil Absorption	1,800	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Washington County													
Cedar Lake Rest Home	Town of West Bend	Institutional	Sanitary	Contact Stabilization and Lagoon	Soil Aborption	N/A	N/A	35,000	N/A	N/A	N/A	N/A	N/A
Level Valley Dairy	Town of Jackson	Industrial	Process and Cooling	Aeration and Lagoon	Cedar Creek	172,000	N/A	218,100	51.7	48.0	16.0	19.5	N/A
Libby Mc Neill and Libby-Jackson	Town of Jackson	Industrial	Process and Cooling	Lagoon and Spray Irrigation	Soil Absorption	144,000	N/A	144,000	8.4	11.4	0.0	0.35	N/A

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System, questionnaire data obtained by SEWRPC, reports filed under Section NR 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the data as reported in or requirements of the permit itself.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

treatment facilities are currently in operation. These include the systems operated by the Village of Campbellsport in Fond du Lac County and the Villages of Cascade, Adell, and Random Lake in Sheboygan County. These wastewater treatment plants have a combined average design capacity of about 0.60 mgd, while serving an estimated population of about 4,200 people. The newest plant to be built in the Upper Milwaukee River watershed outside the Region is the Village of Cascade, which was constructed in 1976. Pertinent data on the existing wastewater treatment plants for 1976 is presented in Table 15.

In addition to the four existing wastewater treatment facilities, two plants have been proposed within Fond du Lac County under the regional sanitary sewerage system plan. The proposed sewage treatment facility of Forest Lake is planned to serve an estimated 0.1 square mile within the Town of Auburn or about 600 population with an average hydraulic loading of 0.10 mgd. The other future plant located at Kettle Moraine Lake is proposed to serve an estimated 0.2 square mile with an estimated population of 800 and an average hydraulic loading of 0.10 mgd.

More detailed information concerning plant design and recommendations for the four existing and two proposed plants can be found in the Commission Planning Report No. 16, A Regional Sanitary Sewerage System Plan for Southeastern Wisconsin.

Known point sources of wastewater other than public sewage treatment plants are shown on Map 6. The characteristics of these point sources of wastewater sources are shown in Tables 16 and 17.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Upper Milwaukee River subregional area serve a total area of about 13.4 square miles, or 4 percent of the total area of the subregional area, and a total population of about 48,600, or about 64 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quartersection not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quartersection with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban while quartersections with between 6 and 31 housing units or one housing unit for every 5 to 27 gross acres, was classified as rural-urban. Quartersections with 5 or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Table 14

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE UPPER MILWAUKEE SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	MILWAUKEE RIVER WATERSHED																
	Ozaukee County																
1	Ataco Steel Products Company	3312	Village of Grafton	Cooling	None	1	Milwaukee River via Storm Sewer	20,000	35,000	10.4	2.0	0.23	1.07	N/A	27.8	Yes	--
2	Brunswick Corporation Mercury Marine Division Plant No. 1	3519	City of Cedarburg	Process and Cooling	None	1	Cedar Creek via Storm Sewer	43,000	70,000	12.0	11.0	N/A	N/A	N/A	19.4	Yes	--
3	Brunswick Corporation Mercury Marine Division Plant No. 2	3361	City of Cedarburg	Cooling	None	1	Cedar Creek via Storm Sewer	5,000	10,000	3.0	3.0	0.62	0.0	N/A	25.0	Yes	--
4	Dayton Malleable-Meta-Mold Division	3361	City of Cedarburg	Cooling and Process	None	1	Cedar Creek via Storm Sewer and Drainage Ditch	21,000	35,000	145.0	29.4	0.57	3.65	N/A	18.0	Yes	--
5	Doerr Electric Corporation	3621	City of Cedarburg	Cooling	None	1	Cedar Creek via Storm Sewer	1,000	1,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
				Process	Septic	1	Soil Absorber	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
6	EST Company, Inc.	3361	Village of Grafton	Cooling	None	2	Milwaukee River via Storm Sewer and Drainage Ditch	8,100	14,000	1.2	9.9	84.0	1.25	N/A	16.5	No	--
7	Freeman Chemical Corporation	2821	Village of Saukville	Cooling	None	1	Milwaukee River	344,200	436,700	0.1	0.0	0.92	1.9	N/A	15.7	Yes	--
8	Johnson Brass and Machine Foundry, Inc.	3362	Village of Saukville	Cooling	None	1	Milwaukee River via Storm Sewer	7,000	N/A	N/A	30.0	N/A	N/A	N/A	N/A	No	--
9	KMC Stamping Division . .	3469	Village of Grafton	Cooling	None	1	Milwaukee River via Drainage Ditch	125	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
10	Leeson Electric Corporation	3621	Village of Grafton	Cooling	Lagoon	1	Milwaukee River via Storm Sewer	5,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
11	MSD Plastics, Inc.	3079	Village of Grafton	Cooling	Settling Tank	1	Cedar Creek via Storm Sewer	25,000	35,000	7.0	4.0	N/A	N/A	N/A	25.6	Yes	--
12	Russel T. Gilman, Inc.	3545	Village of Grafton	Cooling	None	1	Milwaukee River via Storm Sewer	700	1,300	N/A	N/A	N/A	N/A	N/A	30.0	No	--
	Washington County																
13	Amity Leather Products Company	3172	City of West Bend	Cooling and Boiler Blowdown	None	1	Milwaukee River via Storm Sewer	N/A	10,000	2.0	0.1	0.2	5.2	N/A	26.6	No	--
14	Bermico Company	2646	City of West Bend	Process and Cooling	Oil Separator	1	Milwaukee River	228,800	295,000	0.02	39.5	N/A	1.0	N/A	15.3	No	--
15	Culligan Water Conditioning, Inc.	7399	City of West Bend	Filter Backwash	None	1	Milwaukee River via Storm Sewer	2,900	3,000	34.0	9.8	0.54	0.87	N/A	N/A	Yes	--
16	Fairmont Foods Company .	2026	Village of Kewaskum	Cooling	None	1	Milwaukee River via Storm Sewer	8,000	10,000	8.4	3.4	0.62	5.2	N/A	12.8	No	--
17	Gehl Company	3523	City of West Bend	Cooling	None	1		64,000	94,000	N/A	N/A	N/A	N/A	N/A	22.2	No	--
				Cooling	None	2	Milwaukee River	4,000	4,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
				Cooling	None	3	via Storm Sewer	17,000	37,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
				Cooling	None	4	Milwaukee River	168,000	456,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
18	Kewaskum Frozen Foods. .	2011	Village of Kewaskum	Cooling	None	1	Milwaukee River via Storm Sewer	10,000 to 50,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
19	Pick Automotive Corporation	3714	City of West Bend	Cooling	None	1	Milwaukee River via Storm Sewer	1,000	N/A	N/A	N/A	N/A	N/A	N/A	14.8	No	--
20	Regal Ware Inc.	3631	Village of Kewaskum	Cooling	None	1	Milwaukee River	124,300	168,300	N/A	3.0	0.2	N/A	N/A	21.4	Yes	--
21	The West Bend Company . .	3634	City of West Bend	Cooling	None	1	Milwaukee River	1,000	1,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	2	Milwaukee River	1,000	1,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	3	Milwaukee River	45,000	62,000	0.5	1.3	0.025	0.84	N/A	17.9	Yes	--
				Cooling	None	4	Milwaukee River	29,000	39,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	5	Milwaukee River	6,000	8,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	6	Milwaukee River	3,000	4,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	8	Milwaukee River	1,000	1,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	9	Milwaukee River	52,000	72,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	10	Milwaukee River	1,000	1,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--
				Cooling	None	11	Milwaukee River	4,000	5,000	0.5	1.3	0.025	0.84	N/A	N/A	Yes	--

NOTE: N/A indicates data not available.

a Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section NR 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in or requirements of the permit. In some cases when wastewater characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Together these nonsewered areas total about 327 square miles, or 96 percent of the total area of the subregional area, and contain a total population of about 26,900, or 36 percent of the total population of the subregional area. Of that total, about 11.2 square miles, or 3 percent of the total area of the subregional area containing a total population of 7,000, or 9 percent of the total population of the subregional area are classified as urban nonsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into 22 named major urban concentrations which are shown on Map 6. The estimated population and urban development areas of each of these major concentrations are shown in Table 18.

The most common method of providing for sewage disposal for those approximately 26,900 people not served by public sanitary sewers within the Upper Milwaukee River subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of use of other onsite treatment systems. Another method of sewage disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternative is using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system." This system is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through 1975, there were 36 sewage holding tank installations, and two mound systems existing in the Upper Milwaukee River subregional area.

Twenty of the holding tanks served residential homes, while 15 were utilized by commercial establishments, and one was utilized by an industrial establishment. The mound systems were utilized to dispose of sanitary sewage from residences. The location of these systems is indicated on Map 6.

Concluding Remarks—Upper Milwaukee River Subregional Area

Inventories conducted under the areawide water quality management planning program indicated that in 1975 there existed in the Upper Milwaukee River subregional area a total of eight public sanitary sewerage systems, which include 8 sewage flow relief devices and which serve a total area of about 13.3 square miles, or about 4 percent of the total area of the subregional area, and a total of about 48,600 persons, or about 64 percent of the total population of the subregional area. Each of the eight sanitary sewerage systems operates its own sewage treatment facility. In addition to the eight publicly-owned sanitary sewerage systems, five privately-owned wastewater treatment facilities servicing isolated industrial and recreational establishments were found in the inventory. There were also four existing public sanitary sewerage systems north of the Upper Milwaukee River subregional area but within the Milwaukee River watershed. The inventory indicated that as of 1975 there were two proposed new public sanitary sewerage systems within the Upper Milwaukee River subregional area and two facilities north of the subregional area, but within the Milwaukee River watershed. All four of these are intended to serve existing urban development along lake shorelines. There were also 21 point sources of wastewater other than wastewater treatment plants identified in the subregional area consisting primarily of industrial cooling, process, and filter backwash waters. Finally, in 1975 there were an estimated 7,000 persons residing in scattered enclaves of urban development in the upper Milwaukee subregional area not served by public

Table 15

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA (OUTSIDE THE REGION): 1976

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes				Level of Treatment Provided			Disposal of Effluent	Sludge Handling and Disposal Unit Processes				
				Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary		Aerobic Digestion	Anerobic Digestion	Drying Beds	Vacuum Filter	Land Application
Village of Adell	N/A	500	1961	No	Yes	No	Yes	Yes	No	Yes	Soil Absorption	N/A	N/A	N/A	N/A	N/A
Village of Cambellsport	0.41	1,900	1935, 1962	No	Yes	No	Yes	Yes	No	Yes	West Branch of Milwaukee River	N/A	N/A	N/A	N/A	N/A
Village of Cascade	0.22	600	1976	Aerated Lagoons		No	Yes	Yes	No	Yes	North Branch of Milwaukee River	N/A	N/A	N/A	N/A	N/A
Village of Random Lake	N/A	1,200	1936	Yes	No	No	Yes	Yes	No	Yes	Silver Creek	N/A	N/A	N/A	N/A	N/A

Table 15 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975: Annual Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Hydraulic Per Capita (GPD)	Existing Loading - 1975: Maximum Monthly Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Organic (pounds BOD_5/day)	Existing Loading - 1975: Average Annual Organic Per Capita (pounds BOD_5/day)	Existing Loading - 1975: Maximum Monthly Average Organic (pounds BOD_5/day)	Wastewater Strength Parameters in Influent Sewage: BOD_5 (mg/l)	Wastewater Strength Parameters in Influent Sewage: Suspended Solids (mg/l)	Wastewater Strength Parameters in Influent Sewage: Total Phosphorus (mg/l)	Wastewater Strength Parameters in Influent Sewage: Organic Nitrogen-N (mg/l)	Wastewater Strength Parameters in Influent Sewage: Amonia Nitrogen-N (mg/l)	Design Capacity: Population[b]	Design Capacity: Average Hydraulic (MGD)	Design Capacity: Peak Hydraulic (MGD)	Design Capacity: Average Organic (pounds BOD_5/day)	Design Capacity: Average Organic Population[b] Equivalent	Industrial Flows: Design Average Daily Flow (MGD)	Industrial Flows: Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
Village of Adell	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.10	0.16	N/A	N/A	N/A	N/A	N/A
Village of Campbellsport	0.31	163	0.60	N/A	N/A	N/A	172	159	N/A	N/A	N/A	N/A	0.24	N/A	N/A	N/A	N/A	N/A	N/A
Village of Cascade	0.04	67	0.47	N/A	N/A	N/A	142	145	N/A	N/A	N/A	N/A	0.17	0.60	N/A	N/A	N/A	N/A	N/A
Village of Random Lake	0.20	167	0.25	N/A	N/A	N/A	137	166	N/A	N/A	N/A	N/A	0.08	0.30	N/A	N/A	N/A	N/A	N/A

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]: BOD_5 (mg/l) Average Annual	BOD_5 (mg/l) Maximum Monthly Average	Suspended Solids (mg/l) Average Annual	Suspended Solids (mg/l) Maximum Monthly Average	Total Phosphorus (mg/l) Average Annual	Total Phosphorus (mg/l) Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l) Minimum Monthly Average	Chlorine Residual (mg/l) Maximum Monthly Average	Fecal Coliform (number per 100 ml) Average Annual	Fecal Coliform (number per 100 ml) Maximum Monthly Average	Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Date	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
Village of Adell	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	--	N/A
Village of Campbellsport . . .	18	N/A	21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		40	40	--	200
Village of Cascade	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		30	30	--	200
Village of Random Lake	51	N/A	64	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		80	60	--	200

Note: N/A indicates data not available.

[a] Obtained from Wisconsin Department of Natural Resources 1976 data as noted.

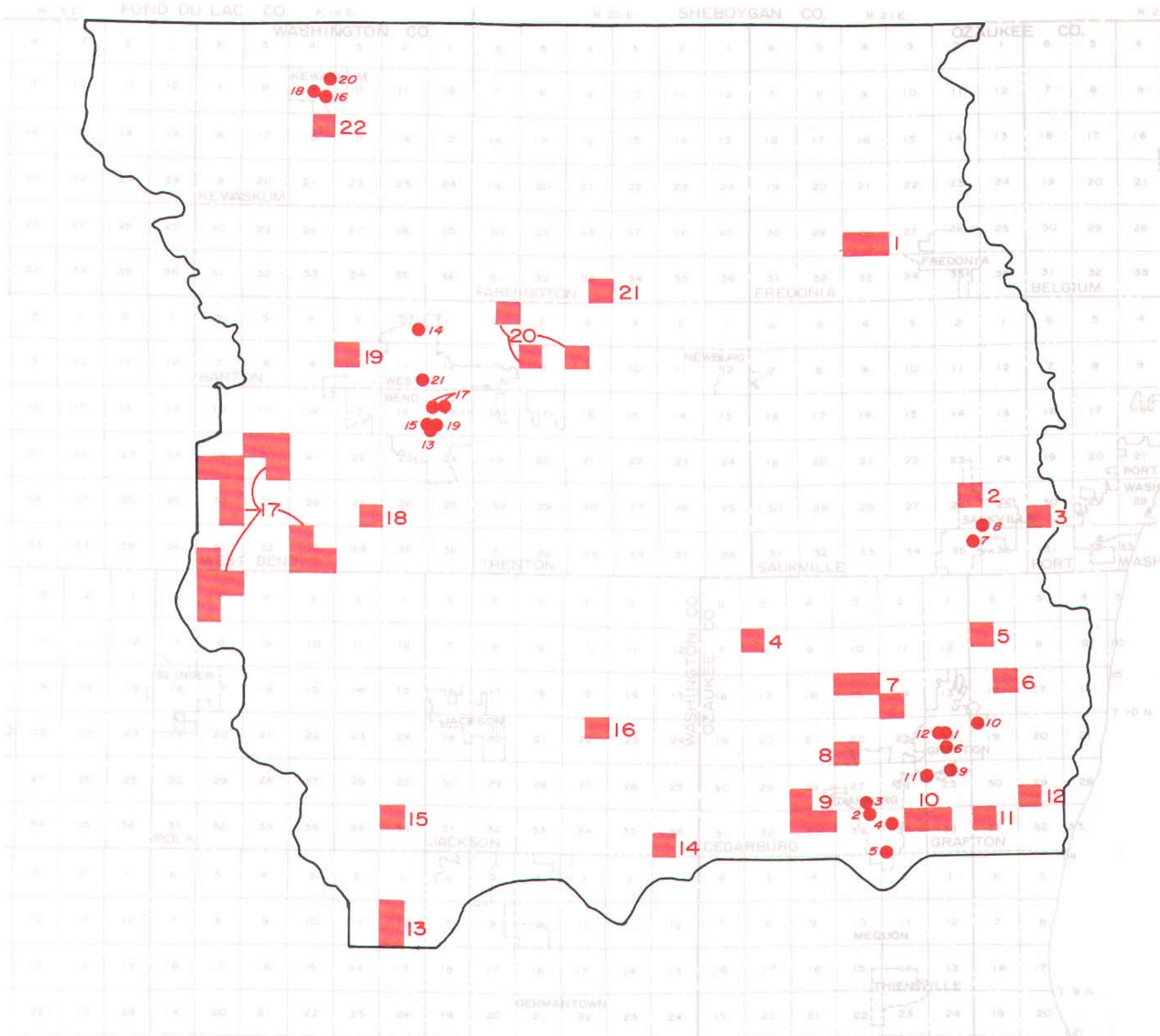
[b] The population design capacity for a given sewage treatement facility was obtained directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.

[c] The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 6

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

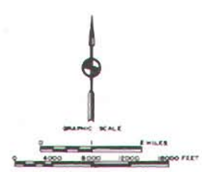


LEGEND

U.S. PUBLIC LAND SURVEY QUARTER SECTION HAVING AT LEAST 32 HOUSING UNITS AND NOT SERVED BY PUBLIC SANITARY SEWERS

22 CODE NUMBER FOR MAJOR CONCENTRATION--SEE TABLE 18

7● EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS--SEE TABLE 14



Significant concentrations of unsewered urban development in the Upper Milwaukee River subregional area are scattered throughout the subregional area. While some of this development represents older established lake oriented development primarily along the shorelines of Big Cedar, Little Cedar, Green, and Silver Lakes and subdivisions developed in the late 1950's and early 1960's, much of the development—principally in the Villages of Kewaskum and Saukville, and the Towns of Jackson, Polk, and Richfield, represents relatively new urban subdivisions. There are also 21 existing (1975) known point sources of wastewater other than wastewater treatment facilities in the Upper Milwaukee River subregional area. Such waste sources are most prevalent in the industrial land use concentrations in the Cities of Cedarburg and West Bend and the Villages of Grafton, Kewaskum, and Saukville.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 16

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA (OUTSIDE THE REGION): 1975

Number	Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average Annual Hydraulic Discharge Rate (gallons/day)	Average Hydraulic Design Capacity (gallons/day)	Reported Maximum Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics				
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
1	Kettle Moraine Correctional Institution	Town of Greenbush	Institutional	Sanitary	Actuated Sludge	Soil Absorption	65,000	60,000	N/A	N/A	N/A	N/A	N/A	N/A

NOTE: N/A indicates data not available.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 17

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA (OUTSIDE THE REGION): 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
1	Ben A. Winton Co.	N/A	Town of Scott	Process	None	--	Melius Creek	1,600,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
2	Foremost Foods, Inc. . . .	N/A	Village of Adell	Process and Non-Contact Cooling	Aerated Lagoons	--	Unnamed Tributary to North Branch of Milwaukee River	85,000	200,000	22	N/A	N/A	N/A	N/A	11.9	No	--
3	Krier Preserving Co.	2033	Village of Random Lake	Process and Non-Contact Cooling	Spray Irrigation	--	Silver Creek	72,000	130,000	7	N/A	N/A	N/A	N/A	5.5	No	--
4	Loehr's Meat Service	2013	Village of Campbellsport	Non-Contact Cooling	None	--	Milwaukee River	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
5	Universal Foods Corp. (Stella Cheese)	2022	Village of Campbellsport	Non-Contact Cooling	None	--	Milwaukee River	63,000	N/A	N/A	N/A	N/A	N/A	N/A	31.7	No	--

NOTE: N/A indicates data not available.

[a] *Obtained from Wisconsin Department of Natural Resources 1976 data.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

sanitary sewer service. Together these enclaves had a total area of about 11.2 square miles. In the areas of the Upper Milwaukee River subregional area not served by sanitary sewers, it is estimated that approximately 314 square miles and 26,900 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, 34 holding tanks and two "mound systems" were also used for sewage disposal in the subregional area.

INVENTORY FINDINGS
SAUK CREEK SUBREGIONAL AREA

The Sauk Creek subregional area includes all of the Sauk Creek watershed, that portion of the Sheboygan River watershed lying within the Region, and minor drainage areas that are directly tributary to Lake Michigan lying generally north of the City of Port Washington. The entire subregional area lies within Ozaukee County. While predominantly rural and agricultural in character, this subregional area contains the City of Port Washington and environs, the Village of Belgium, concentrations of urban development along the shoreline of Lake Michigan in the Town of Belgium, and the Harrington Beach State Park, a major outdoor recreation facility.

Existing Public Sanitary Sewerage Systems

There are two existing public sanitary sewerage systems in the Sauk Creek subregional area which provide centralized sanitary sewer services. These include the systems operated by the City of Port Washington and the Village of Belgium. Together, these two systems serve a total area of about 2.8 square miles, or approximately 4 percent of the total area of the subregional area, and a total population of approximately 10,400 people, or

Table 18

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS
IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
	Ozaukee County		
1	Waubeka	400	317
2	Village of Saukville	100	160
3	Town of Port Washington-Section 30	200	160
4	Deckers Corner	100	161
5	Town of Grafton-Section 7	100	165
6	Town of Grafton-Section 18	200	163
7	Town of Cedarburg-Sections 14 & 15	600	482
8	Town of Cedarburg-Section 22	200	160
9	Town of Cedarburg-Sections 28 & 33	400	483
10	Town of Cedarburg-Sections 35 & 36	300	317
11	Town of Grafton-Section 31	200	163
12	Town of Grafton-Section 29	100	160
	Washington County		
13	Town of Richfield-Section 12	400	330
14	Town of Jackson-Section 36	300	163
15	Town of Polk-Section 36	100	161
16	Town of Jackson-Section 22	300	160
17	Big Cedar Lake	1,800	2,351
18	Silver Lake	100	159
19	City of West Bend-West	100	164
20	City of West Bend-East	400	462
21	Green Lake	100	166
22	Village of Kewaskum	500	162
Total		7,000	7,169

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U. S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b] *See Map 6.*

Source: SEWRPC.

approximately 78 percent of the total population of the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 19 and 20.

City of Port Washington: The existing service area of the City of Port Washington sanitary sewerage system is shown on Map 7. This area totals about 2.5 square miles and has a resident population of about 9,500 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Port Washington is treated at a wastewater treatment plant located on the Lake Michigan shoreline just north of the City of Port Washington Harbor (see Figure 24). The plant has a site area of about one acre, all of which is currently utilized. The plant site is bounded by Lake Michigan on the east, and on the south, west, and north by park and other municipal lands. The plant was constructed in 1956 and underwent major modification in 1972 to provide facilities for secondary waste treatment and advanced waste treatment for phosphorus removal. Effluent disposal is via an outfall sewer to Lake Michigan. The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. The sludge solids removed from the wastewater treatment systems are fed to a digestion system prior to being hauled by tank truck to agricultural land application sites. Both anaerobic and aerobic digesters are utilized. The plant has an average hydraulic design capacity of 1.25 mgd, with a peak hydraulic design capacity of 2.50 mgd and an organic design capacity of 2,130 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.70 and 2.10 mgd respectively, while the average annual and maximum monthly organic loading were reported to be 1,710 and 1,970 pounds of BOD_5 per day, thus indicating that the plant has adequate organic treatment capacity but is operating above its average hydraulic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 12 mg/l of BOD_5, 14 mg/l of suspended solids and 1.0 mg/l of phosphorus. Maximum monthly concentrations of 17 mg/l of BOD_5, 21 mg/l of suspended solids and 2.2 mg/l of phosphorus were reported during 1975. Data on effluent fecal coliform counts was not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.1 mg/l to 0.4 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum daily average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through March 31, 1977.

Table 19

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population[b] Served	Arrangement for Treatment of Sewage (See Table 20)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
City of Port Washington	1,579	2.47	4,122	6.44	9,500	Operates a Facility
Village of Belgium	229	0.36	--	--	900	Operates a Facility
Proposed Systems						
Town of Belgium (Lake Church)	--	--	3,892	6.08	--	--
Subregional Area Total	1,808	2.83	8,014	12.52	10,400	--

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U. S. Public Land Survey quarter section.*

Source: SEWRPC.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains included in the City of Port Washington sanitary sewerage system are shown on Map 7. There are six known points of sewage flow relief in the City of Port Washington sanitary sewerage system, all of which are bypasses including one at the wastewater treatment plant.

Management of the City of Port Washington sanitary sewerage system is under the direction of the Board of Public Works. Day-to-day administration of the system is provided by the Director of Public Works. Financing of the system is provided through general property tax and a sewer service charge equal to 80 percent of the water consumption charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Port Washington sanitary sewerage system approximated $248,581, or about $26.00 per capita. Of this total, $133,163, or about $14.00 per capita, was expended for operation and maintenance, and $115,418, or about $12.00 per capita, was expended for capital improvements.

Village of Belgium: The existing service area of the Village of Belgium sanitary sewerage system is shown on Map 7. This area totals about 0.4 square mile and has a resident population of about 900 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Belgium is treated in a wastewater treatment plant located at the northern Village limits on the Onion River, to which effluent is discharged (see Figure 25). The plant has a site area of about 0.5 acre, all of which is currently utilized. The plant site is bounded by agricultural lands on the west, commercial land use development on the east and north, and a public street on the south. The plant was constructed in 1949 and modified in 1970 with the addition of a chlorine contact tank. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system prior to being hauled by tank truck to agricultural land application sites. The plant has an average hydraulic capacity of 0.07 mgd with a peak hydraulic capacity of 0.10 mgd. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.07 and 0.10 mgd respectively, indicating that the plant is operating near its design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 30 mg/l of BOD_5 and 54 mg/l of suspended solids. Maximum monthly effluent concentrations of 38 mg/l of BOD_5 and 66 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts was not reported routinely during 1975. However, a monthly average effluent chlorine residual which varied from 0.9 mg/l to 1.2 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 60 mg/l of BOD_5, 60 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1975.

The location and configuration of the major trunk sewers serving the Village of Belgium are shown on Map 7. The only known point of sewage flow relief in the Village of Belgium sanitary sewerage system is a bypass located at the wastewater treatment plant. The inventory revealed that the Village is in the early stages of preparation of a facilities plan pertaining to its sanitary sewerage system. The facilities planning program study area includes the unincorporated Village of Lake Church and Harrington Beach State Park and the adjacent urban development along Lake Michigan indicating that the facility plan will evaluate providing public sanitary sewerage service to these areas.

Table 20

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE SAUK CREEK SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes: Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Level of Treatment Provided: Secondary	Advanced	Auxiliary	Disposal of Effluent	Sludge Handling and Disposal Unit Processes: Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application
City of Port Washington	2.47	9,500	1956, 1972	No	Yes	Yes	Yes	Yes	Yes	Yes	Lake Michigan	Yes	Yes	No	No	Yes
Village of Belgium	0.36	900	1949, 1970	No	Yes	No	Yes	Yes	No	Yes	Tributary of Onion River	No	Yes	Yes	No	Yes

Table 20 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975[a]						Wastewater Strength Parameters in Influent Sewage[a]					Design Capacity					Industrial Flows		
	Annual Average Hydraulic (MGD)	Average Annual Hydraulic Per Capita (GPD)	Maximum Monthly Average Hydraulic (MGD)	Average Annual Organic (pounds BOD_5/day)	Average Annual Organic Per Capita (pounds BOD_5/day)	Maximum Monthly Average Organic (pounds BOD_5/day)	BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Organic Nitrogen-N (mg/l)	Ammonia Nitrogen-N (mg/l)	Population[b]	Average Hydraulic (MGD)	Peak Hydraulic (MGD)	Average Organic (pounds BOD_5/day)	Average Organic Population[b] Equivalent	Design Average Daily Flow (MGD)	Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
City of Port Washington	1.70	179	2.10	1,710	0.18	1,970	123	170	6.9[d]	11.2[d]	12.6[d]	12,500	1.25	2.50	2,130	10,140	N/A	N/A	None
Village of Belgium	0.07	78	0.10	90	0.10	121	209	205	11.5	5.5[e]	20.0[e]	1,200	0.07	0.10	N/A	N/A	None	None	None

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]: BOD_5 (mg/l)		Suspended Solids (mg/l)		Total Phosphorus (mg/l)				Chlorine Residual (mg/l)		Fecal Coliform (number per 100 ml)		Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Date	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values			
	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Minimum Monthly Average	Maximum Monthly Average	Average Annual	Maximum Monthly Average			BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
Port Washington	12	17	14	21	1.0	2.17	N/A	N/A	0.1	0.4	N/A	N/A	8	3/31/79	30	30	1.0	200
Belgium	30	38	54	66	9.4	N/A	3.0[e]	24[e]	0.9	1.2	Less[e] Than 10	Less[e] Than 10	N/A	4/30/75	60	60	--	200

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant operating personnel or directly from engineer ing reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

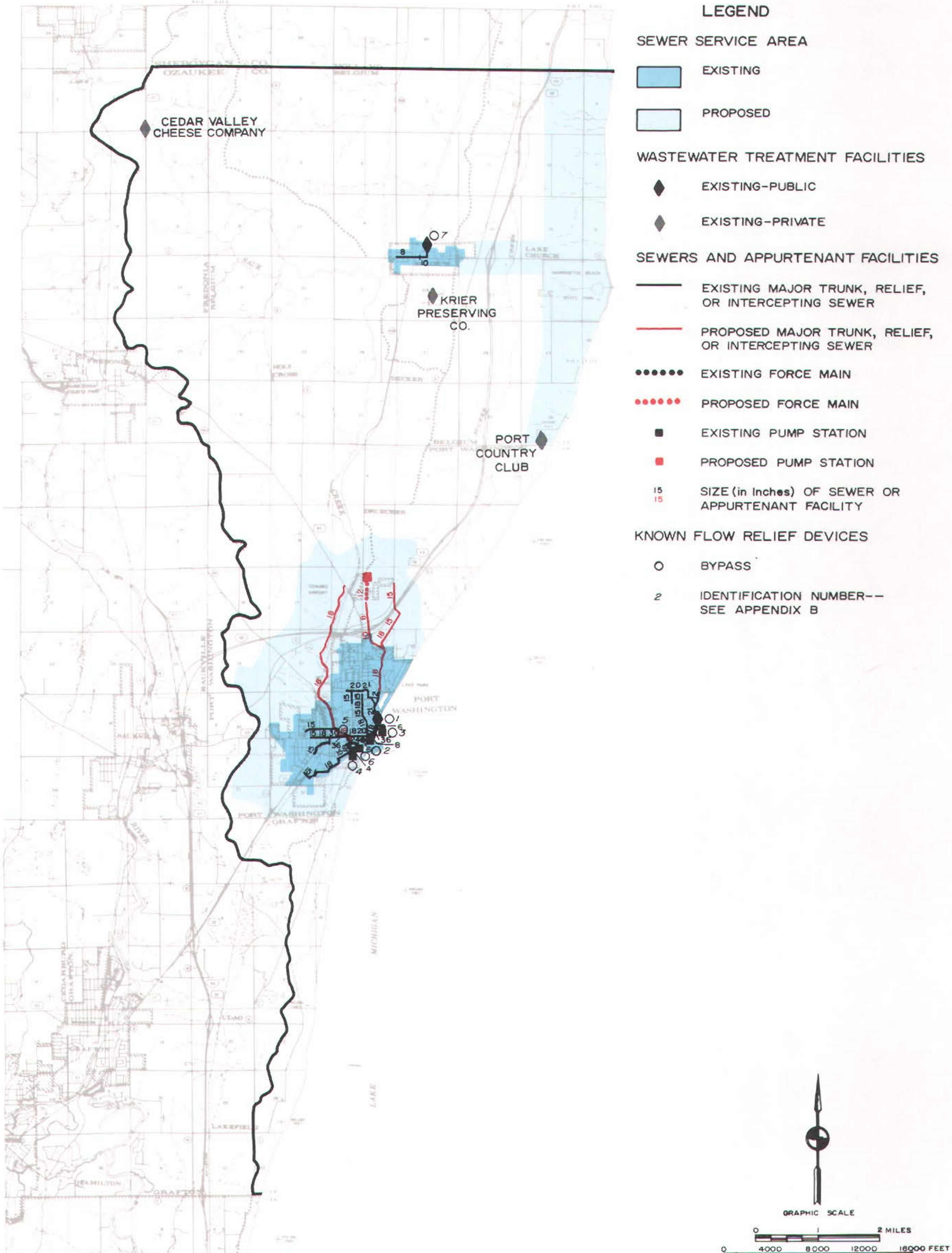
[d] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from a May 1975 survey conducted by the Wisconsin Department of Natural Resources.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 7

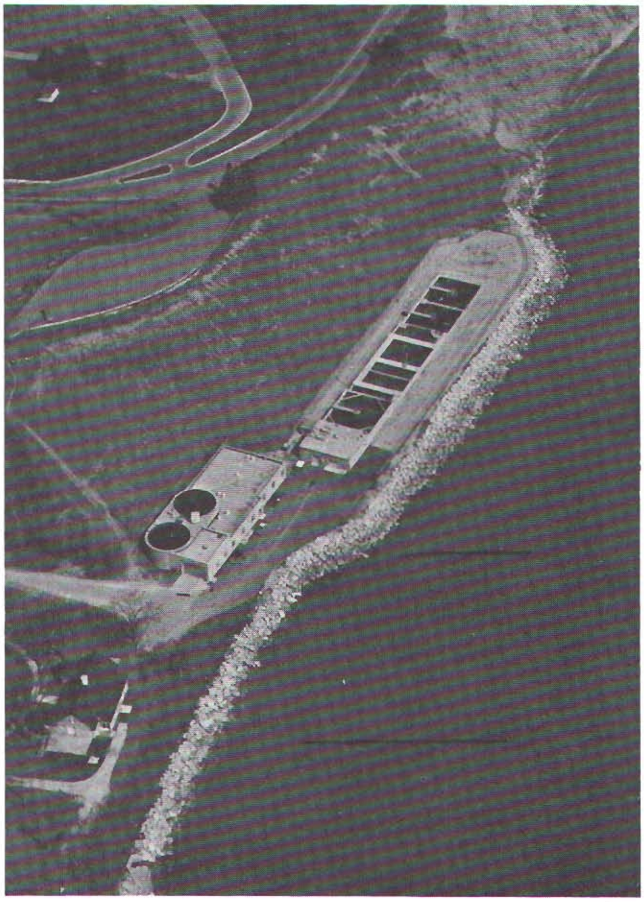
EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE SAUK CREEK SUBREGIONAL AREA: 1975



Source: *Wisconsin Department of Natural Resources and SEWRPC.*

Figure 24

CITY OF PORT WASHINGTON
WASTEWATER TREATMENT PLANT



Source: SEWRPC.

Management of the Village of Belgium sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Sewage Plant Operator. Financing of the system is provided through a system of sewer service charges.

Total expenditures during 1975 for operation and maintenance and capital improvements for the sewerage system including the treatment plant are estimated to be $7,800, or about $9.00 per capita. Of this total, $4,800, or about $6.00 per capita was expended for operation and maintenance and $3,000, or about $3.00 per capita was expended for capital improvements.

Proposed Public Sanitary Sewerage Systems

The inventory revealed that as of 1970 there was one proposed new public sanitary sewerage system to serve urban development in the Sauk Creek subregional area. This system has been under consideration by the Town of Belgium and involves the provision of public sanitary sewer service to a six square mile area of the town or about 1 percent of the subregional area, and a total resident population of about 700. This area, as shown on Map 7, is located along the Lake Michigan shoreline and extends west to include the unincorporated Village of Lake Church. The area also includes Harrington Beach State Park on the Lake Michigan shoreline. The Town of Belgium had been considering two alternative methods of providing wastewater treatment for this area, including the establishment of a new treatment facility which would discharge its effluent to a minor tributary to Lake Michigan, and the connection of the area to the existing Village of Belgium sanitary sewerage system with the concomitant expansion of the Village of Belgium wastewater treatment plant at a new site.

Flow Relief Devices

As noted above on an individual community basis, there are seven flow relief devices in the two public sanitary sewerage systems located within the Sauk Creek subregional area. Table 21 indicates the number and type of relief devices as well as an estimate of the total average annual wastewater discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 7.

Other Wastewater Treatment Facilities

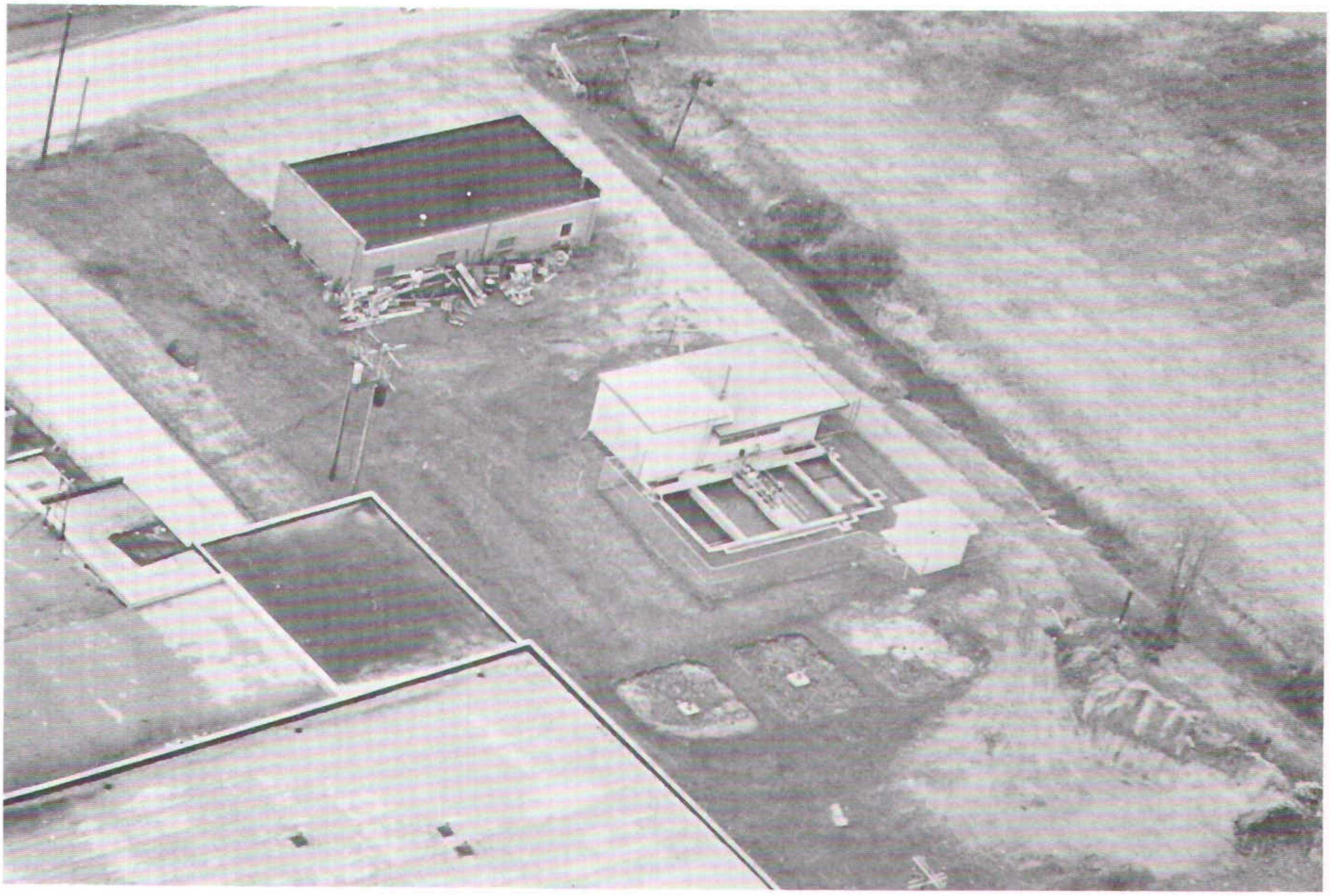
In addition to the two publicly-owned sanitary sewerage systems discussed above, there are a total of three privately-owned wastewater treatment facilities in the Sauk Creek subregional area which serve single isolated land use enclaves and generally treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. Two of these facilities are related to the agricultural products industry. These two waste treatment facilities serve the Cedar Valley Cheese Factory in the Town of Fredonia, and the Krier Preserving Company in the Village of Belgium. The third treatment facility serves a recreational development, the Port Country Club, in the Town of Port Washington. Characteristics of these three facilities are presented in Table 22 and their locations are shown on Map 7.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage flow relief points on both the existing sanitary and combined sewerage systems within the Region which discharged untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of pollution consist primarily of industrial cooling process, rinse and wash waters, which are discharged without treatment or following pretreatment directly to streams and watercourses or to storm sewers

Figure 25

VILLAGE OF BELGIUM WASTEWATER TREATMENT PLANT



Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

Table 21

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE SAUK CREEK SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in the Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
LAKE MICHIGAN WATERSHED								
City of Port Washington	Yes - Bypass	--	3	--	--	--	3	18.0
SAUK CREEK WATERSHED								
City of Port Washington	No	--	2	--	--	--	2	3.0
SHEBOYGAN RIVER WATERSHED								
City of Belgium	Yes - Bypass	--	--	--	--	--	--	--[b]
Subregional Area Total	2 Bypasses	--	5	--	--	--	5	21.0

[a] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loadings on a watershed basis.*

[b] *The annual contribution from flow relief devices is less than 1.0 mg.*

Source: SEWRPC.

Table 22

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Average[a] Hydraulic Design Capacity (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phorphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
LAKE MICHIGAN WATERSHED													
Ozaukee County													
Port Country Club	Town of Port Washington	Recreation	Sanitary	Septic Tank and Sand Filter	Soil Absorption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SAUK CREEK WATERSHED													
Ozaukee County													
Cedar Valley Cheese Factory	Town of Fredonia	Industrial	Process and Cooling	Lagoon, Ridge & Furrow, and Spray Irrigation	Soil Absorption	N/A	N/A	25,000	N/A	N/A	44.0	N/A	N/A
SHEBOYGAN RIVER WATERSHED													
Ozaukee County													
Krier Preserving Company	Town of Belgium	Industrial											
Outfall No. 1			Process	Lagoon	Onion River via Drainage Ditch	Intermittent	N/A	Intermittent	N/A	N/A	N/A	N/A	N/A
Outfall No. 3			Process	Lagoon and Spray Irrigation	Soil Absorption	550,000	N/A	1,100,000	30.0	30.0	8.0	0.2	N/A

NOTE: N/A indicates not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System, questionnaire data obtained by SEWRPC; reports filed under Section 101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the data as reported in or requirements of the permit.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Wisconsin Department of Natural Resources, permits issued and reports filed under the Wisconsin Pollutant Discharge Elimination System, and the portion of the effluent reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of six such known point sources of industrial wastewater were identified in the Sauk Creek subregional area. Characteristics of these six waste sources are identified in Table 23, and their location is shown on Map 8.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Sauk Creek subregional area serve a total area of about three square miles, or 4 percent of the total area of the subregional area, and a total population of about 10,400, or about 78 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban, while quarter sections with between 6 and 31 housing units or one housing unit for every 5 to 27 gross acres were classified as rural-urban. Quarter sections with 5 or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban, and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal, and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 67 square miles, or 96 percent of the total area of the subregional area, and contain a total population of about 3,000, or 22 percent of the total population of the subregional area. Of that total, less than one square mile, or less than one percent of the total area of the subregional area containing a total population of 100, or 1 percent of the total population of the subregional area are classified as urban unsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into a single named major urban concentration which is shown on Map 8. The estimated population and urban development area of this major concentration are shown in Table 24.

The most common method of providing for sewage disposal for those approximately 3,000 people living within urban, urban-rural, and rural areas of the subregional area not served by public sanitary sewers within the Sauk Creek subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the

Table 23

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Caracteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	SAUK CREEK WATERSHED Ozaukee County[a]																
1	Allis Chalmers, Inc., Simplicity Manufacturing Company	3524	City of Port Washington	Cooling	None	1	Tributary of Sauk Creek via Storm Sewer	47,000	125,000	8.8	7.2	0.2	2.0	N/A	25	Yes	--
2	Murphy Oil Corporation	5171	City of Port Washington	Stormwater Runoff from Petroleum Terminal	Oil Separator	1	Tributary of Sauk Creek	76,500	76,500	N/A	N/A	N/A	N/A	N/A	N/A	No	--
	SHEBOYGAN RIVER WATERSHED Ozaukee County																
3	Krier Preserving Company	2033	Town of Belgium	Cooling	None	2	Tributary of Onion River via Drainage Ditch	29,600	30,000	5.0	8.5	0.0	0.2	N/A	31.0	No	--
	LAKE MICHIGAN WATERSHED Ozaukee County																
4	Fromm Laboratories, Inc.		Village of Grafton	Cooling	Lagoon	1	Lake Michigan via Storm Sewer and Drainage Ditch	200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
5	Port Washington Filtration Plant . . .	4941	City of Port Washington	Process	N/A	1	Lake Michigan	14,700	19,400	N/A	14.8	N/A	N/A	N/A	10.0	No	--
6	Wisconsin Electric Power Company-Port Washington Power Plant	4911	City of Port Washington	Process and Cooling	Chlorination	1	Lake Michigan	420,000,000	547,000,000	N/A	0.4	N/A	N/A	N/A	11.0	No	--
				Process and Cooling	Chlorination	2	Lake Michigan	91,000,000	111,000,000	N/A	0.4	N/A	N/A	N/A	8.0	No	--
				Process	Ash Settling Ponds	3	Lake Michigan	1,800,000	2,670,000	N/A	24.0	N/A	N/A	N/A	N/A	No	--
				Process	Ash Settling Ponds	4	Lake Michigan	700,000	1,000,000	N/A	0.4	N/A	N/A	N/A	N/A	No	--

NOTE: N/A indicates data not available.

[a] *Unless specially noted otherwise data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System or under Section NR101 of the Wisconsin Administrative Code or from the Wisconsin Pollutant Discharge Elimination System permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data as reported in or requirements of the permit. In some cases where wastewater characteristics were obtained from the NR101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

extent of the use of other onsite treatment systems. Another method of sewage disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternative using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system," is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

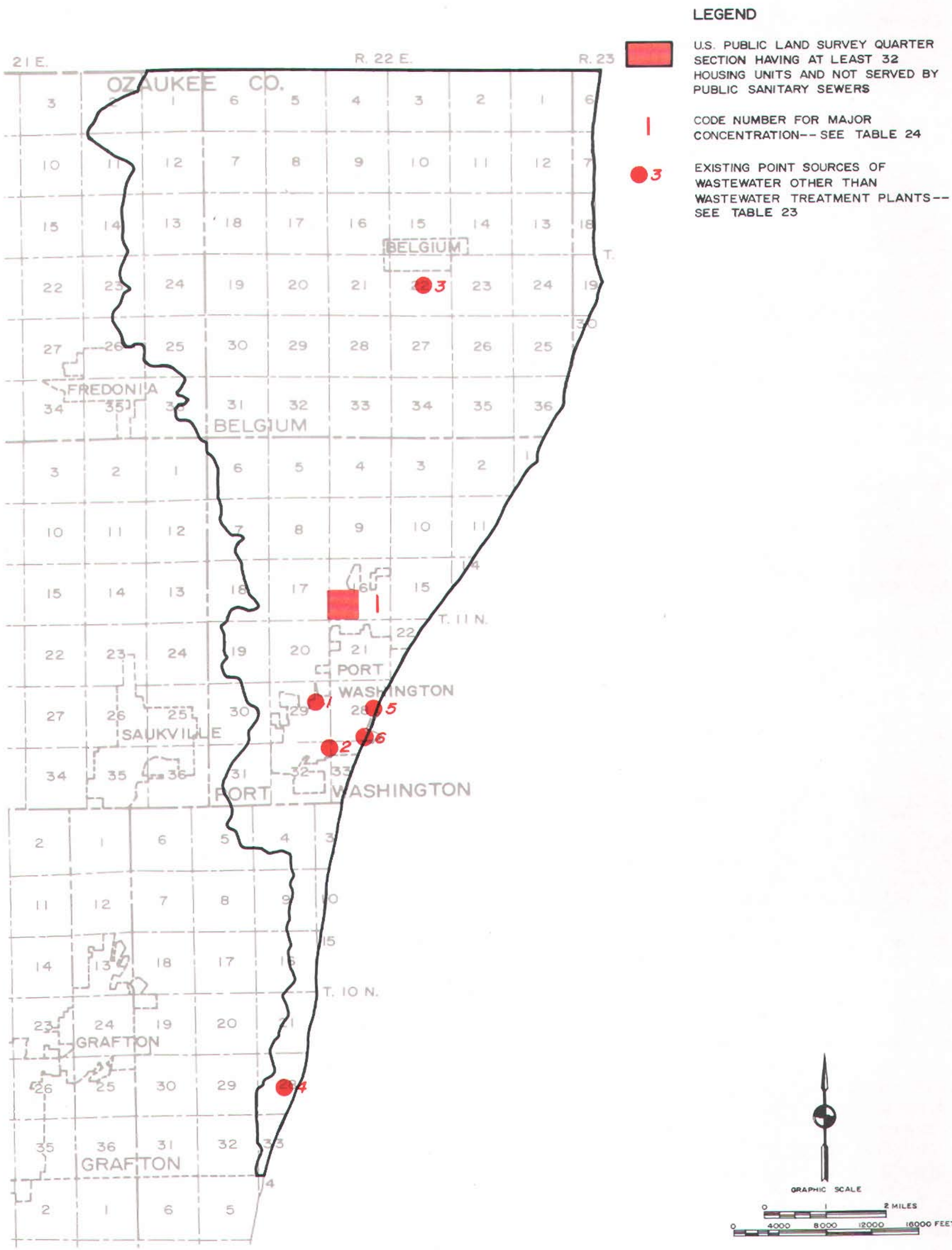
Based upon the permits issued through December, 1975, there were 23 sewage holding tank installations, and one mound system existing in the Sauk Creek subregional area. Twenty-one of the holding tanks served residential homes, while two were utilized by commercial establishments. The mound system was utilized to dispose of sanitary sewage from a residence. The location of these systems is indicated on Map 8.

Concluding Remarks—Sauk Creek Subregional Area

Inventories conducted under the areawide water quality management planning program indicated that in 1975 there existed in the Sauk Creek subregional area a total of two public sanitary sewerage systems which include seven flow relief devices and which serve a total area of about 2.8 square miles, or about 4 percent of the total area of the subregional area, and a total of about 10,400 persons, or about 78 percent of the total population of the subregional area. Each of the two sanitary sewerage systems operate their own wastewater treatment facility. In addition to the two publicly-owned sanitary sewerage systems, three privately-owned wastewater treatment facilities serving isolated industrial and recreational establishments as well as five additional industrial point wastewater sources were found in the inventory. The inventory indicated that as of 1975 there was one proposed new public sanitary sewerage system in the area, which is intended to serve existing urban development along lake shoreline and a state park. There were also six point sources of wastewater other than wastewater treatment plants identified in the subregional area consisting primarily of industrial process, cooling, and sanitary waters. Finally, in 1975, there were an estimated 100 persons residing in scattered enclaves of urban development in the Sauk Creek subregional area not served by public sanitary sewer service. Together these enclaves had a total area of less than one square mile. In the portions of the Sauk Creek subregional area not served by sanitary sewers, it is estimated that approximately 67 square miles and 3,000 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic systems. However, 23 holding tanks and one "mound system" were also used for sewage disposal in the subregional area.

Map 8

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE SAUK CREEK SUBREGIONAL AREA: 1975



The only significant concentration of unsewered urban development in the Sauk Creek subregional area is located in the area of Nellsville adjacent to the City limits of Port Washington. It is interesting to note that the Town of Belgium which covers a large portion of the subregional area and where town officials have taken local action to prevent urban sprawl through the use of agricultural zoning, is without a significant concentration of unsewered urban development. There are also six existing (1975) known point sources of wastewater other than wastewater treatment facilities in the Sauk Creek subregional area. Such sources are most prevalent in the industrial land use concentrations of the City of Port Washington.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 24

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
1	Nellsville	100	160
Total		100	160

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U. S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b] *See Map 8.*

Source: SEWRPC.

INVENTORY FINDINGS KENOSHA-RACINE SUBREGIONAL AREA

The Kenosha-Racine subregional area consists of that portion of Kenosha and Racine Counties which lies east of Interstate Highway 94 and east of the Des Plaines River watershed. This area has been subject in recent years to relatively rapid urbanization, particularly in the areas contiguous to the suburbs and cities of Kenosha and Racine.

Existing Public Sanitary Sewerage Systems

There are a total of 18 existing public sanitary sewerage systems in the Kenosha-Racine subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the Cities of Kenosha and Racine; the Villages of Elmwood Park, North Bay, and Sturtevant; the Towns of Caledonia Sewer Utility District No. 1, the Town of Mt. Pleasant Sewer Utility District, the Town of Pleasant Prairie Sewer Utility District No.'s 1, 2, and A, B, C and E; the Town of Somers Sanitary District No. 1 and Utility District No. 1; the Crestview Sanitary District; the North Park Sewer Utility District; and Pleasant Park Utility Co., Inc. These 18 systems serve a total area of approximately 49.4 square miles; or approximately 31 percent of the total area of the subregional area, and a total population of approximately 221,200 people, or approximately 93 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 25 and 26.

City of Kenosha: The existing service area of the City of Kenosha sanitary sewerage system is shown on Map 9. This area totals about 15.5 square miles and has a resident population of about 83,400 persons. In addition, the City of Kenosha provides on a contract basis treatment for wastewater generated in the Town of Pleasant Prairie Sewer Utility District No.'s 1, 2, and A, B, C and E, and the Town of Somers Sanitary District No. 1. The sewer service area of these special-purpose districts connected to the City of Kenosha sanitary sewerage system totals about 1.8 square miles and has a total population of about 6,100 persons. Thus, the City of Kenosha wastewater treatment facility serves a total sewer service area of about 17.4 square miles and a total resident population of about 89,500 persons.

As noted above, the sanitary sewerage system for the City of Kenosha serves an area of about 15.5 square miles. Of this total, about 13.3 square miles, or about 86 percent, are served by a separate sewer system and about 2.2 square miles, or about 14 percent, are served by a combined sewer system. Until the early 1940's, almost all urban development in the Kenosha area was served by combined sewers which discharged untreated sewage directly to Lake Michigan. Intercepting sewers were subsequently constructed to intercept the normal dry weather flow of sanitary wastes in combined sewers, as well as a portion of the storm flows, and convey these flows to the City of Kenosha wastewater treatment plant, which was constructed in 1941. During periods of heavy rainfall, overflow devices discharge a portion of the combined sanitary-storm water flow, untreated, directly to Lake Michigan. There are four known combined sewer outfalls in the Kenosha area (see Map 9.)

In 1970 the City of Kenosha undertook a sewerage improvement program to effect a greater degree of separation within the combined sewer system. As of early 1977, this program has been partially implemented. It is not anticipated, however, that the program will result in the complete separation of the existing combined sewer system or eliminate all overflows or bypassing during periods of wet weather.[8] In an attempt to find alternative solutions to the combined sewer overflow problem, the City of Kenosha, in cooperation with the U.S. Environmental Protection Agency, conducted a demonstration project to determine the feasibility of using a biological absorption process to treat up to 20 mgd of combined sewer flows at the site of the existing wastewater treatment facility. This project indicated, through an evaluation of the economic as well as the physical feasibility of the process, that the system evaluated

[8]*See "Report on Kenosha Water Pollution Control Plant, Phosphorus Removal and Oil, Grease Sludge Disposal—1971," Alvord, Burdick, and Howson, Engineers, Chicago, Illinois.*

Table 25

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population Served[b]	Arrangement for Treatment of Sewage (See Table 26)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
City of Kenosha	9,939[c]	15.53[c]	21,049	32.89	83,400	Operates a facility
City of Racine	8,499	13.28	109[d]	0.17[d]	96,700	Operates a facility
Village of Elmwood Park	415	0.65	--	--	400	Contracts with Racine
Village of North Bay	69	0.11	--	--	1,300	Contracts with the City of Racine
Village of Sturtevant	531	0.83	468	0.73	4,400	Operates a facility
Town of Caledonia Sewer Utility District No. 1	2,769	4.33	7,666	11.98	4,300	Contracts with the City of Racine
Town of Mt. Pleasant Sewer Utility District No. 1	4,731	7.39	3,709	5.79	13,800	Contracts with the City of Racine
Town of Pleasant Prairie						
Sewer Utility District No. 1	274	0.43	48	0.08	1,600	
Sewer Utility District No. 2	183	0.29	--	--	600	
Sewer Utility District A	111	0.17	--	--	400	Contracts with the City of Kenosha
Sewer Utility District B	47	0.07	36	0.06	1,100	
Sewer Utility District C	14	0.02	100	0.16	700	
Sewer Utility District E	22	0.03	--	--	200	
Town of Somers						
Sanitary District No. 1	535	0.84	--	--	1,500	Contracts with the City of Kenosha
Utility District No. 1	184	0.29	128	0.20	700	Operates a facility
Crestview Sanitary District	423	0.66	220	0.34	2,500	Contracts with North Park Sanitary Dist.
North Park Sanitary District[e]	2,741	4.28	1,734	2.71	6,800	Operates a facility
Pleasant Park Sewer Uitility	127	0.19	16	0.03	800	Operates a facility
Proposed Systems None						
Subregional Area Total	31,614	49.39	35,283	55.14	221,200	

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U. S. Public Land Survey quarter section.*

[c] *Includes a 1.5 square mile area outside the City of Kenosha City Limits principally in Petrifying Spring Park and Parkside campus areas.*

[d] *Includes only that area within the existing (1975) corporate limits of the City of Racine.*

[e] *Includes the Village of Wind Point.*

Source: SEWRPC.

offers a viable alternative to complete separation of the combined sewer system in the City of Kenosha. In 1976, the City initiated a facility planning project to determine the most desirable method of abating the discharges from the City's combined sewer system and of eliminating the discharge of wastewater from sanitary sewer flow relief devices as well as to evaluate other future facilities planning requirements. The initial infiltration/inflow analysis portion of the facility plan was completed late in 1977. The findings and recommendations of the combined sewer overflow pollution abatement program are expected to be available in late 1978.

The Kenosha wastewater treatment facility is located on the Lake Michigan shoreline adjacent to Southport

Park (see Figure 26). The plant has a site area of about 24 acres, of which about 15 acres are currently utilized, leaving 9 acres available for future use. The plant site is bounded by public park lands on the east, residential development on the north and west, and open lands on the south. The plant was constructed in 1941 with an initial average hydraulic design capacity of 10 mgd and a primary level of wastewater treatment. In 1967 the plant was expanded to an average hydraulic design capacity of 18 mgd with a secondary level of treatment. Effluent disposal is via a 1,200-foot outfall sewer to Lake Michigan. The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment processes for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, chemical treatment for phosphorus removal, activated sludge, final clarification, and disinfection. Sludge solids removed from the activated sludge system are thickened and then combined with solids removed from the primary clarifiers prior to being transferred to an anaerobic digestion system, dewatering by means of a filter press, and subsequent application to agricultural land.

As noted above, the City of Kenosha has conducted a demonstration project to determine the feasibility of using a biological absorption process to treat combined sewer overflows at the site of the existing wastewater treatment plant rather than bypass such overflows directly to lake Michigan. A 20 mgd design capacity auxiliary treatment unit utilized to treat the combined sewer overflows was put into operation in 1971. The unit provides for high-rate biological treatment of combined sewage through the utilization of activated sludge, clarification, and disinfection. Sludge is stored in a biosolids reservoir; a contact tank and a solids stabilization tank are maintained in an empty and ready condition. During a rainfall event, sewage which normally is bypassed to Lake Michigan is directed to the contact tank and activated sludge is proportionately introduced. The tank has a 15- to 30-minute contact time. The flow is directed from the contact tank to a clarifier for solids separation. The effluent is then disinfected and discharged to Lake Michigan, with solids returned to the solids stabilization tank and thus reused or wasted to the digesters.

The Kenosha wastewater treatment facility has an average hydraulic design capacity of 18.00 mgd, with a peak hydraulic design capacity of 23.00 mgd. During 1975, the average annual and maximum monthly hydraulic loading to the plant was 18.4 mgd and 20.6 mgd respectively, indicating the plant is operating somewhat above its hydraulic design capacity. The maximum hydraulic loading to the plant, however, does not include unmeasured flows bypassed either at flow relief points in the separate sewer system, at the four combined sewer outfall locations on Lake Michigan, or at the wastewater treatment plant itself. The plant has an organic design capacity of 28,000 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly organic loadings were reported to be 18,034 and 36,026 pounds of BOD_5 per day, respectively, indicating that the plant has an adequate capacity to treat the organic loading from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain an average concentration of 9 mg/l of BOD_5, 21 mg/l of suspended solids, 1.4 mg/l of phosphorus, and an average fecal coliform count of 33 per 100 ml. Maximum monthly average effluent concentration of 28 mg/l of BOD_5, 34 mg/l of suspended solids, and 2.0 mg/l of phosphorus as well as a maximum average fecal coliform count of 73 per 100 ml were reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended

Table 26

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE KENOSHA-RACINE SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes					Level of Treatment Provided				Disposal of Effluent	Sludge Handling and Disposal Unit Processes					
				Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Sand Filter	Secondary	Tertiary	Advanced	Auxiliary		Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
City of Kenosha	17.38	89,500	1941, 1967	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Lake Michigan	No	Yes	No	Press	Yes	No
City of Racine	25.76	116,500	1938, 1967	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Lake Michigan	No	Yes	No	Yes	Yes	Yes
Village of Sturtevant	0.83	4,400	1959, 1974	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Tributary of Pike River	No	Yes	Yes	No	Yes	Yes
Town of Somers Utility Dist. No. 1	0.29	700	1964	No	Yes	No	Yes	No	Yes	No	No	Yes	Tributary of Pike River	No	No	No	No	To Kenosha Plant	
North Park Sanitary District	4.94	9,300	1955, 1964 1972, 1975	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Lake Michigan	No	Yes	Yes	No	Yes	No
Pleasant Park Sewer Utility	0.19	800	1960	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Lake Michigan via drainage ditch	Yes	No	No	No	Yes	No

Table 26 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975: Annual Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Hydraulic Per Capita (GPD)	Existing Loading - 1975: Maximum Monthly Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Organic (pounds BOD_5/day)	Existing Loading - 1975: Average Annual Organic Per Capita (pounds BOD_5/day)	Existing Loading - 1975: Maximum Monthly Average Organic (pounds BOD_5/day)	Wastewater Strength Parameters in Plant Influent[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Organic Nitrogen-N (mg/l)	Ammonia Nitrogen-N (mg/l)	Design Capacity: Population[b]	Design Capacity: Average Hydraulic (MGD)	Design Capacity: Peak Hydraulic (MGD)	Design Capacity: Average Organic (pounds BOD_5/day)	Design Capacity: Average Organic Population[b] Equivalent	Industrial Flows: Design Average Daily Flow (MGD)	Industrial Flows: Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
City of Kenosha	18.40	206	20.80	18,034	0.20	36,026	117	230	6.1[d]	11.0[d]	9.8[d]	N/A	18.00	23.00	28,000	133,300	N/A	N/A	None
City of Racine	19.69	169	24.65	16,042	0.14	18,400	99	121	6.8[e]	9.4[e]	13.0[e]	120,000	23.00	40.00	42,000	200,000	N/A	N/A	None
Village of Sturtevant	0.53	120	0.83	572	0.13	779	139	146	6.2[e]	11.6[f]	31.6[f]	2,500	0.30	0.50	425	2,025	0.02	N/A	None
Town of Somers Utility District No. 1	0.06	87	0.09	102	0.15	152	209	164	N/A	N/A	N/A	250	0.03	0.10	N/A	N/A	None	None	None
North Park Sanitary District . .	1.13	94	1.30	911	0.08	975	97	179	7.0[g]	14.9[g]	18.0[g]	20,000	2.00	3.00	3,400	16,200	0.04	N/A	0.70
Pleasant Park Sewer Utility . . .	0.04	50	0.08	42	0.05	N/A	126	114	10.9[h]	11.5[h]	27.5[h]	600	0.06	N/A	126	600	N/A	N/A	None

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[c]: BOD_5 (mg/l) Average Annual	BOD_5 (mg/l) Maximum Monthly Average	Suspended Solids (mg/l) Average Annual	Suspended Solids (mg/l) Maximum Monthly Average	Total Phosphorus (mg/l) Average Annual	Total Phosphorus (mg/l) Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l) Minimum Monthly Average	Chlorine Residual (mg/l) Maximum Monthly Average	Fecal Coliform (number per 100 ml) Average Annual	Fecal Coliform (number per 100 ml) Maximum Monthly Average	Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Date	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
City of Kenosha	9	28	21	34	1.4	2.0	N/A	N/A	N/A	N/A	33	73	N/A	3-31-79	30	30	1	200
City of Racine	35	41	78	111	4.4	6.2	N/A	N/A	0.5	1.6	259	500	N/A	6-30-77	35	100	4	200
Village of Sturtevant	33	48	40	63	2.3	5.9	N/A	N/A	0.3	0.7	179 246	611 680	203	6-30-77	50	50	1	200
Town of Somers Utility Dist. No. 1	59	91	66	171	N/A	N/A	N/A	N/A	0.2	1.3	2,900	7,700	N/A	6-30-77	30	30	--	200
North Park Sanitary District . .	15	20	24	29	0.8	1.0	1.3[g]	2.6[g]	0.4	0.6	N/A	N/A	None	6-30-77	30	30	1	200
Pleasant Park Sewer Utility. . .	5	N/A	10[h]	N/A	8.1[h]	N/A	2.1[h]	0.6[h]	N/A	N/A	N/A	N/A	N/A	6-30-77	10	10	--	200

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant operating personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

[d] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from 1974 2-month average.*

[f] *Data obtained from 1968 24-hour survey by the Wisconsin Department of Natural Resources.*

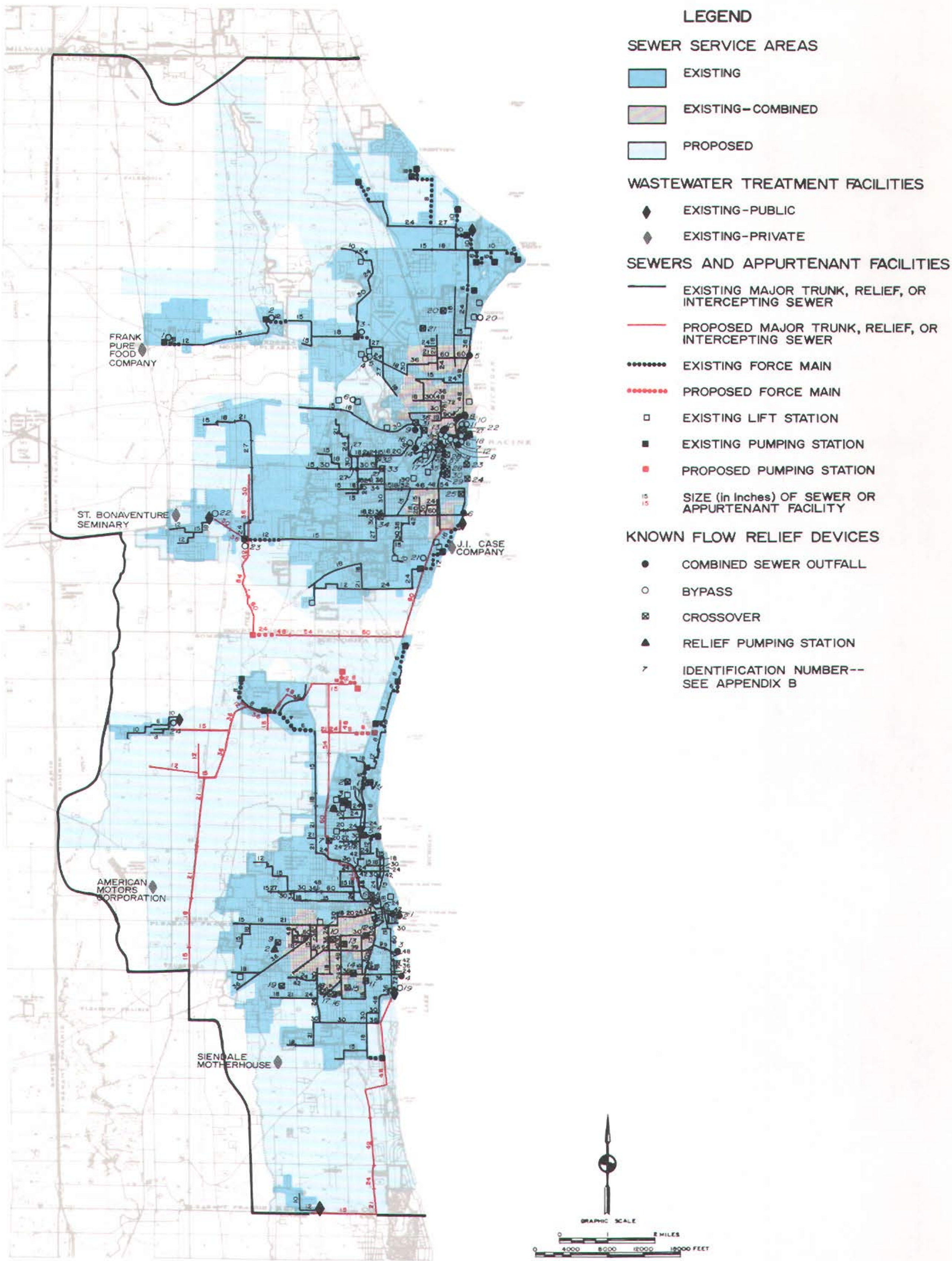
[g] *Data obtained from October 1975 survey by the Wisconsin Department of Natural Resources.*

[h] *Data obtained from 1976 operational records.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 9

EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEM AND OTHER WASTEWATER TREATMENT PLANTS IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975



Source: *Wisconsin Department of Natural Resources and SEWRPC.*

Figure 26

CITY OF KENOSHA WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

solids, 1 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

On October 16, 1973, officials of the Cities of Kenosha and Racine signed a settlement to a Lake Michigan pollution law suit brought by the State of Illinois which would commit the cities to provide higher levels of waste treatment at their wastewater treatment facilities and eliminate pollution from combined sewer overflows. The agreement, which is binding on Racine and Kenosha only if all necessary federal and state funds are made available and if all other municipalities discharging effluent in Lake Michigan in the four states bordering Lake Michigan are also required to meet the treatment standards, provides for more stringent effluent limitations than those recommended in the regional sanitary sewerage system plan. Table 27 summarizes the effluent limitations agreed to by the Cities of Kenosha and Racine and compares these limitations with those recommended in the regional sanitary sewerage system plan. The location and configuration of all major trunk sewers and lift stations comprising the City of Kenosha sanitary sewerage system are shown on Map 9. The known flow relief[9] devices in the City of Kenosha sewerage system, consisting of four combined sewer outfalls, 19 points of crossover from the sanitary sewer system to the storm sewer system, two relief pumping stations, and a bypass at the wastewater treatment plant, are shown on Map 9. The major trunk sewer extensions together with the locally proposed future sewer service area are also shown on Map 9.

The area committed to future sanitary sewer service in local plans totals about 32.9 square miles and is shown on Map 9. This area is bounded generally by

---

[9] *A November, 1977 preliminary report draft covering detailed sewer system studies being conducted by the City of Kenosha reported that there were 41 flow relief devices in the City's separated sanitary sewer system and three such devices at the City's wastewater treatment facility.*

Table 27

COMPARISON OF EFFLUENT LIMITATION: KENOSHA-RACINE AGREEMENT AND REGIONAL SANITARY SEWERAGE SYSTEM PLAN

Effluent Limitation	Kenosha-Racine Agreement			Regional Plan
	By 12/31/76	By 12/31/77	By 7/1/79	
BOD_5	20 mg/l (monthly average)	10 mg/l (monthly average)	4 mg/l (monthly average)	15/mg/l (annual average)
Suspended Solids	20 mg/l (monthly average)	10 mg/l (monthly average)	5 mg/l (monthly average)	--
Phosphorus	1 mg/l (monthly average)	1 mg/l (monthly average) 90% Removal (annual average)	1 mg/l (monthly average) 90% Removal (annual average)	1 mg/l (annual average)
Fecal Coliform	40/100 ml (Maximum at any time) 20/100 ml (annual average)	40/100 ml (Maximum at any time) 20/100 ml (annual average)	40/100 ml (Maximum at any time) 20/100 ml (annual average)	200/100 ml (annual average)

Source: Cities of Kenosha and Racine, and SEWRPC.

the subcontinental divide on the west, the Racine-Kenosha County line on the north, Lake Michigan on the east, and the Wisconsin-Illinois state line on the south. This recommended future sanitary sewer service area was mutually proposed in a 1966 engineering report prepared for the City[10] and was included in the comprehensive plan for the Kenosha Planning District prepared jointly for the City of Kenosha and the Towns of Somers and Pleasant Prairie in 1967 by the Regional Planning Commission.[11]

Management of the City of Kenosha sanitary sewerage system is under the direction of the City of Kenosha Water Utility and City Council. The Utility is governed by a six-member Board of Water Commissioners appointed by the Mayor and subject to confirmation by the City Council. In practice, all of the members of the Board of Water Commissioners are also aldermen and concurrently serve as the Public Works Committee of the Kenosha City Council.

Day-to-day administration of the sanitary sewerage system is provided by the staff of the Water Pollution Control Division of the Kenosha Water Utility and the City Public Works Department.

Local financing of the City of Kenosha sanitary sewerage system is provided through a combination of general taxes and sewer service charges based upon water consumption. Water consumers currently pay a semi-annual sewer service charge of $0.15 cents per 100 cubic foot. The contractual agreement between the Kenosha Water Utility and the Town of Somers Sanitary District No. 1 provides for a metered rate. In 1975 this rate was $210.00 per million gallons. Contracts between the Kenosha Water Utility and the Town of Pleasant Prairie Sewer Utility District No.'s 1 and 2 and A, B, C and E provide for an annual fee payment per sewer connection. In 1975 this fee was $34.00 annually. Each of the special districts contracting for sewage treatment with the City of Kenosha Water Utility is responsible for the operation and maintenance of its local collection sewer system.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Kenosha sanitary sewerage system approximated $1,711,800, or about $21.00 per capita. Of this total, $748,800, or about $9.00 per capita, was expended for operation and maintenance, and $963,000, or about $12.00 per capita, was expended for capital improvements.

---

[10] *See "Relief, Extension and Conversion of Sewer Facilities," Consoer, Townsend, and Associates, Consulting Engineers, Chicago, Illinois, 1966.*

[11] *See SEWRPC Planning Report No. 10, Volumes I and II, A Comprehensive Plan for the Kenosha Planning District, 1967.*

City of Racine: The existing service area of the City of Racine sanitary sewerage system is shown on Map 9. This area totals about 13.3 square miles and has a resident population of about 96,700 persons. In addition, the City of Racine provides treatment on a contract basis for wastewater generated in the Village Elmwood Park, the Village of North Bay, the Town of Caledonia Sewer Utility District No. 1, the Town of Mt. Pleasant Sewer Utility District, and the Colonial Heights Subdivision (located in the Town of Mount Pleasant). The sewer service area of these contract areas connected to the City of Racine sanitary sewerage system totals about 12.5 square miles and has a total resident population of about 19,800 persons. Thus, the City of Racine wastewater treatment facility serves a total sewer service area of about 25.8 square miles and a total resident population of about 116,500 persons.

As noted above, the sanitary sewerage system within the City of Racine serves an area of about 13.3 square miles. Of this total, about 11.2 square miles, or about 84 percent, are served by a separate sewer system and about 2.1 square miles, or about 16 percent, are served by a combined sewer system.

Until about the early 1950's, almost all urban development in the Racine area was served by combined sewers, which discharged untreated wastewater directly to the Root River or to Lake Michigan. Intercepting sewers were subsequently constructed to intercept the normal dry weather flow of sanitary wastes in combined sewers, as well as a portion of the storm flows, and convey these flows to the City of Racine wastewater treatment plant which was constructed in 1938. During periods of heavy rainfall, overflow devices discharge a portion of the combined sanitary-storm water flow, untreated, directly to the Root River or to Lake Michigan. There are ten known combined sewer outfalls in the Racine area, eight of which discharge to the Root River and two of which discharge directly to Lake Michigan (see Map 9).

The City of Racine began in 1967 to undertake a sewerage improvement program to effect a greater degree of separation within the combined sewer system. As a possible alternative to complete separation of the combined sewer system, the City of Racine, in cooperation with the Wisconsin Department of Natural Resources and the U.S. Environmental Protection Agency, completed a demonstration project to study the feasibility of providing wastewater treatment at the combined sewer outfalls. The project demonstrated the feasibility of utilizing a screening-air flotation system of rapid sewage treatment. The demonstration facility was constructed to treat combined sewer overflows from eight outfalls along the Root River, as well as treating "pure" storm water from a separate storm sewer outfall. Personnel of the Racine City Public Works Department have reported that the demonstration facility requires significant maintenance for removal of sludge following each storm. This demonstration provides one alternate solution to complete separation of the combined sewer system in the Racine area.

In 1975, the City completed phase one of a facility planning project to determine the most desirable method of abating discharges from the City's combined sewer system and to develop an infiltration/inflow analysis of the City's sewer system. Subsequent stages of this local facility planning program are continuing during 1978.

The Racine wastewater treatment facility is located on the Lake Michigan shoreline near the intersection of 21st and Main Streets (see Figure 27). The plant has a site area of about 17 acres, of which about 10 acres are currently utilized, leaving seven acres available for future use, assuming that structural retaining walls would be constructed to retain earthen embankments. The plant site is bounded by Lake Michigan on the east, a city street on the north, a steep embankment on the west, and the Lake Michigan shoreline on the south. The plant was constructed in 1938 with an initial average hydraulic design capacity of 12 mgd and a primary level of wastewater treatment. In 1967 the plant was expanded to a primary treatment level capacity of 23 mgd with 12 mgd of secondary treatment capacity. The expansion in 1967 was the first of a planned three-phase expansion program to provide a total average hydraulic design capacity of 36 mgd by 1980. Effluent disposal is via an outfall sewer to Lake Michigan which extends 500 feet beyond the breakwater.

Additions to the existing treatment facilities were completed in 1977. The expanded facility has an average capacity of 30 mgd and a maximum capacity of 52 mgd, and an organic design capacity of 42,000 pounds of BOD_5 per day.

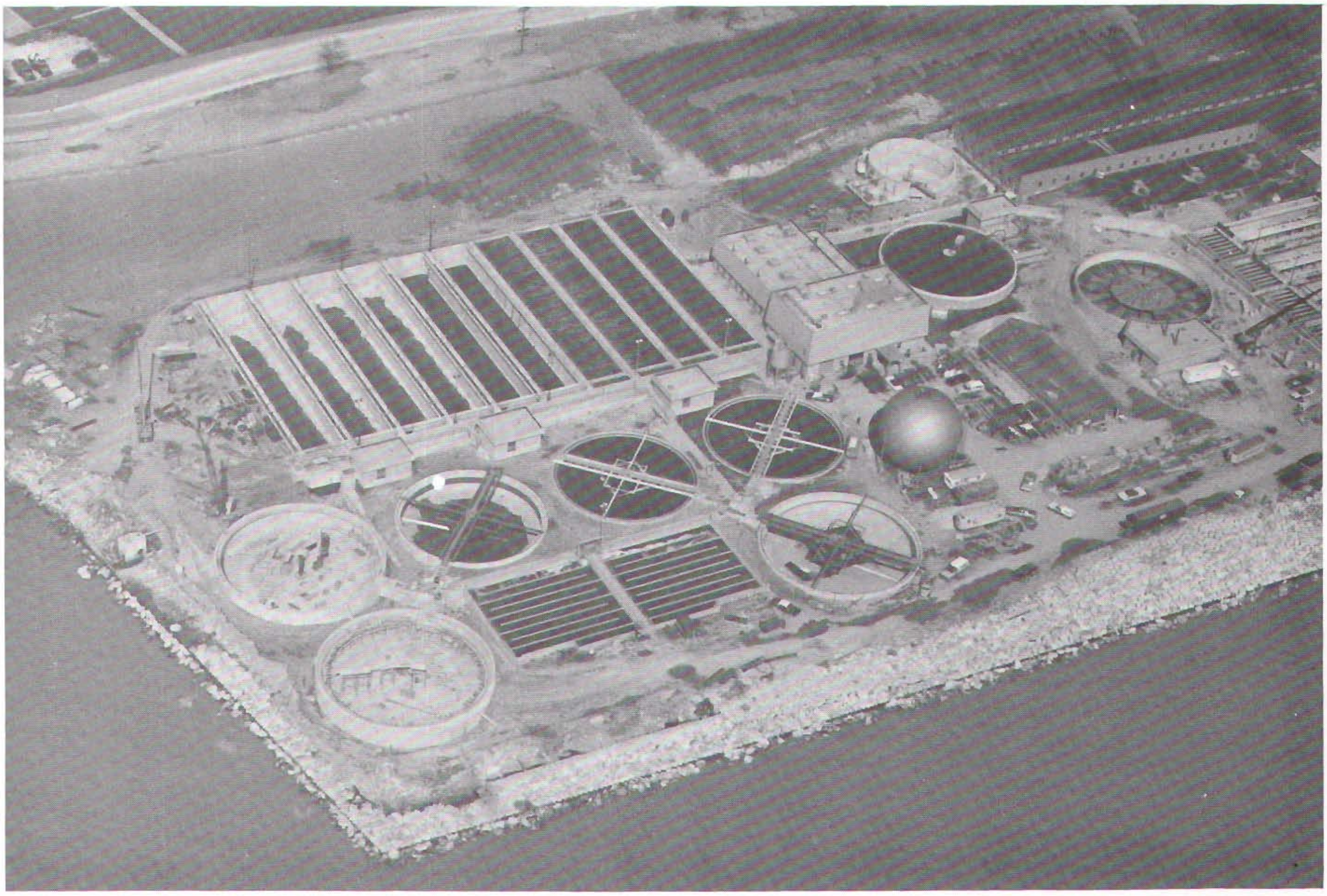
The plant provides primary and secondary waste treatment as well as advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the treatment units are anaerobically digested and then dewatered on vacuum filters prior to application on agricultural lands or disposal in a landfill.

During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 19.69 and 24.65 mgd, respectively, while the average annual and maximum monthly organic loadings were reported to be 16,042 and 18,400 pounds of BOD_5 per day respectively, indicating that the plant is operating above its 1975 design capacity but below its design capacity following the recent plant improvements.

During 1975, the treatment plant effluent was reported to contain an average concentration of 35 mg/l of BOD_5, 78 mg/l of suspended solids and 4.4 mg/l

Figure 27

CITY OF RACINE WASTEWATER TREATMENT PLANT



Source: SEWRPC.

of phosphorus and an average fecal coliform count of 259 per 100 ml. Maximum monthly average effluent concentrations of 41 mg/l of BOD_5, 111 mg/l of suspended solids and 6.2 mg/l of phosphorus as well as a maximum monthly average fecal coliform count of 500 per 100 ml were reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 35 mg/l of BOD_5, 100 mg/l of suspended solids, 4 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977. More stringent limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml go into effect at that time and prevail through the period to March 31, 1979.

As noted under the discussion of the City of Kenosha wastewater treatment plant, a settlement to a Lake Michigan pollution lawsuit brought by the State of Illinois may affect future treatment requirements and combined sewer pollution abatement programs.

The location and configuration of all major trunk sewers and pumping and lift stations and related force mains comprising the Racine sanitary sewerage system are shown on Map 9. In addition to the 12 combined sewer outfalls noted above, there are 31 points of sewage flow relief in the City of Racine sanitary sewerage system, including 17 crossovers and 14 bypasses as shown on Map 9.

Management of the City of Racine sanitary sewerage system is under the direction of the Wastewater Commission of the City of Racine. Day-to-day administration of the system is provided by the staff of the Wastewater Utility of the City of Racine, headed by the General Manager of the Water and Wastewater Utilities.

Local financing of the City of Racine sanitary sewerage system is provided both through the property tax and through funds provided under contractual agreements with other municipalities and special purpose districts. The financing method will be changed during the latter part of 1975 to reflect the implementation of a user charge system. The contractual agreements between the City of Racine and the Town of Mt. Pleasant, and between the City of Racine and the Town of Caledonia Sewer Utility District No. 1 provide that the Town and the District pay to the City of Racine 150 percent of the prorated cost of treating wastewater generated in the contract areas, an additional $40 per million gallons to cover depreciation of the capital facilities already in place, and 100 percent of the cost of additional sewer system components needed to adequately transmit and treat the wastes. The contractual agreement between the City of Racine and the Village of North Bay provides for an annual payment of the actual cost of treating the wastewater from the Village plus 50 percent. Each of the units of government contracting for sewage treatment with the City of Racine is responsible for the operation and maintenance of the local collection sewer system within the contract area.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Racine sanitary sewerage system approximated $10,116,143, or about $105.00 per capita. Of this total, $915,843, or about $10.00 per capita, was expended for operation and maintenance, and $9,200,300, or about $95.00 per capita, was expended for capital improvements.

Village of Elmwood Park Sanitary District: The existing service area of the sanitary sewer system serving the Village of Elmwood Park is shown on Map 9. Sewers were installed in the Village in 1975. This area totals about 0.65 square mile and has a resident population of about 400 persons. The entire area is served by a separate sanitary sewer system. Wastewater from the Village of Elmwood Park is treated at the wastewater treatment facility operated by the City of Racine, as discussed earlier in this chapter.

The location and configuration of the major trunk sewers serving the Village of Elmwood Park are shown on Map 9. There are no known points of sewage flow relief in the sanitary sewer system. The inventory revealed that the Village had no documented plan for the extension of sewer service.

Management of the Village of Elmwood Park Sanitary District sanitary sewerage system is under the direction of a Board of Trustees. Day-to-day administration of the system is provided by the Public Works Director. Financing of the system is provided through a general property tax.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Elmwood sanitary sewerage system were not available.

Village of North Bay: The existing sewer service area of the sanitary sewerage system serving the Village of North Bay is shown on Map 9. As noted above under the discussion of the City of Racine sanitary sewerage system, the Village of North Bay contracts with the City of Racine for wastewater treatment. The North Bay service area totals about 0.11 square miles and has a resident population of about 1,300 persons. The average hydraulic loading on the Racine wastewater treatment plant from the Village of North Bay in 1975 was estimated at 0.06 mgd. There is one known point of sewage flow relief, a bypass located in the Village of North Bay sanitary sewerage system.

Management and day-to-day administration of the Village of North Bay sanitary sewerage system is provided directly by the Village Board. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation, maintenance, and contract payments was $12,236, or about $9.00 per capita. Of this total, $7,835, or about $6.00 per capita, was expended for operation and maintenance, and $4,401 or about $3.00 per capita, was expended for contract payments.

Village of Sturtevant: The existing sewer service area of the Village of Sturtevant sanitary sewerage system is shown on Map 9. This area totals about 0.8 square mile and has a resident population of about 4,400 persons. The entire area is served by a separate sanitary sewerage system.

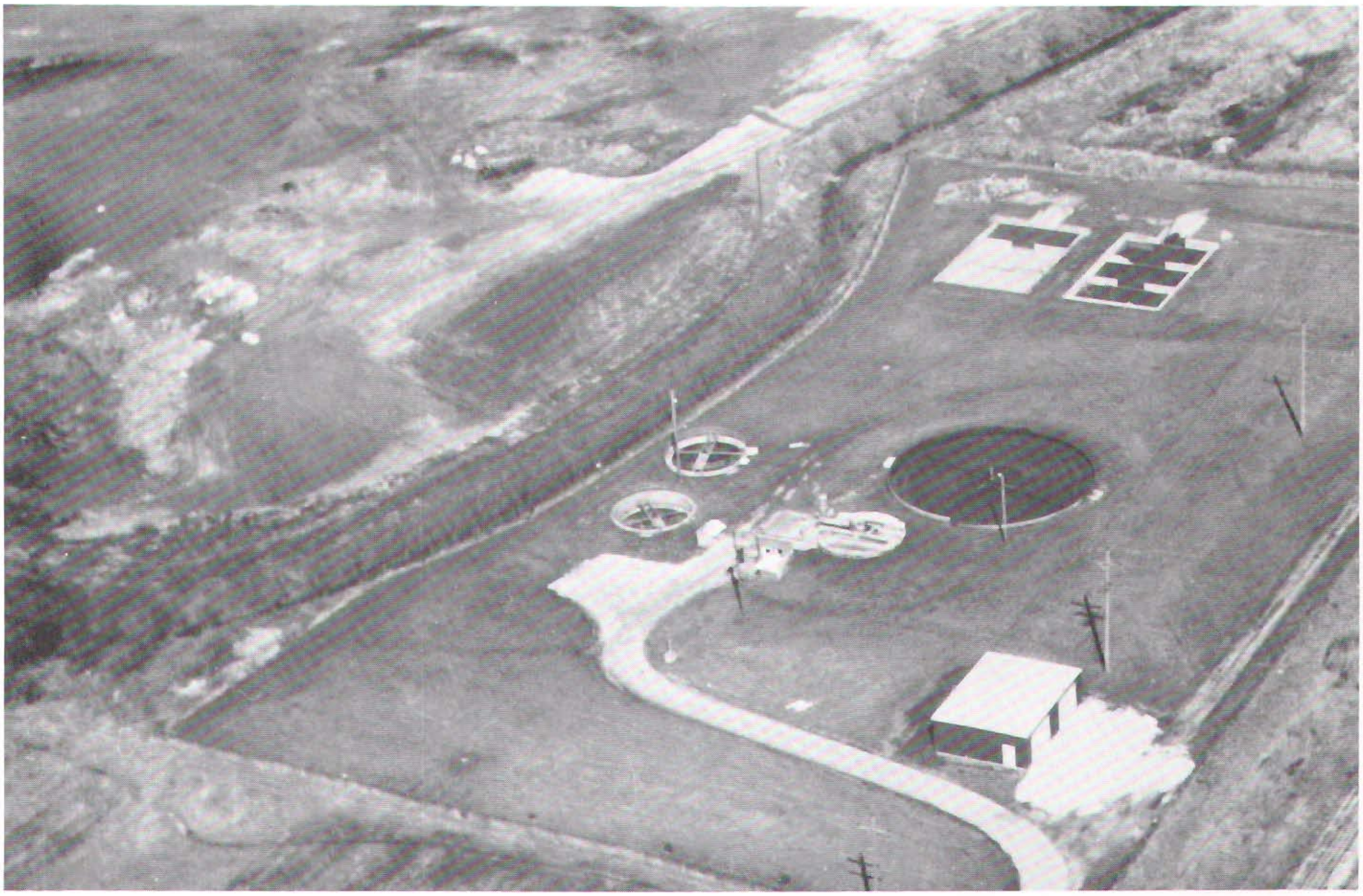
Wastewater from the Village of Sturtevant is treated at a wastewater treatment plant located on a minor drainage course leading to the Pike River, to which effluent is discharged (see Figure 28). The plant has a site area of about four acres, of which about two acres are currently utilized, leaving two acres available for future use. The site is bounded by open lands on the north, east, and west, and by a railroad right-of-way on the south. The plant was constructed in 1959 with modifications including phosphorus removal in 1974.

The treatment plant incorporates primary and secondary waste treatment processes and advanced treatment for phosphorus removal, and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filter, final clarification, chemical treatment for phosphorus removal and chlorination. Sludge solids removed from the secondary clarifier are returned to the comminutor wet well. Sludge solids removed from the primary clarifier are wasted to an anaerobic digestion system and pumped to sludge storage lagoons prior to application as a liquid on agricultural lands.

The plant has an average hydraulic design capacity of 0.30 mgd, with a peak hydraulic design capacity of 0.50 mgd and an organic design capacity of 425 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant

Figure 28

VILLAGE OF STURTEVANT WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

were reported to be 0.53 and 0.83 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 572 and 779 pounds of BOD_5 per day respectively, indicating that the plant is operating above its design capacity.

During 1975, the treatment plant effluent was reported to contain an average concentration of 33 mg/l of BOD_5, 40 mg/l of suspended solids and 2.3 mg/l of phosphorus and an average fecal coliform count of 179,000 per 100 ml. Maximum monthly average effluent concentrations of 48 mg/l of BOD_5, 63 mg/l of suspended solids and 5.9 mg/l of phosphorus as well as a maximum monthly average fecal coliform count of 612,000 per 100 ml were reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 50 mg/l of BOD_5, 50 mg/l of suspended solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per ml, effective through June 30, 1977.

The location and configuration of all major trunk sewers serving the Village of Sturtevant are shown on Map 9. The only known point of sewage flow relief in the Village of Sturtevant sanitary sewerage system is a bypass at the treatment plant. The inventory revealed that the village has a documented plan for the abandonment of the existing facility after the completion of a trunk sewer to the City of Racine. In 1977, the Village had completed a facility plan for the conveyance of wastewater from the Village and the Town of Mount Pleasant to the City of Racine sanitary sewerage sytem and construction of the trunk sewer project was pending grant approvals.

Management of the Village of Sturtevant sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by a Water and Sewer Committee of the Board together with its staff in the Department of Public Works. Financing of the system is provided through a sewer service charge. There is a minimum charge of $5.00 per quarter, to which is a charge of $0.50 per 1,000 gallons in excess of 6,000 gallons each quarter.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Sturtevant sanitary sewerage system approximated $139,021, or about $32.00 per capita. Of this total, $101,430, or about $23.00 per capita, was expended for operation and maintenance, and $37,591, or about $9.00 per capita, was expended for capital improvements.

Town of Caledonia Sewer Utility District: The existing sewer service area of the sanitary sewerage system serving the Caledonia Sewer Utility District in the Town of Caledonia is shown on Map 9. As noted above under the discussion of the City of Racine sanitary sewerage system, the Caledonia Sewer Utility District contracts with the City of Racine for wastewater treatment. The Caledonia Sewer Utility District service area totals about 4.3 square miles and has a resident population of about 4,300 persons. The average hydraulic loadings on the Racine wastewater treatment plant from the Caledonia Sewer Utility District in 1975 was estimated at 0.43 mgd.

The location and configuration of the major trunk sewers and pumping stations and related force mains serving the Caledonia Sewer Utility District are shown on Map 9. There are three known points of sewage flow relief in the system, all of which are bypasses. The inventory revealed that the District had a documented plan for the expansion of its sewerage system to an additional 12.0 square miles area within the District boundaries. However, no locally proposed trunk sewers to serve this additional area were revealed in the inventory.

Management of the Caledonia Sewer Utility District sanitary sewerage system is under the direction of a five-member Utility Board. Day-to-day administration of the system is provided by an appointed manager. Financing of the system is provided through a sewer service charge of $25.00 per calendar quarter per unit of service, a change of $400 per new connection, a tax of 4 mill per $1,000 assessed value, and a per frontage foot of benefiting properties within the extension areas.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Caledonia Sewer Utility District No. 1 sanitary sewerage system approximated $201,600, or about $47.00 per capita. Of this total, $59,000, or about $14.00 per capita, was expended for operation and maintenance, and $142,600, or about $32.00 per capita, was expended for capital improvements.

Town of Mt. Pleasant Sewer Utility District: The existing sewer service area of the sanitary sewerage system serving the Mt. Pleasant Sewer Utility District in the Town of Mt. Pleasant is shown on Map 9. As noted above under the discussion of the City of Racine sanitary sewerage system, the Mt. Pleasant Sewer Utility District contracts with the City of Racine for wastewater treatment. The Mt. Pleasant Sewer Utility District service area totals about 7.4 square miles and has a resident population of about 13,800 persons. The average hydraulic loading on the Racine wastewater treatment plant from the Mt. Pleasant Sewer Utility District in 1975 was estimated at 2.38 mgd.

The location and configuration of the major trunk sewers and pumping and lift stations and related force mains serving the Mt. Pleasant Sewer Utility District are also shown on Map 9. There are three known points of sewage flow relief in the Mt. Pleasant Sewer Utility District sanitary sewerage system, all of which are bypasses. The inventory revealed that the Mt. Pleasant Sewer Utility District had documented plans for the expansion of its sewerage system and for the extension of trunk sewers into the proposed service area.

Management of the Mt. Pleasant Sewer Utility District is under the direction of a three-member commission. Day-to-day administration of the system is provided by the coordinator of the Town of Mt. Pleasant. Financing of the system is provided through a sewer service charge of $20.00 per calendar quarter per sewer connection.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Mt. Pleasant Sewer Utility District sanitary sewerage system approximated $356,337, or about $26.00 per capita. Of this total, $99,481, or about $7.00 per capita, was expended for operation and maintenance, and $256,856, or about $19.00 per capita, was expended for capital improvements.

Town of Pleasant Prairie Sewer Utility Districts: The existing service areas of the sanitary sewerage system serving the Town of Pleasant Prairie Sewer Utility Districts are shown on Map 9. As noted above under the discussion of the City of Kenosha sanitary sewerage system, these six Districts contract with the Kenosha Water Utility for wastewater treatment. Taken together, the service areas of these six districts total about 1.0 square mile and have a resident population of about 4,600 persons. All six areas are served by separate sanitary sewer systems. There are no known points of sewer overflow or bypassing in these systems.

Management of the six utility districts is under the direction of the Town Board. Financing of these six systems is provided through special assessments. Contracts between the Kenosha Water Utility and these six Districts provide for an annual flat fee payment per sewer connection. In 1975 this fee was $42.00 annually. In addition, an annual charge per sewer connection to cover the cost of the maintenance of the local collection sewer systems within the six Districts is added to the above fee.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the sanitary sewerage systems serving the Town of Pleasant Prairie Sewer Utility District approximated $66,640, or about $15.00 per capita. Of this total, $17,388, or about $4.00 per capita, was expended for operation and maintenance, and $49,252, or about $11.00 per capita, was expended for capital improvements.

Town of Somers Sanitary District No. 1: The existing service area of the Town of Somers Sanitary District No. 1 sanitary sewerage system is shown on Map 9. This area totals about 0.8 square mile and has a resident population of about 1,500 persons. The entire area is served by a separate sanitary sewer system. As noted above under the discussion of the City of Kenosha sanitary sewer system, the Town of Somers Sanitary District No. 1 contracts with the Kenosha Water Utility for wastewater treatment. As of 1975 there were no known points of sewer overflow or bypassing within District's sanitary sewerage system.[12]

Management of the Town of Somers Sanitary District No. 1 sanitary sewerage system is under the direction of a three-member commission. The contract between the Kenosha Water Utility and the district provides for a metered rate. In 1975 this rate was $210 per million gallons. The District itself is responsible for the operation and maintenance of the local collection sewer system within the District. Financing of the Town of Somers Sanitary District No. 1 sanitary sewerage system is provided in part through a sewer service charge and in part through the general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Town of Somers Sanitary District No. 1 sanitary sewerage system approximated $80,988, or about $54.00 per capita. Of this total, $32,322, or about $22.00 per capita, was expended for operation and maintenance, and $48,666, or about $32.00 per capita, was expended for capital improvements.

Town of Somers Utility District No. 1: The existing service area of the Town of Somers Utility District No. 1 sanitary sewerage system is shown on Map 9. This area totals about 0.3 square mile and has a resident population of about 700 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Town of Somers Utility District No. 1 is treated in an activated sludge type wastewater treatment plant located at the northeastern district limits (see Figure 29). The plant has a site area of about 1.5 acres, of which about one acre is currently utilized. The plant site is bounded on the south by residential development and on the north, east, and west by agricultural and open lands. The effluent from the plant is discharged to the Somers Branch of the Pike River. The plant was constructed in 1963-64, and incorporates primary and secondary waste treatment processes, as well as auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include extended aeration, activated sludge, final clarification, and disinfection. Sludge solids removed from the clarifier are transported to sludge lagoons for storage prior to transfer to the City of Kenosha treatment plant for final treatment. The comprehensive plan for the Kenosha Planning District recommended that this sewage treatment facility be abandoned and its sewer service area connected to the City of Kenosha sanitary sewerage system as trunk sewer service becomes available.

The plant has an average hydraulic design capacity of 0.03 mgd, with a peak hydraulic design capacity of 0.10 mgd. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.06 and 0.09 mgd respectively,

Figure 29

TOWN OF SOMERS UTILITY DISTRICT NO. 1
WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

---

[12]*A November 1977 preliminary report draft covering detailed sewer system studies being conducted by the City of Kenosha reported that there was one bypass in the Town's sanitary sewer system.*

while the average annual and maximum monthly organic loadings were reported to be 102 and 152 pounds of BOD_5 per day, indicating that the plant is currently operating above the average design capacity.

During 1975, the treatment plant effluent was reported to contain an average concentration of 59 mg/l of BOD_5, 66 mg/l of suspended solids, and an average fecal coliform count of 2,900 per 100 ml. Maximum monthly effluent of 91 mg/l of BOD_5 and 171 mg/l of suspended solids as well as a maximum monthly average fecal coliform count of 7,700 per 100 ml was reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

During 1977 the Town of Somers Utility District No. 1 initiated construction of an interim addition to the existing sewage treatment plant which is planned to bring the hydraulic capacity of the facility up to 0.13 mgd.

The location and configuration of the single major trunk sewer serving the Town of Somers Utility District No. 1 is shown on Map 9. Except for a bypass located at the wastewater treatment plant, there are no known points of sewer overflow or bypassing in the system. Since the comprehensive plan for the Kenosha Planning District recommends the eventual abandonment of this plant, there is no future service area or proposed trunk sewers shown on Map 9, other than that area proposed to be connected to the Kenosha sanitary sewerage system and a 0.2 square mile area within the District limits.

Management of the Town of Sommers Utility District No. 1 sanitary sewerage system is under the direction of the Town Board. Day-to-day administration of the system is also provided directly by the Board members. Financing of the system is provided in part through a quarterly service charge of $13.50 per residential sewer connection and in part through the District tax levy.

Total expenditures during 1970 for operation, maintenance, and capital improvements, including debt retirement, for the Town of Somers Utility District No. 1 sanitary sewerage system approximated $17,669, or about $25.00 per capita. Of this total, $14,000, or about $20.00 per capita, was expended for operation and maintenance, and $3,669, or about $5.00 per capital, was expended for capital improvements.

Crestview Sanitary District: The existing service area of the Crestview Sanitary District sanitary sewerage system in the Town of Caledonia is shown on Map 9. This area totals about 0.66 square mile and has a resident population of about 2,500 persons. The entire area is served by a separate sanitary sewer system. Wastewater from the Crestview Sanitary District is treated at the wastewater treatment facility operated by the North Park Sanitary District, as discussed later in this chapter. The average hydraulic loading on the North Park wastewater treatment plant from the Crestview Sanitary District in 1976 was estimated at 0.3 mgd.

The location and configuration of the major trunk sewer and pumping stations serving the Crestview Sanitary District is shown on Map 9. There are no known points of sewage flow relief in the Crestview Sanitary District. The inventory revealed that the district had a documented plan for the extension of sewer service of 0.34 square mile into the undeveloped portions of the district. This additional proposed service area is also shown on Map 9.

Management of the Crestview Sanitary District sanitary sewerage system is under the direction of a three-member commission. Day-to-day administration of the system is provided by the Treasurer of the Town of Caledonia. Financing of the system is provided through a sewer service charge of $15.00 per calender quarter per sewer connection.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Crestview Sanitary District sanitary sewerage system were not available.

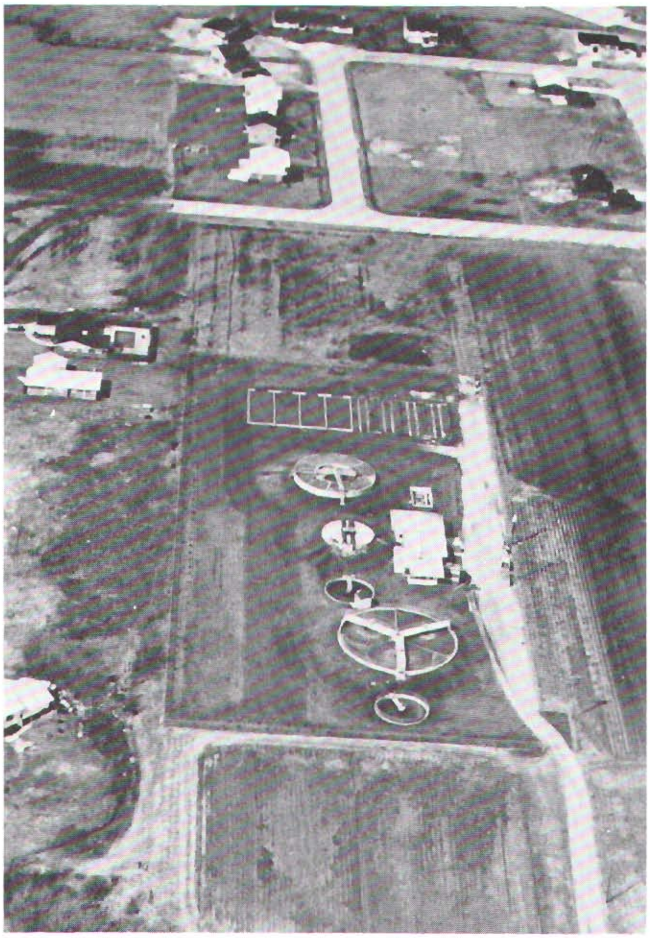
North Park Sanitary District: The existing sewer service area of the North Park Sanitary District sanitary sewerage system is shown on Map 9. This district consists of all of the Village of Wind Point and a portion of the Town of Caledonia. This area totals about 4.3 square miles and has a resident population of about 6,800 persons. The entire area is served by a separate sanitary sewerage system. As noted earlier in this chapter, the North Park Sanitary District contracts to provide treatment for wastewater generated in the Crestview Sanitary District.

Wastewater from the North Park and Crestview Sanitary Districts is treated at a wastewater treatment plant located near the Lake Michigan shoreline, with an outfall sewer leading directly to the lakeshore (see Figure 30). The plant has a site area of about seven acres, of which about five acres are currently utilized, leaving about two acres available for future use. The site is bounded by agricultural and open lands on the south and east and by residential land use on the north and west. The North Park plant actually consists of two parallel treatment facilities. The first plant, constructed in 1955 as a trickling filter type plant, was modified and converted in 1968 to a contact stabilization activated sludge type plant. The second plant, a contact stabilization type plant, was constructed in 1964. The plant was modified further in 1972 and 1975.

The treatment plant incorporates parallel processes providing primary and secondary waste treatment processes and provides advanced waste treatment

Figure 30

NORTH PARK SANITARY DISTRICT
WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chemical treatment for phosphorus removal and chlorination. Sludge solids removed from the clarifier are digested anaerobically prior to partial dewatering on drying beds and application as a cake or liquid on farm lands.

The plant has an average hydraulic design capacity of 2.0 mgd, with a peak hydraulic design capacity of 3.0 mgd and an organic design capacity of 3,400 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.13 mgd and 1.30 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 911 and 975 pounds of BOD_5 per day respectively, indicating that the plant has an adequate capacity to treat the loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain an average concentration of 15 mg/l of BOD_5, 24 mg/l of suspended solids and 0.8 mg/l of phosphorus. Maximum monthly average effluent concentrations of 20 mg/l of BOD_5, 29 mg/l of suspended solids and 1.0 mg/l of phosphorus were reported during 1975. Data on fecal coliform counts was not reported routinely during 1975. However a monthly average effluent chlorine residual which varied from 0.4 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentrations of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through the period to June 30, 1977.

The location and configuration of all major trunk sewers and pumping and lift stations and related force mains included in the North Park Sanitary District sanitary sewerage system are shown on Map 9. There are no known points of sewage flow relief in the North Park Sanitary District sanitary sewerage system.

The inventory revealed that the district had documented plans for the expansion of its sewerage system to an additional 2.71 square mile area. Locally proposed trunk sewers to serve this area are shown on Map 9.

Management of the North Park Sanitary District sanitary sewerage system is under the direction of a three-member commission. Day-to-day administration of the system is provided by the Plant Superintendent. Financing of the system is provided both through a sewer service charge and a general property tax levy. The sewer service charge is currently $7.00 per calendar quarter per sewer connection.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the North Park Sanitary District sanitary sewerage system were not available.

Pleasant Park Sewer Utility: The Pleasant Park Sewer Utility is a privately-owned and operated sanitary sewerage utility. Not unlike a town sanitary district, it serves a significant concentration of urban development in the Town of Pleasant Prairie and for inventory purposes has been regarded herein as a public system. The existing service area of the Pleasant Park Sewer Utility sanitary sewerage system is shown on Map 9. This area totals about 0.2 square mile and has a resident population of about 800 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Pleasant Park Sewer Utility is treated in a plant located at the southeastern limits of the service area (see Figure 31). The plant

Figure 31

PLEASANT PARK SEWER UTILITY WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

has a site area of about 19 acres, of which about two acres are currently utilized leaving 17 acres available for future use. The plant site is bounded on the north by residential development and on the east, west, and south by agricultural and open lands. The effluent from the plant is discharged to an unnamed stream draining directly to Lake Michigan. The plant was constructed in 1960. The treatment plant incorporates primary, secondary, and tertiary waste treatment processes and provides auxiliary treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, sand filtration, and chlorination. Sludge solids are aerobically digested and then disposed of by the Kenosha Water Utility on agricultural lands. The comprehensive plan for the Kenosha Planning District recommends that this sewage treatment facility be ultimately abandoned as trunk sewer service is extended from the City of Kenosha sanitary sewerage system.

The plant has an average hydraulic design capacity of 0.06 mgd with an organic design capacity of 126 pounds of BOD_5 per day. No data for the peak hydraulic design capacity is available. During 1975, the average annual and maximum monthly hydraulic loadings were reported to be 0.04 mgd and 0.08 mgd respectively, while the average annual organic loadings was reported to be 42 pounds of BOD_5 per day, indicating that the plant is currently operating near the average hydraulic design capacity but below its organic design capacity.

During 1975, the treatment plant effluent was reported to contain an average concentration of 5 mg/l of BOD_5 and 10 mg/l of suspended solids. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 10 mg/l of BOD_5, 10 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through the period of June 30, 1977.

The location and configuration of the single trunk sewer serving the Pleasant Park Sewer Utility sanitary sewerage system is shown on Map 9. Since the service area of the Pleasant Park Sewer Utility is completely encompassed by the future service area of the Kenosha sanitary sewerage system, no future service area or proposed trunk sewers for the Pleasant Park Sewer Utility are shown on Map 9.

Management of the Pleasant Park Sewer Utility is provided by the officers of the private corporation. Day-to-day administration of the system is provided by the president of the corporation. Operation and maintenance of the system are financed through a monthly service charge of a minimum of \$7.00 per month to a maximum of \$10.80 per month depending upon total amount of gallons pumped.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Pleasant Park

Sewer Utility sanitary sewerage system were not available.

Flow Relief Devices

As noted above on an individual community basis, there are 76 sewage flow relief devices located in the sanitary sewerage systems located in the Kenosha-Racine subregional area. Table 28 indicates the number and type of flow relief devices as well as an estimate of the total average annual discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 9.

Proposed Public Sanitary Sewerage Systems

The Commission sewer service inventory as of 1975 indicates no known proposals for the construction of new public sanitary sewer systems in the Kenosha-Racine subregional area.

Table 28

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE KENOSHA-RACINE SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in The Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
LAKE MICHIGAN WATERSHED								
City of Kenosha[b]	Yes-Bypass	11	--	--	--	4	15	280.0[c]
City of Racine	No	6	--	--	--	2	8	257.0[d]
Village of North Bay	No plant	--	1	--	--	--	1	--[e]
Town of Mt. Pleasant	No plant	--	1	--	--	--	1	--[e]
Watershed Total	1-Bypass	17	2	--	--	6	25	537.0
ROOT RIVER WATERSHED								
City of Racine	No plant	11	14	--	--	8	33	310.0[f]
Town of Caledonia	No plant	--	3	--	--	--	3	--[e]
Town of Mt. Pleasant	No plant	--	1	--	--	--	1	7.0
Watershed Total	None	11	18	--	--	8	37	317.0
PIKE CREEK WATERSHED								
City of Kenosha[c]	No plant	3	--	2	--	--	5	10.0
Watershed Total	None	3	--	2	--	--	5	10.0
PIKE RIVER WATERSHED								
City of Kenosha[b]	No plant	5	--	--	--	--	5	10.0
Village of Sturtevant	Yes-Bypass	--	--	--	--	--	--	1.0
Town of Mt. Pleasant	No	--	1	--	--	--	1	2.0
Town of Somers Utility Dist. No. 1	Yes-Bypass	--	--	--	--	--	--	2.0
Watershed Total	2-Bypasses	5	1	--	--	--	6	15.0
Subregional Area Total	3-Bypasses	36	21	2	--	14	73	879.0

[a] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loadings on a watershed basis.*

[b] *A November 1977 preliminary draft report covering detailed sewer system studies being conducted by the City of Kenosha reported that there were 41 flow relief devices in the city's separated sanitary sewer system, three such devices at the City's wastewater treatment plant and one flow relief device in the Town of Somers Sanitary District No. 1 sewer systems.*

[c] *Includes an annual estimated contribution of 260 mg from the combined sewer overflows and 20 mg from other flow relief devices.*

[d] *Includes an annual estimated contribution of 130 mg from the combined sewer overflows and 127 mg from other flow relief devices.*

[e] *The annual estimated contribution from flow relief devices is less than 1.0 mg.*

[f] *Includes an annual estimated contribution of 160 mg from combined sewer overflows and 150 mg from other flow relief devices.*

Source: SEWRPC.

Other Wastewater Treatment Facilities

In addition to the 17 publicly-owned and one privately-owned public sanitary sewerage systems discussed above, there are a total of five privately-owned wastewater treatment facilities in the Kenosha-Racine subregional area which in general serve single isolated land use enclaves and generally treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. These five facilities include three industrial wastewater treatment plants directly related to the agricultural, transportation, and the heavy equipment industries, as well as two institutional wastewater treatment plants.

The industrial waste treatment plants serve the American Motors Corporation truck service facility plant in the Town of Somers; the J.I. Case Company Tractor Plant in the Town of Mt. Pleasant. The agricultural waste treatment plant serves the Frank Pure Food Company canning plant in the Town of Mt. Pleasant. The private institutional waste treatment plants serve the St. Bonaventure Prep School in the Town of Mt. Pleasant and the Sienadale Mother House in the Town of Pleasant Prairie. Pertinent characteristics of these facilities are presented in Table 29 and their locations are shown on Map 9.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage overflow points on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, process rinse and wash waters, which are discharged without treatment or following treatment directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters, and records of municipal public works departments. A total of 21 such known point sources of industrial wastewater were identified in the Kenosha-Racine subregional area. Pertinent characteristics of these 21 waste sources are identified in Table 30. The location of these 21 point sources is shown on Map 10.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Kenosha-Racine subregional area serve a total area of about 49.4 square miles, or 31 percent of

Table 29

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/1)	Suspended Solids (mg/1)	Total Phosphorus (mg/1)	Total Nitrogen (mg/1)	Fecal Coliform Bacteria (Number per 100 ml)
LAKE MICHIGAN WATERSHED													
Racine County													
J. I. Case Company	City of Racine	Industrial	Process and Cooling	Chemical Treatment	Lake Michigan	N/A	1,259,400	1,325,800	12.1	15.3	0.162	3.43	N/A
Kenosha County													
Siendale Motherhouse	Town of Pleasant Prairie	Institutional	Sanitary	Extended Aeration and Lagoon	*Bartlett Creek*	4,000	2,000	N/A	N/A	N/A	N/A	N/A	N/A
PIKE RIVER WATERSHED													
Kenosha County													
American Motors Kenosha[b]	Town of Somers	Industrial	Process	Activated Sludge and Sand Filter	Pike River	2,000	2,000	N/A	30	30	N/A	N/A	200
Racine County													
St. Bonaventure Seminary	Town of Mount Pleasant	Institutional	Sanitary	Contact Stabilization and Lagoon	Waxdale Creek	15,000	8,000	10,000	50	N/A	N/A	N/A	200
ROOT RIVER WATERSHED													
Racine County													
Frank Pure Food Company	Town of Caledonia	Industrial	Process	Screening and Lagoon	Hoods Creek via Drainage Tile	N/A	70,000	70,000	9.0	20.4	0.5	1.6	200

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES), questionnaire data obtained by SEWRPC; reports filed under Section 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rate were estimated from the available monthly discharge data reported in or requirements of the permit.*

[b] *The American Motors plant was not in operation in 1978 and the wastes generated are held in a holding tank prior to pick-up by a commercial wastehauler.*

Source: Wisconsin Department of Natural Resources, and SEWRPC.

Table 30

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	LAKE MICHIGAN WATERSHED Kenosha County																
1	Anaconda American Brass Company	3351	City of Kenosha	Cooling and Rinse	Iron precipitation and settling tank	1	Lake Michigan via Storm Sewer	185,500	242,800	2.0	1.2	0.07	7.2	0.0	16.1	Yes	--
2	Eaton Corporation – Industrial Drives Division . .	3566	City of Kenosha	Cooling	None	1	Lake Michigan via Storm Sewer	10,700	14,600	2.0	0.5	N/A	N/A	N/A	31.7	No	--
				Cooling	None	2	Lake Michigan	5,000	11,100	2.0	0.5	N/A	N/A	N/A	10.9	No	--
	Racine County																
3	Harris Metals, Inc.	3361	City of Racine	Cooling and Process	None	1	Birch Creek via Storm Sewer and Drainage Ditch	N/A	1,050,000	N/A	15.0	N/A	N/A	N/A	N/A	No	--
4	J. I. Case Company – Clausen Plant	3523	City of Racine	Process and Cooling	Precipitation and Settling	1	Lake Michigan	35,700	59,500	12.1	15.3	0.162	3.43	N/A	19.6	Yes	--
				Process and Cooling	N/A	2	Lake Michigan	327,900	440,000	12.1	15.3	0.162	3.43	N/A	13.5	Yes	--
				Process and Cooling	N/A	3	Lake Michigan	1,259,400	1,325,800	12.1	15.3	0.162	3.43	N/A	22.6	Yes	--
				Process and Cooling	Oil Separator	4	Lake Michigan	863,100	1,166,700	12.1	15.3	0.162	3.43	N/A	15.7	Yes	--
5	Madison Fuel Company – Baumann Oil Branch	5171	City of Racine	Runoff	N/A	1	Lake Michigan	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
6	Printing Developments, Inc. .	3471	City of Racine	Cooling	None	1	Lake Michigan via Storm Sewer	120,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
7	S. C. Johnson and Son, Inc.. .	2842	City of Racine	Cooling	None	4	Lake Michigan	490,000	930,000	N/A	N/A	N/A	N/A	N/A	18.8	No	--
				Cooling	None	5	Lake Michigan via Storm Sewer	602,900	820,000	N/A	N/A	N/A	N/A	N/A	29.9	No	--
8	TEK Products, Inc.	3079	City of Racine	Cooling	N/A		Lake Michigan via Storm Sewer	26,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
9	Vulcan Materials Company – Construction Materials Division	1422	City of Racine	Process	None	1	Tributary of Lake Michigan via Storm Ditch	421,000	2,160,000	1.0	1.26	0.052	3.33	N/A	N/A	No	--
10	Young Radiator Company . .	3714	City of Racine	Process, Cooling and Boiler Blowdown	None	1	Lake Michigan via Drainage Ditch	40,000	100,000	N/A	20.0	N/A	N/A	N/A	N/A	Yes	--
	PIKE CREEK WATERSHED Kenosha County																
11	American Motors Corporation – Main Plant . .	3711	City of Kenosha	Cooling	Oil Separator	1	Pike Creek	2,335,000	2,834,000	3.0	10.5	0.1	0.35	N/A	11.8	Yes	--

Table 30 (continued)

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	PIKE RIVER WATERSHED Racine County																
12	Ametek Lamb Electric	3621	City of Racine	Cooling	None	1	Sorenson Creek	3,000	7,000	0.0	6.0	0.0	1.85	N/A	18.3	Yes	--
13	J. I. Case Company — Transmission Plant	3714	Town of Mount Pleasant	Cooling	None	1	Pike River	70,000	80,000	4.3	0.03	0.01	0.07	N/A	13.3	Yes	--
14	Rexnord, Inc. — Hydraulic Component Division	3599	Town of Mount Pleasant	Cooling	None	1	Pike River	130,000	231,000	N/A	N/A	N/A	N/A	N/A	15.4	No	--
15	S. C. Johnson and Son, Inc. . .	2842	Village of Sturtevant	Cooling	None	1	Tributary of Pike River	1,291,400	1,550,000	N/A	N/A	N/A	N/A	N/A	19.8	No	--
				Cooling	None	2	Tributary of Pike River	248,000	320,000	N/A	N/A	N/A	N/A	N/A	19.2	No	--
				Cooling	None	2	Tributary of Pike River	96,000	120,000	N/A	N/A	N/A	N/A	N/A	18.5	No	--
	ROOT RIVER WATERSHED Racine County																
16	Emerson Electric Company — Insinkerator Division . . .	3639	City of Racine	Cooling	None	1	Root River via Storm Sewer	27,200	33,000	0.5	0.5	0.2	9.8	N/A	23.7	Yes	--
				Cooling	None	2	Root River via Storm Sewer	13,400	15,800	0.5	0.5	0.2	9.8	N/A	23.0	Yes	--
17	Frank Pure Food Company. .	2033	Town of Caledonia	Cooling	None	2	Hoods Creek via Drainage Tile	12,800	16,000	9.0	20.4	0.5	1.60	N/A	28.3	Yes	--
18	Racine Stamping Corporation	3469	City of Racine	Cooling	None	1	Lake Michigan via Storm Sewer	17,500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
19	Twin Disc, Inc. — Racine Street Plant	3566	City of Racine	Cooling	None	1	Root River via Storm Sewer	17,000	30,000	0.0	9.0	1.55	1.69	N/A	15.0	Yes	--
				Cooling	None	2	Root River via Storm Sewer	11,000	25,000	0.0	9.0	1.55	1.69	N/A	N/A	Yes	--
				Cooling	None	3	Root River via Storm Sewer	29,000	40,000	0.0	9.0	1.55	1.69	N/A	N/A	Yes	--
20	Twin Disc, Inc. — 21st Street Plant	3566	City of Racine	Cooling	None	1	Root River via Storm Sewer	45,000	65,000	15.0	5.0	0.19	0.76	N/A	14.3	Yes	--
				Cooling	None	2	Root River via Storm Sewer	73,000	94,000	15.0	5.0	0.19	0.76	N/A	N/A	Yes	--
				Cooling	None	3	Root River via Storm Sewer	6,000	9,000	15.0	5.0	0.19	0.76	N/A	N/A	Yes	--
21	Western Publishing Company	2731	City of Racine	Cooling	None	1	Root River	154,000	601,300	10.0	3.26	0.63	5.83	658	18.3	Yes	--
				Cooling	None	2	Root River	108,300	371,000	10.0	3.26	0.63	5.83	658	12.8	Yes	--
				Cooling	None	3	Root River	96,000	328,000	10.0	3.26	0.63	5.83	658	12.6	Yes	--

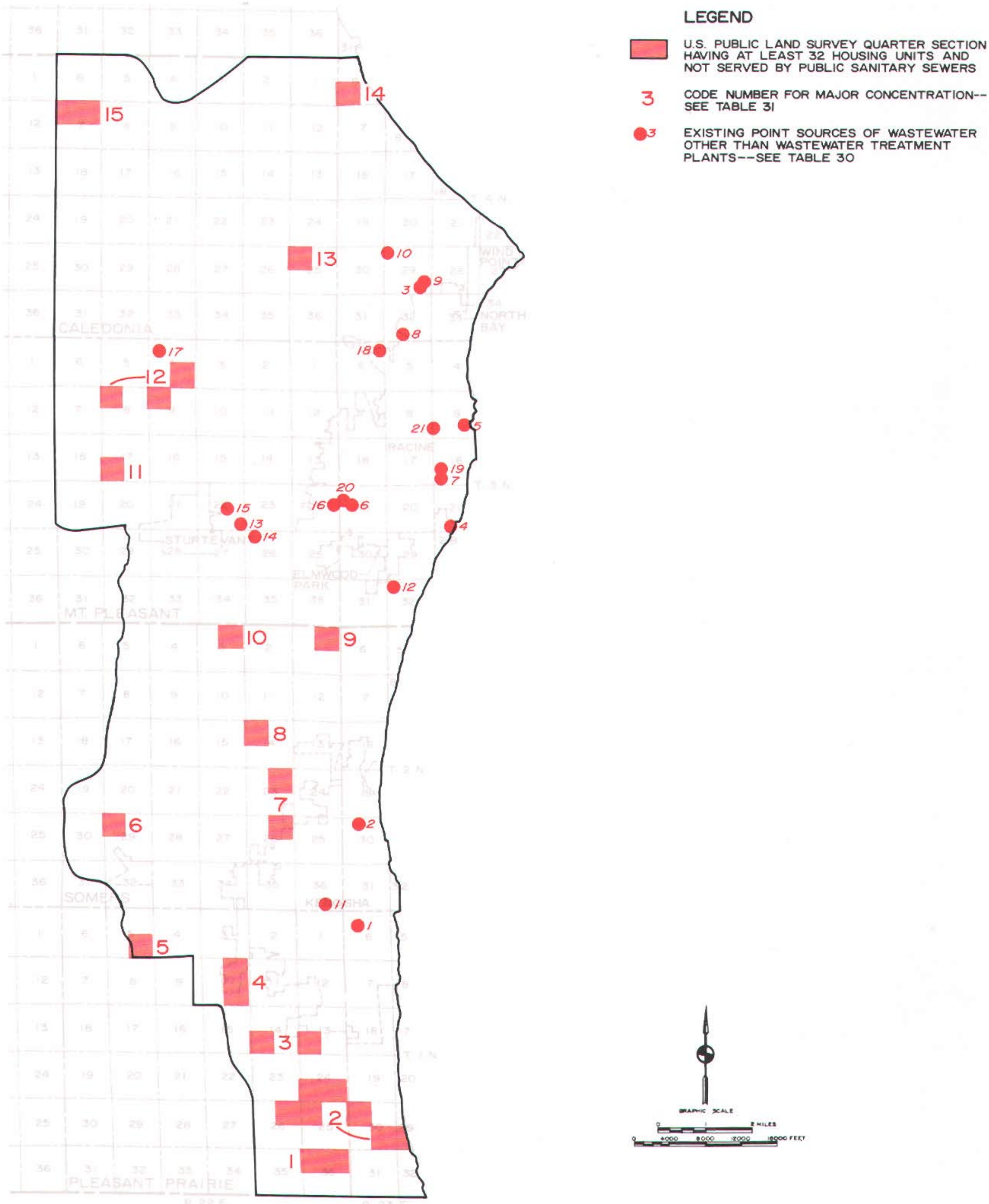
NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wiscon*sin Pollutant Discharge Elimination System (WPDES) or under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the *above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic* discharge rates were estimated from the available monthly discharge data or from the flow data reported in or requirements of the permit itself. In some cases *when wastewater characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values* were available, these were reported.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 10

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975



Significant concentrations of unsewered urban development in the Kenosha-Racine subregional area consist of noncontiguous residential land subdivisions, which represent "leapfrog" urban development in the Kenosha urban area, as well as unsewered subdivisions in the Towns of Caledonia and Mt. Pleasant, which represent remnants of large, unsewered urban areas that developed rapidly in the 1950's and 1960's. There are 21 existing (1975) known point sources of wastewater other than wastewater treatment facilities in the Kenosha-Racine subregional area. Such waste sources are most prevalent in the industrial land use concentrations in the Cities of Kenosha and Racine.

Source: Wisconsin Department of Natural Resources and SEWRPC.

the total area of the subregional area, and a total population of about 221,200, or about 93 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban while quarter sections with between six and 31 housing units or one housing unit for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 109.0 square miles, or 69 percent of the total area of the subregional area, and contain a total population of about 16,600, or 7 percent of the total population of the subregional area. Of that total, about 6.9 square miles or 4 percent of the total area of the subregional area containing a total population of 4,500, or 2 percent of the total population of the subregional area are classified as urban.

For analysis purposes, the existing nonsewered urban development has been combined into 15 named major urban concentrations as shown on Map 10. The estimated population and urban development areas of each of these major concentrations are shown in Table 31.

Table 31

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN KENOSHA-RACINE SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
	Kenosha County		
1	Tobin	300	321
2	Carol Beach	1,400	1,052
3	City of Kenosha-South	300	327
4	City of Kenosha-West	300	322
5	Town of Pleasant Prairie-Section 5	100	163
6	Town of Somers-Section 29	200	159
7	City of Kenosha-North	500	323
8	Parkside	100	162
9	Town of Somers-Section 1	100	166
10	Town of Somers-Section 3	100	161
	Racine County		
11	Town of Mt. Pleasant-Section 17	100	162
12	Town of Mt. Pleasant-Sections 4, 8 & 9	400	488
13	City of Racine-North	200	163
14	Town of Caledonia-Section 6	100	159
15	Town of Caledonia-Section 7	300	307
Total		4,500	4,435

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U. S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b] *See Map 10.*

Source: SEWRPC.

The most common method of providing for wastewater disposal for those approximately 16,600 people not served by public sanitary sewers within the Kenosha-Racine subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of wastewater disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternate, using a septic tank and an aboveground soil absorption system referred to as the "mound type septic system," is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through 1975, there were 26 sewage holding tank installations, and 17 mound systems existing in the Kenosha-Racine subregional area. Fifteen of the holding tanks served residential homes, while 11 were utilized by commercial establishments. The mound systems were all utilized to dispose of sanitary sewage from residences. The location of these systems is indicated on Map 10.

Concluding Remarks—Kenosha-Racine Subregional Area

Inventories conducted under the areawide water quality and management planning program indicated that in 1975 there existed in the Kenosha-Racine subregional area a total of 18 public sanitary sewerage systems, which together served a total area of about 49.4 square miles, or about 31 percent of the total area of the subregional area, and a total of about 221,200 persons, or about 93 percent of the total population of the subregional area, with six of the 18 sanitary sewerage systems operating their own sewage treatment facility. A total of 76 flow relief devices existed in these sanitary sewage systems. In addition, five privately-owned wastewater treatment facilities serving isolated industrial establishments were found in the inventory. The inventory indicated that as of 1975 there were no proposed new public sanitary sewerage systems in the area. There were also 21 sources of wastewater other than wastewater treatment plants identified in the subregional area consisting primarily of industrial cooling, process and rinse wastewaters. Finally, in 1975 there were an estimated 4,500 persons residing in scattered enclaves of urban development in the Kenosha-Racine subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about 6.9 square miles. In the areas of the Kenosha-Racine subregional area not served by sanitary sewers, it is estimated that approximately 109.0 square miles and 16,600 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, 26 holding tanks and 17 "mound systems" were also used for sewage disposal in the subregional area.

INVENTORY FINDINGS ROOT RIVER CANAL SUBREGIONAL AREA

The Root River Canal subregional area consists of the Root River Canal subwatershed portion of the Root River watershed that lies to the west of IH-94 and south of the Milwaukee Metropolitan subregional area. The area is basically agricultural in nature with the only urban area being the Village of Union Grove.

Existing Public Sanitary Sewerage Systems

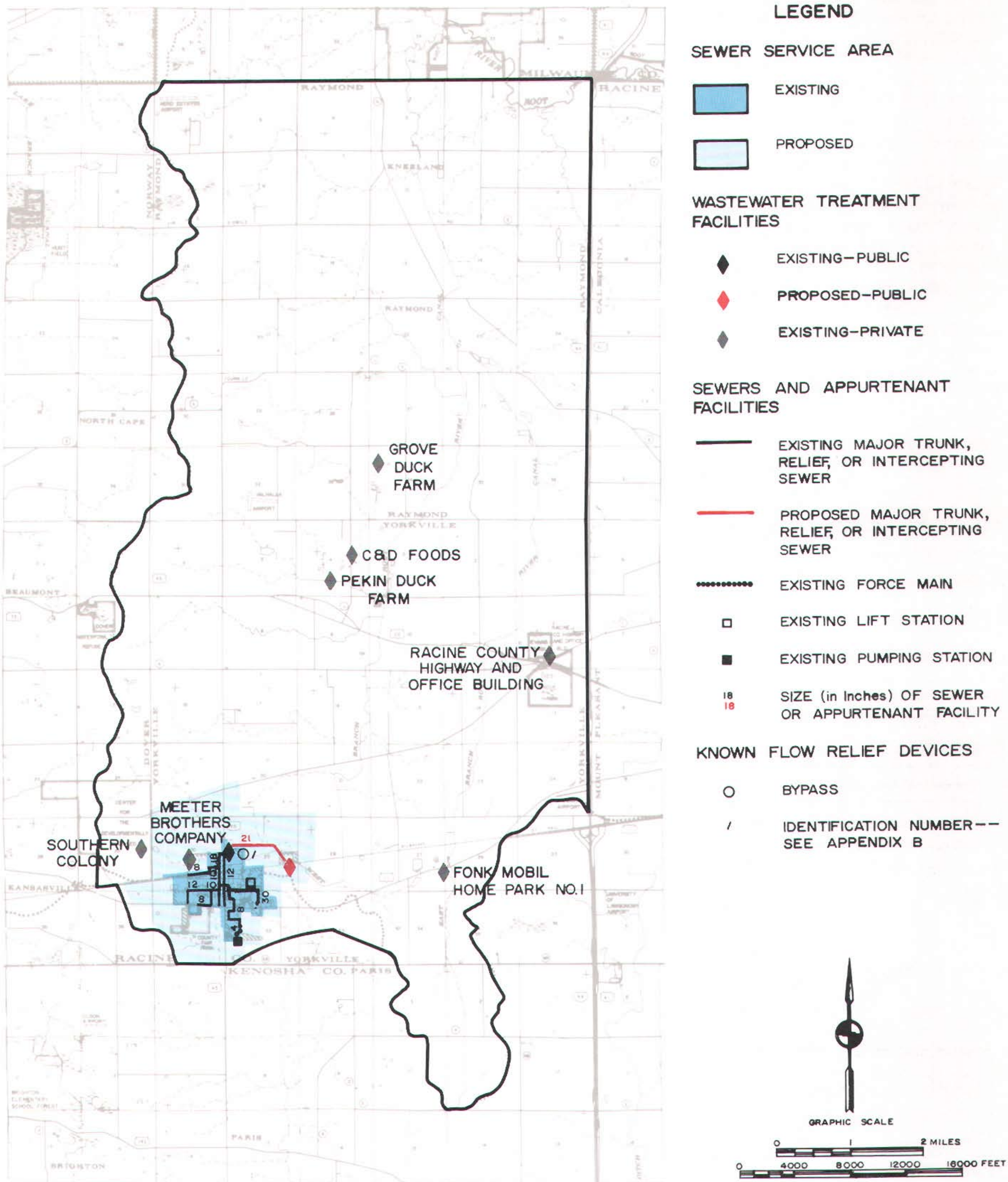
There is one existing public sanitary sewerage system in the Root River Canal subregional area which provides centralized sanitary sewer services. This system is operated by the Village of Union Grove and it serves a total area of approximately one square mile; or approximately 2 percent of the total area of the subregional area, and a total population of approximately 3,200 people, or approximately 31 percent of the total population in the subregional area. The Union Grove public sanitary sewerage system is described in the following paragraphs. Pertinent characteristics of that system are presented in Tables 32 and 33.

Village of Union Grove: The existing service area of the Village of Union Grove sanitary sewerage system is shown on Map 11. This area totals about 1.0 square mile and has a resident population of about 3,200 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Union Grove is treated at a wastewater treatment plant located on a minor drainage course leading to the West Branch of the Root River Canal, to which effluent is discharged through a joint outfall sewer also serving the Wisconsin Southern Colony Institution (see Figure 32). The plant has a very small site area of about one-half acre, all of which is currently utilized. The plant site is bounded by industrial development on the north, residential development on the south, USH-45 on the west, and open lands on the east. There is no room for expansion of the plant at its existing site. The plant was initially constructed in 1937 and underwent modifications in 1962. The treatment plant incorporates primary and secondary treatment processes and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, and chlorination. Sludge solids removed from the wastewater are fed to an anaerobic digestion system and then are transported by tank truck to a sludge lagoon, located about 1,500 feet east of the plant site from which solids are periodically dredged and applied to agricultural land or deposited in a landfill.

Map 11

EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975



Source: Wisconsin Department of Natural Resources and SEWRPC.

Dredging has been required very infrequently. The plant has an average hydraulic design capacity of 0.30 mgd, with a peak hydraulic capacity of 0.72 mgd and an organic design capacity of 510 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly average hydraulic loadings to the plant were reported to be 0.43 and 0.59 mgd respectively, while the average annual and maximum monthly average organic loadings were reported to be 700 and 1,060 pounds of BOD_5 per day, indicating that the plant is operating above its hydraulic and organic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 43 mg/l of BOD_5 and 24 mg/l of suspended solids. Maximum monthly average effluent concentrations of 75 mg/l of BOD_5, and 52 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported in 1975. However, a monthly average effluent chlorine residual which varied from 0.7 mg/l to 1.5 mg/l was reported. The sewage treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 100 mg/l of BOD_5, 100 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1977.

During 1975, the Village of Union Grove completed facilities planning for the construction of a new wastewater treatment plant in order to correct existing deficiencies and provide adequate capacity to accommodate future growth in the Village. Construction was started on the new facility in 1977 at a site about one mile west of the existing plant site. The proposed new plant is planned to have an effluent discharge to the Root River Canal and has been designed with a hydraulic design capacity of 1.0 mgd and an organic design capacity of 1,200 pounds of BOD_5 per day. It is proposed to provide facilities for secondary treatment followed by advanced waste treatment for nitrification and phosphorus removal, and auxiliary waste treatment for effluent aeration and disinfection. The facility plan indicates that the proposed new wastewater treatment

Table 32

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area: Existing Acres	Existing Square Miles	Proposed[a] Acres	Proposed[a] Square Miles	Population[b] Served	Arrangement for Treatment of Sewage (See Table 33)
Existing System						
Village of Union Grove	619	0.97	2,135	3.34	3,200	Operates a Facility
Proposed Systems						
None						
Subregional Area Total	619	0.97	2,135	3.34	3,200	--

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U. S. Public Land Survey quarter section.*

Source: SEWRPC.

Table 33

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE ROOT RIVER CANAL SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes: Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Level of Treatment Provided: Secondary	Advanced	Auxiliary	Disposal of Effluent	Sludge Handling and Disposal Unit Processes: Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
Village of Union Grove	0.97	3,200	1937, 1962	No	Yes	No	Yes	Yes	No	Yes	West Branch Root River Canal	No	Yes	Yes	No	Yes	No

Table 33 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975: Annual Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Hydraulic Per Capita (GPD)	Existing Loading - 1975: Maximum Monthly Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Organic (pounds BOD_5/day)	Existing Loading - 1975: Average Annual Organic Per Capita (pounds BOD_5/day)	Existing Loading - 1975: Maximum Monthly Average Organic (pounds BOD_5/day)	Wastewater Strength Parameters in Plant Influent[a]: BOD_5 (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Suspended Solids (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Total Phosphorus (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Organic Nitrogen-N (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Ammonia Nitrogen-N (mg/l)	Design Capacity: Population[b]	Design Capacity: Average Hydraulic (MGD)	Design Capacity: Peak Hydraulic (MGD)	Design Capacity: Average Organic (pounds BOD_5/day)	Design Capacity: Average Organic Population[b] Equivalent	Industrial Flows: Design Average Daily Flow (MGD)	Industrial Flows: Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
Village of Union Grove	0.43	134	0.59	700	0.22	1,060	212	203	6.1[d]	12.0[d]	12.0[d]	3,000	0.30	0.72	510	2,400	None	None	None

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]: BOD_5 (mg/l) Average Annual	BOD_5 (mg/l) Maximum Monthly Average	Suspended Solids (mg/l) Average Annual	Suspended Solids (mg/l) Maximum Monthly Average	Total Phosphorus (mg/l) Average Annual	Total Phosphorus (mg/l) Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l) Minimum Monthly Average	Chlorine Residual (mg/l) Maximum Monthly Average	Fecal Coliform (number per 100 ml) Average Annual	Fecal Coliform (number per 100 ml) Maximum Monthly Average	Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Date	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
Village of Union Grove	43	75	24	52	1.40[e]	N/A	2.8[e]	14.7[e]	0.7	1.5	N/A	N/A	55	4-30-77	100	100	--	200

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant administrative personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

[d] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from a May, 1975 survey by the Wisconsin Department of Natural Resources.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

plant is being designed in such a manner that the advanced waste treatment units can be expanded to provide nitrification and phosphorus removal for the effluent sewage from the Wisconsin Southern Colony secondary treatment system when these advanced waste treatment requirements become applicable to the effluent from the Wisconsin Southern Colony.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force main included in the Village of Union Grove sanitary sewerage system are shown on Map 11. Except for a bypass located at the wastewater treatment plant, there are no known points of sewage flow relief in the Village of Union Grove Sanitary sewerage system. As noted above, the inventory indicated that the Village has a documented facility plan for the expansion of its sewerage system to an additional 3.3 square mile area and for the replacement of its wastewater treatment plant on a new site, as shown on Map 11.

Figure 32

VILLAGE OF UNION GROVE
WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

Management of the Village of Union Grove sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Director of Public Works. Financing of the system is provided both through the general property tax and through a sewer service charge. The charge is based upon water consumption. Water consumers in the Village currently pay an annual sewer service charge equal to 50 percent of the annual water charge. Water consumers outside the Village currently pay an annual sewer service charge equal to 70 percent of the annual water charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Union Grove sanitary sewerage system approximated $66,404, or about $21.00 per capita. Of this total, $46,031, or about $14.50 per capita, was expended for operation and maintenance, and $20,373, or about $6.50 per capita, was spent for capital improvements.

Proposed Public Sanitary Sewerage Systems

The inventory concluded that as of 1975 there were no proposals made for the construction of new public sanitary sewerage systems in the Root River Canal subregional area.

Flow Relief Devices

As noted above in the discussion of the existing Union Grove public sanitary sewerage system, there is one sewage flow relief device sanitary sewerage system located in the Root River Canal subregional area. Table 34 indicates the type of that flow relief device as well as an estimate of the average annual wastewater discharge from that device. The location of the flow relief device is shown on Map 11.

Table 34

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE ROOT RIVER CANAL SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in The Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
Village of Union Grove	Yes-Bypass	--	--	--	--	--	--	2.0
Total	1-Bypass	--	--	--	--	--	--	2.0

[a] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.*

Other Wastewater Treatment Facilities

In addition to the one public sanitary sewerage system discussed above, there are seven wastewater treatment facilities in the Root River Canal subregional area which, in general, serve single isolated land use enclaves and treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. Four of these facilities are industrial wastewater treatment plants three of which are directly related to the production of fowl for consumption and one which is related to a vegetable processing plant. The other three facilities include one residential, one governmental, and one institutional wastewater treatment plant. The four industrial wastewater treatment plants serve the C & D Foods, Inc. plant in the Town of Yorkville, the Grove Duck Farm in the Town of Raymond, the Meeter Brothers Company in the Town of Dover, and the Pekin Duck Farm plant in the Town of Yorkville. The remaining three plants serve the Fonk's Mobile Home Park No. 1 in the Town of Yorkville, the Racine County Highway and Park Commission Complex in the Town of Yorkville, and the Southern Colony and Training School Treatment Facility in the Town of Dover. Pertinent characteristics of these facilities are presented in Table 35, and their locations are shown on Map 11.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage flow relief points on both the existing sanitary and combined sewerage systems within the Region which discharged untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharges. These other point sources consist primarily of industrial cooling, process, rinse and wash waters which are discharged without treatment or following treatment directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Wisconsin Department of Natural Resources, permits issued and reports filed under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of six such known point sources of industrial wastewater were identified in the Root River Canal subregional area. Pertinent characteristics of these six waste sources are identified in Table 36, and their locations are shown on Map 12.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, the single public sanitary sewerage system in the Root River Canal subregional area serves a total area of about one square mile, or 2 percent of the total area of the subregional area, and a total population of about 3,200, or about 31 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any

Table 35

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
ROOT RIVER WATERSHED Racine County													
C&D Foods, Inc.	Town of Yorkville	Industrial	Process and Sanitary	Lagoon and Activated Sludge	West Branch Root River Canal	N/A	269,900	322,600	37	47	19.4	68.0	42
Fonk's Mobile Home Part No. 1	Town of Yorkville	Residential	Sanitary	Extended Aeration and Lagoon	East Branch Root River Canal	15,000	13,000[b]	N/A	40[b]	10[b]	11.0[b]	21.0[b]	40,000[b]
Grove Duck Farm	Town of Raymond	Industrial	Process and Sanitary	Lagoon	West Branch Root River Canal	N/A	25,000	40,000	39	241	16.3	63.0	1,222
Maeter Brothers Company	Town of Dover	Industrial	Process and Cooling	Lagoon	Tributary of the Des Plaines River via Storm Sewer	N/A	66,500	71,200	23.1	47.8	4.8	26.7	N/A
Pekin Duck Farm	Town of Yorkville	Industrial	Process	Spray Irrigation	Soil Absorption	50,000	6,000	90,000	304	225	32.8	155.0	120,000
Racine County Highway and Park Commission	Town of Yorkville	Governmental	Sanitary	Activated Sludge and Lagoon	Hoods Creek	10,000	N/A	N/A	3[c]	30[c]	0.1[c]	1.6[c]	23[c]
Southern Colony Training School and Treatment Facility	Town of Dover	Institutional	Sanitary	Contact Stabilization and Lagoon	West Branch Root River Canal	445,000	180,000	210,000	48	33	3.7	11.3	3,000

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES), questionnaire data obtained by SEWRPC, reports filed under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the data reported or requirements of the WPDES permit itself.*

[b] *Data obtained from a July 1976 survey by the Wisconsin Department of Natural Resources.*

[c] *Data obtained from 1973 samples reported in the Wisconsin Department of Natural Resources report, Southeastern Wisconsin River Basins, A Drainage Basin Report, November 1976.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban while quarter sections with between six and 31 housing units or one housing unit for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban, and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 63 square miles, or 98 percent of the total area of the subregional area, and contain a total population of about 7,300, or 69 percent of the total population of the subregional area. Of that total, about one square mile, or 2 percent of the total area of the subregional area containing a total population of 1,000, or 10 percent of the total population of the subregional area is classified as urban development.

For analysis purposes, the existing nonsewered urban development has been combined into four named major urban concentrations as shown on Map 12. The estimated population and urban development areas of each of these major concentrations are shown in Table 37.

The most common method of providing for wastewater disposal for those approximately 1,000 people living within urban, urban-rural and rural areas and not served by public sanitary sewers within the Root River Canal subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of wastewater disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternative using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system", is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through December, 1975, there were three sewage holding tank installations, and no mound systems existing in the Root River Canal subregional area. One of the holding tanks served a residential home, while two were utilized by commercial establishments. The location of these systems is indicated on Map 12.

Concluding Remarks—Root River Canal Subregional Area

Inventories conducted under the areawide water quality and management planning program indicated that in 1975 there existed in the Root River Canal subregional area one public sanitary sewerage system, which included one sewage flow relief device, and which serves a total area of about one square mile, or about 2 percent of the total area of the subregional area, and a total of about 3,200 persons, or about 3 percent of the total population of the subregional area. The one sanitary sewage system operates its own wastewater treatment facility. In addition to the one publicly-owned sanitary sewerage system, seven privately-owned wastewater treatment facilities serving isolated industrial, governmental, residential, and institutional developments. There were also six point sources of wastewater other than wastewater treatment plants identified in the subregional area consisting of industrial process,

Table 36

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	ROOT RIVER WATERSHED Racine County																
1	Bardon Rubber Products Company, Inc.	3069	Village of Union Grove	Cooling	None	1	Des Plaines River via storm sewer	64,700	86,000	6.0	1.0	N/A	N/A	N/A	17.3	Yes	--
2	Culligan Water Conditioning Company	7399	Village of Union Grove	Filter Backwash	N/A	1	Des Plaines River via storm sewer	1,100	1,300	N/A	40.0	N/A	N/A	N/A	N/A	Yes	--
3	Fohr's Meat Service	2033	Town of Raymond	Process and Sanitary	Septic	1	Soil Absorption	N/A	1,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
4	Harry Hansen Meat Service	2011	Town of Raymond	Process	Septic System	1	Soil Absorption	1,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
5	Plastic Parts, Inc.	3079	Village of Union Grove	Cooling	N/A	1	Des Plaines River via storm sewer	192,000	214,500	0.0	1.0	0.25	0.17	N/A	14.7	Yes	--
6	Wisconsin Rubber Products Company	3069	Village of Union Grove	Cooling	N/A	1	Des Plaines River via storm sewer	130,000	173,000	N/A	N/A	N/A	N/A	N/A	15.6	No	--

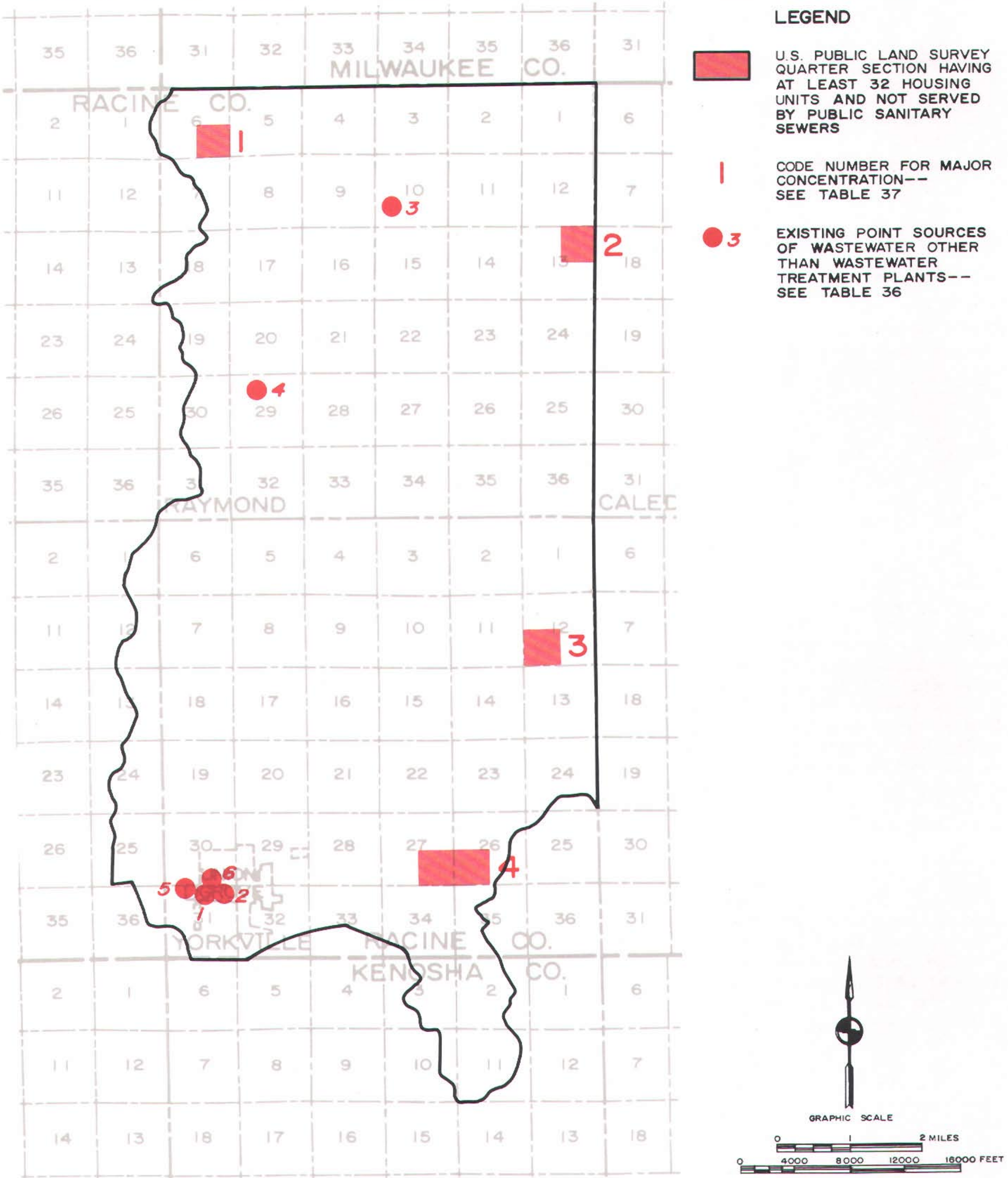
NOTE: N/A indicates data not available.

[a] Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wiscon sin Pollutant Discharge Elimination System (WPDES) or under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data reported in or requirements of the permit itself. In cases when wastewater characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 12

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975



Significant concentrations of unsewered urban development in the Root River Canal subregional area consist of unsewered subdivisions in the Towns of Raymond and Yorkville, and the commercial, industrial, and residential development in the Ives Grove area. There are six existing (1975) known point sources of wastewater other than wastewater treatment facilities in the Root River Canal subregional area, most of which are located in the industrial land concentrations in the Village of Union Grove.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 37

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number [b]	Name		
1	Town of Raymond-Section 6	100	159
2	Town of Raymond-Section 13	200	160
3	Ives Grove	200	157
4	Town of Yorkville-Section 27	500	320
Total		1000	796

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U. S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b] *See Map 12.*

Source: SEWRPC.

cooling, and filter backwash wastewaters. The inventory indicated that as of 1975, there were no proposed new public sanitary sewerage systems in the area. Finally, in 1975 there were an estimated 1,000 persons residing in scattered enclaves of urban development in the Root River Canal subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about one square mile. In the portions of the Root River Canal subregional area not served by sanitary sewers, it is estimated that approximately 63 square miles, and 7,300 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, three holding tanks were also used for sewage disposal in the subregional area.

INVENTORY FINDINGS DES PLAINES RIVER SUBREGIONAL AREA

The Des Plaines River subregional area consists of all that area of the Des Plaines watershed in Kenosha and Racine Counties except for the concentration of urban development along the shorelines of Lake Shangrila and Benet Lake in the Towns of Bristol and Salem, which development has been grouped with adjacent development on the shorelines of Voltz Lake and Cross Lake in the Lower Fox River subregional area for sewerage system planning purposes. The Des Plaines watershed consists of predominantly rural and agricultural land uses with relatively small concentrations of urban development in the Towns of Pleasant Prairie, Bristol, and Salem and the Village of Paddock Lake.

Existing Public Sanitary Sewerage Systems

There are a total of five existing public sanitary sewerage systems in Des Plaines River subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the Village of Paddock Lake, the Town of Bristol Utility District No. 1, the Town of Pleasant Prairie Sewer Utility District D, the Pleasant Prairie Sanitary District No. 73-1, and the Town of Salem Sewer Utility District No. 1. These five systems serve a total area of approximately 2.6 square miles, or 2 percent of the total area of the subregional area, and a total population of approximately 4,800 people, or 39 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 38 and 39.

Village of Paddock Lake: The existing service area of the Village of Paddock Lake sanitary sewerage system is shown on Map 13. This area totals about 0.8 square mile and has a resident population of about 1,900 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Paddock Lake is treated at a wastewater treatment plant located at the northeastern village limits. The plant has a site area of about six acres, of which about two acres are currently utilized, leaving about four acres available for future use. The remaining acreage, however, is within a natural wetland area to which the effluent is discharged (see Figure 33). The wetland area is drained by Brighton Creek, a tributary of the Des Plaines River. The plant site is bounded by the residential development on the west and by agricultural and open lands on the north, south, and east. The plant was constructed in 1958 as a private utility facility by L. B. Harris and Sons, Inc., Chicago, Illinois, to serve the Paddock Lake Dells Subdivision. In 1967, ownership of the plant was assumed by the Village of Paddock Lake and the plant was expanded to provide sufficient capacity to serve the entire village.

The treatment plant incorporates primary and secondary waste treatment processes and provides

Table 38

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population Served[b]	Arrangement for Treatment of Sewage (See Table 39)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
Village of Paddock Lake	504	0.79	--	--	1,900	Operates a Facility
Town of Bristol Utility Dist. No. 1	459	0.72	--	--	800	Operates a Facility
Town of Pleasant Prairie Sanitary Dist. No. 73-1	55	0.09	387	0.60	100	Operates a Facility
Town of Pleasant Prarie Sewer Utility District D	436	0.68	979	1.53	1,000	Operates a Facility
Town of Salem Sewer Utility Dist. No. 1	240	0.37	--	--	1,000	Operates a Facility
Proposed Systems						
Town of Bristol	--	--	540	0.84	--	--
Subregional Area Total	1,694	2.65	1,906	2.97	4,800	--

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U. S. Public Land Survey quarter section.*

Source: SEWRPC.

auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, and disinfection. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system prior to being hauled by tank truck to agricultural land application sites. The plant has an average hydraulic capacity of 0.32 mgd with a peak hydraulic capacity of 0.64 mgd, and an organic design capacity of 544 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.17 and 0.36 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 140 and 220 pounds of BOD_5 respectively, indicating that the plant is operating near its design hydraulic capacity, but below its design organic capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 13 mg/l of BOD_5 and 20 mg/l of suspended solids. Maximum monthly average effluent concentrations of 18 mg/l of BOD_5 and 31 mg/l of suspended solids were reported for 1975. Data on fecal coliform was not routinely reported during 1975; however, a monthly average chlorine residual which was generally maintained at 0.5 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 50 mg/l of BOD_5, 50 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through March 31, 1977.

The location and configuration of the major trunk sewers, pumping stations and related force mains serving the Village of Paddock Lake are shown on Map 13. There is one known point of sewage flow relief in the system—a bypass at the wastewater treatment plant. The inventory revealed that the Village had no documented plan for the extension of trunk sewers to provide service to additional areas. However, the Village is presently in the process of preparing a facilities plan to evaluate wastewater treatment and conveyance facility needs.

Management of the Village of Paddock Lake sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village President and the Sewer Committee of the Village Board. Financing of the system is provided through a monthly sewer service charge and a connection charge for new residences.

Total expenditures during 1975 for operation, maintenance and debt retirement for the Village of Paddock Lake sanitary sewerage system approximated $107,998, or about $57.00 per capita. Of this total, \$59,293, or about \$31.00 per capita, was expended for operation and maintenance, and \$48,705, or about \$26.00 per capita was expended for capital improvements.

Town of Bristol Utility District No. 1: The existing sewer service area of the Town of Bristol Utility District No. 1 sanitary sewerage system is shown on Map 13. This area totals about 0.7 square mile and has a resident population of about 800 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Town of Bristol Utility District No. 1 is treated at a wastewater treatment plant located at the northeastern district limits (see Figure 34). The effluent from the plant is discharged to an unnamed tributary of the Des Plaines River. The plant has a site area of about three acres, of which two acres are currently utilized, leaving one acre available for future use. The plant site is bounded on the west and south by residential development and on the east and north by agricultural and open lands. The plant was constructed in 1965 and underwent modifications in 1971.

The treatment plant incorporates secondary waste treatment processes and provides auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes include activated sludge, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an aerobic digestion system prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.16 mgd, with a peak hydraulic design capacity of 0.27 mgd and an organic design capacity of 270 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.07 and 0.12 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 90 and 110 pounds of BOD_5 respectively, indicating that the plant has adequate capacity to treat the loading from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 8 mg/l of BOD_5 and no suspended solids. Maximum monthly effluent concentrations of 21 mg/l of BOD_5 and no suspended solids were reported. Data on fecal coliforms was not routinely reported during 1975; however, monthly average concentrations of chlorine residual which varied from 0.3 to 2.7 were reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

During 1977, the Town of Bristol Utility District No. 1 initiated a facility planning program to evaluate wastewater treatment on a conveyance needs.

The location and configuration of the major trunk sewers, pumping stations, and force mains serving the Town of Bristol Utility District No. 1 are shown on Map 13. Except for a bypass at the treatment plant, there are no known sewage flow relief devices in the Town of Bristol Utility District No. 1 sanitary sewerage system. The inventory indicated that the town has no documented plan for the expansion of its sanitary sewerage system to serve an outlying area. However, during 1977, the Town did initiate a facilities planning program to evaluate wastewater treatment and conveyance needs.

Table 39

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

				Wastewater Treatment Unit Processes				Level of Treatment Provided				Sludge Handling and Disposal Unit Processes					
Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary	Disposal of Effluent	Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
Village of Paddock Lake	0.79	1,900	1958; 1967	No	Yes	No	Yes	Yes	No	Yes	Marsh Drained by Brighton Creek	No	Yes	No	No	Yes	No
Town of Bristol Utility District No. 1	0.72	800	1965; 1971	No	Yes	No	Yes	Yes	No	Yes	Tributary of Des Plaines River	Yes	No	No	No	Yes	No
Town of Pleasant Prairie Sanitary District No. 73-1 . . .	0.09	100	1975	No	Yes	No	Yes	Yes	No	Yes	Des Plaines River Via Drainage Ditch	Yes	No	No	No	To Kenosha Plant	
Town of Pleasant Prairie Sewer Utility District D	0.68	1,000	1966	No	Yes	No	Yes	Yes	No	Yes	Des Plaines River	Yes	No	No	No	To Kenosha Plant	
Town of Salem Sewer Utility District No. 1 . . .	0.37	1,000	1970	No	Yes	No	Yes	Yes	No	Yes	Salem Branch of Brighton Creek	Yes	No	No	No	To Kenosha Plant	

Table 39 (continued)

Name of Public Sewage Treatment Facility		Existing Loading - 1975					Wastewater Strength Parameters in Plant Influent[a]					Design Capacity					Industrial Flow		
	Annual Average Hydraulic (MGD)	Average Annual Hydraulic Per Capita (GPD)	Maximum Monthly Average Hydraulic (MGD)	Average Annual Organic (pounds BOD_5/day)	Average Annual Organic Per Capita (pounds BOD_5/day)	Maximum Monthly Average Organic (pounds BOD_5/day)	BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Organic Nitrogen-N (mg/l)	Ammonia Nitrogen-N (mg/l)	Population[b]	Average Hydraulic (MGD)	Peak Hydraulic (MGD)	Average Organic (pounds BOD_5/day)	Average Organic Population[b] Equivalent	Design Average Daily Flow (MGD)	Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
Village of Paddock Lake	0.17	89	0.36	140	0.07	220	97	201	N/A	N/A	N/A	3,200	0.32	0.64	544	2,590	N/A	N/A	None
Town of Bristol Utility District No. 1	0.07	87	0.12	90	0.11	110	148	123	N/A	N/A	N/A	1,600	0.16	0.27	270	1,300	None	None	0.04
Town of Pleasant Prairie Sanitary District No. 73-1 . . .	0.03	300	0.04	30	0.30	N/A	115	146	N/A	N/A	N/A	4,000	0.40	0.80	800	3,800	N/A	N/A	0.36
Town of Pleasant Prairie Sewer Utility District D	0.10	102	0.17	100	0.10	120	124	N/A	N/A	N/A	N/A	1,200	0.13	0.25	213	1,000	N/A	N/A	None
Town of Salem Sewer Utility District No. 1	0.08	80	0.13	80	0.08	90	118	157	N/A	N/A	N/A	3,000	0.30	0.60	510	2,400	None	None	0.17

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]												Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Date	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values			
	BOD_5 (mg/l)		Suspended Solids (mg/l)		Total Phosphorus (mg/l)		Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l)		Fecal Coliform (number per 100 ml)				BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average			Minimum Monthly Average	Maximum Monthly Average	Average Annual	Maximum Monthly Average						
Village of Paddock Lake	13	18	20	31	N/A	N/A	N/A	N/A	0.5	0.5	N/A	N/A	52	3/31/77	50	50	--	200
Town of Bristol Utility District No. 1	8	21	0	0	0.5[d]	N/A	0.7[d]	3.7[d]	0.3	2.7	10.5[d]	N/A	2	6/30/77	30	30	--	200
Town of Pleasant Prairie Sanitary District No. 73-1	3	N/A	4	N/A	N/A	N/A	N/A	N/A	0.1	0.6	N/A	N/A	N/A	3/31/79	10	10	1.0	200
Town of Pleasant Prairie Sewer Utility District D	8	12	N/A	N/A	N/A	N/A	N/A	N/A	0.1	0.3	N/A	N/A	N/A	3/31/77	30	30	--	200
Town of Salem Sewer Utility District No. 1	10	18	12	23	1.6[e]	N/A	1.3[e]	0.1[e]	0.3	0.9	N/A	N/A	1	6/30/79	30	30	--	200

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant operating personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

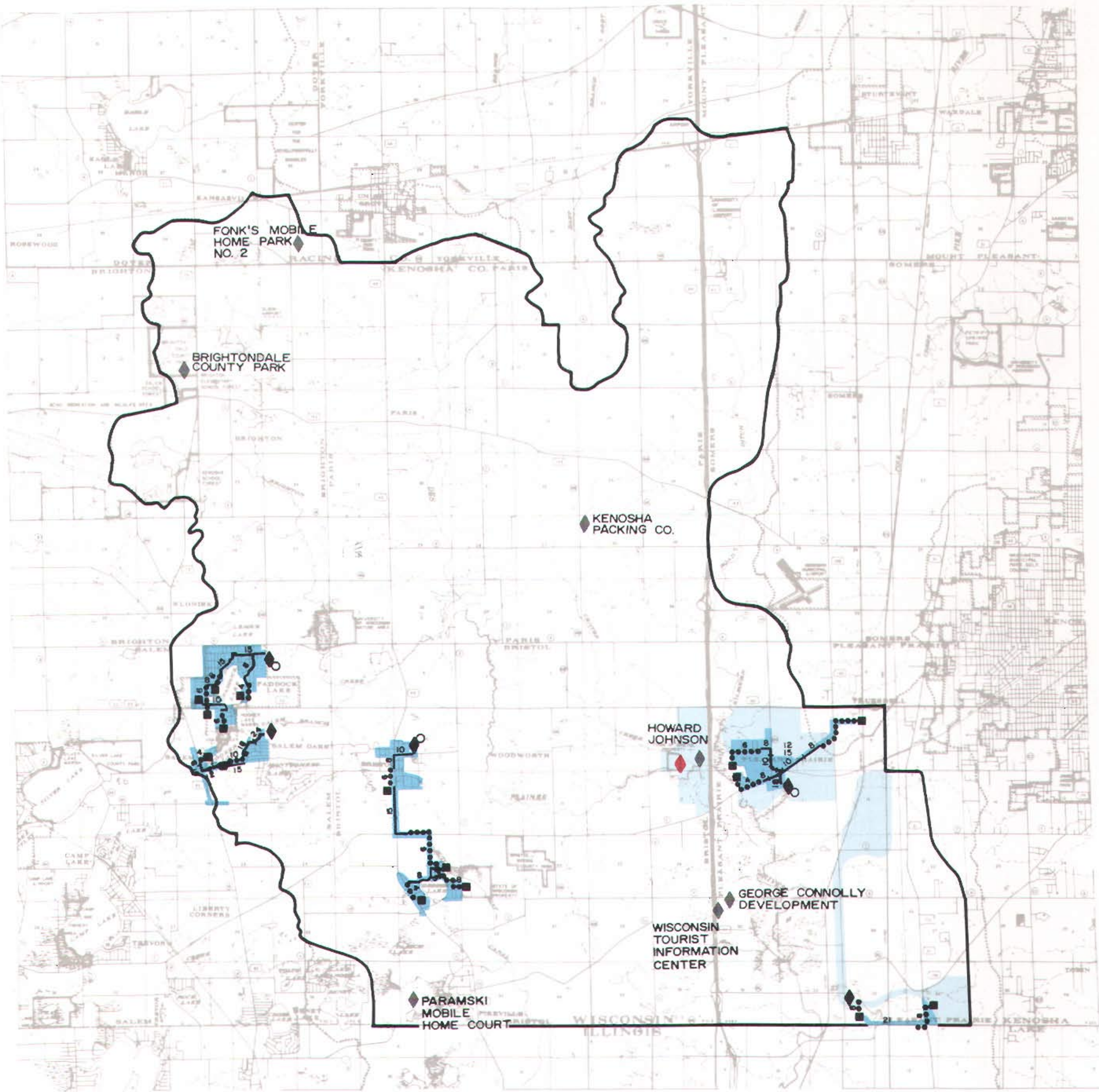
[d] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from 1973 sample reported in the Wisconsin Department of Natural Resources report, Southeastern Wisconsin River Basins, a Draining Basin Report, November 1976.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 13

EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975



LEGEND

SEWER SERVICE AREAS

EXISTING

PROPOSED

WASTEWATER TREATMENT FACILITIES

EXISTING-PUBLIC

PROPOSED PUBLIC

EXISTING-PRIVATE

SEWERS AND APPURTENANT FACILITIES

EXISTING MAJOR TRUNK, RELIEF, OR INTERCEPTING SEWER

EXISTING FORCE MAIN

EXISTING PUMPING STATION

18 / 18 SIZE (in inches) OF SEWER OR APPURTENANT FACILITY

KNOWN FLOW RELIEF DEVICES

BYPASS

IDENTIFICATION NUMBER-- SEE APPENDIX B

GRAPHIC SCALE

0 1 2 MILES

0 4000 8000 12000 16000 FEET

Source: Wisconsin Department of Natural Resources and SEWRPC.

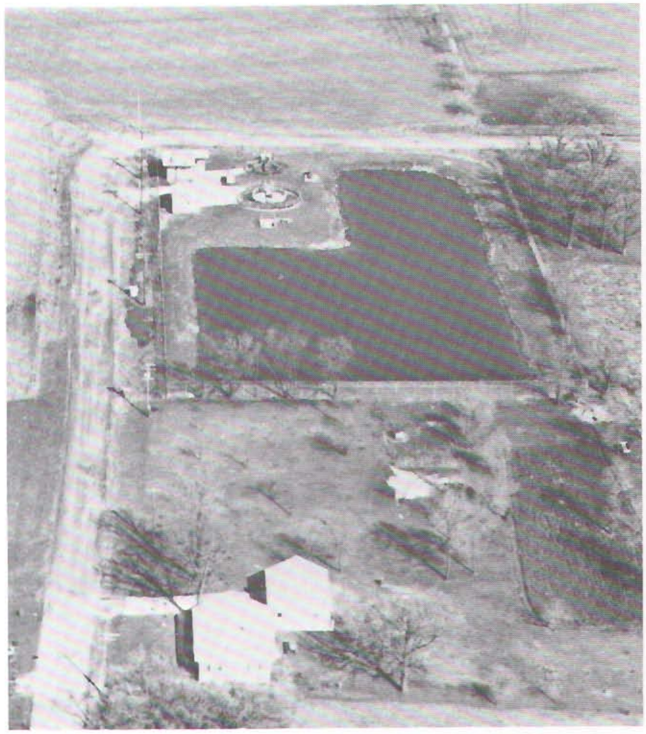
Figure 33

VILLAGE OF PADDOCK LAKE
WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

Figure 34

TOWN OF BRISTOL UTILITY DISTRICT NO. 1
WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

Management of the Town of Bristol Utility District No. 1 sanitary sewerage system is under the direction of a three-member commission. Day-to-day administration of the system is provided by the Chairman of the Commission. Financing of the system is provided through a monthly service charge of $8.00 per residential sewer connection, with industrial users charged on the basis of $8.00 per month for each 25 employees and schools charged on the basis of $8.00 per month for each 25 pupils.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Town of Bristol Utility District No. 1 sanitary sewerage system approximated $20,439, or about $26.00 per capita. Of this total, $7,089, or about $9.00 per capita, was expended for operation and maintenance, and $13,350, or about $17.00 per capita, was expended for capital improvements.

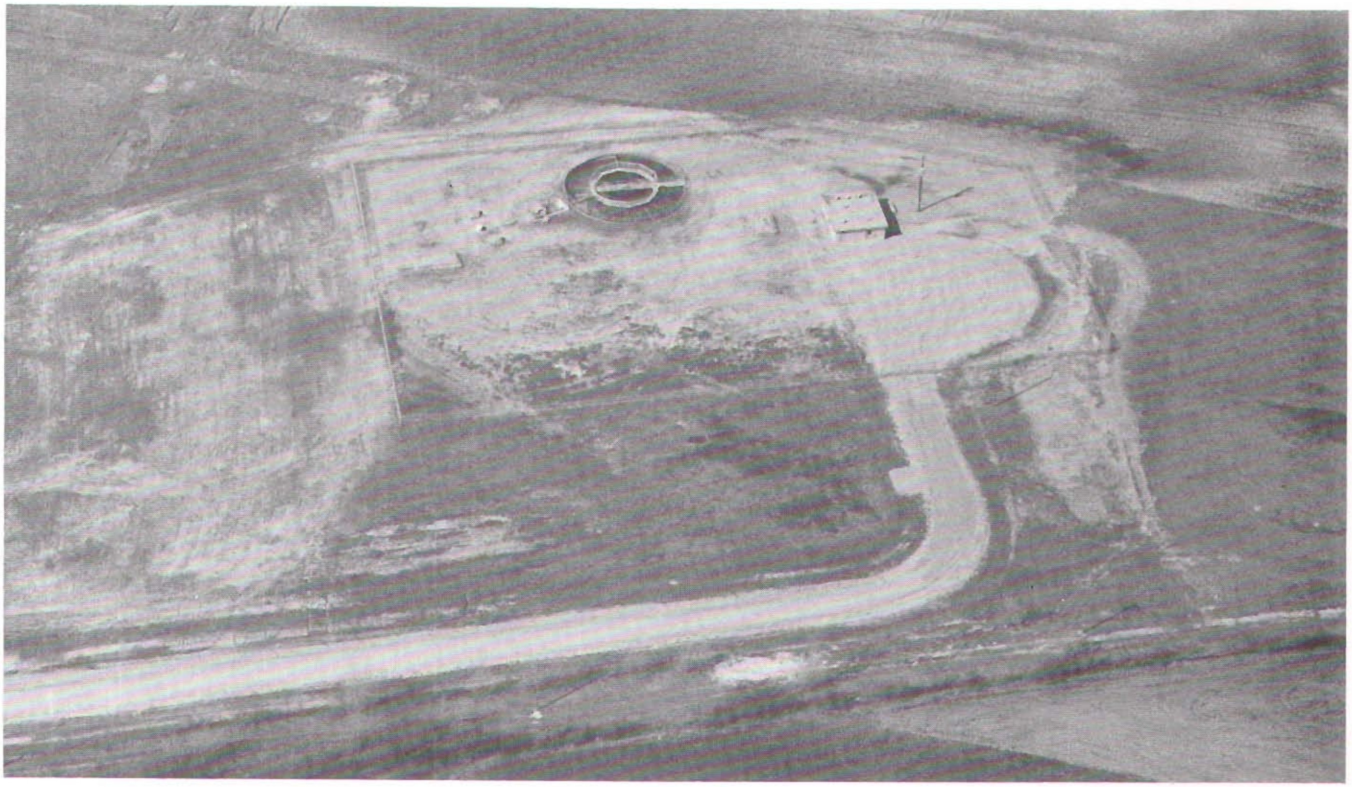
Pleasant Prairie Sanitary District No. 73-1: The existing service area of the Pleasant Prairie Sanitary District No. 73-1 sanitary sewerage system is shown on Map 13. This area totals about 0.1 square mile and has a resident population of about 100 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Pleasant Prairie Sanitary District No. 73-1 is treated at a wastewater treatment plant located at the southwest district. The effluent is discharged to a drainage ditch which leads to the Des Plaines River (see Figure 35). The plant has a site area of about 45 acres, of which about 12 acres are currently utilized, leaving 33 acres available for future use. The plant site is bounded by open and agricultural lands on all sides. The plant was constructed in 1975 with the establishment of the sanitary district.

The treatment plant incorporates secondary treatment and auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, holding lagoon, and effluent chlorination. Sludge solids removed from the wastewater are fed to an aerobic digestion system and then taken to the City of Kenosha wastewater treatment plant for further processing and ultimately land applica-

Figure 35

TOWN OF PLEASANT PRAIRIE SANITARY DISTRICT NO. 73-1 WASTEWATER TREATMENT PLANT



Source: SEWRPC.

tion. The plant has an average hydraulic design capacity of 0.4 mgd, with a peak hydraulic design capacity of 0.8 mgd and an organic design capacity of 800 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.03 and 0.04 mgd respectively, while the average annual organic loading was reported to be 30 pounds of BOD_5 indicating that the plant is operating well below its hydraulic and organic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 3 mg/l of BOD_5 and 4 mg/l of suspended solids. Data on effluent phosphorus concentrations and fecal coliform counts was not routinely reported during 1975; however, a monthly average effluent chlorine residual which varied from 0.1 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 10 mg/l of BOD_5, 10 mg/l of suspended solids, membrane filter fecal coliform counts of 200 per 100 ml, and 1 mg/l raw wastewater effluent phosphorus concentration, effective through March 31, 1979.

The location and configuration of the major trunk sewers, pumping stations and related force mains serving the Pleasant Prairie Sanitary District No. 73-1 are shown on Map 13. As shown on Map 13, there are no known points of sewage flow relief in the system. The inventory revealed that the District had a documented plan for the provision of sewer service to an additional 0.6 square mile area, which area is shown on Map 13.

Management of the Pleasant Prairie Sanitary District No. 73-1 sanitary sewerage system is under the direction of the Town Board. Day-to-day administration of this system is provided by the Town Clerk. Financing of the system is provided through a $600 connection fee and a monthly service charge of $10.00 per connection.

Total expenditures since creation of the District through 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Pleasant Prairie Sanitary District No. 73-1 sewerage system approximated $85,207, or about $852.00 per capita. Of this total, $18,833, or about $188 per capita was expended for operation and maintenance, and $66,375, or about $664.00 per capita, was expended for debt retirement. These per capita costs are relatively high because of the relatively high costs incurred during 1975 when the system was constructed, and because of the low population initially serviced.

Town of Pleasant Prairie Sewer Utility District D: The existing service area of the Town of Pleasant Prairie Sewer Utility District D sanitary sewerage system is shown on Map 13. This area totals about 0.7 square mile and has a resident population of about 1,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Town of Pleasant Prairie Sewer Utility District D is treated at a wastewater treatment plant located in the southeastern portion of the district (see Figure 36). The plant has a site area of about nine acres, of which about seven acres are currently utilized, leaving about two acres available for future use. The plant site is bounded by residential development on the north and by agricultural and open lands on the west, south, and east. The plant was constructed in 1966.

The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chlorination, and lagooning. Sludge solids removed from the wastewater treatment systems are fed to an aerobic digestion system and taken to the City of Kenosha wastewater treatment plant for further processing and ultimately land application. The plant has an average hydraulic capacity of 0.13 mgd, with a peak hydraulic capacity of 0.25 mgd and an organic design capacity of 213 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.10 and 0.17 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 100 and 120 pounds of BOD_5, respectively, indicating that the plant has adequate capacity to treat the loading from the existing sewer service area.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 8 mg/l of BOD_5. Maximum monthly average effluent concentrations of 12 mg/l of BOD_5 were reported in 1975. Data on suspended solids and fecal coliform was not routinely reported during 1975; however, a monthly chlorine residual which varied from 0.1 to 0.3 was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through March 31, 1977.

The location and configuration of the major trunk sewers, pumping station and related force mains serving the Town of Pleasant Prairie Sewer Utility District D are shown on Map 13. As shown on Map 13, there is one known point of sewage flow relief in the Town of Pleasant Prairie Sewer Utility District D sanitary sewerage system—a bypass at the wastewater treatment plant.

The area proposed for expansion by 1990 in the comprehensive plan for the Kenosha Planning District within this special purpose utility district is shown on Map 13. This future sanitary sewer service area totals about 1.5 square miles. The comprehensive plan for the Kenosha Planning District, however, contains no proposed new trunk sewers to serve this expanded area. During 1977, the Town initiated a facilities planning study to evaluate future wastewater treatment and conveyance facility needs.

Management of the Town of Pleasant Prairie Sewer Utility District D sanitary sewerage system is under the direction of the Town Board. Day-to-day administration of the system is provided by the Town Clerk. Financing of the system is provided through special assessments and monthly sewer service charge of $6.00 per residential sewer connection, with industrial users charged on the basis of $6.00 per month for each 10 employees.

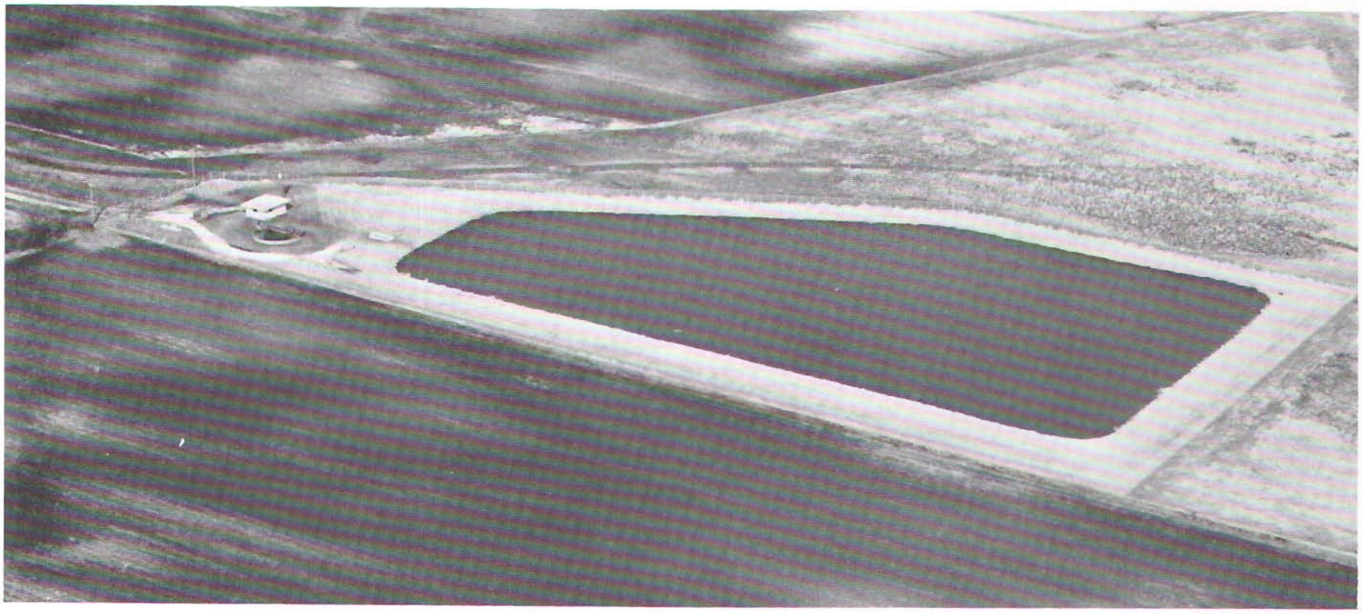
Data pertaining to total expenditures during 1970 for operation, maintenance, and capital improvements, including debt retirement, for the Town of Pleasant Prairie Sewer Utility District D sanitary sewerage system approximated $51,552, or about $51.50 per capita. Of this total, about $17,408, or about $17.50 per capita was expended for operation and maintenance, and $34,144, or about $34.00 per capita was expended for capital improvements.

Town of Salem Sewer Utility District No. 1: The existing sewer service area of the Town of Salem Sewer Utility District No. 1 sanitary sewerage system is shown on Map 13. This area totals about 0.4 square mile and has a resident population of about 1,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Town of Salem Sewer Utility District No. 1 is treated at a wastewater treatment plant located near the northeastern district limits. Effluent is discharged to the Salem Branch of Brighton Creek, a tributary of the Des Plaines River (see Figure 37). The plant has a site area of about 14 acres, all of which are currently utilized. The plant site is bounded by residential land use on the south and agricultural and open lands on the east, west, and north. The plant was constructed in 1970. The treatment plant incorporates primary and secondary treatment processes and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chlorination, and lagooning. Sludge solids removed from the wastewater treatment systems are processed in an aerobic digestion system and taken to the City of Kenosha wastewater treatment plant for further processing and ultimately land application. The plant has an average hydraulic design based upon a capacity of 0.30 mgd, with a peak hydraulic design capacity of 0.60 mgd, while average daily organic design capacity is 510 pounds of BOD_5 per day. During

Figure 36

TOWN OF PLEASANT PRAIRIE SEWER UTILITY DISTRICT D WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.08 and 0.13 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 80 and 90 pounds of BOD_5 respectively, indicating that the plant is operating well below both hydraulic and organic design capacity.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 10 mg/l of BOD_5 and 12 mg/l of suspended solids. Maximum monthly average effluent concentrations of 18 mg/l of BOD_5 and 23 mg/l of suspended solids were reported during 1975. Data on effluent fecal coliform counts was not routinely reported during 1975. However, chlorine residual ranged from 0.30 mg/l to 0.90 mg/l. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1979.

The location and configuration of the major trunk sewers and pumping stations and related force mains serving the Town of Salem Sewer Utility District No. 1 are shown on Map 13. There are no known points of sewage flow relief in the Town of Salem Sewer Utility District No. 1. The inventory indicated that the District had no documented plan for the extension of trunk sewers to provide sewer service to additional areas.

Management of the Town of Salem Sewer Utility District No. 1 sanitary sewerage system is under the direction of a three-member commission, which at the present time are the members of the Salem Town Board. Day-to-day administration of the system is also provided by the Town Board. Financing of the system is provided through a monthly service charge of $10.00 per residential sewer connection and $20.00 per commercial sewer connection.

Data pertaining to total expenditure during 1975 for operation, maintenance, and capital improvements for the Town of Salem Sewer Utility District No. 1 were not available.

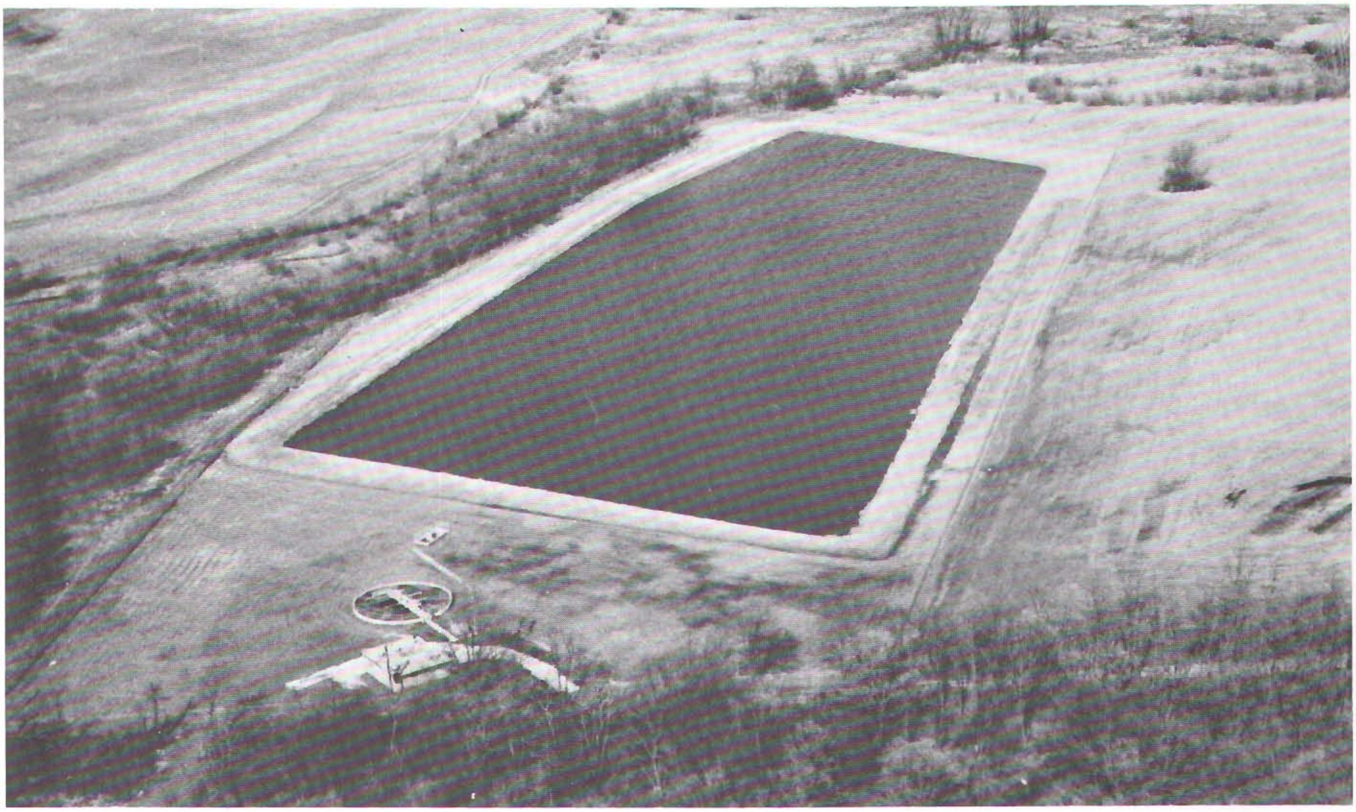
Proposed Public Sanitary Sewerage Systems

The inventory revealed that as of 1975 there was one proposed public sanitary sewerage system in the Des Plaines River subregional area which would provide centralized sanitary sewer service. This proposed system is a utility district serving a portion of the Town of Bristol. This proposed system would serve a total area of about 0.8 square mile, or about 1 percent of the total area of the subregional area, and a total existing population of about 100, or about 1 percent of the total population of the subregional area. This proposed public sanitary sewerage system is described in the following paragraphs.

Town of Bristol Proposed Utility District: The service area of a proposed sewer utility district in the Town of Bristol is shown on Map 13. This area

Figure 37

TOWN OF SALEM SEWER UTILITY DISTRICT NO. 1 WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

totals about 0.8 square mile and has a current resident population of less than 100 persons. The proposed system would serve existing and proposed urban land uses along IH-94 from STH 50 to CTH C, including an existing motel and restaurant complex, automobile service stations, and a major truck terminal facility. At the present time, the motel and restaurant complex and one of the service stations are served by a private sewage treatment facility.

The treatment plant to serve this proposed sewer utility district in the Town of Bristol is proposed to be located on a site adjacent to the Des Plaines River, to which it would discharge sewage effluent. The proposed wastewater treatment facility would have an average hydraulic design capacity of 0.31 mgd, and would be an activated sludge type sewage treatment plant providing a secondary level of treatment. This proposal includes the establishment of a new Town of Bristol sewer utility district to provide management, administration, and financing for this proposed public sanitary sewerage system.

Flow Relief Devices

As noted above on an individual community basis, there are three flow relief devices in the Des Plaines River subregional area. Table 40 summarizes the type of these devices and indicates an estimate of the average annual wastewater discharge from the devices. The locations of the flow relief devices are shown on Map 13.

Other Wastewater Treatment Facilities

In addition to the five public sanitary sewerage systems discussed above, there are a total of seven privately-owned wastewater treatment facilities in the Des Plaines River subregional area which in general serve single isolated land use enclaves and generally treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes.

Three of these treatment facilities serve residential developments and one serves an industrial facility. One of the treatment facilities is associated with recreational development, one with a commercial

Table 40

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE DES PLAINES RIVER SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in The Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
Village of Paddock Lake . . .	Yes - Bypass	--	--	--	--	--	--	--[b]
Town of Bristol Utility District No. 1	Yes - Bypass	--	--	--	--	--	--	--[b]
Town of Pleasant Prairie Sewer Utility District D	Yes - Bypass	--	--	--	--	--	--	2.0
Total	3 Bypasses	--	--	--	--	--	--	2.0

[a]The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.

[b]The annual contribution from flow relief devices is estimated to be less than 1.0 mg.

Source: SEWRPC.

development, and one with a State government operation. The three residential treatment plants serve the George Connolly Development, a mobile home park not yet constructed in 1975; Fonk's Mobile Home Park in the Town of Dover; and the Paramski Mobile Home Park located near the intersection of STH 45 and the Wisconsin-Illinois state line in the Town of Bristol.

The industrial treatment facility is associated with the Kenosha Packing Company in the Town of Paris. The Recreational development served by the private treatment facility is the Brightondale County Park located on a portion of the abandoned Bong Air Force Base in the Town of Brighton, and the governmental facility served is the Wisconsin Tourist Information Center located at the intersection of IH-94 and CTH V in the Town of Pleasant Prairie. The commercial development served is the complex centered on the Howard Johnson Motor Lodge and Restaurant at the Intersection of IH-94 and STH 50 in the Town of Bristol. Pertinent characteristics of these facilities are presented in Table 41 and shown on Map 13.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage overflow points on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consisting primarily of industrial cooling, process, rinse and wash waters, are discharged without treatment or following treatment directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued and reports filed under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters, and records of municipal public works departments. A total of two such known point sources of industrial wastewater were identified in the Des Plaines River subregional area. Characteristics of these two waste sources are identified in Table 42 and their locations are shown on Map 14.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Des Plaines River subregional area serve a total area of about 2.6 square miles, or 2 percent of the total area of the subregional area, and a total population of about 4,800 people, or about 39 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was

Table 41

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
DES PLAINES RIVER WATERSHED													
Kenosha County													
Brightondale County Park	Town of Brighton	Recreational	Sanitary	Activated Sludge and Lagoon	Soil Absorption	10,000	9,700 (May through September)	N/A	4.0	10.0	N/A	N/A	200
George Connolly Development (not yet in operation)	Town of Pleasant Prairie	Residential	Sanitary	Extended Aeration and Sand Filter	Tributary of the Des Plaines River	34,000	--	--	--	--	--	--	200
Howard Johnson Motor Lodge and Restaurant	Town of Bristol	Commercial	Sanitary	Activated Sludge and Lagoon	Des Plaines River	18,300	49,000	77,000	38.0	111.0	8.5	18.0	4,300
Kenosha Packing Co.	Town of Paris	Industrial	Cooling, Process and Sanitary	Ridge and Furrow	Soil Absorption	N/A	23,200	N/A	955.0	217.0	N/A	49.0	11,000
Paramski Mobile Home Park . . .	Town of Bristol	Residential	Sanitary	Extended Aeration and Lagoon	Marth Tributary to Mud Lake	40,000	11,500	N/A	1.0	30.0	4.7	N/A	200
Wisconsin Department of Transportation - Tourist Information Center.	Town of Pleasant Prairie	Governmental	Sanitary	Septic Tank, Sand Filter and Lagoon	Tributary of the Des Plaines River	9,250	4,500	5,800	14.0	14.0	N/A	N/A	900
Racine County													
Fonk's Mobil Home Part No. 1 . .	Town of Dover	Residential	Sanitary	Extended Aeration and Lagoon	Tributary of the Des Plaines River	15,000	2.500[b]	N/A	58.0[b]	32.0[b]	11.0[b]	33.0[b]	7.800[b]

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES), questionnaire data obtained by SEWRPC; reports filed under Section 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rate were estimated from the available monthly discharge data reported or requirements of the permit itself.*

[b] *Data obtained from an October 1975 survey by the Department of Natural Resources.*

SOURCE: Wisconsin Department of Natural Resources, and SEWRPC.

Table 42

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	DES PLAINES RIVER WATERSHED																
	Kenosha County																
1	Bristol Water Utility	4952	Town of Bristol	Filter Backwash	None	1	Tributary of the Des Plaines River	Intermittent	Intermittent	N/A	20.0	N/A	N/A	N/A	N/A	No	--
2	Ladish Company – Tri-Clover Division	3551	Town of Pleasant Prairie	Process and Cooling	Neutralization, Filtration and Lagoon	1	Tributary of the Des Plaines River	94,800	105,300	2.0	2.6	1.7	3.0	N/A	23.8	Yes	--

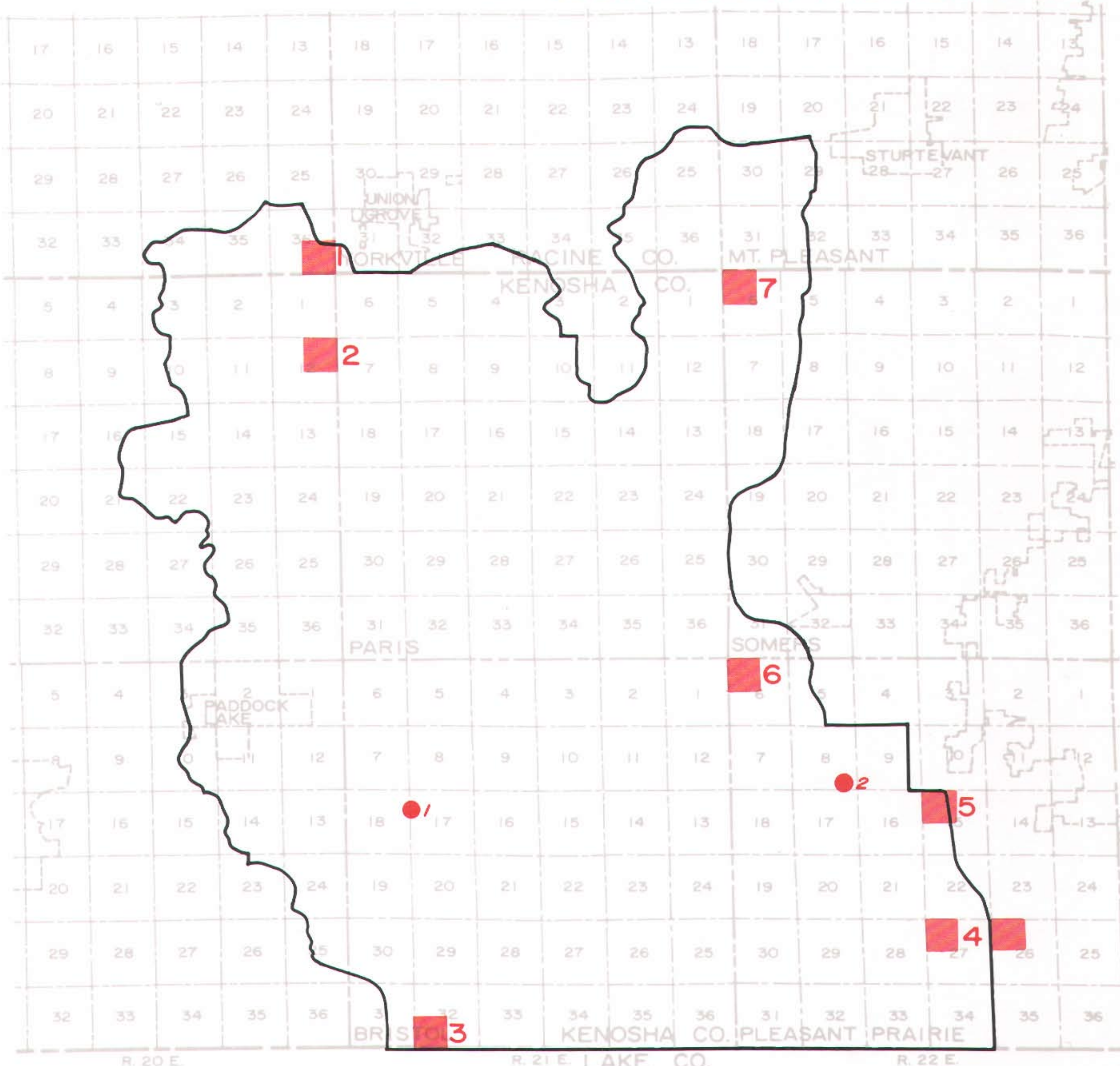
NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES) or under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hudraulic discharge rates were estimated from the available monthly discharge data or from the flow data reported in or requirements of the permit itself. In some cases where water characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 14

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

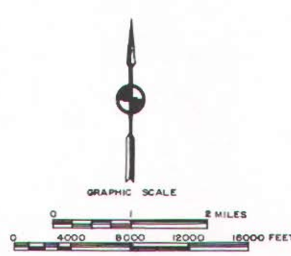


LEGEND

U.S. PUBLIC LAND SURVEY QUARTER SECTION HAVING AT LEAST 32 HOUSING UNITS AND NOT SERVED BY PUBLIC SANITARY SEWERS

5 CODE NUMBER FOR MAJOR CONCENTRATION--SEE TABLE 43

●2 EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS--SEE TABLE 42



Significant concentrations of unsewered urban development in the Des Plaines River subregional area consist of noncontiguous residential land subdivisions located in the Towns of Brighton, Dover, Pleasant Prairie, Bristol, and Somers. It is interesting to note that the Town of Paris has no significant concentrations of unsewered urban development. There are also two existing (1975) known point sources of wastewater other than the wastewater treatment facilities in the Des Plaines River subregional area.

Source: Wisconsin Department of Natural Resources and SEWRPC.

classified as urban, while quarter sections with between six and 31 housing units or one housing unit for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban, and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 123 square miles, or 98 percent of the total area of the subregional area, and contain a total population of about 7,400, or 61 percent of the total population of the subregional area. Of that total, about two square miles or 2 percent of the total area of the subregional area containing a total population of 1,700, or 14 percent of the total population of the subregional area are classified as urban nonsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into seven named major urban concentrations as shown on Map 14. The estimated population and urban development areas of each of these major concentrations are shown in Table 43.

The most common method of providing for sewage disposal for those approximately 7,400 people not served by public sanitary sewers within the Des Plaines River subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of wastewater disposal utilized in the area consists of wastewater holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternative, using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system," is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through 1975, there were twelve wastewater holding tank installations, and seven mound systems existing in the Des Plaines River subregional area. Six of the holding tanks served residential homes, while six were utilized by commercial establishments. The mound systems were all utilized to dispose of sanitary sewage from residences. The location of these systems is indicated on Map 14.

Concluding Remarks—Des Plaines River Subregional Area

Inventories conducted under the areawide water quality and management planning program indicated that in 1975 there existed in the Des Plaines River subregional area a total of five public sanitary sewerage systems, which together served a total area of about 2.6 square miles, or about 2 percent

Table 43

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
1	Town of Dover-Section 36	300	164
2	Town of Brighton-Section 12	200	162
3	Mud Lake	200	161
4	Town of Pleasant Prairie-Sections 26 & 27	300	326
5	Town of Pleasant Prairie-Section 15	100	163
6	Town of Pleasant Prairie-Section 6	200	150
7	Town of Somers-Section 6	400	133
Total		1,700	1,259

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U. S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b] *See Map 14.*

Source: SEWRPC.

of the total area of the subregional area, and a total of about 4,800 persons, or about 39 percent of the total population of the subregional area. Each of the five sanitary sewerage systems operates its own wastewater treatment facility. A total of three flow relief devices existed in these sanitary sewerage systems. In addition to the five publicly-owned sanitary sewerage systems, seven privately-owned wastewater treatment facilities serving isolated residential, industrial, commercial, recreational and governmental developments were found in the inventory. The inventory indicated that as of 1975, there was one proposed new public sanitary sewerage system in the area intended to serve existing urban development. There were also two point sources of wastewater other than wastewater treatment plants identified in the subregional area consisting of industrial process, cooling and filter backwash wastewaters. Finally, in 1975, there were an estimated 1,700 persons residing in scattered enclaves of urban development in the Des Plaines River subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about two square miles. In the portions of the Des Plaines River subregional area not served by sanitary sewers, it is estimated that approximately 123 square miles, and 7,400 people are served by onsite sewage disposal systems. The vast majority of these onsite disposal systems are conventional septic tanks. However, twelve holding tanks and seven "mound systems" were also used for sewage disposal in the subregional area.

INVENTORY FINDINGS UPPER FOX RIVER SUBREGIONAL AREA

The Upper Fox River subregional area consists of all of the Fox River watershed within the Southeastern Wisconsin Region lying generally north of the Vernon Marsh in Waukesha County. This area has been subject in recent years to relatively rapid urbanization, particularly in the City of Waukesha, the westerly portion of the City of Brookfield and New Berlin; the Villages of Lannon, Pewaukee, and Sussex, and the westerly portion of the Village of Menomonee Falls; and all of the Towns of Brookfield, Pewaukee, and Waukesha, and portions of the Towns of Delafield, Genesee, and Lisbon.

Existing Public Sanitary Sewerage Systems

There are a total of four existing public sanitary sewerage systems in the Upper Fox River subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the Cities of Brookfield and Waukesha; and the Villages of Pewaukee and Sussex. These four systems serve a total area of approximately 24.5 square miles; or approximately 14 percent of the total area of the subregional area, and a total population of approximately 76,300 people, or approximately 71 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 44 and 45.

City of Brookfield: The City of Brookfield sanitary sewerage system consists of two separate parts, one to serve the urban development generally located in the Fox River watershed west of the subcontinental divide which will be described here, and the other to serve urban development which was described under the Milwaukee Metropolitan Subregional area and located in the City generally east of the subcontinental divide which traverses the Southeastern Wisconsin Region. The existing service area of the City of Brookfield sanitary sewerage system in the area generally west of the subcontinental divide is shown on Map 15. This area totals about 8.5 square miles and has a resident population of about 16,200 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Brookfield sanitary sewerage system lying generally west of the subcontinental divide is treated at a wastewater treatment plant located near the confluence of Poplar Creek and the Fox River to which effluent is discharged (see Figure 38). The plant has a site area of about 70 acres of which 28 acres are currently utilized, leaving 42 acres available for future use. The plant site is bounded by the Fox River on the north, by industrial lands on the east, by residential and open lands on the south and open lands on the west. The plant was constructed in 1973 and replaced two treatment facilities, one of which was an activated sludge treatment plant located on the Fox River about two miles upstream of the new plant. The second treatment facility was a temporary lagoon which was located adjacent to the present plant site.

The existing treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chemical treatment for phosphorus removal and chlorination. Sludge solids removed from the activated sludge system are fed to an aerobic digestion system prior to being dewatered in a filter press and are then burned in a five-hearth incinerator. A portion of the incinerator ash is used as a dewatering conditioner for sludge solids while the rest of the ash can be used for landfill. The plant has an average hydraulic design capacity of 5.00 mgd, with a peak hydraulic design capacity of 7.50 mgd and an organic design capacity of 3,665 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 2.49 and 3.90 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 2,173 and 3,545 pounds of BOD_5 per day respectively, indicating that the plant has adequate capacity to treat the loadings from the existing sewer service area.

Table 44

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population Served[b]	Arrangement for Treatment of Sewage (See Table 45)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
City of Brookfield-Fox River Watershed System.	5,443	8.50	13,171	20.58	16,200	Operates a Facility.
City of Waukesha	8,695	13.59	11,279	17.62	51,300	Operates a Facility.
Village of Pewaukee	835	1.31	739	4.90	4,800	Operates a Temporary Facility
Village of Sussex	679	1.06	6,572	10.27	4,000	Operates a Temporary Facility
Proposed Systems						
Town of Pewaukee Sanitary District No. 3			8,593	13.43	--	--
Pewaukee Lake Sanitary District.			2,735	4.27	--	--
Subregional Area Total	15,652	24.46	43,089	71.07	76,300	

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U.S. Public Land Survey quarter section.*

Source: SEWRPC.

During 1975, the treatment plant effluent was reported to contain an average concentration of 20 mg/l of BOD_5, 26 mg/l of suspended solids, 2.4 mg/l of phosphorus and an average fecal coliform count of 977 per 100 ml. Maximum monthly average effluent concentrations of 44 mg/l of BOD_5, 46 mg/l of suspended solids and 2.9 mg/l of phosphorus as well as a maximum monthly average fecal coliform count of 5,100 per 100 ml were reported in 1975. The wastewater treatment plant WPDES permit has established monthly effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

During 1977, the City of Brookfield continued meeting with representatives of the areas to which future wastewater treatment service is planned to be provided. Plans for initiating the facilities planning work for an expansion of the areawide facility have been formulated.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains included in that portion of the City of Brookfield sanitary sewerage system which lies generally west of the subcontinental divide are shown on Map 15. There are two known sewage flow relief devices in this portion of the City of Brookfield sanitary sewerage system, both of which are portable pumping stations. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 20.6 square mile area, which is shown on Map 15.

Management of the City of Brookfield sanitary sewerage system is under the direction of a five-member sewer utility board. Day-to-day administration of the system is provided by the Director of Public Works and the Utility Superintendent. Financing of the system is provided through both a sewer service charge and a general property tax levy.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the entire City of Brookfield sanitary sewerage system, including that portion of the City in the Milwaukee metropolitan subregional area, approximated $2,273,600, or about $70.00 per capita. Of this total, $482,900, or about $15.00 per capita, was expended for operation and maintenance, and $1,790,700, or about $55.00 per capita, was expended for capital improvements.

City of Waukesha: The existing service area of the City of Waukesha sanitary sewerage system is shown on Map 15. This area totals about 13.6 square miles and has a resident population of about 51,300 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Waukesha is treated at a wastewater treatment plant located on the Fox River, to which effluent is discharged (see Figure 39). The plant has a site area of about 40 acres, of which 28 acres are currently utilized, leaving 12 acres available for future use. The plant site is bounded by the City Public Works Garage on the north, the municipal incinerator on the south, the

Fox River and its floodplains on the west, and Sentry Drive on the east. The plant was initially constructed in 1949 and was modified and expanded in 1967. Phosphorus removal facilities were added in 1976. The treatment plant incorporates primary and secondary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, two stage trickling filter, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system and then stored in sludge lagoons where it is partially dried and then is stockpiled and hauled away for use as a soil conditioner by public and private concerns. The plant has an average hydraulic design capacity of 8.50 mgd, with a peak hydraulic design capacity of 12.00 mgd and an organic design capacity of 11,500 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 9.90 and 11.98 mgd, respectively, while the average annual and maximum monthly organic loadings were reported to be 13,280 and 18,630 pounds of BOD_5 per day, thus indicating that the plant is operating above its hydraulic and organic design capacity.

During 1975, treatment plant effluent was reported to contain average concentrations of 8 mg/l of BOD_5, 20 mg/l of suspended solids and 2.9 mg/l of phosphorus. Maximum monthly average effluent concentrations of 14 mg/l of BOD_5, 26 mg/l of suspended solids and 3.6 mg/l of phosphorus were reported during 1975. Data on effluent fecal coliform counts were not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.2 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 15 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1979.

During 1975, the City of Waukesha conducted facilities planning for the expansion of the wastewater treatment plant in order to correct existing deficiencies and provide adequate capacity to accommodate future growth in the City. The facilities plan proposes an addition to the existing two-stage trickling filter plant at the site of the existing plant. The expanded treatment plant would be designed to provide secondary and tertiary waste treatment followed by advanced waste treatment for nitrification and phosphorus removal and auxiliary waste treatment for effluent disinfection. The average hydraulic design capacity of the new plant is proposed to be 16.00 mgd, with a peak hydraulic design capacity of 28 mgd and an organic design capacity of 20,000 pounds of BOD_5 per day.

The location and configuration of all major trunk sewers, pumping and lift stations, and related force mains included in the City of Waukesha sanitary sewerage system are shown on Map 15. There are ten known points of sewage flow relief in the City of Waukesha sanitary sewerage system. Eight of these devices are bypasses including the one which is located at the wastewater treatment plant, and two of the devices are portable pumping stations. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 17.6 square mile area, which is shown on Map 15.

Management of the City of Waukesha sanitary sewerage system is under the direction of the Mayor and Common Council, advised by the Board of Public Works. Day-to-day administration of the system is provided by the Director of Public Works and the Sewage Plant Superintendent. Financing of the system is provided through general property tax.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Waukesha sanitary sewerage system approximated $779,585 or about $16.00 per capita. Of this total, $389,200, or about

Table 45

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE UPPER FOX RIVER SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes					Level of Treatment Provided			Disposal of Effluent	Sludge Handling and Disposal Unit Processes							
				Trickling Filter	Activated Sludge	Rotating Biological Disc	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary		Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Filter Press	Land Application	Landfill	Incineration
City of Brookfield	8.50	16,200	1973	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Fox River	Yes	No	No	No	Yes	No	Yes	Yes
City of Waukesha	13.59	51,300	1949, 1967	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Fox River	No	Yes	No	No	No	Yes	No	No
Village of Pewaukee	1.31	4,800	1950, 1971	Yes	No	Yes	No	Yes	Yes	No	Yes	Pewaukee River	Yes	Yes	Yes	No	No	Yes	Yes	No
Village of Sussex	1.06	4,000	1960, 1975	Yes	No	No	No	Yes	Yes	No	Yes	Sussex Creek	Yes	No	Yes	No	No	Yes	No	No

Table 45 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975: Annual Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Hydraulic Per Capita (GPD)	Existing Loading - 1975: Maximum Monthly Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Organic (pounds BOD_5/day)	Existing Loading - 1975: Average Annual Organic Per Capita (pounds BOD_5/day)	Existing Loading - 1975: Maximum Monthly Average Organic (pounds BOD_5/day)	Wastewater Strength Parameters in Plant Influent[a]: BOD_5 (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Suspended Solids (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Total Phosphorus (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Organic Nitrogen-N (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Ammonia Nitrogen-N (mg/l)	Design Capacity: Population[b]	Design Capacity: Average Hydraulic (MGD)	Design Capacity: Peak Hydraulic (MGD)	Design Capacity: Average Organic (pounds BOD_5/day)	Design Capacity: Average Organic Population[b] Equivalent	Industrial Flows: Design Average Daily Flow (MGD)	Industrial Flows: Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
City of Brookfield	2.49	147	3.90	2,173	0.13	3,545	110	195	6.4[d]	1.3[d]	1.5[d]	22,000	5.0	7.5	3,665	17,500	None	None	1.10
City of Waukesha	9.90	193	11.98	13,280	0.26	18,630	162	153	7.7[e]	6.5[e]	9.3[e]	50,000	8.5	12.0	11,500	54,800	N/A	N/A	None
Village of Pewaukee	0.30	63	0.45	483	0.10	845	203	276	13.1[f]	14.8[f]	17.5[f]	7,500	0.8	1.2	1,595	7,600	N/A	N/A	0.35
Village of Sussex	0.47	118	0.62	545	0.14	672	142	191	9.9[e]	11.1[e]	22.5[e]	3,000	0.30	1.50	510	2,400	None	None	None

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]: BOD_5 (mg/l) Average Annual	BOD_5 (mg/l) Maximum Monthly Average	Suspended Solids (mg/l) Average Annual	Suspended Solids (mg/l) Maximum Monthly Average	Total Phosphorus (mg/l) Average Annual	Total Phosphorus (mg/l) Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l) Minimum Monthly Average	Chlorine Residual (mg/l) Maximum Monthly Average	Fecal Coliform (number per 100 ml) Average Annual	Fecal Coliform (number per 100 ml) Maximum Monthly Average	Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Data	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
City of Brookfield	20	44	26	46	2.4	2.9	N/A	N/A	0.0	0.6	977	5,100	None	6-30-77	30	30	1	200
City of Waukesha	8	14	20	26	2.9	3.6	3.5[e]	1.9[e]	0.2	0.6	N/A	N/A	N/A	4-30-77	15	30	1	200
Village of Pewaukee	30	42	37	55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None	6-30-77	30	30	--	200
Village of Sussex	32	43	35	50	4.5	8.4	2.2[e]	8.9[e]	0.4	0.5	N/A	N/A	None	12-31-76	50	60	1	200

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant administrative personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

[d] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

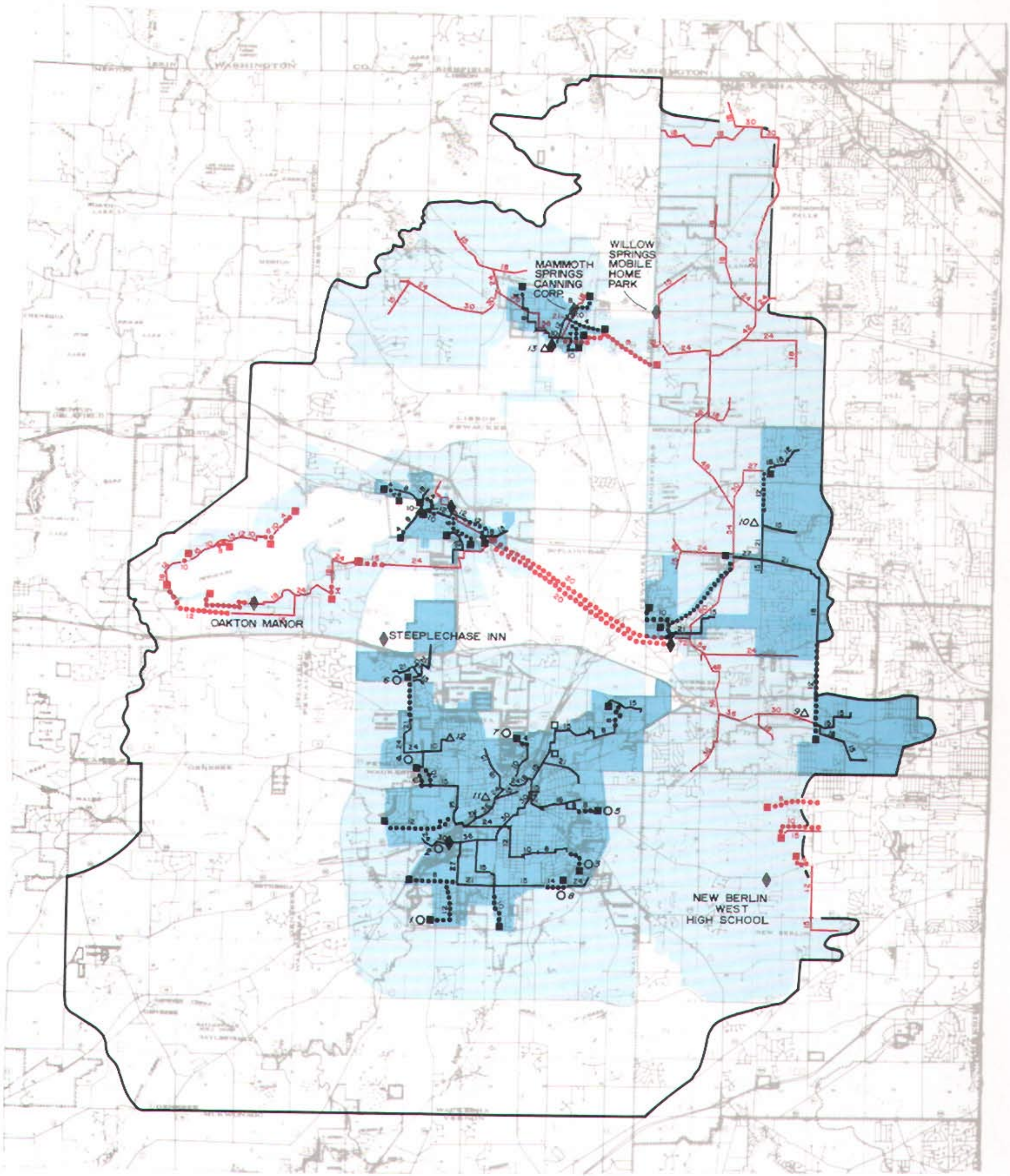
[e] *Data obtained from a July 1, 1975 survey by the Wisconsin Department of Natural Resources.*

[f] *Data obtained from an October, 1975, 24 hour survey by the Wisconsin Department of Natural Resources.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 15

EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975



LEGEND

SEWER SERVICE AREA

- EXISTING
- PROPOSED

WASTEWATER TREATMENT FACILITIES

- EXISTING-PUBLIC
- EXISTING-PRIVATE

SEWERS AND APPURTENANT FACILITIES

- EXISTING MAJOR TRUNK, RELEIF, OR INTERCEPTING SEWER
- PROPOSED MAJOR TRUNK, RELEIF, OR INTERCEPTING SEWER
- EXISTING FORCE MAIN
- PROPOSED FORCE MAIN
- EXISTING LIFT STATION
- PROPOSED LIFT STATION
- EXISTING PUMPING STATION
- PROPOSED PUMPING STATION
- 15 SIZE (in Inches) OF SEWER OR APPURTENANT FACILITY

KNOWN FLOW RELIEF DEVICES

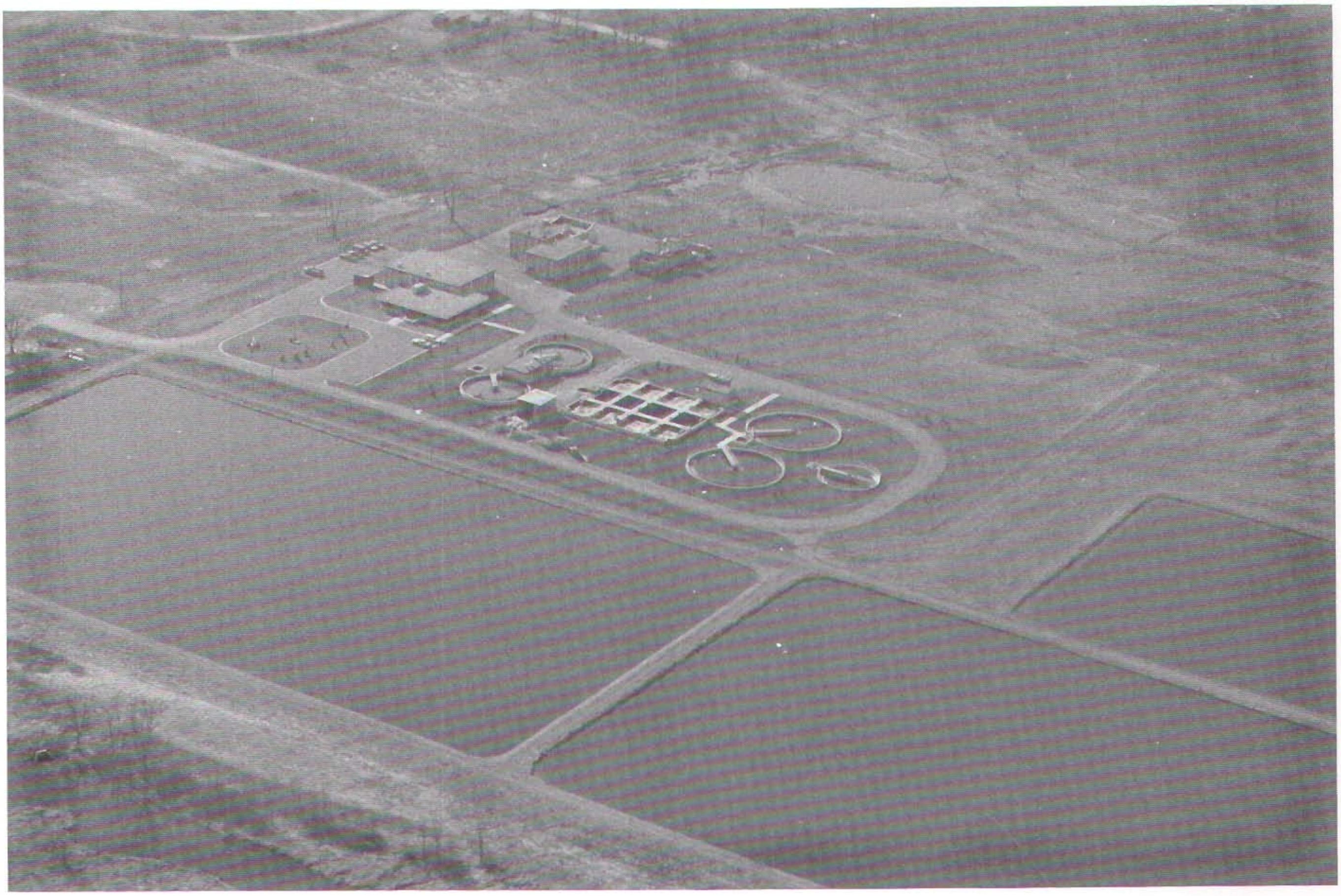
- BYPASS
- PORTABLE RELIEF PUMPING STATION
- 3 IDENTIFICATION NUMBER--SEE APPENDIX B

GRAPHIC SCALE
0 1 2 MILES
0 4000 8000 12000 16000 FEET

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 38

CITY OF BROOKFIELD WASTEWATER TREATMENT PLANT



Source: SEWRPC.

$8.00 per capita, was expended for operation and maintenance, and $390,385, or about $8.00 per capita, was expended for capital improvements.

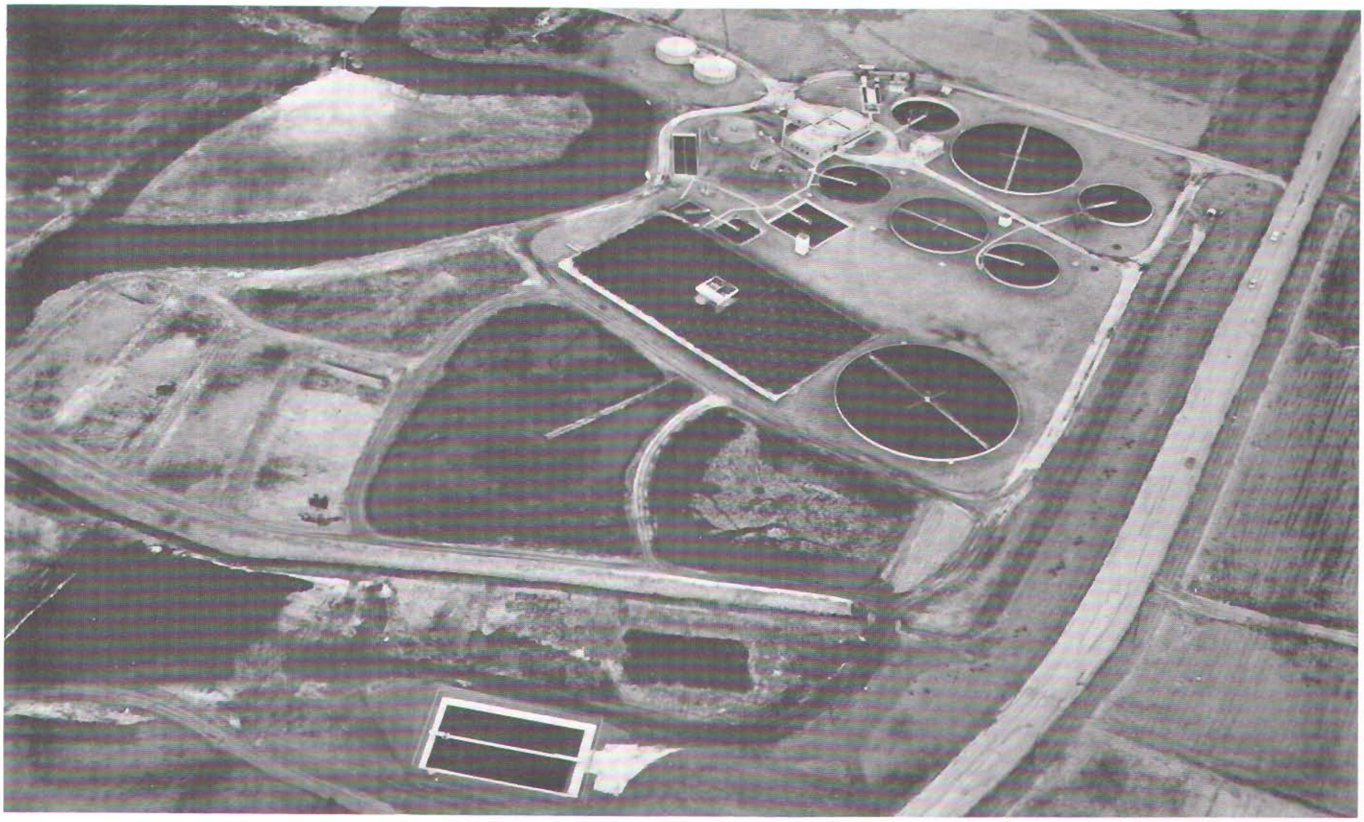
Village of Pewaukee: The existing service area of the Village of Pewaukee sanitary sewerage system is shown on Map 15. This area totals about 1.3 square miles and has a resident population of about 4,800 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Pewaukee is treated at a wastewater treatment plant located on the Pewaukee River, to which effluent is discharged (see Figure 40). The plant has a site area of about three acres, all of which are currently utilized. The plant site is bounded by a city street on the north, the Pewaukee River on the south, industrial land use on the west and open land on the east. The plant was constructed in 1950 and was modified in 1971. The treatment plant incorporates secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes in the plant include primary sedimentation, trickling filter, rotating biological contactors, final clarification, and chlorination. Sludge solids removed from the treatment process are divided between an aerobic and anaerobic digestion system and then are conveyed to sludge drying beds prior to being placed in a landfill or applied on agricultural lands. The plant has an average hydraulic design capacity of 0.80 mgd, with a peak hydraulic design capacity of 1.20 mgd and an organic capacity of 1,595 pounds of BOD_5 per day. During 1975, the average annual hydraulic loading to the plant was reported to be 0.48 mgd, while the average annual and maximum monthly organic loadings were reported to be 483 and 845 pounds of BOD_5 per day, indicating that the plant has adequate capacity to treat the hydraulic and the organic loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 30 mg/l of BOD_5 and 37 mg/l of suspended solids. Maximum monthly

Figure 39

CITY OF WAUKESHA WASTEWATER TREATMENT PLANT



Source: Karl W. Emrich and Ching-Chi Wu.

average effluent concentrations of 42 mg/l of BOD_5 and 55 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations, chlorine residual and fecal coliform counts were not reported routinely during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains included in the Village of Pewaukee sanitary sewerage system are shown on Map 15. There are no known points of sewage flow relief in the system. The inventory revealed that the Village had a documented plan for the provision of sewer service to an additional 4.9 square mile area, which is shown on Map 15.

The inventory also indicated that the Village has completed its facilities plan for the Village of Pewaukee to connect with the City of Brookfield area-wide wastewater treatment plant. During 1977, this major wastewater conveyance project, which will allow for abandonment of the Village's wastewater treatment plant, was being designed.

Management of the Village of Pewaukee sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Village Administrative Engineer. Financing of the system is provided through a sewer service charge equal to 100 percent of the quarterly water bill.

Total expenditures during 1975 for operation and maintenance and capital improvements at the sewerage system, including the treatment plant, are estimated to be $207,742, or about $44.00 per capita. Of this total, $63,997, or about $14.00 per capita, was expended for operation and maintenance, and $143,745, or about $30.00 per capita, was expended for capital improvements.

Village of Sussex: The existing service area of the Village of Sussex sanitary sewerage system is shown on Map 15. This area totals about 1.1 square miles

Figure 40

VILLAGE OF PEWAUKEE WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

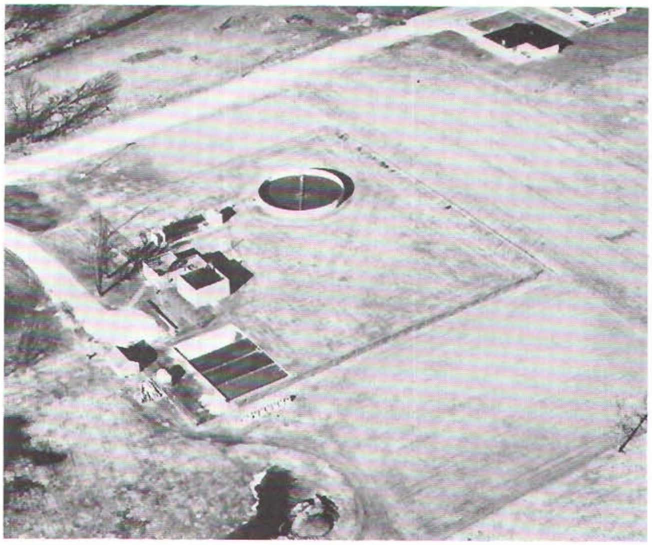
and has a resident population of about 4,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Sussex is treated at a wastewater treatment plant located on Sussex Creek, a tributary of the Fox River, to which effluent is discharged (see Figure 41). The plant has a site area of about 12 acres, of which about four acres are currently utilized, leaving eight acres available for future use. The site is bounded by agricultural land uses on the north, south and west and by residential land use on the east. The plant was constructed in 1958. The treatment plant incorporates primary and secondary waste treatment processes. Wastewater treatment unit processes incorporated into the plant include primary clarification, trickling filter, final clarification, and chlorination. Sludge solids removed from the wastewater are fed to an aerobic digestion system and then to drying beds prior to application on agricultural land. The plant has an average hydraulic design capacity of 0.30 mgd, with a peak hydraulic design capacity of 1.50 mgd and an organic design capacity of 510 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.47 and 0.62 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 545 and 672 pounds of BOD_5 respectively, indicating that the plant is operating above its hydraulic and organic design capacity.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 32 mg/l of BOD_5, 35 mg/l of suspended solids and 4.5 mg/l of phosphorus. Maximum monthly average effluent concentrations of 43 mg/l of BOD_5 and 50 mg/l of suspended solids and 8.4 mg/l of phosphorus were reported during 1975. Data on fecal coliform counts was not routinely reported during 1975. However, a monthly average effluent chlorine residual which

Figure 41

VILLAGE OF SUSSEX
WASTEWATER TREATMENT PLANT



Source: Karl W. Emrich and Ching-Chi Wu.

varied from 0.4 mg/l to 0.5 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 50 mg/l of BOD_5, 60 mg/l of suspended solids, 1.0 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1979.

During 1976, the Village of Sussex initiated construction of an addition to its existing wastewater treatment facility to provide for interim growth until the proposed Upper Fox River watershed system consisting of two areawide treatment facilities—one in the City of Brookfield and one in the City of Waukesha—is implemented. The addition to the existing plant would result in a total average hydraulic design capacity of 1.0 mgd with a peak hydraulic design capacity of 2.0 mgd and an organic design capacity of 1,580 pounds of BOD_5 per day.

The location and configuration of the major trunk sewers, pumping stations, and associated force mains included in the Village of Sussex sanitary sewerage system are shown on Map 15. There is one known point of sewage flow relief in the system, a portable pumping station.

The inventory revealed that the village had a documented plan for the provision of sewer service to an additional 10.3 square mile area, which is shown on Map 15.

Management of the Village of Sussex sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Village Engineer. Financing of the system is provided through the general property tax and a sewer service charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Sussex sanitary sewerage system approximated $52,750, or about $14.00 per capita. Of this total, $43,867, or about $11.00 per capita, was expended for operation and maintenance, and $8,883, or about $3.00 per capita, was expended for capital improvements.

Proposed Public Sanitary Sewerage Systems

The Commission sewer service inventory indicated that, as of 1975, proposals had been made for the construction of two new sanitary sewerage systems in the Upper Fox River subregional area.

Pewaukee Lake Sanitary District: This proposed system will serve that urban development along and adjacent to the shoreline of Pewaukee Lake in the Towns of Pewaukee and Delafield. As shown on Map 15, the proposed system will serve a total area of about 4.3 square miles, or about 2 percent of the subregional area, and a total resident population of about 3,300. The facilities plan completed by the Pewaukee Lake Sanitary District in 1975 recommends that sewers be constructed along the lake shoreline, and that the collected wastewaters together with the wastewater from the Village of Pewaukee, be conveyed through a new major trunk sewer along the Pewaukee River which will connect with another major trunk sewer along the Fox River serving the Villages of Sussex, Lannon, and Menomonee Falls, to the areawide wastewater treatment plant in the City of Brookfield.

Presently, the sewer construction along the shoreline of Pewaukee Lake has been completed, and it is planned that wastewater will be temporarily transported to the Village of Pewaukee wastewater treatment plant until connections can be made to the Brookfield wastewater treatment plant.

Town of Pewaukee Sanitary District No. 3: This proposed system will serve urban concentrations portions in the remaining area of the Town of Pewaukee not served by the Pewaukee Lake Sanitary District. As shown on Map 15, the proposed system will service a total area of about 13.4 square miles, or about 3 percent of the subregional area and a total resident population of 1,600. The Town of Pewaukee Sanitary District No. 3 plans to enter into an agreement for sewerage service with the City of Brookfield and the City of Waukesha under the present plan for the Upper Fox River watershed areawide sewerage system plan.

Flow Relief Devices

As noted above on an individual community basis, there are 13 sewage flow relief devices located in the sanitary sewerage system located in the Upper

Table 46

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE UPPER FOX RIVER SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in the Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
FOX RIVER WATERSHED								
City of Brookfield	No	--	--	--	2	--	2	4.0
City of Waukesha.	Yes, Bypass	--	7	--	2	--	9	26.0
Village of Sussex	No	--	--	--	1	--	1	2.0
Subregional Area Subtotal	1 Bypass	--	7	--	5	--	12	32

[a]The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.

Source: SEWRPC.

Fox River subregional area. Table 46 indicates the number and type of flow relief devices as well as an estimate of the total average annual discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 16.

Other Wastewater Treatment Facilities

In addition to the four publicly-owned sewerage systems discussed above, there are a total of five privately-owned wastewater treatment facilities in the Upper Fox River subregional area which in general serve single isolated land use enclaves and generally treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes.

One of the five treatment facilities in the subregional area serves an agricultural food processing industry, the Mammoth Springs Canning Corporation located in the Town of Lisbon. The remaining four treatment facilities are institutional, commercial, recreational, and residential establishments including the New Berlin High School within the City of New Berlin; Oakton Manor-Tumblebrook Golf Course, a recreational facility located in the Town of Delafield on the south shore of Pewaukee Lake; Steeplechase Inn located in the Town of Pewaukee; and the Willow Springs Mobile Home Park located in the Town of Lisbon. Pertinent characteristics of these treatment facilities are identified on Table 47 and their location is shown on Map 16.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage overflow points on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, process, rinse and wash waters, which are discharged, without treatment or following treatment, directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of 20 such known point sources of wastewater were identified in the Upper Fox River subregional area. Characteristics of these 20 waste sources are identified in Table 48. Their location is shown on Map 16.

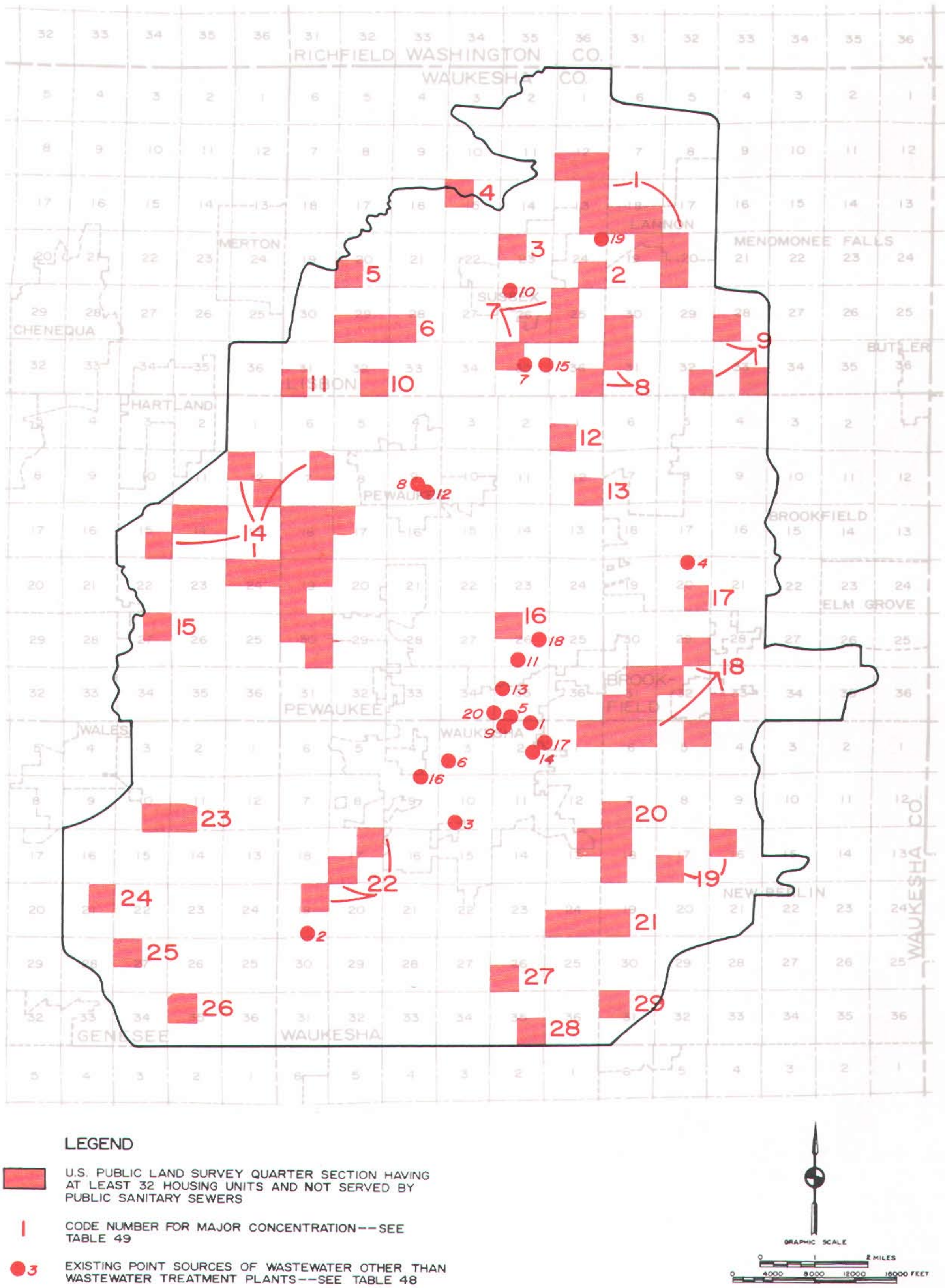
Existing Urban Development
Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Upper Fox River subregional area serve a total area of about 24.5 square miles, or 14 percent of the total area of the subregional area, and a total population of about 76,300, or about 71 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban, while quarter sections with between six and 31 housing units or one housing unit

Map 16

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975



Significant concentrations of unsewered urban development in the Upper Fox River subregional area may be characterized in three types of development. The first type consists of remaining unsewered remnants of urban development in the Cities of Brookfield and New Berlin, the Village of Menomonee Falls, and the Town of Brookfield which occurred in the late 1950's and early 1960's. Such development is rapidly being provided with centralized sanitary sewer service. The second type consists of relatively older urban development, principally around Pewaukee Lake, which is presently in the process of being sewered. Finally, the third type consists of new "leapfrog sprawl" subdivisions which have occurred throughout nearly every town in the subregional area since the mid-1960's. There are 20 existing (1975) known point sources of wastewater other than wastewater treatment facilities in the Upper Fox River subregional area. Such wastewater sources are found mainly in the industrial land use concentrations in the City of Waukesha and the Towns of Lisbon and Pewaukee.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 47

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
FOX RIVER WATERSHED Waukesha County													
Mammoth Spring Canning Corporation	Town of Lisbon	Industrial	Process	Screening and Spray Irrigation	Soil Absorpson	N/A	200,000	250,000	N/A	N/A	N/A	N/A	N/A
New Berlin West High School	City of New Berlin	Institutional	Sanitary	Septic Tank, Sand Filter and Lagoon	Tributary of Poplar Creek	24,000	18,000	23,000	30.0	30.0	N/A	N/A	200
Oakton Manor–Tumblebrook Golf Course	Town of Delafield	Recreational	Sanitary	Activated Sludge and Lagoon	Pewaukee Lake	36,000	800	2,000[b]	16.5[b]	30.0[b]	N/A	N/A	500
Steeplechase Inn	Town of Pewaukee	Commercial	Sanitary	Extended Aeration and Lagoon	Soil Absorption	25,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Willow Springs Mobile Home Park	Town of Lisbon	Residential	Sanitary	Soil Absorption System	Soil Absorption	N/A	N/A	36,000	N/A	N/A	N/A	N/A	N/A

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System, (WPDES) questionnaire data obtained by SEWRPC; reports filed under Section 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rate, were based upon the available monthly discharge data or from the data reported or requirements of the WPDES permit itself.*

[b] *Data obtained from 1976 Wisconsin Department of Natural Resources survey.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 156 square miles, or 86 percent of the total area of the subregional area, and contain a total population of about 31,800, or 29 percent of the total population of the subregional area. Of that total, about 20.6 square miles, or 11 percent of the total area of the subregional area, containing a total population of 20,300 or 19 percent of the total population of the subregional area are classified as urban nonsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into 29 named major urban concentrations as shown on Map 16. The estimated population and urban development areas of each of these major concentrations are shown in Table 49.

The most common method of providing for wastewater disposal for those approximately 31,800 people not served by public sanitary sewers within the Upper Fox River subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of wastewater disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternate, using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system," is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through 1975, there were 42 wastewater holding tank installations, and nine mound systems existing in the Upper Fox River subregional area.

Six of the holding tanks served residential homes, while 35 were utilized by commercial establishments, and one was utilized by an industrial establishment. The mound systems were all utilized to dispose of sanitary sewage from residences. The location of these systems is indicated on Map 16.

Table 48

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	FOX RIVER WATERSHED Waukesha County																
1	Alloy Products Corporation	3494	City of Waukesha	Process and Cooling	Lagoon	1	Soil Absorption	34,000	46,000	1.5	127.0	18.6	37.0	N/A	N/A	Yes	--
				Process and Cooling	Lagoon	2	Soil Absorption	34,000	46,000	1.5	127.0	18.6	37.0	N/A	N/A	Yes	--
2	American Telephone and Telegraph Company—Long Lines Division	4811	Town of Waukesha	Cooling, Tower Blowdown and Groundwater Seepage	None	1	Fox River	28,000	28,000	N/A	30.0	N/A	N/A	N/A	25.5	No	--
3	Amron Corporation	3489	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	1,000	7,000	1.6	0.3	0.0	0.2	N/A	19.7	No	--
				Cooling and Process	None	2	Fox River via Storm Sewer	1,000	1,000	1.6	0.3	0.0	0.2	N/A	N/A	No	--
				Cooling and Process	None	3	Fox River via Storm Sewer	1,000	1,000	1.6	0.3	0.0	0.2	N/A	N/A	No	--
				Cooling	None	4	Fox River via Storm Sewer	72,000	288,000	1.6	0.3	0.0	0.2	N/A	N/A	No	--
4	Elmbrook Memorial Hospital	8062	City of Brookfield	Cooling	None	1	Fox River	8,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
5	General Casting Corporation	3321	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	227,000	270,000	0.0	2.2	0.0	0.0	N/A	29.0	No	--
				Cooling	None	2	Fox River via Storm Sewer	42,000	N/A	0.0	2.2	0.0	0.0	N/A	30.6	No	--
				Cooling	None	3	Fox River via Storm Sewer	180,000	N/A	0.0	2.2	0.0	0.0	N/A	30.9	No	--
6	Grede Foundries, Inc.—Spring City Foundry	3321	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	70,000	80,000	N/A	N/A	N/A	N/A	N/A	24.4	No	--
				Cooling	None	2	Fox River via Storm Sewer	158,000	179,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
7	Halquist Stone Company Inc.	1429	Town of Lisbon	Washwater	Lagoon	1	Sussex Creek	1,035,000	1,186,000	N/A	26.7	N/A	N/A	N/A	N/A	No	--
8	Howard B. Stark Company	2065	Village of Pewaukee	Cooling	Lagoon	1	Pewaukee River	55,000	88,000	N/A	N/A	N/A	N/A	N/A	20.9	No	--
9	International Harvester Company	3321	City of Waukesha	Cooling	None	1	Tributary of Fox River	8,900	14,900	0.5	20.0	0.36	0.18	N/A	20.3	No	--
				Cooling	None	2	Tributary of Fox River	18,000	32,000	0.5	59.7	0.36	0.18	N/A	N/A	No	--
				Cooling	None	3	Tributary of Fox River	26,000	72,000	0.5	20.0	0.36	0.18	N/A	N/A	No	--
				Cooling	None	5	Tributary of Fox River	112,000	154,000	0.5	20.0	0.36	0.18	N/A	N/A	No	--
				Cooling	None	6	Tributary of Fox River	174,000	198,000	0.5	20.0	0.36	0.18	N/A	N/A	No	--
10	Mammoth Springs Canning Corporation	2033	Town of Lisbon	Cooling	Lagoon	1	Sussex Creek	6,000	9,000	1.35	30.65	7.8	13.0	N/A	32.2	No	--
				Cooling	None	2	Soil Absorption	40,000	40,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
11	Payne & Dolan of Wisconsin Inc.	2951	Town of Pewaukee	Washwater	Lagoon	1	Fox River	95,000	168,000	N/A	19.5	N/A	N/A	N/A	N/A	No	--
				Washwater	Lagoon	2	Fox River	922,000	1,723,000	N/A	258.2'	N/A	N/A	N/A	N/A	No	--
12	Port Shell Moulding, Inc. . .	3369	Town of Pewaukee	Cooling	None	1	Pewaukee River	2,700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
13	R. T. E. Corporation	3612	City of Waukesha	Cooling	Oil Separator	1	Fox River via Storm Sewer	46,000	52,000	N/A	N/A	N/A	N/A	N/A	16.8	No	--
				Cooling	None	2	Fox River via Storm Sewer	60,000	60,000	N/A	N/A	N/A	N/A	N/A	23.1	No	--
14	Quality Aluminum Casting Company	3341	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	2,300	2,400	N/A	N/A	N/A	N/A	N/A	23.3	No	--
15	Vulcan Materials Company. .	1442	Town of Lisbon	Groundwater	None		Fox River via Drainage Ditch	498,000	1,468,000	N/A	2.9	N/A	N/A	N/A	N/A	No	--
16	Waukesha Engine—Division of Dresser Industries, Inc.	3519	City of Waukesha	Cooling	None		Marsh Adjacent to the Fox River	418,000	900,000	0.5	2.4	0.73	0.29	91	21.8	Yes	--
17	Waukesha Foundry	3321	City of Waukesha	Cooling	None		Fox River via Drainage Ditch	272,000	272,000	0.912	0.0	0.2	1.0	N/A	23.0	No	Chlorides
18	Waukesha Lime & Stone Company, Inc.	1411	Town of Pewaukee	Groundwater	Lagoon		Fox River	120,000	N/A	N/A	20.0	N/A	N/A	N/A	N/A	No	--
19	Western Bituminous Company, Inc.	2891	Town of Lisbon	Process	Lagoon		Fox River	1,500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
20	Wisconsin Centrifugal, Inc. . .	3362	City of Waukesha	Cooling	None	1	Fox River via Storm Sewer	80,000	102,000	0.1	18.0	0.035	2.36	N/A	26.2	Yes	--
				Cooling	None	2	Fox River via Storm Sewer	16,000	60,000	0.1	18.0	0.035	2.36	N/A	16.1	Yes	--

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural resources under the Wisconsin Pollutant Discharge Elimination System (WPDES) or under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rate were estimated from the available monthly discharge data or from the flow data as reported in or requirements of the permit itself. In some cases where wastewater characteristics were obtained from the NR 101 reports, if the average values were available, these were reported. If only maximum values were available, these were reported.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 49

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
1	Lannon	2,700	1,449
2	Willow Springs	700	160
3	Village of Sussex-North	300	161
4	Town of Lisbon-Section 15	100	160
5	Town of Lisbon-Section 20	100	160
6	Town of Lisbon-Sections 28 & 29	400	488
7	Village of Sussex-Southeast	900	643
8	Oakwood Park	700	495
9	Village of Menomonee Falls-Sections 28, 32, 33	1,100	490
10	Town of Lisbon-Section 32	100	160
11	Town of Lisbon-Section 31	300	153
12	Town of Pewaukee-Section 1	100	155
13	Duplainville	300	167
14	Pewaukee Lake	4,300	2,986
15	Town of Delafield-Section 27	100	157
16	City of Waukesha-North	300	161
17	City of Brookfield-Section 20	300	165
18	Goerkes Corners-South	3,100	1,605
19	City of New Berlin-Sections 16 & 17	600	314
20	City of Waukesha-Southeast	1,000	665
21	Town of Waukesha-Section 24 City of New Berlin-Section 19	400	497
22	City of Waukesha-Southwest	600	500
23	Town of Genesee-Section 10, 11	400	325
24	Genesee Depot	200	156
25	Genesee	200	161
26	Town of Genesee-Section 35	100	162
27	Town of Waukesha-Section 26	100	163
28	Town of Waukesha-Section 35	100	163
29	City of New Berlin-Section 31	700	173
Total		20,300	13,194

[a]*Urban development is defined in this context as concentrations of urban land uses within any given U.S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b]*See Map 16.*

Source: SEWRPC.

Concluding Remarks—
Upper Fox River Subregional Area

Inventories conducted under the areawide water quality planning and management program indicated that in 1975, there existed in the Upper Fox River subregional area a total of four public sanitary sewerage systems, which included 13 sewage flow relief devices and which together serve an area of about 24.5 square miles, or about 14 percent of the total area of the subregional area, and a total of about 76,300 persons, or about 71 percent of the total population of the subregional area. Each of the four sanitary sewerage systems operates its own wastewater treatment facility. In addition to the four publicly-owned sanitary sewerage systems, five privately-owned wastewater treatment facilities serving isolated commercial, residential, institutional, industrial, and recreational developments were found in the inventory. The inventory indicated that as of 1975, there were two proposed new public sanitary sewerage systems in the area, which are intended to serve existing urban development along the shorelines of Pewaukee Lake. There were also 20 point sources of wastewater other wastewater treatment plants identified in the subregional area consisting primarily of industrial cooling, process, rinse and washwater discharges. Finally, in 1975 there were an estimated 20,300 persons residing in scattered enclaves of urban development in the Upper Fox River subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about 20.6 square miles. In the areas of the Upper Fox River subregional area not served by sanitary sewers, it is estimated that approximately 156 square miles, and 31,800 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, 42 holding tanks and nine "mound systems" were also used for sewage disposal in the subregional area.

INVENTORY FINDINGS
LOWER FOX RIVER SUBREGIONAL AREA

The Lower Fox River subregional area consists of all that area of the Fox River watershed lying generally south of the Vernon Marsh in Waukesha County. This area has been subject in recent years to relatively rapid urbanization, particularly along the shorelines of several major lakes, including Browns Lake, Camp and Center Lakes, Eagle Lake, Tichigan Lake, and Wind Lake.

Existing Public Sanitary Sewerage Systems

There are a total of 11 existing public sanitary sewerage systems in the Lower Fox River subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the Cities of Burlington and Lake Geneva; the Villages of East Troy, Mukwonago, Genoa City, Silver Lake, and Twin Lakes; the Browns Lake Sanitary District; and the Western Racine County Sewerage District serving the Villages of Rochester and Waterford and a portion of the Town of Rochester. These 11 systems serve a total area of approximately 11.1 square miles; or approximately 2 percent of the total area of the subregional area, and a total population of approximately 31,300 people, or approximately 37 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 50 and 51.

City of Burlington: The existing service area of the City of Burlington sanitary sewerage system is shown on Map 17. This area totals about 2.3 square miles and has a resident population of about 8,900 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Burlington is treated at a wastewater treatment plant located on the Fox River, to which effluent is discharged (see Figure 42). The plant has a site area of about four acres, of which approximately two acres are currently utilized, leaving two acres available for future treatment plant use. The plant site is bounded by railroad right-of-way on the north and west, the Fox River on the east, and open lands on the south. The plant was initially constructed in 1934 and underwent modifications in 1938, 1962, 1970, and 1975. The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent aeration and disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the activated sludge system are thickened and then combined with solids removed from the primary sedimentation units prior to being transferred to an aerobic digestion system. The sludge solids are then dewatered with a centrifuge and then are applied to agricultural lands. The plant has an average hydraulic design capacity of 2.50 mgd, with a peak hydraulic design capacity of 3.00 mgd and an organic design capacity of 5,000 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.48 and 1.80 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 2,548 and 3,704 pounds of BOD_5 per day respectively, indicating that the plant has adequate capacity to treat the hydraulic and the organic loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain an average concentration of 8 mg/l of BOD_5, 6 mg/l of suspended solids, 4.3 mg/l of phosphorus and an average fecal coliform count of 105 per 100 ml. Maximum monthly average effluent concentrations of 10 mg/l of BOD_5, 10 mg/l of suspended solids and 6.6 mg/l of phosphorus as well as a maximum monthly average fecal coliform count of 150 per 100 ml were reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentrations limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers and lift stations included in the City of Burlington sanitary sewerage system are shown on Map 17. There are no known sewage flow relief devices in the City of Burlington sanitary sewerage system. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 3.5 square mile area, which is shown on Map 17.

Management of the City of Burlington sanitary sewerage system is under the direction of the Mayor and City Council. Day-to-day administration of the system is provided by the City Engineer. Financing of the system is provided through the general property tax.

Table 50

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population Served[b]	Arrangement for Treatment of Sewage (See Table 51)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
City of Burlington	1,451	2.27	2,223	3.47	8,900	Operates a Facility
City of Lake Geneva	1,252	1.96	--	--	5,700	Operates a Facility
Village of East Troy	523	0.82	--	--	2,200	Operates a Facility
Village of Genoa City	174	0.27	--	--	1,100	Operates a Facility
Village of Mukwonago	804	1.26	2,274	3.55	3,400	Operates a Facility
Village of Rochester	120	0.19	13,013[c]	20.33[c]	800	Part of Western Racine County Sewerage District
Village of Silver Lake	298	0.47	405	0.63	1,300	Operates a Facility
Village of Twin Lakes	1,478	2.31	--	--	3,400	Operates a Facility
Village of Waterford	369	0.58	--[d]	--[d]	2,300	Part of Western Racine County Sewerage District
Town of Rochester Sewer Utility District No. 1	110	0.17	--[d]	--[d]	300	Part of Western Racine County Sewerage District
Browns Lake Sanitary District	505	0.79	484	0.76	1,900	Contracts with City of Burlington
Western Racine County Sewerage District	--[d]	--[d]	--[d]	--[d]	--[d]	Operates a Facility
Proposed Systems						
Eagle Lake Sewer Utility District	--	--	1,430	2.23		
Town of East Troy Sanitary District No. 2			200	0.31		
Town of Lyons Sanitary District No. 2	--	--	247	0.39		
Village of North Prairie			373	0.58		
Town of Norway Sanitary District No. 1	--	--	2,847	4.45		
Town of Salem Sewer District No. 2	--	--	2,309	3.61		
Tichigan Lake Sanitary District	--	--	--[e]	--[e]		
Subregional Area Total	7,084	11.09	25,805	40.31	31,300	

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U.S. Public Land Survey quarter section.*

[c] *Includes the total area proposed for sewer service by the Western Racine County Sewerage District, which District includes the Villages of Rochester and Waterford, and the Town of Rochester Sewer Utility No. 1. This proposed service area includes Tichigan Lake Sanitary District in the Town of Waterford, which totals 3,373 acres or 5.27 square miles.*

[d] *Service area and population included in the service areas of Villages of Rochester and Waterford and Town of Rochester Sewer Utility District No. 1.*

[e] *Included as part of the area noted for the Village of Rochester.*

Source: SEWRPC.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Burlington sanitary sewerage system were not available.

City of Lake Geneva: The existing service area of the City of Lake Geneva sanitary sewerage system is shown on Map 17. This area totals about 2.0 square miles and has a resident population of about 5,700 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Lake Geneva is treated at a wastewater treatment plant located on the White River, to which effluent is discharged (see Figure 43). The plant has a site area of about 15 acres, of which approximately three acres are currently utilized, leaving 12 acres available for future treatment plant use. The plant site is bounded by residential development on the west and by open and agricultural lands on the north, south, and east. The plant was initially constructed in 1930 and underwent modifications in 1966. The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filter, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids are transferred to an anaerobic digestion system prior to final disposal in a landfill. The plant has an average hydraulic design capacity of 1.10 mgd, with an organic design capacity of 1,890 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.74 and 0.90 mgd, respectively, while the average annual and maximum monthly organic loadings were reported to be 776 and 1,017 pounds of BOD_5 per day, respectively, indicating that the plant has adequate capacity to treat the hydraulic and the organic loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain an average concentration of 26 mg/l of BOD_5, 40 mg/l of suspended solids, and 7.2 mg/l of phosphorus. Maximum monthly average effluent concentrations of 42 mg/l of BOD_5, 50 mg/l of suspended solids and 9 mg/l of phosphorus were also recorded. The fecal coliform count was not routinely recorded during 1975. However, an effluent chlorine residual which varied from 0.4 mg/l to 0.8 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 45 mg/l of BOD_5, 45 mg/l of suspended solids, 1.0 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains included in the City of Lake Geneva sanitary sewerage system are shown on Map 17. Except for one bypass at the wastewater treatment plant, there are no known points of overflow or bypassing in the City of Lake Geneva sanitary sewerage system. The inventory indicated that the city had no documented plan for the extension of trunk sewers to provide service to additional areas. Management of the City of Lake Geneva sanitary sewerage system is under the direction of the Mayor and City Council. Day-to-day administration of the system is provided by the Sewer and Water Superintendent. Financing of the system is provided through a sewer service charge equal to 100 percent of a consumer's water bill.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Lake Geneva sanitary sewerage system approximated $373,310, or about $65.00 per capita. Of this total, $69,660, or about $12.00 per capita, was expended for operation and maintenance, and $303,650, or about $53.00 per capita, was expended for capital improvements.

Village of East Troy: The existing service area of the Village of East Troy sanitary sewerage system is shown on Map 17. This area totals about 0.8 square mile and has a resident population of about 2,200 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of East Troy is treated at a wastewater treatment plant located on Honey Creek, to which effluent is discharged (see Figure 44). The plant has a site area of about 5.5 acres, of which about two acres are currently utilized, leaving 3.5 acres available for future use. The plant site is bounded by open lands on the south, east, and west and by an industrial site on the north. The plant was constructed in 1958. The treatment plant incorporates primary and secondary waste treatment processes. Wastewater treatment unit processes in the plant include primary sedimentation, trickling filter, and final clarification. Sludge solids removed from the

Table 51

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes				Level of Treatment Provided			Disposal of Effluent	Sludge Handling and Disposal Unit Processes					
				Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary		Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
City of Burlington	2.27	10,800	1934, 1938, 1962, 1970, and 1975	No	Yes	Yes	Yes	Yes	Yes	Yes	Fox River	Yes	No	No	No	Yes	No
City of Lake Geneva	1.96	5,700	1930, 1966	Yes	No	Yes	Yes	Yes	Yes	Yes	White River	No	Yes	No	No	No	Yes
Village of East Troy	0.82	2,200	1960	Yes	No	No	No	Yes	No	No	Honey Creek	No	Yes	Yes	No	Yes	No
Village of Genoa City	0.27	1,100	1923, 1959	Yes	No	No	Yes	Yes	No	Yes	Nippersink Creek	No	Yes	Yes	No	Yes	No
Village of Mukwonago	1.26	3,400	1950, 1975	Yes	No	Yes	Yes	Yes	Yes	Yes	Mukwonago River	No	Yes	Yes	No	Yes	No
Village of Silver Lake	0.47	1,300	1966	No	Yes	No	Yes	Yes	No	Yes	Fox River	Yes	No	No	No	Yes	No
Village of Twin Lake	2.31	3,400	1958, 1970	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Basset Creek	Yes	Yes	Yes	No	No	Yes
Western Racine County Sewerage District	0.94	3,400	1969, 1976	No	Yes	Yes	Yes	Yes	Yes	Yes	Fox River	Yes	No	Yes	No	Yes	No

Table 51 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975						Wastewater Strength Parameters in Plant Influent[a]					Design Capacity					Industrial Flows		
	Annual Average Hydraulic (MGD)	Average Annual Hydraulic Per Capita (GPD)	Maximum Monthly Average Hydraulic (MGD)	Average Annual Organic (pounds BOD_5/day)	Average Annual Organic Per Capita (pounds BOD_5/day)	Maximum Monthly Average Organic (pounds BOD_5/day)	BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Organic Nitrogen-N (mg/l)	Ammonia Nitrogen-N (mg/l)	Population[b]	Average Hydraulic (MGD)	Peak Hydraulic (MGD)	Average Organic (pounds BOD_5/day)	Average Organic Population[b] Equivalent	Design Average Daily Flow (MGD)	Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
City of Burlington	1.48	137	1.80	2,548	0.24	3,704	212	142	8.2[d]	11.5[d]	12.5[d]	N/A	2.50	3.0	5,000	23,800	Yes	Yes	0.75
City of Lake Geneva	0.74	129	0.90	776	0.14	1,017	127	149	10.3[f]	N/A	N/A	97,500	1.10	N/A	1,890	9,000	N/A	N/A	0.20
Village of East Troy	0.25	112	0.27	218	0.10	311	105	54	12.0[d]	N/A	N/A	3,200	0.32	0.64	417	2,000	None	None	0.05
Village of Genoa City	0.07	65	0.10	77	0.07	117	132	110	14.0[e]	N/A	N/A	N/A	0.12	0.24	200	1,000	None	None	0.02
Village of Mukwonago	0.44	128	0.60	430	0.13	665	121	127	6.4[g]	9.8[g]	15.0[g]	1,500	0.22	0.56	485	2,800	None	None	None
Village of Silver Lake	0.15	115	0.20	58	0.04	67	47	74	17.8[g]	9.0[g]	39.0[g]	3,000	0.30	0.50	510	2,400	None	None	0.10
Village of Twin Lake.	0.41	121	0.50	460	0.14	690	137	293	8.9[h]	9.0[h]	18.0[h]	8,200	0.82	1.64	1,390	6,600	None	None	0.32
Western Racine County Sewage District	0.24	72	0.30	329	0.10	428	162	198	5.6[d]	13.0[d]	14.0[d]	5,000	0.50	1.0	850	4,000	None	None	0.20

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]												Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Data	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values			
	BOD_5 (mg/l)		Suspended Solids (mg/l)		Total Phosphorus (mg/l)		Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l)		Fecal Coliform (number per 100 ml)				BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average	Average Annual	Maximum Monthly Average			Minimum Monthly Average	Maximum Monthly Average	Average Annual	Maximum Monthly Average						
City of Burlington	8	10	6	10	4.3	6.6	N/A	N/A	0.6	0.7	105	150	None	5-31-79	30	30	1	200
City of Lake Geneva	26	42	40	50	7.2	9.0	N/A	N/A	0.4	0.8	N/A	N/A	None	6-30-77	45	45	1	200
Village of East Troy	28	53	16	24	13.5[e]	N/A	N/A	N/A	N/A	N/A	9,512	31,275	None	6-30-77	30	30	--	200
Village of Genoa City	19	28	16	36	12.8[e]	N/A	N/A	N/A	0.5	0.6	N/A	N/A	None	6-30-77	30	30	--	200
Village of Mukwanago	29	46	25	44	0.8	1.0	3.2[g]	13.0[g]	N/A	N/A	N/A	N/A	None	3-31-77	50	50	--	200
Village of Silver Lake	2	4	2	3	7.2[g]	N/A	2.2[g]	0.5[g]	N/A	N/A	N/A	N/A	2	6-30-77	30	30	--	200
Twin Lake.	14	18	N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.7	N/A	N/A	2	6-30-77	20	20	1	200
Western Racine County Sewerage District	8	11	6	10	10.3[e]	N/A	N/A	N/A	0.5	0.6	N/A	N/A	None	6-30-77	30	30	1	200

NOTE: N/A indicates data not available.

[a] *Average and maximum of the monthly valves reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained directly from plant administrative personnel or from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *Difference between Average Hydraulic Design Capacity and Maximum Monthly Average Hydraulic Loading.*

[d] *Data obtained from 1976 24 hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from a sample reported in the Wisconsin Department of Natural Resources report, Fox (Illinois) River, Pollution Investigation Survey, dated May, 1972.*

[f] *Data obtained from 1970 24 hour survey by the Wisconsin Department of Natural Resources.*

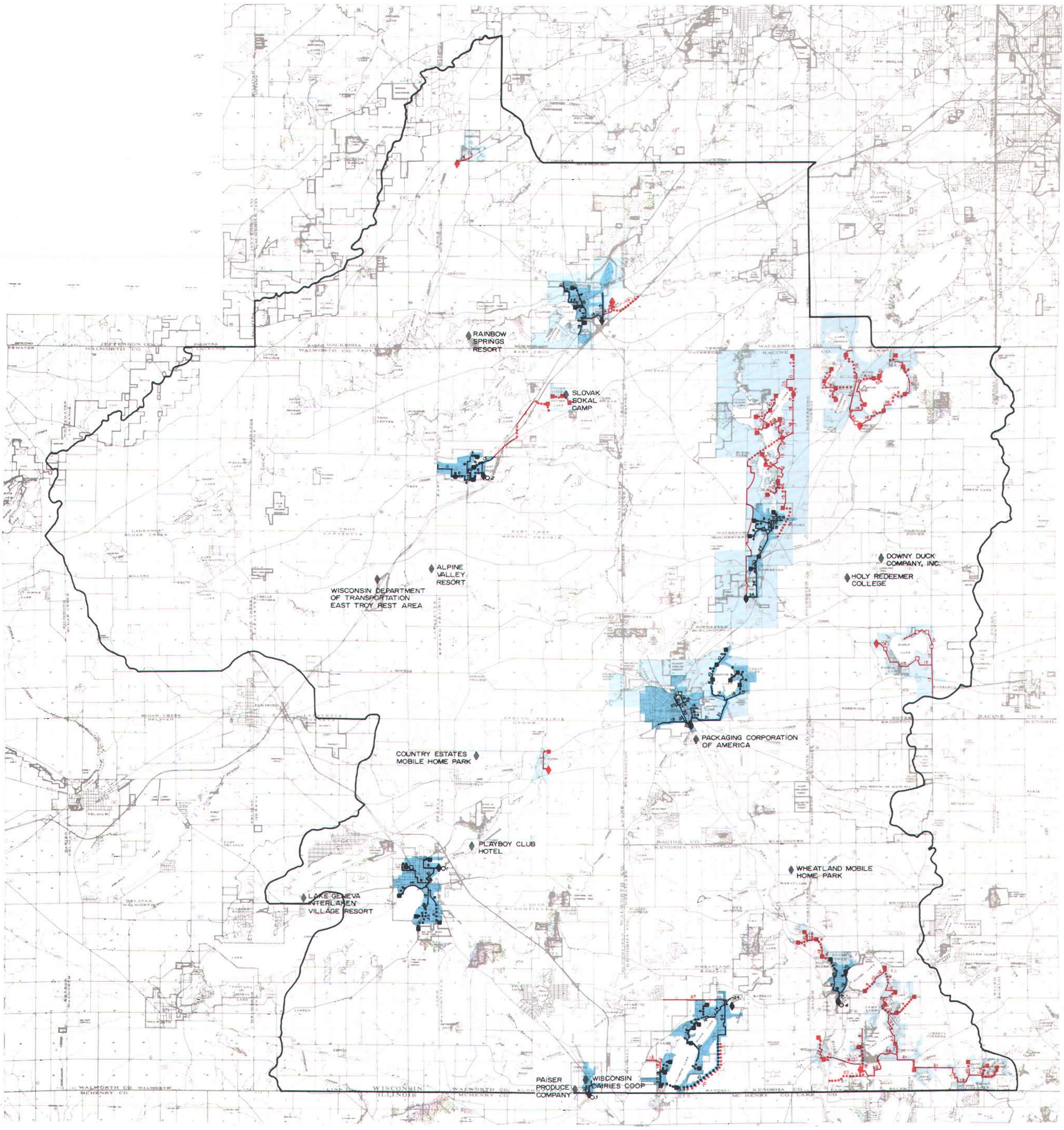
[g] *Data obtained from an August, 1975 survey by the Wisconsin Department of Natural Resources.*

[h] *Data obtained from 1975 24 hour survey by the Wisconsin Department of Natural Resources.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 17

EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE LOWER FOX RIVER SUBREGIONAL AREA



LEGEND

SEWER SERVICE AREA

- EXISTING
- PROPOSED

WASTEWATER TREATMENT FACILITIES

- EXISTING-PUBLIC
- EXISTING-PRIVATE
- PROPOSED

SEWERS AND APPURTENANT FACILITIES

- EXISTING MAJOR TRUNK, RELIEF, OR INTERCEPTING SEWER
- PROPOSED MAJOR TRUNK, RELIEF, OR INTERCEPTING SEWER
- EXISTING FORCE MAIN
- PROPOSED FORCE MAIN
- EXISTING LIFT STATION
- PROPOSED LIFT STATION
- EXISTING PUMPING STATION
- PROPOSED PUMPING STATION
- SIZE (in Inches) OF SEWER OR APPURTENANT FACILITY

KNOWN FLOW RELIEF DEVICES

- BYPASS
- IDENTIFICATION NUMBER--SEE APPENDIX B

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 42

CITY OF BURLINGTON WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

treatment process are fed to an anaerobic digestion system and then to sludge drying beds prior to application on the land at the municipal airport or on agricultural lands. The plant has an average hydraulic design capacity of 0.32 mgd, with a peak hydraulic design capacity of 0.64 mgd and an organic design capacity of 417 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.25 and 0.30 mgd, respectively, while the average annual and maximum monthly organic loadings were reported to be 218 and 311 pounds of BOD_5 per day, indicating that the plant has adequate capacity to treat the hydraulic and the organic loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 28 mg/l of BOD_5 and 16 mg/l of suspended solids. Maximum monthly average effluent concentrations of 53 mg/l of BOD_5 and 24 mg/l of suspended solids and a maximum monthly fecal coliform count of 9,512 per 100 ml were reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

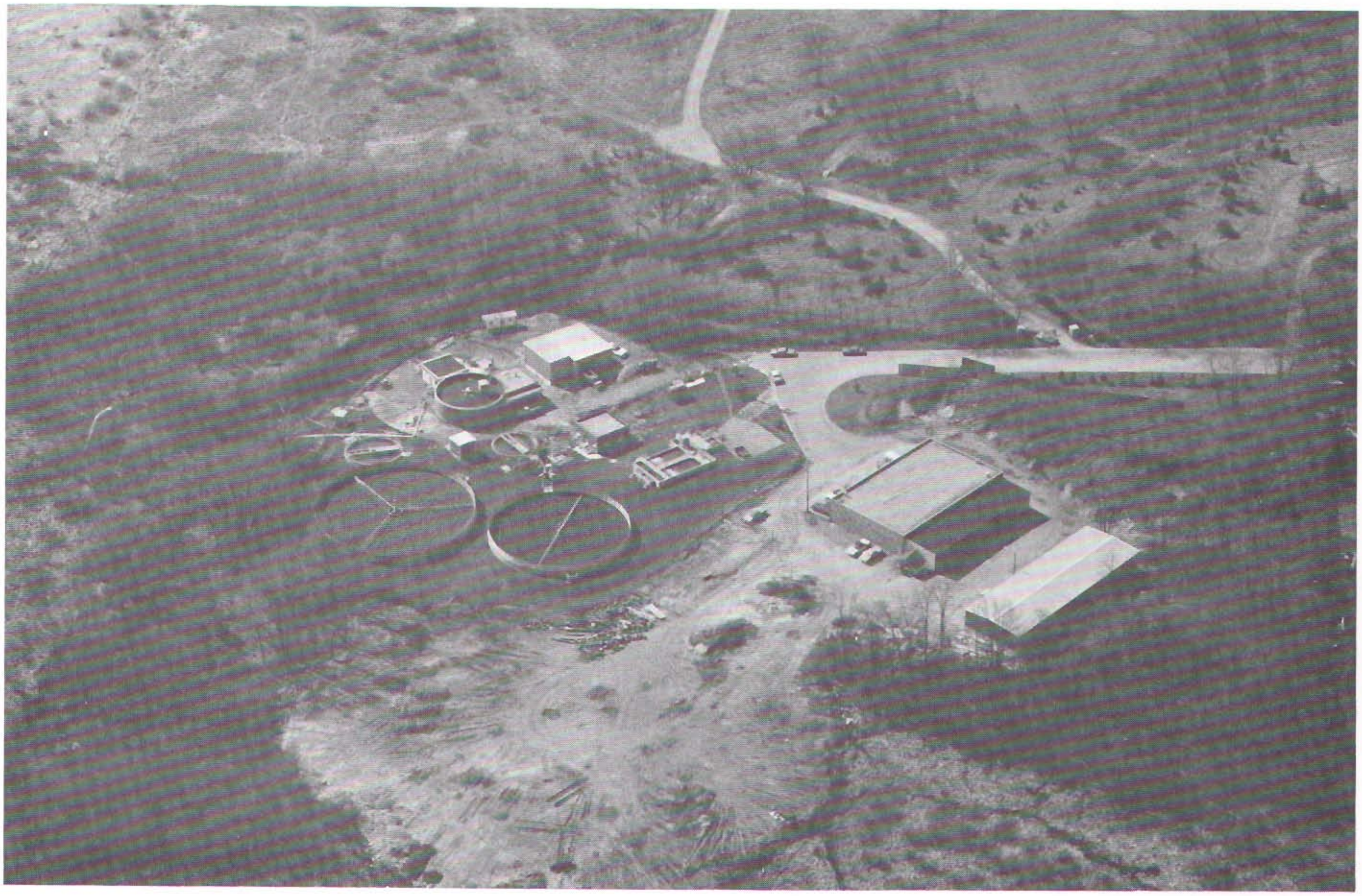
The location and configuration of the major trunk sewers, pumping stations and associated force mains included in the Village of East Troy sanitary sewerage system are shown on Map 17. The only known point of sewage flow relief in the Village of East Troy sanitary sewerage system is a bypass located at the wastewater treatment plant.

The inventory indicated that, during 1977, the Village of East Troy initiated facilities planning studies for sewerage system improvements including consideration of the necessary treatment and conveyance facilities to serve the Town of East Troy Sanitary District No. 2 Potter Lake area.

Management of the Village of East Troy sanitary sewerage system is under the direction of the

Figure 43

CITY OF LAKE GENEVA WASTEWATER TREATMENT PLANT



Source: SEWRPC.

Village Board. Day-to-day administration of this system is provided by the Superintendent of Public Works. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation and maintenance and capital improvements, including debt retirement, for the Village of East Troy sanitary sewerage system approximated $59,710, or about $27.00 per capita, all of which was expended for operation and maintenance.

Village of Genoa City: The existing service area of the Village of Genoa City sanitary sewerage system is shown on Map 17. This area totals about 0.3 square miles and has a resident population of about 1,100 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Genoa City is treated at a wastewater treatment plant located on Nippersink Creek, to which effluent is discharged (see Figure 45). The plant has a site area of about five acres, of which about four acres are currently utilized, leaving one acre available for future use. The plant site is bounded by residential land uses on the north, open lands on the east, the Wisconsin-Illinois state line on the south, and Nippersink Creek on the west. The plant was constructed in 1923 and was modified in 1959. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes in the plant include primary sedimentation, trickling filter, final sedimentation, and chlorination. Sludge solids removed from the treatment process are fed to an anaerobic digestion system and then to sludge drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.12 mgd, with a peak hydraulic design capacity of 0.24 mgd and an organic design capacity of 200 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.07 and 0.10 mgd respectively,

Figure 44

VILLAGE OF EAST TROY
WASTEWATER TREATMENT PLANT

Source: Roger R. Ross and Joseph C. Ruys.

Figure 45

VILLAGE OF GENOA CITY
WASTEWATER TREATMENT PLANT

Source: Roger R. Ross and Joseph C. Ruys.

while the average annual and maximum monthly organic loadings were reported to be 77 and 117 pounds of BOD_5 per day, indicating that the plant has adequate capacity to treat the hydraulic loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 19 mg/l BOD_5 and 16 mg/l of suspended solids. Maximum monthly average effluent concentrations of 28 mg/l of BOD_5 and 36 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations fecal coliform counts were not reported routinely during 1975. However, a monthly average effluent chlorine residual which varied from 0.50 mg/l to 0.60 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers serving the Village of Genoa City are shown on Map 17. The only known point of sewage flow relief in the Village of Genoa City sanitary sewerage system is a bypass located at the wastewater treatment plant. The inventory indicated that the Village had no documented plan for extension of trunk sewers to provide service to additional areas.

Management of the Village of Genoa City sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Water and Sewer Utility Superintendent. Financing of the system is provided through the general property tax and a sewer service charge equal to 55 percent of the consumer's water bill.

Total expenditures during 1975 for operation and maintenance and capital improvements including debt retirement, for the Village of Genoa City sanitary sewerage system approximated $24,337, or about $22.00 per capita. Of this total, $17,342, or about $16.00 per capita, was expended for operation and maintenance, and $6,995, or about $6.00 per capita, was expended for capital improvements.

Village of Mukwonago: The existing service area of the Village of Mukwonago sanitary sewerage system is shown on Map 17. This area totals about 1.3 square miles and has a resident population of about 3,400 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Mukwonago is treated at an activated sludge wastewater treatment plant located on the Mukwonago River, to which effluent is discharged (see Figure 46). The plant has a site area of about two acres, of which about one acre is currently utilized, leaving one acre available for future use. The plant site is bounded by agricultural or open lands on all sides. The plant was constructed

Figure 46

VILLAGE OF MUKWONAGO
WASTEWATER TREATMENT PLANT

Source: Roger R. Ross and Joseph C. Ruys.

in 1950. The treatment plant incorporates primary and secondary waste treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes in the plant include primary sedimentation, trickling filter, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the treatment processes are fed to an anaerobic digestion system and then to sludge drying beds prior to application on agricultural land. The plant has an average hydraulic design capacity of 0.22 mgd, with a peak hydraulic design capacity of 0.56 mgd and an organic design capacity of 485 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.44 and 0.60 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 430 and 665 pounds of BOD_5 per day, indicating that the plant is operating above its hydraulic and organic capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 29 mg/l BOD_5 and 25 mg/l of suspended solids, and 0.84 mg/l of phosphorus. Maximum monthly average effluent concentrations of 46 mg/l of BOD_5 and 44 mg/l of suspended solids, and 1.0 mg/l of phosphorus were reported during 1975. Data on fecal coliform counts and chlorine residual were not reported routinely during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 50 mg/l of BOD_5, 50 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

Early in 1977, the Village of Mukwonago was in the final stages of the facility planning process for the construction of a new wastewater treatment plant and trunk sewers in order to correct existing deficiencies and provide adequate capacity to accommodate future growth in the Village. The Village plans to locate the proposed plant about one-half mile northeast of the existing treatment plant site. Alternative plans were considered, including treatment and discharge to the Mukwonago River and also the Fox River. The recommended plan provides for an effluent outfall sewer to the Fox River. The proposed wastewater treatment plant is planned to provide secondary waste treatment, advanced waste treatment for phosphorus removal, and auxiliary waste treatment for effluent disinfection. The plant is proposed to have an average hydraulic design capacity of 1.50 mgd with a peak hydraulic design capacity of 3.75 mgd and an organic design capacity of 2,500 pounds of BOD_5 per day.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains included in the Village of Mukwonago sanitary sewerage system are shown on Map 17. There are no points of sewer overflow or bypassing in the Village of Mukwonago sanitary sewerage system. The inventory revealed that the Village had a documented plan for the provision of sewer service to an additional 3.6 square mile area, which is shown on Map 17.

Management of the Village of Mukwonago sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Village Engineer and the Plant Superintendent. Financing of the system is provided through the general property tax.

Total expenditures during 1975 for operation and maintenance and capital improvements including debt retirement for the Village of Mukwonago sanitary sewerage system approximated $37,123, or about $11.00 per capita. Of this total, $32,063, or about $9.00 per capita, was expended for operation and maintenance, and $5,060, or about $2.00 per capita, was expended for capital improvements.

Village of Rochester: The existing service area of the Village of Rochester sanitary sewerage system is shown on Map 17. This area totals about 0.2 square mile and has a resident population of about 800 persons. The entire area is served by a separate sanitary sewer system. Wastewater from the Village of Rochester is treated at the wastewater treatment facility operated by the Western Racine County Sewerage District, as discussed later in this Chapter. The average hydraulic loading on the district plant from the Village of Rochester in 1975 was estimated at 0.04 mgd.

The location and configuration of the major trunk sewers, pumping and lift stations, and related force mains included in the Village of Rochester sanitary sewerage system are shown on Map 17. There are no known points of sewage flow relief in the Village of Rochester sanitary sewerage system. The inventory revealed that the Village was included in plans to extend trunk sewers to additional areas tributary to the Western Racine County Sewerage District as shown on Map 17.

Management of the Village of Rochester sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village President. Financing of the system is provided through a sewer service charge of $8.00 per month per connection. The revenue is utilized to operate, maintain, and expand the existing village system, as well as the village's share of operating the sewerage facilities of the Western Racine County Sewerage District. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Rochester sanitary sewerage system approximated $32,940, or about $41.00 per capita. Of this total, $3,495, or about $4.00 per capita, was expended for operation and maintenance, and $29,445 or about $37.00 per capita, was expended for capital improvements.

Village of Silver Lake: The existing service area of the Village of Silver Lake sanitary sewerage system is shown on Map 17. This area totals about 0.5 square mile and has a resident population of about 1,300 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Silver Lake is treated at a wastewater treatment plant located at the southern village limits on the Fox River, to which effluent is discharged (see Figure 47). The plant has a site area of about seven acres, of which about two acres are currently utilized, leaving five acres available for future use. The plant site is bounded by the Fox River and park lands on the west and by agricultural and open lands on the north, south, and east. The plant was constructed in 1966. The treatment plant incorporates secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes in the plant include activated sludge, final clarification, and chlorination. Sludge solids removed from the treatment process are fed to an aerobic digestion system prior to liquid application to agricultural lands. The plant has an average hydraulic design capacity of 0.30 mgd, with a peak hydraulic design capacity of 0.50 mgd and an organic design capacity of 510 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.15 and 0.20 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 58 and 67 pounds of BOD_5 per day, indicating that the plant has adequate capacity to treat the wastewater from the existing service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 2 mg/l of BOD_5 and 2 mg/l of suspended solids. Maximum monthly average effluent concentrations of 4 mg/l of BOD_5 and 3 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not reported routinely during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping stations, and associated force mains included in the Village of Silver Lake sanitary sewerage system are shown on Map 17. The only known point of sewage flow relief in the Village of Silver Lake sanitary sewerage system, is a bypass located at the wastewater treatment plant. The inventory revealed that the Village had a documented plan for the provision of sewer service to an additional 0.6 square mile area, which is shown on Map 17.

Management of the Village of Silver Lake sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Deputy Village Clerk. Financing of the system is provided through general property tax, special assessments, and a monthly service charge of $5.00 per residential sewer connection, with the monthly charge for nonresidential connections negotiated on a case-by-case basis.

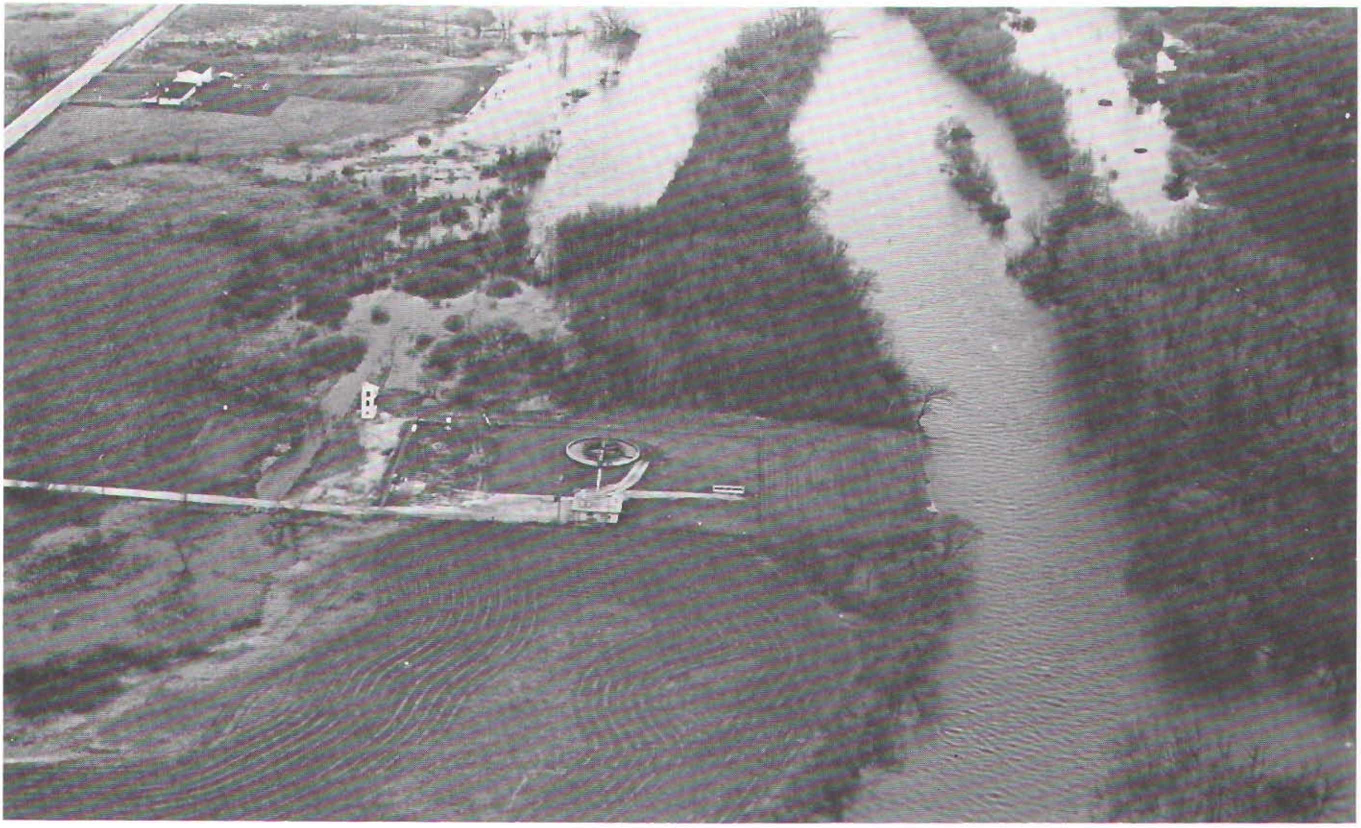
Total expenditures during 1975 for operation and maintenance and capital improvements including debt retirement for the Village of Silver Lake sanitary sewerage system approximated $98,082, or about $76.00 per capita. Of this total, $30,362, or about $24.00 per capita, was expended for operation and maintenance, and $67,720, or about $52.00 per capita, was expended for capital improvements.

Village of Twin Lakes: The existing service area of the Village of Twin Lakes sanitary sewerage system is shown on Map 17. This area totals about 2.3 square miles and has a resident population of about 3,400 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Twin Lakes is treated at a wastewater treatment plant located at the north-

Figure 47

VILLAGE OF SILVER LAKE WASTEWATER TREATMENT PLANT



Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

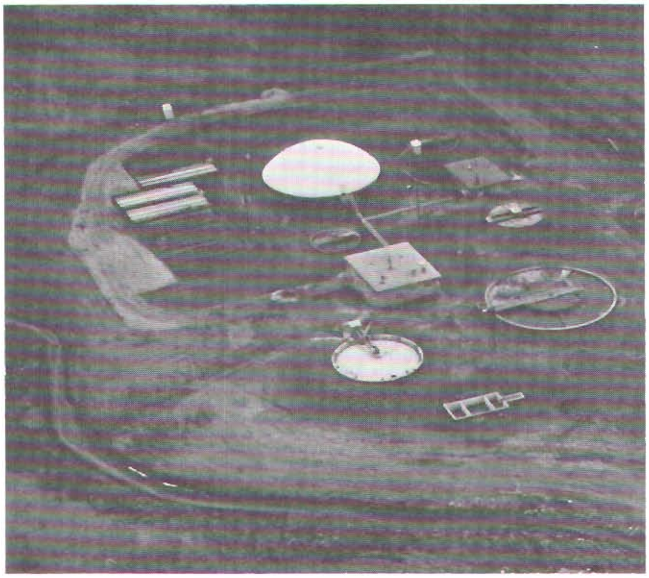
eastern Village limits on Bassett Creek, to which effluent is discharged (see Figure 48). The plant has a site area of about 10 acres, of which about two acres are currently utilized, leaving eight acres available for future use. The plant site is bounded on the south by a golf course and residential development and on the east, west, and north by agricultural and open lands. The plant was constructed in 1958 and was modified in 1970. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes in the plant include primary sedimentation, trickling filter, activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the treatment process are divided between an anaerobic and an aerobic digestion system and are then conveyed to sludge drying beds prior to final disposal in a landfill. The plant has an average hydraulic design capacity of 0.82 mgd, with a peak hydraulic design capacity of 1.64 mgd and an organic design capacity of 1,390 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.41 and 0.50 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 460 and 690 pounds of BOD_5 per day, indicating that the plant has adequate capacity to treat hydraulic loading from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain average concentrations of 14 mg/l of BOD_5 and 156 mg/l of suspended solids. Maximum monthly average effluent concentrations of 18 mg/l of BOD_5 and 789 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not reported routinely during 1975. However, a monthly average effluent chlorine residual which varied from 0.5 mg/l to 0.7 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 20 mg/l of BOD_5, 20 mg/l of suspended solids, 1 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains included in the Village of Twin Lakes

Figure 48

VILLAGE OF TWIN LAKES
WASTEWATER TREATMENT PLANT



Source: Roger R. Ross and Joseph C. Ruys.

sanitary sewerage system are shown on Map 17. There are no known points of sewage flow relief in the Village of Twin Lakes sanitary sewerage system. The inventory revealed that the Village had no documented plan for the provision of sewer service to additional areas. However, the Village has initiated a facility planning program to evaluate existing and future sewerage system needs.

Management of the Village of Twin Lakes sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Sewer Committee of the Village Board. Financing of the system is provided through the general property tax, and a monthly service charge of $6.50 per residential sewer connection, with a monthly charge for nonresidential connections negotiated on a case-by-case basis.

Total expenditures during 1975 for operation and maintenance and capital improvements including debt retirement for the Village of Twin Lakes sanitary sewerage system approximated $309,093, or about $91.00 per capita. Of this total, $69,469, or about $20.00 per capita, was expended for operation and maintenance, and $239,624, or about $71.00 per capita, was expended for capital improvements.

Village of Waterford: The existing service area of the Village of Waterford sanitary sewerage system is shown on Map 17. This area totals about 0.6 square mile and has a resident population of about 2,300 persons. The entire area is served by a separate sanitary sewer system. Sewage from the Village of Waterford is treated at the sewage treatment facility operated by the Western Racine County Sewerage District, as discussed later in this chapter. The average hydraulic loading on the District plant from the Village of Waterford in 1975 was estimated at 0.2 mgd.

The location and configuration of all major trunk sewers, pumping and lift stations, and related force mains included in the Village of Waterford sanitary sewerage system are shown on Map 17. There are no known points of sewage flow relief in the Village of Waterford sanitary sewerage system. The inventory indicated that the Village was involved in plans to provide sewer service to additional areas tributary to the Western Racine County Sewerage District as shown on Map 17.

Management of the Village of Waterford sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Village Clerk. Financing of the system is provided through the general property tax, a special assessment, and a sewer service charge equal to 170 percent of the charge for metered water usage during the first quarter of the year. This revenue is utilized to operate, maintain, and expand the existing Village system, as well as to provide the Village's share of operating the sewerage facilities of the Western Racine County Sewerage District. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Waterford sanitary sewerage system approximated $66,460, or about $29.00 per capita. Of this total, $21,803, or about $10.00 per capita, was expended for operation and maintenance, and $44,657, or about $19.00 per capita, was expended for capital improvements.

Town of Rochester Sewer Utility District No. 1: The existing sewer service area of the Town of Rochester Sewer Utility District No. 1 sanitary sewerage system is shown on Map 17. This area totals about 0.2 square mile and has a resident population of about 300 persons. The entire area is served by a separate sanitary sewer system. Wastewater from the Town of Rochester Sewer Utility District No. 1 is treated at the wastewater treatment facility operated by the Western Racine County Sewerage District, as discussed later in this chapter. The average hydraulic loading on the Western Racine County sewage treatment plant from the Town of Rochester Sewer Utility District No. 1 in 1975 was estimated at 0.02 mgd.

The location and configuration of the major trunk sewer serving the Town of Rochester Sewer Utility District No. 1 is shown on Map 17. There are no known points of sewer overflow or bypassing in the Town of Rochester Sewer Utility District No. 1 sanitary sewerage system. The inventory indicated that the District was involved in plans to provide sewer service to additional areas tributary to the Western Racine County Sewerage District as shown on Map 17.

Management of the Town of Rochester Sewer Utility District No. 1 sanitary sewerage system is under the direction of the Town Board. Day-to-day administration of the system is provided by the staff of the Western Racine County Sewerage District. Financing of the system is provided through a sewer service charge of $7.50 per month per connection. Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Town of Rochester Sewer Utility District No. 1 sanitary sewerage system approximated $11,831, or about $39.00 per capita. Of this total, $3,335, or about $11 per capita, was expended for operation and maintenance, and $8,496, or about $28 per capita, was expended for capital improvements.

Browns Lake Sanitary District: The existing service area of the Browns Lake Sanitary District sanitary sewerage system in the Town of Burlington is shown on Map 17. This area totals about 0.8 square mile and has a resident population of about 1,900 persons. The entire area is served by a separate sanitary sewer system. Wastewater from the Browns Lake Sanitary District is treated at the wastewater treatment facility operated by the City of Burlington. The average hydraulic loading on the Burlington wastewater treatment plant from the Browns Lake Sanitary District in 1975 was estimated at 0.09 mgd.

The location and configuration of the major trunk sewer, pumping stations, and associated force mains included in the Browns Lake Sanitary District sanitary sewerage system is shown on Map 17. There are no known points of sewage flow relief in the Browns Lake Sanitary District. The inventory revealed that the District had a documented plan for the extension of sewer service into the undeveloped portions of the District. This additional proposed service area of 0.8 square mile is also shown on Map 17.

Management of the Browns Lake Sanitary District sanitary sewerage system is under the direction of a three-member commission. Day-to-day administration of the system is provided by the Commissioners. Financing of the system is provided through a sewer service charge of $10.00 per month per sewer connection and a property tax levy.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Browns Lake Sanitary District sanitary sewerage system approximated $109,393, or about $58.00 per capita. Of this total, $35,110, or about $19.00 per capita, was expended for operation and maintenance, $66,000, or about $35.00 per capita, was expended for capital improvements and $8,283, or about $4.00 per capita, was paid to the City of Burlington as a contract payment for wastewater treatment.

Western Racine County Sewerage District: The existing service area of the Western Racine County Sewerage District sanitary sewerage system is shown on Map 17. This area includes the service areas of the Villages of Rochester and Waterford and the Town of Rochester Sewer Utility District No. 1, totals about .9 square miles and has a resident population of about 3,400 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Western Racine County Sewerage District is treated at a wastewater treatment plant located on the Fox River, to which effluent is discharged (see Figure 49). The plant has a site area of about 20 acres, of which approximately three acres are currently utilized, leaving 17 acres available for future treatment plant use. The plant site is bounded by open lands on the north, the Fox River on the west and south, and State Highway 36 on the east. The plant was initially constructed in 1969 with modifications in 1976. The treatment plant incorporates secondary waste treatment processes and provides advanced waste treatment for phosphorus removal, and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chemical treatment for phosphorus removal, and chlorination. Sludge solids removed from the activated sludge system are transferred to an aerobic digestion system and then to sludge drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.50 mgd, with a peak hydraulic design capacity of 1.00 mgd and an organic design capacity of 850 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.24 and 0.30 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 329 and 428 pounds of BOD_5 per day, respectively, indicating that the plant had adequate capacity to treat the hydraulic and the organic loadings from the existing sewer service area.

During 1975, the treatment plant effluent was reported to contain an average concentration of 8 mg/l of BOD_5 and 6 mg/l of suspended solids. Maximum monthly average effluent concentrations of 11 mg/l of BOD_5 and 10 mg/l of suspended solids were reported in 1975. Data on effluent phosphorus concentrations and fecal coliform counts was not reported routinely during 1975. However, a monthly average effluent chlorine residual which varied from 0.5 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, 1.0 mg/l of phosphorus, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains tributary to the Western Racine County

Figure 49

WESTERN RACINE COUNTY SEWERAGE DISTRICT WASTEWATER TREATMENT PLANT

Source: Michael G. Dorn, Charles L. Hamilton, and Mark W. Sheets.

Sewerage District wastewater treatment plant are shown on Map 17. There are no known sewage flow relief devices in the Western Racine County Sewerage District sanitary sewerage system. The inventory indicated that the District has a documented plan for the provision of sewer service to an additional 20.3 square mile area including the Tichigan Lake area discussed below. In 1977, the District was in the process of preparing a facility plan to evaluate existing and future sewerage system requirements.

Management of the Western Racine County sanitary sewerage system is under the direction of a three-member commission. Day-to-day administration of the system is provided by the commission itself. Financing of the system is provided by the two Villages and Town Utility District which contribute sewage to the District. The metered rate charged by the District to each of its constituent units was $85 per million gallons.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Western Racine County sanitary sewerage system approximated $149,208, or about $44.00 per capita. Of this total, $42,377, or about $13.00 per capita, was expended for operation and maintenance, and $106,831, or about $31.00 per capita, was expended for capital improvements. These expenditures were included as part of the expenditures reported for the Villages of Rochester and Waterford and the Town of Rochester Sewer Utility District No. 1.

Proposed Public Sanitary Sewerage Systems

The sewer service inventory indicated that, as of 1975, proposals had been made for the construction of seven new sanitary sewerage systems in the Lower Fox River subregional area.

Village of North Prairie: The Village of North Prairie is considering the establishment of a centralized public sanitary sewerage system. The proposed service area of this system is shown on Map 17. This area totals about 0.6 square mile and has a current resident population of about 500 persons. Wastewater from this area is proposed to be treated at a wastewater treatment plant located southwest of the Village.

Eagle Lake Sewer Utility District: The Eagle Lake Sewer Utility District in the Town of Dover was formed in 1970 to provide sanitary sewer service to existing urban development along the shoreline of Eagle Lake and adjacent urban development in the unincorporated community of Kansasville. The adopted comprehensive plan for the Fox River watershed recommended that such sewer service be provided and that the utility district construct a wastewater treatment plant near the lake outlet. The District has proceeded to carry out this recommendation and has completed engineering studies and detailed design work for the construction of the needed sewerage system. The proposed facilities are currently under construction.

The proposed service area of the Eagle Lake Sewer Utility District is shown on Map 17. This area totals about 2.2 square miles and has a current resident population of about 1,100 persons. The District has selected a 15-acre site adjacent to Eagle Creek to which it would discharge wastewater treatment plant effluent. The proposed wastewater treatment facility is designed to have an average hydraulic design capacity of 0.40 mgd with a peak hydraulic design capacity of 0.70 mgd, and an organic design capacity of 1,105 pounds of BOD_5 per day. The plant would be an activated sludge type wastewater treatment plant designed to provide a secondary treatment with advanced waste treatment for nitrification and auxiliary waste treatment for effluent aeration and disinfection.

Management of the Eagle Lake Sewer Utility District is under the direction of a three-member board. Day-to-day administration of the proposed system is to be provided by a certified Plant Operator. Operation and maintenance of the system are to be financed through a sewer service charge of about $4.50 per month per connection.

Town of East Troy Sanitary District No. 2: A new sanitary sewerage system to serve existing urban development along the shoreline of Potters Lake in the Town of East Troy has been proposed by the Town of East Troy Sanitary District No. 2. Local residents living in the District have become increasingly concerned about the quality of water in Potters Lake and the effect upon such quality caused by inoperative onsite, soil absorption, sewage disposal systems. The district has completed preliminary engineering studies for the construction of a sanitary sewerage system and has proposed that wastewater be conveyed to the Village of East Troy for wastewater treatment on a contract basis.

The Village of East Troy has initiated facilities planning studies to evaluate wastewater treatment and conveyance needs including providing service to the Potters Lake area.

The proposed service area of the Town of East Troy Sanitary District No. 2 is shown on Map 17. This area totals about 0.3 square mile and has a current resident population of about 1,000 persons.

Management of the Town of East Troy Sanitary District No. 2 is under the direction of a three-member commission. Day-to-day administration of the proposed sewerage system will be provided by a plant superintendent. Operation and maintenance of the system is to be financed through sewer service charges.

Town of Lyons Sanitary District No. 2: The Town of Lyons Sanitary District No. 2 was formed in 1970 to provide sanitary sewer service to existing urban development in the unincorporated community of Lyons, located on the White River about midway between the Cities of Lake Geneva and Burlington. The District was formed in response to a water pollution abatement order issued to the Town by the Wisconsin Department of Natural Resources. The District had hired a consulting engineer and has conducted initial engineering studies for the provision of sewer service in response to the state orders.

The proposed service area of the Town of Lyons Sanitary District No. 2 is shown on Map 17. This area totals about 0.4 square mile and has a current resident population of about 600 persons.

Management of the Town of Lyons Sanitary District No. 2 is under the direction of a three-member commission. Day-to-day administration of the proposed system is to be provided by a certified treatment plant operator. Operation and maintenance of the system is to be financed through sewer service charges and a general tax levy.

Town of Norway Sanitary District No. 1: The Town of Norway Sanitary District No. 1 was formed in 1969 to provide sanitary sewer service to existing urban development along the shorelines of Wind, Waubeesee, and Long Lakes in the Town of Norway. The adopted comprehensive plan for the Fox River watershed recommended that sewer service be provided to the Wind Lake area and that the District construct a wastewater treatment plant near the Wind Lake outlet. The District has expanded this recommendation to include nearby development around Waubeesee and Long Lakes. In addition, it has been proposed that the District be further expanded to serve urban development around Denoon Lake in the City of Muskego, Waukesha County. The Town of Norway Sanitary District No. 1 has completed engineering studies and detailed design work for the construction of the needed sewerage system. Construction of the project is currently underway.

The proposed service area of the Town of Norway Sanitary District No. 1 is shown on Map 17. This area totals about 4.5 square miles and has a current resident population of about 3,700 persons. The District has proposed a 20-acre wastewater treatment plant site adjacent to the Wind Lake canal, to which it would discharge wastewater treatment plant effluent. The proposed wastewater treatment facility is designed to have an average hydraulic design capacity of about 0.70 mgd, with a peak hydraulic design capacity of 1.90 mgd and an organic design capacity of 1,250 pounds of BOD_5 per day. The proposed plant is an activated sludge type wastewater treatment plant designed to provide secondary waste treatment, advanced waste treatment for nitrification and phosphorus removal, and auxiliary waste treatment for effluent aeration and disinfection.

Management of the Town of Norway Sanitary District No. 1 is under the direction of a three-member commission. Day-to-day administration of the proposed system is to be provided by a certified plant operator. Operation and maintenance of the system is to be financed through a sewer service charge of about $3.00 per month per connection.

Town of Salem Sewer Utility District No. 2: A second sewer utility district has been formed in the Town of Salem for the purpose of providing sanitary sewer service to existing and proposed urban development in the town, including urban development on the shores of Camp Lake, Center Lake, Rock Lake, Cross Lake, Bennett Lake, Voltz Lake, and Shangrila Lake and in the unincorporated community of Wilmot. This proposed service area totals about 3.6 square miles and would serve an existing resident population of about 4,700 persons as shown on Map 17.

During 1977, facility planning work for the proposed sewerage system was completed and a detailed design work is pending fund action of federal and state grants in support of the project.

The proposed wastewater treatment facility would be located on a site southwest of Camp Lake and would discharge its effluent into the Fox River below the Town of Wilmot. The proposed wastewater treatment plant would provide secondary waste treatment, provide an advanced waste treatment for phosphorus removal, and auxiliary waste treatment for effluent disinfection. The plant is proposed to have an average hydraulic design capacity of 1.50 mgd with a peak hydraulic design capacity of 3.00 mgd and an organic design capacity of 2,550 pounds of $CBOD_5$ per day. This proposal represents a locally proposed expansion of the recommendation contained in the Fox River watershed plan to provide sanitary sewer service to the urban development located along shores of Camp and Center Lakes.

Tichigan Lake Sanitary District: The Tichigan Lake Sanitary District was formed in 1972 to provide sanitary sewer service to existing urban development in the Tichigan Lake area of the Town of Waterford. The adopted comprehensive plan for the Fox River watershed recommended that sewer service be provided to the immediate area around Tichigan Lake and that a wastewater treatment facility be constructed at the southern end of Tichigan Lake and discharge effluent to the Fox River. The adopted plan further recommends that an eventual connection be made for the Tichigan Lake area to the Western Racine County Sewerage District wastewater treatment plant located below Rochester. The District has begun steps toward implementation of the plan recommendation and is currently examining alternative methods of providing wastewater treatment to the area. As shown on Map 17, the proposed service area of the Tichigan Lake Sanitary District totals about 5.3 square miles and has a current population of about 2,600 persons. It should be noted that this proposed service area is also included in the proposed service area of the Western Racine County Sewerage District.

Flow Relief Devices

As noted above on an individual community basis, there are four sewage flow relief devices located in the sanitary sewerage system located in the Lower Fox River subregional area. Table 52 indicates the number and type of flow relief devices as well as an estimate of the total average annual discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 17.

Other Wastewater Treatment Facilities

In addition to the 11 publicly-owned sanitary sewerage systems discussed above, there are a total of 13 privately-owned wastewater treatment facilities in the Lower Fox River subregional area which, in general, serve single isolated land use enclaves and treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. Five of the treatment plants serve recreational developments while four serve industrial facilities and two serve residential developments. Of the remaining two plants, one serves an institutional facility and one serves a state governmental establishment. These 13 wastewater treatment facilities serve the Alpine Valley Resort and the Wisconsin Department of Transportation—East Troy Rest Area located in the Town of LaFayette, County Estates Mobile Home Park and the Playboy Club Hotel located in the Town of Lyons, and the Lake Geneva Interlaken Resort Village located in the Town of Geneva, Praiser Produce Company and Wisconsin Dairies Cooperative located in the Village of Genoa City, the Slovak Sokol Camp located in the Town of East Troy, and the Rainbow Springs Resort in the Town of Mukwonago, which is not presently in operating, Wheatland Mobile Home Park in the Town of Wheatland, the Downey Duck Company and Holy Redeemer College located in the Town of Dover, and the Packaging Corporation of America located in the Town of Burlington. Pertinent characteristics of these facilities are presented in Table 53 and their location is shown on Map 18.

Table 52

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE LOWER FOX RIVER SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in the Sewer System: Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
FOX RIVER WATERSHED								
City of Lake Geneva. . . .	Yes, Bypass	--	--	--	--	--	--	4.0
Village of East Troy	Yes, Bypass	--	--	--	--	--	--	--[b]
Village of Genoa City . . .	Yes, Bypass	--	--	--	--	--	--	1.0
Village of Silver Lake . . .	Yes, Bypass	--	--	--	--	--	--	--[b]
Subregional Area Subtotal	4-Bypasses	--	--	--	--	--	--	5.0

[a] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.*

[b] *The annual contribution from flow relief devices is less than 1.0 mg.*

Source: SEWRPC.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known flow relief devices on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling process, rinse and wash waters, which are discharged without treatment or following treatment directly to streams and watercourses, or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of 14 such known point sources of wastewater were identified in the Lower Fox River subregional area. Pertinent characteristics of these 14 waste sources are identified in Table 54 and their location is shown on Map 18.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Lower Fox subregional area serve a total area of about 11.1 square miles, or 2 percent of the total area of the subregional area, and a total population of about 31,300, or about 37 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban while quarter sections with between six and 31 housing units or one housing unit for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential of nonpoint pollution source.

Together these nonsewered areas total about 642 square miles, or 94 percent of the total area of the subregional area, and contain a total population of about 54,000, or 63 percent of the total population of the subregional area. Of that total, about 43.5 square miles, or 6 percent of the total area of the subregional area containing a total population of 25,100, or 29 percent of the total population of the subregional area are classified as urban nonsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into 44 named major urban concentrations as shown on Map 18. The

Table 53

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
FOX RIVER WATERSHED													
Walworth County													
Alpine Valley Resort, Inc.	Town of LaFayette	Recreational	Sanitary	Activated Sludge and Lagoon	Soil Absorption	40,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Country Estates Mobile Home Park	Town of Lyons	Residential	Sanitary	Extended Aeration and Lagoon	White River	N/A	15,000	23,000	29.0	26.0	N/A	N/A	200
Lake Geneva Interlacken Resort Village		Recreational	Sanitary	Contact Stabilization Sand Filter and Lagoon	Soil Aborption	125,000	27,000	72,000	8.0	4.0	N/A	N/A	N/A
Playboy Club Hotel	Town of Lyons	Recreational	Sanitary	Contact Stabilization and Lagoon	White River	500,000	120,000	278,000	5.0	10.0	1.0	N/A	200
Paiser Produce (Not in operation) .	Village of Genoa City	Industrial	Process	Lagoon	Soil Absorption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Slovak Sokol Camp	Town of East Troy	Recreational	Sanitary	Activated Sludge	Potters Lake	N/A	20,000	N/A	10.0	12.0	N/A	N/A	200
Wisconsin Dairies Cooperative . .	Village of Genoa City	Industrial	Process	Activated Sludge	Nippersink Creek	N/A	6,200	N/A	14.0	35.0	N/A	N/A	1,435
Wisconsin Department of Transportation—East Troy Rest Area	Town of LaFayette	Governmental	Sanitary	Contact Stabilization and Sand Filter	Tributary of Sugar Creek	18,000	N/A	N/A	39.0	15.0	N/A	N/A	39
Waukesha County													
Rainbow Springs Resort (Not in Operation)	Town of Mukwonago	Recreational	Sanitary	Activated Sludge	Tributary of Mukwonago River	160,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kenosha County													
Wheatland Mobil Homes Park . . .	Town of Wheatland	Residential	Sanitary	Contact Stabilization and Lagoon	Fox River	39,000	37,000	N/A	25.0	17.0	3.6	4.9	50
Racine County													
Downy Duck Company, Inc. . . .	Town of Dover	Industrial	Process and Sanitary	Lagoon and Spray Irrigation	Soil Absorption	200,000	45,000	125,000	18.0	24.0	35.8	118.3	34,500
Holy Redeemer College	Town of Dover	Institutional	Sanitary	Extended Aeration and Lagoon	Tributary of Wind Lake Canal	15,000	8,000	13,000	7.0	5.0	4.1	2.74	10
Packaging Corporation of America	Town of Burlington	Industrial	Process and Sanitary	Extended Aeration and Sand Filter	Tributary of Fox River	10,000	7,500	11,600	12.0	20.0	20.3	0.3	54

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES) questionaire data obtained by SEWRPC; reports filed under Section 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the data as reported in or requirements of the permit WPDES itself.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

estimated population and urban development areas of each of these major concentrations are shown in Table 55.

The most common method of providing for wastewater disposal for those approximately 54,000 people not served by public sanitary sewers within the Lower Fox River subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of wastewater disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternate, using a septic tank and an aboveground soil absorption system referred to as the "mound type septic system," is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

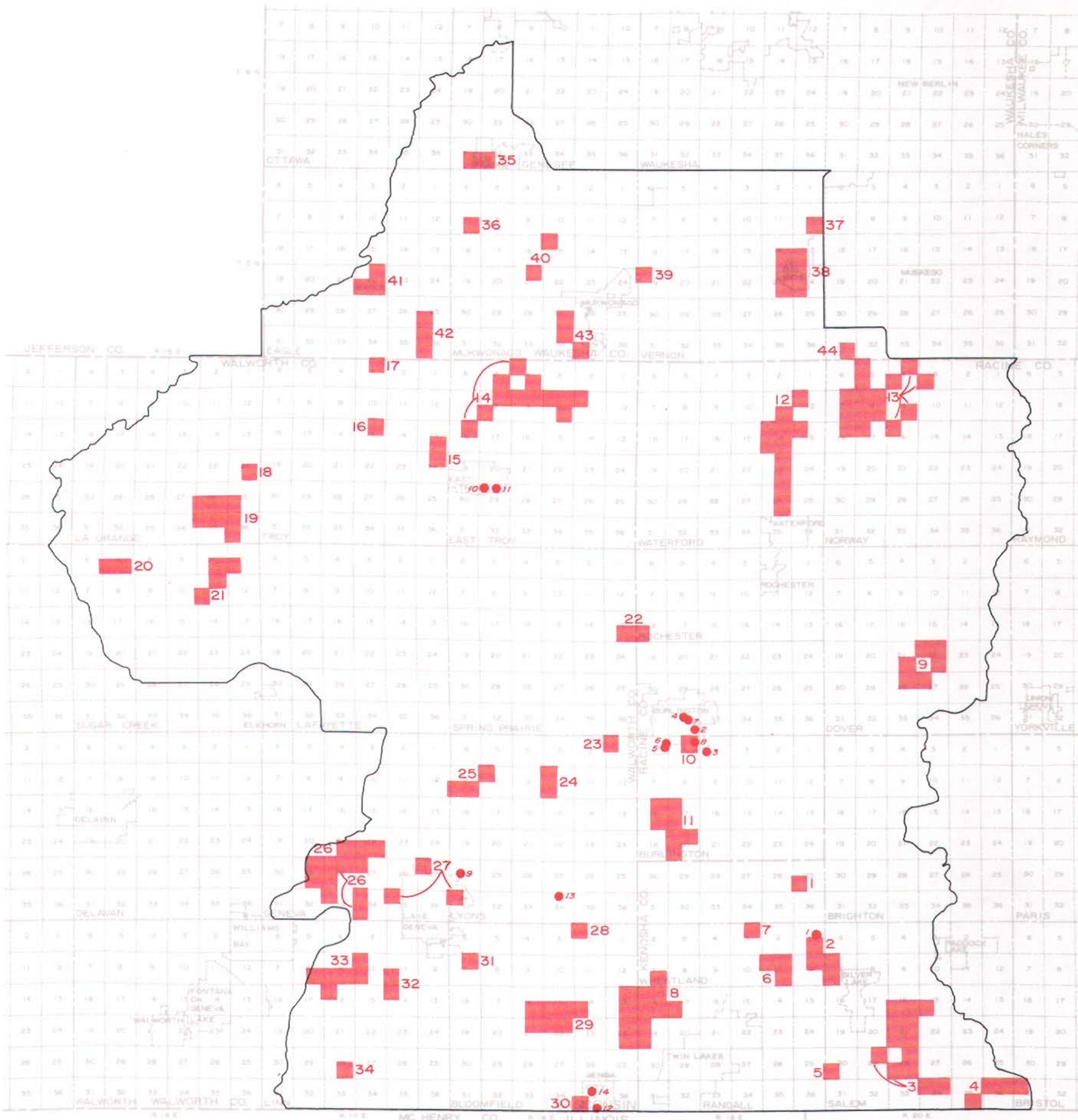
Based upon the permits issued through 1975, there were 86 wastewater holding tank installations, and one mound system existing in the Lower Fox River subregional area. Seventy-one of the holding tanks served residential homes, while 15 were utilized by commercial establishments. The mound system was utilized to dispose of sanitary sewage from a residence. The location of these systems is indicated on Map 18.

Concluding Remarks—Lower Fox River Subregional Area

Inventories conducted under the areawide water quality and management planning program indicated that in 1975 there existed in the Lower Fox River subregional area a total of 11 public sanitary sewerage systems, which include four sewage flow relief device and which together served a total area of about 11.1 square miles, or about 2 percent of the total area of the subregional area, and a total of about 31,300 persons, or about 37 percent of the total population of the subregional area. Eight wastewater treatment plants serve the 11 sanitary sewerage systems located in the Lower Fox River subregional

Map 18

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975



LEGEND

U.S. PUBLIC LAND SURVEY QUARTER SECTION HAVING AT LEAST 32 HOUSING UNITS AND NOT SERVED BY PUBLIC SANITARY SEWERS

30 CODE NUMBER FOR MAJOR CONCENTRATION--SEE TABLE 55

●7 EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS--SEE TABLE 54

Significant concentrations of unsewered urban development in the Lower Fox River subregional area consist of three types of development. The first type consists of lake-oriented urban development—both seasonal and year-round residences—which has occurred around nearly every lake in the subregional area. Centralized sanitary sewerage systems have been proposed for most of these lake-oriented concentrations which are located in the Kenosha and Racine County portions of the subregional area. The second type consists of small unincorporated places in the subregional area which historically have served as service centers for the agricultural industry, such as Troy Center, Lyons, and Zenda. Finally, the third type consists of unsewered, older, established areas such as the Villages of Big Bend, Eagle, and North Prairie. There are also 14 existing (1975) known point sources of wastewater other than the wastewater treatment facilities in the Lower Fox River subregional area. Such waste sources are most prevalent in the industrial land use concentrations in the City of Burlington, the Villages of East Troy and Genoa City, and the Town of Lyons.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 54

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	FOX RIVER WATERSHED																
	Kenosha County																
1	White Construction Company	1500	Town of Wheatland	Groundwater Seepage	None	1	Tributary of Fox River	Intermittent	Intermittent	N/A	40.0	N/A	N/A	N/A	N/A	No	--
	Racine County																
2	Burlington Brass Works. . . .	3432	City of Burlington	Sanitary and and Processes	None	2	Fox River via Storm Sewer	1,700	N/A	3.0	5.0	0.15	1.8	N/A	17.2	Yes	--
3	Continental Can Company, Inc.	3411	City of Burlington	Process	None	1	Soil Absorption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
4	Culligan Soft Water Service. .	7399	City of Burlington	Process	None	1	Fox River via Storm Sewer	1,100	1,300	0.0	216.0	N/A	8.4	N/A	N/A	Yes	--
5	Foster-Forbes Glass Company	3221	Town of Burlington	Cooling	Lagoon and Oil Separator	1	Fox River	212,000	370,000	2.8	18.0	0.0	0.08	N/A	14.7	Yes	--
				Cooling	None	2	Fox River	141,000	173,000	2.8	5.0	0.0	0.08	N/A	N/A	Yes	--
				Cooling	None	3	Fox River	228,000	294,000	2.8	5.0	0.0	0.08	N/A	N/A	Yes	--
6	Lavelle Industries, Inc.	3069	City of Burlington	Cooling and Process	None	1	Fox River via Storm Sewer	55,000	60,000	34.0	21.0	2.8	0.465	N/A	17.5	Yes	--
7	Murphy Products Company, Inc.	2048	City of Burlington	Cooling	None	3	Fox River via Storm Sewer	3,000	3,600	0.0	11.0	0.1	10.0	N/A	15.3	Yes	--
8	The Nestle Company, Inc. . .	2066	City of Burlington	Cooling	None	2	Fox River via Storm Sewer	12,000	15,000	7.0	12.0	0.8	1.0	N/A	18.3	Yes	--
	Walworth County																
9	Coca-Cola Bottling Company, Inc.	2086	Town of Lyons	Washwater	None	1	White River via Drainage Ditch	7,000	10,000	86.0	48.0	0.044	46.7	N/A	21.1	Yes	--
10	Crucible, Inc.— Trent Tube Division Plant No. 1 . .	3317	Village of East Troy	Cooling and Process	Lagoon	1	Honey Creek	480,000	520,000	1.5	10.4	0.8	3.1	N/A	16.7	Yes	--
11	Crucible, Inc.— Trent Tube Division Plants No. 2 and No. 3	3317	Village of East Troy	Cooling and Process	Chemical Treatment and Ph Adjustment	1	Honey Creek	64,000	104,000	4.6	17.6	0.23	1.7	N/A	16.4	Yes	--
12	Genoa City Water Treatment Plant	4952	Village of Genoa City	Filter Backwash	None	1	North Branch Nippersink Creek	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
13	Lake Geneva Packing, Inc. . .	2011	Town of Lyons	Process	None	1	Soil Absorption	N/A	1,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
14	Wisconsin Dairies Cooperative	2026	Village of Genoa City	Cooling	None	1	Nippersink Creek	3,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES), questionnaire data obtained by SEWRPC; reports filed under Section 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the flow data reported in or requirements of the permit itself. In cases when wastewater characteristics were obtained from NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 55

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
Kenosha County			
1	Town of Wheatland-Section 25	500	160
2	Silver Lake-Northwest	600	656
3	Silver Lake, Camp Lake, Trevor	2,400	2,096
4	Cross Lake, Voitz & Benet Lakes	1,300	643
5	Wilmot	300	167
6	Lily Lake	300	489
7	New Munster	100	165
8	Powers & Benedict Lakes	1,100	1,919
Racine County			
9	Eagle Lake Manor	800	955
10	City of Burlington	200	157
11	Bohner Lake	700	1,116
12	Tichigan Lake	1,600	1,749
13	Wind Lake	2,700	2,356
Walworth County			
14	Lake Beulah-Potter Lake	100	1,925
15	Booth Lake	100	320
16	Troy Center	100	161
17	Town of Troy-Section 3	100	142
18	Pleasant Lake	0	162
19	Mill Lake	300	1,136
20	North Lake	200	323
21	Lake Wandawega & Silver Lake	600	635
22	Vienna-Honey Lake	300	319
23	Town of Lyons-Section 1	100	160
24	Lyons	500	323
25	Springfield	500	472
26	Lake Como	1,600	1,775
27	City of Lake Geneva	500	478
28	Lake Ivanhoe	100	162
29	Pell Lake	1,300	1,116
30	Genoa City	100	163
31	Town of Bloomfield-Section 7	100	157
32	Town of Linn-Sections 11 & 14, 9 & 10	500	318
33	Town of Linn-Sections 15 & 16	500	972
34	Zenda	100	162
Waukesha County			
35	North Prairie	800	328
36	Town of Mukwonago-Section 7	200	163
37	Town of Vernon-Section 12	200	159
38	Big Bend	1,800	968
39	Town of Vernon-Section 19	200	142
40	Town of Mukwonago-Sections 15 & 21	200	319
41	Eagle	800	478
42	Eagle Spring Lake	400	485
43	Phantom Lakes	400	483
44	Lake Denoon	200	165
Total		25,100	27,857

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U.S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b] *See Map 18.*

Source: SEWRPC.

area. The Browns Lake Sanitary District has a collection system. However, its wastes are treated by the Burlington Sewage Treatment Plant. The Village of Rochester and Waterford and the Town of Rochester Sewer Utility District No. 1 systems are all connected to the Western Racine County Sewerage District Treatment Plant. In addition to the 11 publicly-owned sanitary sewerage systems, 13 privately-owned wastewater treatment facilities serving isolated industrial, recreational, residential, and institutional developments were found in the inventory. The inventory indicated that as of 1975 there were seven proposed new public sanitary sewerage systems in the area, three of which are intended to serve existing urban development along lake shorelines. There were also 14 point sources of wastewater other than wastewater treatment plants identified in the subregional area, consisting primarily of industrial cooling, process, rinse and washwaters. Finally, in 1975 there were an estimated 25,000 persons residing in scattered enclaves of urban development in the Lower Fox River subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about 43.5 square miles. In the portions of the Lower Fox River subregional area not served by sanitary sewers, it is estimated that approximately 642 square miles and 54,000 people are served by onsite sewage disposal systems. The vast majority of these onsite wastewater disposal systems are conventional septic tanks. However, 86 holding tanks and one mound system were also used for sewage disposal in the subregional area.

INVENTORY FINDINGS UPPER ROCK RIVER SUBREGIONAL AREA

The Upper Rock River subregional area consists of all that area of the Rock River watershed in Washington County. This portion of the Rock River watershed is comprised of all or portions of several watersheds, including the Rock River East Branch subwatershed, the Kohlsville River subwatershed, the Limestone Creek subwatershed, the Rubicon River subwatershed, the Bark River subwatershed, the Ashippun River subwatershed, and the Oconomowoc River subwatershed. Concentrations of urban development are found in the City of Hartford, the Village of Slinger, and the unincorporated Village of Allenton in the Town of Addison. In addition, the southern portion of this subregional area has been subject in recent years to extensive low-density urban residential development, particularly in the Towns of Erin and Richfield. The Upper Rock River subregional area contains all or portions of two major state-owned wildlife areas—the Theresa Marsh in the Town of Wayne and the Allenton Wildlife Area in the Town of Addison—as well as Pike Lake State Park, a major regional outdoor recreation facility recommended to be established in the adopted regional land use plan.

Existing Public Sanitary Sewerage Systems

There are a total of three existing public sanitary sewerage systems in the Upper Rock River subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the City of Hartford, the Village of Slinger, and the Allenton Sanitary District in the Town of Addison. Together these systems serve a total area of about 2.6 square miles, or approximately 1 percent of the total area of the subregional area, and a total population of about 9,700, or approximately 39 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of these systems are presented in Tables 56 and 57.

City of Hartford: The existing service area of the City of Hartford sanitary sewerage system is shown on Map 19. This area totals about 1.9 square miles and has a resident population of about 7,600 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Hartford is treated at a wastewater treatment plant located on the Rubicon River, to which effluent is discharged (see Figure 50). The plant has a site area of about 32 acres, of which 14 acres are currently utilized, leaving 18 acres available for future use. The plant site, is bounded by agricultural lands on the east, north, and west and the main stem of the Rubicon River on the south. The plant was constructed in 1973, replacing an older treatment plant constructed in 1924 on a site about 0.75 mile downstream of the present plant site. The new treatment plant is designed to treat wastes from the Libby, McNeil, and Libby, Inc., canning plant. These industrial wastes are partially treated in an aerated lagoon system prior to being conveyed to the municipal treatment plant. The treatment plant incorporates primary, secondary and tertiary treatment processes and provides advanced waste treatment for phosphorus removal and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chemical treatment for phosphorus removal, microscreening, chlorination and lagooning. Sludge solids removed from the wastewater are fed to an aerobic digestion system prior to being hauled by tank truck to agricultural land application sites. A portion of the sludge is dewatered in sludge drying beds prior to land application. The plant has an average hydraulic design capacity of 2.00 mgd, with a peak hydraulic design capacity of 6.00 mgd and an organic design capacity of 10,000 pounds of BOD_5 per day.

During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.37 and 1.80 mgd respectively, while the

Table 56

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area: Existing Acres	Existing Square Miles	Proposed[a] Acres	Proposed[a] Square Miles	Population[b] Served	Arrangement for Treatment of Sewage (See Table 57)
Existing Systems						
City of Hartford	1,230	1.92	3,619	5.65	7,600	Operates a Facility.
Village of Slinger	289	0.45	1,019	1.59	1,300	Operates a Facility.
Allenton Sanitary District	120	0.19	247	0.39	800	Operates a Facility.
Proposed Systems						
None	--	--	--	--	--	
Subregional Area Total	1,639	2.56	4,885	7.63	9,700	--

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U.S. Public Land Survey quarter section.*

Source: SEWRPC.

average annual and maximum monthly organic loadings were reported to be 2,121 and 3,129 pounds of BOD_5 per day, thus indicating that the plant has adequate capacity to treat the wastewater from the existing service area.

During 1975, treatment plant effluent was reported to contain average concentrations of 6 mg/l of BOD_5, 9 mg/l of suspended solids and 1.0 mg/l of phosphorus. Maximum monthly average concentrations of 10 mg/l of BOD_5, 22 mg/l of suspended solids and 1.8 mg/l of phosphorus were reported during 1975. Data on effluent fecal coliform counts was not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.3 mg/l to 0.7 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 15 mg/l of BOD_5, 15 mg/l of suspended solids, 1.0 mg/l of phosphorus and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping and lift stations, and associated force mains included in the City of Hartford sanitary sewerage system are shown on Map 19. There are no known points of sewage flow relief in the City of Hartford sanitary sewerage system. The inventory indicated that the City had a documented plan for the provision of sewer service to an additional 5.7 square mile area, including the urban development around Pike Lake and the Pike Lake State Park shown on Map 19.

Table 57

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE UPPER ROCK RIVER SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes: Trickling Filter	Activated Sludge	Phosphorus Removal	Microscreening	Disinfection	Level of Treatment Provided: Secondary	Tertiary	Advanced	Auxiliary	Disposal of Effluent	Sludge Handling and Disposal Unit Processes: Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
City of Hartford	1.92	7,600	1973	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Rubicon River	Yes	No	Yes	No	Yes	No
Village of Slinger	0.45	1,300	1950	Yes	No	No	No	Yes	Yes	No	No	Yes	Marshland Drained by the Rubicon River	No	Yes	Yes	No	Yes	No
Allenton Sanitary District No. 1	0.19	800	1961	No	Yes	No	No	Yes	Yes	No	No	Yes	East Branch of the Rock River	No	Yes	Yes	No	Yes	No

Table 57 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975: Annual Average Hydraulic (MGD)	Average Annual Hydraulic Per Capita (GPD)	Maximum Monthly Average Hydraulic (MGD)	Average Annual Organic (pounds BOD_5/day)	Average Annual Organic Per Capita (pounds BOD_5/day)	Maximum Monthly Average Organic (pounds BOD_5/day)	Wastewater Strength Parameters in Plant Influent[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Organic Nitrogen-N (mg/l)	Ammonia Nitrogen-N (mg/l)	Design Capacity: Population[b]	Average Hydraulic (MGD)	Peak Hydraulic (MGD)	Average Organic: (pounds BOD_5/day)	Average Organic: Population[b] Equivalent	Industrial Flows: Design Average Daily Flow (MGD)	Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
City of Hartford	1.37	180	1.80	2,121	0.28	3,129	190	246	N/A	N/A	N/A	10,000	2.00	6.00	10,000	47,620	None	0.05	0.2
Village of Slinger	0.15	115	0.29	157	0.12	250	127	169	12.5[d]	N/A	N/A	1,900	0.15	0.30	792	3,770	0.75	0.50	None
Allenton Sanitary District No. 1	0.08	100	0.11	263	0.33	410	424	479	N/A	N/A	N/A	1,000	0.10	0.15	170	810	None	0.05	None

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]: BOD_5 (mg/l) Average Annual	BOD_5 (mg/l) Maximum Monthly Average	Suspended Solids (mg/l) Average Annual	Suspended Solids (mg/l) Maximum Monthly Average	Total Phosphorus (mg/l) Average Annual	Total Phosphorus (mg/l) Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l) Minimum Monthly Average	Chlorine Residual (mg/l) Maximum Monthly Average	Fecal Coliform (number per 100 ml) Average Annual	Fecal Coliform (number per 100 ml) Maximum Monthly Average	Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Data	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
City of Hartford	6	10	9	22	1.0	1.8	N/A	N/A	0.3	0.7	N/A	N/A	None	6-30-77	15	15	1	200
Village of Slinger	24	46	38	54	N/A	N/A	4.0[e]	0.6[e]	0.2	0.4	N/A	N/A	None	6-30-77	60	60	--	200
Allenton Sanitary District No. 1	17	26	37	82	N/A	N/A	N/A	N/A	0.4	0.6	N/A	N/A	N/A	6-30-77	30	30	--	200

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant administrative personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

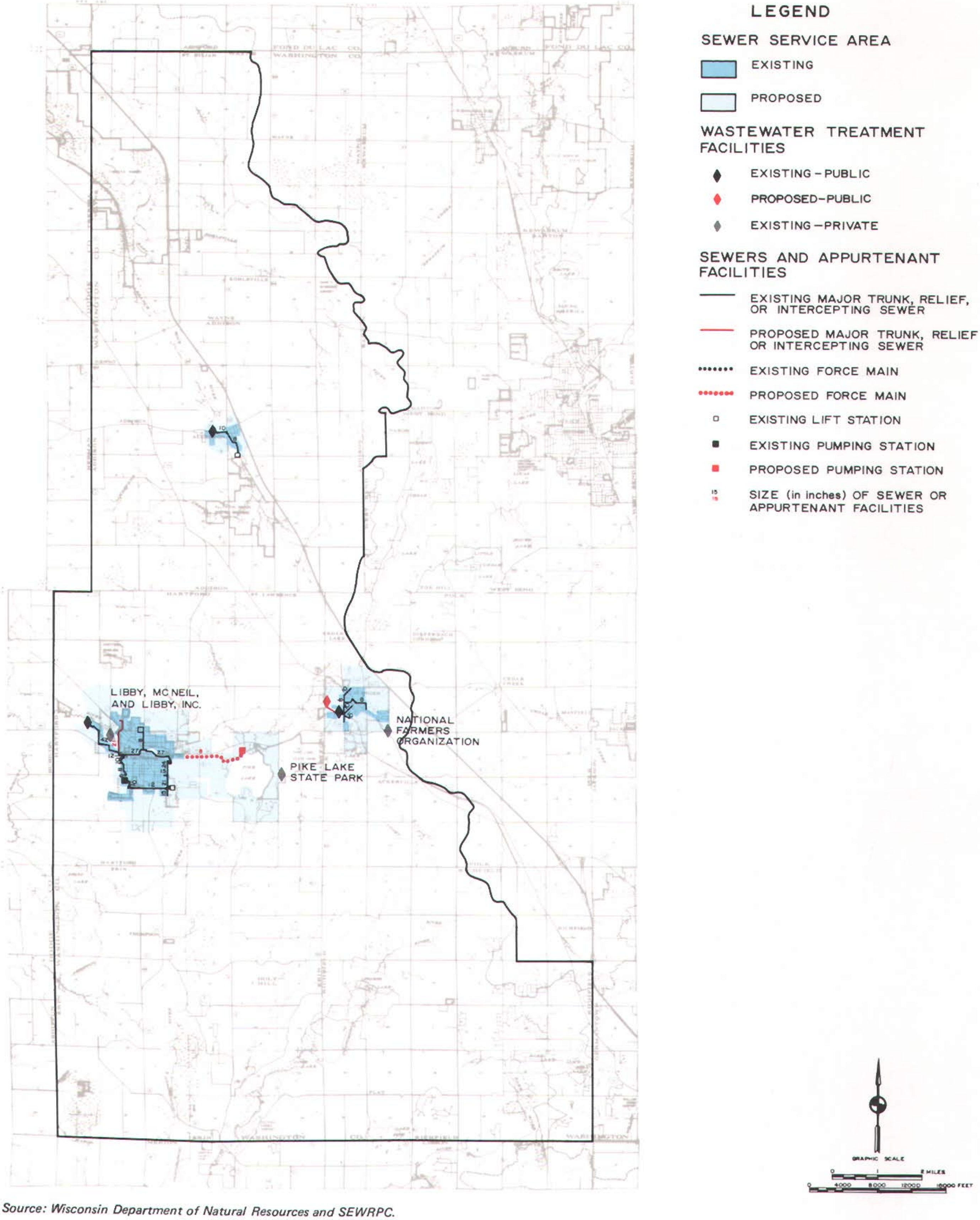
[d] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from 1976 sample reported in the Wisconsin Department of Natural Resources report Upper Rock River, Drainage Basin Report, dated August 1976.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 19

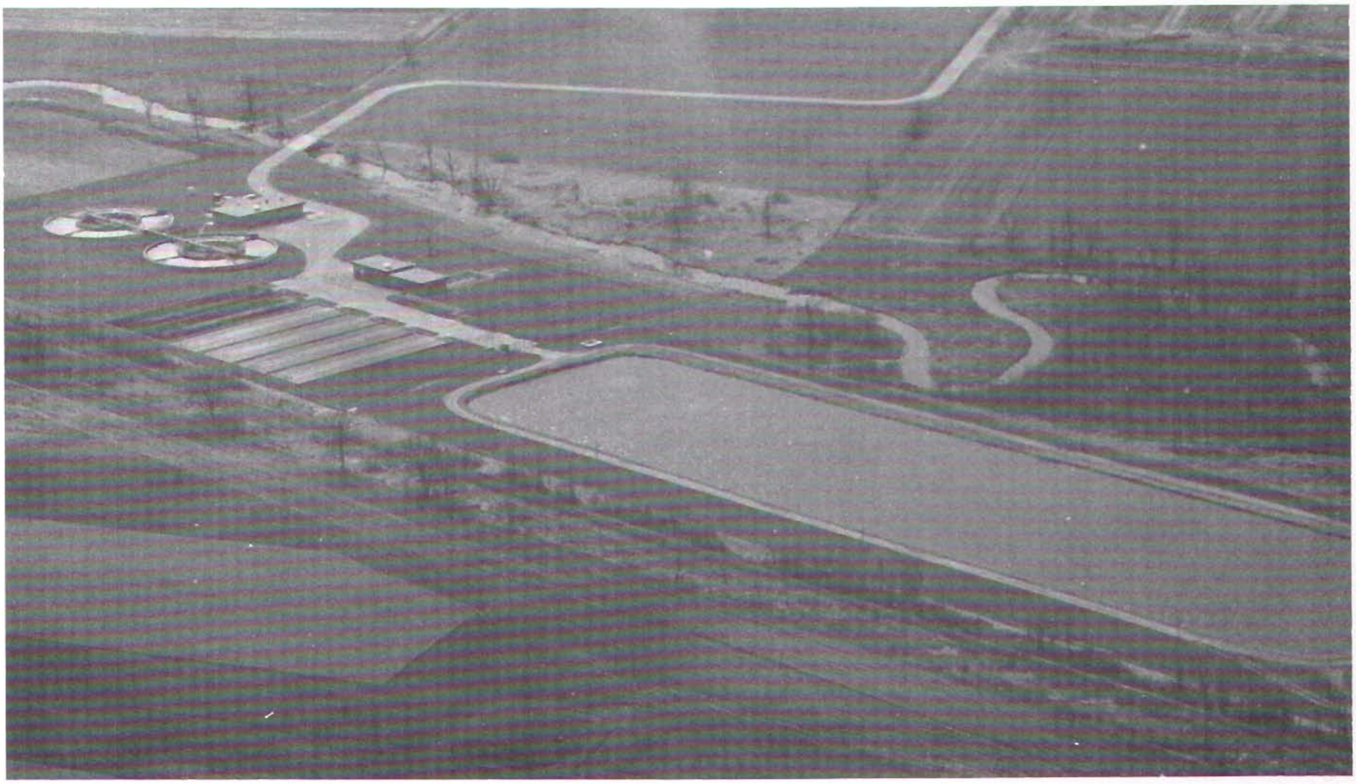
EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 50

CITY OF HARTFORD WASTEWATER TREATMENT PLANT



Source: SEWRPC.

Management of the City of Hartford sanitary sewerage system is under the direction of the Mayor and Common Council. Day-to-day administration of the system is provided by the Director of Public Works. Financing of the system is provided through general property tax levy and a sewer service charge based on water consumption.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Hartford sanitary sewerage system approximated $299,870, or about $39.50 per capita. Of this total, $179,371, or about $23.50 per capita, was expended for operation and maintenance, and $120,499, or about $16.00 per capita, was expended for capital improvements.

Village of Slinger: The existing service area of the Village of Slinger sanitary sewerage system is shown on Map 19. This area totals about 0.5 square mile and has a resident population of about 1,300 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Slinger is treated at a wastewater treatment plant located on a minor drainage ditch leading to a marshland which drains into the Rubicon River, to which effluent is discharged (see Figure 51). The plant has a site area of about two acres, both of which are currently utilized. The plant site is bounded by open land uses on the north, the Chicago, Milwaukee, St. Paul and Pacific Railroad on the south, and residential land use on the west and east. The plant was constructed in 1950. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filter aeration, final clarification, and chlorination.

Sludge solids removed from the wastewater are fed to an anaerobic digestion system and then to sludge drying beds prior to being hauled by trunk to agricultural land application sites. The plant has an average hydraulic design capacity of 0.15 mgd, with a peak hydraulic design capacity of 0.30 mgd, an organic design capacity of 792 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.15 and 0.29 mgd, respectively, while the average annual and maximum monthly organic loadings were reported to be 157 and 250 pounds of BOD_5 per day, indicating that while the plant has adequate organic treatment capacity, it is operating above its average hydraulic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 24 mg/l BOD_5 and 38 mg/l of suspended solids. Maximum monthly average effluent concentrations of 46 mg/l of BOD_5 and 54 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average effluent chlorine residual which varied from 0.2 mg/l to 0.4 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 60 mg/l of BOD_5, 60 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

Figure 51

VILLAGE OF SLINGER WASTEWATER TREATMENT PLANT

Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

Early in 1977, the Village of Slinger was in the final stages of the facilities planning process for the construction of a new wastewater plant in order to correct existing deficiencies and provide adequate capacity to accommodate future growth in the Village. It is planned to locate the proposed treatment plant adjacent to the Rubicon River and about three miles northwest of the existing plant site. The proposed wastewater treatment plant would discharge effluent to the Rubicon River and would be designed to provide secondary waste treatment, advanced waste treatment for nitrification and auxiliary waste treatment for effluent disinfection. The plant is proposed to have an average design capacity of 0.76 mgd with a peak daily design flow of 1.90 mgd and an organic design capacity of 1,270 pounds of BOD_5 per day.

The location and configuration of the major trunk sewers serving the Village of Slinger is shown on Map 19. There are no known points of sewage flow relief in the Village of Slinger sanitary sewerage system. The inventory indicated that the Village had a documented plan for the provision of sewer service to an additional 1.6 square mile area, which is shown on Map 19.

Management of the Village of Slinger sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Village Clerk. Financing of the system is provided through the general property tax and a sewer service charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement for the Village of Slinger sanitary sewerage system approximated $38,347, or about $29.50 per capita. Of this total, $31,750, or about $24.50 per capita was expended for operation and maintenance, and $6,597, or about $5.00 per capita, was expended for capital improvements.

Allenton Sanitary District: The existing service area of the Allenton Sanitary District sanitary sewerage system in the Town of Addison is shown on Map 19. This area totals about 0.2 square mile and has a resident population of about 800 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Allenton Sanitary District is treated at a wastewater treatment plant located on a minor drainage course leading to the East Branch of the Rock River, to which effluent is discharged (see Figure 52). The plant has a site area of about 10 acres, of which less than one is utilized, leaving nine acres available for future use. The plant site is bounded by open land uses on the north, south, and west, and industrial land uses on the east. The plant was constructed in 1961. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, final clarification, and chlorination. Sludge solids removed from the wastewater are fed to an anaerobic digestion system and then to drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.10 mgd, with a peak hydraulic design capacity of 0.15 mgd and an organic design capacity of 170 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.08 and 0.11 mgd respectively while the average annual and maximum monthly organic loadings were reported to be 263 and 410 pounds of BOD_5 per day, respectively, indicating that the plant is operating near its hydraulic design capacity and above its organic design capacity.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 17 mg/l of BOD_5 and 37 mg/l of suspended solids. Maximum monthly average effluent concentrations of 26 mg/l of BOD_5 and 82 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average effluent chlorine residual which varied from 0.4 mg/l to 0.6 mg/l was reported. The waste-

Figure 52

ALLENTON SANITARY DISTRICT
WASTEWATER TREATMENT PLANT

Source: Melissa D. Creamer, Michael G. Dorn, Jean A. Hervert, and Kenneth E. Johnson.

water treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

The location and configuration of the major trunk sewer included in the Allenton Sanitary District are shown on Map 19. There are no known points of sewage flow relief in the Allenton Sanitary District system. The inventory indicated that the District had a documented plan for the provision of sewer service to an additional 0.39 square mile area, which area is shown on Map 19.

Management of the Allenton Sanitary District sanitary sewerage system is under the direction of a three-member Commission. Day-to-day administration of this system is provided by a part-time certified plant operator. Financing of the system is provided through the general property tax and a sewer service charge.

Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Allenton Sanitary District sanitary sewerage system were not available.

Proposed Public Sanitary Sewerage Systems

The Commission sewer service inventory concluded that, as of 1975, there were no proposals made for the construction of new public sanitary sewerage systems in the Upper Rock River subregional area.

Flow Relief Devices

As noted above on an individual community basis, there are no reported sewage flow relief devices located in the sanitary sewerage systems within the Upper Rock River subregional area.

Other Wastewater Treatment Facilities

In addition to the three public sanitary sewerage systems discussed above, there are a total of three wastewater treatment facilities in the Upper Rock River subregional area which, in general, serve single isolated land use enclaves and treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. Two of these wastewater treatment facilities are related to the agricultural products industry. These two facilities serve the National Farmers Organization milk processing facility in the Town of Polk, and serve the Libby, McNeill and Libby, Inc. canning plant in the City of Hartford. The third treatment facility serves the recreational development at the Pike Lake State Park in the Town of Hartford. Characteristics of these facilities are presented in Table 58 and their location is shown on Map 19. The new Hartford treatment facility includes a design capacity of 40,000 population equivalent for industrial wastewater mainly from the Libby, McNeill and Libby, Inc. canning plant. A portion of this design flow is detained in the existing Libby, McNeill and Libby, Inc. wastewater lagoons and released to the centralized sewerage system on a controlled basis. The Pike Lake State Park wastewater treatment facility is also planned to be connected to the Hartford municipal wastewater treatment plant in the future.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage flow relief devices on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and

Table 58

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
ROCK RIVER WATERSHED Washington County													
Libby McNeil and Libby Inc. . . .	City of Hartford	Industrial	Process	Lagoon	Hartford Sewage Treatment Plant	N/A	458,000	763,000	--	--	--	--	--
National Farmers Organization —Slinger Transfer Station	Town of Polk	Industrial	Washwater	Ridge and Furrow and Septic Tank	Soil Absorption	N/A	N/A	5,500	N/A	N/A	N/A	N/A	N/A
Pike Lake State Park	Town of Hartford	Recreational	Sanitary	Lagoon	Soil Absorption	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTE: N/A indicates parts not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES) questionnaire data obtained by SEWRPC, reports filed under Section NR 101 of the Wisconsin Administration Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the data reported or requirements of the WPDES permit itself.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, rinse, process and wash waters, which are discharged, without treatment or following treatment, directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued and reports filed under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of four such known point sources of industrial wastewater were identified in the Upper Rock River subregional area. Characteristics of these four waste sources are identified in Table 59 and their location is shown on Map 20.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Upper Rock River subregional area serve a total area of about 2.6 square miles, or 1 percent of the total area of the subregional area, and a total population of about 9,700, or about 39 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban while quarter sections with between six and 31 housing units or one housing unit for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 178 square miles, or 99 percent of the total area of the subregional area, and contain a total population of about 15,500, or 61 percent of the total population of the subregional area. Of that total, about 6.5 square miles, or 4 percent of the total area of the subregional area containing a total population of 5,500, or 22 percent of the total population of the subregional area, are classified as urban unsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into 13 named major urban concentrations, as shown on Map 20. The estimated population and urban development areas of each of these major concentrations are shown in Table 60.

The most common method of providing for wastewater disposal for those approximately 15,500 people living within urban, urban-rural, and rural areas and not served by public sanitary sewers within the Upper Rock River subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another

Table 59

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	BOD_5 (mg/l)	Suspended Solids (mg/l)	Reported Discharge Wastewater Characteristics[a] Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	ROCK RIVER WATERSHED Washington County																
1	International Stamping Company, Inc.	3714	City of Hartford	Cooling	None	1	Rubicon River	154,000	217,000	N/A	N/A	N/A	N/A	N/A	12.1	No	--
2	Oak Cheese Factory	2022	Town of Hartford	Washwater	Septic System and Lagoon	1	Soil Absorption	N/A	400	N/A	N/A	N/A	N/A	N/A	N/A	No	--
3	W. B. Place & Company, Inc.	3111	City of Hartford	Process	Settling Basin, Screening Sludge and Dewatering	1	Rubicon River	200	400	N/A	150.0	25.0	1.5	N/A	37.5	Yes	--
4	Wissota Sand & Company, Inc.	1442	Town of Richfield	Washwater	Settling Lagoon	1	Bark River	50,000	N/A	N/A	20.0	N/A	N/A	N/A	N/A	No	--

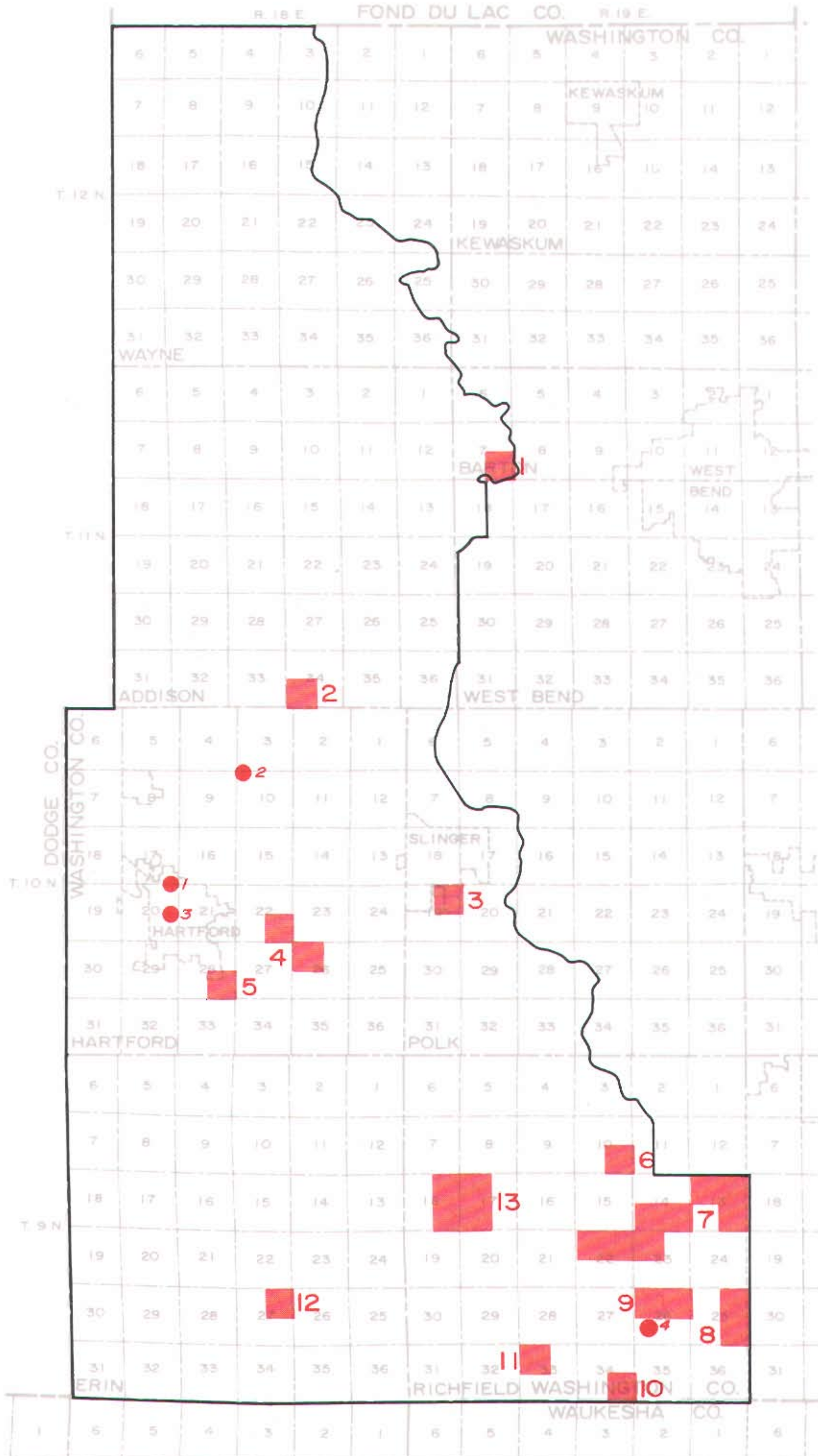
NOTE: N/A indicates data not available.

[a] Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES) or under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data reported in or requirements of the permit itself. In some cases when wastewater characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.

Source. Wisconsin Department of Natural Resources and SEWRPC.

Map 20

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

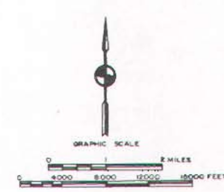


LEGEND

U.S. PUBLIC LAND SURVEY QUARTER SECTION HAVING AT LEAST 32 HOUSING UNITS AND NOT SERVED BY PUBLIC SANITARY SEWERS

8 CODE NUMBER FOR MAJOR CONCENTRATION -- SEE TABLE 60

●3 EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS-- SEE TABLE 59



Significant concentrations of unsewered urban development in the Upper Rock River subregional area are found both in the older, established areas consisting primarily of lake-oriented development along the lakeshores of Amy Bell, Bark, Friess, and Pike Lake, and in the relatively new urban subdivisions such as those located throughout the Town of Richfield. There are four known point sources of wastewater other than wastewater treatment facilities in the Upper Rock River subregional area; including two located in the City of Hartford, and one each in the Towns of Hartford and Richfield.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 60

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Major Urban Concentration[a] Number[b]	Major Urban Concentration[a] Name	Estimated Resident Population	Developed Urban Quarter Section Area (acres)
1	Town of Barton-Section 7	100	159
2	Town of Addison St. Lawrence	300	164
3	Village of Slinger Area Mudlake	400	156
4	Pike Lake Area	400	323
5	City of Hartford Area	100	161
6	Town of Richfield-Section 10	100	165
7	Town of Richfield-Sections 13, 14, 22, and 23	2,200	1,274
8	Amy Bell Lake	400	318
9	Bark Lake	400	315
10	Town of Richfield-Section 34	200	161
11	Town of Richfield-Section 33	200	156
12	Town of Erin-Section 27	100	159
13	Friess Lake	600	631
Total		5,500	4,142

[a]Urban development is defined in this context as concentrations of urban land uses within any given U.S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.

[b]See Map 20.

Source: SEWRPC.

method of wastewater disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternative, using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system" is utilized in areas where high ground-water tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through December 1975, there were five sewage holding tank installations, and no mound systems existing in the Upper Rock River subregional area. Four of the holding tanks served residential homes, while one was utilized by commercial establishments. The location of these systems is indicated on Map 20.

Concluding Remarks—
Upper Rock River Subregional Area

Inventories conducted under the areawide water quality planning and management program indicated that in 1975 there existed in the Upper Rock River subregional area a total of three public sanitary sewerage systems, which together served a total area of about 2.6 square miles, or about 1 percent of the total area of the subregional area, and a total of about 9,700 persons, or about 38 percent of the total population of the subregional area. Each of the three sanitary sewerage systems operates their own wastewater treatment facility. In addition to the three publicly-owned sanitary sewerage systems, three privately-owned wastewater treatment facilities serving isolated industrial and recreational establishments as well as four additional industrial point wastewater sources were found in the inventory. The inventory indicated that as of 1975 there were no proposed new public sanitary sewerage systems in the area. There were also four point sources of wastewater other than wastewater treatment plants identified in the subregional area, consisting primarily of industrial process, cooling, and washwater discharges. Finally, in 1975 there were an estimated 5,500 persons residing in scattered enclaves of urban development in the Upper Rock River subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about 6.5 square miles. In the portions of the Upper Rock River subregional area not served by sanitary sewers, it is estimated that approximately 178.2 square miles and 15,500 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, five holding tanks were also used for sewage disposal within the subregional area.

INVENTORY FINDINGS
MIDDLE ROCK RIVER SUBREGIONAL AREA

The Middle Rock River subregional area consists of all that area of the Rock River watershed in Waukesha County. This portion of the Rock River watershed is comprised of all or portions of several subwatersheds, including the Oconomowoc River subwatershed, the Ashippun River subwatershed, the Bark River subwatershed, and the Scuppernong Creek subwatershed. A large portion of the Middle Rock River subregional area consists of existing and proposed Kettle Moraine State Forest lands. To the north of the State Forest lands lie the rapidly urbanizing inland lakes area of western Waukesha County. Major concentrations of urban development are found in the Cities of Delafield and Oconomowoc, and the Villages of Chenequa, Dousman, Hartland, Lac La Belle, Merton, Nashotah, and Wales. Urban development contiguous to the Village of Lac La Belle in the Town of Ixonia, Jefferson County, outside of the Region, has also been included for sewerage system planning purposes in the Middle Rock River subregional area.

Existing Public Sanitary Sewerage Systems

There are a total of three existing public sanitary sewerage systems in the Middle Rock River subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the City of Oconomowoc, and the Villages of Dousman and Hartland. These three systems serve a total area of approximately 4.4 square miles; or approximately 2 percent of the total area of the subregional area, and a total population of approximately 16,500 people, or approximately 40 percent of the total population in the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 61 and 62.

City of Oconomowoc: The existing service area of the City of Oconomowoc sanitary sewerage system is shown on Map 21. This area totals about 2.7 square miles and has a resident population of about 11,100 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Oconomowoc is treated at a wastewater treatment plant located on the Oconomowoc River, to which effluent is discharged (see Figure 53). The plant has a site area of about 25 acres, of which 10 acres are currently utilized, leaving 15 acres available for future use. The plant site is bounded by residential land use on the north and open land uses on the south, west, and east. The plant was constructed in 1936. A new treatment plant was placed into operation early in 1977. The treatment facility existing in 1975 incorporated primary and secondary treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filtration, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system and then to sludge drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 1.50 mgd, with a peak hydraulic design capacity of 3.00 mgd and an organic design capacity of 2,500 pounds of BOD_5

Table 61

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population[b] Served	Arrangement for Treatment of Sewage (See Table 62)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
City of Oconomowoc	1,752	2.74	24,326	38.01	11,100	Operates a Facility.
Village of Dousman	288	0.45	--	--	1,000	Operates a Facility.
Village of Hartland	799	1.25	--[c]	--[c]	4,400	Operates a Facility.
Proposed Systems						
Hartland-Delafield Water Pollution Control Commission	--	--	7,897	12.34	--	--
Subregional Area Total	2,839	4.44	32,223	50.35	16,500	--

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U.S. Public Land Survey quarter section.*

[c] *The locally proposed sewer service area for the Village of Hartland is included in the proposed service area for the Hartland-Delafield Water Pollution Control Commission.*

Source: SEWRPC.

per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.90 and 2.33 mgd, respectively, while the average annual and maximum monthly organic loadings were reported to be 3,644 and 5,431 pounds of BOD_5 per day, thus indicating that the plant is operating above its design capacity.

During 1975, treatment plant effluent was reported to contain average concentrations of 41 mg/l of BOD_5 and 68 mg/l of suspended solids. Maximum monthly average effluent concentrations of 69 mg/l of BOD_5 and 78 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.2 mg/l to 0.5 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 50 mg/l of BOD_5 70 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977. From July 1, 1977 until March 31, 1979, the maximum monthly average effluent concentration limits are set at 10 mg/l BOD_5, 10 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml.

As previously noted, the City of Oconomowoc constructed a new wastewater treatment plant in order to correct existing deficiencies and provide adequate capacity to accommodate future growth in the City. The facility was completed early in 1977. The plant is proposed to serve as an areawide sewage treatment facility for existing and proposed urban development in several adjacent communities lying in the Oconomowoc River basin. The plant is located immediately adjacent to the site of the existing sewage treatment facility on the remaining land area. The average hydraulic design capacity of the new plant is 4.0 mgd with a peak hydraulic design capacity of 9.0 mgd and an organic design capacity of 8,340 pounds of BOD_5 per day. The plant includes facilities for secondary treatment followed by tertiary waste treatment and auxiliary waste treatment for effluent disinfection.

The location and configuration of the major trunk sewers, pumping and lift stations and related force mains included in the City of Oconomowoc sanitary sewerage system are shown on Map 21. There are four known points of sewage flow relief in the City of Oconomowoc sanitary sewerage system, all of which are bypasses—including the one at the wastewater treatment plant. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 38 square mile area, which is shown on Map 21.

Management of the City of Oconomowoc sanitary sewerage system is under the direction of the Mayor and Common Council. Day-to-day administration of the system is provided by the Director of Public Works. Financing of the system is provided through general property tax and a sewer service charge equal to 100 percent of the winter-quarter water bill.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Oconomowoc sanitary sewerage system approximated $161,788, or about $14.50 per capita. Of this total, $89,477, or about $8.00 per capita, was expended for operation and maintenance, and $72,311, or about $6.50 per capita, was expended for capital improvements.

Village of Dousman: The existing service area of the Village of Dousman sanitary sewerage system is shown on Map 21. This area totals about 0.5 square mile and has a resident population of about 1,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Dousman is treated at a wastewater treatment plant located on the Bark River, to which effluent is discharged (see Figure 54). The plant has a site area of about 10 acres, of which about one acre is currently utilized, leaving nine acres available for future use. The plant site is bounded by the Bark River on the north and unused vegetated land areas on the south, west, and east. The plant was constructed in 1961 and was modified in 1972. The treatment plant incorporates primary and secondary waste treatment processes and

Table 62

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA

				Wastewater Treatment Unit Processes				Level of Treatment Provided				Sludge Handling and Disposal Unit Processes					
Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary	Disposal of Effluent	Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
City of Oconomowoc	2.71	11,100	1936	Yes	No	No	Yes	Yes	No	Yes	Oconomowoc River	No	Yes	Yes	No	Yes	No
Village of Dousman	0.45	1,000	1961, 1972	No	Yes	No	Yes	Yes	No	Yes	Bark River	Yes	No	No	No	Yes	No
Village of Hartland	1.16	4,400	1933, 1962	No	Yes	No	Yes	Yes	No	Yes	Bark River	No	Yes	Yes	No	Yes	No

Table 62 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975: Annual Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Hydraulic Per Capita (GPD)	Existing Loading - 1975: Maximum Monthly Average Hydraulic (MGD)	Existing Loading - 1975: Average Annual Organic (pounds BOD_5/day)	Existing Loading - 1975: Average Annual Organic Per Capita (pounds BOD_5/day)	Existing Loading - 1975: Maximum Monthly Average Organic (pounds BOD_5/day)	Wastewater Strength Parameters in Plant Influent[a]: BOD_5 (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Suspended Solids (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Total Phosphorus (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Organic Nitrogen-N (mg/l)	Wastewater Strength Parameters in Plant Influent[a]: Ammonia Nitrogen-N (mg/l)	Design Capacity: Population[b]	Design Capacity: Average Hydraulic (MGD)	Design Capacity: Peak Hydraulic (MGD)	Design Capacity: Average Organic (pounds BOD_5/day)	Design Capacity: Average Organic Population[b] Equivalent	Industrial Flows: Design Average Daily Flow (MGD)	Industrial Flows: Estimated Daily Flow 1975 (MGD)	Reserve[c] Hydraulic Capacity (MGD)
City of Oconomowoc	1.90	171	2.33	3,644	0.33	5,431	232	180	6.0[d]	N/A	N/A	5,000	1.50	3.00	2,500	11,900	N/A	N/A	None
Village of Dousman	0.11	110	0.13	98	0.10	136	94	135	29.6[e]	15.8[e]	8.7[e]	1,500	0.12	0.30	200	950	None	None	None
Village of Hartland	0.42	95	0.50	335	0.08	409	95	157	8.7[f]	9.0[f]	24.0[f]	3,500	0.35	0.70	700	3,330	N/A	N/A	None

Name of Public Sewage Treatment Facility	Final Effluent[a]: BOD_5 (mg/l) Average Annual	Final Effluent[a]: BOD_5 (mg/l) Maximum Monthly Average	Final Effluent[a]: Suspended Solids (mg/l) Average Annual	Final Effluent[a]: Suspended Solids (mg/l) Maximum Monthly Average	Final Effluent[a]: Total Phosphorus (mg/l) Average Annual	Final Effluent[a]: Total Phosphorus (mg/l) Maximum Monthly Average	Final Effluent[a]: Average Annual Organic Nitrogen-N (mg/l)	Final Effluent[a]: Average Annual Ammonia Nitrogen-N (mg/l)	Final Effluent[a]: Chlorine Residual (mg/l) Minimum Monthly Average	Final Effluent[a]: Chlorine Residual (mg/l) Maximum Monthly Average	Final Effluent[a]: Fecal Coliform (number per 100 ml) Average Annual	Final Effluent[a]: Fecal Coliform (number per 100 ml) Maximum Monthly Average	Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Data	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values: BOD_5 (mg/l)	1975 WPDES Limitations: Suspended Solids (mg/l)	1975 WPDES Limitations: Total Phosphorus (mg/l)	1975 WPDES Limitations: Fecal Coliform Bacteria (number per 100 ml)
City of Oconomowoc	41	69	68	78	N/A	N/A	N/A	N/A	0.2	0.5	N/A	N/A	N/A	6-30-77	50	70	--	200
Village of Dousman	23	27	31	48	1.25[g]	N/A	2.3[g]	Less than 0.2[g]	0.4	0.9	N/A	N/A	N/A	6-30-77	30	30	-	200
Village of Hartland	11	17	29	50	3.00	3.9	6.4[g]	26.4[g]	N/A	N/A	N/A	N/A	N/A	6-30-77	45	45	1	300

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant administrative personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reserve capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

[d] *Data obtained from 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

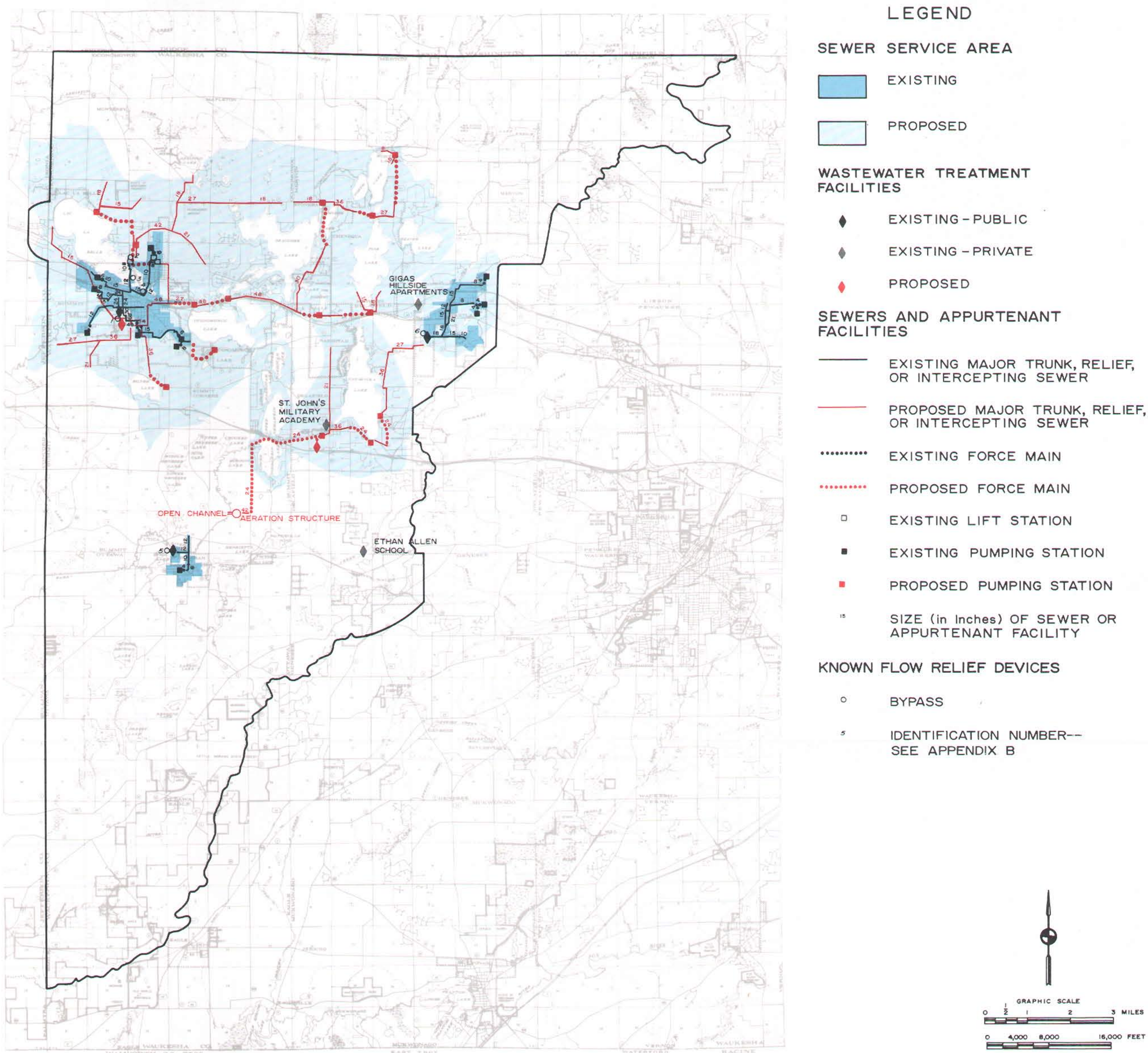
[f] *Data obtained from a May, 1975 survey conducted by the Wisconsin Department of Natural Resources.*

[g] *Data obtained from a 1971 sample reported in the Wisconsin Department of Natural Resources report, Lower Rock River, Pollution Investigation Survey, dated February 1971.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 21

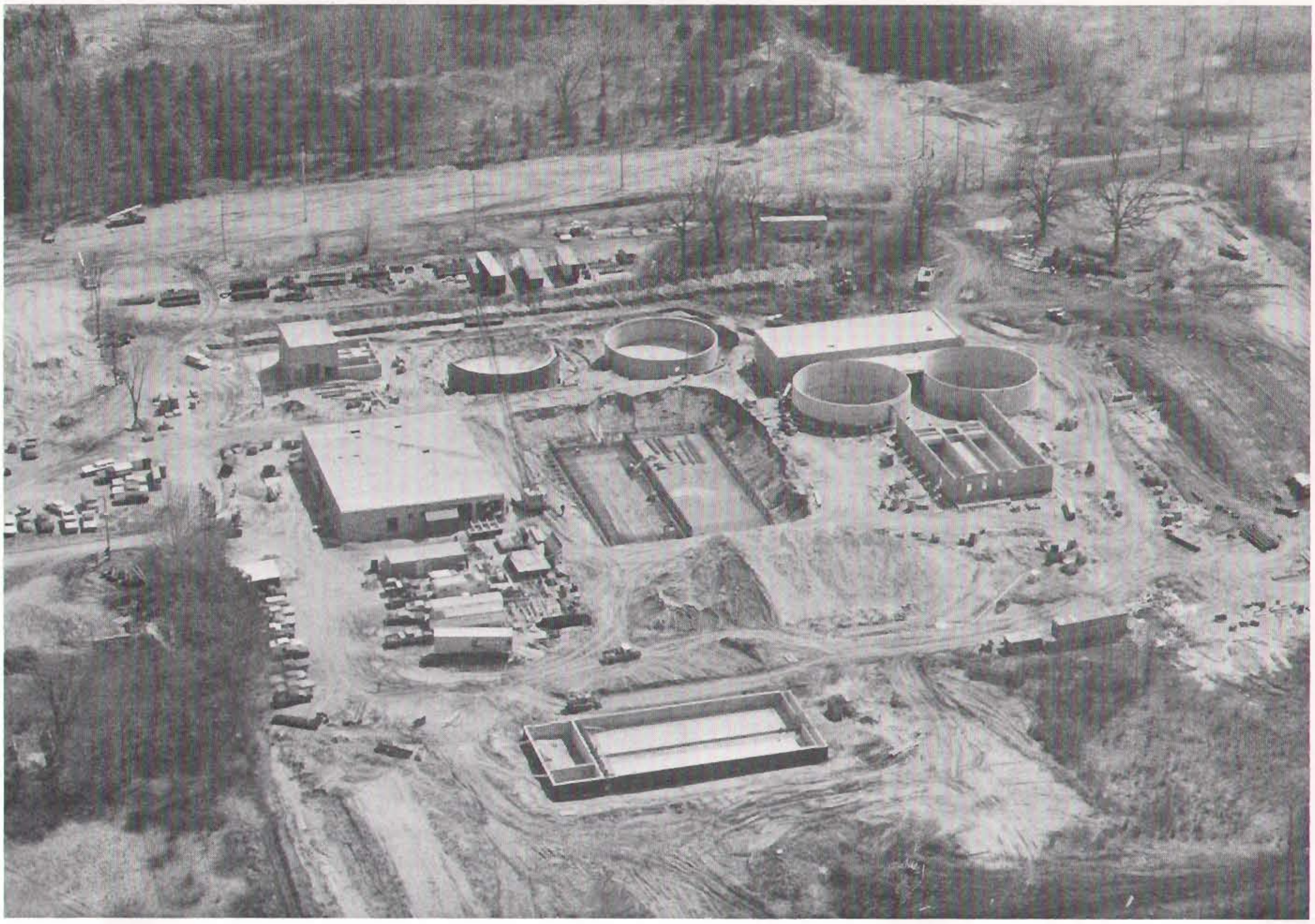
EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975



Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure 53

CITY OF OCONOMOWOC WASTEWATER TREATMENT PLANT



Source: SEWRPC.

provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes in the plant include primary sedimentation, activated sludge, final clarification, and chlorination. Sludge solids removed from the treatment process are fed to an aerobic digestion system prior to being hauled by tank truck to agricultural land application sites. The plant has an average hydraulic design capacity of 0.12 mgd, with a peak hydraulic design capacity of 0.30 mgd, and an organic design capacity of 200 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.11 and 0.13 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 98 and 136 pounds of BOD_5 per day, indicating that while the plant has adequate organic treatment capacity, it is operating near its design hydraulic capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 23 mg/l BOD_5 and 31 mg/l of suspended solids. Maximum monthly average effluent concentrations of 27 mg/l of BOD_5 and 48 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average effluent chlorine residual which varied from 0.4 mg/l to 0.9 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

During 1978, the Village completed a facilities planning project to evaluate future wastewater treatment and conveyance needs. That plan proposes the construction of a new wastewater treatment plant designed to provide secondary and tertiary waste treatment, advanced waste treatment for nitrification and auxiliary waste treatment for effluent disinfection. The plant is proposed to have an average hydraulic capacity of 0.35 mgd.

The location and configuration of the major trunk sewers serving the Village of Dousman are shown on Map 21. The only known point of sewage flow relief

Figure 54

VILLAGE OF DOUSMAN
WASTEWATER TREATMENT PLANT

Source: Karl W. Emrich and Ching-Chi Wu.

in the Village of Dousman sanitary sewerage system is a bypass located in a manhole at the sewage treatment plant. The inventory indicated that the Village had no documented plan for the extension of trunk sewers to provide service to additional areas. Thus, no locally proposed service area or trunk sewers are shown on Map 21.

Management of the Village of Dousman sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Plant Superintendent. Financing of the system is provided through the general property tax and a sewer service charge for each connection.

Total expenditures during 1975 for operation, maintenance and capital improvements, including debt retirement, for the Village of Dousman sewerage system approximated $29,251, or about $29.00 per capita. Of this total, $15,112, or about $15.00 per capita was expended for operation and maintenance, and $14,139, or about $14.00 per capita, was expended for capital improvements.

<u>Village of Hartland</u>: The existing service area of the Village of Hartland sanitary sewerage system is shown on Map 21. This area totals about 1.2 square miles and has a resident population of about 4,400 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Hartland is treated at a wastewater treatment plant located upstream from Nagawicka Lake on the Bark River, to which effluent is discharged (see Figure 55). The plant has a site area of about 37 acres, of which five acres are currently utilized, leaving 32 acres available for future use. The plant site is bounded by agricultural lands on all sides. The plant was constructed in 1933 and underwent modification in 1962. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, activated sludge, and chlorination. Sludge solids removed from the wastewater are fed to an anaerobic digestion system and then to sludge drying beds prior to being stockpiled for public pickup and subsequent land application. The plant has an average hydraulic design capacity of 0.35 mgd, with a peak hydraulic design capacity of 0.70 mgd and an organic design capacity of 700 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.42 and 0.50 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 335 and 409 pounds of BOD_5 respectively, indicating that the plant is operating above its hydraulic design capacity, but below its organic design capacity.

During 1975, the wastewater treatment plant effluent was reported to contain average concentrations of 11 mg/l of BOD_5, 29 mg/l of suspended solids, and 3.0 mg/l of total phosphorus. Maximum monthly average effluent concentrations of 17 mg/l of BOD_5, 50 mg/l of suspended solids and 3.9 mg/l of total phosphorus were reported during 1975. Data on effluent fecal coliform counts and chlorine residual were not routinely reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 45 mg/l of BOD_5, 45 mg/l suspended solids, membrane filter fecal coliform counts of 200 per 100 ml, and 1 mg/l of the raw wastewater influent phosphorus concentration, effective through June 30, 1977.

The location and configuration of the major trunk sewers, pumping stations, and related force mains included in the Village of Hartland sanitary sewerage system are shown on Map 21. As shown on Map 21, there is one known point of sewage flow relief in the Village of Hartland sanitary sewerage system, a bypass, located at the sewage treatment plant. The inventory indicated that the Village has, as part of the Delafield-Hartland Water Pollution Control Commission, a documented plan for the provision of sewer service to additional areas outside the present Village sewer service area, which area is shown on Map 21, and is discussed more specifically later in this chapter as part of the proposed sanitary sewer system of the Delafield-Hartland Water Pollution Control Commission.

Figure 55

VILLAGE OF HARTLAND WASTEWATER TREATMENT PLANT

Source: Karl W. Emrich and Ching-Chi Wu.

Management of the Village of Hartland sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Village Engineer. Financing of the system is provided through the general property tax and a sewer service charge equal to 100 percent of the winter quarter water bill.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Hartland sanitary sewerage system approximated $58,386, or about $13.00 per capita. Of this total, $51,225, or about $11.50 per capita, was expended for operation and maintenance, and $7,161, or about $1.50 per capita, was expended for capital improvements.

Proposed Public Sanitary Sewerage Systems

The Commission sewer service inventory concluded that as of 1975, a proposal had been made for the construction of one new public sanitary sewerage system in the Middle Rock River subregional area. This system would serve the City of Delafield, the Villages of Hartland and Nashotah, and the urban development along the shorelines of Nashotah and Nemahbin Lakes in the Town of Summit. This proposed system developed out of a pollution abatement order to the City of Hartland and public concern over the deteriorating lake water quality of Nagawicka Lake.

An institutional structure—the Hartland-Delafield Water Pollution Control Commission—has been formed by the Village of Hartland and the City of Delafield to construct, operate, and maintain the necessary components of the areawide sanitary sewerage system. The joint commission plans to build and operate the treatment plant and the necessary trunk sewer to interconnect the communities that are to be served (see Map 21).

Table 63

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in the Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
ROCK RIVER WATERSHED								
City of Oconomowoc . . .	Yes, Bypass	--	3	--	--	--	3	6.0
Village of Dousman	Yes, Bypass	--	--	--	--	--	--	--[b]
Village of Hartland.	Yes, Bypass	--	--	--	--	--	--	--[b]
Subregional Area Total	3 Bypasses	--	3	--	--	--	3	6.0

[a]The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.

Source: SEWRPC.

During 1976, the Hartland-Delafield Water Pollution Control Commission was in the final stages of the facility planning process for the construction of a new wastewater treatment plant and wastewater conveyance system to serve the proposed sewer service area. This area totals about 12.3 square miles and has a current resident population of about 6,300 persons, not including that area and population now served in the Village of Hartland. Wastewater from this area is proposed to be treated at a new wastewater treatment plant located at the west limits of the City of Delafield. The average hydraulic design capacity of the proposed plant would be 2.2 mgd. The proposed plant would provide secondary waste treatment followed by advanced waste treatment for nitrification and auxiliary waste treatment for effluent aeration and disinfection. Effluent from the proposed facility would be discharged through an outfall sewer to a point on the Bark River downstream of Crooked Lake in the Town of Summit.

Flow Relief Devices

As noted above, on an individual community basis, there are six sewage flow relief devices in sanitary sewerage systems located in the Middle Rock River subregional area. Table 63 indicates the number and type of flow relief devices as well as an estimate of the total average annual wastewater discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 21.

Other Wastewater Treatment Facilities

In addition to the three public sanitary sewerage systems discussed above, there are a total of three wastewater treatment facilities in the Middle Rock River subregional area which, in general, serve single, isolated land use enclaves and treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. These three wastewater treatment facilities serve residential and institutional developments, which include: the Gigas Hillside Apartments in the Town of Delafield; St. John's Military Academy in the City of Delafield; and the Ethan Allen School in the Town of Delafield. Characteristics of these facilities are presented in Table 64, and their locations are shown on Map 21.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private sewage treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known sewage flow relief devices on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, rinse, process, and wash waters, which are discharged, without treatment or following treatment, directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued and reports filed under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of seven such known point sources of industrial wastewater were identified in the Middle Rock River subregional area. Characteristics of these seven waste sources are identified in Table 65. There location is shown on Map 22.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Middle Rock River subregional area serve

Table 64

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
ROCK RIVER WATERSHED Waukesha County													
Ethan Allan School	Town of Delafield	Institutional	Sanitary	Contact Stabilization and Lagoon	Soil Absorption	165,000	59,000	86,000	N/A	N/A	N/A	N/A	N/A
Gigas Hillside Apartments	Town of Delafield	Residential	Sanitary	Activated Sludge and Lagoon	Soil Absorption	20,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
St. John's Military Academy . . .	City of Delafield	Institutional	Sanitary	Septic System and Lagoon	Bark River	75,000	30,000[b]	N/A	8[b]	N/A	N/A	N/A	16,000[b]

NOTE: N/A indicates data not available.

[a] Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES) questionnaire data obtained by SEWRPC, reports filed under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual and maximum monthly hydraulic discharge rates were based upon the available monthly discharge data or from the data as reported in or requirements of the WPDES permit itself.

[b] Data obtained from 1970 sample reported in Wisconsin Department of Natural Resources Report Lower Rock River Pollution Investigation Survey, 1971.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 65

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]							
										BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	ROCK RIVER WATERSHED Waukesha County																
1	Carnation Company—Can Division	3411	City of Oconomowoc	Cooling	None	1	Oconomowoc River via Storm Sewer	18,200	19,500	43.4	13.7	0.18	3.0	N/A	19.3	No	--
2	Carnation Company—Instant Products Division. . .	2099	City of Oconomowoc	Cooling and Boiler Blowdown	None	1	Oconomowoc River via Storm Sewer	1,234,000	1,554,000	N/A	N/A	N/A	N/A	N/A	22.9	No	--
3	Essential Chemicals Corporation	2841	Town of Merton	Cooling	None	1	Bark Creek via Storm Sewer	500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
4	Hartland Plastic, Inc.	2821	Village of Hartland	Cooling	Lagoon	1	Soil Absorption	3,000	3,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
5	Labelle Industries, Inc. . . .	3861	City of Oconomowoc	Cooling	None	1	Oconomowoc River via Storm Sewer	17,500	21,000	N/A	N/A	N/A	N/A	N/A	19.4	No	--
6	State Sand & Gravel	1442	Village of North Lake	Washwater	Lagoon	1	Tributary of Oconomowoc River	670,000	670,000	N/A	4.4	N/A	N/A	N/A	N/A	No	--
7	U. S. Gypsum Company—Fiberesin Plastics Division . .	2621	City of Oconomowoc	Cooling and Boiler Blowdown	N/A	1	Soil Absorption	3,500	5,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--

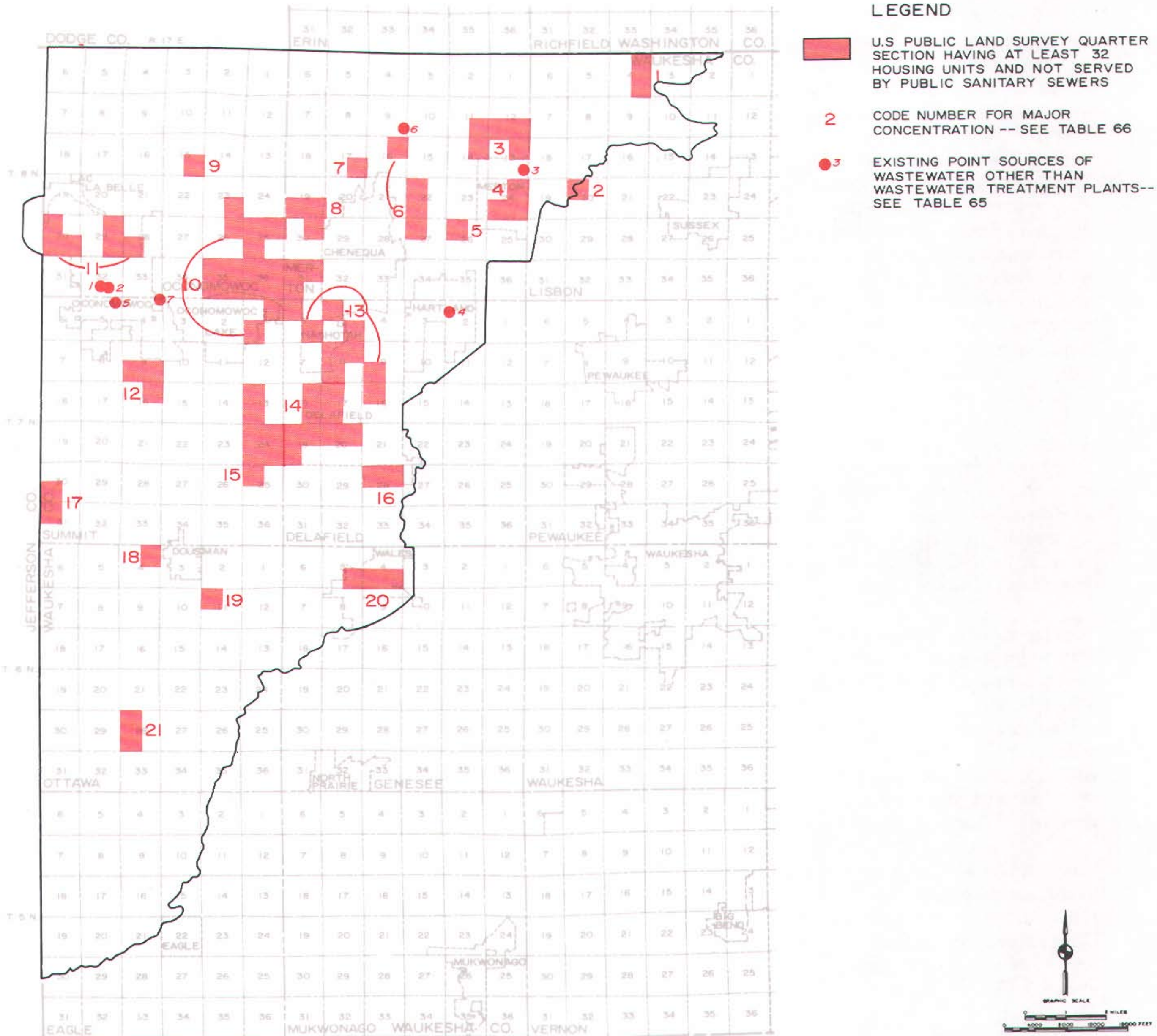
NOTE: N/A indicates data not available.

[a] Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wiscon sin Pollutant Discharge Elimination System (WPDES) or under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data reported in or requirements of the permit itself. In some cases when wastewater characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.

Source. Wisconsin Department of Natural Resources and SEWRPC.

Map 22

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975



Significant concentrations of unsewered urban development in the Middle Rock River subregional area may be characterized in three types of development. The first type consists of unsewered, older, established development in areas such as the Villages of Merton and Wales. The second type consists of relatively older, lake-oriented urban development which exists in areas around all of the lakes in the subregional area. Finally, the third type consists of the new ' leapfrog sprawl" development which has occurred throughout most of the portion of the subregional area located in Waukesha County. There are seven existing (1975) known point sources of wastewater other than wastewater treatment facilities in the Middle Rock River subregional area, most of which are located in the City of Oconomowoc.

Source: Wisconsin Department of Natural Resources and SEWRPC.

a total area of about 4.4 square miles, of 2 percent of the total area of the subregional area, and a total population of about 16,500, or about 40 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban while quarter sections with between six and 31 housing units or one housing unit for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential of providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirement for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 192.6 square miles, or 98 percent of the total area of the subregional area, and contain a total population of about 25,000, or 60 percent of the total population of the subregional area. Of that total, about 21.1 square miles, or 11 percent of the total area of the subregional area containing a total population of 13,400, or 32 percent of the total population of the subregional area are classified as urban nonsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into 21 named major urban concentrations as shown on Map 22. The estimated population and urban development areas of each of these major concentrations are shown in Table 66.

The most common method of providing for wastewater disposal for those approximately 25,000 people living within urban, urban-rural, and rural areas and not served by public sanitary sewers within the Middle Rock River subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of wastewater disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternative, using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system," is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based on the permits issued through December 1975, there were seven sewage holding tank installations, and one mound system existing in the Middle Rock River subregional area. Four of the holding tanks served residential homes, while three were utilized by commercial establishments. The mound system was utilized to dispose of sanitary sewage from a residence. The location of these systems is indicated on Map 22.

Concluding Remarks—
Middle Rock River Subregional Area

Inventories conducted under the areawide water quality planning and management program indicated that in 1975 there existed in the Middle Rock River subregional area, a total of three public sanitary sewerage systems, which included six flow relief devices and which together served a total area of about four square miles, or about 2 percent of the total area of the subregional area, and a total of about 16,500 persons, or about 40 percent of the total population of the subregional area. Each of the three sanitary sewerage systems operates their own wastewater treatment facility. In addition to the three publicly-owned sanitary sewerage systems, three privately-owned wastewater treatment facilities serving isolated institutional and residential establishments were found in the inventory. The inventory indicated that, as of 1975, there was one proposed new public sanitary sewerage system in the area, which is intended to serve the City of Delafield, the Villages of Hartland and Nashotah, and the urban development along the shorelines of Nashotah and Nemahbin Lakes in the Town of Summit. There were also seven point sources of wastewater other than wastewater treatment plants identified in the subregional area consisting of industrial cooling, washwater and boiler blowdown discharges. Finally, in 1975, there were an estimated 13,400 persons residing in scattered enclaves of urban development in the Middle Rock River subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about 21.1 square miles. In the portions of the Middle Rock River subregional area not served by sanitary sewers, it is estimated that approximately 192.6 square miles, and 25,000 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, seven holding tanks and one "mound system" were also utilized for sewage disposal within the subregional area.

Table 66

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
1	Town of Lisbon-Section 4	200	349
2	Town of Lisbon-Section 20	100	158
3	Lake Keesus	600	794
4	Village of Merton	600	479
5	Beaver Lake	100	162
6	Town of Merton-Section 16, 22, 27	500	638
7	North Lake	100	159
8	Stonebank-Chenequa	500	465
9	Ashippun Lake	200	169
10	Okauchee Lake-Mud Lake	3,700	3,073
11	Lac La Belle (Lake)	1,000	960
12	Town of Summit-Silver Lake	300	482
13	Nashotah	1,200	1,312
14	Town of Delafield-Section 17, 18, 19, 20	1,800	1,447
15	Nemahbin Lakes (Town of Summit)	800	1,101
16	Town of Delafield-Section 28	100	319
17	Golden Lake	200	311
18	Utica Lake	200	177
19	Hunters Lake	100	157
20	Village of Wales	900	483
21	Pretty Lake	200	319
Total		13,400	13,514

[a]*Urban development is defined in this context as concentrations of urban land uses within any given U.S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.*

[b]*See Map 22.*

Source: SEWRPC.

INVENTORY FINDINGS LOWER ROCK RIVER SUBREGIONAL AREA

The Lower Rock River subregional area consists of all that area of the Rock River watershed in Walworth County together with urban concentrations in the Fox River watershed at the wastern end of Geneva Lake. Several subwatersheds comprise the Lower Rock River subregional area, including the Whitewater Creek subwatershed, the Turtle Creek subwatershed, the Jackson Creek subwatershed, the Picasaw Creek subwatershed, and the Sharon Creek subwatershed. Major concentrations of urban development are found in the Cities of Delavan, Elkhorn, and Whitewater; the Villages of Darien, Fontana, Sharon, Walworth, and Williams Bay, and the Delavan Lake area in the Town of Delavan.

Existing Public Sanitary Sewerage Systems

There are a total of eight existing public sanitary sewerage systems in the Lower Rock River subregional area which provide centralized sanitary sewer service to various parts of the subregional area. These include the systems operated by the Cities of Delavan, Elkhorn, and Whitewater; and the Villages of Darien, Fontana, Sharon, Walworth, and Williams Bay. Together, these systems serve a total area of about 10.9 square miles, or approximately 4 percent of the total area of the subregional area, and a total population of approximately 28,800, or approximately 71 percent of the total population of the subregional area. Each of these public sanitary sewerage systems is described in the following paragraphs. Pertinent characteristics of each system are presented in Tables 67 and 68.

City of Delavan: The existing service area of the City of Delavan sanitary sewerage system is shown on Map 23. This area totals about 2.0 square miles and has a resident population of about 5,800 persons. The entire area is served by a separate sanitary sewer system.

Table 67

AREA AND POPULATION SERVED BY EXISTING AND LOCALLY PROPOSED SANITARY SEWERAGE SYSTEMS IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Name of Public Sanitary Sewerage System	Estimated Service Area				Population[b] Served	Arrangement for Treatment of Sewage (See Table 68)
	Existing		Proposed[a]			
	Acres	Square Miles	Acres	Square Miles		
Existing Systems						
City of Delavan	1,285	2.01	1,597	2.49	5,800	Operates a Facility
City of Elkhorn	1,551	2.42	1,340	2.09	4,400	Operates a Facility
City of Whitewater	1,524[c]	2.38[c]	2,222[c]	3.47[d]	11,000[e]	Operates a Facility
Village of Darien	303	0.47	9	0.01	1,000	Operates a Facility
Village of Fontana	909	1.42	551	0.86	1,800	Operates a Facility
Village of Sharon	340	0.53	--	--	1,400	Operates a Facility
Village of Walworth	303	0.47	863	1.35	1,700	Operates a Facility
Village of Williams Bay	771	1.21	--	--	1,700	Operates a Facility.
Proposed Systems						
Delavan Lake Sanitary District	--	--	2,359	3.69	--	--
Subregional Area Total	6,986	10.91	8,941	13.96	28,800	--

[a] *As identified in locally prepared plans and engineering reports.*

[b] *Based upon an approximation of the existing sewer service area by U.S. Public Land Survey quarter section.*

[c] *Includes 141 acres (0.22 square miles) in Jefferson County.*

[d] *Includes 865 acres (1.35 square miles) in Jefferson County.*

[e] *Includes 1,800 residents of the City of Whitewater within Jefferson County.*

Source: SEWRPC.

Table 68

SELECTED CHARACTERISTICS OF EXISTING PUBLIC WASTEWATER TREATMENT FACILITIES IN THE LOWER ROCK RIVER SUBREGIONAL AREA

Name of Public Sewage Treatment Facility	Estimated Total Area Served (square miles)	Estimated Total Population Served	Date of Original Construction and Major Modification	Wastewater Treatment Unit Processes				Level of Treatment Provided			Disposal of Effluent	Sludge Handling and Disposal Unit Processes					
				Trickling Filter	Activated Sludge	Phosphorus Removal	Disinfection	Secondary	Advanced	Auxiliary		Aerobic Digestion	Anaerobic Digestion	Drying Beds	Vacuum Filter	Land Application	Landfill
City of Delavan	2.01	5,800	1930, 1949 1975	Yes	No	No	Yes	Yes	No	Yes	Turtle Creek	No	Yes	Yes	No	Yes	No
City of Elkhorn	2.42	4,400	1927, 1949 1976	Yes	No	No	Yes	Yes	No	Yes	Jackson Creek	No	Yes	Yes	No	Yes	No
City of Whitewater	2.38	11,000	1937, 1956 1968	Yes	Yes	No	Yes	Yes	No	Yes	Whitewater Creek	No	Yes	Yes	No	Yes	Yes
Village of Darien	0.47	1,000	1968	No	Yes	No	Yes	Yes	No	Yes	Turtle Creek	Yes	No	No	No	Yes	No
Village of Fontana	1.42	1,800	1957, 1973	Yes	Yes	No	Yes	Yes	No	Yes	Soil Absorption and Lake Geneva	No	Yes	No	No	Yes	No
Village of Sharon	0.53	1,400	1959	Yes	No	No	Yes	Yes	No	Yes	Turtle Creek	No	Yes	No	No	Yes	No
Village of Walworth	0.47	1,700	1952, 1965 1975	Yes	No	No	Yes	Yes	No	Yes	Picasaw Creek	No	Yes	Yes	No	Yes	No
Village of Williams Bay	1.21	1,700	1931, 1968	No	Yes	No	Yes	Yes	No	Yes	Seepage Lagoon	No	Yes	No	No	Yes	No

Table 68 (continued)

Name of Public Sewage Treatment Facility	Existing Loading - 1975						Wastewater Strength Parameters in Plant Influent[a]					Design Capacity					Industrial Flows		Reserve[c] Hydraulic Capacity (MGD)
	Annual Average Hydraulic (MGD)	Average Annual Hydraulic Per Capita (GPD)	Maximum Monthly Average Hydraulic (MGD)	Average Annual Organic (pounds BOD_5/day)	Average Annual Organic Per Capita (pounds BOD_5/day)	Maximum Monthly Average Organic (pounds BOD_5/day)	BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Organic Nitrogen-N (mg/l)	Ammonia Nitrogen-N (mg/l)	Population[b]	Average Hydraulic (MGD)	Peak Hydraulic (MGD)	Average Organic (pounds BOD_5/day)	Average Organic Population[b] Equivalent	Design Average Daily Flow (MGD)	Estimated Daily Flow 1975 (MGD)	
City of Delavan	0.59	102	0.91	528	0.09	1,466	101	160	8.0[d]	5.8[d]	8.4[d]	10,000	1.00	1.50	N/A	N/A	N/A	N/A	0.09
City of Elkhorn	0.69	157	1.37	774	0.18	1,118	152	113	N/A	N/A	N/A	4,500	0.50	N/A	1,510	7,200	None	N/A	None
City of Whitewater	1.14	104	1.47	4,348	0.40	5,856	461	281	21.5[g]	31.7[g]	32.0[g]	35,750	2.50	3.75	6,080	28,959	0.10	N/A	1.03
Village of Darien	0.14	140	0.18	131	0.13	166	122	119	N/A	N/A	N/A	1,500	0.15	0.30	255	1,210	0.15	Less than 0.01	None
Village of Fontana	0.52[e]	289[e]	0.52[e]	291[e]	0.16[e]	291[e]	67	82	N/A	N/A	N/A	N/A	0.90	1.80	N/A	N/A	N/A	N/A	0.38
Village of Sharon	0.08	57	0.13	49	0.04	77	73	54	N/A	N/A	N/A	2,000	0.15	0.30	260	1,240	None	None	0.02
Village of Walworth	N/A	N/A	N/A	N/A	N/A	N/A	159	151	13.5[f]	7.8[f]	6.0[f]	7,050	0.15	0.30	1,480	7,050	N/A	None	N/A
Village of Williams Bay	0.20	118	0.20[h]	206	0.12	206	126	57	N/A	N/A	N/A	6,500	0.80	1.20	1,100	5,238	N/A	N/A	0.60

Name of Public Sewage Treatment Facility	Wastewater Strength Parameters in Final Effluent[a]												Number of Days in 1975 Plant Flow Exceeded Plant Meter Capacity	1975 WPDES Permit Expiration Data	1975 WPDES Discharge Concentrations Limitations Maximum Monthly Average Values			
	BOD_5 (mg/l) Average Annual	BOD_5 (mg/l) Maximum Monthly Average	Suspended Solids (mg/l) Average Annual	Suspended Solids (mg/l) Maximum Monthly Average	Total Phosphorus (mg/l) Average Annual	Total Phosphorus (mg/l) Maximum Monthly Average	Average Annual Organic Nitrogen-N (mg/l)	Average Annual Ammonia Nitrogen-N (mg/l)	Chlorine Residual (mg/l) Minimum Monthly Average	Chlorine Residual (mg/l) Maximum Monthly Average	Fecal Coliform (number per 100 ml) Average Annual	Fecal Coliform (number per 100 ml) Maximum Monthly Average			BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
City of Delavan	19	52	18	24	7.6[d]	N/A	2.1[d]	2.1[d]	0.2	0.7	N/A	N/A	3	6-30-77	30	30	--	200
City of Elkhorn	13	24	10	16	N/A	N/A	N/A	N/A	0.4	0.6	N/A	N/A	2	6-30-77	30	30	--	200
City of Whitewater	50	74	82	141	13.0[d]	N/A	N/A	N/A	0.3	1.4	N/A	N/A	None	4-30-77	140	200	--	200
Village of Darien	8	17	7	11	N/A	N/A	N/A	N/A	0.4	0.6	N/A	N/A	None	6-30-77	30	30	--	200
Village of Fontana	11[e]	N/A	10[e]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12-31-77	--	--	--	--
Village of Sharon	27	38	8	29	6.0[d]	N/A	N/A	N/A	0.2	0.4	N/A	N/A	N/A	4-30-77	30	30	--	200
Village of Walworth	25	40	51	86	13.0[d]	N/A	4.8[d]	6.6[d]	N/A	N/A	N/A	N/A	N/A	4-30-77	30	30	--	200
Village of Williams Bay	32[e]	N/A	5[e]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6-30-77	--	--	--	--

NOTE: N/A indicates data not available.

[a] *Average, maximum and minimum of reported monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *The population design capacity for a given sewage treatment facility was obtained from plant administrative personnel or directly from engineering reports prepared by or for the local unit of government operating the facility and reflects assumptions made by the design engineer. The population equivalent design capacity was estimated by the Commission staff by dividing the design BOD_5 loading in pounds per day, as set forth in the engineering reports, by an estimated per capita contribution of 0.21 pound of BOD_5 per day. If the design engineer assumed a different daily per capita contribution of BOD_5, the population equivalent design capacity will differ from the population design capacity shown in the table.*

[c] *The reverse capacity was calculated as the difference between average hydraulic design capacity and maximum monthly average hydraulic loading.*

[d] *Data obtained from sample reported in the Wisconsin Department of Natural Resources report, Lower Rock River, Pollution Investigation Survey, dated February, 1971.*

[e] *Data based on one month reported during 1975.*

[f] *Data obtained from a 24-hour survey by the Wisconsin Department of Natural Resources—1969.*

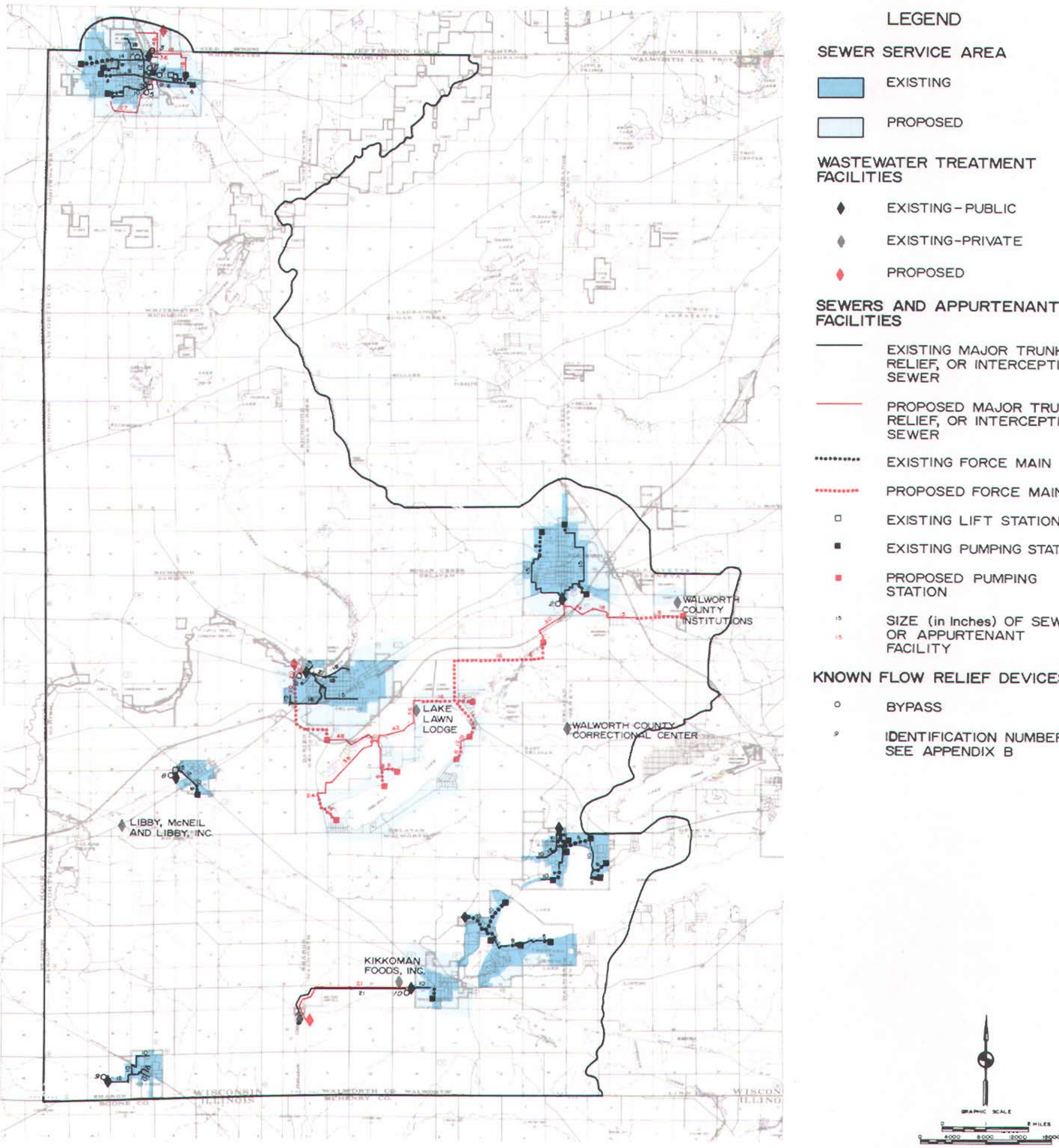
[g] *Data obtained from a 24-hour survey by the Wisconsin Department of Natural Resources—1969.*

[h] *Data based upon one month reported in 1975. The Jensen and Johnson, Inc. report Village of Williams Bay 201 Facility Plan — Volume I Regional Considerations, May, 1978, indicates a summer average hydraulic loading of 0.55 mgd.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 23

EXISTING AND LOCALLY PROPOSED PUBLIC SANITARY SEWERAGE SYSTEMS AND OTHER WASTEWATER TREATMENT PLANTS IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975



Source: Wisconsin Department of Natural Resources and SEWRPC.

Wastewater from the City of Delavan is treated at a wastewater treatment plant located on Turtle Creek, to which effluent is discharged (see Figure 56). The plant has a site area of about 10 acres, of which three acres are currently utilized, leaving seven acres available for future use. The plant site is bounded on all sides by wetlands, floodlands, and other open lands. The plant was constructed in 1930 and modified in 1949 and 1975. The treatment plant incorporates primary and secondary treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, high-rate trickling filtration, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system and then to sludge drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 1.00 mgd, with a peak hydraulic design capacity of 1.50 mgd. The design organic capacity of the plant is not available. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.59 and 0.91 mgd respectively, indicating that the plant has adequate hydraulic treatment capacity to treat the loadings from the existing sewer service area.

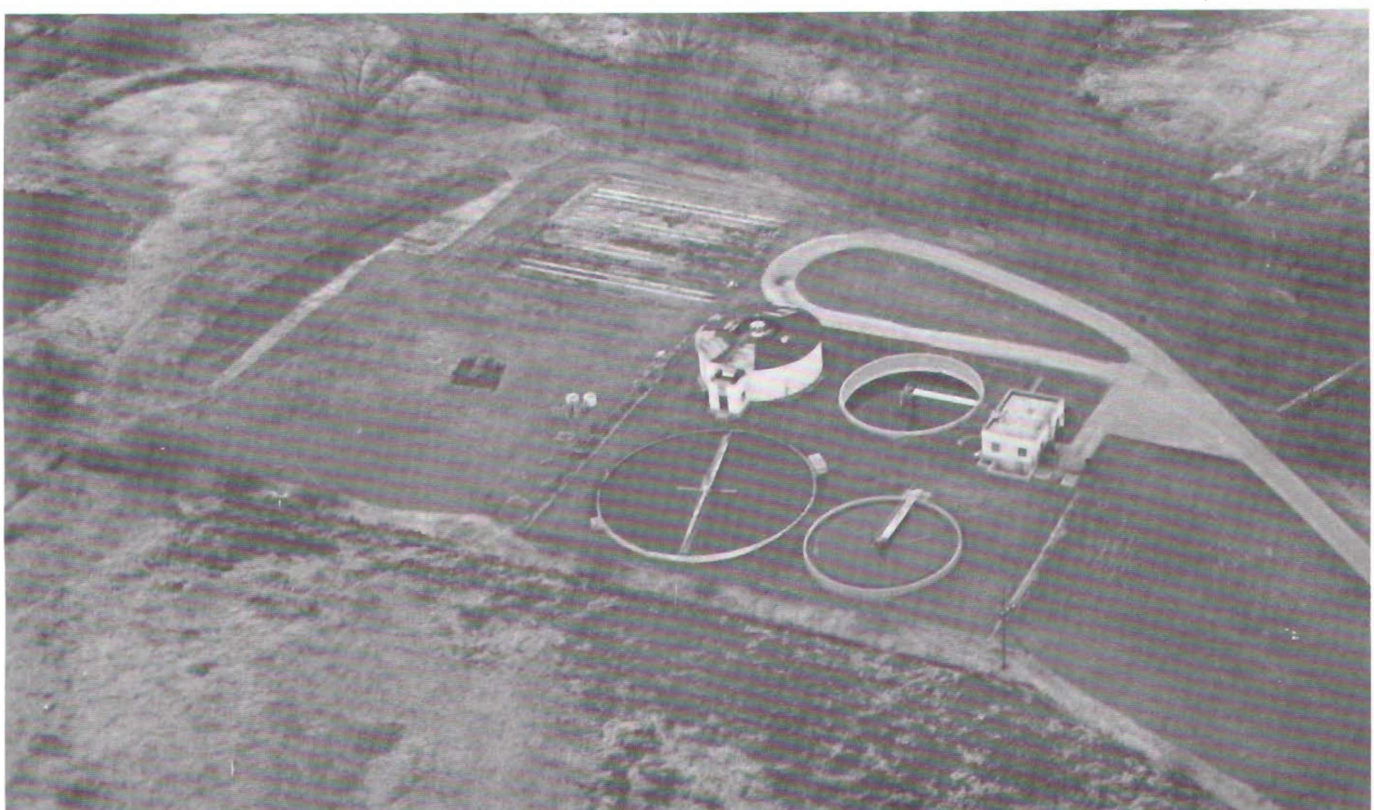
During 1975, treatment plant effluent was reported to contain average concentrations of 19 mg/l of BOD_5 and 18 mg/l of suspended solids. Maximum monthly average effluent concentrations of 52 mg/l of BOD_5 and 24 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average chlorine residual which varied from 0.2 mg/l to 0.7 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

During 1977, facility planning for wastewater treatment and trunk sewers proposed by the Walworth County Metropolitan Sewerage District was completed. That facility plan, which is discussed more specifically later in this chapter, includes the City of Delavan in the planning area.

The location and configuration of the major trunk sewers included in the City of Delavan sanitary sewerage system are shown on Map 23. There is only one known point of sewage flow relief in the

Figure 56

CITY OF DELAVAN WASTEWATER TREATMENT PLANT



Source: Roger R. Ross and Joseph C. Ruys.

City of Delavan sanitary sewerage system, a bypass located at the wastewater treatment plant. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 2.5 square mile area, which is shown on Map 23.

Management of the City of Delavan sanitary sewerage system is under the direction of the Mayor and Common Council. Day-to-day administration of the system is provided by the Water and Sewer Department of the City, headed by the City Engineer. Financing of the system is provided through a sewer service charge equal to 50 percent of a consumer's water bill.

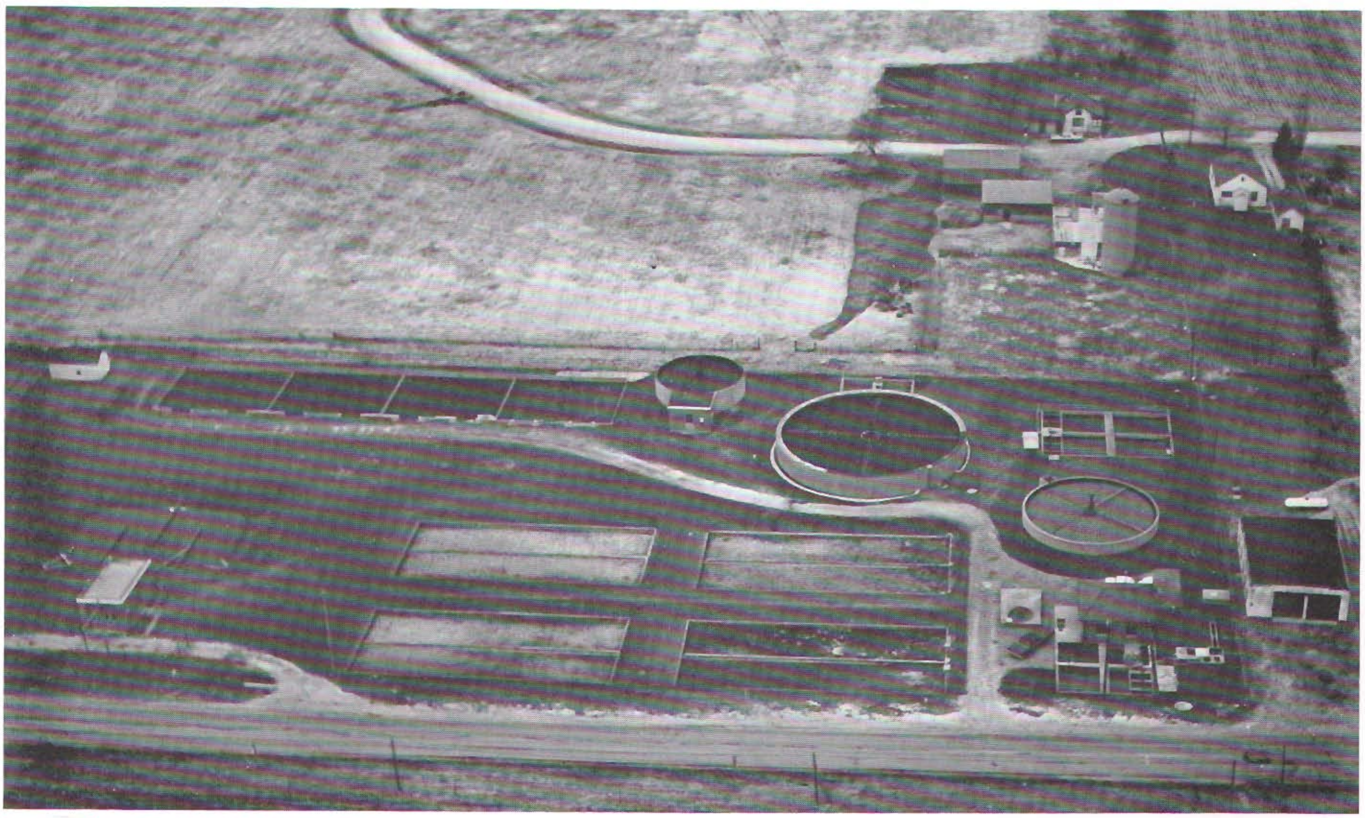
Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Delavan sanitary sewerage system approximated $179,318, or about $31.00 per capita. Of this total, $65,998, or about $11.50 per capita, was expended for operation and maintenance, and $113,320, or about $19.50 per capita, was expended for capital improvements.

City of Elkhorn: The existing service area of the City of Elkhorn sanitary sewerage system is shown on Map 23. This area totals about 2.4 square miles and has a resident population of about 4,400 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Elkhorn is treated at a wastewater treatment plant located on a minor tributary to Jackson Creek, to which effluent is discharged (see Figure 57). The plant has a site area of about three acres, all of which are currently utilized. The plant site is bounded by residential land uses on the north and by agricultural and open lands on the east, west, and south. The plant was constructed in 1927, with modifications in 1949 and 1976. The treatment plant incorporates primary and secondary treatment processes and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filter, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system and then to sludge drying beds prior to application on agricultural lands or disposal in a landfill. The plant has an average hydraulic design capacity of 0.50 mgd and an organic design capacity of 1,510 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.69 and 1.37 mgd respectively, while

Figure 57

CITY OF ELKHORN WASTEWATER TREATMENT PLANT



Source: Roger R. Ross and Joseph C. Ruys.

the average annual and maximum monthly organic loadings were reported to be 774 and 1,118 pounds of BOD_5 per day, indicating that while the plant has adequate organic treatment capacity, it is operating above the average hydraulic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 13 mg/l of BOD_5, and 10 mg/l of suspended solids. Maximum monthly average effluent concentrations of 24 mg/l of BOD_5 and 16 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average effluent chlorine residual which varied from 0.4 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through June 30, 1977.

During 1977, facility planning for sewage treatment and trunk sewers, proposed by the Walworth County Metropolitan Sewerage District was completed. That facility plan, which is discussed in more detail later in this chapter, includes the City of Elkhorn in the planning area.

The location and configuration of the major trunk sewers, pumping stations and related force mains included in the City of Elkhorn sanitary sewerage system are shown on Map 23. As shown on Map 23, there is only one known point of sewage flow relief in the City of Elkhorn sanitary sewerage system, a bypass located at the wastewater treatment plant. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 2.1 square mile area, which is shown on Map 23.

Management of the City of Elkhorn sanitary sewerage system is under the direction of the Mayor and Common Council. Day-to-day administration of the system is provided by the Street Commissioner. Financing of the system is provided through general property taxes and a sewer service charge equal to 65 percent of a consumer's water bill.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Elkhorn sanitary sewerage system approximated $263,234, or about $60.00 per capita. Of this total, $56,815, or about $13.00 per capita, was expended for operation and maintenance, and $206,419, or about $47.00 per capita, was expended for capital improvements.

City of Whitewater: The existing service area of the City of Whitewater sanitary sewerage system is shown on Map 23. This area totals about 2.4 square miles and has a resident population of about 11,000 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the City of Whitewater is treated at two parallel wastewater treatment facilities located on the Whitewater Creek, to which effluent is discharged (see Figure 58). The plant has a site area of about eight acres, of which six acres are currently utilized, leaving two acres available for future use. The plant site is bounded by agricultural lands on the east, residential land use on the south, commercial lands on the north, and Whitewater Creek on the west. The first plant, a trickling filter type plant, was constructed in 1937 with major modifications in 1956. The second plant, an activated sludge type plant, was constructed in 1968. The treatment plant incorporates primary and secondary treatment processes and auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filtration, final clarification, activated sludge, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system and then to sludge drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 2.50 mgd, with a peak hydraulic design capacity of 3.75 mgd and an organic design capacity of 6,080 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 1.14 and 1.47 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 4,348 and 5,856 pounds of BOD_5 per day, thus indicating that the plant has adequate capacity to treat the loading from the existing sewer service area.

During 1975, treatment plant effluent was reported to contain average concentrations of 50 mg/l of BOD_5, and 81.5 mg/l of suspended solids. Maximum monthly average effluent concentrations of 74 mg/l of BOD_5 and 141 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average combined chlorine residual which varied from 0.3 mg/l to 1.4 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 140 mg/l of BOD_5, 200 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1977.

Early in 1977, the City of Whitewater was in the final stages of the facility planning process for the construction of a new wastewater treatment plant and trunk sewers in order to correct existing deficiencies and provide adequate capacity to accommodate future growth in the City. It is planned to locate the proposed plant about one-half mile northeast of the existing treatment plant site. The proposed wastewater treatment plant is planned to have an effluent discharge to Whitewater Creek and would be designed to provide secondary and tertiary waste treatment followed by advanced waste treatment for nitrification and auxiliary waste treatment for effluent disinfection. The plant is proposed to have an average design capacity of 3.65 mgd with a peak hydraulic design capacity of 9.1 mgd and an organic design capacity of 11,425 pounds of BOD_5 per day.

The location and configuration of all major trunk sewers, pumping and lift stations, and related force mains included in the City of Whitewater sanitary sewerage system are shown on Map 23. As shown on Map 23, there are five known points of sewage flow relief in the City of Whitewater sanitary sewerage system—all of which are bypasses including the one at the wastewater treatment plant. The inventory indicated that the City has a documented plan for the provision of sewer service to an additional 3.5 square mile area, which is shown on Map 23.

Management of the City of Whitewater sanitary sewerage system is under the direction of the Mayor and Common Council. Day-to-day administration of the system is provided by the City Manager. Financing of the system is provided through a general property tax and a sewer service charge equal to 100 percent of the water consumption charge.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the City of Whitewater sanitary sewerage system approximated $365,941, or about $33.50 per capita. Of this total, $168,819, or about $15.50 per capita, was expended for operation and maintenance, and $197,122, or about $18.00 per capita, was expended for capital improvements.

Village of Darien: The existing service area of the Village of Darien sanitary sewerage system is shown on Map 23. This area totals about 0.5 square mile and has a resident population of about 1,000 persons. The entire area is served by a separate sanitary sewer system.

Figure 58

CITY OF WHITEWATER WASTEWATER TREATMENT PLANT

Source: Roger R. Ross and Joseph C. Ruys.

Wastewater from the Village of Darien is treated at a wastewater treatment plant located on a minor drainage ditch tributary to Turtle Creek, to which overflow effluent from a seepage lagoon is discharged (see Figure 59).

The plant has a site area of about 9.6 acres, of which about six acres are currently utilized, leaving 3.6 acres available for future use. The plant site is bounded by a county trunk highway on the north and agricultural lands on the south, west, and east. The plant was constructed in 1968 and became operational in 1970. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent disinfection. Wastewater treatment unit processes incorporated into the plant include activated sludge, final clarification, chlorination, and lagooning. Sludge solids removed from the wastewater are fed to an aerobic digestion system prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.15 mgd, with a peak hydraulic design capacity of 0.30 mgd, and an organic design capacity of 255 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.14 mgd and 0.18 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 131 and 166 pounds of BOD_5 per day, indicating that the plant is operating near its hydraulic design capacity, but below its organic design capacity.

During 1975, the treatment plant effluent was reported to contain average concentrations of 8 mg/l BOD_5 and 7 mg/l of suspended solids. Maximum monthly average effluent concentrations of 17 mg/l of BOD_5 and 11 mg/l of suspended solids were reported during 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported during 1975. However, a monthly average effluent chlorine residual which varied from 0.4 mg/l to 0.6 mg/l was reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through December 31, 1976.

Figure 59

VILLAGE OF DARIEN WASTEWATER TREATMENT PLANT

Source: Roger R. Ross and Joseph C. Ruys.

The location and configuration of the major trunk sewers, pumping and lift stations and related force mains included in the Village of Darien sanitary sewerage system are shown on Map 23. As shown on Map 23, there is one known point of sewage flow relief in the Village of Darien sanitary sewerage system, a bypass located at the wastewater treatment plant. The inventory indicated that the Village had a documented plan for the provision of service to an additional nine acre area, which is shown on Map 23. During 1977 the Village was in the process of preparing a facility plan to evaluate future wastewater treatment and conveyance needs.

Management of the Village of Darien sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Sewer and Water Superintendent. Financing of the system is provided through the general property tax and a sewer service charge of $15.00 per quarter per connection plus 150 percent of a consumer's water bill for all water used above a specific amount.

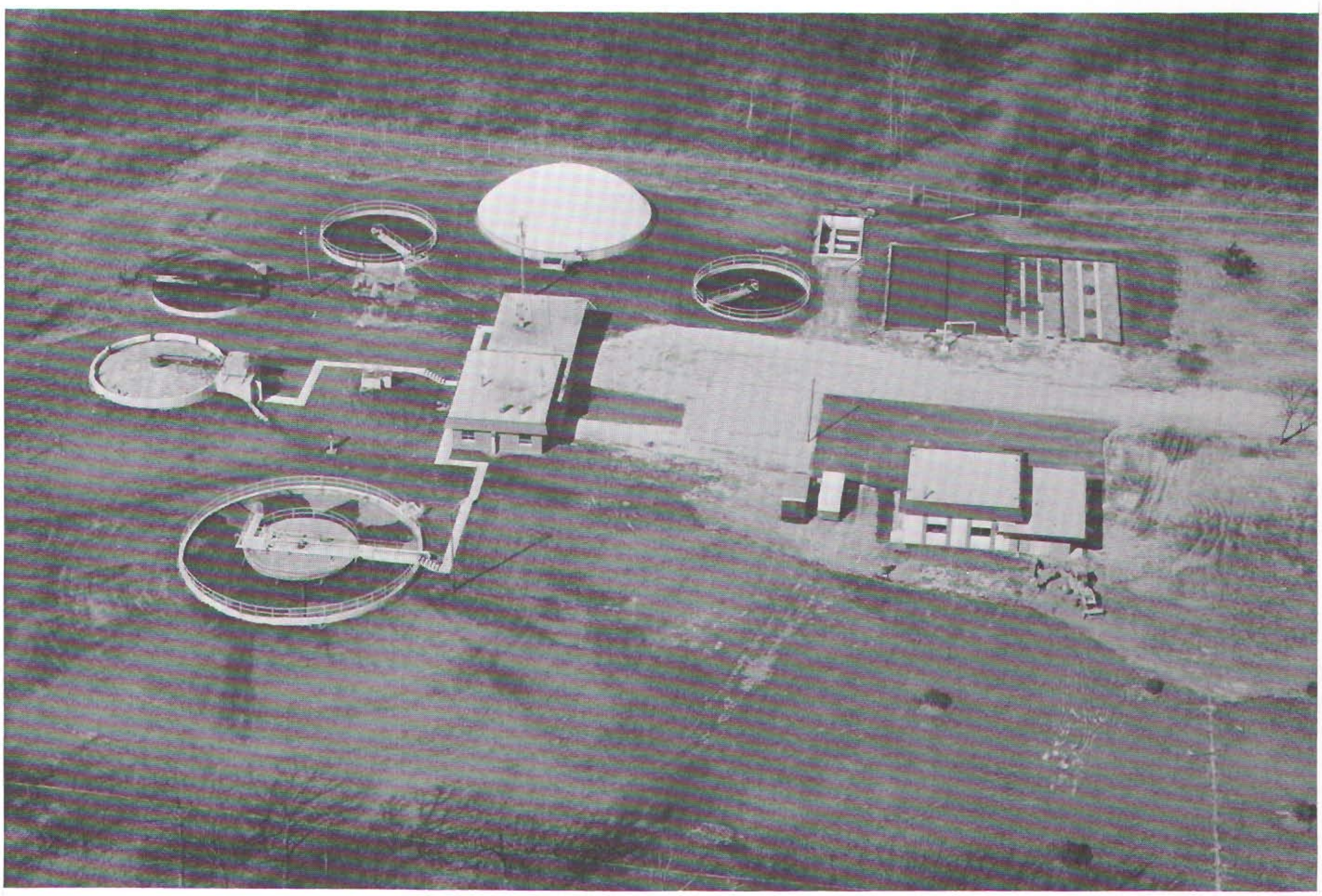
Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Darien sanitary sewerage system were not available.

Village of Fontana on Geneva Lake: The existing service area of the Village of Fontana sanitary sewerage system is shown on Map 23. This area totals about 1.4 square miles and has a resident population of about 1,800 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Fontana is treated at a wastewater treatment plant located near the northwestern corner of the village. Effluent from the plant is discharged to a seepage lagoon which was originally designed to have no discharge to surface waters (see Figure 60). However, the lagoon now is reported to have an overflow discharge to Lake Geneva. The plant has a site area of about 55 acres, of which 16 acres are currently utilized, leaving 39 acres available for future use. The plant site is bounded by agricultural lands on all sides.

Figure 60

VILLAGE OF FONTANA-ON-GENEVA LAKE WASTEWATER TREATMENT PLANT



Source: SEWRPC.

The plant was constructed in 1957 and was expanded in 1973. The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filtration, activated sludge, final clarification, chlorination, and a seepage lagoon. Sludge solids removed from the wastewater are fed to an anaerobic digestion system prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.90 mgd, with a peak hydraulic design capacity of 1.80 mgd. The organic design capacity of the plant was not available. During 1975, the hydraulic loading to the plant during the one month of reporting was 0.52 mgd, indicating that the plant is operating below its hydraulic design capacity. However the seepage lagoon system is not adequate to handle the existing loading.

During 1975, the Village of Fontana only reported data for the month of December, and the wastewater treatment plant effluent was reported to contain an average of 11 mg/l of BOD_5 and 10 mg/l of suspended solids. Data on effluent phosphorus concentrations, fecal coliform counts and monthly average effluent chlorine residual were not reported routinely during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits effective through December 31, 1977, such that organic or suspended matter does not interfere with the operation of the system.

The location and configuration of the major trunk sewers, pumping stations, and associated force mains included in the Village of Fontana sanitary sewerage system are shown on Map 23. There are no known points of sewage flow relief in the system. The inventory revealed that the Village had a documented plan for the provision of sewer service to an additional 0.9 square mile, which is shown on Map 23. During 1976, the Village of Fontana initiated facility planning studies for wastewater treatment plant improvements and trunk sewers to serve the Village environs. This facilities planning effort is being coordinated with similar planning being done by the City of Lake Geneva and the Villages of Walworth and Williams Bay in order to evaluate joint treatment alternatives.

Management of the Village of Fontana sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of this system is provided by the Water and Sewer Superintendent. Financing of the system is provided through a sewer service charge.

Data regarding expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Fontana on Geneva Lake sanitary sewerage system were not available.

Village of Sharon: The existing service area of the Village of Sharon sanitary sewerage system is shown on Map 23. This area totals about 0.5 square miles and has a resident population of about 1,400 persons. The entire area is served by a separate sanitary sewer system.

Wastewater from the Village of Sharon is treated at a wastewater treatment plant located on Turtle Creek, to which effluent is discharged (see Figure 61). The plant has a site area of about two acres, of which about 0.5 acre is currently utilized, leaving about 1.5 acres available for future use. The plant was constructed in 1959 and was expected to have a flow meter added in 1976.

The treatment plant incorporates primary and secondary waste treatment processes and provides auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include primary sedimentation, trickling filtration, final clarification, and chlorination. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system prior to being hauled by tank truck to agricultural land application sites. The plant has an average hydraulic design capacity of 0.15 mgd, with a peak hydraulic design capacity of 0.30 and an organic design capacity of 260 pounds of BOD_5 per day. During 1975, the average annual and maximum monthly hydraulic loadings to the plant were reported to be 0.08 and 0.13 mgd respectively, while the average annual and maximum monthly organic loadings were reported to be 49 and 77 pounds of BOD_5 respectively, indicating that the plant has adequate capacity to treat the wastewater from the existing service area.

During 1975, the wastewater treatment plant effluent was reported to contain an average of 27 mg/l of BOD_5 and 8 mg/l of suspended solids. Maximum monthly average effluent concentrations of 38 mg/l of BOD_5 and 29 mg/l of suspended solids were reported for 1975. Data on effluent phosphorus concentrations and fecal coliform counts were not routinely reported. However, chlorine residuals which varied from 0.2 mg/l to 0.4 mg/l were reported. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1977.

The location and configuration of the major trunk sewers serving the Village of Sharon are shown on Map 23. There are no known points of sewage flow relief in the Village sanitary sewerage system except a bypass located at the wastewater treatment plant. The inventory indicated that the Village has no documented plan for the expansion of its sanitary sewerage system. However, during 1976, the Village of Sharon initiated facility planning studies for wastewater treatment plant improvements to serve the Village and environs.

Management of the Village of Sharon sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Plant Operator. Financing of the system is provided through a sewer service charge.

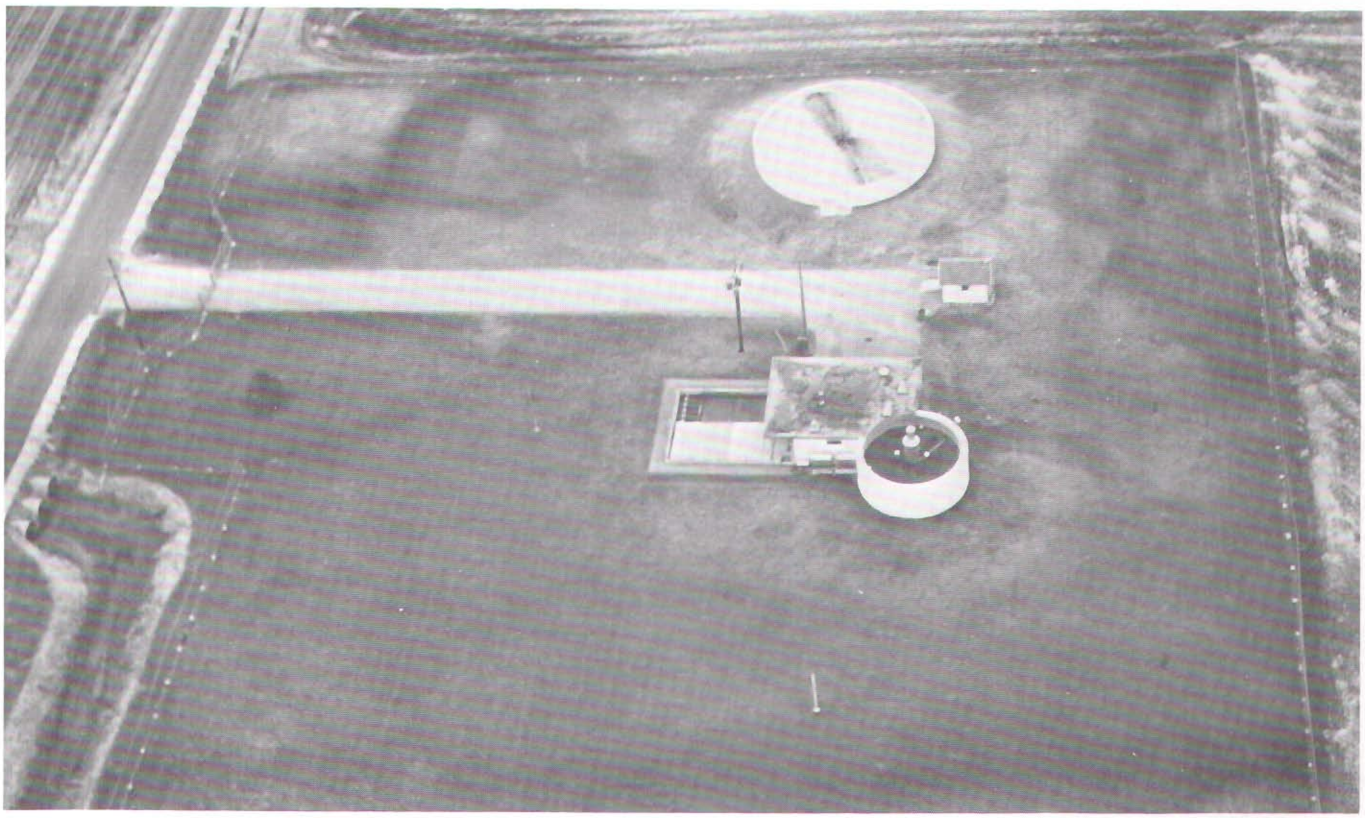
Total expenditures during 1970 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Sharon sanitary sewerage system approximated $35,086, or about $25.00 per capita. Of this total, $21,266, or about $15.00 per capita, was expended for operation and maintenance, and $13,820, or about $10.00 per capita, was expended for capital improvements.

Village of Walworth: The existing service area of the Village of Walworth sanitary sewerage system is shown on Map 23. This area totals about 0.5 square mile and has a resident population of about 1,700 persons. The entire area is served by a separate sewer system.

Wastewater from the Village of Walworth is treated at a wastewater treatment plant located at the western Village limits, with effluent piped to flow-through lagoons for final effluent treatment located about three miles from the treatment plant on Picasaw Creek, to which the final effluent is discharged (see Figure 62). The plant has a site area of about 24 acres, of which about four acres represent the wastewater treatment plant site, and 20 acres represent the effluent lagoon site on Picasaw Creek. Of the four acres located at the wastewater treatment plant, two acres are currently utilized, leaving two acres available for future use. Of the 20 acres located on the Picasaw Creek, 10 acres are currently utilized, leaving 10 acres available for future use. Both the plant site and the Picasaw Creek site are bounded by agricultural land uses on all sides. The plant was constructed in 1952, with modifications in 1965 and 1975. The treatment plant provides primary and secondary waste treatment and auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes incorporated into the plant include Imhoff tank treatment, trickling filtration, final clarification, chlorination and lagooning. Sludge solids removed from the wastewater treatment systems are

Figure 61

VILLAGE OF SHARON WASTEWATER TREATMENT PLANT



Source: Roger R. Ross and Joseph C. Ruys.

fed to an anaerobic digestion system and sludge drying beds prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.15 mgd, with an estimated peak hydraulic design capacity of about 0.30 mgd, and an organic design capacity of 1,480 pounds of BOD_5 per day. Data on the average annual hydraulic loading and average organic loading to the plant was not available for 1975.

During 1975, the wastewater treatment plant effluent contained average concentrations of 25 mg/l of BOD_5 and 51 mg/l of suspended solids. Maximum monthly average effluent concentrations of 40 mg/l of BOD_5 and 86 mg/l of suspended solids were reported for 1975. Data on effluent phosphorus concentrations, fecal coliform counts and average effluent chlorine residual were not routinely reported in 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits of 30 mg/l of BOD_5, 30 mg/l of suspended solids, and membrane filter fecal coliform counts of 200 per 100 ml, effective through April 30, 1977.

The location and configuration of the major trunk sewers and lift stations serving the Village of Walworth are shown on Map 23. There are no known points of sewage flow relief in the Village of Walworth sanitary sewerage system except a bypass at the wastewater treatment plant.

The inventory indicated that the Village is in the early stages of preparation of a facilities plan and has a documented plan for the provision of sewer service to an additional 1.4 square mile area (see Map 23). During 1976, the Village of Walworth initiated facility planning studies for wastewater treatment plant improvements and trunk sewers to serve the Village and environs. This facilities planning effort is being coordinated with similar planning being done by the City of Lake Geneva and the Villages of Fontana and Williams Bay in order to evaluate joint treatment alternatives.

Management of the Village of Walworth sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the water and sewer utility Superintendent. Financing of the system is provided through a sewer service charge.

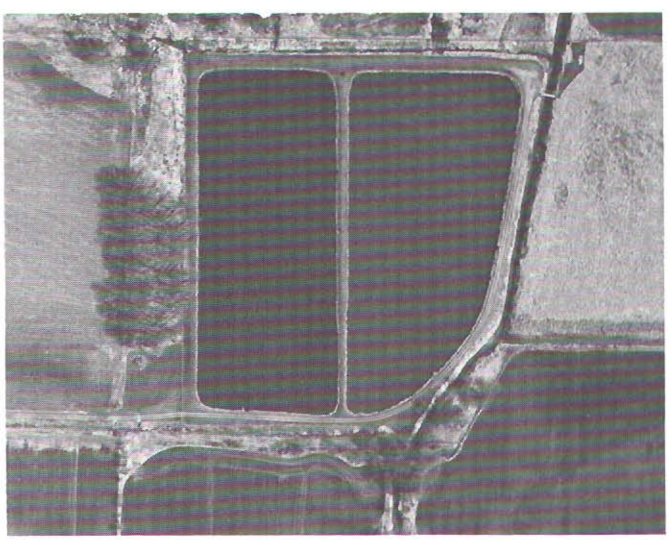
Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Walworth sanitary sewerage system were not available.

Village of Williams Bay: The existing sewer service area of the Village of Williams Bay sanitary sewerage system is shown on Map 23. This area totals about 1.2 square miles and has a resident population of about 1,700 persons. The entire area is served by a separate sanitary sewer system.

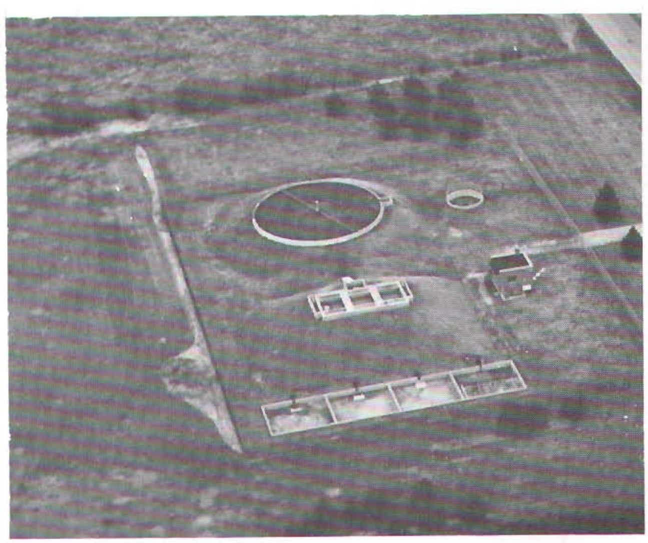
Wastewater from the Village of Williams Bay is treated at a wastewater treatment plant located at the northern village limits. Effluent from the plant is discharged to a seepage lagoon which has no outlet (see Figure 63). The plant has a site area of about 3.4 acres, of which one acre are currently utilized, leaving 2.3 acres available for future use. The plant

Figure 62

VILLAGE OF WALWORTH WASTEWATER TREATMENT PLANT



Source: SEWRPC.



Source: Roger R. Ross and Joseph C. Ruys.

site is bounded by agricultural lands on the west and north, residential land uses on the south, and STH 67 on the east. The plant was constructed in 1931 and underwent modifications in 1968.

The treatment plant incorporates primary and secondary waste treatment processes and auxiliary waste treatment for effluent chlorination. Wastewater treatment unit processes include primary sedimentation, activated sludge, final sedimentation, chlorination, and lagooning. Sludge solids removed from the wastewater treatment systems are fed to an anaerobic digestion system prior to application on agricultural lands. The plant has an average hydraulic design capacity of 0.80 mgd, with a peak hydraulic design capacity of 1.2 mgd and an organic design capacity of 1,100 pounds of BOD_5 per day. During 1975 only one month's data was reported for the Williams Bay sanitary sewer system. Hydraulic loading to the plant was reported to be 0.20 mgd while the organic loading was reported to be 206 pounds of BOD_5, indicating that the plant has adequate capacity to treat the loading from the existing sewer service area.

During the month reported in 1975, the wastewater treatment plant effluent was reported to contain 32 mg/l of BOD_5 and 5 mg/l of suspended solids. Data on effluent phosphorus concentrations, fecal coliforms, and effluent chlorine residual were not reported during 1975. The wastewater treatment plant WPDES permit has established maximum monthly average effluent concentration limits effective through June 30, 1978, such that organic or suspended matter does not interfere with the operation of the system.

The location and configuration of the major trunk sewers, pumping stations, and associated force mains included in the Village of Williams Bay sanitary sewer system are shown on Map 23. There are no known points of sewer overflow or bypassing in the Village of Williams Bay sanitary sewerage system. The inventory indicated that the Village has a documented plan for the expansion of its sanitary sewerage system as shown on Map 23. During 1977, the Village of Williams Bay initiated facility planning studies for wastewater treatment plant improvements and trunk sewers to serve the Village and environs. This facilities planning effort is being coordinated with similar planning being done by the City of Lake Geneva and the Villages of Fontana and Walworth in order to evaluate joint treatment alternatives.

Management of the Village of Williams Bay sanitary sewerage system is under the direction of the Village Board. Day-to-day administration of the system is provided by the Superintendent of Sewers. Financing of the system is provided through a sewer service charge equal to 100 percent of the quarterly water bill.

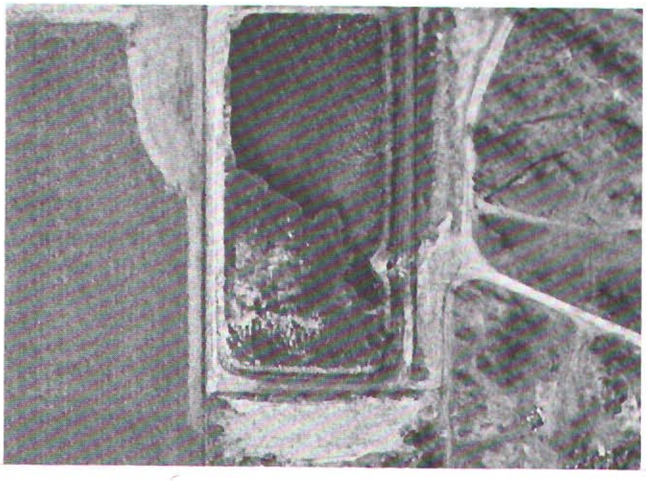
Data pertaining to expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the Village of Williams Bay sanitary sewerage system were not available.

Proposed Public Sanitary Sewerage Systems

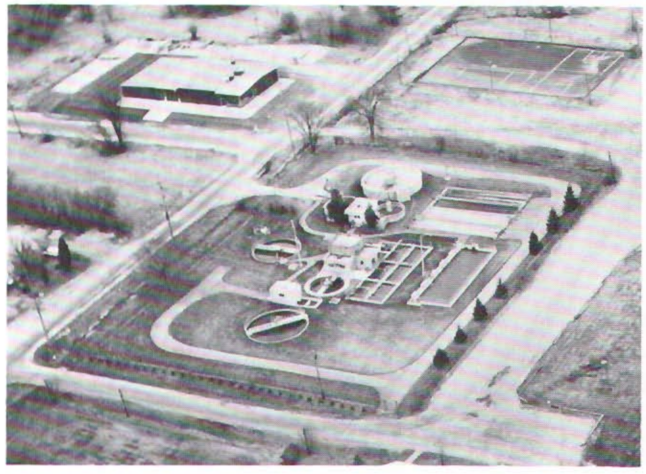
The Commission sewer service inventory concluded that, as of 1975, proposals had been made for the construction of one new public sanitary sewerage system in the Lower Rock River subregional area. The system would serve the Delavan Lake Sanitary District, consisting of urban development along the

Figure 63

VILLAGE OF WILLIAMS BAY WASTEWATER TREATMENT PLANT



Source: SEWRPC.



Source: Roger R. Ross and Joseph C. Ruys.

shoreline of Delavan Lake. The formation of this district followed several years of effort on the part of local residents concerned with the quality of the water in Delavan Lake and with malfunctioning septic tank systems along its lake shoreline. The District has completed engineering studies for the construction of a sanitary sewerage system. The Delavan Lake Sanitary District sewer service area is planned to be connected to the new areawide wastewater treatment plant proposed by the Walworth County Metropolitan Sewerage District at a site adjacent to the existing City of Delavan wastewater treatment plant on Turtle Creek. The new plant is proposed to provide wastewater treatment for the Cities of Delavan and Elkhorn, and the Walworth County Institutions in addition to the Delavan Lake Sanitary District. The treatment plant is proposed to have an average hydraulic design capacity of 3.6 mgd, with a peak hydraulic design capacity of 9.8 mgd, and an organic design capacity of 5,600 pounds of BOD_5 per day. The proposed plant would provide secondary and tertiary waste treatment, with advanced waste treatment for nitrification and auxiliary waste treatment for effluent aeration and disinfection.

The proposed service area of the Delavan Lake Sanitary District is shown on Map 23. This area totals about 3.7 square miles and has a current resident population of about 2,800 persons.

Management of the Delavan Lake Sanitary District is under the direction of a three-member commission. Day-to-day administration of the proposed system is to be provided by a certified plant operator and superintendent. Operation and maintenance of the system is to be financed through a sewer service charge of about $10.00 per month per connection.

Flow Relief Devices

As noted above on an individual community basis, there are 10 sewage flow relief devices located in the sanitary sewerage system located in the Lower Rock River subregional area. Table 69 indicates the number and type of flow relief devices as well as an estimate of the total average annual discharge from these devices. The spatial distribution of the flow relief devices is shown on Map 23.

Other Wastewater Treatment Facilities

In addition to the eight public sanitary sewerage systems discussed above, there are a total of five private wastewater treatment facilities in the Lower Rock River subregional area which, in general, serve single isolated land use enclaves and treat wastes which can be considered for inclusion in areawide wastewater systems utilizing domestic wastewater treatment processes. Two of these wastewater treatment facilities are related to the food products industry. These two facilities serve Kikkoman Foods, Inc. processing plant in the Town of Walworth and the Libby, McNeil and Libby, Inc. canning plant in the Town of Darien. The remaining three facilities serve recreational, and institutional development including Lake Lawn Lodge in the Town of Delavan; Lakeland Nursing Home and associated County institutions in the Town of Geneva; and the Walworth County Corrections Center (not presently in operation) located in the Town of Geneva. Characteristics of these facilities are presented in Table 70 and their location is shown on Map 23.

Other Known Point Sources of Wastewater

In addition to identifying all existing public and private sewage treatment plants which discharge

Table 69

KNOWN SEWAGE FLOW RELIEF DEVICES IN THE LOWER ROCK RIVER SUBREGIONAL AREA

Sanitary Sewer System	Sewage Treatment Plant Flow Relief Device (Yes or No and Type)	Sewage Flow Relief Devices in the Sewer System						Total Estimated[a] Average Annual Wastewater Discharge from Flow Relief Devices (mg)
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total	
City of Delavan	Yes, Bypass	--	--	--	--	--	--	2.0
City of Elkhorn	Yes, Bypass	--	--	--	--	--	--	--[b]
City of Whitewater	Yes, Bypass	--	4	--	--	--	4	7.0
Village of Darien	Yes, Bypass	--	--	--	--	--	--	1.0
Village of Sharon	Yes, Bypass	--	--	--	--	--	--	--[b]
Village of Walworth	Yes, Bypass	--	--	--	--	--	--	--[b]
Total	6 Bypasses	--	4	--	--	--	4	10.0

[a] *The contribution from flow relief devices was approximated for purposes of quantifying the magnitude of their total pollutant loading on a watershed basis.*

[b] *The annual contribution from flow relief devices is less than 1.0 mg.*

Source: SEWRPC.

treated wastes to streams and watercourses within the Region, and all known wastewater overflow points on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the areawide water quality planning and management program to identify, through previous studies conducted by the Commission and existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, rinse, process, and wash waters, which are discharged, without treatment or following treatment, directly to streams and watercourses or to storm sewers tributary to such streams and watercourses. The secondary sources consulted included river basin survey reports and pollution abatement orders of the Department of Natural Resources, permits issued and reports filed under the Wisconsin Pollutant Discharge Elimination System, and the portion of the reports submitted under Chapter NR 101 of the Wisconsin Administrative Code which deals with facility discharges to surface waters. A total of 13 such known point sources of industrial wastewater were identified in the Lower Rock River subregional area. Characteristics of these 13 waste sources are identified in Table 71 and their location is shown on Map 24.

Existing Urban Development Not Served by Public Sanitary Sewers

As noted earlier, public sanitary sewerage systems in the Lower Rock River subregional area serve a total area of about 10.9 square miles, or 4 percent of the total area of the subregional area, and a total population of about 28,800, or about 71 percent of the total population of the subregional area.

An inventory was conducted in the planning program to broadly classify the developable land in the subregional area not served in 1975 by public sanitary sewer service with regard to the degree of development. Each U.S. Public Land Survey quarter section not having development served by a centralized sanitary sewerage system was examined to determine the amount of development present in 1975. Any quarter section with at least 32 housing units, or an average of one housing unit per five gross acres was classified as urban while quarter sections with between six and 31 housing units or one housing unit for every five to 27 gross acres, was classified as rural-urban. Quarter sections with five or less housing units or one unit per 32 or more gross acres were classified as rural. The major purpose of classifying the nonsewered areas of the subregional area in such a manner was to provide a basis for analyzing the potential for providing public sanitary sewerage service to areas of the Region classified as urban and to consider the present distribution of the areas deemed to remain unsewered as it relates to treatment facility requirements for septage and holding tank disposal and as it represents a potential nonpoint pollution source.

Together these nonsewered areas total about 254 square miles, or 96 percent of the total area of the subregional area, and contain a total population of about 11,700, or 29 percent of the total population

Table 70

SELECTED CHARACTERISTICS OF PRIVATE WASTEWATER TREATMENT FACILITIES IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Name	Civil Division Location	Type of Land Use Served	Type of Wastewater	Type of Treatment Provided	Disposal of Effluent	Average Hydraulic Design Capacity (gallons/day)	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]				
									BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)
ROCK RIVER WATERSHED Walworth County													
Kikkoman Foods, Inc.	Town of Walworth	Industrial	Process and Sanitary	Aerobic Digestor and Lagoon	Soil Absorption	N/A	240,000	264,000	N/A	N/A	N/A	N/A	N/A
Lake Lawn Lodge	Town of Delavan	Recreational	Sanitary	Activated Sludge	Delavan Lake	100,000	69,000	103,000	82.0	69.0	N/A	N/A	210
Lakeland Nursing Home-Walworth County Institutions. . .	Town of Geneva	Institutional	Sanitary	Activated Sludge and Lagoon	Jackson Creek	230,000	80,000	N/A	30.0	30.0	N/A	N/A	200
Libby McNeil and Libby, Inc. . .	Town of Darien	Industrial											
Outfall 1			Process	Lagoon and Spray Irrigation	Soil Absorption	N/A	1,100,000	1,700,000	N/A	N/A	N/A	N/A	N/A
Outfall 2			Sanitary	Septic System	Soil Absorption	N/A	10,000	10,000	N/A	N/A	N/A	N/A	N/A
Walworth County Correction Center (Not in Operation)	Town of Geneva	Institutional	Sanitary	Activated Sludge and Lagoon	Tributary to Jackson Creek	N/A	--	--	--	--	--	--	--

NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System (WPDES) questionnaire data obtained by SEWRPC; reports filed under Section 101 of the Wisconsin Administrative Code or from the (WPDES) permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rate were estimated from the available monthly discharge data or from the data as reported in or requirements of the WPDES permit itself.*

Source: Wisconsin Department of Natural Resources, and SEWRPC.

Table 71

KNOWN POINT SOURCES OTHER THAN WASTEWATER TREATMENT PLANTS IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Number	Name	Standard Industrial Classification Code	Civil Division Location	Type of Wastewater	Known Treatment	Outfall Number	Receiving Water Body	Reported Average[a] Annual Hydraulic Discharge Rate (gallons/day)	Reported Maximum[a] Monthly Hydraulic Discharge Rate (gallons/day)	Reported Discharge Wastewater Characteristics[a]: BOD_5 (mg/l)	Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Fecal Coliform Bacteria (number per 100 ml)	Temp °C	Heavy Metals Reported	Other Parameters Indicated
	ROCK RIVER WATERSHED Walworth County																
1	A. K. Rubber Products Company, Inc.	3069	City of Elkhorn	Cooling	None	1	Jackson Creek via Storm Sewer	1,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
2	Allied Music Corporation . .	7696	City of Elkhorn	Process	Lagoon	1	Soil Absorption	3,000	N/A	N/A	30.0	N/A	N/A	N/A	N/A	Yes	--
3	Alpha Cast, Inc.	3321	City of Whitewater	Cooling	None	1	Whitewater Creek	125,000	150,000	1.5	3.6	N/A	N/A	N/A	21.1	No	--
4	Buncker Ramo Corporation .	3829	City of Delavan	Cooling	None	8	Swan Creek via Storm Sewer	2,200	3,300	1.0	2.0	N/A	N/A	N/A	14.6	Yes	--
				Cooling	None	9	Swan Creek via Storm Sewer	2,200	5,500	1.0	2.0	N/A	N/A	N/A	N/A	Yes	--
5	Darien Waterworks	4941	Village of Darien	Filter Backwash	Sedimentation Tank	1	Turtle Creek via Storm Sewer	Intermittent	Intermittent	N/A	N/A	N/A	N/A	N/A	N/A	No	--
6	Elkhorn Light and Water Commission	4941	City of Elkhorn	Filter Backwash	N/A	1	Jackson Creek via Storm Sewer	40,000	40,000	N/A	12.2	N/A	N/A	N/A	N/A	No	--
				Process	N/A	2	Jackson Creek via Storm Sewer	10,000	10,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--
7	Frank Holton and Company .	3931	City of Elkhorn	Process	Settling Basin, PH Adjustment, Lagoon and Sludge Dewatering	1	Soil Absorption	15,000	N/A	N/A	30.0	N/A	N/A	N/A	N/A	Yes	--
8	Getzen Company, Inc.	3931	City of Elkhorn	Process	Lagoon	1	Soil Absorption	N/A	10,000	N/A	30.0	N/A	N/A	N/A	N/A	No	--
9	Hawthorn Melody Farms Dairy	2026	Town of Whitewater	Cooling	None	1	Whitewater Creek	1,157,000	1,458,000	0.0	0.0	N/A	N/A	N/A	14.7	No	--
				Cooling	None	2	Whitewater Creek	123,000	163,000	0.0	0.0	N/A	N/A	N/A	18.5	No	--
10	J. W. Reichel and Sons, Inc.. .	3369	City of Elkhorn	Cooling	None	1	Jackson Creek via Storm Sewer	3,500	4,500	N/A	N/A	N/A	N/A	N/A	N/A	No	--
11	Sharon Foundry, Inc.	3321	Town of Sharon	Cooling	Settling Tank	1	Little Turtle Creek	750	750	N/A	N/A	N/A	N/A	N/A	28.7	No	--
12	U. S. Gypsum Company . . .	3296	Village of Walworth	Boiler Blowdown	Lagoon	1	Soil Absorption	35,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	--
13	Whitewater Water Utility. . .	4941	City of Whitewater	Backwash	N/A	1	Whitewater Creek via Storm Sewer	92,000	120,000	N/A	N/A	N/A	N/A	N/A	N/A	No	--

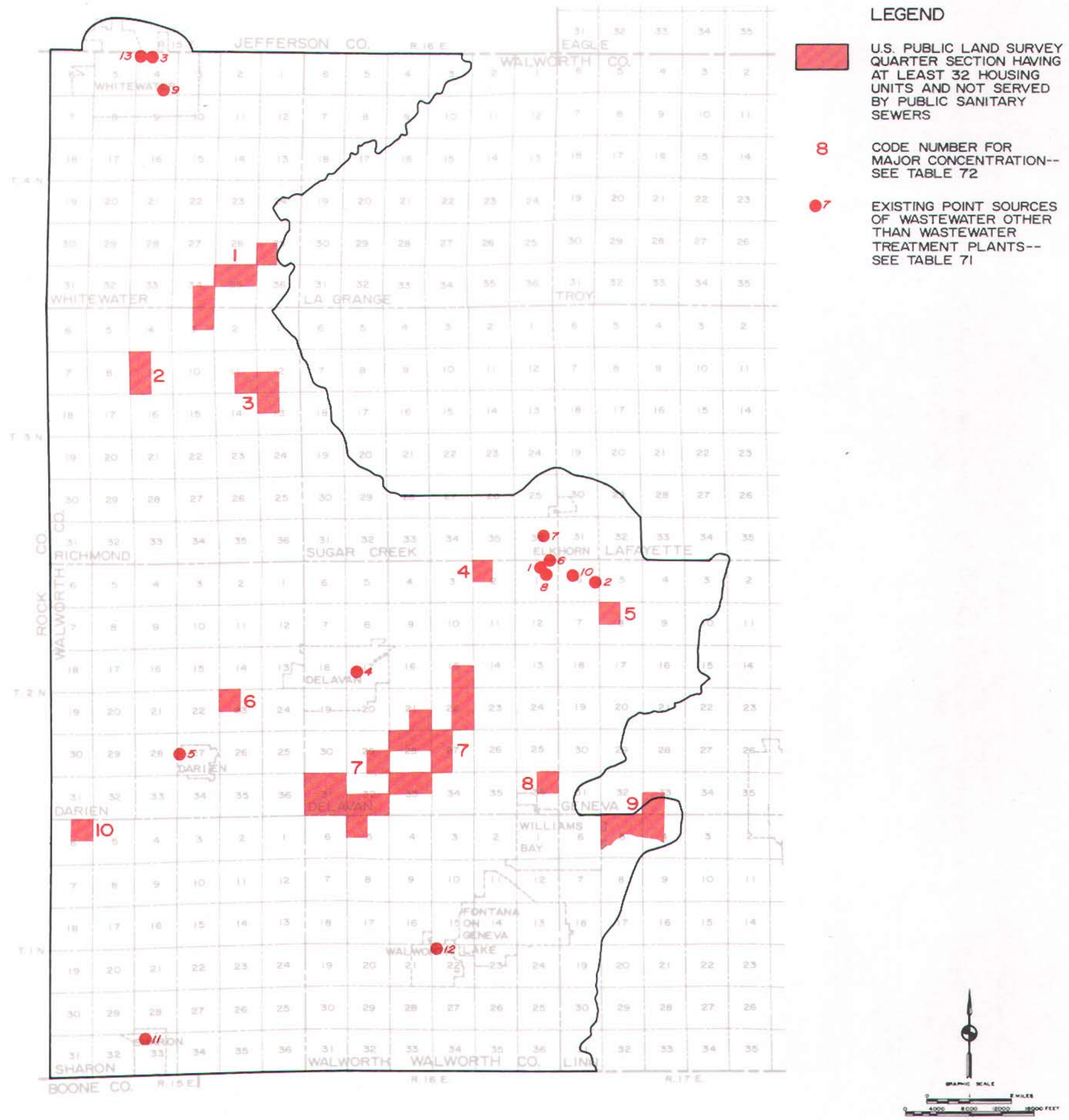
NOTE: N/A indicates data not available.

[a] *Unless specifically noted otherwise, data was obtained from quarterly reports filed with the Wisconsin Department of Natural Resources under the Wiscon sin Pollutant Discharge Elimination System (WPDES) or under Section NR 101 of the Wisconsin Administrative Code or from the WPDES permit itself in the above cited order of priority. In some cases when twelve months of flow data were not reported, the average annual, and maximum monthly hydraulic discharge rates were estimated from the available monthly discharge data or from the flow data reported in or requirements of the permit itself. In some cases when wastewater characteristics were obtained from the NR 101 reports, if average values were available, these were reported. If only maximum values were available, these were reported.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Map 24

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS AND EXISTING POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975



Significant concentrations of unsewered urban development in the Lower Rock River subregional area consist of two types of development. The first type consists of lake-oriented urban development—both seasonal and year-round residences—which has occurred around nearly every lake in the subregional area. Centralized sanitary sewerage systems have been proposed for the lake-oriented urban concentrations around Delavan and Geneva Lakes. The second type consists of the small unincorporated places in the subregional area which have developed at the outer fringes of the City of Elkhorn or along the major highways in the subregional area. There are also 13 existing (1975) known point sources of wastewater other than the wastewater treatment facilities in the Lower Rock River subregional area. These waste sources are most prevalent in the industrial land uses in the Cities of Elkhorn and Whitewater.

Source: Wisconsin Department of Natural Resources and SEWRPC.

of the subregional area. Of that total, about 9.7 square miles, or 4 percent of the total area of the subregional area containing a total population of 4,900, or 12 percent of the total population of the subregional area are classified as urban nonsewered development.

For analysis purposes, the existing nonsewered urban development has been combined into 10 named major urban concentrations, as shown on Map 24. The estimated population and urban development areas of each of these major concentrations are shown in Table 72.

The most common method of providing for wastewater disposal for those approximately 11,700 people living within urban, urban-rural, and rural areas not served by public sanitary sewers within the Lower Rock River subregional area is the conventional septic tank and attendant leaching field. An inventory was conducted to determine the extent of the use of other onsite treatment systems. Another method of sewage disposal utilized in the area consists of sewage holding tanks which are emptied on a regular basis and transported to a centralized disposal site. A second alternative, using a septic tank and an above-ground soil absorption system referred to as the "mound type septic system", is utilized in areas where high groundwater tables on soil with poor absorption rates limits the viability of traditional subsurface drain fields. The mound system involves the use of a soil absorption field placed on top of the existing soil to treat the effluent from the septic tank which is discharged inside the mounded bed through a dosing system.

Based upon the permits issued through December 1975, there were 25 sewage holding tank installations, and two mound systems existing in the Lower Rock River subregional area. Twenty-two of the holding tanks served residential homes, while three were utilized by commercial establishments. The mound systems were both utilized to dispose of sanitary sewage from residences. The location of these systems is indicated on Map 24.

Concluding Remarks—
Lower Rock River Subregional Area

Inventories conducted under the areawide water quality and management planning program indicated that in 1975 there existed in the Lower Rock River subregional area a total of eight public sanitary sewerage systems which included 10 sewage flow relief devices and which together serve a total area of about 10.9 square miles, or about 4 percent of the total area of the subregional area, and a total population of about 28,800 persons, or about 71 percent of the total population of the subregional area. Each of the eight sanitary sewerage systems operates their own wastewater treatment facility.

Table 72

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number[b]	Name		
1	Whitewater Lake	500	806
2	Lake Loraine	300	321
3	Turtle Lake	300	488
4	Town of Delavan-Section 2	200	158
5	Town of Geneva-Section 8	300	164
6	Town of Darien-Section 23	300	162
7	Delavan Lake	2,500	2,886
8	Town of Delavan-Section 36	100	157
9	Village of Williams Bay	300	860
10	Allens Grove	100	187
Total		4,900	6,189

[a] Urban development is defined in this context as concentrations of urban land uses within any given U.S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.

[b] See Map 24.

Source: SEWRPC.

In addition to the eight public sanitary sewerage systems, an additional five wastewater treatment facilities serving isolated industrial, institutional and recreational establishments were found in the inventory. There were also 13 point sources of wastewater other than wastewater treatment plants identified in the subregional area, consisting of industrial cooling, process, filter backwash and boiler blowdown wastewaters. The inventory indicated that as of 1975 there was one proposed new public sanitary sewerage system in the subregional area. Finally, in 1975 there were an estimated 4,900 persons residing in scattered enclaves of urban development in the Lower Rock River subregional area not served by public sanitary sewer service. Together these enclaves had a total area of about 9.7 square miles. In the areas of the Lower Rock River subregional area not served by sanitary sewers, it is estimated that approximately 254 square miles, and 11,700 people are served by onsite sewage disposal systems. The vast majority of these onsite sewage disposal systems are conventional septic tanks. However, 25 holding tanks and two "mound systems" are also used for sewage disposal within the subregional area.

INVENTORY FINDINGS WASTEWATER CHARACTERISTICS

Wastewater Flow Components

The principal sources of wastewater are spent municipal water supply, groundwater infiltration, and stormwater inflow. Wastewater flow rates for design purposes must, therefore, include allowances for the nonwaste components which inevitably become a part of the total wastewater flow, as well as for the waste component of the total flow. Within the Region, the quantity of wastewater derived from spent municipal water supplied to residential, commercial, industrial, institutional, and other consumers usually corresponds closely to the quantity of water supplied. Two major exceptions occur. The first exception takes place during the summer season when relatively large volumes of water may be used for lawn sprinkling and cooling purposes, while the second exception occurs during periods of wet weather or high ground water conditions when infiltration and inflow quantities within the sewer system increase.

Clear water enters the wastewater collection system both as groundwater infiltration through cracked pipes, defective joints and faulty manholes, and as storm and flood waters which may enter the sewerage system directly through submerged manhole covers or through illegally connected roof and foundation drains which the operating agency has been unable, or unwilling, to eliminate. Storm water soaking into the soil may also accelerate the rate of infiltration at sewer and manhole joints. Another significant source of clear water entering the wastewater collection system is storm water in areas served by combined rather than separate storm water and sanitary sewers. Combined sewer systems presently exist within and serve parts of only four[13] communities within the Region—the Cities of Kenosha, Milwaukee, and Racine, and the Village of Shorewood—and, therefore, cannot be considered typically a part of the existing sewerage systems within the Region. No new combined sewer systems are being constructed within the Region. In addition, in urban renewal areas where clearance and replacement of the existing buildings and related land use activities are involved, new separate storm and sanitary sewers are generally installed to replace combined sewers which may exist. Flow data from sewerage systems having combined sewer service areas were considered in the determination of sewage flow and strength characteristics.

In order to permit the ready and convenient derivation of wastewater flows from adopted regional and subregional land use plans, it was decided to establish design criteria which relate annual average wastewater flows to the major land use categories used in the adopted land use plans. This required the establishment of unit design flow criteria which could be applied to three major land use categories: general urban development, major commercial concentrations, and major industrial concentrations. It should be noted that these land use categories are gross in nature, in that they also contain, as appropriate, related supporting land uses such as streets and highways, railroads, parks and open spaces, institutions, and minor commercial and industrial establishments. The establishment of these unit design flow criteria, in turn, required investigation and analyses of the wastewater flows generated by comparable existing land uses.

In order to permit individual consideration in the development of the design criteria of the major factors involved, the amount of wastewater flow presently generated from the following sources was investigated:

1. The amount of wastewater flow contributed by all general urban land uses except major commercial and industrial concentrations. These land uses include all residential, minor commercial, institutional, governmental, minor industrial, and other land uses within the sewer service areas. Flows from such land uses generally vary with the resident population level, and the relationship between land use and wastewater flow was, therefore, expressed on a per capita basis, in terms

[13] *At the time of the inventory for the areawide water quality management planning program, the combined sewer areas in the City of Port Washington were essentially separated.*

of gallons per capita per day. It should be noted that this approach incorporates consideration of population density as well as population level.

2. The amount of wastewater flow contributed by major commercial concentrations. For system planning purposes, commercial wastewater flows were expressed on a per capita basis in terms of gallons per capita per day. Since such flows are not always directly related to residential population levels, but to the amount and type of commercial activity, the relationship was also expressed on an areal basis in terms of gallons per acre per day.

3. The amount of wastewater flow contributed by major industrial concentrations. For system planning purposes, industrial wastewater flows were expressed on a per capita basis in terms of gallons per capita per day. Since such flows are not directly related to residential population levels but to the amount and type of industrial activity, the relationship was expressed on an areal basis in terms of gallons per acre per day.

4. The amount of wastewater flow contributed by clear water infiltration through manholes, sewer joints, and cracks. The relationship was expressed on a per capita basis, in terms of gallons per capita per day and also was expressed on an areal basis in terms of gallons per minute per acre.

5. The amount of wastewater flow contributed by stormwater inflow both through manholes and connected building roof and foundation drains. This relationship was also expressed on a per capita basis in terms of gallons per capita per day and was also expressed on an areal basis in terms of gallons per minute per acre.

The first three of the foregoing wastewater flow contributions were first analyzed on an annual average daily basis. The flow contributions by infiltration and stormwater inflows were analyzed separately on a dry weather-wet weather basis, respectively. Then peak-to-average flow rates were investigated.

To provide a basis for the selection of the design criteria, inventories were conducted of water consumption and wastewater flow for communities within the Region. These data were then analyzed to determine the amount of wastewater flow that is currently contributed by each of the three major land use and flow categories noted above, as well as to determine the peak-to-average flow ratios. The results of these inventories are presented in the following discussion. The actual design criteria selected for use in the areawide water quality management planning program, which criteria are based upon not only the data presented in this chapter, but only upon widely accepted engineering standards as revealed by the preparation of a state-of-the-art report on water pollution control in southeastern Wisconsin, and upon experienced local engineering judgment incorporated through the careful review of the preliminary criteria by the Technical Advisory Committee on Areawide Wastewater Treatment and Water Quality Management Planning, will be presented in SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000. It should be noted that wastewater characteristics analyses included in this chapter were specifically developed for regional sewerage system planning purposes. The design of local wastewater collection and treatment facilities and systems may require more detailed wastewater flow and constituent analyses, based upon consideration of specific industrial, institutional, commercial and other land uses to be served, as well as of the varying local infiltration and stormwater inflow conditions.

Domestic Wastewater Flows: Water consumption and wastewater flow data for the Region is summarized in Tables 73 and 74. A breakdown of the water consumption and wastewater flow data on a community basis is presented in Appendix D. The domestic flows include water consumption by and estimated wastewater received from all residential, commercial, institutional, and governmental land uses within the sewer service area. The industrial category includes the municipal water supply delivered to the industrial land uses, less the known spent water discharged to the storm sewer system or water consumed in production. The data in Tables 73 and 74 generally show that there is variability in the ratio of domestic water delivered to domestic wastewater received, and that on a regional basis domestic water delivered can be estimated at approximately 84-90 percent of the domestic wastewater received on an annual average basis for the Region. Additional domestic wastewater is expected to be composed of clear water—infiltration and inflow—which enters the sanitary sewerage system. Spent water delivered was assumed to represent the domestic wastewater contribution other than that portion of the domestic wastewater which is attributed by infiltration and stormwater inflow and other than spent water originally supplied by private water systems.

In order to present a complete picture of the water consumption and wastewater flow relationships, per capita wastewater contributions were calculated for each subregional area and for the Region as a whole by two different methods. The first method utilized the mean value of the per capita water consumption and wastewater values reported for the treatment plants in the particular subregional area. Similarly the average regional per capita water consumption and wastewater values were calculated as the mean

Table 73

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE REGION: 1975

Subregional Area	Water Consumption Average Water System Per Capita Relationship[a]		Wastewater Flow Average Treatment Plant Per Capita Relationship[a]		Ratio of Water Consumption To Wastewater Received Based on Per Capita Relationship	
	Total	Domestic	Total	Domestic	Total Flow	Domestic Flow
Milwaukee-Metropolitan. . .	139	103	121	96	1.15	1.07
Upper Milwaukee River . . .	143	87	142	112	1.01	0.78
Sauk Creek	134	89	128	124	1.05	0.72
Kenosha-Racine	131	86	140	114	0.94	0.76
Root River Canal.	191	94	134	133	1.43	0.71
Des Plaines River.	87	87	90	90	0.97	0.97
Upper Fox River	121	90	130	114	0.93	0.79
Lower Fox River.	124	86	108	105	1.15	0.82
Upper Rock River	137	84	132	82	1.04	1.02
Middle Rock River.	168	93	127	136	1.32	0.68
Lower Rock River	128	88	138	105	0.93	0.84
Regional Average[a]	133	89	126	106	1.08	0.84

[a] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values presented on a community basis in Appendix D.*

Source: SEWRPC.

Table 74

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE REGION: 1975

Subregional Area	Water Consumption Average Per Capita Relationship[a]		Wastewater Flow Average Per Capita Relationship[a]		Ratio of Water Consumption To Wastewater Received Based on Per Capita Relationship	
	Total	Domestic	Total	Domestic	Total Flow	Domestic Flow
Milwaukee-Metropolitan . . .	175	114	200	120	0.88	0.95
Upper Milwaukee River	147	88	148	110	0.99	0.80
Sauk Creek	114	88	170	163	0.67	0.54
Kenosha-Racine	172	96	180	130	0.95	0.74
Root River Canal.	191	94	134	133	1.43	0.71
Des Plaines River.	86	86	88	88	0.98	0.98
Upper Fox River.	158	95	171	139	0.92	0.68
Lower Fox River.	149	87	121	115	1.23	0.76
Upper Rock River	109	83	165	105	0.66	0.79
Middle Rock River.	166	101	148	136	1.12	0.74
Lower Rock River	129	88	123	93	1.05	0.94
Regional Average[a]	170	108	190	121	0.99	0.89

[a] *Averages are calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion or region as reported in Appendix D.*

Source: SEWRPC.

value of all reported per capita values for the treatment plants within the Region. Results of these calculations may be found in Table 73. The second method utilized the total water and wastewater flow in each subregional area and divided the total by the population of the corresponding subregional area to obtain an average per capita value for each subregional area. Similarly the regional per capita values were calculated by dividing the total regional water consumption and wastewater flow by the corresponding regional population. Results of these calculations are reported in Table 74.

The water delivered for domestic consumption can most conveniently be expressed in gallons per capita per day (gpcd). As shown in Table 73, domestic water consumption in the Region, based on an average of the consumption rates in Appendix D, is 89 gpcd.

On a population weighed basis, reflecting the total reported domestic water consumed in the Region divided by the total reported population served, the domestic water consumption is 108 gpcd. This indicates the effect of the generally higher water consumption in communities with the higher populations. In SEWRPC Planning Report No. 16, A Regional Sanitary Sewerage System Plan for Southeastern Wisconsin, the average domestic water consumption rate in 1960 and 1970 was estimated at 67 gpcd and 88 gpcd, respectively, based on seven typical communities within the Region, thus indicating an increasing per capita domestic water consumption in the Region over the past 15 years.

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, require that all users of public sewerage systems which are involved in the grant program of that Act, pay their proportionate share of the operation and maintenance cost of these systems. Such payments are often based upon water consumption records. In view of this recent development as well as an increasing awareness of the need to conserve natural resources, it is unlikely that the per capita domestic water consumption in the Region will continue to follow the historically increasing trend.

Industrial Wastewater Flows: Table 75 presents a summary of the per capita relationship between the estimated industrial wastewater flow, and the sewer service population by subregional area in the Region. Appendix E presents this data on a community basis. Traditionally, industrial wastewater flows are expressed in terms of tributary industrial acreage. However, the industrial wastewater-sewered population relationship has also been established for use in development of the design criteria for the water quality management plan for system planning purposes. It can be noted by review of the data in Appendix E that, in general, the larger and older the community, the greater the estimated industrial wastewater flow rate in terms of gallons per capita per day. The industrial wastewater flow rate in the Region, based on an average of the per capita flow rates in Appendix E, is estimated at 16 gallons per capita per day, corresponding to approximately 10,000 gallons per day per gross acre of industrial sewered land use. In SEWRPC Planning Report No. 16, A Regional Sanitary Sewerage System Plan for Southeastern Wisconsin, the regional industrial contribution to wastewater flow was established as 12,300 gallons per acre per day, based on seven selected communities within the Region. On a population weighed basis reflecting the total industrial wastewater estimated to be received by the treatment plants in the Region, divided by the total reported population, the average per capita industrial wastewater contribution is 65 gpcd. This reflects the generally higher per capita industrial wastewater contribution at treatment facilities with higher tributary populations.

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, require that industrial users of sewerage facilities which are involved in the grant program of that Act pay their proportionate share of operation and maintenance costs. Industrial users are also required to repay the federal cost of construction of such facilities in proportion to their use of the facilities capacity. Therefore, it is considered unlikely that industry will continue to utilize water and discharge wastewater in the future at the same rates presently experienced. Surface water quality problems and the attendant need for higher levels of waste treatment, together with the attendant increased cost of treating industrial wastewaters in municipal plants and the potential for recycling industrial wastes in order to recover economically valuable raw materials, products, or byproducts, may also be expected to lead increasingly to industrial water conservation and reuse within major industrial plants.

Commercial Wastewater Flows: Table 75 presents a summary of the per capita relationship between the estimated total commercial wastewater flow, which was assumed to be equal to metered commercial water supply, and the sewer service area population by subregional area in the Region. It can be noted by review of the data in Appendix E that, in general, the larger and older the community the greater the estimated commercial wastewater flow rate in terms of gallons per capita per day. Commercial wastewater flow in the Region, based on an average of the per capita flow rates in Appendix E, is 16 gallons per capita per day, which corresponds to approximately 4,000 gallons per day per gross acre of commercial land.

The commercial wastewater contribution which was developed in SEWRPC Planning Report No. 16, and based on seven select communities in the Region, was 7,640 gallons per acre per day. On a population weighed basis reflecting the total commercial wastewater estimated to be received by the treatment plants in the Region, divided by the total reported population, the average per capita commercial wastewater contribution is 20 gpd, reflecting the generally higher commercial wastewater contribution at treatment facilities with higher tributary populations.

As previously noted, the Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, require that all users of public sewerage systems which are involved in the grant program of that Act pay their proportionate share of the operation and maintenance cost of these systems. Such payments are often based upon water consumption records. Because of this development and the increasing awareness in the need for resource conservation, in the future, commercial establishments possibly may institute water conservancy and reuse practices which will decrease the commercial contribution to wastewater flow.

Table 75

SUBREGIONAL INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW: 1975

Subregional Area	Average Industrial[a] Wastewater Flow Rate (gallons/capita/day)	Average Commercial[a] Wastewater Flow Rate (gallons/capita/day)
Milwaukee-Metropolitan . . .	28	7
Upper Milwaukee River. . . .	32	11
Sauk Creek.	5	18
Kenosha-Racine.	25	14
Root River Canal.	0	20
Des Plaines River	0	N/A
Upper Fox River	17	21
Lower Fox River.	2	10
Upper Rock River	51	18
Middle Rock River.	7	23
Lower Rock River	12	21
Regional Average[a]	16	16

[a]Average is calculated as the average of the total number of values presented on a community basis in Appendix E and is not weighed based upon the population of the various treatment plant tributary populations. When the regional value is calculated on a population weighed basis reflecting the total estimated industrial and commercial wastewater flow in the region, divided by the corresponding reported service area population, the region industrial and commercial per capita contribution is 65 gpd and 20 gpd respectively.

Source: SEWRPC.

Infiltration: Groundwater infiltration through joints in sewer pipes and manholes can result in appreciable contributions to the total wastewater flow. Old sewerage systems may show infiltration rates as high as 60,000 gallons per day per mile of sewer.[14] Modern techniques of joining sewers and building manholes should, however, result in future decreases in infiltration. Although state requirements mandate design and construction procedures that minimize infiltration, sanitary sewerage system planning and design must recognize that some settlement and subsequent increases in infiltration may occur. Allowances for infiltration should, therefore, be somewhat greater than those anticipated at that time of initial construction. Infiltration rates commonly used for system planning purposes range nationally from 10,000-40,000 gallons per day per mile, depending on sewer size and soil and groundwater conditions.[15] Draft guidelines criteria of the U.S. EPA[16] indicate that it is usually cost effective to eliminate infiltration/inflow in excess of 5,000 gallons per day per inch diameter per mile, and that it is generally not cost effective to eliminate infiltration/inflow of less than 1,000 gallons per day per inch diameter per mile. Thus, it is suggested that special study may be necessary for infiltration/inflow rates of between 1,000 and 5,000 gallons per day per inch diameter per mile. These general guidelines would not be applicable without further study in systems with relatively large sanitary or combined sewer systems. Sewers which are located below the water table for varying periods during the year will obviously be subject to greater rates of infiltration than those located above the water table in well-drained soils for the entire year. For sewer design and construction purposes, the infiltration allowances are usually expressed in gallons per inch of sewer diameter per mile of sewer. For system planning purposes, however, it is also useful to express the infiltration allowances in terms of gallons per capita per day for a given sewer service area population, and on a regional basis in terms of gallons per minute per acre.

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, require that each community involved in the grant program under that Act prepare an infiltration/inflow analysis of the wastewater collection system as part of the sewer system evaluation survey prior to receiving a grant for the construction or expansion of the community's wastewater treatment facility. Approximately 40 communities in the Region have completed infiltration/inflow studies and several communities are currently

[14]*Design and Construction of Sanitary and Storm Sewers, ASCE Manual of Engineering Practice No. 37, 1969, pp. 30.*

[15]*Ibid, pp. 31.*

[16]*U.S. Environmental Protection Agency, Program Guidance Memorandum-Infiltration/Inflow Program, Draft, July, 1976.*

conducting or have contracted for infiltration/inflow analyses. The existing infiltration/inflow-data for the communities within the Region, supplemented with additional analyses conducted by the Commission staff, provide a basis for the selection of a design parameter for infiltration as a component of the total wastewater flow for the areawide water quality planning and management study.

For those sanitary sewerage systems in the Region which did not have completed infiltration/inflow analyses, water pumpage and wastewater flow records were utilized in the development of infiltration/inflow analyses. Monthly water pumpage and wastewater flow values for May, 1975, were selected for the infiltration analyses for the following two reasons: 1) water tables in the Region are generally high in the spring months due to normal spring rainfall events in addition to snowmelt conditions, and therefore, infiltration is normally most significant during the spring; and 2) a review of monthly rainfall amounts as recorded at 15 meteorologic stations in the Region for 1975 indicate that May was the lowest total spring rainfall month and, therefore, the amount of wastewater contributed by inflow should be a relatively low portion of the monthly wastewater flow.

Theoretical average base wastewater flows—the amount of wastewater that would be comprised of only spent domestic, commercial, and industrial water—were estimated by: 1) adjusting monthly water pumpage for May, 1975, to account for water that was known to be delivered to industries and eventually discharged to storm sewers or watercourses, and 2) reducing the resulting flow rate by a factor of 10 percent to account for losses in the water distribution system, lawn sprinkling, other internal uses, and water service areas not served by sanitary sewers. Groundwater infiltration rates were then calculated as the average wastewater flow rates for the month of May 1975, less the theoretical base wastewater flow rates.

The results of those analyses are summarized in Table 76. Appendix F presents the data on a community basis. The average of the per capita groundwater infiltration rate in Appendix F is 84 gallons per capita per day which can be expressed as 0.59 gallon per minute per acre based upon medium density development of 10.2 persons per gross acre. This per acre contribution can be calculated to be 0.28 gallons per minute per acre based upon the total infiltration wastewater flow contribution and the total area served by public sanitary sewers. SEWRPC Planning Report No. 16 developed a regional infiltration contribution of 0.24 gallons per minute per acre based on seven select communities in the Region. On a population weighted basis reflecting the total estimated infiltration contribution to wastewater in the Region divided by the total reported tributary population, the average per capita infiltration contribution is 60 gpcd, indicating somewhat lower per capita infiltration wastewater contributions at treatment facilities with higher tributary populations. It is important to note that these estimated infiltration values calculated when no community analysis infiltration rates were available, are based on average monthly water pumpage and wastewater flow rates, and as such, daily infiltration rates may be expected to be somewhat greater.

Stormwater Inflow: Stormwater inflow during periods of intense rainfall or surface flooding can also result in appreciable contributions to the total wastewater flow, particularly for short periods during and after rainfall events. Stormwater inflow enters the sanitary sewer system by a number of sources including: roof leaders, cellar, yard and area drains, foundation drains, manhole covers, cross connections from storm sewers and catch basins. Although state and local regulations prohibit the discharge of stormwater from roof or foundation drains to sanitary sewers, such connections are often the most significant source of clearwater inflow.

As mentioned previously, about 40 communities have prepared infiltration/inflow reports and several communities are currently conducting, or plan to in the near future, infiltration/inflow studies. Data from existing infiltration/inflow reports supplemented with inflow studies prepared by the Commission staff provided the basis for the selection of a design parameter for stormwater inflow in the areawide water quality planning and management program. For system planning purposes, it is convenient to express the inflow allowances in terms of gallons per capita per day, and also as gallons per minute per acre.

Monthly water pumpage and peak daily wastewater flow data were utilized in order to develop stormwater inflow rates for those sewerage systems for which existing infiltration/inflow reports were not available. Monthly water pumpage and peak daily wastewater flow rates for August, 1975, were selected in determining stormwater inflow for the following two reasons: 1) a review of monthly total rainfall at 15 meteorologic stations in the Region for 1975 indicated that the maximum precipitation was recorded in August and, therefore, it was assumed that significant amounts of stormwater inflow would be expected to occur in any system which experienced inflow problems; 2) the water table is generally low in the late summer-early fall months in southeastern Wisconsin and therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of the total flow. It was also assumed that water pumpage generally does not vary significantly within a given month and therefore, the average monthly water pumpage for August, 1975, was assumed to be typical of the daily water pumpage.

Table 76

SUBREGIONAL INFILTRATION AND INFLOW CONTRIBUTION TO WASTEWATER FLOW: 1975

Subregional Area	Average Infiltration Rate[a] (gallons/capita/day)	Average Inflow Rate[a] (gallons/capita/day)	Average Infiltration/Inflow Rate[a,b] (gallons/capita/day)
Milwaukee-Metropolitan . . .	64	177	272
Upper Milwaukee River. . . .	96	81	175
Sauk Creek	239	259	498
Kenosha-Racine.	96	330	425
Root River Canal	94	198	292
Des Plaines River	99	89	188
Upper Fox River	134	25	167
Lower Fox River	38	90	118
Upper Rock River	186	105	291
Middle Rock River	50	47	84
Lower Rock River	19	24	43
Regional Average	84	125	217[b]

[a]*Average is calculated as the average of the total number of values presented on a community basis in Appendix F and is not weighed based upon the population of the various treatment plant tributary populations. When the regional value is calculated on a population weighed basis reflecting the total estimated infiltration and contribution to wastewater flow in the Region divided by the corresponding reported tributary area population, the infiltration and inflow per capita contributions is 60 gpcd and 350 gpcd respectively.*

[b]*Total infiltration and inflow value is somewhat different than the sum of the values for infiltration and inflow due to the different number of available data points for each total in Appendix G.*

Source: SEWRPC.

Theoretical base wastewater flows—the amount of wastewater that would be comprised of only spent domestic and industrial water—were determined by: 1) adjusting the monthly water pumpage for August 1975 to account for water that was delivered to industries and eventually discharged to storm sewers or watercourses, and 2) reducing the resulting flow rate by a factor of 10 percent to account for losses in the water distribution system, internal uses and water service areas not served by sanitary sewers. Paeak daily wastewater flow rates were selected by examining daily precipitation records for August, 1975, and selecting the peak daily wastewater flow coinciding with the maximum rainfall event.

Stormwater inflow rates were then calculated as the peak daily wastewater flow rates, less the theoretical base wastewater flow rates for August, 1975.

The results of this analysis are presented in summary in Table 76. Appendix G presents the data on a community basis.

The total stormwater inflow rate in the Region is 125 gallons per capita per day, or about 0.88 gallons per minute per acre based upon a medium density development of 10.2 persons per gross acre. This per acre contribution can be calculated to be 1.66 gallons per minute per acre based upon the total inflow wastewater flow contributions and the total area served by public sanitary sewer in the Region. This later regional value of 1.66 gallons per minute per acre is significantly affected by the relatively larger inflow contribution from the Milwaukee Metropolitan area which is due in part to the contribution from the combined sewer system in that area.

The regional inflow contribution that was developed in SEWRPC Planning Report No. 16 was 0.57 gallons per minute per acre based on seven select communities in the Region. On a population weighted basis reflecting the total estimated inflow contribution to wastewater in the Region, divided by the total reported tributary population, the average infiltration contribution is 350 gpcd, indicating a very dominant effect of the high wastewater contributions at treatment facilities with higher tributary populations, and in the case of the largest four treatment plants in the Region, the effect of the combined sewers on the regional per capita inflow contribution.

Peak to Average Flow Ratios

Wastewater flows normally vary greatly, exhibiting seasonal, daily, and hourly ebbs and floods which must be recognized in sewerage planning and design. Although annual average and monthly average flow rates normally provide one basis for the sizing of sewerage systems, certain important components of the system must be designed to provide adequate capacity for peak flows, while functioning at minimum flows both initially and finally without nuisance. Estimates of peak flow rates are therefore required to determine the hydraulic capacity of sewers as well as of some treatment plant, and lift and pump station components. For design purposes, the peak rate of flow can be defined as the mean rate of flow during the maximum 15-minute period in any 12-month period. For system planning and design purposes, however, peak flow rates are estimated by factoring annual average flow rates. Therefore, the ratio of peak-to-average flow must be established.

As already noted, sanitary wastewater flows are generally comprised of spent domestic and industrial water supplies, such groundwater as may enter the sewers through leaking joints and manholes, and such storm water as may enter the sewers through connected building roof and foundation drains. In addition, in older sewerage systems which incorporate combined sewers, storm water may be admitted to the sewers by design. Each of these components of the total wastewater flow has individual time patterns, which together determine the overall time pattern of the total sewage flow. The flow of spent domestic and industrial water supplies will vary with the day of the week and with the hour of the day. Extreme low flows usually occur between midnight and 6 a.m. on Sundays, with a daily peak flow occurring in a regular pattern during the midday daylight hours. The ground and surface water components of the total flow, on the other hand, remain practically constant throughout any one day but vary widely with the season and weather, with flows peaking immediately during and after periods of rainfall.

The ratio of the peak-to-average flow will also vary with the size of the tributary drainage area served, that ratio generally being lower for relatively large sewers serving relatively large tributary drainage areas, and higher for relatively small sewers serving relatively small tributary drainage areas. The ratio of peak-to-average flow will also vary with the type of land use in the service area and with changes in land use over time.

In order to provide a basis for the selection of design criteria relating to peak to average flows for regional sanitary sewerage system planning purposes, an analysis was made of the variations in wastewater flows which occur within sewerage systems serving the Region. Daily wastewater flow records for June, 1975, were examined to determine the daily peak flow rates for the following two reasons: 1) as noted previously, water tables within the Region are normally high during spring months; 2) a review of recorded precipitation at 15 meteorological stations within the Region indicated that June was the wettest spring month in 1975. Ratios of peak daily to average annual wastewater flow were developed. The ratio between regional average peak daily wastewater flow and the average annual wastewater flow is 1.75. Actual peaks defined as the ratio of the peak 15 minute flow rate during the year to the average annual flow rate could be expected to represent a much higher ratio than indicated by the ratios of the estimated peak daily to annual average ratio.

Inasmuch as wastewater effluent standards generally include requirements for monthly average limitations —for example BOD_5 monthly averages of 15 mg/l— design criteria should be such that the maximum monthly wastewater flow—in terms of both quantity and quality—can be adequately treated, the ratio of peak monthly to average monthly wastewater flow rates were examined for use in determining treatment plant design criteria. The regional average ratio of peak monthly wastewater flow to average annual wastewater flow is 1.37.

Wastewater Strengths

Variation in sewage strengths is not as critical a consideration in regional sanitary sewerage system planning as is variation in sewage flow rates, since treatment plant construction costs are primarily a function of the volume of the sewage flow. A knowledge of sewage strength characteristics is required, however, to determine the required type and level of treatment and the potential effects of effluent discharges on the quality of the receiving stream. Concentrations of pollutants or contaminants in sewage treatment plant effluent are neither constant nor directly proportional to raw inflow sewage strengths, varying throughout the day and from season to season. Common indicators used to measure the strength of sewage are the concentrations of oxygen-demanding materials, nutrients and suspended solids. These commonly used indicators of sewage strength are the same as certain commonly used indicators of stream water quality, and are discussed, together with their importance in the design of sewage treatment works, in some detail in this report.

Survey Findings: In order to provide a basis for selecting wastewater strength design criteria for use in the Areawide Water Quality Planning and Management Program, analyses were made of available data pertaining to carbonaceous biochemical oxygen demand (BOD_5) suspended solids, and nutrient influent concentrations from municipal wastewater treatment plants within the Region. Influent data from a total of 61 municipal wastewater treatment plants were analyzed. The data utilized in this analysis are presented in Table 77, along with the estimated regional average values for the various wastewater strength parameters. The per capita values indicated for each subregional area and for the Region were calculated based upon the average of the total number of values presented on a community basis in Appendix H, and not weighted based upon the population of the various treatment plant tributary populations. Based on data from 61 sewerage systems, the average annual five-day carbonaceous biochemical oxygen demand value is 0.164 pound per capita per day. The average maximum monthly suspended solids value is 0.193 pound per capita

Table 77

SUBREGIONAL WASTEWATER STRENGTH PARAMETERS

	Average Wastewater Strength Parameter In Influent Wastewater											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia Nitrogen	
Subregional Area	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual mg/1	Average Annual lb/day/cap	Average Annual mg/1	Average Annual lb/day/cap	Average Annual mg/1	Average Annual lb/day/cap	Average Annual mg/1	Average Annual lb/day/cap	Average Annual mg/1	Average Annual lb/day/cap
Milwaukee-Metropolitan . . .	124	165	169	0.195	186	0.217	9.0	0.010	8.3	0.008	12.3	0.012
Upper Milwaukee River . . .	141	190	176	0.210	254	0.301	10.8	0.013	10.1	0.013	15.1	0.017
Sauk Creek.	128	169	166	0.160	188	0.193	9.2	0.009	8.4	0.010	16.3	0.016
Kenosha-Racine	140	180	132	0.145	163	0.192	6.5	0.008	9.2	0.010	18.1	0.021
Root River Canal	134	184	212	0.236	203	0.226	6.1	0.007	12.0	0.013	12.0	0.013
Des Plaines River	90	158	122	0.091	160	0.115	--	--	--	--	--	--
Upper Fox River	130	178	154	0.161	204	0.205	9.3	0.009	8.4	0.008	12.7	0.012
Lower Fox River	110	133	131	0.121	145	0.112	9.9	0.010	10.5	0.010	19.7	0.019
Upper Rock River.	132	200	247	0.253	298	0.310	12.5	0.012	--	--	--	--
Middle Rock River	127	151	140	0.166	157	0.170	14.8	0.015	12.4	0.011	16.4	0.013
Lower Rock River	135	166	137	0.130	110	0.106	17.5	0.016	19.8	0.018	20.0	0.018
Regional Average	126	167	156	0.164	180	0.193	10.12	0.010	10.2	0.011	15.7	0.016

[a]*Average is calculated as the average of the total number of values presented on a community basis in Appendix H.*

Source: SEWRPC.

per day, based upon data from 56 sewerage systems. The average annual total phosphorus value is 0.010 pound per capita per day, based upon data from 40 sewerage systems. The average annual organic nitrogen value is 0.011 pounds per capita per day based on data from 34 sewerage systems. The average annual ammonia nitrogen value is 0.016 pound per capita per day, based upon data from 33 sewerage systems.

When the regional per capita values are calculated on a population weighted basis, reflecting the total estimated pollutant loading divided by the corresponding service area population, the regional pollutant per capita contributions are as follows:

BOD_5: 0.494 pound per capita per day.

Suspended Solids: 0.528 pound per capita per day.

Total Phosphorus: 0.011 pound per capita per day.

Organic Nitrogen: 0.009 pound per capita per day.

Ammonia Nitrogen: 0.016 pound per capita per day.

Summary

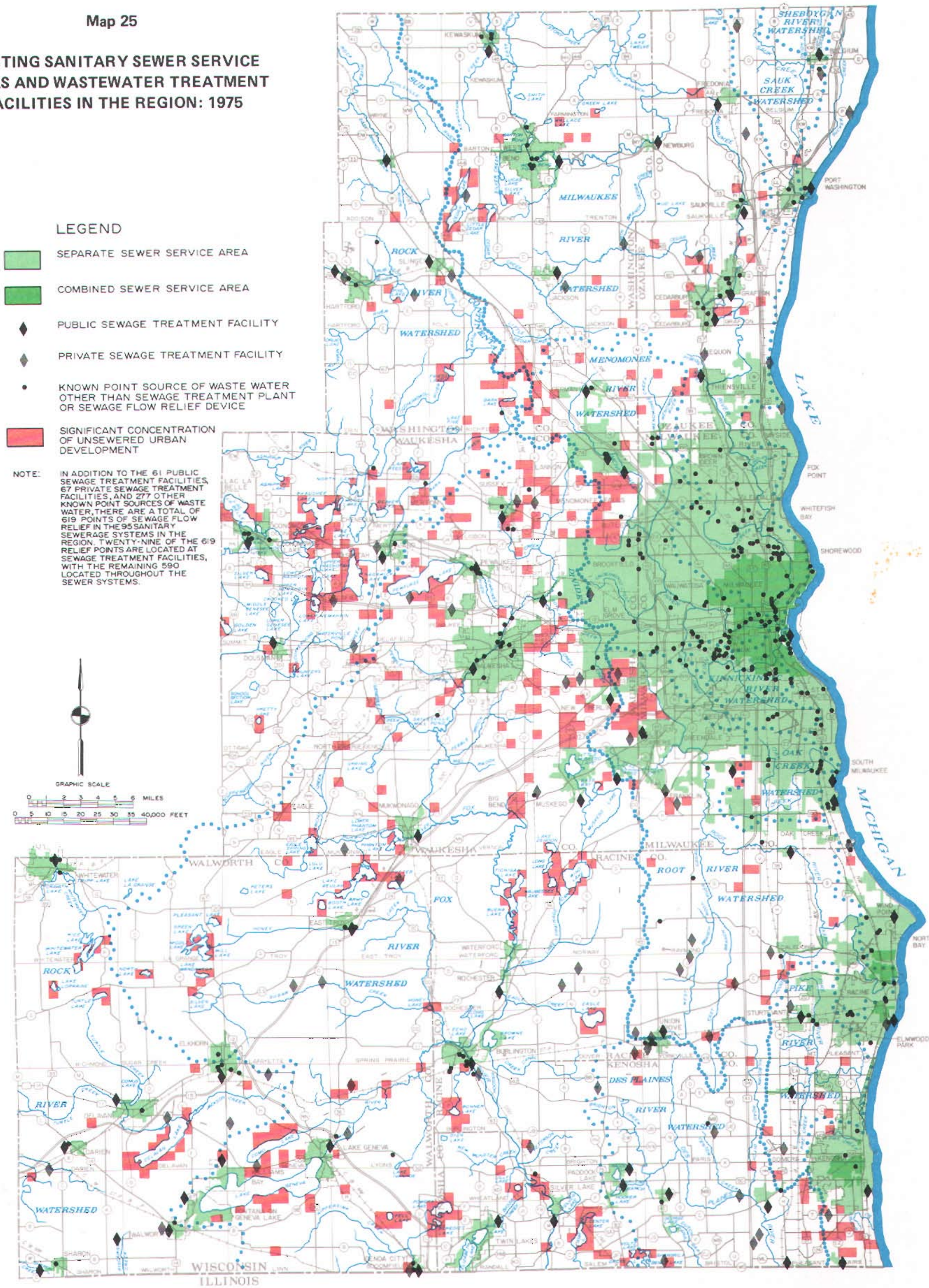
One of the initial steps in the areawide water quality management planning program was an inventory of all existing sanitary and combined sewerage systems within the Region, whether publicly or privately owned. Such an inventory is essential to an evaluation of the adequacy of the existing networks of sanitary sewers presently serving urban land use development within the Region; to an analysis of the deficiencies in the existing systems in meeting present needs; and to a determination of the capabilities of the existing systems to be expanded to meet probable future needs. Also included under the inventory of the existing sanitary sewerage systems was an inventory of all locally prepared sanitary sewerage system plans and engineering reports.

The inventory found that there are a total of 95 existing public sanitary sewerage systems in the Southeastern Wisconsin Region which provide public sanitary sewer service to the 11 designated subregional areas of the Region. Together these 95 systems serve a total area of about 353 square miles, or about 13 percent of the total area of the Region, and a total population of about 1,544,000 million, or over 86 percent of the total population of the Region (see Map 25). The area and population served by public sanitary sewerage systems in each subregional area of the Region are summarized in Table 78. The percent of total area of a subregional area ranges from a high of about 54 percent in the Milwaukee metropolitan subregion to a low of less than 2 percent in the Lower Fox River, Root River Canal and Upper Rock River subregional areas.

Comparable data relating to sanitary sewer service area and population served by sanitary sewers for the year 1970—the data base year for the regional sanitary sewerage system plan—are also presented in Table 78. It is noted that the percentage of the total regional population served has increased from 84.8 percent in 1970 to 86.3 percent in 1975. This percentage of the population served had remained relatively constant between 1963—the year when the Commission first inventoried sanitary sewerage systems as a part of the initial regional land use-transportation study—and 1970.

Map 25

EXISTING SANITARY SEWER SERVICE AREAS AND WASTEWATER TREATMENT FACILITIES IN THE REGION: 1975



Centralized public sanitary sewer service in the Region is currently provided by 95 public sewerage systems to an area of about 353 square miles, or 13 percent of the total area of the Region. These 95 systems serve more than 1.5 million persons, or about 86 percent of the total population of the Region. About 27 square miles, primarily located in the central cities of Kenosha, Milwaukee, and Racine, are served by combined storm and sanitary sewers. Treatment for sewage generated in the Region is provided at 61 public sewage treatment facilities, which collectively discharge about 293 million gallons of sewage effluent per day. Of this total, 254 mgd, or 87 percent, are discharged directly to Lake Michigan. There are also 67 sewage treatment facilities serving isolated enclaves of urban land use development, as well as 277 known point sources of wastewater other than sewage treatment plants, which consist primarily of industrial cooling, rinse, process, and wash waters discharged directly to storm sewers or streams. While not shown on this map, there are an additional 590 known points of sewage flow relief in the Region, consisting of combined sewer overflows, relief pumping stations, crossovers from the sanitary to the storm sewer system, and gravity bypasses directly to the streams of the Region. In total, then, there are nearly 1,000 point sources of raw sewage, sewage effluent, and industrial waste discharge throughout the Region.

Source: SEWRPC.

Table 78

EXISTING AREA AND POPULATION SERVED BY CENTRALIZED SANITARY SEWERS IN THE REGION BY SUBREGIONAL AREA: 1970 AND 1975

Subregional Area	Sanitary Sewer Service Area				Population Served			
	1970		1975		1970		1975	
	Square Miles	Percent of Subregional Area	Square Miles	Percent of Subregional Area	Number	Percent of Subregional Area	Number	Percent of Subregional Area
Milwaukee-Metropolitan . . .	207.5	48.8	230.8	54.3	1,096,300	93.8	1,093,200	95.9
Upper Milwaukee River. . . .	11.9	3.5	13.4	3.9	35,800	57.9	48,600	64.4
Sauk Creek.	2.3	3.3	2.8	4.0	9,600	74.4	10,400	77.4
Racine-Kenosha	46.1	29.1	49.4	31.2	209,400	92.2	221,200	93.0
Root River Canal	0.7	1.1	1.0	1.6	2,800	28.2	3,200	30.6
Des Plaines River	2.0	1.6	2.6	2.1	3,600	32.1	4,800	39.3
Upper Fox River	16.2	9.0	24.5	13.6	58,700	62.9	76,300	70.6
Lower Fox River	7.6	1.1	11.1	1.6	22,800	30.5	31,300	36.7
Upper Rock River.	2.2	1.2	2.6	1.4	8,500	40.4	9,700	38.6
Middle Rock River	3.3	1.7	4.4	2.2	13,000	36.3	16,500	39.7
Lower Rock River.	9.6	3.6	10.9	4.1	28,200	72.7	28,800	71.2
Region	309.4	11.5	353.5	13.1	1,488,700	84.8	1,544,000	86.3

Source: SEWRPC.

It is noted that the proportion of the total population served in the Milwaukee-Metropolitan subregional area was about 96 percent in 1975 and was 94 percent in 1970. Despite the fact that the total population served by sewers in the Milwaukee Metropolitan subregion remained nearly constant from 1970 to 1975, total average daily sewerage flow from within the Milwaukee Metropolitan subregional area increased from about 198 mgd in 1970 to about 219 mgd in 1975. On a per capita basis, this represents an increase in flow from 180 gallons per day in 1970 to about 200 gallons per day in 1975. That part of the total wastewater flow made up of infiltration and stormwater inflow in the separate and combined sewer service areas of the Milwaukee subregional area should not vary significantly with population declines in the central area of the City of Milwaukee, since such flows are directly related to rainfall. Thus, the stabilization in population in that subregional area has not reduced the need for the completion of programmed relief trunk sewers nor the need to resolve the combined sewer overflow and the sanitary sewer relief problems in the manner recommended in the regional sanitary sewerage system plan and in the comprehensive plan for the Milwaukee River watershed. The increase in per capita wastewater flows can largely be attributed to increasing per capita water consumption and perhaps due to sewerage system improvements resulting in increased interception of previously bypassed flows.

Of the total 353.5 square miles of area served by public sanitary sewers in the Region, about 26.1 square miles, or about 7 percent, consist of combined sewer service area where, by design, sanitary sewerage and stormwater are collected and conveyed in a single sewer system (see Map 25). About 21 of the 26 square miles of combined sewer service area are in the City of Milwaukee, about one square mile in the Village of Shorewood, and about two square miles each in the Cities of Kenosha and Racine.

Treatment for wastewater generated in the 95 centralized sanitary sewerage systems is provided at 61 wastewater treatment facilities throughout the Region, indicating that many systems are actually subsystems of larger systems that provide wastewater treatment on an intergovernmental contract and special purpose district basis (see Map 25). All but one of these 61 wastewater treatment facilities discharge treated wastes to the surface water of the Region. The remaining treatment plant serving the Village of Williams Bay discharges treated wastes to the groundwater reservoir through a seepage lagoon. In addition a portion of the effluent from the treatment plants operated by the Villages of Darien and Fontana on Geneva Lake are discharge to the groundwater through soil absorption lagoons. In 1970, two other treatment plants incorporated seepage lagoons for effluent disposal. However, since that time operational difficulties have necessitated use of these lagoons as flow through treatment units with discharges to surface waters at least a portion of the time. The wastewater treatment facilities range in size, as measured by average hydraulic design capacity from 0.03 mgd at the wastewater treatment facilities serving the Town of Somers Utility District No. 1 in Kenosha County, and the Village of Jackson in Washington County, to 200 mgd at the Jones Island wastewater treatment plant operated by the Milwaukee-Metropolitan Sewerage Commissions. Of the 61 wastewater treatment facilities, all were equipped to provide at least a secondary level of waste treatment, two were equipped to provide a tertiary level of waste treatment, and 31 were equipped to provide an advanced level of waste treatment. The level of treatment provided by the 61 wastewater treatment plants is indicated in Table 79.

As shown in Table 80, the total effluent discharged from municipal wastewater treatment plants in the Region during 1975 was about 293 mgd. Of this total, 254 mgd, or nearly 87 percent, were discharged directly to Lake Michigan while an additional 13 mgd, or an additional 4 percent, were discharged to streams draining directly to Lake Michigan. Clearly, the waters in the Lake Michigan basin bear the greatest burden of wastewater assimilation in the Region. The total wastewater treatment plant effluent discharged to streams west of the subcontinental divide and, therefore, in the Mississippi River basin, was about 25 mgd, or only about 8 percent of the total sewage effluent discharged in 1975 in the Region. The remaining wastewater which accounts for less than 0.1 percent of the regional total is discharged to the groundwater reservoir.

In addition to the 61 facilities providing treatment for wastes generated in the 95 centralized sanitary sewerage systems in the Region, there are a total of 67 wastewater treatment facilities generally serving isolated enclaves of urban land use development (see Map 25). Of these 67 small treatment plants, 27 are located in the Lake Michigan basin, and 40 in the Mississippi River basin. Twenty-eight of these treatment facilities serving isolated enclaves or urban land use development discharge effluent to the groundwater reservoir via seepage lagoons or via ridge and furrow or spray irrigation systems, and the 39 remaining plants discharge to the surface waters. Twenty-five of these facilities provide treatment for wastes predominantly industrial in nature, as opposed to domestic or sanitary. Thus, there are in all a total of 128 sewage treatment facilities in the Southeastern Wisconsin Region, of which all but 29 discharge wastes to the surface waters of the Region. The distribution of these wastewater treatment facilities by subregional area is summarized in Table 81. Comparable data relating to the number of treatment facilities in the Region for the year 1970—the data base year for the regional sanitary sewerage system plan—are also presented in Table 81. This data indicates a reduction in the number of public wastewater treatment facilities from 64 in 1970 to 61 in 1975, and an increase in the number of known private treatment facilities from 59 in 1970 to 67 in 1975.

Of the 61 municipal wastewater treatment plants serving the centralized sanitary sewerage systems in the Region, 17 were found to be operating over their design capacity when comparing annual average loading to the plant hydraulic capacity, indicating that the plant capacity is probably exceeded during both dry weather months and wet weather months or months of high groundwater. These plants accounted for about 40 mgd, or 13 percent of the average daily wastewater flow within the Region. It should be noted that in all of these instances, the communities operating the overloaded facilities have acted to either begin construction or engineering studies to provide new or expanded treatment facilities. In addition to the 17 municipal plants which are operating over their design capacity, based on average annual flow, there are 14 plants which exceeded their design flow during at least one monthly reporting period during the year, indicating that the facilities may be experiencing overloading only during periods of high wastewater flows due to wet weather or high groundwater conditions. These plants accounted for about 28.3 mgd, or about 10 percent of the average daily wastewater flow within the Region. Clear water infiltration and stormwater inflow into separate sanitary sewer systems are the primary causes of such peak flow bypassing and waste treatment problems, and are a major problem throughout the Region. The facilities operating over their hydraulic design capacity are shown on Table 82.

While a comparison between the average annual and maximum monthly hydraulic loadings and the average annual hydraulic design capacity provides one indication of possible existing and potential problems associated with wastewater treatment facilities, it is important to note that other facilities in the Region, while not overloaded when the average hydraulic loading is compared with the maximum monthly average hydraulic capacity, may be experiencing overloading during peak flow periods resulting in temporary bypassing of influent wastewater and greatly reduced efficiencies of wastewater treatment. Clear water infiltration and stormwater inflow into separate sanitary sewer systems are the primary causes of such peak flow bypassing and are a significant problem in many communities throughout the Region.

Limited data has been recorded by some communities relating to the frequency, volume, and quality of wastewater discharged to surface waters through flow relief devices. This information was generally developed in response to WPDES requirements or as part of the community's sewer system improvement program.

During the inventory process, appropriate officials from each community having public sanitary sewerage systems were asked to identify all known sewerage overflow, or relief, points located on either the separate or combined sewerage systems in order to determine the number of points at which untreated wastewater is presently discharged to surface waters in the Region, particularly during periods of wet weather and peak sewage flows. The results of that inventory are presented by sewerage system and summarized by subregional area in Table 83. Twenty-nine of the 61 public wastewater treatment facilities serving the Region had a flow relief device located

Table 79

LEVEL OF TREATMENT PROVIDED BY THE PUBLIC WASTEWATER TREATMENT PLANTS IN THE REGION: 1975

Name of Public Wastewater Treatment Facility	Level of Treatment Provided
Milwaukee-Metropolitan Subregional Area	
Jones Island	Secondary plus Advanced
South Shore	Secondary plus Advanced
Hales Corners	Secondary
City of Muskego	
Big Muskego Plant	Secondary plus Advanced
N.E. District Plant	Secondary plus Advanced
City of New Berlin (Regal Manor)	Secondary
City of South Milwaukee	Secondary plus Advanced
Village of Germantown	Secondary plus Advanced
Village of Menomonee Falls	
Pilgrim Road Plant	Secondary plus Advanced
Lily Road Plant	Secondary plus Advanced
Village of Thiensville	Secondary plus Advanced
Caddy Vista Sanitary District	Secondary
Rawson Homes Sewer and Water Trust	Secondary
Upper Milwaukee River Subregional Area	
City of Cedarburg	Secondary plus Advanced
City of West Bend	Secondary plus Advanced
Village of Fredonia	Secondary
Village of Grafton	Secondary plus Advanced
Village of Jackson	Secondary
Village of Kewaskum	Secondary plus Advanced
Village of Newburg	Secondary
Village of Saukville	Secondary
Sauk Creek Subregional Area	
City of Port Washington	Secondary plus Advanced
Village of Belgium	Secondary
Racine-Kenosha Subregional Area	
City of Kenosha	Secondary plus Advanced
City of Racine	Secondary plus Advanced
Village of Sturtevant	Secondary plus Advanced
Town of Somers Utility District No. 1	Secondary
North Park Sanitary District	Secondary plus Advanced
Pleasant Park Sewer Utility	Secondary plus Tertiary
Root River Canal Subregional Area	
Village of Union Grove	Secondary

at the sewage treatment plant that would allow for direct bypass of untreated wastewater at any time the plant capacity is exceeded or the plant is not operable for some reason. There are 590 additional known flow relief devices in the sanitary sewer systems tributary to the wastewater treatment plants within the Region. Of this total, 488 have been identified in the Milwaukee Metropolitan subregional area. It should be noted that the inventory could not assess in every case the amount of waste bypassed at a particular device or whether the device was even active during periods of high flow. Thus, some of the flow relief devices noted may not operate at all or only under very extreme hydraulic loading conditions.

It should be stressed that several problems were encountered in the conduct of this inventory which affect the findings as presented in Table 83. Several data sources were utilized to estimate the number of flow relief devices. These sources included WPDES reports, locally prepared planning reports, sewer system maps, and data reported by officials in charge of sanitary sewerage systems. Such data was not always available on a uniform data base time period and degree of accuracy basis. The number of sewage flow relief devices reported in Table 83 cannot be assumed to be a reliable and accurate inventory of all such devices within the Region. Rather, the data presented represents only an approximation of the total number of such devices.

Table 79 (continued)

Name of Public Wastewater Treatment Facility	Level of Treatment Provided
Des Plaines River Subregional Area	
Village of Paddock Lake	Secondary
Town of Bristol Utility District No. 1	Secondary
Town of Pleasant Prairie	
Sanitary District No. 73-1	Secondary
Sewer Utility District D	Secondary
Town of Salem Sewer Utility District No. 1	Secondary
Upper Fox River Subregional Area	
City of Brookfield	Secondary plus Advanced
City of Waukesha	Secondary plus Advanced
Village of Pewaukee	Secondary
Village of Sussex	Secondary
Lower Fox Subregional Area	
City of Burlington	Secondary plus Advanced
Village of East Troy	Secondary
Village of Genoa City	Secondary
City of Lake Geneva	Secondary plus Advanced
Village of Mukwonago	Secondary plus Advanced
Village of Silver Lake	Secondary
Village of Twin Lakes	Secondary plus Advanced
Western Racine County Sewerage District	Secondary plus Advanced
Upper Rock River Subregional Area	
City of Hartford	Secondary plus Advanced plus Tertiary
Village of Slinger	Secondary
Allenton Sanitary District No. 1	Secondary
Middle Rock River Subregional Area	
City of Oconomowoc	Secondary
Village of Dousman	Secondary
Village of Hartland	Secondary
Lower Rock River Subregional Area	
City of Delavan	Secondary
City of Elkhorn	Secondary
City of Whitewater	Secondary
Village of Darien	Secondary
Village of Fontana	Secondary
Village of Sharon	Secondary
Village of Walworth	Secondary
Village of Williams Bay	Secondary

Source: Wisconsin Department of Natural Resources and SEWRPC.

Particularly good records of the existence of such devices were found in several municipalities within the Milwaukee Metropolitan subregional area, and may account, therefore, for the preponderance of such devices allocated to this area in Table 83. It should be recognized, however, that the sewer service area in the Milwaukee Metropolitan area approximates 65 percent of the total area served in the Region and that the systems in this area are among the oldest in the Region. Therefore, it is expected that the majority of sewage flow devices would be found to occur in the Milwaukee Metropolitan subregion. Of the 590 such devices in the Region, not including bypasses or relief pumping stations at wastewater treatment plants, 126 are combined sewer outfalls located in the Cities of Kenosha, Milwaukee, Racine, and the Village of Shorewood; 271 are gravity crossovers from the separate sanitary sewer system to a storm sewer system; 81 are gravity bypasses from the separate system directly to surface watercourses; 40 are relief pumping stations, pumping wastewater from the separate sanitary sewer system directly to surface watercourses; and 72 are portable pumping stations, also utilized to pump wastewater from the separate sewer system to the surface watercourses. Ideally, all

Table 80

DISTRIBUTION OF PUBLIC WASTEWATER TREATMENT PLANT EFFLUENT DISCHARGE AND POPULATION SERVED BY PUBLIC SANITARY SEWERAGE SYSTEMS BY RECEIVING WATER SYSTEM IN THE REGION: 1975

Receiving Water System	Wastewater Treatment Plant Effluent Discharge		Estimated Population Served	
	MGD	Percent of Total	Number	Percent of Total
Lake Michigan-St. Lawrence River Drainage System				
Lake Michigan	254.43	87.1	1,267,900	82.2
Milwaukee River Watershed	7.78	2.7	52,800	3.4
Menomonee River Watershed	2.98	1.0	25,000	1.6
Root River Watershed	1.38	0.5	19,600	1.2
Pike River Watershed	0.59	0.2	5,100	0.3
Sheboygan River Watershed	0.07	0.0	900	0.1
Subtotal	267.23	91.5	1,371,300	88.8
Mississippi River Drainage System				
Des Plaines River Watershed	0.45	0.1	4,800	0.3
Fox River Watershed	18.16	6.0	114,700	7.4
Rock River Watershed	6.67	2.3	51,500	3.4
Subtotal	25.28	8.4	171,000	11.1
Total Discharge to Surface Water System	291.81	99.9	1,542,300	99.9
Discharge to Groundwater Reservoir	0.20	0.1	1,700	0.1
Total Discharge	292.71	100.0	1,544,000	100.0

sewage flow relief points on the separate sanitary sewer system should be eliminated through the construction of relief sewers and, as necessary, the provision of additional treatment plant capacity. The combined sewer outfalls pose a special problem in that combined sewer overflows need to be either collected at the outfall points and conveyed, either directly or after temporary storage to either one or more special treatment facilities, or eliminated through a sewer separation program.

In order to develop an estimate of the magnitude of the pollutant loading attributable to the discharge of wastewater from the flow relief devices, the available data on the bypass frequency, quantity, and quality was examined. It was necessary to use average values of flow bypass quantity and quality to characterize the loadings from devices where no data was available. The annual discharge of wastewater to the Region's surface waters through flow relief devices was estimated to be 5,044 mg of which 3,893 mg was attributed to combined sewer overflows, and 1,051 mg was attributable to other flow relief devices.

In addition to identifying all existing public and private wastewater treatment plants which discharge treated wastes to streams and watercourses within the Region, and all known wastewater overflow points on both the existing sanitary and combined sewerage systems within the Region which discharge untreated wastes to streams and watercourses, an attempt was made in the regional sanitary sewerage system planning program to identify, through existing secondary sources, all other known point sources of wastewater discharge. These other point sources of pollution consist primarily of industrial cooling, process, rinse, and wash waters, which in many cases may be discharged directly and without treatment to streams and watercourses or to storm sewers tributary to such streams and watercourses. The

Table 81

DISTRIBUTION OF WASTEWATER TREATMENT FACILITIES IN THE REGION BY SUBREGIONAL AREA: 1970 AND 1975

Subregion	Number of Sewerage Treatment Facilities								
	Serving Public Sanitary Sewerage Systems			Serving Isolated Urban Land Use Enclaves			Total		
	1970	1975	Percent Increase	1970	1975	Percent Increase	1970	1975	Percent Increase
Milwaukee-Metropolitan. . . .	16	13	-18.8	14	11	-21.4	30	24	-20.0
Upper Milwaukee River	8	8	0.0	4	5	25.0	12	13	8.3
Sauk Creek	2	2	0.0	2	3	50.0	4	5	25.0
Racine-Kenosha	6	6	0.0	5	5	0.0	11	11	0.0
Root River Canal	1	1	0.0	7	6	-14.3	8	7	-8.3
Des Plaines River	4	5	25.0	6	8	33.3	10	13	30.0
Upper Fox River.	5	4	-20.0	4	5	25.0	9	9	-10.0
Lower Fox River	8	8	0.0	8	13	62.5	16	21	31.0
Upper Rock River.	3	3	0.0	2	3	50.0	5	6	20.0
Middle Rock River	3	3	0.0	3	3	0.0	6	6	0.0
Lower Rock River.	8	8	0.0	4	5	25.0	12	13	8.3
Regional Total	64	61	-4.7	59	67	13.6	123	128	4.1

Source: SEWRPC.

secondary sources consulted included river basin survey reports and pollution abatement orders of the Wisconsin Department of Natural Resources, and records of municipal public works departments. A total of 277 known establishments which have a total of 452 outfalls discharging wastewater were identified in the Region. The location of these point sources in each subregional area is shown in Table 84.

An important aspect of the inventory of existing sanitary sewerage systems in the Region relates to sewerage system expenditures. It was initially intended to develop a time series of such expenditures utilizing the uniform audit reports required by the Wisconsin Department of Administration, Bureau of Municipal Audit. A review of these reports revealed, however, obvious nonuniformity of reporting, including in some cases nonreporting, particularly with respect to capital versus operating and maintenance expenditures. The audit reports were not considered, therefore, for the purpose of tabulating accurately expenditures made over a period of years in each of the 95 centralized sanitary sewerage systems in the Region. Accordingly, it was determined to pursue an alternate means of obtaining accurate and reliable data for 1975 directly from the local public officials responsible for management of each sanitary sewerage system. The results of that inventory are presented in summary form in Table 85.

Total expenditures during 1975 for operation, maintenance, and capital improvements, including debt retirement, for the sanitary sewerage system in the Region approximated $60.0 million, or about $40.00 per capita, such per capita cost based upon the estimated total population within the Region served by sanitary sewers. Of this total, about $17.9 million, or about $12.00 per capita, was expended for operation and maintenance, and about $42.1 million, or about $28.00 per capita, was expended for capital improvements. Total expenditures during 1975 on a per capita basis ranged from a low of $9.00 in the Village of Belgium to a high of $852.00 in the Town of Pleasant Prairie Sanitary District No. 73-1, which is a recently constructed system with a relatively low initial served population.

Capital expenditures during 1975 on a per capita basis ranged from a low of $1.00 in the City of South Milwaukee, to a high of $664.00 in the Town of Pleasant Prairie Sanitary District No. 73-1. Operation and maintenance expenditures during 1975 ranged from a low of $5.00 per capita in the City of Franklin and the Village of Jackson to a high of $188.00 per capita in the Town of Pleasant Prairie Sanitary District No. 73-1.

The data in Table 85 represent the cost records as maintained by each municipality and reported directly to the Commission. Caution should be exercised in utilizing the data to make comparisons on a community-by-community basis. There is no assurance that the data have been reported on a strictly uniform basis. For example, different criteria may have been used locally to determine whether to report a given expenditure as a capital

Table 82

PUBLIC WASTEWATER TREATMENT FACILITIES OPERATING AT OR OVER AVERAGE HYDRAULIC DESIGN CAPACITIES IN THE REGION BY SUBREGIONAL AREA: 1975

Subregional Area	Name of Public Wastewater Treatment Facility	Average Hydraulic Design Capacity (MGD)	Annual Average Hydraulic Loading (MGD)	Maximum Monthly Average Loading (MGD)	Percent Maximum Monthly Average Loading is Over Design Capacity
Milwaukee-Metropolitan	City of Muskego-Big Muskego Plant.	0.70	0.58	0.88	25.7
	-Northeast District Plant. . . .	0.50	0.34	0.51	2.0
	Village of Germantown	1.00	0.80	1.06	6.0
	Village of Menomonee Falls-Lily Road Plant	1.00	0.78	1.02	2.0
	Village of Thiensville	0.24	0.57	1.02	325.0
Upper Milwaukee River	City of West Bend	2.50	3.70	4.20	68.0
	Village of Fredonia	0.12	0.28	0.37	208.3
	Village of Grafton.	1.00	0.88	1.05	5.0
	Village of Jackson.	0.03	0.26	0.28	833.3
	Village of Newburg	0.05	0.07	0.07	40.0
	Village of Saukville	0.28	0.29	0.42	50.0
Sauk Creek	City of Port Washington	1.25	1.70	2.10	68.0
	Village of Belgium.	0.07	0.07	0.10	42.9
Kenosha-Racine	City of Kenosha	18.00	18.40	20.80	15.6
	City of Racine	23.00	19.69	24.65	7.2
	Village of Sturtevant	0.30	0.53	0.83	176.7
	Town of Somers Utility District No. 1	0.03	0.06	0.09	200.0
	Pleasant Park Sewer Utility.	0.06	0.04	0.08	33.3
Root River	Village of Union Grove	0.30	0.43	0.59	96.7
Des Plaines River	Village of Paddock Lake	0.32	0.17	0.36	12.5
	Town of Pleasant Prairie Sewer Utility District D	0.13	0.10	0.17	30.8
Upper Fox River	City of Waukesha	8.50	9.90	11.98	40.9
	Village of Sussex.	0.30	0.47	0.62	106.7
Lower Fox River	Village of Mukwonago	0.22	0.44	0.60	172.7
Upper Rock River	Village of Slinger	0.15	0.15	0.29	93.3
	Allenton Sanitary District	0.10	0.08	0.11	10.0
Middle Rock River	City of Oconomowoc.	1.50	1.90	2.33	55.3
	Village of Dousman	0.12	0.11	0.13	8.3
	Village of Hartland	0.35	0.42	0.50	42.9
Lower Rock River	City of Elkhorn	0.50	0.69	1.37	174.0
	Village of Darien.	0.15	0.14	0.18	20.0

Source: Wisconsin Department of Natural Resources and SEWRPC.

expenditure or as an operation and maintenance cost hence, similar expenditures in two communities may be reported as a capital cost in one community and an operation and maintenance cost in the other community. Also, in some cases, communities may have included in their reports operation, maintenance and/or capital costs directly related to storm sewerage systems. In addition to these problems of nonconformity of reporting, it must be realized that the data presented in no way reflect the level of the sewerage service being provided, particularly with respect to the level of treatment provided. It also should be recognized that those communities with new systems or currently undergoing rapid development or redevelopment may be experiencing disproportionately high expenditures for capital improvements. For example, the very high per capita improvement costs noted in 1975 in the Cities of Franklin and Mequon include contract expenditures during calendar year 1975 for sewerage projects. Similarly, it should be noted that the distribution of land uses within communities affects per capita costs. For example, there is a relatively high per capita operation and maintenance cost for the Village of West Milwaukee. This is to be expected since the Village experiences high wastewater flows due to the large amount of industrial and commercial land use development within the community, coupled with a relatively low resident population.

The data presented in Table 85 relate only to one year. Therefore, with respect to data for any given individual sanitary sewerage system and subject to the aforementioned qualifications in using the data in making comparisons of variations in sewerage costs between communities, it is reasonable to

Table 83

DISTRIBUTION OF KNOWN SEWAGE FLOW RELIEF DEVICES IN THE REGION BY SANITARY SEWERAGE SYSTEM: 1975

Sanitary Sewerage System	Sewage Treatment Plant Flow Relief Device (Number and Type)	Sewage Flow Relief Devices in Sewer Systems					
		Crossovers	Bypasses	Relief Pumping Stations	Portable Pumping Stations	Combined Sewer Outfalls	Total
Milwaukee-Metropolitan . . .	3 Bypasses	235	37	37	67	112	488
Upper Milwaukee River. . . .	3 Bypasses	--	4	1	--	--	5
Sauk Creek.	2 Bypasses	--	5	--	--	--	5
Racine-Kenosha.	3 Bypasses	36	21	2	--	14	73
Root River Canal.	1 Bypass	--	--	--	--	--	--
Des Plaines River	3 Bypasses	--	--	--	--	--	--
Upper Fox River	1 Bypass	--	7	--	5	--	12
Lower Fox River.	4 Bypasses	--	--	--	--	--	--
Upper Rock River	None	--	--	--	--	--	--
Middle Rock River.	3 Bypasses	--	3	--	--	--	3
Lower Rock River	6 Bypasses	--	4	--	--	--	4
Region Total	29	271	81	40	72	126	590

Source: SEWRPC.

Table 84

POINT SOURCES OF WASTEWATER OTHER THAN WASTEWATER TREATMENT PLANTS: 1975

Subregional Area	Number of Point Sources Other Than Sewage Treatment Plants
Milwaukee-Metropolitan . . .	163
Upper Milwaukee River. . . .	21
Sauk Creek.	6
Kenosha-Racine.	21
Root River Canal.	6
Des Plaines River	2
Upper Fox River	20
Lower Fox River	14
Upper Rock River	4
Middle Rock River.	7
Lower Rock River	13
Region Total	277

Source: SEWRPC.

assume that, because they include both average and extreme situations, the county and regional average represent valid per capita cost for a typical year. This would be particularly true with respect to the operation and maintenance costs. As noted above, the average per capita cost for operation and maintenance of sanitary sewerage systems during 1975 was $12.00. On a subregional basis, such per capita costs ranged from $9.00 in the Middle Rock River subregional area to $27.00 in the Des Plaines River subregional area. The per capita operation and maintenance costs for each reporting system in the Region during 1975 are depicted in a scatter diagram reproduced as Figure 64. From this it may be

Table 85

ESTIMATED SANITARY SEWERAGE EXPENDITURES IN THE REGION BY PUBLIC SANITARY SEWERAGE SYSTEM: 1975

Public Sanitary Sewerage System	Estimated Population Served	Sanitary Sewerage Expenditures					
		Operation and Maintenance		Capital Improvements Including Debt Retirement		Total	
		Dollars	Dollars Per Capita	Dollars	Dollars Per Capita	Dollars	Dollars Per Capita
Milwaukee Metropolitan Subregional Area							
City of Brookfield	16,300	234,450	14	905,850	56	1,140,300	70
City of Cudahy	21,700	334,163	15	367,068	17	701,231	32
City of Franklin	8,800	47,736	5	1,852,292	211	1,900,028	216
City of Glendale	13,500	186,338	14	575,578	43	761,916	57
City of Greenfield	29,900	210,257	7	1,076,659	36	1,286,916	43
City of Mequon	9,500	149,034	16	1,399,013	147	1,548,047	163
City of Milwaukee	670,100	8,655,940	13	14,214,907	21	22,870,847	34
City of Muskego	10,200	95,939	9	160,000	16	255,939	25
City of New Berlin	13,600	130,412	10	765,450	56	895,862	66
City of Oak Creek	14,400	472,552	33	618,167	43	1,090,719	76
City of South Milwaukee	23,400	316,600	14	29,525	1	346,125	15
City of St. Francis	9,900	92,525	9	110,750	11	203,275	20
City of Wauwatosa	55,700	469,468	8	1,256,952	23	1,726,420	31
City of West Allis	69,000	646,809	9	1,902,956	28	2,549,765	37
Village of Bayside	4,400	41,516	10	111,530	25	153,046	35
Village of Brown Deer	13,600	105,836	8	215,362	16	321,198	24
Village of Butler	2,100	27,605	13	49,169	23	76,774	36
Village of Elm Grove	7,000	87,585	13	148,686	21	236,271	34
Village of Fox Point	7,900	68,504	9	173,217	22	241,721	31
Village of Germantown	4,600	N/A	- -	N/A	- -	N/A	- -
Village of Greendale	16,800	143,132	8	413,485	25	556,617	34
Village of Hales Corners	8,800	56,862	6	252,623	29	309,485	35
Village of Menomonee Falls	20,400	N/A		N/A		N/A	
Village of River Hills	1,500	29,115	19	198,936	133	228,051	152
Village of Shorewood	14,300	122,742	9	222,181	15	344,923	24
Village of Thiensville	4,200	68,855	16	10,950	3	79,805	19
Village of West Milwaukee	3,800	264,689	70	327,011	86	591,700	156
Village of Whitefish Bay	16,200	99,177	6	283,694	18	382,871	24
Caddy Vista Sanitary District	1,000	14,862	15	6,200	6	21,062	21
Rawson Homes Sewer and Water Trust	600	N/A	- -	N/A	- -	N/A	- -
Subregional Area Subtotal	1,093,200	13,172,703	12	27,648,211	26	40,820,714	38

concluded that, in general, operation and maintenance costs for sanitary sewerage systems decrease with increasing system size.

Comparable regional data relating to sanitary sewerage system expenditures for the year 1970—the data base year for the sanitary sewerage system plan—is presented in Table 86. It is noted that the regional average annual costs for operation, maintenance, and capital improvements increased from $29.00 per capita in 1970 to $40.00 per capita in 1975, representing an increase of about 38 percent over the five-year period. Annual costs expended for operation and maintenance increased from $6.00 per capita in 1970 to $12.00 per capita in 1975, representing an increase of 100 percent, while the annual expenditures for capital improvements rose from $23.00 per capita in 1970 to $28.00 per capita in 1975, representing an increase of 22 percent. These increases in expenditures can be expected due to inflation factors as well as the increased costs of construction and operation and maintenance for providing a higher level of treatment.

As noted earlier, centralized sanitary sewerage systems in the Region serve a total area of about 353 square miles, or about 13 percent of the total area of the Region, and a total population of 1.54 million persons, or 86.3 percent of the total population of the Region. The remaining 13.7 percent of the total Region population, or about 246,000 persons rely on onsite sewage disposal. Of this total, about 113,500 persons, or about 6 percent of the total regional population, reside in significant concentrations of urban development (see Table 88). These scattered quarter sections of urban concentrations

Table 85 (continued)

Public Sanitary Sewerage System	Estimated Population Served	Sanitary Sewerage Expenditures: Operation and Maintenance: Dollars	Operation and Maintenance: Dollars Per Capita	Capital Improvements Including Debt Retirement: Dollars	Capital Improvements Including Debt Retirement: Dollars Per Capita	Total: Dollars	Total: Dollars Per Capita
Upper Milwaukee River Subregional Area							
City of Cedarburg	10,400	154,721	15	149,533	15	304,254	30
City of West Bend	21,000	200,242	9	248,775	12	449,017	21
Village of Fredonia	1,500	16,084	11	9,000	6	25,084	17
Village of Grafton	8,800	175,430	20	37,335	4	212,765	24
Village of Jackson	2,000	9,138	5	26,752	13	35,890	18
Village of Kewaskum	2,000	84,961	42	17,761	9	102,722	51
Village of Newburg	600	13,345	22	9,765	16	23,110	38
Village of Saukville	2,300	52,045	23	22,531	10	74,576	33
Subregional Area Subtotal	48,600	705,966	14	521,452	11	1,227,418	26
Sauk Creek Subregional Area							
City of Port Washington	9,500	133,163	14	115,418	12	248,581	26
Village of Belgium	900	4,800	6	3,000	3	7,800	9
Subregional Area Subtotal	10,400	137,963	13	118,418	11	256,381	24
Kenosha-Racine Subregional Area							
City of Kenosha	83,400	748,800	9	963,000	12	1,711,800	21
City of Racine	96,700	915,843	10	9,200,300	95	10,116,143	105
Village of Elmwood Park	400	N/A	--	N/A	--	N/A	--
Village of North Bay	1,300	N/A	--	N/A	--	N/A	--
Village of Sturtevant	4,400	101,430	23	37,591	9	139,021	32
Town of Caledonia Sewer Utility District	4,300	59,000	14	142,600	33	201,600	47
Town of Mt. Pleasant	13,800	99,481	7	256,856	19	356,337	26
Town of Pleasant Prairie—		17,388	4	49,252	11	66,640	15
Sewer Utility District 1	1,600	--	--	--	--	--	--
Sewer Utility District 2	600	--	--	--	--	--	--
Sewer Utility District A	400	--	--	--	--	--	--
Sewer Utility District B	1,100	--	--	--	--	--	--
Sewer Utility District C	700	--	--	--	--	--	--
Sewer Utility District E	200	--	--	--	--	--	--
Town of Somers Sanitary District 1	1,500	32,322	22	48,666	32	80,988	54
Town of Somers Utility District 1	700	14,000	20	3,669	5	17,669	25
Crestview Sanitary District	2,500	N/A	--	N/A	--	N/A	--
North Park Sewer Utility District	6,800	N/A	--	N/A	--	N/A	--
Pleasant Park Utility Co.	800	N/A	--	N/A	--	N/A	--
Subregional Area Subtotal	221,200	1,988,264	10	10,701,934	51	12,690,198	61
Root River Canal Subregional Area							
Village of Union Grove	3,200	46,031	15	20,373	6	66,404	21
Subregional Area Subtotal	3,200	46,031	15	20,373	6	66,404	21

total about 144.9 square miles of urban land use on a quarter section basis, or about 5 percent of the area of the Region (see Map 25).

As already noted, an inventory was also conducted of all local plans and engineering reports relating to the future provision of sanitary sewer service in the Region. As shown in Table 87, local units of government in the Region have proposed the extension of sanitary sewer service to about an additional 372 square miles of land throughout the Region. This can be compared to the approximately 353 square miles of area in the Region now served by centralized sanitary sewers. If it is assumed that urban development would take place throughout the locally proposed sewer service area at an average overall population

Table 85 (continued)

Public Sanitary Sewerage System	Estimated Population Served	Sanitary Sewerage Expenditures: Operation and Maintenance — Dollars	Operation and Maintenance — Dollars Per Capita	Capital Improvements Including Debt Retirement — Dollars	Capital Improvements Including Debt Retirement — Dollars Per Capita	Total — Dollars	Total — Dollars Per Capita
Des Plaines River Subregional Area							
Village of Paddock Lake	1,900	59,293	31	48,705	26	107,998	57
Town of Bristol Utility District 1	800	7,089	9	13,350	17	20,439	26
Town of Pleasant Prairie Sewer Utility District D	1,000	17,408	17	34,144	34	51,552	51
Town of Pleasant Prairie Sanitary District 73-1	100	18,833	188	66,375	341	85,208	852
Town of Salem Sewer Utility District 1	1,000	N/A	--	N/A		N/A	--
Subregional Area Subtotal	4,800	102,623	27	162,574	43	265,197	70
Upper Fox River Subregional Area							
City of Brookfield	16,200	240,700	15	892,600	55	1,133,300	70
City of Waukesha	51,300	389,200	8	390,385	8	779,585	16
Village of Pewaukee	4,800	63,997	14	143,745	30	207,742	44
Village of Sussex	4,000	43,867	11	8,883	3	52,750	14
Subregional Area Subtotal	76,300	737,764	10	1,435,613	19	2,173,377	29
Lower Fox River Subregional							
City of Burlington	8,900	N/A	--	N/A	--	N/A	--
City of Lake Geneva	5,700	69,660	12	303,650	53	373,310	66
Village of East Troy	2,200	59,710	27	0	0	59,710	28
Village of Genoa City	1,100	17,342	16	6,995	6	24,337	23
Village of Mukwonago	3,400	32,063	9	5,060	2	37,123	11
Village of Rochester	800	3,495	4	29,445	37	32,940	
Village of Silver Lake	1,300	30,362	24	67,720	52	98,082	76
Village of Twin Lakes	3,400	69,469	20	239,624	71	309,093	91
Village of Waterford	2,300	21,803	10	44,657	19	66,460	
Town of Rochester Sewer Utility District No. 1	300	3,335	11	8,496	28	11,831	58
Brown's Lake Sanitary District	1,900	43,393	23	66,000	35	109,393	58
Subregional Area Subtotal	31,300	350,632	16	771,647	34	1,122,279	50

density equal to 5,000 persons per square mile, the average population density for new development as recommended in the adopted regional land use plan, the locally proposed sewer service area could be expected to accommodate a future population increment of about 1.8 million persons. Thus, locally proposed sewer service areas in the Region already contain enough area to nearly double the population of the Region. Even the most optimistic population forecasts indicate an increase in the population of the Region over the next 25-year period of no more than one million persons. Clearly, there is a need to better coordinate land use development with sewer service. The most appropriate vehicle for providing such coordination is the adopted regional land use plan.

Of particular importance in the planning and design of sanitary sewerage systems are the characteristics of the wastewater to be collected and treated, including the rate and volume of flow and the concentration of contaminants. Several investigations were made under the areawide water quality management planning program to determine the flow and strength characteristics of wastewater generated within the Region. Such characteristics will be utilized, together with widely accepted engineering standards and experienced engineering judgement, as a basis for the selection of sewerage system design criteria presented in SEWRPC Planning Report No. 30, A Water Quality Management Plan for Southeastern Wisconsin.

The principal sources of sanitary wastewater are spent municipal water supply, groundwater infiltration, and stormwater inflow. Analyses conducted under the regional sanitary sewerage system planning program indicated the following average conditions for the Region with respect to wastewater flow components:

Table 85 (continued)

Public Sanitary Sewerage System	Estimated Population Served	Sanitary Sewerage Expenditures: Operation and Maintenance: Dollars	Operation and Maintenance: Dollars Per Capita	Capital Improvements Including Debt Retirement: Dollars	Capital Improvements Including Debt Retirement: Dollars Per Capita	Total: Dollars	Total: Dollars Per Capita
Upper Rock River Subregional Area							
City of Hartford	7,600	179,371	24	120,499	16	299,870	40
Village of Slinger	1,300	31,750	24	6,597	5	38,347	29
Allenton Sanitary District	800	N/A	--	N/A	--	N/A	--
Subregional Area Total	9,700	211,121	24	127,096	14	338,217	38
Middle Rock River Subregional Area							
City of Oconomowoc	11,100	89,477	8	72,311	7	161,788	15
Village of Dousman	1,000	15,112	15	14,139	14	29,251	29
Village of Hartland	4,400	51,225	11	7,161	2	58,386	13
Subregional Area Total	16,500	155,814	9	93,611	6	249,425	15
Lower Rock River Subregional Area							
City of Delavan	5,800	65,998	11	113,320	20	179,318	31
City of Elkhorn	4,400	56,815	13	206,419	47	263,234	60
City of Whitewater	11,000	168,819	15	197,122	18	365,941	33
Village of Darien	1,000	N/A	--	N/A	--	N/A	--
Village of Fontana	1,800	N/A	--	N/A	--	N/A	--
Village of Sharon	1,400	21,266	15	13,820	10	35,086	25
Village of Walworth	1,700	N/A	--	N/A	--	N/A	--
Village of Williams Bay	1,700	N/A	--	N/A	--	N/A	--
Subregional Area Subtotal	28,800	312,898	14	530,681	23	843,579	37
Region Total	1,544,000	17,921,779	12	42,131,610	28	60,053,387	40

Source: SEWRPC.

1. Average amount of domestic wastewater flow contributed by all urban land uses except major industrial and commercial concentrations and based upon water delivery records: 89 gallons per capita per day, based on an average of all the reported per capita usage at the various communities within the Region, and 108 gallons per capita per day when dividing the total regional domestic water consumption by the total population served.

2. Average amount of wastewater flow contributed by major concentrations of industrial land uses: 17 gpcd (or about 10,000 gallons per day per acre) based upon an average of all the reported per capita contributions at the various treatment plants within the Region, and 65 gpcd when dividing the total estimated industrial regional wastewater flow by the total population served.

3. Average amount of regional wastewater flow contributed by major concentrations of commercial land uses: 15 gpcd (or 4,000 gallons per day per acre) based upon an average of all the reported per capita contributions at the various treatment plants within the Region and 20 gpcd when dividing the total estimated commercial regional wastewater flow by the total population served.

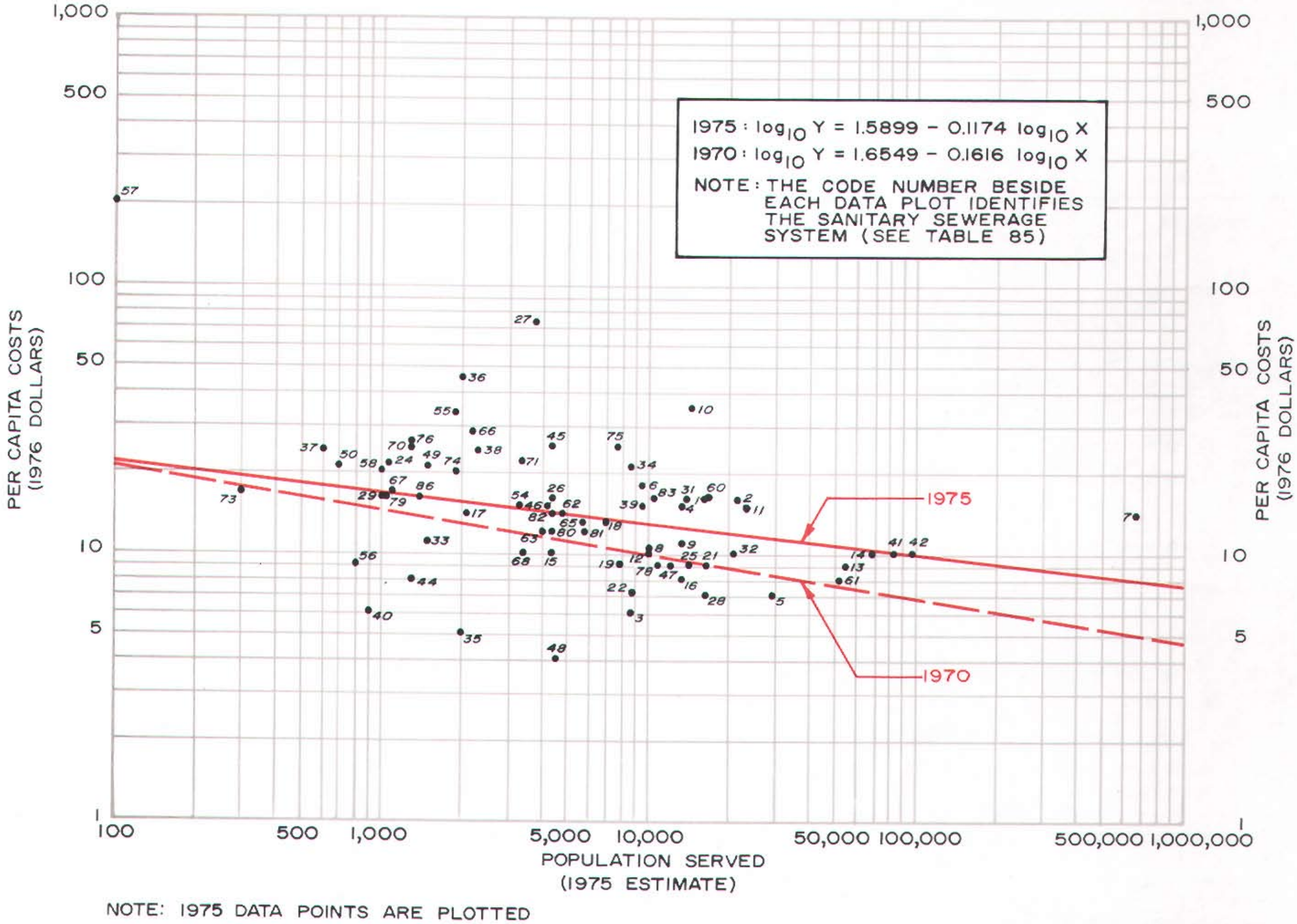
4. Average infiltration rate: 84 gpcd, or 0.40 gallons per minute per gross developed acre.

5. Average stormwater inflow rate: 125 gpcd, or 0.59 gallons per minute per gross developed acre.

6. Peak-to-average flow rates: 1.37 to 1 for a peak monthly average to annual average basis, and 1.75 to 1 on a maximum daily to annual average basis.

Figure 64

RELATIONSHIP BETWEEN SANITARY SEWERAGE OPERATION AND MAINTENANCE EXPENDITURES AND SEWERAGE SYSTEM SIZE IN THE REGION: 1975



Source: SEWRPC.

Table 86

ESTIMATED SANITARY SEWER SYSTEM EXPENDITURES IN THE REGION: 1970 AND 1975

Year	Estimated[a] Population Served	Sanitary Sewerage Expenditures					
		Operation and Maintenance		Capital Improvements Including Debt Retirement		Total	
		Dollars	Dollars Per Capita	Dollars	Dollars Per Capita	Dollars	Dollars Per Capita
1970	1,488,700	9,390,804	6	33,672,947	23	43,063,751	29
1975	1,544,000	17,921,779	12	42,131,610	28	60,053,539	40
Percent Increase 1970-1975	4	91	100	25	22	39	38

[a]*In calculating the per capita costs on a county basis, only that aggregate population in those communities providing expenditure data was included.*

Source: SEWRPC.

Table 87

LOCALLY PROPOSED ADDITIONAL SANITARY SEWER SERVICE AREAS IN THE REGION BY SUBREGIONAL AREA: 1975

Subregion	Proposed Sewer Service Area	
	Square Miles	Percent of Subregion
Milwaukee-Metropolitan . . .	105.67	25
Upper Milwaukee River. . . .	9.68	3
Sauk Creek	12.52	18
Racine-Kenosha.	55.14	35
Root River Canal.	3.33	5
Des Plaines River	2.97	2
Upper Fox River	71.07	39
Lower Fox River	40.31	6
Upper Rock River	7.63	4
Middle Rock River.	50.35	26
Lower Rock River	13.96	5
Region Total	322.64	14

Source: SEWRPC.

Table 88

NONSEWERED URBAN DEVELOPMENT: 1975

Subregional Area	Population		Quarter Section Square Miles	
	Number	Percent of Subregional Area Population	Number	Percent of Subregional Area
Milwaukee-Metropolitan . . .	30,000	3	22.1	5
Upper Milwaukee River	7,000	9	11.2	3
Sauk Creek	100	1	0.3	1
Racine-Kenosha	4,500	2	6.9	4
Root River Canal	1,000	10	1.2	2
Des Plaines River	1,700	14	2.0	2
Upper Fox River	20,300	19	20.6	11
Lower Fox River	25,100	29	43.3	6
Upper Rock River.	5,500	22	6.5	4
Middle Rock River	13,400	32	21.1	11
Lower Rock River	4,900	13	9.7	4
Region Total	113,500	6	144.9	5

Source: SEWRPC.

While variation in wastewater strengths is not as critical a consideration in regional sanitary sewerage system planning as variations in wastewater flow rates, a knowledge of wastewater strength characteristics is required to determine the necessary type and level of treatment to be provided and the potential effects of effluent discharges on the quality of the receiving stream. Indicators commonly used today, but not necessarily historically, to measure the strength of sewage are concentrations of oxygen-demanding materials, nutrients, suspended solids, and the pH—that is, the relative acidity and alkalinity—of the sewage. Analyses conducted under the regional sanitary sewerage system planning program indicated the following average conditions for the Region with respect to sewage strength characteristics:

1. Average five-day biochemical oxygen demand value: 0.164 pounds per capita per day.
2. Average suspended solids value: 0.193 pounds per capita per day.
3. Average total phosphorus value: 0.010 pounds per capita per day.
4. Average organic nitrogen value: 0.011 pounds per capita per day.
5. Average ammonia nitrogen value: 0.016 pounds per capita per day.

When the regional per capita values are calculated on a population weighted basis reflecting the total estimated pollutant loading divided by the corresponding service area population, the regional pollutant per capita contributions are as follows:

BOD_5: 0.494 pound per capita per day.

Suspended Solids: 0.528 pound per capita per day.

Total Phosphorus: 0.011 pound per capita per day.

Organic Nitrogen: 0.009 pound per capita per day.

Ammonia Nitrogen: 0.016 pound per capita per day.

Chapter IV

EXISTING URBAN STORM WATER DRAINAGE SYSTEMS

INTRODUCTION

A network of storm water drainage facilities consisting of many individual systems presently serves existing urban land use development in the Region. Storm water drainage facilities are defined for the purposes of this report as conveyances—including, but not limited to, subsurface pipes and conduits, ditches, channels, and appurtenant inlet, outlet, storage, and pumping facilities—located in urbanized areas, and constructed or improved and operated for purposes of collecting storm water runoff from tributary developed areas, and conveying such runoff to natural watercourses for disposal. In the larger and more intensely developed urban communities of the Region, these facilities generally consist of complete, largely piped, storm water drainage systems which have been planned, designed, and constructed in a manner similar to sanitary sewer and water utility systems. In other smaller and less intensely developed urban communities, these facilities tend to consist of fragmented or partially piped systems incorporating open surface channels to as great a degree as possible. In such communities, subsurface conduits are generally installed as appurtenances to street construction or maintenance programs rather than as separate utility systems.

The more extensive storm sewer systems occur in the older and larger urban areas of the Region such as in the Cities of Milwaukee, Racine, and Kenosha. In these communities the basic storm water drainage systems were originally constructed in the form of combined storm and sanitary sewers. In more recent years additions to these systems were made on a separate basis. In addition, programs of separating the existing combined systems were instituted along with other measures to reduce the discharge of combined sanitary sewage and storm water to natural watercourses during rainfall or snowmelt periods.

When first built within the Region—beginning in the late 1840's—sewers served essentially as urban storm water drains carrying storm water and snowmelt runoff. Because the runoff from streets was recognized to carry obnoxious substances, particularly animal wastes, the design of storm sewer systems generally included catch basins. As draft animals were replaced by automotive vehicles, emphasis was placed on utilizing the water from rain storms to develop self-cleaning sewers which could function without the significant maintenance requirements associated with catch basins. This practice has reduced the need for catch basins to prevent solids buildup within the sewers, and in the newer storm sewer systems such catch basins were replaced by inlets, even as new knowledge of surface water chemistry began to emphasize that storm water collects and carries many substances potentially harmful to natural aquatic systems. Besides the potential direct threat to surface water quality from pollutants carried through urban drainage facilities, there exists a potential indirect threat to water quality, caused by inadequate storm water drainage facilities which, through street and basement flooding, contribute flows to existing separate sanitary sewerage systems, thereby contributing to sewer surcharging and sanitary sewage bypassing.

Because of these direct and indirect relationships between urban storm water drainage systems and surface water quality, the Commission areawide water quality management planning effort included an inventory and evaluation of the existing urban storm water drainage systems within the Region. The effort included an inventory of the location, and tributary drainage area of all significant urban storm sewer outfalls and estimation of the frequency, amount, and probable quality of the associated discharges.

The inventory included a determination of the general configuration of the existing piped storm water drainage facilities, associated urban drainage channels, and appurtenant pumping stations and storage facilities.

This chapter presents the results of this inventory of existing urban storm water drainage systems. Included in this chapter is a descriptive analysis of all existing urban storm water drainage systems, excluding combined storm and sanitary sewerage systems. The latter were included in the inventory of existing sanitary sewerage systems, and the inventory findings presented in summary form in Chapter III. Estimates of the anticipated amount of discharge from the inventoried urban storm water drainage systems within the Region are also included in this section. The quality of these discharges is discussed in Chapters V, VI, and VII of this report, in the sections pertaining to the water quality effects of the land uses within the areas drained by the urban storm sewerage systems.

Since stream and lake water quality management problems are reflective of the human activities within the tributary drainage areas, and because urban storm water drainage systems within the Region serve generally to direct storm water flow within—but not across—the natural hydrologic watershed units, the inventory data in this chapter have been organized by watershed.[1] Tabulations of the inventory data organized on a county basis, which parallel those included in this chapter on a watershed basis, are presented in Appendix I. The presentations of the data on a county basis was provided because most local officials and interested citizens are more familiar with political boundaries than with watershed limits and because the day-to-day control and management of these urban storm water systems is more likely to fall to an existing unit of government which relates to artificial geographic limits, rather than to actual watershed limits.

DESCRIPTION OF WATERSHEDS

Since the streams, lakes, and ponds of a watershed together with the associated storm water drainage and flood control facilities, form a single integrated system over the watershed, the watershed is the basic analytic unit for instream water quality analysis utilized in the areawide water quality management planning effort. This unit must be capable of accommodating both present and probable future runoff quantity and quality loadings generated by existing and probable future land use and land management practices within the watershed. It must also be recognized, however, that not all pollutants generated within a given watershed are discharged into the surface water system of that watershed. Sanitary sewerage systems in particular may divert pollutants across even major watershed divides. Consequently, while recognizing the watershed as the basic analytical unit, the water quality management planning effort also recognizes the need to consider the interrelationships between watersheds on a regional basis.

There are 11 major watersheds which have been designated within the Southeastern Wisconsin Region. These major watersheds are discussed in this chapter and include the Des Plaines, Fox, Kinnickinnic, Menomonee, Milwaukee, Oak Creek, Pike, Rock, Root, Sauk Creek and Sheboygan River watersheds. A twelfth area consisting of land drained by minor streams directly tributary to Lake Michigan has also been designated. The watershed of minor streams directly tributary to Lake Michigan, inclusive of Barnes Creek, Pike Creek, and Sucker Creek are assessed individually as subwatersheds, due to differing land uses and other physical characteristics. These 12 watershed areas are shown on Map 26. All or major portions of these areas lie within the Region, and the boundaries are based upon natural watershed divides.

---

[1] *The construction of urban streets and associated storm water drainage facilities may modify the location of natural watershed boundaries. Such modifications are, however, usually relatively minor and may be regarded as adjustments rather than major relocations of the natural watershed boundaries.*

1. The Des Plaines River watershed consists of that portion of the Region that is drained by the Des Plaines River and its tributaries. The Des Plaines River originates south of the Village of Union Grove near the Racine-Kenosha County line. It generally flows southward, leaving the state about 1.5 miles east of IH 94. The major tributaries to the Des Plaines River within the Region are the North Branch of the Des Plaines River, Brighton Creek, Salem Branch, Center Creek, Kilbourn Road Ditch, Dutch Gap Canal, and Jerome Creek.

2. The Fox River watershed consists of that portion of the Region that is drained by the Fox River and its tributaries. The Fox River originates in northern Waukesha County, near the Village of Lannon and generally flows southward, leaving the state near Wilmot in Kensoha County. The major tributaries to the Fox River within the Region are the Mukwonago River, Muskego Canal, Wind Lake Drainage Canal, White River, Como Creek, Honey Creek, Sugar Creek, Bassett Creek, Nippersink Creek, Sussex Creek, Pewaukee River, Poplar Creek, Deer Creek, Pebble Creek, Pebble Brook, Ore Creek, Saylesville Creek, Jericho Creek, Peterson Creek, Hoosier Creek, Ivanhoe Creek, and Genesee Creek.

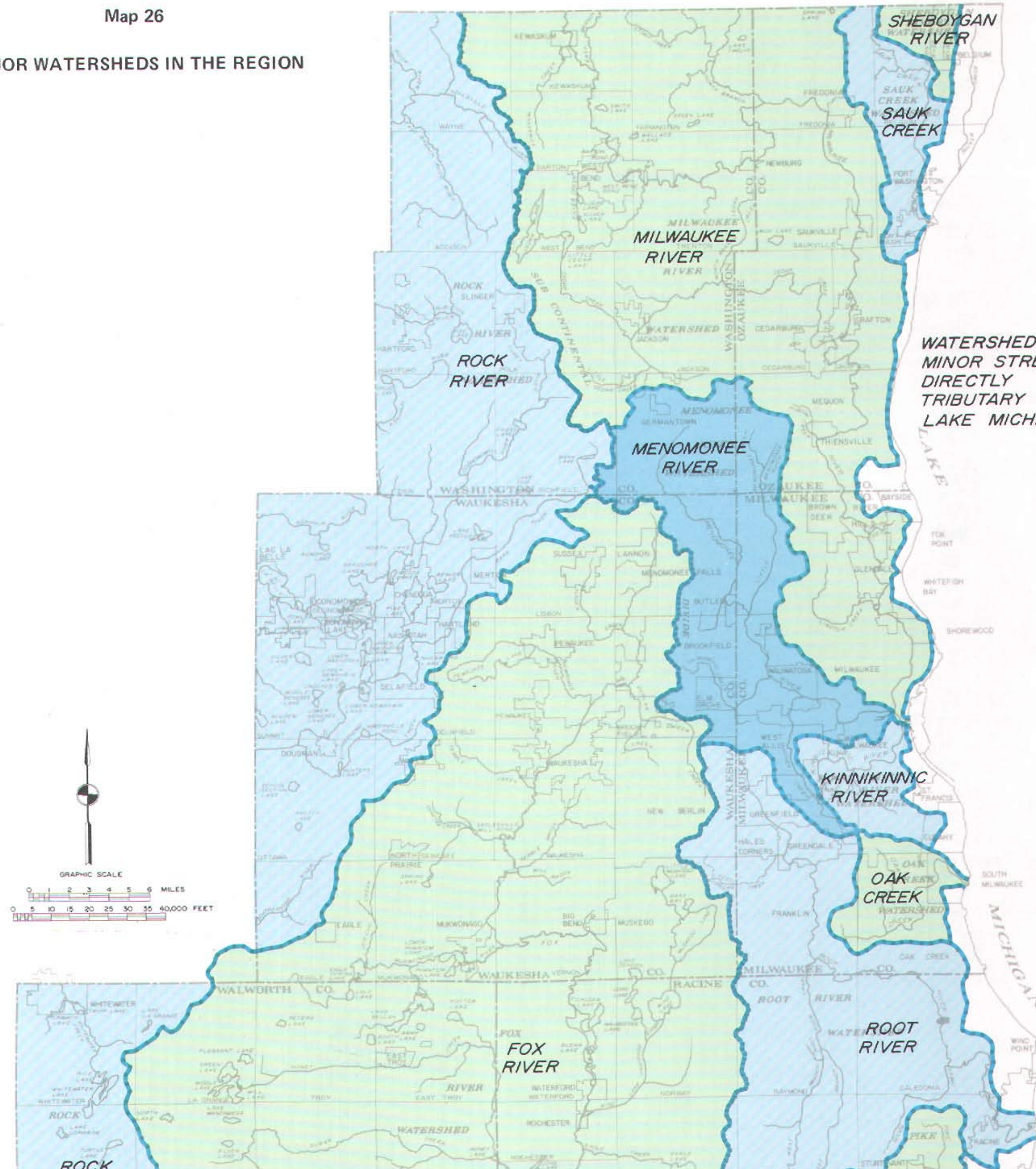
3. The Kinnickinnic River watershed consists of that portion of the Region that is drained by the Kinnickinnic River. The Kinnickinnic River originates in central Milwaukee County and generally flows eastward, discharging to Lake Michigan through the Milwaukee Harbor estuary. Major tributaries to the Kinnickinnic River are the Lyons Park Creek, South 43rd Street ditch tributary, Wilson Park Creek, Cherokee Park Creek, Villa Mann Creek and Holmes Avenue Creek.

4. The Menomonee River watershed consists of that portion of the Region that are drained by the Menomonee River and its tributaries. The Menomonee River originates in the Village of Germantown in Washington County. It generally flows southeastward to Lake Michigan, discharging to Lake Michigan through the Milwaukee Harbor estuary. The major tributaries to the Menomonee River are the Little Menomonee River, Lilly Creek, Underwood Creek, and Honey Creek, North and West Branch of the Menomonee River, Willow Creek, Dousman Ditch, Nor-X-Way Channel, and the Butler Ditch.

5. The Milwaukee River watershed consists of that portion of the Region that is drained by the Milwaukee River and its tributaries. The Milwaukee River originates north of the

Map 26

MAJOR WATERSHEDS IN THE REGION



A subcontinental divide traverses the Southeastern Wisconsin Region. That part of the Region lying east of this divide is tributary to the Great Lakes-St. Lawrence River drainage system, while that part of the Region lying west of this divide is tributary to the Mississippi River drainage system. This subcontinental divide has certain important implications for water resources planning and management, since major diversions of water across this divide are restricted by law and interstate and international compacts. The generally dendritic surface water drainage pattern of the Region, which is the result of the glacial land forms and features, divides the Region into 11 individual watersheds, three of which—the Des Plaines, Fox, and Rock River watersheds—lie west of the subcontinental divide. In addition to the 11 watersheds, there are numerous small catchment areas along the Lake Michigan shoreline that drain directly to the lake, which areas together may be considered to comprise a twelfth watershed.

Source: SEWRPC.

Region in northern Fond du Lac County and generally flows southeastward, discharging to Lake Michigan through the Milwaukee Harbor estuary. The major tributaries to the Milwaukee River are Cedar Creek, Cedarburg Creek, Kewaskum Creek, Little Cedar Creek, North Branch Cedar Creek, North Branch Milwaukee River, East Branch Milwaukee River, West Branch Milwaukee River, Stony Creek, Silver Creek, Lincoln Creek, Beaver Creek, Indian Creek, Pigeon Creek, Silver Creek (Random Lake), Watercress Creek, Mink Creek, Batavia Creek, and Chambers Creek.

6. The Oak Creek watershed consists of that portion of the Region that is drained by Oak Creek and its tributaries. Oak Creek originates in the City of Franklin in Milwaukee County and generally flows eastward, discharging to Lake Michigan at Grant Park in the City of South Milwaukee. The principle tributary is the North Branch of Oak Creek.

7. The Pike River watershed consists of that portion of the Region that is drained by the Pike River and its tributaries. The Pike River originates in southeastern Racine County about two miles north of the Village of Sturtevant and generally flows southeastward through the northern part of the City of Kenosha, discharging to Lake Michigan. The major tributary to the Pike River is Pike Creek.

8. The Rock River watershed consists of that portion of the Region that is drained by the Rock River and its tributaries. The Rock River itself flows entirely outside of the Region. There are, however, 17 tributaries of the Rock which originate in the Region and drain that portion of the Rock River basin located within the Region. The major tributaries of the Rock River within the Region are the East Branch Rock River, Kohlsville River, Allenton Creek, Limestone Creek, Rubicon River, Oconomowoc River, Little Oconomowoc River, Ashippun River, Bark River, Mason Creek, Scuppernong River, Scuppernong Creek, Bluff Creek, Swan Outlet, Turtle Creek, Piscasaw Creek, Whitewater Creek, Jackson Creek, Little Turtle Creek, and Ladd Creek.

9. The Root River watershed consists of that portion of the Region that is drained by the Root River and its tributaries. The Root River originates in Milwaukee County and generally flows southward to the City of Racine where it discharges into Lake Michigan. Major tributaries to the Root River mainstem are the North Branch of the Root River, East Branch of the Root River, Upper Creek, Hales Corners Creek, Tess Corners Creek, Whitnall Park Creek, Ryan Creek, Root River Canal, East Branch of the Root River Canal, West Branch of the Root River Canal, and Hoods Creek.

10. The Sauk Creek watershed consists of that portion of the Region that is drained by Sauk Creek and its tributaries. Sauk Creek originates about two miles northeast of the Village of Fredonia and discharges to Lake Michigan in the harbor area of the City of Port Washington.

11. The Sheboygan River watershed consists of that portion of the Region that is drained by the Sheboygan River and its tributaries. The Sheboygan River watershed within the Region is drained by Belgium Creek which is tributary to the Sheboygan River by way of the Onion River. Belgium Creek originates in the Town of Belgium and generally flows northward out of the Region.

12. The watershed of the minor streams tributary to Lake Michigan is a composite of areas drained by the major subwatersheds and numerous minor streams that are directly tributary to Lake Michigan. The three major subwatersheds are:

    —Sucker Creek, which originates about two miles northeast of the Village of Belgium and generally flows southward, discharging into Lake Michigan about three miles north of the harbor at the City of Port Washington.

    —Pike Creek, which originates near the north central portion of the City of Kenosha and generally flows eastward through the City of Kenosha to Lake Michigan.

    —Barnes Creek, which originates about two miles north of the Illinois State line and generally flows eastward, discharging to Lake Michigan south of the City of Kenosha.

    The minor streams are for the most part unnamed and inconsequential, and will not be considered explicitly in the water quality management planning program.

INVENTORY PROCEDURES

The inventory of the existing urban storm water drainage system facilities in the Region conducted under the areawide water quality management planning program was designed to update a 1964 inventory of such facilities conducted by the Commission under its initial public utilities study as reported in SEWRPC Planning Report No. 6, The Public Utilities of Southeastern Wisconsin. In that 1964 study, all known existing piped storm water drainage systems were mapped on a uniform basis by county at a scale of 1″ = 2,000′. Tributary drainage areas together with the geographic locations of known trunk sewers, storm water pumping stations, improved watercourses and drainage channels were shown on the system maps.

Both the Commission's previous inventory of storm water conveyance systems and the update of that inventory under the areawide water quality management planning program were designed to make full use of all existing and available surveys, studies, reports, and other pertinent data. Additional data collection activities conducted for this inventory update were limited to those essential to developing the information base necessary to the preparation of a sound water quality management plan for the Region. While the magnitude and complexity of the data involved preclude full presentation in published form, the descriptive analyses presented in this chapter includes the following information:

1. The location and configuration of trunk sewers, known major drainage channels, and storm water outlets, and the location of appurtenant storm water pumping stations and storage facilities. For the purposes of the storm water drainage system inventory, major trunk sewers were defined as follows: for a community of up to 10,000 resident population, 12″ diameter minimum; for a community of 10,001 to 50,000 resident population, 24″ diameter minimum; and for communities of over 50,000 residents population, 30″ diameter minimum. In some cases, in order to facilitate the delineation of the tributary drainage areas, sewers with a diameter less than the minimum size were identified.

2. The size and extent of the estimated drainage area tributary to each storm water conveyance system (drainage district) and estimates of the frequency and amount of the storm water discharges from the tributary area.

Generally, direct measurements of storm water flow are not available for urban storm sewer systems. Accordingly, it is necessary to use other procedures for estimating the amount of urban storm water runoff contributed to the lakes and streams of the Region. Computational procedures are available by which the volume and rates of storm water discharges can be estimated. These procedures take into account the size and configuration of the drainage area tributary to the discharge point, precipitation patterns, and factors which affect the fraction of the rainfall which may be expected to runoff of the drainage area. Included among the latter factors are imperviousness, slope, vegetative cover, and the hydrologic properties of the soils. Some of these variables are in fact transitory and subject to seasonal and other temporal variations. Indeed, of all the factors involved, only one can be measured with reasonable precision and accuracy as it effects runoff, namely the drainage area tributary to each subsystem of the identified existing storm drainage systems.

The areal extent of the drainage area tributary to the outlet of each urban storm water drainage system inventoried was determined by analyzing the storm water drainage system maps in conjunction with the best topographic maps available. Wherever possible, 1″ = 100′ scale two-foot contour interval and 1″ = 200′ scale 2-4 foot contour interval topographic maps were used. Where necessary and available, 1″ = 200′ scale five-foot contour topographic maps were used. Otherwise 1″ = 2,000′ scale, ten-foot contour interval USGS quadrangle maps were used. The topographic maps were supplemented by current 1″ = 400′ scale aerial photography and special field observations as necessary.

The storm sewered areas were segregated into one or more drainage districts, each district generally draining to an outlet of 30 inches or more in diameter or to more than one outlet of less than 30 inches in diameter. In some cases, areas drained by smaller outlets located immediately adjacent to areas drained by larger outlets were included in the identified drainage district of the larger—30 inches or more in diameter—outlet. The drainage areas so delineated by drainage district were measured on the best maps available, using a polar planimeter and the measurements were utilized in computing estimated volume and discharge rates for the corresponding storm water drainage system outlets.

The maximum rates of discharge from each drainage district for two-year and five-year recurrence interval rainfall intensities were estimated utilizing the rational method of calculating storm water runoff. The values of the coefficient of runoff, "C," utilized in the calculations of the flow rates were generally based upon the percent of impervious area of the drainage district as identified in the Commission's detailed land cover inventory conducted under the areawide water quality management planning program, the hydrologic categories of the dominant soils occurring within the previous areas of the drainage district, and the average of the land slopes measured at the center of alternate quarter sections within the drainage district boundaries for the Fox River, Lake Michigan, Milwaukee River, Rock River, Sauk Creek, and Sheboygan River watersheds. Slope measurements were available for every quarter section in the Des Plaines River, Kinnickinnic River, Menomonee River, Oak Creek, Pike River, and Root River watershed. The time of concentration of storm water flow within the storm sewers was estimated as the sum of the estimated flow time through the sewer at an average velocity of four feet per second, the flow time through open channels at an average velocity of three feet per second, and an assumed inlet time of 15 minutes.

The annual storm water quantity was approximated utilizing the areal extent of the drainage district, an analysis of rainfall event volume and frequency, and an estimate of the conversion from precipitation volume to runoff volume. The precipitation volume and frequency data were based upon about 37 years—January 1, 1940 through October 31, 1976—of hourly precipitation data as recorded at the Milwaukee National Weather Service station currently located at General Mitchell Field. The annual average amount of precipitation was estimated at 31 inches per year, while the number of precipitation events was estimated to average 77 per year when the minimum length of the antecedent and subsequent dry periods was defined to be 24 hours. This 24-hour minimum length of antecedent and subsequent dry period used to define a precipitation event was selected in order to establish the volume and frequency of a set of runoff events. These runoff events are isolated by a period of time which is practical for further analysis of storm water related pollutant control practices under the Areawide Water Quality Management Planning Program. Storage facilities for storm water, which are generally utilized in conjunction with structural pollution control practices, require a period of time subsequent to the precipitation event for dewatering in order that the facility capacity may be available for the next precipitation occurrence. Twenty-four hours was selected as a minimum time for such dewatering. The precipitation events were then categorized by volume of runoff storage facility. The conversion from precipitation volume to runoff volume was accomplished with an existing U.S. Department of Agriculture, Soil Conservation Service (SCS) procedure[2]. The SCS procedure converts a specified rainfall depth to runoff and incorporates average antecedent soil moisture conditions, hydrologic soil type, land use, and percent imperviousness. Different annual runoff values were calculated for the runoff curves and then utilized with the areas tributary to each outfall based upon the percent of impervious area and hydrologic soil group of the drainage district. A curve was selected for each land use density which was about the average for the soil types given. Table 89 depicts the estimated annual runoff in inches and the number of rainfall events which were equal to or greater than 0.01 inch for each runoff curve number used.

[2] *U.S. Department of Agriculture, Soil Conservation Service, "Urban Hydrology for Small Watersheds", Technical Release No. 55, Chapter II, "Estimating Runoff From Urban Areas", January, 1975.*

FINANCIAL EXPENDITURES

The inventory of storm water drainage systems included an analysis of the expenditures related to storm water drainage systems as reported in the audit reports submitted to the Department of Administration, Bureau of Municipal Audit. A review of these reports revealed obvious nonuniformity of reporting. It was noted that capital expenditures related to storm water drainage systems and funded through the issuance of bonds were not always possible to determine. Consequently, the expenditure data presented in Table 90 varies in reliability and cannot be assumed to be a fully accurate inventory of all such expenditures in the Region. Rather, the data presents only an approximation of the magnitude of the expenditures for storm water drainage systems. Total expenditures during 1975 for operation and maintenance and capital improvements for the stormwater drainage systems in the Region approximate $14.3 million, or about $9.72 per capita, such per capita cost based upon the estimated total expenditures and total population within the communities which have known storm drainage systems. Of this total, about $5.5 million, or about $3.69 per capita, was expended for operation and maintenance, and about $8.9 million, or about $6.02 per capita, was expended for capital improvements.

Table 89

RUNOFF CURVES AND ASSOCIATED ESTIMATED ANNUAL RUNOFF AND NUMBER OF RAINFALL EVENTS GREATER THAN 0.01 INCH COMPONENTS

Runoff Curve	60	65	70	75	80	85	90	95	98
Estimated Annual Runoff (inches)	0.65	1.04	1.59	2.82	4.64	7.57	12.38	18.64	24.62
Number of Events Equal to or Greater than 0.01 inch per year	3	5	7	41	46	57	65	70	70

Source: SEWRPC.

Table 90

ESTIMATED STORM WATER DRAINAGE EXPENDITURES IN THE REGION
BY PUBLIC STORM WATER SEWERAGE SYSTEM: 1975

Public Storm Water Drainage System	Estimated Population Served	Storm Water Drainage Expenditures: General Administration Operation and Maintenance		Capital Improvements		Total	
		Dollars	Dollars[a] Per Capita	Dollars	Dollars[a] Per Capita	Dollars	Dollars[a] Per Capita
Kenosha County							
City of Kenosha	83,800	113,025	1.35	1,764,380	21.05	1,877,405	22.40
Village of Silver Lake	1,300	440	0.34	4,915	3.78	5,355	4.12
Village of Twin Lakes	3,100	9,080	2.93	22,325	7.20	31,405	10.13
Milwaukee County							
City of Cudahy	21,700	52,470	2.42	0	0	52,470	2.42
City of Franklin	14,000	21,430	1.53	0	0	21,430	1.53
City of Glendale	13,400	268,960	20.07	0	0	268,960	20.07
City of Greenfield	31,700	16,640	0.52	0	0	16,640	0.52
City of Milwaukee	670,700	2,429,635	3.62	0	0	2,429,635	3.62
City of Oak Creek	15,700	596,690	38.01	0	0	596,690	38.01
City of St. Francis	9,900	27,450	2.77	1,563,205	157.90	1,590,655	160.67
City of South Milwaukee	23,400	23,610	1.01	46,020	1.97	69,630	2.98
City of Wauwatosa	55,700	92,005	1.65	397,485	7.14	489,490	8.79
City of West Allis	69,000	205,080	2.97	198,200	2.87	403,280	5.84
Village of Brown Deer	13,600	53,700	3.95	20,750	1.52	74,450	5.47
Village of Fox Point	7,900	61,850	7.83	12,770	1.62	74,620	9.45
Village of Greendale	16,800	60,990	3.63	24,925	1.48	85,915	5.11
Village of Hales Corners	8,800	10,405	1.18	0	0	10,405	1.18
Village of Shorewood	14,300	N/A	N/A	N/A	N/A	N/A	N/A
Village of West Milwaukee	3,800	6,870	1.81	0	0	6,870	1.81
Village of Whitefish Bay	16,200	83,770	5.17	0	0	83,770	5.17
Ozaukee County							
City of Cedarburg	9,800	61,100	6.24	69,405	7.08	130,505	13.32
City of Port Washington	9,400	22,945	2.44	84,710	9.01	107,655	11.45
Village of Belgium	800	275	0.34	0	0	275	0.34
Village of Grafton	8,000	104,930	13.12	0	0	104,930	13.12
Village of Saukville	2,500	655	0.26	0	0	655	0.26
Village of Thiensville	3,800	1,930	0.51	0	0	1,930	0.51
Racine County							
City of Burlington	8,700	32,360	3.72	36,855	4.24	69,215	7.96
City of Racine	97,200	160,005	1.65	3,381,000	34.78	3,541,005	36.43
Village of Rochester	600	2,630	4.38	0	0	2,630	4.38
Village of Sturtevant	4,400	146,945	33.40	0	0	146,945	33.40
Village of Union Grove	3,000	N/A	N/A	N/A	N/A	N/A	N/A
Village of Waterford	2,300	N/A	N/A	N/A	N/A	N/A	N/A

Table 90 (continued)

Public Storm Water Drainage System	Estimated Population Served	Storm Water Drainage Expenditures: General Administration Operation and Maintenance: Dollars	Dollars[a] Per Capita	Capital Improvements: Dollars	Dollars[a] Per Capita	Total: Dollars	Dollars[a] Per Capita
Walworth County							
City of Delavan	5,800	26,945	4.65	0	0	26,945	4.65
City of Elkhorn	4,300	9,150	2.13	44,650	10.38	53,800	12.51
City of Lake Geneva	5,300	4,300	0.81	0	0	4,300	0.81
City of Whitewater	11,000[b]	6,705	0.73	0	0	6,705	0.73
Village of East Troy	2,200	1,125	0.51	0	0	1,125	0.51
Washington County							
City of Hartford	7,200	19,305	2.68	1,810	0.25	21,115	2.93
City of West Bend	20,300	54,610	2.69	237,255	11.69	291,865	14.38
Village of Jackson	1,900	17,265	9.09	0	0	17,265	9.09
Village of Kewaskum	2,300	9,200	4.00	0	0	9,200	4.00
Village of Slinger	1,500	3,350	2.23	0	0	3,350	2.23
Waukesha County							
City of Brookfield	33,400	30,040	0.90	150,115	4.49	180,155	5.39
City of Muskego	13,400	84,330	6.29	0	0	84,330	6.29
City of New Berlin	31,300	161,845	5.17	264,300	8.44	426,145	13.61
City of Oconomowoc	10,300	37,640	3.66	20,435	1.98	58,075	5.64
City of Waukesha	47,400	156,140	3.29	144,490	3.05	300,630	6.34
Village of Butler	2,200	60	0.03	182,480	82.94	182,540	82.97
Village of Elm Grove	7,700	103,060	13.38	0	0	103,060	13.38
Village of Hartland	4,100	4,260	1.04	6,165	1.50	10,425	2.54
Village of Menomonee Falls	33,400	48,500	1.45	216,450	6.48	264,950	7.93
Village of Mukwonago	3,100	2,535	0.82	0	0	2,535	0.82
Village of Pewaukee	4,400	3,680	0.84	0	0	3,680	0.84
Village of Sussex	4,100	N/A	N/A	N/A	N/A	N/A	N/A
Village of Wales	1,800	N/A	N/A	N/A	N/A	N/A	N/A
Regional Total	1,503,700	5,451,920	3.69	8,895,095	6.02	14,347,015	9.21

Note: N/A indicates data not available.

[a] *In calculating the per capita costs, only the aggregate population in those communities for which expenditure data was available was included.*

[b] *Includes 1800 residents of the City of Whitewater within Jefferson County.*

Source: Wisconsin Department of Administration, Bureau of Municipal Audit and SEWRPC reports.

INVENTORY FINDINGS— DES PLAINES RIVER WATERSHED

There is one known existing urban storm water drainage system that provides service to subareas of the Des Plaines River watershed. This is the system operated by the Village of Union Grove. The portion of the system that lies within the Des Plaines River watershed has a tributary drainage area of about 0.3 square mile, or about 0.2 percent of the total area of the watershed. Included within this drainage area are a total of two known storm water outfalls, which are 24 and 36 inches in diameter. Both these outlets discharge to a tributary of the Des Plaines River. There are no known storm water pumping or storage facilities in the watershed. The total average annual discharge from these two storm water drainage outfalls is estimated to be about 62 million gallons per year occurring in 65 events. The combined maximum discharge rate for these outfalls is estimated to be about 124 cubic feet per second for a two-year recurrence interval rainfall event and about 166 cubic feet per second for a five-year recurrence interval rainfall event.

Pertinent characteristics of the single storm water drainage system in the Des Plaines River watershed are summarized in Table 91 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits, as well as the system outfalls and estimated tributary areas within the Des Plaines River watershed are shown on Map 27.

Further references to the storm water drainage system serving the Village of Union Grove are to be found elsewhere in this chapter under the Root River watershed findings.

INVENTORY FINDINGS— FOX RIVER WATERSHED

There are a total of 16 known urban storm water drainage systems which provide service to the subareas of the Fox River watershed. These include the systems operated by the Cities of Brookfield, Burlington, Elkhorn, Lake Geneva, Muskego, New Berlin, and Waukesha, and the Villages of East Troy, Menomonee Falls, Mukwonago, Pewaukee, Rochester, Sussex, Twin Lakes, Wales, and Waterford. The Cities of Lake Geneva and Muskego, and the Village of East Troy were unable to provide a copy of a map of their systems. Together, the 13 storm water drainage systems, for which mapping was available, have a tributary drainage area of about 19.4 square miles, or about 2 percent of the total area of the watershed. Included within this storm water drainage area of the watershed are a total of 212 known storm water outfalls, ranging in size from eight to 78 inches in diameter. There are no known storm water pumping facilities and three known storm water storage facilities in the watershed. The total average annual discharge from these outfalls is estimated to be about 1,125 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 6,157 cubic feet per second for a two-year recurrence interval rainfall event and about 8,208 cubic feet per second for a five-year recurrence interval rainfall event.

Each of these storm water drainage systems is described in detail in the following paragraphs. Pertinent characteristics of each system are summarized in Table 92 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits, as well as the systems outfalls and estimated tributary areas of the 13 storm water drainage systems within the Fox River watershed are shown on Map 28.

City of Brookfield

The storm water drainage system serving the portion of the City of Brookfield that lies within the Fox River watershed is shown on Map 28, together with the tributary drainage area of about 2.1 square miles. The system consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Brookfield storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 15 known storm water outfalls ranging in size from 15 to 42 inches in diameter, of which one discharges to the Fox River, 12 discharge to unnamed tributaries of the Fox River, one discharges to Deer Creek, and one discharges to a tributary of Deer Creek. The total annual average discharge from these outfalls is

Table 91

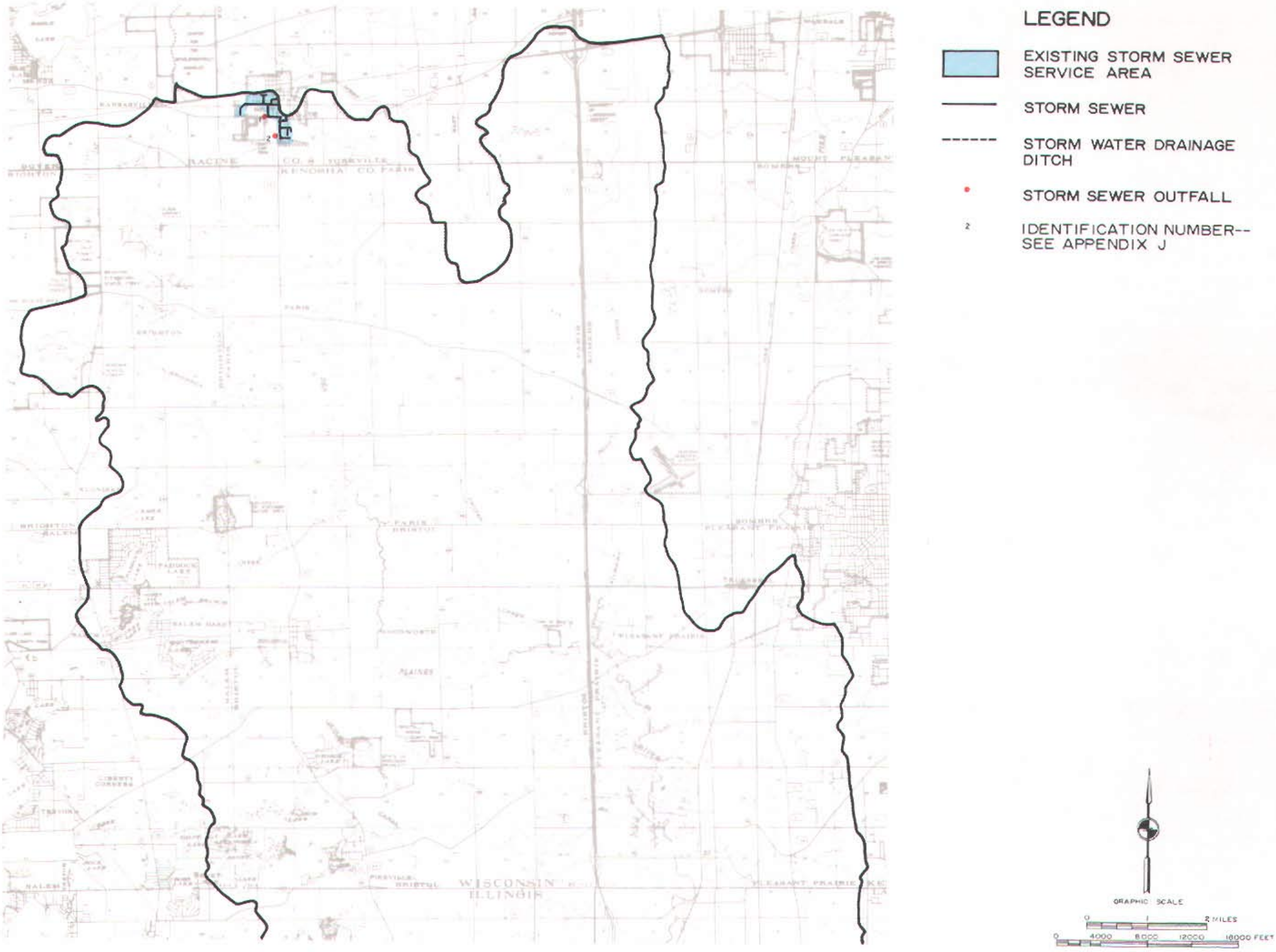
AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE DES PLAINES RIVER WATERSHED

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume	Estimated Maximum Storm Water Discharge Rates	
						2-Year Recurrence Interval Event	5-Year Recurrence Interval Event
	Acres	Square Miles		Diameter in Inches	Million Gallons	Cubic Feet per Second	Cubic Feet per Second
Village of Union Grove	184	0.29	2	24-36	62	124	166
Total	184	0.29	2	24-36	62	124	166

Source: SEWRPC.

Map 27

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE DES PLAINES RIVER WATERSHED



Source: SEWRPC.

estimated to be about 204 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 784 cubic feet per second for a two-year recurrence interval rainfall event and about 1,032 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Brookfield can be found elsewhere in this chapter under the Menomonee River watershed findings.

City of Burlington

The storm water drainage system serving the City of Burlington lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 2.0 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 39 known storm water outfalls ranging in size from eight to 72 inches in diameter, of which 17 discharge to the Fox River, three discharge to the internally drained Rock Lake basin, six discharge to the White River, and 13 discharge to Echo Lake. The total annual average discharge from these outfalls is estimated to be about 87 million gallons per year occurring in 41 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 641 cubic feet per second for a two-year recurrence interval rainfall event and about 830 cubic feet per second for a five-year recurrence interval rainfall event.

Table 92

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE FOX RIVER WATERSHED

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System (diameter in inches)	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles				2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Brookfield	1,338	2.09	15	15 to 42	204	784	1,033
City of Burlington	1,247	1.95	39	8 to 72	87	642	831
City of Elkhorn	443	0.69	4	12 to 42	29	166	217
City of Lake Geneva	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Muskego	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of New Berlin	413	0.65	16	15 to 48	82	289	387
City of Waukesha	6,617	10.34	52	15 to 78	510	2,963	3,983
Village of East Troy	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Village of Menomonee Falls . . .	230	0.36	1	Open ditch	29	98	132
Village of Mukwonago	177	0.28	5	18 to 48	13	96	127
Village of Pewaukee	454	0.71	26	15 to 36	39	293	392
Village of Rochester	24	0.04	1	24	1	14	18
Village of Sussex	574	0.90	17	12 to 29 x 45	33	305	411
Village of Twin Lakes	395	0.62	10	12 to 30	39	246	325
Village of Wales[a]	39	0.06	--	--	--	--	--
Village of Waterford	435	0.68	24	12 to 72 x 44	59	261	352
Total	12.386	19.35	210	8 to 78	1,125	6,157	8,208

NOTE: N/A indicates data not available.

[a] *Consists of two stormwater retention areas that receive surface drainage from portions of Cambian Hills Subdivision and drain to groundwater.*

Source SEWRPC.

City of Elkhorn

The stormwater drainage system serving the portion of the City of Elkhorn that lies within the Fox River watershed is shown on Map 28, together with the tributary drainage area of about 0.7 square mile. The system consists principally of subsurface conduits.

This portion of the City of Elkhorn storm water drainage system includes no known storm water pumping or storage facilities and is tributary to four known storm water outfalls ranging in size from 12 to 42 inches in diameter, all of which discharge to tributaries of Sugar Creek. The annual average discharge from these outfalls is estimated to be about 29 million gallons per year occurring in 41 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 166 cubic feet per second for a two-year recurrence interval rainfall event and about 217 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Elkhorn can be found elsewhere in this chapter under the Rock River watershed findings.

City of Lake Geneva

As stated above, the City of Lake Geneva was unable to provide a copy of the systems map. Therefore, no detailed discussion of the storm water drainage system is included.

City of Muskego

As stated above, the City of Muskego was unable to provide a copy of the systems map. Therefore, no detailed discussion of the storm water drainage system is included.

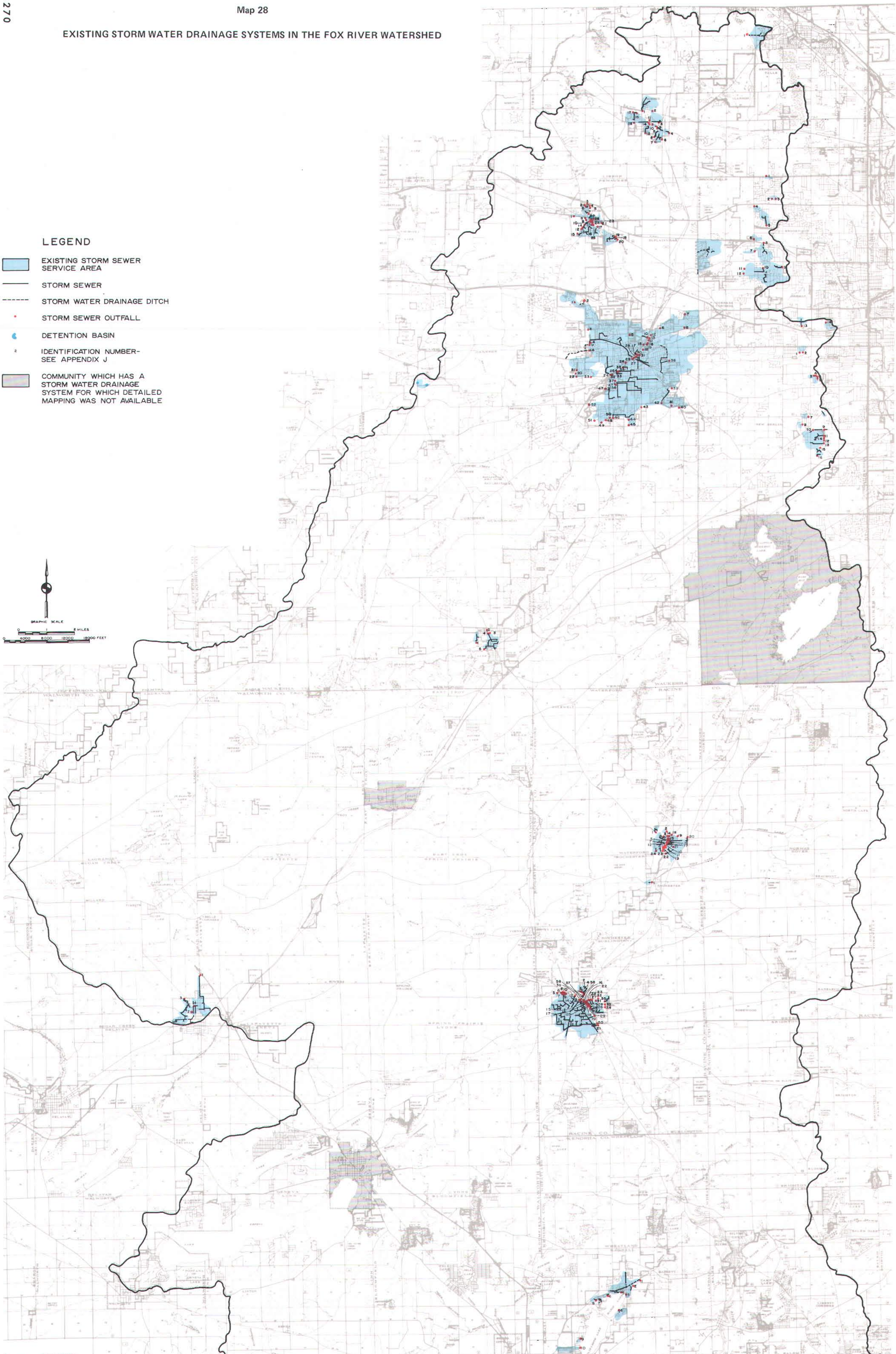
City of New Berlin

The storm water drainage system serving the portion of the City of New Berlin that lies within the Fox River watershed is shown on Map 28, together with the tributary drainage area of about 0.7 square mile. The system, which serves only isolated portions of the City of New Berlin, consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in many locations.

This portion of the City of New Berlin storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 16 known storm water outfalls ranging in size from 15 to 48 inches in diameter, of which six discharge to Deer Creek, nine discharge to tributaries of Deer Creek, and one discharges to a tributary of Little Muskego Lake. The total annual average discharge from these outfalls is estimated to be about 82 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 289 cubic feet per second for a two-year recurrence interval rainfall event, and about 387 cubic feet per second for a five-year recurrence interval rainfall event.

Map 28

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE FOX RIVER WATERSHED



Further references to the storm water drainage system serving the City of New Berlin can be found elsewhere in this chapter under the Menomonee River and Root River watershed findings.

City of Waukesha

The storm water drainage system serving the City of Waukesha lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 10.3 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to 52 known storm water outfalls ranging in size from 15 to 78 inches in diameter. Twenty three of these storm water outfalls discharge to the Fox River, 14 discharge to unnamed tributaries of the Fox River, one discharges to a tributary of Poplar Creek, one discharges to Pebble Brook, four discharge to tributaries of Pebble Brook, six discharge to a tributary of Brandy Brook, one discharges to a tributary of Pebble Creek, and two discharge to a tributary of Pewaukee Lake. The total annual average discharge from these outfalls is estimated to be about 510 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 2,963 cubic feet per second for a two-year recurrence interval rainfall event, and about 3,983 cubic feet per second for a five-year recurrence interval rainfall event.

Village of East Troy

As noted above, the Village of East Troy was unable to provide a copy of the systems map. Therefore, no detailed discussion of the storm water drainage system is included.

Village of Menomonee Falls

The storm water drainage systems serving the portion of the Village of Menomonee Falls that lies within the Fox River watershed is shown on Map 28, together with the tributary drainage area of about 0.4 square mile. The system consists principally of subsurface conduits with one drainage ditch incorporated into the drainage system.

This portion of the Village of Menomonee Falls storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outfall, a drainage ditch that discharges to the Fox River directly. The total annual average discharge from this outfall is estimated to be about 29 million gallons per year occurring in 46 events. The maximum discharge rate for this storm water outfall is estimated to be about 98 cubic feet per second for a two-year recurrence interval rainfall event and about 132 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Menomonee Falls can be found elsewhere in this chapter under the Menomonee River watershed findings.

Village of Mukwonago

The storm water drainage system serving the Village of Mukwonago lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 0.3 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to five known storm water outfalls ranging in size from 18 to 48 inches in diameter, of which one discharges to Lower Phantom Lake, and four discharge to tributaries of Lower Phantom Lake. The total annual average discharge from these outfalls is estimated to be about 13 million gallons per year occurring in 41 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 96 cubic feet per second for a two-year recurrence interval rainfall event, and about 127 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Pewaukee

The storm water drainage system serving the Village of Pewaukee lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 0.7 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping facilities and one known storm water storage facility, a storm water detention pond, and is tributary to 26 known storm water outfalls ranging in size from 15 to 36 inches in diameter, of which five discharge to Pewaukee Lake, 13 discharge to the Pewaukee River, and eight discharge to tributaries of the Pewaukee River. The total annual average discharge from these outfalls is estimated to be about 39 million gallons per year occurring in 46 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 293 cubic feet per second for a two-year recurrence interval rainfall event, and about 392 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Rochester

The storm water drainage system serving the Village of Rochester lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 0.04 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outfall which is 24 inches in diameter and discharges to the Fox River directly. The total annual average discharge from this outfall is estimated to be about one million gallons per year occurring in seven events. The maximum discharge rate for this storm water outfall is estimated to be about 14 cubic feet per second for a two-year recurrence interval rainfall event, and about 18 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Sussex

The storm water drainage system serving the Village of Sussex lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 0.9 square mile. The system consists principally of subsurface conduits with two major drainage ditches and short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 17 known storm water outfalls ranging in size from 12 inches in diameter to a 29 x 45 inch box culvert, of which 12 discharge to Sussex Creek and five discharge to tributaries of Sussex Creek. The total annual average discharge from these outfalls is estimated to be about 33 million gallons per year occurring in 41 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 305 cubic feet per second for a two-year recurrence interval rainfall event, and about 411 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Twin Lakes

The storm water drainage system serving the Village of Twin Lakes lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 0.6 square mile. The system which serves only isolated portions of the Village of Twin Lakes consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 10 known storm water outfalls ranging in size from 12 to 30 inches in diameter, of which two discharge to Elizabeth Lake, six discharge to Lake Marie, and two discharge to a tributary of Bassett Creek. The total annual average discharge from these outlets is estimated to be about 39 million gallons per year occurring in 46 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 246 cubic feet per second for a two-year recurrence interval rainfall event, and about 325 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Wales

The Village of Wales does not operate a major storm water drainage system. However, the Cambrian Hills subdivision which lies within the corporate limits of the Village of Wales has two storm water retention areas which receive surface flow from a 39-acre portion of the subdivision and which both discharge to the groundwater.

Village of Waterford

The storm water drainage system serving the Village of Waterford lies totally within the Fox River watershed and is shown on Map 28, together with the tributary drainage area of about 0.7 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 24 known storm water outfalls ranging in size from 12 inches in diameter to a 72 inch by 44 inch box culvert, of which 19 discharge to the Fox River and five discharge to tributaries of the Fox River. The total annual average discharge from these outfalls is estimated to be about 59 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 261 cubic feet per second for a two-year recurrence interval rainfall event, and about 352 cubic feet per second for a five-year recurrence interval rainfall event.

INVENTORY FINDINGS— KINNICKINNIC RIVER WATERSHED

There are a total of six known existing urban storm water drainage systems which provide service to the subareas of the Kinnickinnic River watershed. These include the systems operated by the Cities of Cudahy, Greenfield, Milwaukee, St. Francis, and West Allis, and the Village of West Milwaukee. Together these systems have a tributary drainage area of about 16.6 square miles, or about 67 percent of the total area of the watershed. Another portion of the watershed is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer service area are discussed in Chapter III. Included within this storm water drainage area of the watershed are a total of 94 known storm water outfalls ranging in size from 12 inches in diameter to a 142 inch by 89 inch box culvert. There are no known storm water pumping or storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 2,768 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 6,708 cubic feet per second for a two-year recurrence interval rainfall event, and about 9,337 cubic feet per second for a five-year recurrence interval rainfall event. Another portion of the watershed is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

Each of these storm water drainage systems is described in detail in the following paragraphs. Pertinent characteristics of each system are summarized in Table 93 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the systems outfalls and estimated tributary areas of the six storm water drainage systems within the Kinnickinnic River watershed are shown on Map 29.

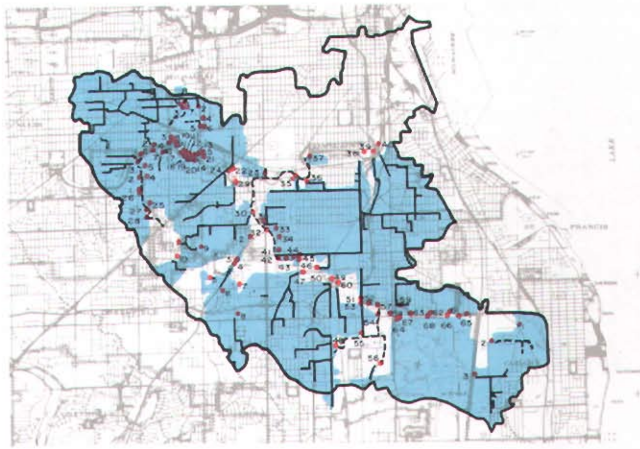
City of Cudahy

The storm water drainage system serving the portion of the City of Cudahy that lies within the Kinnickinnic River watershed is shown on Map 29, together with the tributary drainage area of about 1.5 square miles. The system consists principally of subsurface conduits with two major open drainage ditches.

This portion of the City of Cudahy storm water drainage system includes no known storm water pumping or storage facilities and is tributary to three known storm water outfalls ranging in size from 36 to 72 inches in diameter, of which one discharges to Wilson Park Creek, and two discharge to tributaries of Wilson Park Creek. The total annual average discharge from these outfalls is estimated to be about 201 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 517 cubic feet per second for a two-year recurrence interval rainfall event and about 703 cubic feet per second for a five-year recurrence interval rainfall event.

Map 29

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE KINNICKINNIC RIVER WATERSHED



LEGEND

EXISTING STORM SEWER SERVICE AREA

STORM SEWER

STORM WATER DRAINAGE DITCH

STORM SEWER OUTFALL

IDENTIFICATION NUMBER- SEE APPENDIX J

Source: SEWRPC.

Table 93

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE KINNICKINNIC RIVER WATERSHED

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area[a]		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System (diameter in inches)	Summation of Drainage Districts[a]		
					Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rate	
	Acres	Square Miles				2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Cudahy	977	1.53	3	36 to 72	201	517	703
City of Greenfield	542	0.85	10	15 to 72	159	446	596
City of Milwaukee	7,608	11.89	68	12 to 142 x 89	1,928	4,288	5,758
City of St. Francis	42	0.07	1	30	1	28	38
City of West Allis	469	0.73	4	24 to 60	156	555	746
Village of West Milwaukee	960	1.50	8	18 to 78	323	874	1,496
Total	10,598	16.57	94	12 to 142 x 89	2,768	6,708	9,337

[a] *When a storm water outfall drainage area was located in more than one civil division, the drainage area and corresponding estimated discharge volumes and flow rates were included in the data corresponding to the civil division in which the outfall is located.*

Source: SEWRPC.

Further references to the storm water drainage system serving the City of Cudahy can be found in this chapter under the Lake Michigan—minor streams, and Oak Creek watershed findings.

City of Greenfield

The storm water drainage system serving the portion of the City of Greenfield that lies within the Kinnickinnic River watershed is shown on Map 29, together with the tributary drainage area of 0.9 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Greenfield storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 10 known storm water outfalls ranging in size from 15 to 72 inches in diameter, of which seven discharge to the Cherokee Park Creek, two discharge to Lyons Park Creek, and one discharges to a tributary of Wilson Park Creek. The total annual average discharge from these outfalls is estimated to be about 159 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 446 cubic feet per second for a two-year recurrence interval rainfall event and about 596 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Greenfield can be found elsewhere in this chapter under the Menomonee River and Root River watershed findings.

City of Milwaukee

The storm water drainage system serving the portion of the City of Milwaukee that lies within the Kinnickinnic River watershed is shown on Map 29, together with the tributary drainage area of about 11.9 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations. Another portion of the watershed in the City of Milwaukee is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III. Also, that portion of General Billy Mitchell Field which lies in the Kinnickinnic River watershed, although Milwaukee County property, is included in the City of Milwaukee totals.

This portion of the City of Milwaukee storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 68 known storm water outfalls ranging in size from 12 inches in diameter to a 142 inch by 89 inch box culvert. Eight outfalls discharge to Lyons Park Creek; 29 outfalls discharge to Wilson Park Creek; three outfalls discharge to Holmes Avenue Creek; one outfall discharges to a tributary of Holmes Avenue Creek, and 27 outfalls discharge to the Kinnickinnic River. The total average annual discharge from these outfalls is estimated to be about 1,928 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 4,288 cubic feet per second for a two-year recurrence interval rainfall event, and about 5,758 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Milwaukee can be found elsewhere in this chapter under the Lake Michigan—minor streams, Menomonee River, Milwaukee River, Oak Creek, and Root River watershed findings.

City of St. Francis

The storm water drainage system serving the portion of the City of St. Francis that lies within the Kinnickinnic River watershed is shown on Map 29, together with the tributary drainage area of about 0.1 square mile. The system consists principally of subsurface conduits.

This portion of the City of St. Francis storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outfall which is 30 inches in diameter and discharges directly to Wilson Park Creek. The total annual discharge from this outfall is estimated to be about 1.0 million gallons per year occurring in three events. The maximum discharge rate for this storm water outfall is estimated to be about 28 cubic feet per second for a two-year recurrence interval rainfall event and about 38 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of St. Francis can be found elsewhere in this chapter under the Lake Michigan—minor streams watershed findings.

City of West Allis

The storm water drainage system serving the portion of the City of West Allis that lies within the Kinnickinnic River watershed is shown on Map 29, together with the tributary drainage area of about 0.7 square mile. The system consists principally of subsurface conduits.

This portion of the City of West Allis storm water drainage system includes no known storm water pumping or storage facilities and is tributary to four known storm water outfalls ranging in size from 24 to 60 inches in diameter, all of which discharge directly to the Kinnickinnic River. The total annual average discharge from these outfalls is estimated to be about 156 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 555 cubic feet per second for a two-year recurrence interval rainfall event, and about 746 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of West Allis can be found elsewhere in this chapter under the Menomonee River and Root River watersheds findings.

Village of West Milwaukee
The storm water drainage system serving the Village of West Milwaukee that lies within the Kinnickinnic River watershed is shown on Map 29, together with the tributary drainage area of about 1.5 square miles. The system consists principally of subsurface conduits with one major open drainage ditch and short reaches of channels incorporated into the drainage system in some locations.

This portion of the Village of West Milwaukee storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to eight known storm water outfalls ranging in size from 18 to 78 inches in diameter, all of which discharge directly to the South 43rd Street Ditch. The total annual average discharge from these outfalls is estimated to be about 323 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 874 cubic feet per second for a two-year recurrence interval rainfall event and about 1,496 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of West Milwaukee can be found elsewhere in this chapter under the Menomonee River watershed findings.

INVENTORY FINDINGS— MENOMONEE RIVER WATERSHED

There are a total of 10 known existing urban storm water drainage systems which provide service to the subareas of the Menomonee River watershed. These include the systems operated by the Cities of Brookfield, Greenfield, Milwaukee, New Berlin, Wauwatosa, and West Allis, and the Villages of Butler, Elm Grove, Menomonee Falls, and West Milwaukee. Together these systems have a tributary drainage area of about 42.7 square miles, or about 3.1 percent of the total area of the watershed. Included within this storm water drainage area of the watershed are a total of 344 known storm water outfalls ranging in size from 12 inches in diameter to a triple 90 inch by 54 inch box culvert. There are no known storm water pumping facilities and two known storm water storage facilities in the watershed. The total annual average discharge from these outlets is estimated to be about 5,587 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 20,679 cubic feet per second for a two-year recurrence interval rainfall event and about 27,674 cubic feet per second for a five-year recurrence interval rainfall event. Another portion of the watershed is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

Each of the storm water drainage systems is described in the following paragraphs. Pertinent characteristics of each system are summarized in Table 94 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the systems within the Menomonee River watershed are shown on Map 30.

Table 94

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE MENOMONEE RIVER WATERSHED

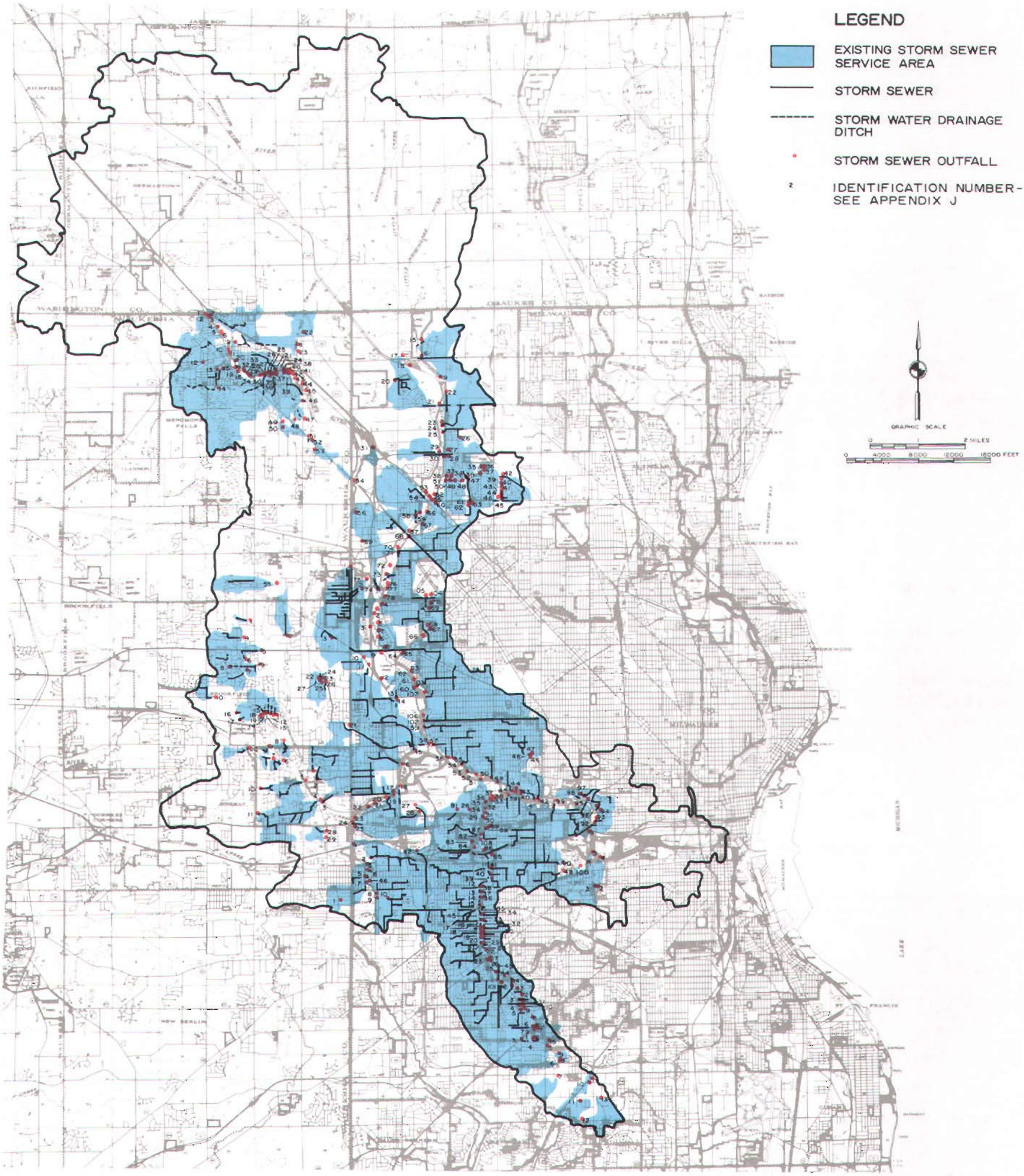
Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area[a]		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System (diameter in inches)	Summation of Drainage Districts[a]		
					Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles				2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Brookfield	1,438	2.25	29	15-60	199	974	1,312
City of Greenfield	1,051	1.64	15	12-84	202	823	1,097
City of Milwaukee	9,135	14.27	108	12-68 x 98	2,016	6,979	9,382
City of New Berlin	21	0.03	1	18"	4	16	22
City of Wauwatosa	5,942	9.28	70	12-120 x 62	1,227	4,646	6,189
City of West Allis	4,592	7.18	48	15 - triple 90 x 54 box	1,143	3,954	5,261
Village of Butler	331	0.52	2	36-36 x 60	68	241	331
Village of Elm Grove	1,075	1.68	11	24-78	135	634	843
Village of Menomonee Falls	3,446	5.38	55	6-60	477	2,069	2,767
Village of West Milwaukee	348	0.54	5	18-66	116	343	470
Total	27,379	42.78	344	12 to triple 90 x 54 box	5,587	20,679	27,674

[a] *When a storm water outfall drainage area was located in more than one civil division, the drainage area and corresponding discharge volume and flow rates corresponding estimated discharge volume and flow rates were included in the data corresponding to the civil division in which the outfall is located.*

Source: SEWRPC.

Map 30

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE MENOMONEE RIVER WATERSHED



Source: SEWRPC.

City of Brookfield

The storm water drainage system serving the portion of the City of Brookfield that lies in the Menomonee River watershed is shown on Map 30, together with the tributary drainage area of about 2.3 square miles. The system consists principally of subsurface conduits with four major drainage ditches and short reaches of surface channels incorporated into the drainage system in many locations.

This portion of the City of Brookfield storm water drainage system includes no known storm water pumping facilities and two known storm water storage facilities, both storm water detention basins, and is tributary to 29 known storm water outfalls ranging in size from 15 to 60 inches in diameter, of which 10 outfalls discharge to Underwood Creek, three discharge to tributaries of Underwood Creek, two discharge to Butler Ditch, 12 discharge to tributaries of Butler Ditch, one discharges to Dousman Ditch, and one discharges to a tributary of the Menomonee River. The total annual average discharge from these outfalls is estimated to be about 199 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 974 cubic feet per second for a two-year recurrence interval rainfall event and about 1,312 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Brookfield can be found elsewhere in this chapter under the Fox River watershed findings.

City of Greenfield

The storm water drainage system serving the portion of the City of Greenfield that lies within the Menomonee River watershed in shown on Map 30, together with the tributary drainage area of about 1.6 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Greenfield storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 15 known storm water outfalls ranging in size from 12 to 84 inches in diameter, of which nine discharge to Honey Creek and six discharge to a tributary of Honey Creek. The total annual average discharge from these outfalls is estimated to be about 202 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 823 cubic feet per second for a two-year recurrence interval rainfall event and about 1,097 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Greenfield can be found elsewhere in this chapter under the Kinnickinnic River and Root River watershed findings.

City of Milwaukee

The storm water drainage system serving the portion of the City of Milwaukee that lies within the Menomonee River watershed is shown on Map 30, together with the tributary drainage area of about 14.3 square miles. The system consists principally of subsurface conduits. Another portion of the City of Milwaukee is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

This portion of the City of Milwaukee storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 108 storm water outfalls ranging in size from 12 inches in diameter to a 68 inch by 98 inch box culvert. Twenty-six of the storm water outfalls discharge to Honey Creek, one discharges to a tributary of Honey Creek, 29 discharge to the Little Menomonee River, four discharge to tributaries of the Little Menomonee River, 16 discharge to the Menomonee River, three discharge to tributaries of the Menomonee River, 20 discharge to Noyes Creek, five discharge to a tributary of Noyes Creek, two discharge to Woods Creek, and two discharge to Grantosa Creek. The total annual average discharge from these outfalls is estimated to be about 2,016 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 6,978 cubic feet per second for a two-year recurrence interval rainfall event and about 9,382 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Milwaukee can be found elsewhere in this chapter under the Kinnickinnic River, Lake Michigan, Milwaukee River, Oak Creek, and Root River watershed findings.

City of New Berlin

The storm water drainage system serving the portion of the City of New Berlin that lies within the Menomonee River watershed is shown on Map 30, together with the tributary drainage area of about 0.03 square mile. The system consists principally of subsurface conduits.

This portion of the City of New Berlin storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outfall which is 18 inches in diameter and discharges to a tributary of the South Branch Underwood Creek. The total annual average discharge from this outfall is estimated to be about four million gallons per year occurring in 57 events. The maximum discharge rate for this storm water outfall is estimated to be about 16 cubic feet per second for a two-year recurrence interval rainfall event and about 22 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of New Berlin can be found elsewhere in this chapter under the Fox River and Root River watershed findings.

City of Wauwatosa

The storm water drainage system serving the City of Wauwatosa lies totally within the Menomonee River watershed and is shown on Map 30, together with the tributary drainage area of about 9.3 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 70 known storm water outfalls ranging in size from 12 inches in diameter to a 120 inch by 62 inch box culvert. Thirty-one of these storm water outfalls discharge to the Menomonee River, five discharge to unnamed tributaries of the Menomonee River, three discharge to Schoonmaker Creek, 11 discharge to Underwood Creek, two discharge to a tributary of Underwood Creek, 10 discharge to Honey Creek, one discharges to a tributary of Honey Creek, and seven discharge to Grantosa Creek. The total annual average discharge from these outfalls is estimated to be about 1,227 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 4,646 cubic feet per second for a two-year recurrence interval rainfall event and about 6,189 cubic feet per second for five-year recurrence interval rainfall event.

City of West Allis

The storm water drainage system serving the portion of the City of West Allis that lies within the Menomonee River watershed is shown on Map 30, together with the tributary drainage area of about 7.1 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of West Allis storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 48 known storm water outfalls ranging in size from 15 inches in diameter to a triple 90 inch by 54 inch box culvert, of which 33 outfalls discharge to Honey Creek, two discharge to a tributary of Honey Creek, eight discharge to the South Branch Underwood Creek, four discharge to tributaries of the South Branch Underwood Creek, and one discharges to Woods Creek. The total annual average discharge from these outfalls is estimated to be about 1,143 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 3,954 cubic feet per second for a two-year recurrence interval rainfall event and about 5,261 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of West Allis can be found elsewhere in this chapter under the Kinnickinnic River and Root River watershed findings.

Village of Butler

The storm water drainage system serving the Village of Butler lies totally within the Menomonee River watershed and is shown on Map 30, together with the tributary drainage area of about 0.5 square mile. The system consists principally of subsurface conduits.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to two known storm water outfalls of which one is 36 inches in diameter and one is a 36 inch by 60 inch box culvert. Both discharge to the Menomonee River. The total annual average discharge from these outfalls is estimated to be about 68 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 241 cubic feet per second for a two-year recurrence interval rainfall event and about 331 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Elm Grove

The storm water drainage system serving the Village of Elm Grove lies totally within the Menomonee River watershed and is shown on Map 30, together with the tributary drainage area of about 1.7 square miles. The system consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in many locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 11 known storm water outfalls ranging in size from 24 to 78 inches in diameter, of which two outfalls discharge to Dousman Ditch, one discharges to the South Branch Underwood Creek, two discharge to Underwood Creek, and six discharge to tributaries of Underwood Creek. The total annual average discharge from these outfalls is estimated to be about 135 million gallons per year occurring in 46 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 634 cubic feet per second for a two-year recurrence interval rainfall event and about 843 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Menomonee Falls

The storm water drainage system serving the portion of the Village of Menomonee Falls that lies within the Menomonee River watershed is shown on Map 30, together with the tributary drainage area of about 5.4 square miles. The system consists principally of subsurface conduits with four major drainage ditches and short reaches of surface channels incorporated into the drainage system in many locations.

This portion of the Village of Menomonee Falls storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 55 known storm water outfalls which range in size from six to 60 inches in diameter. These storm water outfalls discharge to the following streams: 37 discharge to the Menomonee River, seven discharge to tributaries of the Menomonee River, three discharge to the Nor-X-Way Channel, four discharge to Lilly Creek, and four discharge to tributaries of Lilly Creek. The total annual average discharge from these outlets is estimated to be about 477 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 2,069 cubic feet per second for a two-year recurrence interval rainfall event and about 2,767 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Menomonee Falls can be found elsewhere in this chapter under the Fox River watershed findings.

Village of West Milwaukee

The storm water drainage system serving the portion of the Village of West Milwaukee that lies within the Menomonee River watershed is shown on Map 30, together with the tributary drainage area of about 0.5 square mile. The system consists principally of subsurface conduits.

This portion of the Village of West Milwaukee storm water drainage system includes no known storm water pumping or storage facilities and is tributary to five known storm water outfalls ranging in size from 18 to 66 inches in diameter, of which one outfall discharges to the Menomonee River, two discharge to an unnamed tributary of the Menomonee River, and two discharge to Woods Creek. The total annual average discharge from these outfalls is estimated to be about 116 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 343 cubic feet per second for a two-year recurrence interval rainfall event and about 470 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of West Milwaukee can be found elsewhere in this chapter under the Kinnickinnic River watershed findings.

INVENTORY FINDINGS— MILWAUKEE RIVER WATERSHED

There are a total of 13 known existing urban storm water drainage systems which provide service to the subareas of the in-Region portion of the Milwaukee River watershed. These include the systems operated by the Cities of Cedarburg, Glendale, Milwaukee, and West Bend, and the Villages of Brown Deer, Fox Point, Grafton, Jackson, Kewaskum, Saukville, Shorewood, Thiensville, and Whitefish Bay. The Village of Kewaskum was unable to provide a copy of a map of their storm water drainage system. Information concerning the storm water drainage systems serving civil divisions located within the Milwaukee River watershed but outside of the Region, was not obtained for this inventory. Therefore, no detailed discussion of the out-of-Region portion of the watershed is included. Together, the 12 storm water drainage systems, for which mapping was available, have a tributary drainage area of about 38.7 square miles, or about 8.9 percent of the total in-Region area of the watershed. Included within this storm water drainage area of the watershed are a total of 309 known storm water outfalls ranging in size from 12 inches in diameter to a 144 inch by 60 inch box culvert. There are no known storm water pumping facilities and four known storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 5,369 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 13,028 cubic feet per second for a two-year recurrence interval rainfall event and about 17,710 cubic feet per second for a five-year recurrence interval rainfall event. Another portion of the watershed is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

Each of the storm water drainage systems is described in the following paragraphs. Pertinent characteristics of each system are summarized in Table 95 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the system's outfalls and estimated tributary areas of the 12 storm water drainage systems within the Milwaukee River watershed are shown on Map 31.

City of Cedarburg

The storm water drainage system serving the City of Cedarburg lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 1.3 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 11 known storm water outfalls ranging in size from 12 to 42 inches in diameter, of which nine outfalls discharge to Cedar Creek and two discharge to a tributary of Cedar Creek. The total annual average discharge from these outfalls is estimated to be about 64 million gallons per year occurring in 46 events. The combined maximum

Table 95

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE MILWAUKEE RIVER WATERSHED

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area[a]		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System (diameter in inches)	Summation of Drainage Districts[a]		
					Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles				2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Cedarburg	839	1.31	11	12 to 42	64	568	759
City of Glendale	4,436	6.93	59	12 to 78	776	1,937	2,619
City of Milwaukee	12,695	19.84	102	12 to 144 x 60	3,585	6,758	9,132
City of West Bend	2,764	4.32	63	12 to 36 x 58	227	1,510	2,030
Village of Brown Deer	839	1.31	19	12 to double 60	192	524	707
Village of Fox Point	653	1.02	15	12 to 72	52	362	588
Village of Grafton	1,274	1.99	23	12 to 54	138	470	672
Village of Jackson	171	0.27	5	12 to 21	53	67	91
Village of Kewaskum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Village of Saukville	64	0.10	1	36	8	31	42
Village of Shorewood	372	0.58	5	18 to 72	124	330	437
Village of Thiensville	357	0.56	4	18 to 36	39	212	277
Village of Whitefish Bay	331	0.52	2	24	111	259	356
Total	24,795	38.74	309	12 to 144 x 60	5,369	13,028	17,710

[a] *When a storm water outfall drainage area was located in more than one civil division, the drainage area and corresponding discharge volume and flow rates corresponding estimated discharge volume and flow rates were included in the data corresponding to the civil division in which the outfall is located.*

Source: SEWRPC.

discharge rate for these storm water outfalls is estimated to be about 568 cubic feet per second for a two-year recurrence interval rainfall event and about 759 cubic feet per second for a five-year recurrence interval rainfall event.

City of Glendale

The storm water drainage system serving the City of Glendale lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 6.9 square miles. The system consists principally of subsurface conduits with two major drainage ditches and short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping facilities and two known storm water storage facilities, both storm water detention basins, and is tributary to 59 known storm water outfalls ranging in size from 12 to 78 inches in diameter. Four of these storm water outfalls discharge to Lincoln Creek, one discharges to a tributary of Lincoln Creek, 53 discharge to the Milwaukee River, and one discharges to a tributary of Brown Deer Park Creek. The total annual average discharge from these outfalls is estimated to be 776 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,937 cubic feet per second for a two-year recurrence interval rainfall event and about 2,619 cubic feet per second for a five-year recurrence interval rainfall event.

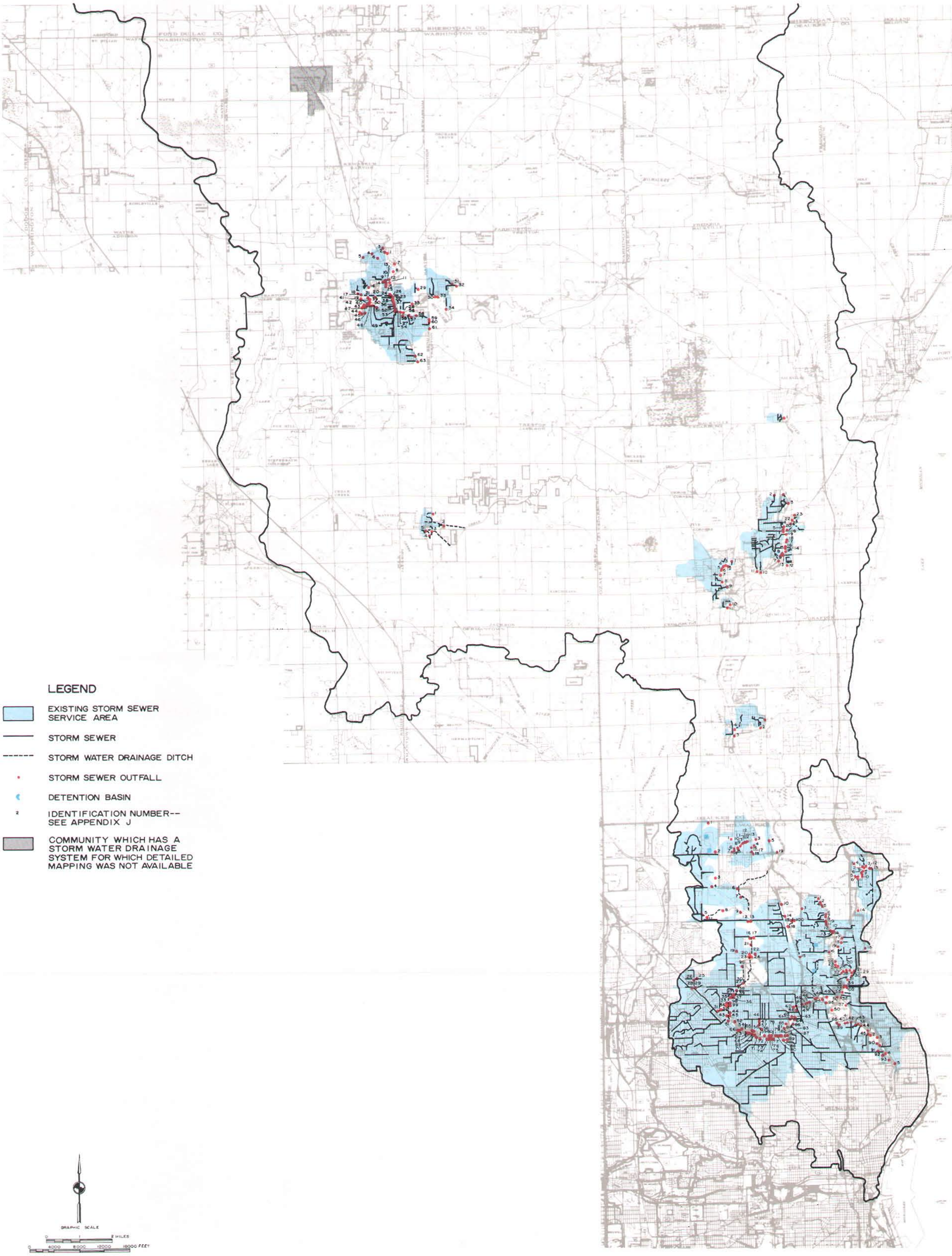
City of Milwaukee

The storm water drainage system serving the portion of the City of Milwaukee that lies within the Milwaukee River watershed is shown on Map 31, together with the tributary drainage area of about 19.8 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations. Another portion of the City of Milwaukee is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

This portion of the City of Milwaukee storm water drainage system includes no known storm water pumping facilities and two known storm water storage facilities, both storm water detention ponds, and is tributary to 102 known storm water outfalls ranging in size from 12 inches in diameter to a 144 inch by 60 inch box culvert. Six of these storm water outfalls discharge to the Milwaukee River, four discharge to unnamed tributaries of the Milwaukee River, 76 discharge to Lincoln Creek, 10 discharge to tributaries of Lincoln Creek, one discharges to Beaver Creek, and five discharge to Brown Deer Park Creek. The total annual average discharge from these outfalls is estimated to be about 3,585 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 6,758 cubic feet per second for a two-year recurrence interval rainfall event and about 9,132 cubic feet per second for a five-year recurrence interval rainfall event.

Map 31

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE MILWAUKEE RIVER WATERSHED



Source: SEWRPC.

Further references to the storm water drainage system serving the City of Milwaukee can be found elsewhere in this chapter under the Kinnickinnic River, Lake Michigan—minor streams, Menomonee River, Oak Creek, and Root River watershed findings.

City of West Bend

The storm water drainage system serving the City of West Bend lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 4.3 square miles. The system consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 63 known storm water outfalls ranging in size from 12 inches in diameter to a 58 inch by 36 inch box culvert. Thirty of these storm water outfalls drain to the Milwaukee River, 11 discharge to unnamed tributaries of the Milwaukee River, eight discharge to Silver Creek, and 14 discharge to tributaries of Silver Creek. The total annual average discharge from these outfalls estimated to be about 227 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,510 cubic feet per second for a two-year recurrence interval rainfall event and about 2,030 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Brown Deer

The storm water drainage system serving the Village of Brown Deer lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 1.3 square miles. The system consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 19 known storm water outfalls ranging in size from 12 inches in diameter to a twin outfall 60 inches in diameter. One outfall discharges to an unnamed tributary of the Milwaukee River, 13 discharge to Beaver Creek, and five discharge to tributaries of Beaver Creek. The total annual average discharge from these outfalls is estimated to be about 192 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 524 cubic feet per second for a two-year recurrence interval rainfall event and about 707 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Fox Point

The storm water drainage system serving the portion of the Village of Fox Point that lies within the Milwaukee River watershed is shown on Map 31, together with the tributary drainage area of about 1.0 square mile. The system consists principally of subsurface conduits with two major drainage ditches and short reaches of surface channels incorporated into the drainage system in many locations.

This portion of the Village of Fox Point storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 15 known storm water outfalls ranging in size from 12 to 72 inches in diameter, of which one outfall discharges to an unnamed tributary of the Milwaukee River, 11 discharge to Indian Creek, and three discharge to tributaries of Indian Creek. The total annual average discharge from these outfalls is estimated to be about 52 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 362 cubic feet per second for a two-year recurrence interval rainfall event and about 588 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Fox Point can be found elsewhere in this chapter under the Lake Michigan—Minor Streams watershed findings.

Village of Grafton

The storm water drainage system serving the Village of Grafton lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 2.0 square miles. The system consists principally of subsurface conduits with two major drainage ditches and short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 23 known storm water outfalls ranging in size from 12 to 54 inches in diameter, of which 18 outfalls discharge to the Milwaukee River, three discharge to unnamed tributaries of the Milwaukee River, and two discharge to Cedar Creek. The total annual average discharge from these outfalls is estimated to be about 138 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 470 cubic feet per second for a two-year recurrence interval rainfall event and about 672 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Jackson

The storm water drainage system serving the Village of Jackson lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 0.3 square mile. The system consists partially of subsurface conduits with one major drainage ditch and surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to five known storm water outfalls ranging in size from 12 to 21 inches in diameter, all of which discharge to tributaries of Cedar Creek. The total annaul average discharge from these outfalls is estimated to be about 53 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 67 cubic feet per second for a two-year recurrence interval rainfall event and about 91 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Kewaskum

As stated above, the Village of Kewaskum was unable to provide a copy of their systems map. Therefore, no detailed discussion of the storm water drainage system is included.

Village of Saukville

The storm water drainage system serving the Village of Saukville lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 0.1 square mile. The system consists principally of subsurface conduits.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outfall which is 36 inches in diameter and drains to a tributary of the Milwaukee River. The total annual average discharge from this outfall is estimated to be about eight million gallons per year occurring in 46 events. The maximum discharge rate for this storm water outfall is estimated to be about 31 cubic feet per second for a two-year recurrence interval rainfall event and about 42 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Shorewood

The storm water drainage system serving the portion of the Village of Shorewood that lies within the Milwaukee River watershed is shown on Map 31, together with the tributary drainage area of about 0.6 square mile. The system consists principally of subsurface conduits. Another portion of the Village of Shorewood is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

This portion of the Village of Shorewood storm water drainage system includes no known storm water pumping or storage facilities and is tributary to five known storm water outfalls ranging in size from 18 to 72 inches in diameter, all of which discharge to the Milwaukee River directly. The total annual average discharge from these outfalls is estimated to be about 124 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 330 cubic feet per second for a two-year recurrence interval rainfall event and about 437 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Shorewood can be found elsewhere in this chapter under the Lake Michigan—Minor Streams watershed findings.

Village of Thiensville

The storm water drainage system serving the Village of Thiensville lies totally within the Milwaukee River watershed and is shown on Map 31, together with the tributary drainage area of about 0.6 square mile. The system consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to four known storm water outfalls ranging in size from 18 to 36 inches in diameter, of which three outfalls discharge to the Milwaukee River and one discharges to Pigeon Creek. The total annual average discharge from these outfalls is estimated to be about 39 million gallons per year occurring in 46 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 212 cubic feet per second for a two-year recurrence interval rainfall event and about 277 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Whitefish Bay

The storm water drainage system serving the portion of the Village of Whitefish Bay that lies within the Milwaukee River watershed is shown on Map 31, together with the tributary drainage area of about 0.5 square mile. The system consists principally of subsurface conduits.

This portion of the Village of Whitefish Bay storm water drainage system includes no known storm water pumping or storage facilities and is tributary to two known storm water outfalls one of which is 24 inches in diameter and the other is of an unknown size, and both of which discharge directly to the Milwaukee River. The total annual average discharge from these outfalls is estimated to be about 111 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 259 cubic feet per second for a two-year recurrence interval rainfall event and about 356 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Whitefish Bay can be found elsewhere in this chapter under the Lake Michigan—Minor Streams watershed findings.

INVENTORY FINDINGS— WATERSHED OF MINOR STREAMS DIRECTLY TRIBUTARY TO LAKE MICHIGAN

There are a total of 10 existing urban storm water drainage systems which provide service to the subareas of streams directly tributary to Lake Michigan, including the Barnes Creek, Pike Creek, and Sucker Creek subwatershed. These systems include those operated by the Cities of Cudahy, Kenosha, Oak Creek, Port Washington, Racine, South Milwaukee, and St. Francis, and the Villages of Fox Point, Shorewood, and Whitefish Bay. Together these systems have a tributary drainage area of about 28.8 square miles or about 30 percent of the total area of the watershed. Included within the storm water drainage area of the watershed are a total of 94 known storm water outfalls ranging in size from 12 inches in diameter to an 82 inch by 128 inch box culvert. There are two known storm water pumping facilities and three known storm water storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 4,108 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 9,947 cubic feet per second for a two-year recurrence interval rainfall event and about 14,339 cubic feet per second for a five-year recurrence interval rainfall event.

Each of these storm water drainage systems is described in detail in the following paragraphs. Another portion of the watershed, in the Cities of Kenosha, Milwaukee, and Racine is served by combined sanitary and storm sewers. The sewer systems and tributary areas of the combined sewer service areas are discussed in Chapter III. The entire Lake Michigan—Minor Streams portion of the City of Milwaukee lies within the combined sewer service area and is discussed only in Chapter III. Pertinent characteristics of each system are summarized in Table 96 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the systems outfalls and estimated tributary areas of the 10 storm water drainage systems within the Lake Michigan—Minor Streams watershed are shown on Map 32.

City of Cudahy

The storm water drainage system serving the portion of the City of Cudahy that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 1.5 square miles. The system consists principally of subsurface conduits.

This portion of the City of Cudahy storm water drainage system includes no known storm water pumping or storage facilities and is tributary to three known storm water outfalls which are 60, 66, and 72 inches in diameter, all of which discharge directly to Lake Michigan. The total annual average discharge from these outfalls is estimated to be about 318 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 692 cubic feet per second for a two-year recurrence interval rainfall event and about 916 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Cudahy can be found elsewhere in this chapter under the Kinnickinnic River watershed findings.

Table 96

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE MINOR STREAMS WATERSHED DIRECTLY TRIBUTARY TO LAKE MICHIGAN

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume	Estimated Maximum Storm Water Discharge Rates: 2-Year Recurrence Interval Event	Estimated Maximum Storm Water Discharge Rates: 5-Year Recurrence Interval Event
	Acres	Square Miles		Diameter in Inches	Million Gallons	Cubic Feet per Second	Cubic Feet per Second
City of Cudahy	944	1.48	3	60 to 72	318	692	916
City of Kenosha	8,145	12.73	26	15 to 82 x 128	1,406	3,325	5,624
City of Oak Creek	230	0.36	1	78	77	253	333
City of Port Washington	394	0.62	14	12 to 36	29	221	292
City of Racine	4,543	7.10	15	15 to 96	1,223	2,320	3,159
City of South Milwaukee	1,063	1.66	9	12 to 43 x 68	201	588	804
City of St. Francis	1,441	2.25	11	12 to 126	510	1,496	1,813
Village of Fox Point	841	1.31	10	12 to 66	74	405	530
Village of Shorewood	55	0.09	1	24 x 48	19	48	65
Village of Whitefish Bay	755	1.18	4	10 to 60	251	599	803
Total	18,411	28.77	94	10 to 82 x 128	4,108	9,947	14,339

Source: SEWRPC.

City of Kenosha

The storm water drainage system serving the portion of the City of Kenosha that lies within the Lake Michigan—Minor Streams watershed including Pike Creek is shown on Map 32, together with the tributary drainage area of about 12.7 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations. Another portion of the City of Kenosha is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

This portion of the City of Kenosha storm water drainage system includes two known storm water pumping facilities and one known storage facility, a storm water detention basin, and is tributary to 26 known storm water outfalls ranging in size from 15 inches in diameter to an 82 inch by 128 inch box culvert, of which 12 outfalls discharge directly to Lake Michigan, two discharge to an unnamed tributary of Lake Michigan, 10 discharge to Pike Creek, and two discharge to a tributary of Pike Creek. The total annual average discharge from these outfalls is estimated to be about 1,406 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 3,325 cubic feet per second for a two-year recurrence interval rainfall event and about 5,624 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Kenosha can be found elsewhere in this chapter under the Pike River watershed findings.

City of Oak Creek

The storm water drainage system serving the portion of the City of Oak Creek that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 0.4 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Oak Creek storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outfall which is 78 inches in diameter and discharges directly to Lake Michigan. The total annual average discharge from this outfall is estimated to be about 77 million gallons per year occurring in 65 events. The maximum discharge rate for this storm water outfall is estimated to be about 253 cubic feet per second for a two-year recurrence interval rainfall event and about 333 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Oak Creek can be found elsewhere in this chapter under the Oak Creek and Root River watershed findings.

City of Port Washington

The storm water drainage system serving the portion of the City of Port Washington that lies in the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 0.6 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Port Washington storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 14 known storm water outfalls ranging in size from 12 to 36 inches in diameter, of which two outfalls discharge directly to Lake Michigan, and 12 discharge to a tributary of Lake Michigan. The total annual average discharge from these outfalls is estimated to be about 29 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 221 cubic feet per second for a two-year recurrence interval rainfall event and about 292 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Port Washington can be found elsewhere in this chapter under the Sauk Creek watershed findings.

City of Racine

The storm water drainage system serving the portion of the City of Racine that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 7.1 square miles. The system consists principally of subsurface conduits. Another portion of the City of Racine is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer service area are discussed in Chapter III.

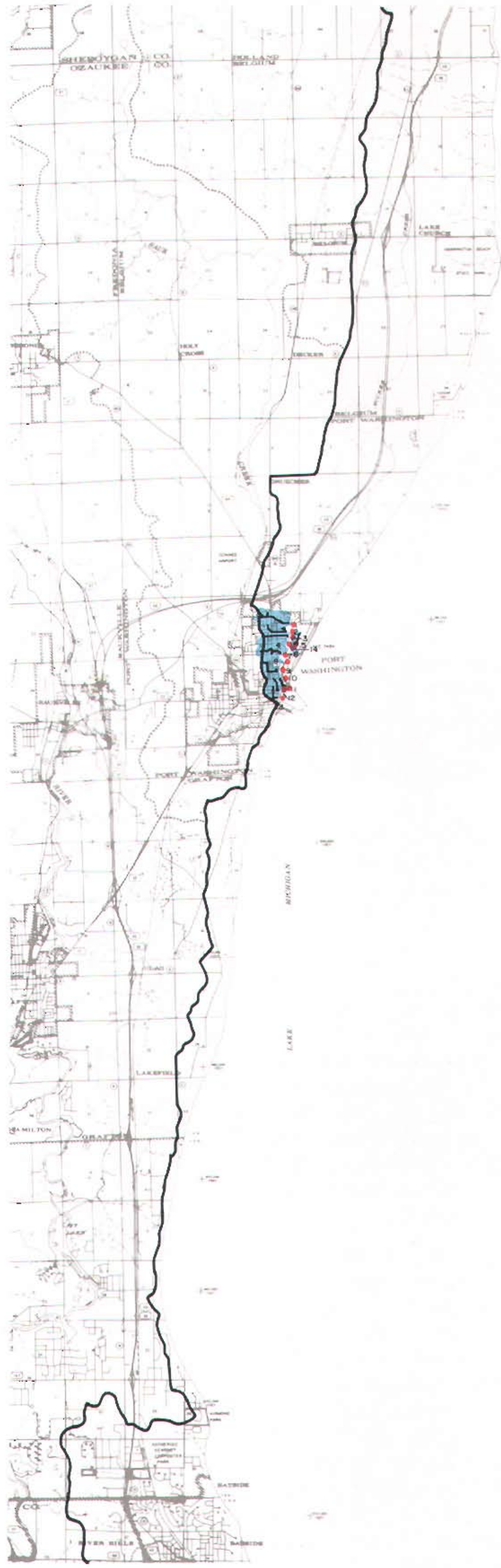
This portion of the City of Racine storm water drainage system includes no known storm water pumping facilities and two known storm water storage facilities—both storm water detention basins—and is tributary to 15 known storm water outfalls ranging in size from 15 to 96 inches in diameter, of which 14 outfalls discharge directly to Lake Michigan and one discharges to a tributary of Lake Michigan. The total annual average discharge from these outfalls is estimated to be about 1,223 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 2,320 cubic feet per second for a two-year recurrence interval rainfall event and about 3,159 cubic feet per second for a five-year recurrence interval rainfall event.

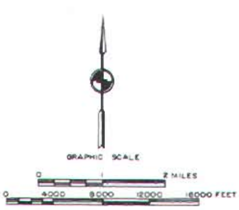
Map 32

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE WATERSHED OF MINOR STREAMS DIRECTLY TRIBUTARY TO LAKE MICHIGAN

LEGEND

- EXISTING STORM SEWER SERVICE AREA
- STORM SEWER
- STORM WATER DRAINAGE DITCH
- STORM SEWER OUTFALL
- DETENTION BASIN
- 2 IDENTIFICATION NUMBER–SEE APPENDIX J

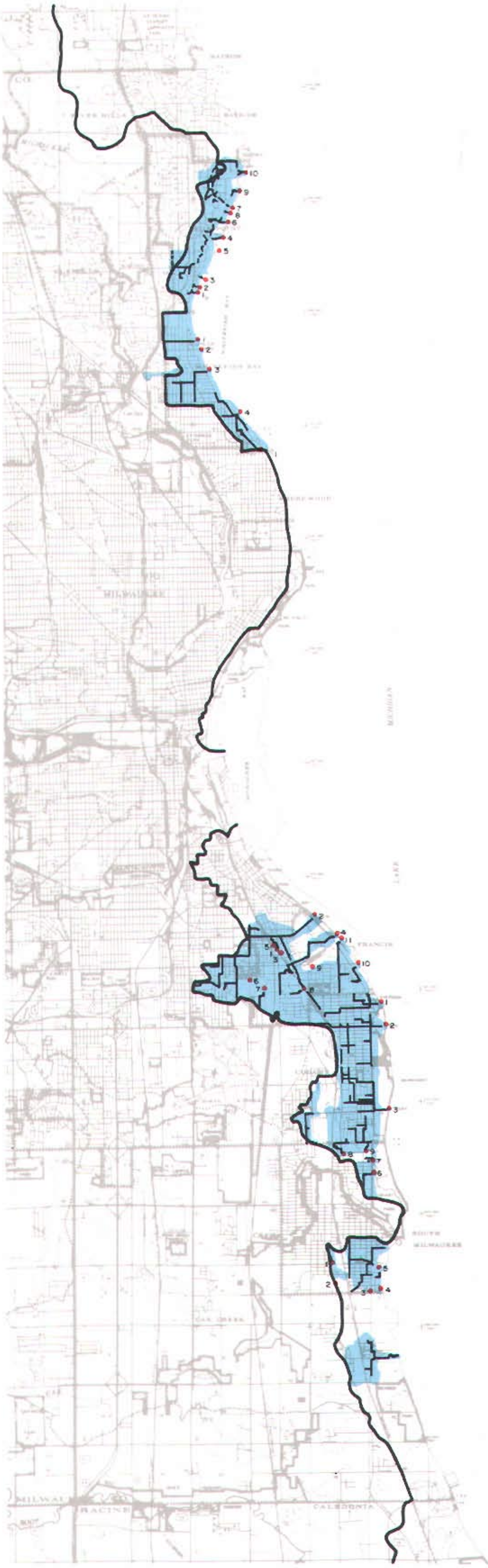




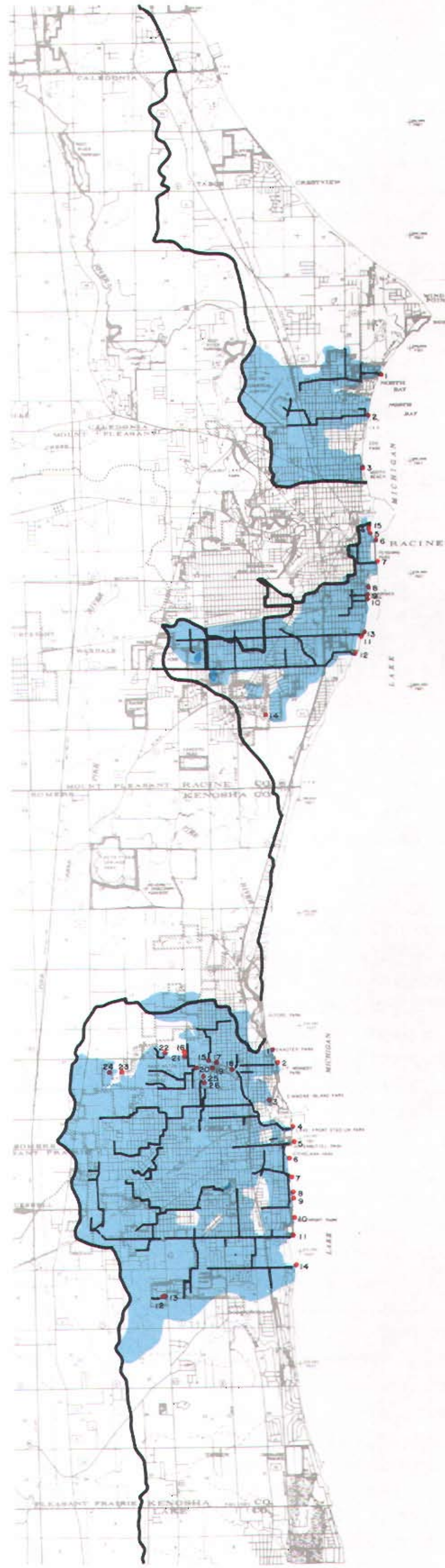
Source: SEWRPC.

Map 32 (continued)

Milwaukee County



Racine-Kenosha Counties



Further references to the storm water drainage system serving the City of Racine can be found elsewhere in this chapter under the Pike River and Root River watershed findings.

City of South Milwaukee

The storm water drainage system serving the portion of the City of South Milwaukee that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 1.7 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of South Milwaukee storm water drainage system includes no known storm water pumping or storage facilities and is tributary to nine known storm water outfalls ranging in size from 12 inches in diameter to a 43 inch by 68 inch box culvert, of which one outfall discharges directly to Lake Michigan, and eight discharge to tributaries of Lake Michigan. The total annual average discharge from these outfalls is estimated to be about 201 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 588 cubic feet per second for a two year recurrence interval rainfall event and about 804 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of South Milwaukee can be found elsewhere in this chapter under the Oak Creek watershed findings.

City of St. Francis

The storm water drainage system serving the portion of the City of St. Francis that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of 2.3 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of St. Francis storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 11 known storm water outfalls ranging in size from 12 to 126 inches in diameter, of which four outfalls discharge directly to Lake Michigan, and seven discharge to tributaries of Lake Michigan. The total annual average discharge from these outfalls is estimated to be about 510 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,496 cubic feet per second for a two-year recurrence interval rainfall event and about 1,813 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of St. Francis can be found elsewhere in this chapter under the Kinnickinnic River watershed findings.

Village of Fox Point

The storm water drainage system serving the portion of the Village of Fox Point that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 1.3 square miles. This consists partially of subsurface conduits and partially of surface channels incorporated into the drainage system in many locations.

This portion of the Village of Fox Point storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 10 known storm water outfalls ranging in size from 12 to 66 inches in diameter, all of which discharge directly to Lake Michigan. The total annual average discharge from these outfalls is estimated to be about 74 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 405 cubic feet per second for a two-year recurrence interval rainfall event and about 530 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Fox Point can be found elsewhere in this chapter under the Milwaukee River watershed findings.

Village of Shorewood

The storm water drainage system serving the portion of the Village of Shorewood that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 0.1 square mile. The system consists principally of subsurface conduits. Another portion of the Village of Shorewood is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer service area are discussed in Chapter III.

This portion of the Village of Shorewood storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outlet which is a 24 inch by 48 inch box culvert that discharges directly to Lake Michigan. The total annual average discharge from this outfall is estimated to be about 19 million gallons per year occurring in 65 events. The maximum discharge rate for this storm water outfall is estimated to be about 48 cubic feet per second for a two-year recurrence interval rainfall event and about 65 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Shorewood can be found elsewhere in this chapter under the Milwaukee River watershed findings.

Village of Whitefish Bay
The storm water drainage system serving the portion of the Village of Whitefish Bay that lies within the Lake Michigan—Minor Streams watershed is shown on Map 32, together with the tributary drainage area of about 1.2 square miles. The system consists principally of subsurface conduits.

This portion of the Village of Whitefish Bay storm water drainage system includes no known storm water pumping or storage facilities and is tributary to four known storm water outfalls ranging in size from 10 to 60 inches in diameter, all of which discharge directly to Lake Michigan. The total annual average discharge from these outfalls is estimated to be about 251 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 599 cubic feet per second for a two-year recurrence interval rainfall event and about 803 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Whitefish Bay can be found elsewhere in this chapter under the Milwaukee River watershed findings.

INVENTORY FINDINGS— OAK CREEK WATERSHED

There are a total of four known existing urban storm water drainage systems which provide service to the subareas of the Oak Creek watershed. These include the systems operated by the Cities of Franklin, Milwaukee, Oak Creek, and South Milwaukee. Together these systems have a tributary drainage area of about 9.7 square miles, or about 37 percent of the total area of the watershed. Included within this storm water drainage area of the watershed are a total of 85 known storm water outfalls ranging in size from 12 inches to 78 inches in diameter. There are no known storm water pumping or storage facilities in the watershed. The total annual average discharges from these outfalls is estimated to be about 1,133 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 3,099 cubic feet per second for a two-year recurrence interval rainfall event and about 4,220 cubic feet per second for a five-year recurrence interval rainfall event.

Each of these storm water drainage systems is described in the following paragraphs. Pertinent characteristics of each system are summarized in Table 97 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the systems outfalls and tributary areas of the four storm water drainage systems within the Oak Creek watershed are shown on Map 33.

City of Franklin
The storm water drainage system serving the portion of the City of Franklin that lies within the Oak Creek watershed is shown on Map 33, together with the tributary drainage area of about 0.1 square mile. The system consists principally of subsurface conduits with short reaches of surface channels in some locations.

This portion of the City of Franklin storm water drainage system includes no known storm water pumping or storage facilities and is tributary to one known storm water outfall of an unknown size, which discharges directly to Oak Creek. The total annual average discharge from this outfall is estimated to be about three million gallons per year occurring

Table 97

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE OAK CREEK WATERSHED

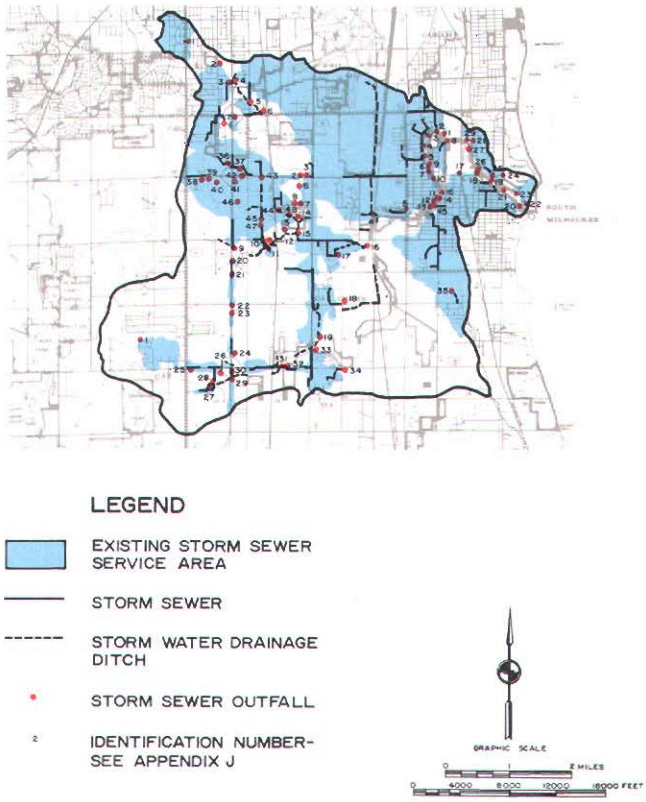
Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System (diameter in inches)	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles				2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Franklin	34	0.05	1	N/A	3	16	22
City of Milwaukee	403	0.63	7	15 to 60	83	262	349
City of Oak Creek	3,845	6.01	48	12 to 66	703	1,721	2,330
City of South Milwaukee	1,898	2.97	29	12 to 54	344	1,100	1,519
Total	6,180	9.66	85	12 to 78	1,133	3,099	4,220

NOTE: N/A indicates data not available.

Source: SEWRPC.

Map 33

EXISTING STORM WATER DRAINAGE SYSTEMS
IN THE OAK CREEK WATERSHED



Source: SEWRPC.

in 41 events. The maximum discharge rate for this storm water outfall is estimated to be about 16 cubic feet per second for a two-year recurrence interval rainfall event and about 22 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Franklin can be found elsewhere in this chapter under the Root River watershed findings.

City of Milwaukee

The storm water drainage system serving the portion of the City of Milwaukee that lies in the Oak Creek watershed is shown on Map 33, together with the tributary drainage area of about 0.6 square mile. The system consists of subsurface conduits. This portion of the City of Milwaukee storm water drainage system includes no known storm water pumping or storage facilities and is tributary to seven known storm water outfalls ranging in size from 15 to 60 inches in diameter, of which six outfalls discharge to the North Branch of Oak Creek and one discharges to a tributary of the North Branch of Oak Creek. The total annual average discharge from these outfalls is estimated to be about 83 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 262 cubic feet per second for a two-year recurrence interval rainfall event and about 349 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Milwaukee can be found elsewhere in this chapter under the Kinnickinnic River, Lake Michigan—Minor Streams, Menomonee River, Milwaukee River, and Root River watershed findings.

City of Oak Creek

The storm water drainage serving the portion of the City of Oak Creek what lies in the Oak Creek watershed is shown on Map 33, together with the tributary drainage area of about 6.0 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations. In addition, a mostly ditched and partially sewered drainage system for General Billy Mitchell Field, known as Mitchell Field Ditch, is incorporated into the City of Oak Creek storm water drainage system.

This portion of the City of Oak Creek storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 48 known storm water outfalls ranging in size from 12 to 66 inches in diameter. Twelve of these storm water outfalls discharge to the North Branch of Oak Creek, 19 discharge to tributaries of the North Branch of Oak Creek, 10 discharge to Oak Creek, and seven discharge to tributaries of Oak Creek. The total annual average discharge from these outfalls is estimated to be about 703 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,721 cubic feet per second for a two-year recurrence interval rainfall event and about 2,330 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Oak Creek can be found elsewhere in this chapter under the Lake Michigan—Minor Streams and Root River watershed findings.

City of South Milwaukee

The storm water drainage system serving the portion of the City of South Milwaukee that lies in the Oak Creek watershed is shown on Map 33, together with the tributary drainage area of about 3.0 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of South Milwaukee storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 29 known storm water outlets ranging in size from 12 to 54 inches in diameter, of which 28 discharge to Oak Creek and one discharges to a tributary of Oak Creek. The total annual average discharge from these outfalls is estimated to be about 344 million gallons per year occurring in 57 events. The combined maximum discharge from these outfalls is estimated to be about 1,100 cubic feet per second for a two-year recurrence interval rainfall event and about 1,519 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of South Milwaukee can be found elsewhere in this chapter under the Lake Michigan—Minor Streams watershed findings.

INVENTORY FINDINGS— PIKE RIVER WATERSHED

There are a total of three known existing urban storm water drainage systems which provide service to the subareas of the Pike River watershed. These include the systems operated by the Cities of Kenosha and Racine, and the Village of Sturtevant. Together these systems have a tributary drainage area of about 3.8 square miles, or about 7.5 percent of the total area in the watershed. Included within this storm water drainage area of the watershed are a total of 13 known storm water outfalls ranging in size from 15 inches in diameter to a 72 inch by 113 inch box culvert. There are no known storm water pumping facilities and one storm water storage facility in the watershed. The total annual average discharge from these outfalls is estimated to be approximately 246 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,009 cubic feet per second for a two-year recurrence interval rainfall event and about 1,349 cubic feet per second for a five-year recurrence interval rainfall event.

Each of these storm water drainage systems is described in the following paragraphs. Pertinent characteristics of each system are summarized in Table 98 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the systems outlets and estimated tributary areas of the three storm water drainage systems within the Pike River watershed are shown on Map 34.

City of Kenosha

The storm water drainage system serving the portion of the City of Kenosha that lies within the Pike River watershed is shown on Map 34, together with the tributary drainage area of about 2.5 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Kenosha storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to eight known storm water outfalls ranging in size from 15 to 90 inches in diameter, of which six outfalls discharge to the Pike River and two discharge to a tributary of the Pike River. The total annual average discharge from these outfalls is estimated to be about 124 million gallons per year occurring in 41 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 725 cubic feet per second for a two-year recurrence interval rainfall event and about 963 cubic feet per second for a five-year recurrence interval rainfall event.

Table 98

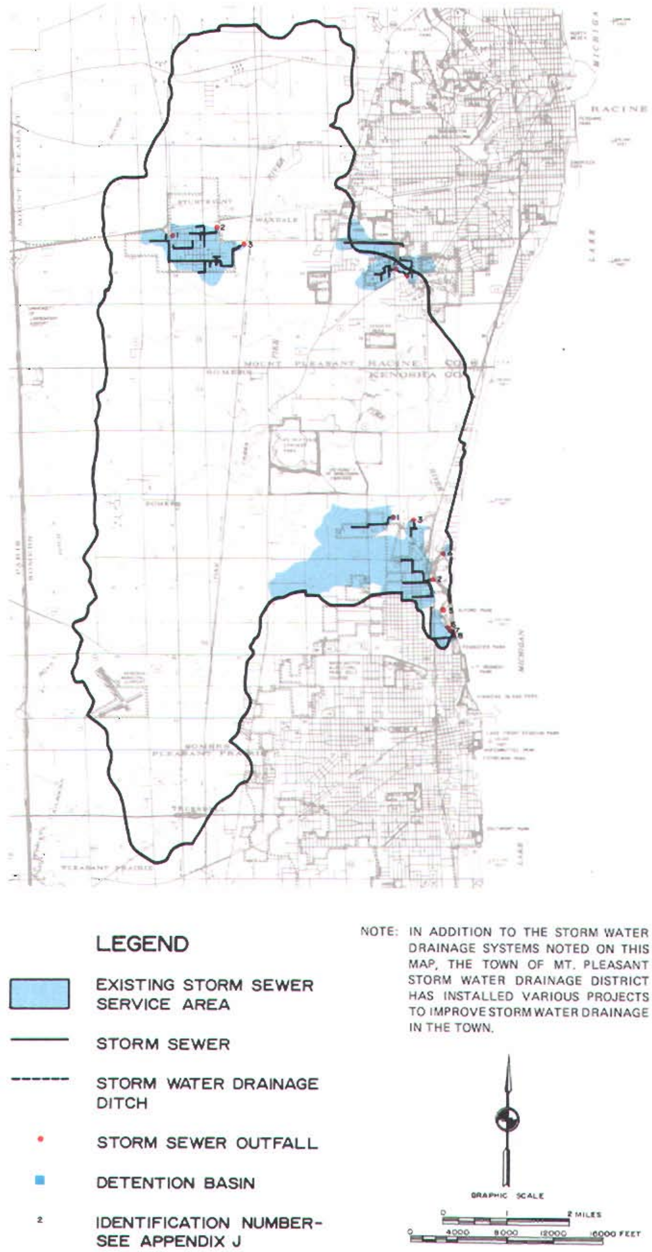
AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE PIKE RIVER WATERSHED

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume	Estimated Maximum Storm Water Discharge Rates	
						2-Year Recurrence Interval Event	5-Year Recurrence Interval Event
	Acres	Square Miles		Diameter in Inches	Million Gallons	Cubic Feet per Second	Cubic Feet per Second
City of Kenosha	1,609	2.51	8	15 to 90	124	725	963
City of Racine	359	0.56	2	43 x 68 & 72 x 113	73	114	155
Village of Sturtevant	440	0.69	3	Unknown to 60	49	170	231
Total	2,408	3.76	13	15-72 x 113	246	1,009	1,349

Source: SEWRPC.

Map 34

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE PIKE RIVER WATERSHED



Source: SEWRPC.

Further references to the storm water discharge system serving the City of Kenosha can be found elsewhere in this chapter under the Lake Michigan—Minor Streams and Pike Creek watersheds findings.

City of Racine

The storm water drainage system serving the portion of the City of Racine that lies within the Pike River watershed is shown on Map 34, together with the tributary drainage area of about 0.6 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Racine storm water drainage system includes no known storm water pumping facilities and one known storm water storage facility, a storm water detention basin. This portion of the storm water drainage system is also tributary to two known storm water outfalls, one a 43 inch by 68 inch box culvert and the other a 72 inch by 113 inch box culvert, both of which discharge to a tributary of the Pike River. The total annual average discharge from these outfalls is estimated to be about 73 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 114 cubic feet per second for a two-year recurrence interval rainfall event and about 155 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Racine can be found elsewhere in this chapter under the Lake Michigan—Minor Streams and Root River watershed sections.

Village of Sturtevant

The storm water drainage system serving the Village of Sturtevant lies totally within the Pike River watershed and is shown on Map 34, together with the tributary drainage area of about 0.7 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The Village of Sturtevant storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to three known storm water outfalls, one 60 inches in diameter, one 30 inches in diameter, and one of less than 30 inches in diameter, all of which discharge to the Waxdale Tributary. The total annual average discharge from these outfalls is estimated to be about 49 million gallons per year occurring in 46 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 170 cubic feet per second for a two-year recurrence interval rainfall event and about 231 cubic feet per second for a five-year recurrence interval rainfall event.

INVENTORY FINDINGS—ROCK RIVER WATERSHED

There are a total of seven known existing urban storm water drainage systems which provide service to the subareas of the Rock River watershed. These include the systems operated by the Cities of Delavan, Elkhorn, Hartford, Oconomowoc, and Whitewater, and the Villages of Hartland and Slinger. The City of Oconomowoc and the Village of Hartland were unable to provide a copy of a map of their systems. Together, the five storm water drainage systems, for which mapping was available, have a tributary drainage area of about 5.6 square miles, or about 1 percent of the total area of the watershed. Included within this storm water drainage area of the watershed are a total of 67 known storm water outfalls ranging in size from 12 inches to 78 inches in diameter. There are no known storm water pumping or storage facilities in the watershed. The total annual average discharge from these outfalls is estimated to be about 282 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,880 cubic feet per second for a two-year recurrence interval rainfall event and about 2,495 cubic feet per second for a five-year recurrence interval rainfall event.

Each of these storm water drainage systems is described in the following paragraphs. Pertinent characteristics of each system are summarized in Table 99 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the systems outfalls and estimated tributary areas of the five storm water drainage systems within the Rock River watershed are shown on Map 35.

City of Delavan

The storm water drainage system serving the City of Delavan lies totally within the Rock River watershed and is shown on Map 35, together with the tributary drainage area of about 1.6 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 15 known storm water outfalls ranging in size from 12 to 78 inches in diameter, of which eight discharge to Swan Creek, four discharge to Turtle Creek, and three discharge to Comus Lake. The total annual average discharge from these outfalls is estimated to be about 56 million gallons per year occurring in 41 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 396 cubic feet per second for a two-year recurrence interval rainfall event and about 524 cubic feet per second for a five-year recurrence interval rainfall event.

City of Elkhorn

The storm water drainage system serving the portion of the City of Elkhorn that lies within the Rock River watershed is shown on Map 35, together with the tributary drainage area of about 0.6 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Elkhorn storm water drainage system includes no known storm water pumping or storage facilities and is tributary to six known storm water outfalls ranging in size from 12 to 36 inches in diameter, all of which discharge to a tributary of Jackson Creek. The total annual average discharge from these outfalls is estimated to be about 48 million gallons per year occurring in

Table 99

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE ROCK RIVER WATERSHED

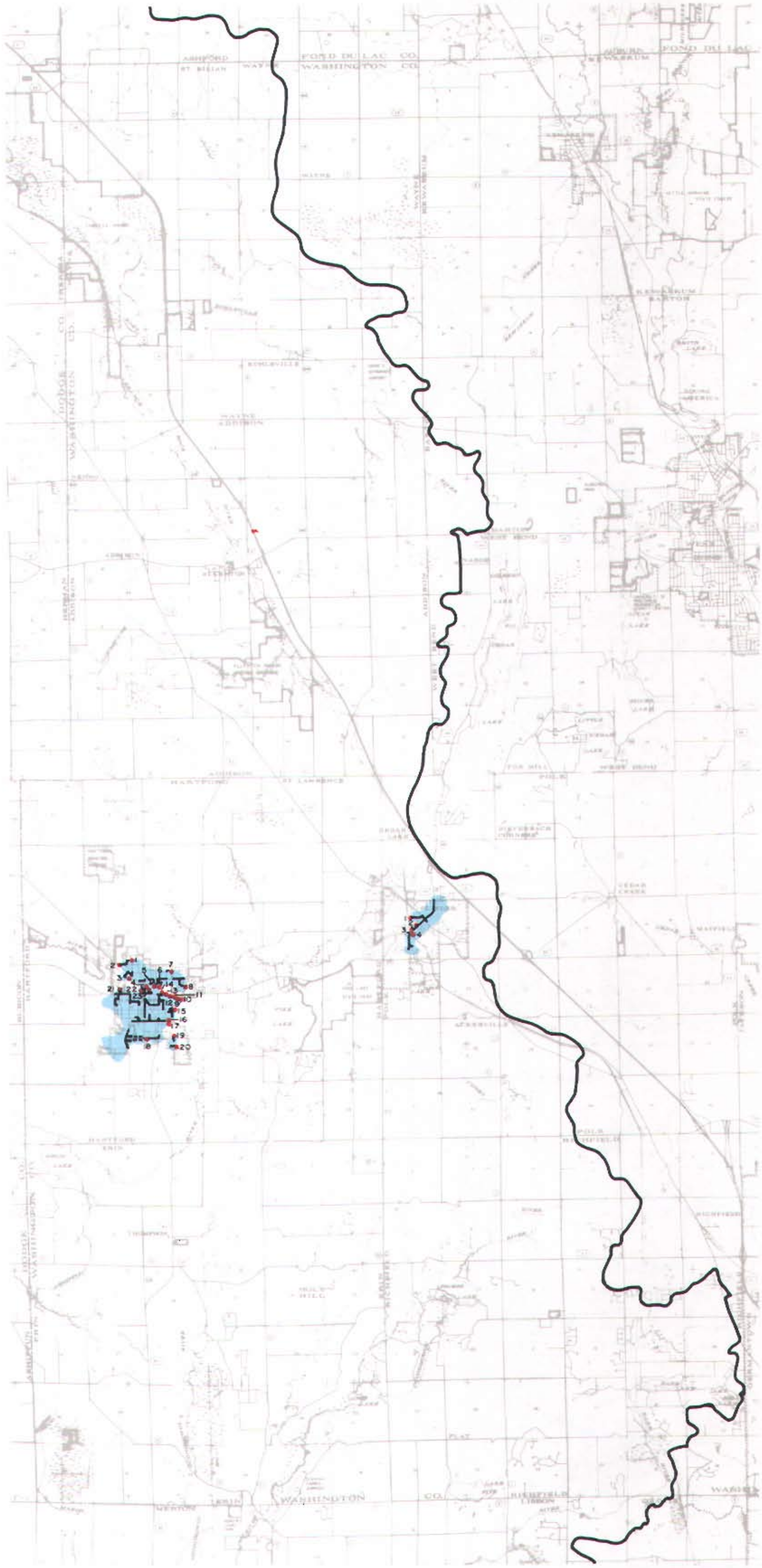
Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System (diameter in inches)	Summation of Drainage Districts		
						Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			Total Estimated Annual Discharge Volume (million gallons)	2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Delavan	1,050	1.64	15	12 to 78	56	396	524
City of Elkhorn	370	0.58	6	12 to 36	48	222	295
City of Hartford	752	1.18	23	12 to (2) 28 x 24 arch	80	508	671
City of Oconomowoc	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Whitewater	963	1.50	19	12 to 60	75	513	688
Village of Hartland	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Village of Slinger	370	0.58	4	36 to 54	23	241	317
Total	3,505	5.48	67	12 to 78	282	1,880	2,495

NOTE: N/A indicates data not available.

Source: SEWRPC.

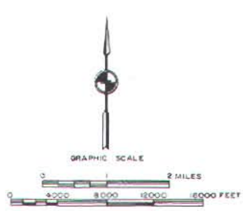
Map 35

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE ROCK RIVER WATERSHED



LEGEND

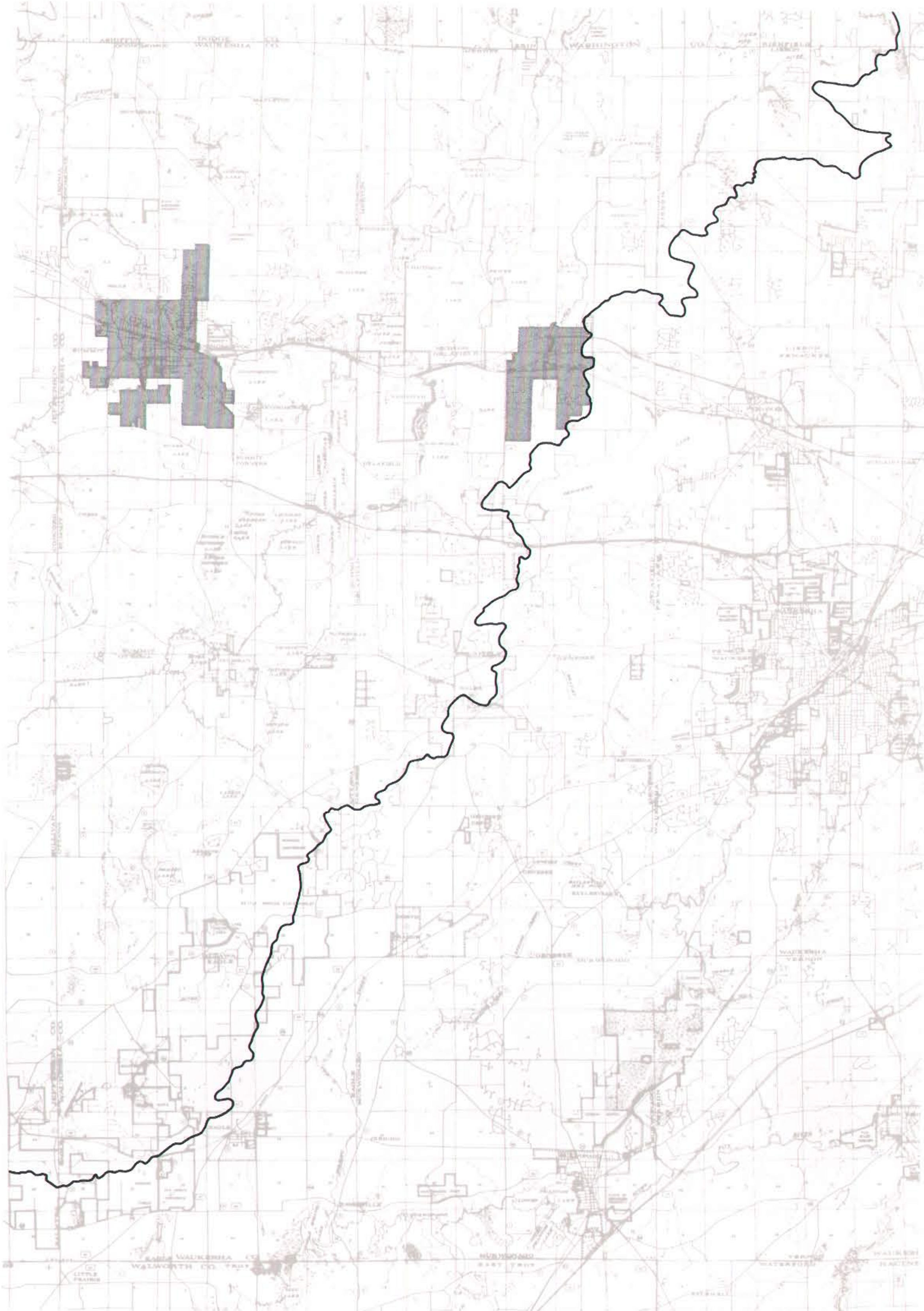
- EXISTING STORM SEWER SERVICE AREA
- STORM SEWER
- STORM WATER DRAINAGE DITCH
- STORM SEWER OUTFALL
- 2 IDENTIFICATION NUMBER-- SEE APPENDIX J
- COMMUNITY WHICH HAS A STORM WATER DRAINAGE SYSTEM FOR WHICH DETAILED MAPPING WAS NOT AVAILABLE



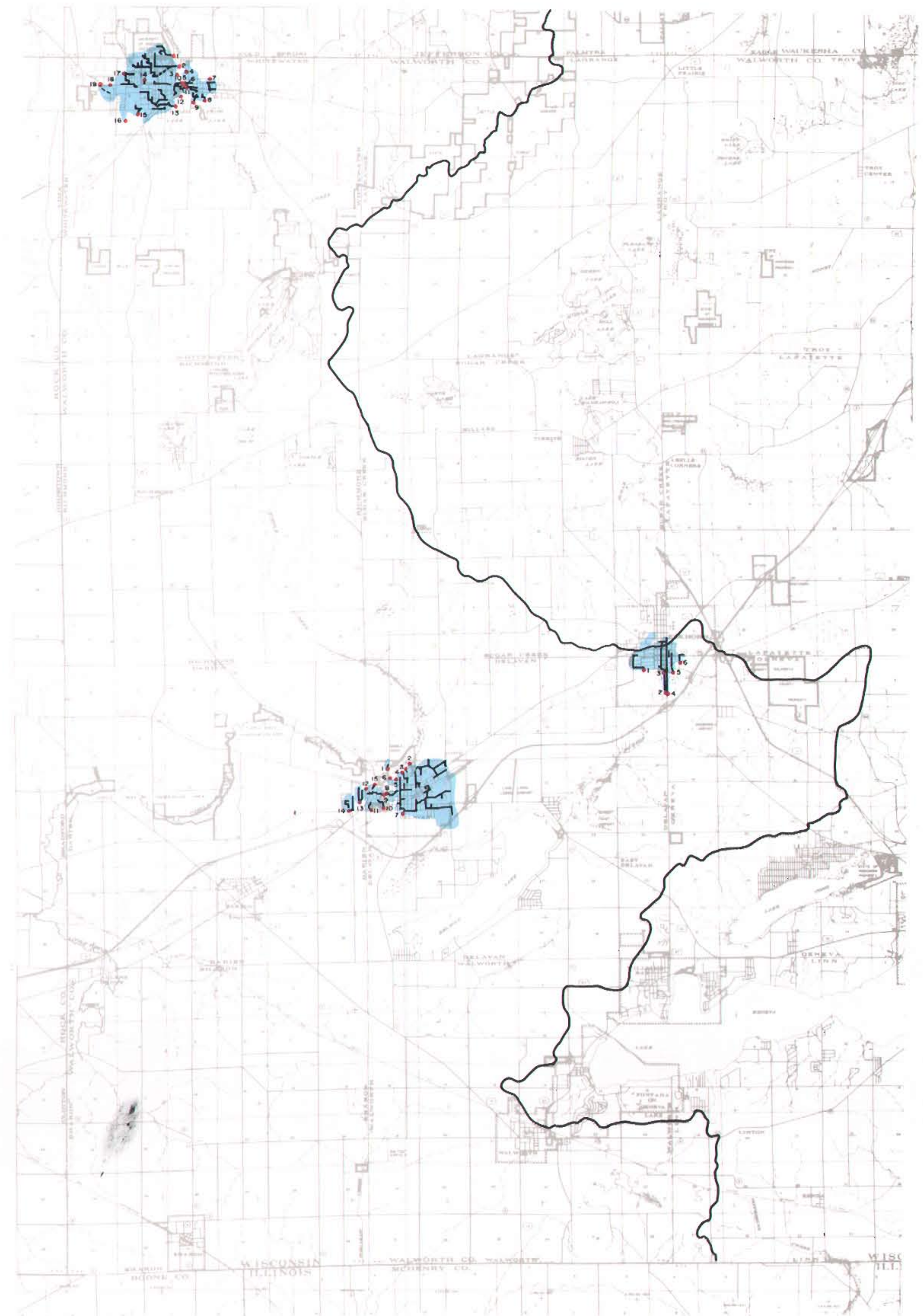
Source: SEWRPC.

Map 35 (continued)

Waukesha County



Walworth County



46 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 222 cubic feet per second for a two-year recurrence interval rainfall event and about 295 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Elkhorn can be found elsewhere in this chapter under the Fox River watershed findings.

City of Hartford

The storm water drainage system serving the City of Hartford lies totally within the Rock River watershed and is shown on Map 35, together with the tributary drainage area of about 1.2 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 23 known storm water outfalls ranging in size from 12 inches in diameter to a double 28 inch by 24 inch arch, of which 10 outfalls discharge to the Rubicon River and 13 discharge to tributaries of the Rubicon River. The total annual average discharge from these outfalls is estimated to be about 80 million gallons per year occurring in 46 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 508 cubic feet per second for a two-year recurrence interval rainfall event and about 671 cubic feet per second for a five-year recurrence interval rainfall event.

City of Oconomowoc

As stated above, the City of Oconomowoc was unable to provide a copy of their systems map. Therefore, no detailed discussion of the storm water drainage system is included. All of the storm water drainage system outfalls discharge within the Oconomowoc River subwatershed of the Rock River watershed.

City of Whitewater

The storm water drainage system serving the City of Whitewater lies totally within the Rock River watershed and is shown on Map 35, together with the tributary drainage area of 1.5 square miles. Although the City of Whitewater corporate limits extend outside the Region into Jefferson County, the entire storm water drainage system is discussed here. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The City of Whitewater storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 19 known storm water outfalls ranging in size from 12 to 60 inches in diameter, of which one discharges to Tripp Lake, three discharge to Cravath Lake, and 15 discharge to Whitewater Creek either directly or via tributaries. The total annual average discharge from these outfalls is estimated to be about 75 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 513 cubic feet per second for a two-year recurrence interval rainfall event and about 688 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Hartland

As stated above, the Village of Hartland was unable to provide a copy of their systems map. Therefore, no discussion of the storm water drainage system is included. All of the storm water drainage system outfalls discharge within the Bark River subwatershed of the Rock River watershed.

Village of Slinger

The storm water drainage system serving the Village of Slinger lies totally within the Rock River watershed and is shown on Map 35, together with the tributary drainage area of about 0.6 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

The Village of Slinger storm water drainage system includes no known pumping or storage facilities and is tributary to four known storm water outfalls ranging in size from 36 to 54 inches in diameter, of which two outfalls discharge to the Rubicon River, two discharge to a tributary of the Rubicon River. The total annual average discharge from these outfalls is estimated to be about 23 million gallons per year occurring in 41 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 241 cubic feet per second for a two-year recurrence interval rainfall event and about 317 cubic feet per second for a five-year recurrence interval rainfall event.

INVENTORY FINDINGS— ROOT RIVER WATERSHED

There are a total of 11 known existing urban storm water drainage systems which provide service to the subareas of the Root River watershed. These include the systems operated by the Cities of Franklin, Greenfield, Milwaukee, Muskego, New Berlin, Oak Creek, Racine, and West Allis, and the Villages of Greendale, Hales Corners, and Union Grove. The City of Muskego and Village of Hales Corners were unable to provide maps of their systems due to a lack of available mapping. Together, the nine storm water drainage systems for which mapping was available have a tributary drainage area of about 16.5 square miles, or about 8 percent of the total area of the watershed. Included within this storm water drainage area of the watershed are a total of 124 known storm water outfalls ranging in size from 12 to 96 inches in diameter. There are no known storm water pumping facilities and three known storm water storage facilities in the watershed. The total annual average discharges from these outlets is estimated to be about 2,113 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 5,931 cubic feet per second for a two-year recurrence interval rainfall event and about 8,015 cubic feet per second for a five-year recurrence interval rainfall event. Another portion of the watershed is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

Each of these storm water drainage systems is described in the following paragraphs. Pertinent characteristics of each system are summarized in Table 100 and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits as well as the systems outfalls and estimated tributary areas of the 11 storm water drainage systems within the Root River watershed are shown on Map 36.

City of Franklin

The storm water drainage system serving the portion of the City of Franklin that lies within the Root River watershed is shown on Map 36, together with the tributary drainage area of about 1.2 square miles. The system, which serves only isolated portions of the City of Franklin, consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Franklin includes no known storm water pumping facilities and one known storm water storage facility, and is tributary to seven known storm water outfalls of unknown size, of which two discharge to the East Branch Root River, two discharge to tributaries of the Root River, and three discharge to Whitnall Park Creek. The total annual average discharge from these outfalls is estimated to be about 129 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 285 cubic feet per second for a two-year recurrence interval rainfall event and about 375 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the City of Franklin can be found elsewhere in this chapter under the Oak Creek watershed findings.

City of Greenfield

The storm water drainage system serving the portion of the City of Greenfield that lies within the Root River watershed is shown on Map 36, together with the tributary drainage area of about 2.1 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of Greenfield storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to 19 known storm water outfalls ranging in size from 12 inches in diameter to a 72 inch by 84 inch box

Table 100

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE ROOT RIVER WATERSHED

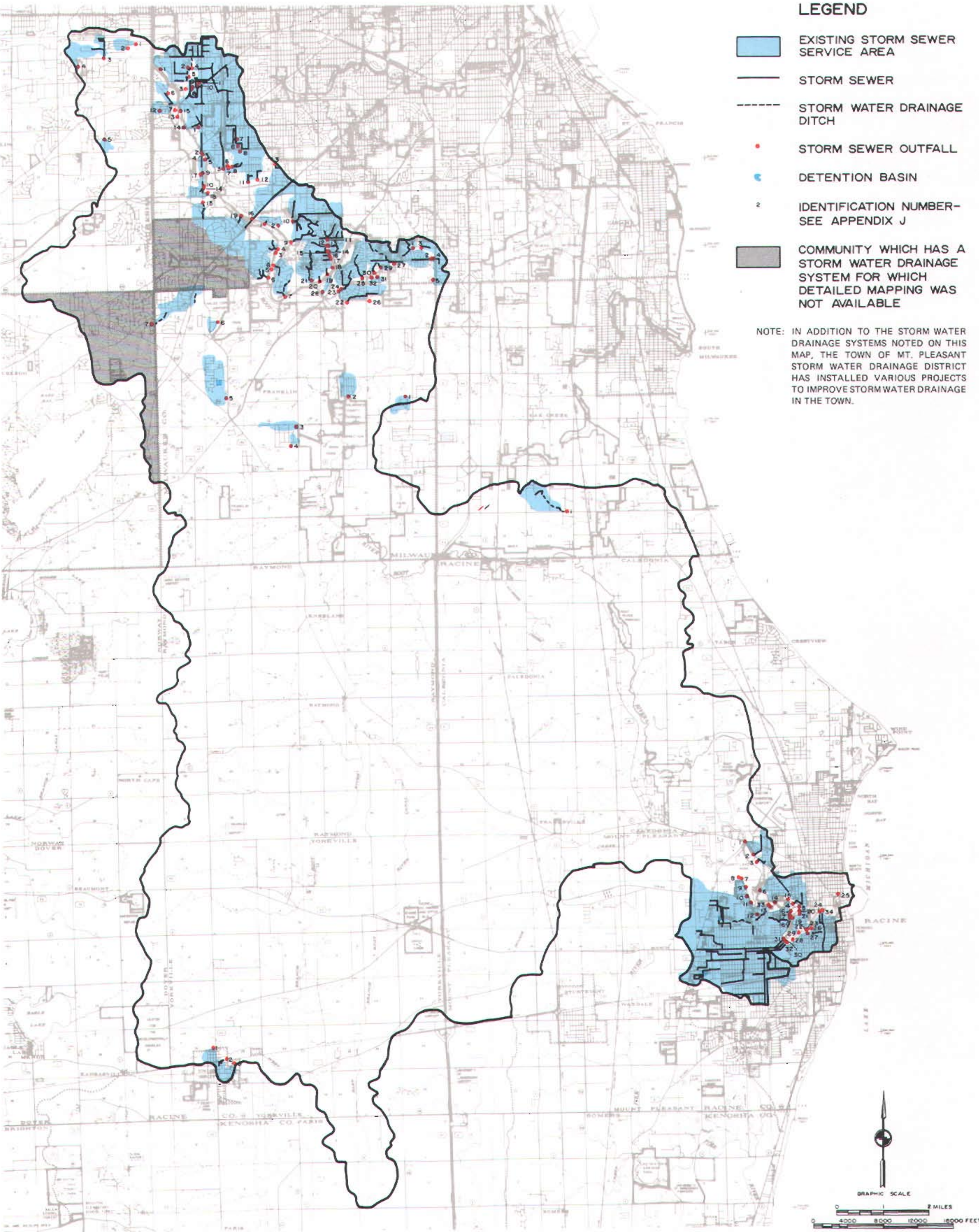
Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System (diameter in inches)	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles				2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Franklin	758	1.18	7	N/A	129	285	375
City of Greenfield	1,315	2.05	19	12 to 72 x 84	243	806	1,070
City of Milwaukee	621	0.97	8	27 to 91 x 58	124	440	579
City of Muskego	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of New Berlin	224	0.35	5	10 to 60	43	143	195
City of Oak Creek	230	0.36	1	Open ditch	29	41	55
City of Racine	3,646	5.70	34	12 to 96	822	1,763	2,443
City of West Allis	1,468	2.30	15	21 to 48 x 96	314	882	1,199
Village of Greendale	2,126	3.32	32	15 to 76 x 48	357	1,482	1,977
Village of Hales Corners	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Village of Union Grove	153	0.24	3	12 to 42	52	89	122
Total	10,541	16.47	124	12 to 96	2,113	5,931	8,015

NOTE: N/A indicates data not available.

Source: SEWRPC.

Map 36

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE ROOT RIVER WATERSHED



Source: SEWRPC.

culvert, of which five outfalls discharge to the Root River, and 14 discharge to tributaries of the Root River. The total annual average discharge from these outfalls is estimated to be about 243 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 806 cubic feet per second for a two-year recurrence interval rainfall event and about 1,070 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Greenfield can be found elsewhere in this chapter under the Kinnickinnic River and Menomonee River watershed findings.

City of Milwaukee

The storm water drainage system serving the portion of the City of Milwaukee that lies within the Root River watershed is shown on Map 36, together with the tributary drainage area of about 1.0 square mile. The system consists principally of subsurface conduits.

This portion of the City of Milwaukee storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to eight known storm water outfalls ranging in size from 27 inches in diameter to a 91 inch by 58 inch box culvert, of which three outfalls discharge to a tributary of the Root River and five discharge to the East Branch of the Root River. The total annual average discharge from these outfalls is estimated to be about 124 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 440 cubic feet per second for a two-year recurrence interval rainfall event and about 579 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Milwaukee can be found elsewhere in this chapter under the Kinnickinnic River, Lake Michigan—Minor Streams, Menomonee River, Milwaukee River, and Oak Creek watershed findings.

City of Muskego

As stated above, the City of Muskego was unable to provide a copy of their systems map. Therefore, no detailed discussion of the storm water drainage system is included. It is known that the storm water drainage system does include some subsurface conduits along major thoroughfares and surface channels in the remaining areas.

City of New Berlin

The storm water drainage system serving the portion of the City of New Berlin that lies within the Root River watershed is shown on Map 36, together with the tributary drainage area of 0.4 square mile. The system, which serves only isolated portions of the City of New Berlin, consists principally of subsurface conduits with short reaches of surface channels incorporated into the system in some locations.

This portion of the City of New Berlin storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to five known storm water outfalls ranging in size from 10 to 60 inches in diameter, all of which discharge to tributaries of the Root River. The total annual average discharge from these outfalls is estimated to be about 43 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 143 cubic feet per second for a two-year recurrence interval rainfall event and about 195 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of New Berlin can be found elsewhere in this chapter under the Fox River and Menomonee River watershed findings.

City of Oak Creek

The storm water drainage system serving the portion of the City of Oak Creek that lies within the Root River watershed is shown on Map 36, together with the tributary drainage area of about 0.4 square mile. The system, which serves only an isolated portion of the City of Oak Creek, consists partially of subsurface conduits and partially of a surface channel.

This portion of the City of Oak Creek storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to one known storm water outlet which is an open ditch that discharges to a tributary of the Root River. The total annual average discharge from this outlet is estimated to be about 29 million gallons per year occurring in 46 events. The maximum discharge rate for this storm water outlet is estimated to be about 41 cubic feet per second for a two-year recurrence interval rainfall event and about 55 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Oak Creek can be found elsewhere in this chapter under the Lake Michigan—Minor Streams and Oak Creek watershed findings.

City of Racine

The storm water drainage system serving the portion of the City of Racine that lies within the Root River watershed is shown on Map 36, together with the tributary drainage area of 5.7 square miles. The system consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in some locations. Another portion of the watershed in the City of Racine is served by combined sanitary and storm sewers. The sewer system and tributary area of the combined sewer area are discussed in Chapter III.

This portion of the City of Racine storm water drainage system includes no known storm water pumping facilities and two known storm water storage facilities, both storm water detention basins, and is tributary to 34 known storm water outfalls ranging in size from 12 to 96 inches in diameter, of which 28 discharge to the Root River and six discharge to a tributary of the Root River. The total annual average discharge from these outfalls is estimated to be about 822 million gallons per year occurring in 70 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,763 cubic feet per second for a two-year recurrence interval rainfall event and about 2,443 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of Racine can be found elsewhere in this chapter under the Lake Michigan—Minor Streams and Pike River watershed findings.

City of West Allis

The storm water drainage system serving the portion of the City of West Allis that lies within the Root River watershed is shown on Map 36, together with its tributary drainage area of about 2.3 square miles. The system consists principally of subsurface conduits with one major drainage ditch and short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the City of West Allis storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to 15 known storm water outfalls ranging in size from 21 inches in diameter to a 48 inch by 96 inch box culvert, of which six outfalls discharge to the Root River and nine discharge to tributaries of the Root River. The total annual average discharge from these outfalls is estimated to be about 314 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 882 cubic feet per second for a two-year recurrence interval rainfall event and about 1,199 cubic feet per second for a five-year recurrence interval rainfall event.

Further references to the storm water drainage system serving the City of West Allis can be found elsewhere in this chapter under the Kinnickinnic River and Menomonee River watershed findings.

Village of Greendale

The storm water drainage system serving the Village of Greendale lies totally within the Root River watershed and is shown on Map 36, together with the tributary drainage area of about 3.3 square miles. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in many locations.

The Village of Greendale storm water drainage system includes no known storm water pumping or storage facilities and is tributary to 32 known storm water outfalls ranging in size from 15 inches in diameter to a 76 inch by 48 inch box culvert, of which one outfall discharges to the East Branch Root River, nine discharge to the Root River, and the remaining 22 discharge to tributaries of the Root River. The total annual average discharge from these outfalls is estimated to be about 357 million gallons per year occurring in 57 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 1,482 cubic feet per second for a two-year recurrence interval rainfall event and about 1,977 cubic feet per second for a five-year recurrence interval rainfall event.

Village of Hales Corners

As stated above, the Village of Hales Corners was unable to provide a copy of their systems map. Therefore, no detailed discussion of the storm water drainage system is included. It is known that the storm water drainage system does include some subsurface conduits along major thoroughfares and surface channels in the remaining areas.

Village of Union Grove

The storm water drainage system serving the portion of the Village of Union Grove that lies within the Root River watershed is shown on Map 36, together with the tributary drainage area of about 0.2 square mile. The system consists principally of subsurface conduits with short reaches of surface channels incorporated into the drainage system in some locations.

This portion of the Village of Union Grove storm water drainage system includes no known storm water pumping or storage facilities, and is tributary to three known storm water outfalls which are 12, 21, and 42 inches in diameter in size, and all of which discharge to the West Branch Root River Canal. The total annual average discharge from these outfalls is estimated to be about 52 million gallons per year occurring in 65 events. The combined maximum discharge rate for these storm water outfalls is estimated to be about 89 cubic feet per second for a two-year recurrence interval rainfall event and about 122 cubic feet per second for a five-year recurrence interval rainfall event.

Further reference to the storm water drainage system serving the Village of Union Grove can be found elsewhere in this chapter under the Des Plaines River watershed findings.

INVENTORY FINDINGS— SAUK CREEK WATERSHED

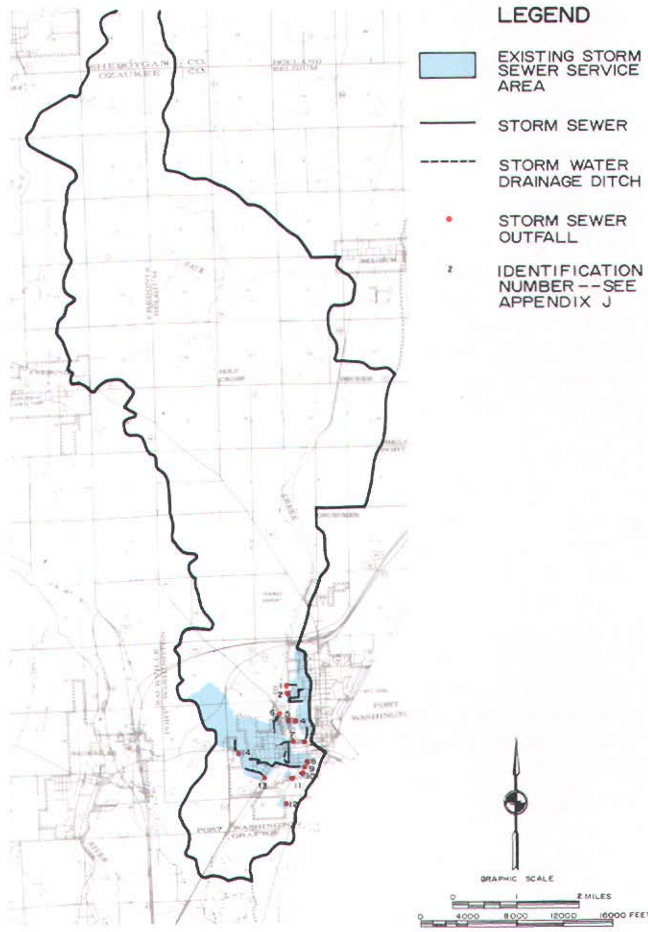
There is one known existing urban storm water drainage system that provides service to subareas of the Sauk Creek watershed. This is the system operated by the City of Port Washington. The portion of the system that lies within the Sauk Creek watershed has a tributary drainage area of 1.4 square miles, or about 4 percent of the total area of the watershed. Included within this drainage area are a total of 14 known storm water outfalls ranging in size from 12 to 72 inches in diameter, of which seven outfalls discharge to Sauk Creek and seven discharge to tributaries of Sauk Creek. There are no known storm water pumping or storage facilities in the watershed. The total average annual discharge from these storm water drainage outfalls is estimated to be 59 million gallons per year occurring in 41 events. The combined maximum discharge rate for these outfalls is estimated to be about 616 cubic feet per second for a two-year recurrence interval rainfall event and about 777 cubic feet per second for a five-year recurrence interval rainfall event.

Pertinent characteristics of the single storm water drainage system in the Sauk Creek watershed are summarized in Table 101, and are presented in greater detail in Appendix J. The location and configuration of the major storm water drainage conduits, as well as the system outlets and estimated tributary areas within the Sauk Creek watershed are shown on Map 37.

Further references to the storm water drainage system serving the City of Port Washington are to be found elsewhere in this chapter under the Lake Michigan—Minor Streams watershed findings.

Map 37

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE SAUK CREEK WATERSHED



Source: SEWRPC.

Table 101

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE SAUK CREEK WATERSHED

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume	Estimated Maximum Storm Water Discharge Rates	
						2-Year Recurrence Interval Event	5-Year Recurrence Interval Event
	Acres	Square Miles		Diameter in Inches	Million Gallons	Cubic Feet per Second	Cubic Feet per Second
City of Port Washington	921	1.44	14	12 to 72	59	616	777
Total	921	1.44	14	12 to 72	59	616	777

Source: SEWRPC.

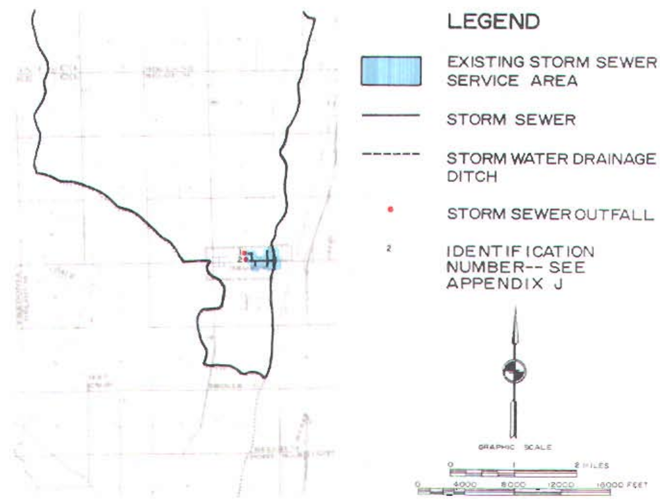
INVENTORY FINDINGS— SHEBOYGAN RIVER WATERSHED

There is one known existing urban storm water drainage system that provides service to subareas of the Sheboygan River watershed. This is the system operated by the Village of Belgium. The system lies totally within the Sheboygan River watershed and has a tributary drainage area of about 0.2 square mile, or about 2 percent of the total area of that portion of the watershed within the Region. Included within this drainage area are a total of two storm water outfalls, which are 15 and 24 inches in diameter respectively, and both of which discharge to a tributary of the Onion River. There are no known storm water pumping or storage facilities in the watershed. The total average annual discharge from these two storm water drainage outfalls is estimated to be about four million gallons per year occurring in seven events. The combined maximum discharge rate for these outfalls is estimated to be about 40 cubic feet per second for a two-year recurrence interval rainfall event and about 54 cubic feet per second for a five-year recurrence interval rainfall event.

Pertinent characteristics of the single storm water drainage system in the Sheboygan River watershed are summarized in Table 102 and are presented in greater detail in Appendix J. The location and configuration of the two storm water drainage conduits, as well as the systems outfalls and estimated tributary areas within the Sheboygan River watershed are shown on Map 38.

Map 38

EXISTING STORM WATER DRAINAGE SYSTEMS IN THE SHEBOYGAN RIVER WATERSHED



Source: SEWRPC.

SUMMARY

Urban storm water drainage systems are important to any inventory of water pollution sources because such systems provide conveyance facilities which deliver the pollutants associated with storm water runoff directly to receiving surface waters. Accordingly, an inventory was made of the location and tributary drainage areas of all urban storm sewer outlets. The frequency and amount of the associated storm water discharges were estimated. A total of 55 urban storm water drainage systems consisting of a combination of piped and channelized drains and in some cases natural surface drainage channels were identified. Storm water drainage system mapping covering 183 square miles or about 6.8 percent of the total area of the Region, was available from 48 civil divisions. These 48 storm water drainage systems contained a total of 1,358 known storm water outfalls. The remaining seven civil divisions are known to operate storm water drainage systems, but were unable to provide systems mapping. The 55 storm water drainage systems serve civil divisions in which about 1,501,900 persons reside, or about 84 percent of the total population of the Region. In addition to natural drainageways, constructed or improved surface channels, and subsurface conduits, these systems also include two known storm water pumping facilities and 16 known storm water storage facilities.

Table 102

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE SHEBOYGAN RIVER WATERSHED

Civil Division Location of Public Storm Water Conveyance System	Estimated Tributary Area		Number of Storm Water Outfalls in System Discharging to Surface Waters	Size Range of Outfalls in System	Summation of Drainage Districts		
					Total Estimated Annual Discharge Volume	Estimated Maximum Storm Water Discharge Rates	
						2-Year Recurrence Interval Event	5-Year Recurrence Interval Event
	Acres	Square Miles		Diameter in Inches	Million Gallons	Cubic Feet per Second	Cubic Feet per Second
Village of Belgium	95	0.15	2	15-24	4	40	54
Total	95	0.15	2	15-24	4	40	54

Source: SEWRPC.

As shown in Table 103 the total runoff discharged from the 48 storm water drainage systems for which system maps was available as they existed as of 1975—excluding the combined sewer systems—in the Region during an average year was estimated at about 22,856 million gallons (mg) occurring in 70 events. Of this total, about 21,387 mg, or about 93.6 percent, were discharged to the Lake Michigan basin. The combined maximum discharge rate for these systems is estimated to be about 69,218 cubic feet per second for a two-year recurrence interval rainfall event and about 94,344 cubic feet per second for a five-year recurrence interval rainfall event.

Other storm water surface drainage systems relying only on efficiency enhancements to the natural surface drainage channels which exist in the Region were generally not included in the inventory identified.

Table 103

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE REGION

Watershed	Estimated Tributary Area		Number of Storm Water Outfalls in Watershed Discharging to Surface Waters	Size Range of Outfalls in Watershed	Summation of Drainage Districts: Total Estimated Annual Discharge Volume	Estimated Maximum Storm Water Discharge Rates: 2-Year Recurrence Interval Event	5-Year Recurrence Interval Event
	Acres	Square Miles		Diameter in Inches	Million Gallons	Cubic Feet per Second	Cubic Feet per Second
Des Plaines River	184	0.29	2	24-36	62	124	166
Fox River	12,386	19.35	210	8-78	1,125	6,157	8,208
Kinnickinnic River	10,598	16.56	94	12-142 x 89	2,768	6,708	9,337
Lake Michigan - Minor Streams	18,411	28.77	94	12-82 x 128	4,108	20,679	14,339
Menomonee River	27,379	42.78	344	12 - triple 90 x 54	5,587	20,678	27,674
Milwaukee River	24,795	38.74	309	12-144 x 60	5,369	13,028	17,710
Oak Creek	6,180	9.66	85	12-78	1,133	3,099	4,220
Pike River	2,408	3.76	13	15-72 x 113	246	1,009	1,349
Rock River	3,505	5.48	67	12-78	282	1,880	2,495
Root River	10,541	16.47	124	12-96	2,113	5,931	8,015
Sauk Creek	921	1.44	14	12-72	59	616	777
Sheboygan River	95	0.15	2	15-24	4	40	54
Regional Total	117,403	183.44	1,358		22,856	69,218	94,344

Source: SEWRPC.

(This page intentionally left blank)

Chapter V

DIFFUSE SOURCES OF WATER POLLUTION IN THE REGION

INTRODUCTION

To identify the sources of water pollution which affect a network of continuously and intermittently flowing streams, lakes, ponds, and flowages, it is necessary to consider many factors. The municipal and industrial wastewater outfalls and flow relief devices, as presented in Chapter III of this report; the storm sewer outfalls, as presented in Chapter IV of this report; and the urban and rural land use activities must all be related as sources of water pollution. As noted in SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams of Southeastern Wisconsin: 1964-1975, the water quality of streams and lakes have undergone a subtle deterioration since 1964 despite substantially improved sanitary wastewater treatment practices in some portions of the Region. The study concluded that even if the discharge of all wastes from municipalities and industries ceased, pollution from diffuse sources would have a sufficiently adverse effect to violate the state and federally adopted water quality standards in many streams. Accordingly, this chapter identifies and discusses the various categories of diffuse pollution sources, including residential, industrial, commercial, mining, construction, transportation, recreational, agricultural, and silvicultural land uses; dredging and channelization; and the atmosphere and wetlands. Presented for each category is a description of the pollution source; the mechanisms by which pollutants are contributed; an identification of the major pollutants associated with each of the sources; and a discussion of probable loading rates for the major pollutants considered in this report. The loading rates are applied to the land use data to estimate the total pollution from the diffuse sources in the Region.

In the analyses of the relative magnitude of the pollutant loadings from each of the general pollution sources considered, annual loading rates were used to estimate average, wet-year, and dry-year contributions of total phosphorus, total nitrogen, biochemical oxygen demand, sediment and fecal coliform organisms—generally reported as membrane filter fecal coliform counts (counts)—from the various pollution sources. These pollutants were chosen because they are the most frequently-used indicators of water quality and are known to be direct contributors to water quality degradation, such as algae blooms and oxygen depletion. In addition, pollutant run-off data are most readily available for these pollutants in the literature, and their use is consistent with the general nature of the pollutant loading analysis. As described in Chapter I of this report, this generalized estimate of annual loadings serves as a cross-check and as a planning tool, along with the more detailed analyses conducted in the development and evaluation of pollution control alternatives as presented in SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin.

It was deemed desirable for convenience in presentation to assemble the description of the inventory procedures, as well as the general discussion of each diffuse pollution source, in an introductory section rather than repeating such description and discussion in each of the subsequent sections which deal with individual watersheds. This introductory section sets forth the sources of the data utilized in the pollutant loading analyses presented in the sections on each watershed, together with the key assumptions underlying the analyses.

The critical importance of the values assumed to reflect the general loading rates should be recognized by all concerned. Although the magnitude and importance of pollutant loadings vary with the type and intensity of the specific pollutant-contributing activities, as well as with soil type, land slope and topography, hydrology and climate, it was necessary—due to the complexity of these variables and the inventory data limitations—to develop and apply generalized pollutant loading rates to estimate the pollutant contributions from the various diffuse pollution source categories. Certain assumptions were required to develop the loading rates. Wherever possible, these assumptions were based upon examination of data from within the Region. It should be emphasized, however, that the loading rates that are used in the pollutant loading analysis are not precise quantifications of pollutant loadings from all specific pollutant sources within the Region, but rather estimates of pollution runoff from general land uses or other categories of diffuse sources of pollution.

URBAN LAND USES AND ACTIVITIES

Residential Land Use

The residential land use category includes and identifies both land actually occupied by a residence, vacant building sites between existing residences, and improved but still vacant residential subdivisions. The concentration of people, domestic structures, and activities in residential areas and the alteration of natural drainage and infiltration characteristics results in the production and release of water pollutants from diffuse sources. Runoff from lawns, gardens, rooftops, driveways, sidewalks, and unused land is channeled through drainageways and streets and is transported directly as overland flow, or indirectly through storm sewerage systems, to surface waters. Pollutant sources associated with residential land uses include street debris, fertilizers, pesticides, pet wastes, garbage and litter, vegetation, degraded surface coatings such as paint particles, and detergent. Surface runoff from precipitation events and from human activities within residential areas, such as lawn sprinkling or automobile washing, release pollutants to the environment.

Streets in residential areas are both diffuse sources of pollutants and a drainageway for pollutants from other sources. Fuel, oil, grease, hydraulic fluids, coolants, engine emission particles, rubber particles, brake lining particles, pavement particles, litter, deicing salts, and deposited air pollutants accumulate on streets and are removed by runoff. Additional pollutants from lawns, rooftops, driveways, and sidewalks are transported to streets during precipitation events, and are subsequently carried to surface waters.

Buildings, along with street surfaces, comprise a significant portion of the impervious area of residential areas and include houses, garages, sheds, schools, and miscellaneous buildings. The impervious area reduces infiltration and roof drains may directly enter storm sewerage systems or streets, thus increasing peak runoff. Generally, the percent of impervious area increases with dwelling density as shown in Table 104. Higher residential densities produce more runoff and, in general, a greater amount of pollutants. Fuel combustion for the heating of residential buildings emits air pollutants which may eventually enter surface waters via dry fallout or precipitation washout. Building debris, such as wood, plaster, and paint chips, may also be transported to streets or drainageways by runoff.

Lawns and gardens are sources of organic matter, plant nutrients, and pesticides. Grass clippings and other organic debris may be deposited in streets and transported by runoff to surface waters. Nutrient runoff and leaching to the ground water will be enhanced by excessive application rates and lawn sprinkling. Pesticides applied to lawns and gardens become attached to the soil particles and are transported as the exposed soil erodes.

Fecal wastes from dogs and cats are also important sources of organic matter, nutrients, solids, and bacteriological contamination. The Wisconsin Humane Society estimates the cat and dog populations of the area at one dog for every six residents, and one cat for every three residents. Based on these ratios, the 1975 pet populations in the Region may be estimated as set forth in Table 105.

It is estimated that the daily fecal deposition from larger dogs (such as German shepards, St. Bernards, Doberman pinschers, Great Danes, Siberian huskies, and Malamutes) averages 0.75 pounds,[1] and that such deposition from smaller dogs produces about 0.25 pounds daily. Assuming an equal population of small and large dogs, the average fecal deposition may be estimated at 0.5 pounds. It is estimated that cats produce about 0.1 pounds of fecal waste daily. If it is assumed that the fecal material from 75 percent of the dogs and 10 percent of the cats is deposited outdoors and not collected for proper disposal as solid waste and that 10 percent of this material eventually enters surface waters, nearly 12,000 pounds of fecal waste material from pets is estimated to be released to surface waters of the Region annually.

Vacant lots, fields, and abandoned sites in residential areas are often used as dump sites and playgrounds and may be subject to soil erosion and the accumulation of inorganic (i.e., metals, concrete) and organic (i.e., wood, garbage) debris. The pollution potential

[1] *A. M. Beck, "The Public Health Implications of Urban Dogs", AJPH, Vol. 65, No. 12, Dec., 1975, pp. 1315-1318.*

Table 104

PERCENT IMPERVIOUS AREA IN RELATION TO RESIDENTIAL DENSITY

Residential Density (dwelling units/ net residential acre)	Percent Impervious Area
Low (0.2-2.2)	15
Medium (2.3-6.9)	30
High (7.0-17.9)	60

Source: SEWRPC.

Table 105

ESTIMATED DOG AND CAT POPULATION IN REGION

County	Population	Number of Dogs	Number of Cats
Kenosha	127,000	21,200	42,400
Milwaukee	1,004,100	167,400	334,700
Ozaukee	66,700	11,100	22,200
Racine	179,300	29,900	59,800
Walworth	68,200	11,400	22,700
Washington	78,300	13,000	26,100
Waukesha	269,900	45,000	90,000
Region Total	1,793,500	299,000	597,900

Source: SEWRPC.

from unused land is highly variable and dependent upon the physical characteristics of the site and the type and amount of debris present.

Leaf leaching is a major source of organic pollutants in many urban areas, where leaves comprise a substantial portion of the street debris. The leaves are often raked into piles on streets and other impervious areas, thus becoming a direct source of street contaminants. Cowen[2] reported that during the summer, vegetative matter accounts for 11 percent of all street refuse, whereas in autumn, the value is 55 percent. This dramatic increase is attributed to the release and accumulation of deciduous leaves in autumn. About 75 pounds of dry leaves may be dropped annually from a deciduous tree[3]; and about 3,000 pounds of dry leaves may be deposited per acre per year in wooded areas.[4] The City of Milwaukee Bureau of Forestry estimates a density of about one mature tree per property site in urban areas. Leaves contain from 0.3 to 0.7 percent nitrogen and from 0.05 to 0.7 percent phosphorus.[5] The dominant form of phosphorus in tree leaves is soluble orthophosphate, which is readily leached from leaves and is immediately available for biological utilization. Wet/dry and freeze/thaw cycles, and mechanical mulching or break-up greatly accelerate the leaching of substances from leaves.

It has been estimated that a minimum of 20 percent of leaf debris is not properly disposed of and hence is available for removal and leaching by runoff.[6] Proper disposal of leaves involves raking and piling or bagging for solid waste pickup. Truck-mounted vacuum equipment—originally designed to clean storm sewer catch basins—is used in some communities for this purpose, as shown in Figure 65. In many communities the leaves are then disposed of at landfill sites or in composting operations for the production of soil conditioner. If the leaves are bagged, left on the lawn or are placed in piles on grass areas, the amount of leaching will be less than if disposed of in streets and gutters. The burning of leaves does not effectively remove all nutrients, and leaching of the ashes will add to the nutrient load. Many urban areas in the Region have adopted comprehensive ordinances against burning because of affects on air quality. Improved street cleaning operations and rapid leaf pickup services will minimize leaf leaching and vegetative debris accumulation. Some studies have suggested that the nutrient potential of grass clippings and tree seeds may be nearly as important as leaves.[7]

Runoff loading rates from residential land may be estimated by application of the following equation presented by the U.S. Environmental Protection Agency:[8]

$$L = A \cdot R \cdot P$$

where:

L = Pollutant runoff loads in lbs/acre/year

Figure 65

VACUUM STREET CLEANERS USED FOR STREET SWEEPING, LEAF PICKUP, AND CATCH BASIN CLEANING

Source: Waukesha Freeman.

---

[2] *W. Cohen, "Available Phosphorus in Urban Runoff in Lake Ontario Tributary Waters", Ph.D. Thesis, Water Chemistry Department, University of Wisconsin-Madison, 1974.*

[3] *Dane County Advisory Council for Lake Quality Improvement, Report of the Dane County Advisory Council for Lake Quality Improvement: A Framework for Lake Management, 1975.*

[4] *SEWRPC Technical Report No. 18, State of the Art of Water Pollution Control in Southeastern Wisconsin, Volume 4, Rural Storm Water Runoff, December, 1976.*

[5] *Ibid.*

[6] *Dane County Advisory Council for Lake Quality Improvement, Report of the Dane County Advisory Council for Lake Quality Improvement: A Framework for Lake Management, 1975.*

[7] *Ibid.*

[8] *U.S. Environmental Protection Agency, Areawide Assessment Procedures Manual, Vol. I, EPA-600/9-76-014, July, 1976, pp. 3-37.*

A = a loading constant for a given pollutant in lbs/acre/inch of precipitation which varies as shown:

Suspended solids - 16.3
BOD_5 - 0.799
Total Nitrogen - 0.131
Total Phosphorus (as PO_4) - 0.0336

R = annual precipitation, in inches

P = a population density factor represented as:

$P = 0.142 + 0.218 (D)^{0.54}$

where:

D = population density of residential land in persons per acre, calculated for the Region by dividing the 1970 population (excluding group quarter dwellers) or 1,714,598 persons, by the 1970 net residential area of the Region or 131,683 acres, for an average density of 13 persons per acre of residential land.

The estimated loads from residential land uses are 4.0 lbs/acre/year of total nitrogen, 1.0 lbs/acre/year of phosphorus (as PO_4) 24.3 lbs/acre/year of BOD_5, and 495 lbs/acre/year of suspended solids.

Phosphorus as PO_4 was converted to phosphorus as P for the loading analysis, by multiplying by a factor of 0.32. The suspended solids load was multiplied by 110 percent to account for bedload and thus provide a more accurate indication of total sediment yield from urban land. Fecal coliform loads were estimated from the findings of a study by CH_2M-Hill Consultants.[9]

The resulting estimated channel pollutant loads from residential areas that were used in the gross pollutant load analysis are presented in Table 106.

Commercial Land Use

The commercial activity category includes all retail and service type commercial uses, including both local and regional shopping centers, highway-oriented commercial centers, professional and executive offices, and appurtenant parking lots. The high percentage of impervious area and attendant high runoff rates, together with the intense activity and accumulation of litter and debris continue to make commercial land a significant contributor of pollutants. Rainfall and snowmelt runoff from rooftops, parking lots, buildings, alleys, streets, loading docks and work areas, and adjacent sidewalks and open areas contribute sediment, oxygen-demanding substances, dissolved substances, nutrients, toxic and hazardous substances, oil, grease, bacteria, and viruses to the streets and storm sewers which drain the commercial areas and discharge into the lakes and streams of the Region. Another source of runoff is the washing of debris from loading docks, sidewalks, and areas adjacent to the loading or storage areas as a method of debris removal performed in order to present a clean and orderly appearance to commercial customers.

Channel loading rates from commercial land use were estimated by the application of the equation used to estimate loading rates from residential land use, except the values for the factor "A" were changed to 0.296 for total nitrogen, 0.0757 for total phosphate, 3.20 for BOD_5, 22.2 for suspended solids, and a value of 1.0 was used for the factor "P". The resultant estimated loading rates for commercial land uses are 9.0 lbs/acre/year total nitrogen, 2.3 lbs/acre/year total phosphorus, 97.6 lbs/acre/year BOD_5, and 677 lbs/acre/year of suspended solids.

As with residential activities, it was necessary to convert the phosphate, (as PO_4) to phosphorus (as P) for the loading analysis. Suspended solids load were similarly multiplied by 110 percent to account for bedload and thus provide a more accurate indication of total sediment yield from commercial land. Fecal coliform loads were estimated from a study conducted in Seattle, Washington by CH_2M-Hill Consultants.[10] Loading rates from commercial activities that are utilized in the gross pollutant loading analysis are shown in Table 107.

[9] *CH_2M-Hill Consultants, Seattle Water Resources Management Study.*

[10] *Ibid.*

Table 106

ESTIMATED CHANNEL LOADING RATES FOR RESIDENTIAL LAND USE

Pollutant	Loading Rates lbs/acre/year
Total Nitrogen	4.0
Total Phosphorus	0.32
BOD_5	24.3
Fecal Coliform	1.6×10^{10} counts/acre/year
Sediment	545

Source: SEWRPC.

Table 107

ESTIMATED CHANNEL LOADING RATES FOR COMMERCIAL LAND USE

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	9.0
Total Phosphorus	0.75
BOD_5	97.6
Fecal Coliform	3.3×10^{10} counts/acre/year
Sediment	745

Source: SEWRPC.

Industrial Land Use

The industrial land use category includes all manufacturing activities, wholesaling offices, warehouse and storage areas, railroad yards, and adjacent parking lots. Runoff from industrial spills, production and distribution sites, loading docks and work areas, materials storage sites, industrial buildings, and adjacent streets, parking lots, rooftops, lawns, sidewalks, and open areas transport fuels, oil, grease, wood, metals, paper, plastics, salt, sand and gravel, organic substances, flyash, petroleum and chemical products, corrosives, waste chemicals, brush, garbage, rubber, acids, glass, ceramics, paint particles, glue and solvents to streets, storm sewers, and large collector sewers. These substances contain sediments, dissolved substances, oxygen-demanding substances, toxic and hazardous substances, nutrients, bacteria, viruses, grease, and oil, which contribute to the degradation of streams and lakes.

Large quantities of raw materials may be delivered to the site of a manufacturing operation to await use in the process itself or as a component of the final product. These materials consist of lumber, virgin and scrap iron, paper products, aluminum, copper, plastics, and various other components of the manufacturing operation. Many industrial operations do not have the indoor or covered storage capacity to house the raw materials awaiting processing, and therefore store the materials in the outdoor bins or designated areas exposed to natural weathering processes. Breakage, leakage, erosion, oxidation, heat, cold, and moisture effects result in the degradation of the material and the potential for removal and transport to surface waters by storm runoff or snowmelt.

Storage sites for coal, salt, and sand and gravel are susceptible to wind and water erosion and are therefore a source of pollution to the lakes and streams of the Region. The largest coal storage sites within the Region exist in the Menomonee River Valley along the Menomonee River Canal and at the Wisconsin Electric Power Company power generating stations in Port Washington and Milwaukee. Although retaining walls often enclose the coal stockpiles, sediment laden runoff has the capacity of entering streams via storm sewers adjacent to the coal storage areas and small crevices which exist in the retaining walls.

Flyash wastes are a byproduct of various industrial process and power generation and are disposed of by two known methods: landfilling or use in roadbed construction. In most cases, the larger producers of flyash, such as the Wisconsin Electric Power Company, haul the wastes on a daily basis to licensed landfill sites, or sell the materials to the construction firms. However, during storage and transport or inadequate waste disposal, wind and water erosion may transport flyash particles to surface waters.

Industrial spills are an additional source of pollution to surface waters. Common to many industrial activities are the storage of petroleum and chemical substances. Leaking oil drums, overflowing scrap hoppers and bins of scrap metals saturated with cutting oils, punctured industrial waste hoppers, and spilled greases, fuels, batteries, tannery wastes, animal wastes, food wastes, chemical wastes, toxic wastes, polychlorinated biphenyls (PCB's), heavy metals, and other unique organic materials contribute heavy loadings of nutrients, oxygen-demanding substances, suspended and dissolved solids, toxic substances, and fecal coliform bacteria to waterways. Table 108 illustrates the numbers, type, location and estimated quantity of substances known to have been spilled to the surface waters or land within the Region in 1975, as reported to the Wisconsin Department of Natural Resources. Additional accidental spills or deliberate illegal discharges probably occurred without the knowledge of the Department of Natural Resources, or the U.S. Coast Guard, which have primary responsibility for spill prevention and clean-up in the Region, and for spill clean-up in the navigable waters of the Lake Michigan drainage areas within the Region, respectively. As indicated by the magnitude of several of the spills cited in Table 108, the resulting pollution of the surface water resources by careless or improper handling of industrial substances can be catastrophic.

Loading rates from industrial activities were estimated by the application of the same procedure used to estimate loads from residential and commercial activities. The pollutant constant "A" was changed to 0.277 for total nitrogen, 0.0705 for total phosphate, 1.21 for BOD_5, and 29.1 for suspended solids, and a value of 1.0 was used for the factor "P", to account for industrial activities. Total phosphorus and sediment loads were computed in the same manner as for residential and commercial land uses. Fecal coliform loads were estimated from data from a study in Seattle, Washington by CH_2-M Hill Consultants.[11] The resulting pollutant loads that are utilized in the gross pollutant loading analysis are presented in Table 109.

Mining and Attendant Washing Operations

The extraction of sand, gravel, lannon stone, and other minerals may result in significant water quality deterioration within and downstream from the extractive sites. Drainage from active and inactive quarries may produce chemical and physical pollution of both groundwater and surface waters. Lands adjacent to extractive sites may be reduced in economic value and potential use, hence, water quality and land degradation may severely restrict socio-economic development of areas adjacent to quarrying operations.

---

[11] *Ibid.*

Table 108

KNOWN OIL AND/OR TOXIC AND HAZARDOUS SPILLS OCCURRING WITHIN THE REGION: 1975

Date of Spill	Source of Spill	Type of Spill and Amount If Known	Location of Spill and Receiving Stream	Action Taken By
1/ 3/75	Wisconsin Centrifugal, Inc.	Oil	Fox River via storm sewer	DNR
1/ 9/75	Private Property Owner	Fuel oil	2832 N. 32nd St. Milw. Metropolitan Sewerage District via sanitary sewer	U. S. Coast Guard & Milw. Metropolitan Sewerage District
1/19/75	Unknown	Fuel oil	Lake Michigan via storm sewer	Kenosha Fire Dept.
2/21/75	Warden Drain Oil Service Div. of Lubricates, Inc.	Fuel oil and sulfuric acid	1910 S. 75th-West Allis Milw. Metropolitan Sewerage District via sanitary sewer	U. S. Coast Guard & Milw. Metropolitan Sewerage District
3/10/75	Milwaukee Fire Dept.	Fuel oil from boiler 10 gal.	68th and Burleigh Milwaukee River via storm sewer	Milwaukee Fire Dept.
3/20/75	Chicago, Milwaukee, St. Paul and Pacific Railroad	Heavy oil 50 gal.	Menomonee River via storm sewer	U. S. Coast Guard
3/28/75	Westport Volkswagon, Inc.	Kerosene and detergent	7500 W. Layton Root River via storm sewer	Greendale Fire Dept.
4/ 2/75	C-W Transport, Inc., Semi-truck trailer	Diesel fuel 40 gal.	Ramp from Watertown Plank Rd. to STH 45-Menomonee River via storm sewer	Wauwatosa Fire Dept.
4/ 4/75	Unknown	Oil 50 gal.	Milwaukee Harbor	U. S. Coast Guard
4/10/75	Unknown	Oil	Menomonee River via storm sewer	DNR
4/13/75	Industrial Fuel Co.	Fuel oil 8,000 gal.	610 W. Rawson Oak Creek via storm sewer	Industrial Fuel Co. and EPA
4/13/75	Unknown	Gasoline	Hwy. 74 at 175-Menomonee Falls Menomonee River via storm sewer	Menomonee Falls Fire Dept.
4/15/75	Unknown	Gasoline	Thiensville sewerage treatment plant via sanitary sewer	Thiensville Fire Dept.
4/17/75	Unknown	Oil and sewage	STH 31 Pike River via storm sewer	DNR
4/17/75	Unknown	Oil	Kilbourn Bridge—Milwaukee River via storm sewer	U. S. Coast Guard & City of Milwaukee
5/ 6/75	Unknown	Oil	Kenosha Harbor	U. S. Coast Guard
5/ 8/75	Unknown	Oil	S. 43-44th at Greenfield Menomonee River via storm sewer	Village of West Milwaukee
6/ 6/75	South Shore Sewage Treatment Plant of the Milwaukee Metropolitan Sewerage District	Digester supernatant	Lake Michigan	None
6/ 6/75	West Allis Fire Dept.	Gasoline 20 gal.	76th and Oklahoma Menomonee River via Underwood Creek via storm sewer	West Allis Fire Dept.
6/25/75	Unknown	Oil	Racine Harbor	U. S. Coast Guard
6/29/75	Private Property Owner	Waste engine oil	208 Paul Street-Burlington Fox River via storm sewer	DNR
7/ 3/75	Private Property Owner	Waste engine oil	208 Paul Street-Burlington Fox River via storm sewer	DNR
7/14/75	Unknown	Oil	932 N. 107th Street Menomonee River via storm sewer	DNR

Table 108 (continued)

Date of Spill	Source of Spill	Type of Spill and Amount If Known	Location of Spill and Receiving Stream	Action Taken By
7/15/75	Unknown	Oil from barge refueling	N. Water Street Bridge Milwaukee River via storm sewer	U. S. Coast Guard
7/15/75	Unknown	Oil	Kenosha Harbor	U. S. Coast Guard
8/11/75	Culligan Soft Water Service	Potassium permanganate	Burlington Fox River via storm sewer	DNR
8/21/75	Zignego Contractors, Inc.	Transmission oil	3300 W. Rawson Root River via storm sewer	DNR
9/ 3/75	Unknown	Oil	South Milwaukee Yacht Club Lake Michigan	U. S. Coast Guard
9/15/75	Unknown	Oil	35th and Congress Milwaukee River via storm sewer	DNR
9/17/75	Unknown	Oil	Fox River Watershed Phantom Lake	DNR
9/21/75	Chicago, Milwaukee, St. Paul and Pacific Railroad	Diesel oil	Menomonee River via storm sewer	U. S. Coast Guard
10/14/75	Unknown	Kerosene 30-70 gal.	Mitchell Field Kinnickinnic River via storm sewer	Airport Fire Dept.
10/15/75	Unknown	Oil	Kinnickinnic River via Burnham Canal	U. S. Coast Guard
10/22/75	Unknown	Asphalt-kerosene mix	116 E. St. Paul Avenue Fox River via storm sewer	City of Waukesha
10/27/75	Unknown	Green dye	Milwaukee River via Lincoln Creek	DNR
10/27/75	Unknown	Red dye	North Water Street Milwaukee River via storm sewer	DNR
11/ 3/75	S. C. Johnson and Son, Inc.	Styrene & acrylic acid 8,000 gal.	Waxdale Pike River via storm sewer	S. C. Johnson and Son, Inc.
11/ 6/75	Unknown	Oil 100 gal.	S. 47th Street Menomonee River via storm sewer	Chicago, Milwaukee, St. Paul and Pacific Railroad
11/ 9/75	Unknown	Oil	Kenosha Harbor	U. S. Coast Guard
11/ 9/75	Freighter (Northern Frost)	Bilge oil 6 gal.	Milwaukee Harbor	U. S. Coast Guard
11/13/75	Unknown	Jet fuel 200-300 gal.	Mitchell Field Kinnickinnic River via storm sewer	Airport Fire Dept.
11/13/75	Northwest Airlines, Inc.	Jet fuel	Mitchell Field Kinnickinnic River via storm sewer	Airport Fire Dept.
11/24/75	Northwest Airlines, Inc.	Jet fuel	Mitchell Field Kinnickinnic River via storm sewer	Airport Fire Dept.
11/24/75	United Airlines	Jet fuel	Mitchell Field Kinnickinnic River via storm sewer	Airport Fire Dept.
12/ 1/75	Unknown	Insulating oil 500-1,000 gal.	66th Street & 35th Avenue Pike Creek via storm sewer	Kenosha Fire Dept.
12/15/75	Unknown	Oil	City of Waukesha Fox River via storm sewer	DNR
12/25/75	Unknown	Fuel oil	Menomonee River via storm sewer	U. S. Coast Guard

NOTE: The spills reported above include both the spills to the land surface, and the spills directly to drainage channels of the Region, as noted by the location reported. All of the spills were potentially available for transport by storm water run off.

Source: Wisconsin Department of Natural Resources.

Table 109

ESTIMATED CHANNEL LOADING RATES FOR INDUSTRIAL LAND USE

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	8.4
Total Phosphorus	0.70
BOD_5	36.9
Fecal Coliform	6.2×10^{10} counts/acre/year
Sediment	977

Source: SEWRPC.

Subsurface drainage and surface runoff from extractive sites and spoil storage areas is a source of water pollution when dissolved, suspended, or other mineral wastes and debris enter receiving streams or the groundwater system. Soluble substances, such as limestone, will be dissolved by the flowing or infiltrating water until an equilibrium concentration is reached in the water, at which time no further solution of the material will occur until dilution or deposition lowers the substance concentration below the equilibrium level.

In southeastern Wisconsin, open pit mining—as opposed to shaft mining—is conducted almost exclusively by extractive procedures and results in a large open hole with a relatively small amount of spoil. This form of surface mining may result in a relatively large amount of sediment runoff as disturbance of the land surface usually increases the erodability of the materials and the protective vegetation is destroyed. The use of settling basins may decrease the amount of sediment which enters surface waters.

Map 39 indicates the locations of the 307 quarries and sand and gravel pits which are active within the Region, of which nine have Wisconsin Discharge Elimination Permits to discharge effluent directly into nearby surface waters. The other quarries will eventually have to be issued permits specifying the conditions of their wastewater discharges to groundwater. Map 39 also indicates the remaining 67 quarries within the Region which had been abandoned and were not in active use as of 1975.

The current status—active or abandoned—of an extractive site is important in that most potential water pollution problems may be expected to be associated with abandoned sites, since federal and state discharge requirements regulate the active operations. The necessary characteristics of extractive activities—working near or beneath the water table or bedrock—may present a severe potential for pollution unless proper measures are developed and implemented to prevent polluted water from infiltrating to the groundwater or being transported by surface runoff. Not all quarries and gravel washing operations contribute significant amounts of pollutants to surface and groundwaters. Numerous quarrying activities occur in the glacial overburden comprising hillsides far above bedrock depths, and—provided that measures have been taken to prevent surface runoff from these operations and an attempt is made to reduce the ponding and overflows resulting after a significant storm event—little transport of contaminated runoff should occur.

Because of the similar characteristics of land disturbance caused by construction and extractive activities, whereby exposed subsoils are subject to a high degree of wind and water erosion, the pollutant loading rates shown in Table 110 were applied to extractive activities as well as to construction activities from which the estimates were developed.

Solid and Semi-Solid Waste Disposal by Landfill

Large quantities of solid waste are generated within the Region every day and present a significant handling and disposal problem. As presented in Table 111, a total of 6,600 tons per day of solid waste are generated daily from residential, commercial, and industrial activities.[12] In addition, agricultural wastes are generated from crops and livestock.[13] Of the total tonnage of solid waste generated daily within the Region, approximately 700 tons from the City of Milwaukee are processed through the Americology resource recovery program, resulting in a 90 percent bulk recovery,[14] and about 105 tons per day are incinerated by the City of Waukesha,[15]

---

[12] *Board of Engineering Consultants, Wisconsin Solid Waste Recycling Predesign Report, Governor's Recycling Task Force, May, 1973.*

[13] *Wisconsin Department of Natural Resources, Report on the State of Wisconsin Solid Waste Management Plan, 1974.*

[14] *Americology Division, American Can Company, Americology-Milwaukee.*

[15] *City Engineer, Waukesha, Wisc., Pers. Comm., June 27, 1977.*

Table 110

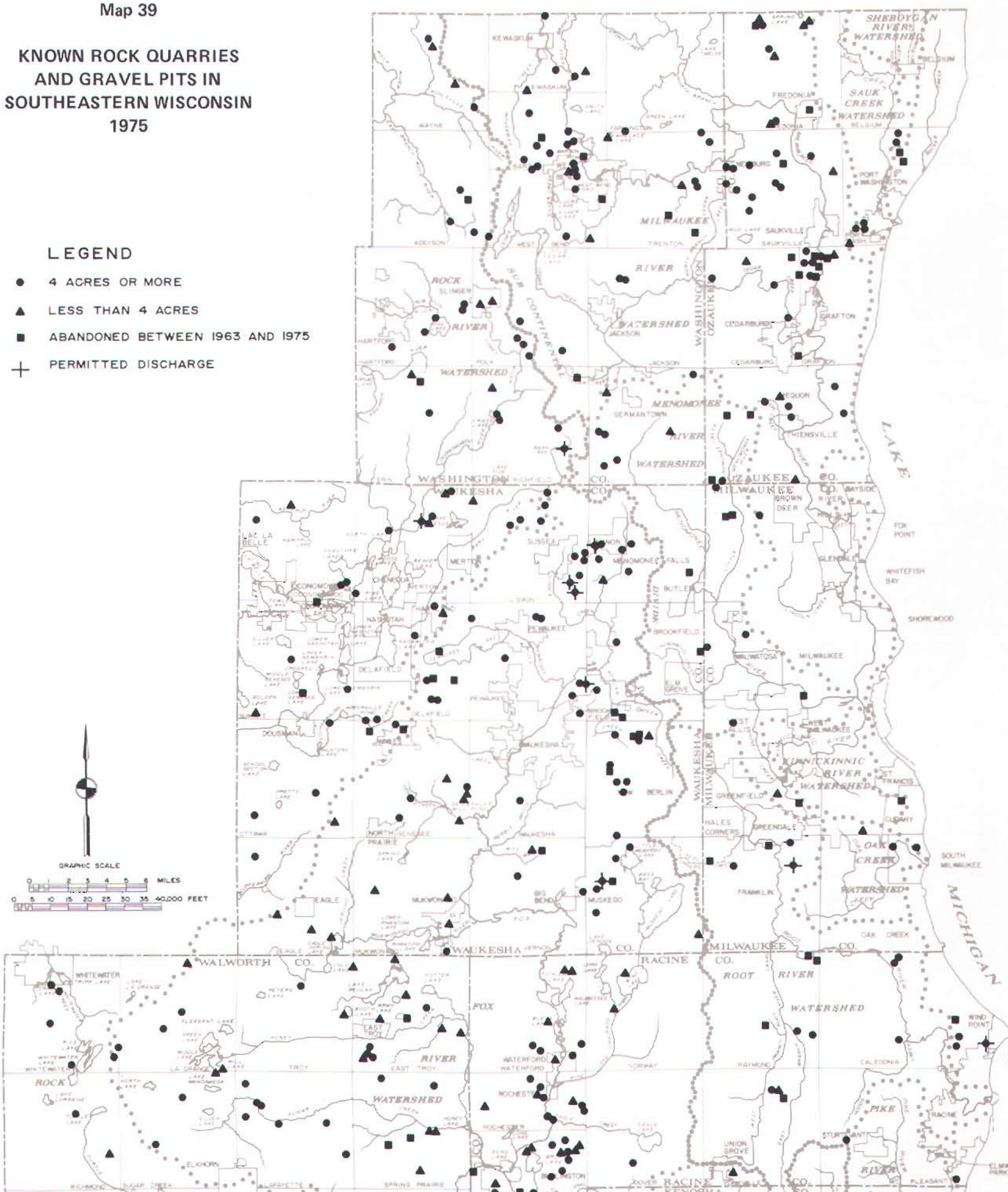
ESTIMATED CHANNEL LOADING RATES FOR MINING AND ATTENDANT WASHING OPERATIONS

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	60
Total Phosphorus	45
BOD_5	120
Sediment	150,000

Source: SEWRPC.

Map 39

KNOWN ROCK QUARRIES AND GRAVEL PITS IN SOUTHEASTERN WISCONSIN 1975



A total of 374 extractive mining operations including rock quarries and gravel pits were known to exist within the Region as of 1975. Of this total, 103 operations, or 28 percent, were less than four acres in size and 271 operations, the remaining 72 percent, were four acres or more in size. Of the total of 374, 67 operations, or 18 percent, were abandoned or inactive as of 1975. Nine of the 374 operations had stone or gravel washing operations and associated wastewater discharges to surface waters, and were therefore regulated by permits of the Wisconsin Pollution Discharge Elimination System.

Source: SEWRPC.

Table 111

ESTIMATED SOLID WASTE PRODUCTION IN THE REGION: 1975

County	Solid Waste Produced in Tons Per Day								Total
	Residential	Bulky	Brush	Sewage Sludge	Demolition	Automobiles	Commercial	Industrial	
Kenosha	147.1	6.0	24.1	12.0	33.9	25.1	43.1	92.2	383.5
Milwaukee	1,306.6	53.2	212.7	106.3	321.1	212.7	823.8	1,232.5	4,268.9
Ozaukee	74.1	2.3	9.2	4.6	8.4	12.9	17.7	59.4	188.6
Racine	203.9	5.7	22.9	11.4	35.7	38.1	66.1	217.2	601.0
Walworth	60.3	2.2	8.8	4.4	9.5	14.0	33.6	38.7	171.5
Washington	70.0	2.0	7.9	3.9	10.5	15.3	14.4	44.2	168.2
Waukesha	327.2	11.2	44.7	22.3	60.4	57.7	99.7	193.8	817.0
Region	2,189	83	330	165	480	376	1,098	1,878	6,600

Source: Board of Engineering Consultants and SEWRPC.

resulting in an approximate 60 percent reduction in weight and a 90 percent reduction in volume.[16] The remaining 5,900 tons per day are transported to landfills and disposed of. These wastes are potentially damaging to the water quality of lakes and streams since improper solid waste disposal may pollute surface runoff and cause groundwater pollution, which in turn may feed pollutants to the surface waters.

It is important to recognize the distinction between the properly designed and constructed sanitary landfill and the variety of operations that are referred as to refuse dumps—especially with respect to potential effects on water quality. A solid waste disposal site may be defined as any land area used for the deposit of solid wastes regardless of how it is operated or whether or not a subsurface excavation is actually involved. A sanitary landfill may be defined as a solid waste disposal site which is carefully located, designed and operated to avoid nuisances or hazards to public health or safety. Proper design or sanitary landfills utilizes the principles of engineering to confine refuse to the smallest practical area, to reduce it to the smallest practical volume, to avoid surface water runoff or leachate production, and to seal the surface with a layer of earth at the conclusion of each day's operation or at more frequent intervals as necessary.

Although it is reported[17] that nationally less than 10 percent of all refuse disposal sites are operated within this accepted definition of a sanitary landfill, this is not the case within the Southeastern Wisconsin Region. As of January 1, 1975, only one major landfill was operating without a state issued permit, and all the remaining 88 sanitary landfills were licensed and operating properly under the requirements of State administrative codes. Consequently, surface and groundwater pollution resulting from these operations should be minimal. Map 40 indicates the locations of the landfill sites—both those presently operating and those which had been closed as of 1975—and the auto salvage yards in the Region.

Whereas properly located, designed, and operated sanitary landfills effectively control pollutant transport to surface waters and groundwater, landfills which are improperly located, designed or operated may result in pollutants leaching to the groundwater or discharging to surface drainageways. Of greater significance than the licensed sanitary landfills are those refuse dumps which were established long ago to serve immediate local needs but have been abandoned—perhaps as a direct result of new regulations and guidelines governing the collection and disposal of solid waste. Landfills which are improperly located within shallow and fractured bedrock or a high water table are inadequately covered with a layer of earth, have leaky clay or plastic liners used to reduce the release of leachates, or have other related problems often result in the production and release of significant amounts of pollutants.

The potential of landfills as a pollution source is affected not only by the siting, design, and operation of the landfill, but also by the total amount of waste generated, its areal distribution, the composition of the waste itself, and the underlying geology. Typical values of components of solid waste collected in the Region are shown in Table 112. From this table it may be concluded that slightly over 70 percent by

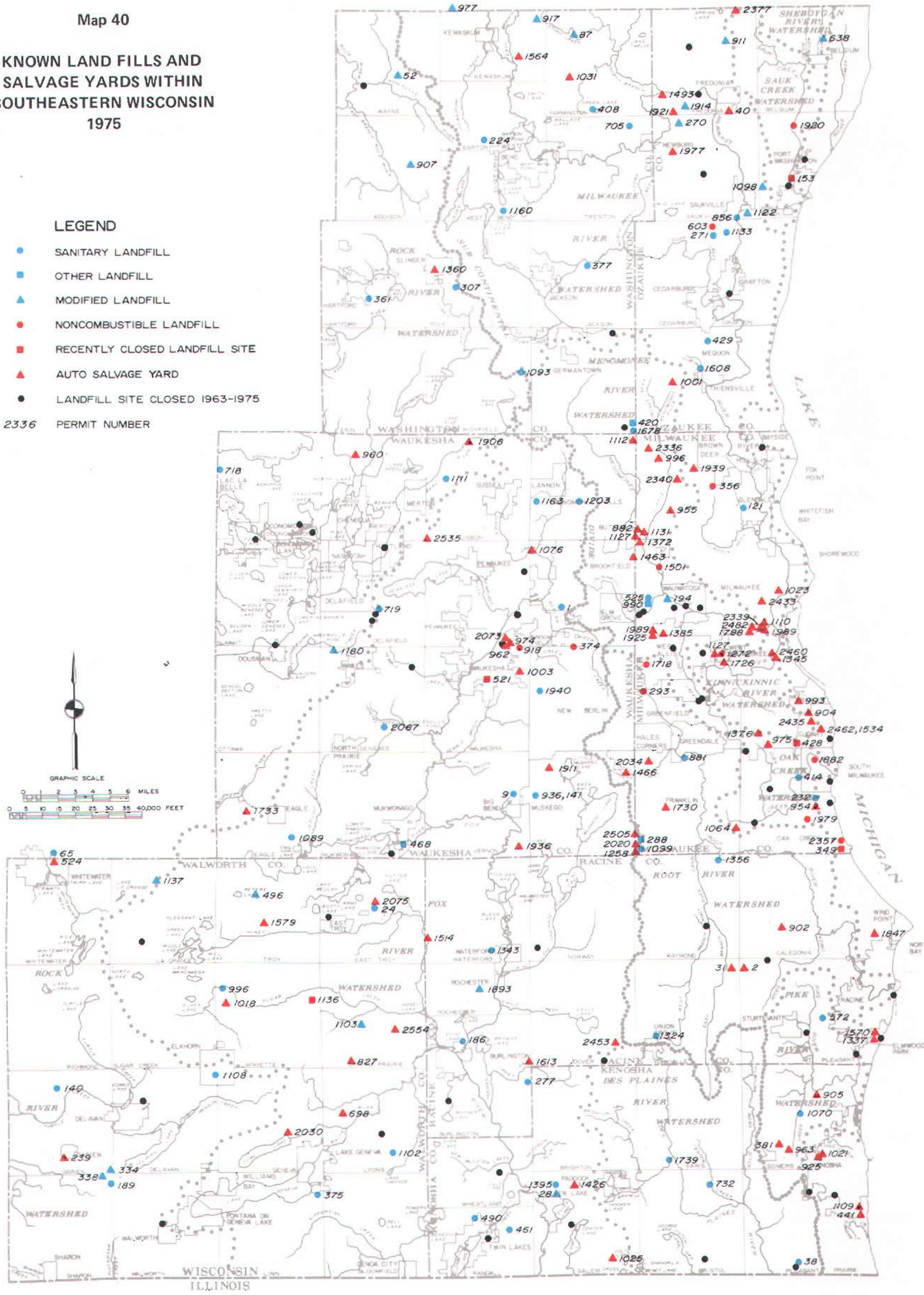
---

[16] *Wisconsin Department of Natural Resources, Report on the State of Wisconsin Solid Waste Management Plan, 1974.*

[17] *U.S. Environmental Protection Agency, Groundwater Pollution from Subsurface Excavations, 1973.*

Map 40

KNOWN LAND FILLS AND SALVAGE YARDS WITHIN SOUTHEASTERN WISCONSIN 1975



There were a total of 88 known landfill sites active and authorized to operate in the Region under the terms of a state permit as of 1975. In addition, a total of 62 landfill sites were known to have been closed between 1963 and 1975. There were also a total of 86 auto salvage yards in the Region as of 1976. These and similar industrial land use activities contribute pollutants to storm water runoff, and leach substances into the surface waters through the movement of contaminated groundwater.

Source: SEWRPC.

Table 112

SUMMARY OF AVERAGE WASTE COMPOSITION IN WISCONSIN—FROM DOMESTIC, COMMERCIAL, AND INDUSTRIAL SOURCES

Waste Component	Percent of Total
Paper and Wood	50
Ferrous Metals	12
Glass	11
Garbage	10
Rubber and Plastics	5
Non-Ferrous Metals	1
Yard Wastes	4
Textiles and Fabrics	3
Other	4
Total	100

Source: Board of Engineering Consultants, Wisconsin Solid Waste Recycling Predesign Report, Governor's Recycling Task Force, May, 1973.

weight of domestic refuse is biodegradable organic matter, with about three-quarters of this fraction being paper or wood materials.

In order for a landfill to produce leachate there must be some source of water moving through the fill material. Possible sources include precipitation, moisture content of the refuse itself, surface water infiltration, groundwater migrating into the fill from adjacent land areas, or groundwater below and in contact with the fill. In any event, leachate is not released from a landfill until at least some significant portion of the fill material exceeds its saturation level. If the external sources of water are excluded from the sanitary landfill, the production of leachates in a well-designed and managed sanitary landfill can be effectively eliminated. The quantity of leachate depends on the quantity of water that enters the solid waste fill site minus the quantity that is removed by evapotranspiration. Studies have estimated that for a typical landfill about 20 to 50 percent of the rainfall infiltrated into the solid waste and became leachate. Accordingly, a total annual rainfall of 30 inches could produce approximately 160,000 to 400,000 gallons of leachate per acre of landfill, if the facility is not properly located, designed and operated.

Of further significance with regard to sanitary landfills is the disposal of toxic and hazardous waste products from industrial processes and sewage sludge. Presently, only two sanitary landfill sites are known to be licensed to receive toxic and hazardous wastes within the Southeastern Wisconsin Region—these sites referred to as being the "Lauer-2" site located in the far southeastern corner of the Village of Germantown, and the site operated by Land Reclamation Ltd., located between the City of Racine and the Village of Sturtevant. In addition, there are 10 known sanitary landfill operations which currently accept wastewater sludges at their own discretion from 10 municipal sewage treatment plants within the Region.

Industrial wastes are also disposed of by landfill on privately-owned property or in licensed landfills holding a permit from the Department of Natural Resources. A survey of sludge disposal by industries which discharge more than 10,000 gallons per day of wastewaters was conducted by the Commission, and the findings of this survey—including the amounts of wastewater and sludge generated, treatment processes utilized, and chemical analyses of the sludges—are presented in SEWRPC Planning Report No. 29: A Regional Sludge Management Plan for Southeastern Wisconsin.

Also of significance are the numerous auto salvage and wrecking yards located within the seven-county area. Although burning of the interiors of these automobiles has been discontinued since 1972, thereby reducing the air pollutant loadings to the atmosphere, excessive amounts of oils, greases, gasoline, and solids may enter surface waters via direct surface runoff from salvage yards during periods of wet weather. Due to the nature of salvage operations, in which crushing and shredding activities produce large amounts of airborne particulates, it is difficult to prevent the accumulation of debris on surfaces within the site and on nearby service areas inclusive of rooftops, parking lots, streets, sidewalks, and highways. Such debris is then transported by runoff during precipitation events.

Since solid waste disposal facilities as a source of water pollution are subject to numerous localized and specific factors, generalized loadings of the ground or surface water pollutant contributions are virtually impossible to apply. A great amount of additional study is required if meaningful estimates of the quantitative effects of solid waste disposal sites on groundwater quality—through the discharge of such groundwater on lakes and streams—are to be prepared. Because there is a paucity of data in the literature on water pollution loadings associated with solid waste disposal activities, the following loading rates, (as shown in Table 113) developed for industrial areas, were applied.

Transportation Activities

Transportation-related activities contribute significant amounts of pollutants to surface waters in southeastern Wisconsin as goods and people are moved by rail, air, bus or car, truck, and ship. The terminals, transportation routes, and service or maintenance areas are all sites of pollutant build-up and potential release. Motor vehicle pollutants accumulate on freeways and expressways, highways, streets, and parking lots. Airports, railroad yards, shipping operations, and bus terminals are important

Table 113

ESTIMATED CHANNEL LOADING RATES FOR SOLID WASTE DISPOSAL ACTIVITIES

Pollutant	Loading Rates lbs/acre/year
Total Nitrogen	8.4
Total Phosphorus	0.70
BOD_5	36.9
Fecal Coliform	6.2×10^{10} counts per year
Sediment	977

Source: SEWRPC.

sources of particulates, exhaust gases, oil and grease, and litter to surface waters. The pollutants may directly enter water bodies via direct surface runoff and through storm sewers, or may be emitted to the atmosphere and be eventually deposited in surface waters by dry fallout or precipitation washout.

Motor vehicles deposit fuel, oil and grease, hydraulic fluids, coolants, exhaust emission particulates and gases, tire rubber, litter, heavy metals, asbestos, and nutrients on streets. The organic matter, including oil and grease, consumes oxygen in receiving waters. Deicing salts, pavement debris, vegetation debris, animal wastes, litter, fertilizers, pesticides and chemicals, and material from adjacent land also accumulate on streets. Because the transportation-related urban surfaces are impervious and designed to drain very quickly, they play a particularly important role in the transport of pollutants.

Street surface contaminants are detached or dissolved from the pavement by rainfall or storm runoff and are carried in sheet-flow transversely to the gutter or roadside ditch. Gutter flow enters storm water inlets and is rapidly transported to surface waters via storm or combined sewers.

The rate at which rainfall loosens and transports particulate matter from impervious street surfaces depends on particle size, rainfall intensity, and street surface characteristics. It has been reported that a total rainfall of 0.5 inches will remove 90 percent of street surface particulates.[18] The pollutant loading rate to surface waters is a function of the quantity and pollutant concentration of the runoff. As the total inches of runoff increases, the total pollutant loading will increase, but the average pollutant concentration will decrease due to dilution.

Street surface contaminants can be partially removed by street cleaning operations, primarily sweepers. Improvement of street sweeper efficiency can be achieved by increasing the frequency and removal effectiveness of the cleaning practices. Typically, about half of the street surface contaminants can be removed by mechanical street sweepers, with vacuum sweepers having a slightly higher removal efficiency. The removal efficiency is related to particle size, with the larger, most aesthetically objectionable particles being the most effectively removed. However, organic matter and nutrients are most often associated with the fine clay-sized particles, which are not as effectively removed by sweepers.

A survey conducted by the Commission and reported in Appendix K determined that an estimated average of 14.3 tons of material is removed by street sweepers per mile of street within surveyed communities that practice street cleaning. The average sweeper removal rates can be applied to the other civil divisions of the Region that sweep streets to estimate that 103,310 tons of pollutants are removed by street sweeping operations in the Region annually.

Pollutant loads from local and collector streets serving agricultural, residential, industrial, and commercial areas are included in the loading rates developed for the adjacent rural and urban land uses. The loading rates presented in Table 115 however, apply to major arterials and freeways within the Region.

Deicing Salts: Initially, salts were used in conjunction with abrasives such as sand or ashes to facilitate travel on snowy and icy highways. In the winter of 1956-1957, the Wisconsin Highway Commission along with other highway agencies in the United States, initiated a "bare pavement" winter maintenance program, which required liberal and frequent applications of "straight" salt, in order to provide wherever possible, a consistently dry and therefore safer driving surface.

Whereas abrasives require ice to form before they can be effective, salts are immediate in their action. Salts are usually applied early in a snow storm to prevent the bonding of the snow to the street surface, and then reapplied after snow plowing. Sodium chloride is the most commonly used deicing salt, but loses its effectiveness at about 20°F. Mixtures of sodium chloride and calcium chloride (CaCl), effective to about 0°F, are used at lower temperatures. The deicing salts dissolve to form solutions with lower freezing points than water. Calcium chloride has a lower freezing point than sodium chloride, has an affinity for water, and emits heat as it goes into solution. However, it has higher storage costs and handling problems, and leaves the pavement wet as it has a slow evaporation rate. Sodium chloride leaves a dry surface once the salt solution has drained.

---

[18] *URS Research Company, Water Quality Management Planning for Urban Runoff, Prepared for U.S. Environmental Protection Agency, December, 1974.*

The application of deicing salts on highways during the winter significantly affects the quality of runoff water. The salt applied to a highway must either be carried by surface runoff or must infiltrate the ground surface. Studies have indicated that runoff from salt-treated roads in Chippewa Falls and Madison, Wisconsin, reached maximum levels of 10,250 mg/l and 3,275 mg/l of chloride, respectively. Improper or excessive salt application may lead to groundwater or surface water contamination, soil contamination, damage to plants, damage to wildlife, increased corrosion, and possible human toxicity in extreme circumstances.

Various substances may be added to sodium chloride and calcium chloride to reduce corrosion, prevent caking, and prevent stockpile freezing. Prussian Blue, Yellow Prussiate of Soda, sodium and ferric ferrocyanide, chromates, and phosphates have all been used as deicing additives. Common mixing levels are from 0.25 to two pounds of additive per ton of salt. Although high concentrations of some additive chemicals have been shown to be toxic to certain organisms, no significant adverse environmental effects have been noted at the recommended low use levels.

The 1975 street and highway practices survey conducted by the Commission indicates a total of 252,400 tons of dry salt were applied to streets in southeastern Wisconsin in the winter of 1975-1976. In addition, 46,217 gallons of liquid CaCl were applied. More than half of the total salt usage occurs in Milwaukee County. The U.S. Environmental Protection Agency[19] has estimated that more than 90 percent of deicing salts applied to urban streets and 70 percent of salts applied to rural streets eventually enter surface waters. Accordingly, over 200,000 tons of salt including over 120,000 tons of chloride are estimated to be contributed to surface waters in southeastern Wisconsin from street deicing activities annually.

Salt storage yards within the Region are listed in Table 114. These contribute a significant amount of chloride contamination to the surface waters of the Region. An inventory conducted by the Commission indicated that approximately 98 percent of all salt storage facilities located in the Region were enclosed by either a building or a three-sided covered shed. Nevertheless, only about 10 percent of the total volume of salt stored within the Region is stored in covered facilities. This is a result of the presence of major harbor facilities in the Region, which serve as a point of temporary storage and transfer of deicing materials for the state and other areas of the Midwest. The enclosed salt storage facilities range in size up to 2,000 tons and are mostly located in the rural areas, being built on impervious blacktop or concrete slabs to contain the salt piles. The larger salt piles, which account for significantly more of the tonnage stored, are located in the industrial areas of Milwaukee—specifically on Jones Island and in the Menomonee Valley. Due to their size, containment in an enclosure is not practical. However, an attempt is made to cover these piles with large tarpaulins. This procedure requires that areas of the pile be periodically exposed to facilitate removal, which allows wind and water erosion of the salt pile to occur.

Sand and gravel storage required for street sanding during deicing operations in the rural areas of the Region is a source of sediments to the streams and lakes of the Region. Often uncovered, they may contribute large quantities of sediment to nearby surface water during precipitation events. The storage, removal, transport, and application of sand and gravel to roadways are all subject to sediment erosion by wind and water and the subsequent transport of the particles to surface waters, thus affecting the water quality of these areas.

Freeways

Because of the relatively high speeds, high traffic volumes, and good drainage, freeways and expressways induce different effects on lake and stream water quality than do ordinary surface streets. In general, loading rates of pollutants to surface waters from a mile of freeway are significantly greater than from a mile of equivalent width surface of street. This is to be expected since the freeway system, although comprising only 10 percent of the total arterial street and highway mileage within the Region, carries one-third of the total vehicle miles of travel. The Commission's 1975 survey of street, highway, and freeway maintenance practices indicated, however, that significant amounts of materials, including litter and carrion, are removed from the freeways through maintenance.

Loading rates for freeways and major arterials were developed from data from a study of two freeway segments in Milwaukee County[20] which measured the intensity and duration of precipitation events and associated pollutant concentrations. Assuming an average annual precipitation for the Region and typical freeway and shoulder surface areas, the loading rates shown in Table 115 were developed.

Airports: The existing air transportation system of the Southeastern Wisconsin Region consists of a complex network of airways and 46 airports. The airport facilities, including runways, taxiways, aprons, buildings, roads, automobile parking areas, and fueling facilities contribute pollution to surface

---

[19] *U.S. Environmental Protection Agency, Interim Report on Loading Functions for Assessment of Water Pollution from Nonpoint Sources, November, 1975.*

[20] *J.B. Jodie, Quality of Urban Freeway Storm Water, M.S. Thesis, Civil Engineering, University of Wisconsin-Milwaukee, May, 1974.*

Table 114

KNOWN SALT STORAGE FACILITIES IN THE REGION: WINTER, 1975-1976

Subwatershed	No. of Shed-Type Structures	No. of Salt Piles	Total No. of Facilities	Total % of Salt Facilities In Piles	Tons Stored in Sheds	Tons Stored in Piles	Total Tonnage Stored	Percent Total Tonnage Stored in Piles
Barnes Creek	0	0	0	0	0	0	0	0
Des Plaines River	1	0	1	0	5	0	5	0
Lower Fox River	16	8	24	33	5,219	146	5,365	3
Upper Fox River	5	6	11	55	2,260	1,519	3,779	40
Kinnickinnic River	5	2	7	29	4,050	600	4,650	13
Menomonee River	10	5	15	33	6,822	100,430	107,252	94
Lower Milwaukee River	11	0	11	0	5,670	0	5,670	0
Upper Milwaukee River	7	5	12	42	2,350	81	2,431	3
Minor Streams	3	5	8	63	325	200,400	200,725	99
Oak Creek	1	1	2	50	200	300	500	60
Pike Creek	1	0	1	0	900	0	900	0
Pike River	1	1	2	50	300	60	360	17
Lower Rock River	5	1	6	17	77	1	78	1
Middle Rock River	5	6	11	55	785	298	1,083	28
Upper Rock River	2	2	4	50	1,400	222	1,622	14
Root River	7	3	10	30	2,805	31,030	33,835	92
Sauk Creek	3	0	3	0	1,350	0	1,350	0
Sheboygan River	0	0	0	0	0	0	0	0
Sucker Creek	0	0	0	0	0	0	0	0
Region Total	83	45	128	35	34,518	335,087	369,605	91

NOTE: Data from the Towns of Erin and Troy are not available. Also storage capacity data was not available for the City of Whitewater, Villages of Big Bend and Chenequa, Towns of Barton, Delavan and LaFayette. Average storage volumes for towns, villages, and cities were applied for these municipalities to estimate the total storage in the Region.

Source: SEWRPC.

Table 115

ESTIMATED CHANNEL LOADING RATES FOR FREEWAYS AND ARTERIALS

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	23.4
Total Phosphorus	1.4
BOD_5	159
Fecal Coliform	6.7×10^{10} counts/acre/year
Sediment	42,600

Source: SEWRPC.

waters as runoff, which removes particulates and soluble substances from both the impervious and vegetated areas. Of the total of 46 airports within the Region, 32, or 70 percent, do not have hard surface runways. Approximately 17 to 20 percent of the total site area of typical general utility airports in the Region are covered by impervious areas. By comparison, impervious surfaces cover about 30 percent of the total land area of a typical, medium density residential neighborhood.

Pollutants are generated from aircraft engine exhausts, motor vehicle exhausts, fuel and oil leaks and spills, litter, tires and brake linings, deicing and plane washing fluids, and asphalt degradation. These may eventually reach nearby surface waters both via dry fallout and precipitation washout and washoff. Aircraft engine exhaust gases contain essentially the same air pollutants associated with motor vehicle operation—carbon monoxide, particulate matter, hydrocarbons, organic gases (aldehydes), oxides of nitrogen, and sulfur oxides. The relative proportions of exhaust products from aircraft piston engines are similar to those from piston engines in terrestrial vehicles, with lead being the dominant particle emmited. For turbine (jet) engines, the relative proportions of the contaminants are different, with carbon dioxide, water vapor, carbon monoxide, and hydrocarbons being the primary exhaust products. The emission of particulates from commercial airliners is expected to decrease substantially during the present decade as new engines for the Boeing 747, Douglas DC-10, and Lockheed 1011 aircarft come into greater use, and older engines are retrofitted with improved combustors.

Pollutant loading rates from portions of General Mitchell Field in Milwaukee have been measured by the Wisconsin Department of Natural Resources in a special sampling effort to assess the water quality of storm water runoff at airports, as shown in Tables 116 and 117. Data from a portion of Mitchell Field which excluded the terminal and parking area were used to develop the loading rates presented below which were applied to the other airports within the Region.

Other Transportation Activities: Railroad yards contribute significant amounts of solids, grease and oil, other organic materials, and nutrients to surface waters. Debris is accumulated on the land surface as a result of the movement and maintenance of the railroad engines and cars, and cargo loading operations. Because of the types of pollutants generated and the machinery involved in railroad operations, loading rates developed for industrial areas were applied to railroad yards.

Major harbor facilities, dockage, and heavy cargo handling equipment within the Region are concentrated in the Port of Milwaukee. Facilities of a lesser scale exist at the Ports of Racine and Kenosha. Petroleum products and coal are also delivered by ship at Port Washington for local and utility use. The shipping operations, transfer procedures, and industrial distribution processes at these ports produce petroleum wastes, spillage, and debris which may reach water bodies. These effects are probably significant, particularly with respect to the water quality of the respective estuaries and Lake Michigan. These effects cannot be adequately quantified in terms of total pollutant loadings given the available data. Nor can the effects of these loadings on the surface waters be quantified because of the very complex hydrologic character of the estuaries and lack of agreement on the water quality sensitivities of the Great Lakes. Accordingly, the Commission has not addressed these topics in the preparation of the initial areawide water quality management plan for southeastern Wisconsin, except to estimate for use in future studies the estimated total annual pollutant loading from the harbor facilities. Loading rates for industrial areas were used for this purpose.

Table 116

ESTIMATED CHANNEL LOADING RATES FOR GENERAL MITCHELL FIELD

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	13.5
Total Phosphorus	2.6
BOD_5	73.0
Fecal Coliform	Negligible
Sediment	2,900

Source: SEWRPC.

Table 117

ESTIMATED CHANNEL LOADING RATES FOR AIRPORTS EXCLUDING GENERAL MITCHELL FIELD

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	12.0
Total Phosphorus	2.7
BOD_5	17.6
Fecal Coliform	Negligible
Sediment	3,200

Source: SEWRPC.

Recreational Activities

Certain outdoor recreational activities which utilize large areas of land and water may function as diffuse sources of pollution. Such outdoor recreational activities include motor boating, fishing, recreational vehicle use, skiing, camping, horseback riding, hiking hunting and golfing.[21]

Motor Boating: The larger lakes which are free from shallow rocky areas, weed growth, and underwater hazards, and which have access sites with adequate parking for cars and trailers are generally the most popular for motor boating. Motor boating commonly

---

[21] *A detailed description of the number and geographical distribution of various outdoor recreation facilities and the use of those facilities is contained in Chapter VI, "Outdoor Recreation Activities, Facilities, and Use", of SEWRPC Planning Report No. 27, A Regional Park and Open Space Plan for Southeastern Wisconsin.*

occurs on 60 of the 100 major inland lakes—50 acres or more in surface area—in the Region. The most popular major lakes are Lake Geneva in Walworth County, Big Cedar Lake in Washington County, and La Belle, Nagawicka, Okauchee, and Pewaukee Lakes in Waukesha County.

While motor boats are increasing in number and in average horsepower, there has been growing public concern over the possibility that the use of motor boats could be detrimental to water quality. The environmental effects of motor boating include the mixing of the water column and the subsequent resuspension of sediments, increased turbidity, dissolved oxygen reduction in the upper water layers, possible release of nutrients attached to sediments, fish tainting, foul odor and taste, and the destruction of aquatic organisms and water fowl.

Outboard engines, which comprise the vast majority of boat motors, contribute to the pollution of the waters in which they operate by discharging engine exhaust: a study[22] has shown that water into which outboard motor exhaust has been discharged may contain 28 grams per liter of lubrication oil; 15 grams per liter of gasoline; 0.14 grams per liter of lead; and 0.16 grams per liter of phenols. From 10 to 20 percent of outboard motor fuel may be discharged directly into the water as unburned wastes.

The depth of mixing caused by motor boats varies with the size of the engine. Average mixing depths range from less than five feet for small engines to 15 feet for 50-horsepower motors.[23] Mixing can effectively destroy the thermal stratification of shallower lakes, cause sediment resuspension with a resulting increased turbidity of the water column, and result in a significant reduction in dissolved oxygen concentrations of the upper layers. In shallow, eutrophic lakes, outboard motor boats resuspend those sediments previously deposited on aquatic plant leaves, stems, and on the lake bottom. Resuspension of these sediments is affected by water depth, particle size and composition, motor power, boat characteristics, and the condition of the lake. Areas close to the shoreline, particularly with less than five feet of water depth and loose detritus and sludge deposits, show rapid changes in turbidity due to boating activities. In the shallow shore areas with water depth less than five feet, physical changes in turbidity and floating matter at the surface have been observed within less than five minutes of the boating activity.[24] One hour after cessation of boating activity, a decrease in turbidity measurements was observed. The increase in turbidity is generally accompanied by an increased availability of dissolved organic carbon and particulate phosphorus which may further accelerate eutrophication of fertile lakes.

In shallow, eutrophic lakes, where stratification and hypolimnion dissolved oxygen depletion exist, mixing between layers occurs and may result in a considerable reduction of the dissolved oxygen in the upper layers. Aquatic sediments and detritus also consume oxygen when stirred in aerated water. In addition, approximately 2,800 grams of oxygen are required for the complete oxidation of one liter of mineral oil.[25] This oxygen demand from one liter of oil would completely deplete the oxygen content of 560,000 liters of water at an oxygen concentration of 5 mg/l. Accordingly, it is evident that through the oxidation of oil and the increased chemical and biological oxygen demand from resuspended sediments, the dissolved oxygen content of a water body may be significantly reduced by the activities of motor boats.

Although the available data indicate that motor boating may have an adverse effect on the water quality of lakes, the large variability in the types, sizes, and depths of lakes, their public access and the amount of recreational use vary widely. Accordingly, general pollutant loading rates from motor boating activities have not been estimated and broadly applied in the general loading estimates for watersheds. Indeed, it is not likely that these pollutants are as important to the quality of the waters downstream from a lake as to the lake itself, since the lakes act to trap these and other pollutants, preventing their release to the outflowing stream. These factors are, however, being considered in the detailed inland lake studies being conducted as part of the Commission areawide water quality management planning program.

Fishing: Fishing takes place on both lakes and rivers, and includes shoreline fishing on small lagoons and streams, as well as boat fishing on large lakes. Generally, large lakes which possess adequate spawning areas, depth, and bottom structure support large fish populations. Fishing commonly occurs on the major inland lakes in the Region, the most popular of which are Elizabeth and Silver Lakes in Kenosha County, Wind Lake in Racine County, Beulah and Geneva Lakes in Walworth County, Big Cedar Lake in Washington County, and Nagawicka, Nemahbin, Okauchee, and Pewaukee Lakes in Waukesha County.

---

[22] *R. Stewart, and A. Muratori, Jr., Outboard Motor Fuel Discharge: A Source of Water Pollution: A Method of Control, presented at the University of Wisconsin Engine Exhaust Institute, October 20, 1967.*

[23] *U.S. EPA, Assessing Effects on Water Quality by Boating Activities, EPA-670/2-74-072, October, 1974.*

[24] *Ibid.*

[25] *Stewart and Muratori, op. cit.*

The principal adverse effects of fishing activities on water quality is from litter, debris, discarded bait, and fish offal deposited by fishermen in or near the water. Fishing is assumed to have no significant impact on water quality, however, because of the modest amount of material contributed. The vast majority of the substances placed into lakes and streams as a result of fishing was already present in the water.

Skiing: Downhill skiing generally occurs on ski hills or slopes developed specifically for that purpose. Most developed ski hills in the Region have a minimum vertical drop of about 200 feet, and a slope grade which ranges from 20 percent to greater than 35 percent. In addition, appropriate support facilities such as a ski chalet, lighting, snow making equipment, ski tows, and adequate automobile parking are normally required. Ski hills construction also necessitates tree and shrub removal from the slopes.

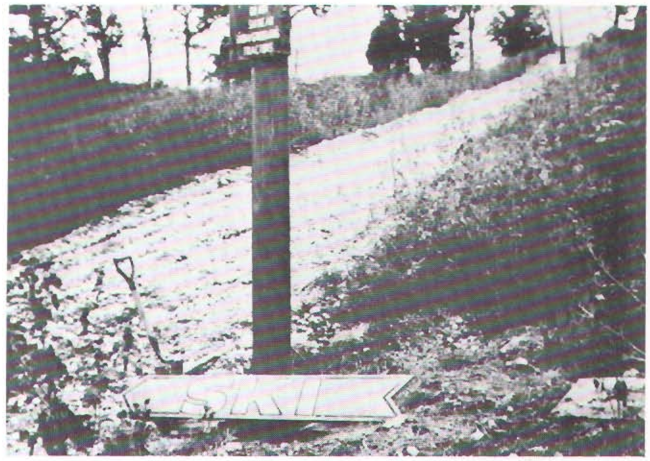
In 1973, there was a total of 182 acres of developed ski slopes in the Region. On a county basis, Walworth, Kenosha, and Washington Counties, with 59, 44, and 39 developed acres respectively, accounted for 78 percent of the total sites in the Region. Eighty-seven percent were in nonpublic ownership.

The same natural amenities that make an area attractive as a ski slope also present a high erosion potential. The steep slopes, often with shallow soils, are vulnerable to high runoff rates, and excessive erosion can occur on poorly vegetated slopes, as demonstrated in Figure 66. The soil exposed during construction and stabilization of the slope, and construction of support facilities is also subject to a high degree of erosion. Therefore, depending on the site characteristics, soil conditions, drainage system, and proximity to surface waters, ski slopes may be significant contributors of sediments to surface water. Similarly, hills used for sledding and tobogganing may also be contributors of such sediments.

Recreational Vehicles: Snowmobiles, trailbikes, and other recreational "off-the-road" vehicles are used for pleasure riding, touring, and racing. Ideally, recreational vehicle use occurs on designated trails through scenic areas having points of natural interest. Ozaukee, Racine, and Washington Counties have developed public snowmobile trails. When confined to specially designed trails, the use of recreational vehicles has an insignificant impact on water quality, with the possible exception of increased erosion in some areas. However, approximately 70 percent of the snowmobile use in the Region occurs on private land, and assumably a significant portion occurs on nondesignated trails. In these cases, increased erosion, vegetation destruction, and oil and gas leakage and spillage in sensitive areas may degrade water quality.

Figure 66

EXAMPLE OF AN ERODED SKI HILL IN THE REGION



Source: SEWRPC.

Camping: Camping is defined as all activities which take place in campgrounds on sites developed for the purposes of accommodating recreational camping vehicles, trailers, or tents for overnight outings. There were 47 developed camping areas with a total of 3,176 camp sites located in the Region in 1973.

The natural settings in which campgrounds are usually located are particularly vulnerable to disturbance, and even relatively small amounts of litter, garbage, sanitary wastes, campfire debris and ashes, sediments and other debris may have a significant adverse impact on the ecology of nearby waters. Scattered impervious areas and sparsely vegetated areas may increase runoff and increase overland and streambank erosion.

Miscellaneous Outdoor Recreational Activities

Picnicking, horseback riding, hiking, and hunting are additional outdoor recreational activities that may have an effect on water quality. While it is recognized that these effects are in most cases relatively minor and of minimal extent, the effects are noted and identified as potential diffuse sources of pollution.

The primary purpose of picnicking is the preparation and/or eating of a meal out of doors, ranging from family backyard barbeques to organizational picnics in a local park. In 1973, there were 429 general use outdoor recreational sites in the Region with picnic areas. Picnic outings, however, often include other resource oriented activities such as boating, volleyball, swimming, or hiking, as well as the picnic activity itself. Principal sources of pollution from picnic activities include litter, garbage, fire debris and ashes, and soil erosion.

Horseback riding, under ideal conditions, occurs in areas of natural interest on a linear or circular trail facility. In 1973, there were a total of 90 miles of designated horseback riding trails located within 16 sites in the Region. Private lands and road rights-of-ways in rural areas also comprise a large portion of areas used for horseback riding. Potential water pollution sources from horseback riding activities are erosion and increased runoff from the compacted trail soils, and manure runoff and leaching. However, loading rates from this activity cannot be adequately quantified.

Hiking and hunting, when conducted in upland areas, do not have a significant impact on water quality. However, hunting activities on or near water, such as waterfowl hunting, may increase sediment resuspension and turbidity, with possible localized increases in turbidity, sediment, oxygen demand and nutrient availability. These are so modest relative to other natural and man-induced effects on lakes and streams that it was deemed impractical to estimate loading rates from those activities.

Because of a great variability in pollutant loadings, and difficulty in identifying the areas most affected by recreational activities, no separate pollutant loading rates were developed for motor boating, fishing, recreational vehicle use, skiing, and camping. Instead, these activities have been implicitly included in the loading rates for adjacent or supporting land uses and the park and golf course uses discussed below.

Parks and Golf Courses

Outdoor recreational sites include relatively large amounts of open space in grassed areas, with additional impervious areas and facilities for recreational activities such as picnicking, tennis, swimming, rowboating, baseball, and golfing. Because outdoor recreational sites usually encompass relatively large areas; are often fertilized and treated with pesticides; are generally well drained; and are usually near or adjacent to streams and lakes, they are potentially important diffuse sources of pollution. In addition, the provision of facilities for activities usually requires some alteration of the natural setting, including paving, grading, artificial drainage, landscaping, and the construction and maintenance of support facilities, such as clubhouses and parking lots.

In 1975, there were 31,800 acres of public parks in the Region. Included in this total are 12,729 acres of public and private golf courses, of which grassed areas, greens and fairways are subject to applications of fertilizers and pesticides. In addition, areas of broadleaf vegetation are also treated with pesticides.

Golf courses are enhanced by the presence of natural resource amenities, and are generally considered aesthetically attractive if they include uneven—but not rugged—topography, some woodland areas, good drainage, and a water body to challenge the golfer's skills. In addition, support facilities such as a clubhouse, parking facilities, and practice areas are usually provided. The fast drainage, fertilization, irrigation, and proximity to water make these potentially important factors in water quality.

Most public parks and golf courses in the Region apply Milorganite as a fertilizer. Table 118 shows the application rate of Milorganite recommended for golf courses by the Milwaukee Metropolitan Sewerage Commission. The Milwaukee County Park Commission estimated that the fertilizer and pesticide application rates (as shown in Table 119) are applied to parks and golf courses in the Milwaukee County Park system. The application rates are similar to the rates recommended by the Milwaukee Metropolitan Sewerage Commission.

Pollutant loading rates were estimated for parks and golf courses. Nutrient runoff from parks and golf courses was estimated from data presented by Bolton, Aylesworth, and Hore[26] in a study on the effect of fertilizer application amounts on nutrient runoff. The percentage of fertilizer that entered tile drains under continuous bluegrass sod was applied to the fertilizer application rates utilized by the Milwaukee County Park Commission, which were assumed to be representative of the Region, to determine the nutrient yields from parks and golf courses. The sediment yield from pastures reported by the U.S. Environmental Protection Agency[27] was applied to parks and golf courses as well because of the similar

---

[26]*E. F. Bolton, J. W. Aylesworth, and F. R. Hore, "Nutrient Losses Through Tile Lines Under Three Cropping Systems and Two Fertility Levels on a Brookston Clay Soil," Can. J. Soil Sci., Vol. 50, 1970, pp. 275-279.*

[27]*U.S. Environmental Protection Agency, Areawide Assessment Procedures Manual, Vol. I, EPA-600/9-76-014, July, 1976, pp. 4-28.*

Table 118

RECOMMENDED FERTILIZER APPLICATION RATES TO GOLF COURSES

Land Type	Milorganite lbs/acre/year	Nitrogen lbs/acre/year	Phosphorus lbs/acre/year
Fairways[a]	2,400	144	48
Green and Tees[b] . .	4,356	261	87

[a] *Applied in three applications—800 lbs./acre each, in June, August, and November.*

[b] *Relatively frequent applications; greens and tees are clipped daily.*

Source: Milwaukee Metropolitan Sewerage Commission.

Table 119

ESTIMATED FERTILIZER AND PESTICIDE APPLICATION RATES FOR MILWAUKEE COUNTY PARKS

Land Type	Fertilizers					When Applied
	Type	Approximate Composition (%N-P-K)	Amount Applied (lbs/acre/year)	Nutrient Loads (lbs/acre/year)		
				N	P	
Parks—						
Grassed Areas	Chaff*	5.7-2-0.3	1,528	87	31	Varies.
Golf Fairways	Milorganite	6-2-0.3	2,903	174	58	Once in late May, and again in September.
Golf Greens	Milorganite	6-2-0.3	5,806	348	116	Applied lightly at 10-14 day intervals.

Land Type	Pesticides			When Applied
	Type	Treatment For	Amount (ounces/acre/year)	
Golf Greens	TRSAN-LSR	Rust	152.5	Twice in spring.
Golf Greens	TRSAN-SP	Snowmold	348.5	Once in winter.
Golf Greens	TRSAN-199	Brown-patch	65.3	10-14 day intervals, May 1-November 1.
Broad-Leafed Plants	2,4-D	Weeds	40.0	Once in spring.

** Chaff is a derivative of Milorganite composed of fibrous, lighter material and having the same approximate nutrient composition.*

Source: Milwaukee County Park Commission.

Table 120

ESTIMATED CHANNEL LOADING RATES FOR PARKS AND GOLF COURSES

Land Type	Loading Rates (lbs/acre/year except fecal coliform in counts/acre/year)				
	Total Nitrogen	Total Phosphorus	BOD_5	Fecal Coliform	Sediment
Parks	2.3	0.06	1.3	3.6×10^9	420
Golf Courses	4.4	0.20	1.3	Negl.	420

Source: SEWRPC.

vegetation cover. Analysis of the soils in the Region indicated a typical organic matter content of about 3 percent, and Basta and Bower[28] estimated that BOD_5 approximates 10 percent of the organic matter content of sediments. Hence, BOD_5 is estimated by multiplying the sediment load by a factor of 0.003. Fecal coliform yield from parks was estimated from data[29] on the quality of runoff from urban open space. Fecal coliform runoff from golf courses is assumed to be negligible because people seldom walk their dogs on golf courses, whereas the activity is more common in parks.

Hence the pollutant loading rates for parks and golf courses presented in Table 120 were used in the pollutant load analysis.

---

[28] *D. J. Basta, and B. T. Bower, Point and Nonpoint Sources of Degradable and Suspended Solids: Impacts on Water Quality Management. JSWC, Vol. 31, No. 6, November-December, 1976.*

[29] *CH_2M-Hill Consultants, Seattle Water Resources Management Study.*

Construction Activities

The development and redevelopment of residential, commercial, industrial, transportation, and recreational areas within the Region can cause significant quantities of pollutants to be contributed to streams and lakes. Construction activities generally involve soil disturbance and destruction of stable vegetative cover; changes in the physical, chemical, and biological properties of the land surface; and attendant changes in the hydrologic and water quality characteristics of the site as an element of the natural system of surface and groundwater movement.

Although there are many different types of construction activities, most use similar types of equipment. Common construction activities in southeastern Wisconsin include construction of transportation facilities such as streets and highways, railways, airports, harbor facilities, bridges, and tunnels; the construction of major structures such as commercial and industrial buildings and electric power generation and transmission facilities; the construction of pipelines for natural gas and petroleum transmission; and the construction of storm and sanitary sewers and appurtenances such as pumping stations. Perhaps most important from a pollution aspect is the development of land for housing and the construction of housing, including site clearance and grading; construction of streets, utilities, and supporting urban infrastructures. The development of recreational facilities such as ski slopes, landscaped park areas, campgrounds, and athletic playing areas may also contribute pollutants to surface waters, and the clearing of land for agricultural use may also create special water pollution problems. Although in many respects similar, each of these types of construction activities has somewhat different problems related to water pollution.

Construction practices which are significant contributors to the degradation of lakes and streams in southeastern Wisconsin are clearing and grubbing, rough grading, facility construction, and finish grading and site restoration. Clearing and grubbing of vegetation, and removal of top soil and unwanted buildings on facility sites and rights-of-way are of particular importance—especially where large areas of land are involved as in the conversion of land from rural to urban uses. Insecticides, rodenticides, and herbicides are sometimes used on construction sites to facilitate construction. Weeds and rodents which require pest control can be problems at construction sites with large areas of exposed soils and improperly stored wastes. Rough grading for site and right-of-way preparation creates several potential pollution problems. The heavy construction equipment used releases diesel fuel, oil, and lubricants to the environment and causes compaction of subsoils, thereby lowering the water infiltration and soil aeration rates. Facility construction primarily involves subsurface excavation and drilling and foundation installation, but may also include dust control operations using oil, spent sulphite liquors, calcium chloride or water to stabilize access roads and sites; diversion of streams to construct bridges, culverts, dams, and other water control facilities; and the construction of storage areas and asphalt operations. Concrete placement operations may release pollutants through spillage and disposal of excess materials. Pollutants released from concrete operations include spilled cement, fuels and curing compounds containing trace elements of cobalt, chromium, manganese, and lead, all of which are recognized water pollutants. Even the restoration of a construction site through finish grading, loosening and tillage of compacted soils, establishment of permanent vegetation, removal of temporary sediment control structures, removal of temporary construction facilities and equipment, and revegetation of borrow pits and stockpile areas may contribute pollutants. Construction activities also involve dirt, gravel, cement, and materials-hauling trucks, which may contribute sediment loadings to streets by material falloff from open trucks. The amount of material lost from trucks depends upon vehicle loading practices, the condition and type of truck, distance of hauling, driving conditions, and driver habits, and is reflected in the pollutant loading rates from arterial streets and highways.

The amount and duration of construction spillage or soil disturbance, and the specific modifications of the properties of the land surface are the principal factors which determine the magnitude and importance of construction activities as a source of water pollution. Potential pollutants from construction activities include soil particles; pesticides, inclusive of insecticides, fungicides, rodenticides, and herbicides; petroleum products, such as oils, grease, gasoline, and asphalts; solid waste materials, such as paper, wood, metal, rubber, garbage, or plastic; other construction chemicals in paints, glues, solvents, sealants, acids, concrete, concrete curing compounds; and soil additives such as lime, flyash, and salt. Also present may be sanitary and other wastewaters, fertilizers, and biological pollutants such as bacteria, fungi or viruses. These potential pollutants contribute soil particles, nitrogen, phosphorus, heavy metals, organic matter, toxic materials, and pathogenic organisms to the surface waters of the Region. The transportation of pollutants from construction sites to natural waters is by direct runoff of storm water and snowmelt, groundwater infiltration and leaching, wind, soil slippage or landslide, and mechanical transfer on vehicles.

Sediment is the most important pollutant from construction sites. Overland—sheet, rill, and gully—erosion predominates in upland areas, but stream channel and shore erosion can occur when storm water runoff rates are increased, or when construction activity takes place near surface waters. Fertilizers, pesticides, heavy metals, and other chemicals may be dissolved or attached to fine clay-sized particles; oil may form a film on the surface and is capable of rapidly affecting a very large surface area. The transport of construction pollutants by infiltration and leaching has been generally unstudied, since the gross contribution of sediment from construction areas presents a more immediate and more voluminous pollutant source. However, it is generally held that the primary danger of groundwater contamination is from sanitary wastes at construction sites. Wind erosion may also be an important transporter of fine sediments and chemical spray droplets which may eventually enter surface waters, but is addressed implicitly in this report in the comments on pollutant loadings from the several types of land use.

Sediment and pollution loads from construction activities are extremely variable and difficult to quantify because they depend upon the period and areal extent of the construction operation; the configuration, location, and topography of the site; the soils and slopes of the site; as well as the construction methods utilized, and the ameliorative measures used to control the release of pollutants from the construction area. In addition, it should be noted that construction occurs in different locations within the Region from year-to-year, and therefore, defies a specific and precise quantification. Because of the temporary, detailed and localized character of these variables, it was not possible for the Commission to obtain specific loading data for construction runoff. Nevertheless, estimates can be made to analyze the relative importance of the typical levels of these activities as diffuse pollution sources of the five major pollutants being considered for purposes of this study. The U.S. Environmental Protection Agency[30] estimates that 150,000 pounds per acre per year of sediments are eroded from land under construction. Since subsurface soils are commonly exposed by construction activities and are therefore, the primary source of construction-related sediment runoff, an estimation of nutrient and oxygen-demanding organic matter runoff rates must consider the relative infertility of subsurface soils. The U.S. Soil Conservation Service reported that, for a representative sample of eight soils in southeastern Wisconsin, the nitrogen content averaged 0.04 percent at a depth of from 16 to 37 inches.[31] Although the SCS did not analyze the phosphorus content of soils, phosphorus has been shown to approximate 80 percent of the nitrogen in soils,[32] or an estimated 0.032 percent of the sediments. Organic carbon for the same soils at the same depth was estimated by the SCS to average 0.42 percent. Percent organic matter has been shown to approximate roughly double the organic carbon content,[33] or about 0.8 percent. Furthermore, Basta and Bower[34] have estimated the BOD_5 content to average 10 percent of the organic matter content of soils, or 0.08 percent of subsoils in southeastern Wisconsin. Fecal coliform loadings from construction activities should be negligible, provided sanitary wastes are properly disposed of, which is generally assumed to be the case under current practices in the Region. Loading rates utilized in the pollutant loading analysis are presented in Table 121.

Dredging, Channelization, and Fill Activities

Dredging is the process by which sediments are removed from the bottoms of streams, lakes, and harbors, transported via barge or pipeline, and disposed of on land or in water. The purposes of dredging are to extend, widen, deepen or maintain navigable waterways; improve flood control; or rehabilitate inland lakes for enhanced recreational values. The purpose of dredging activities, therefore, may be the enhancement of surface waters for intended human use. The removal and disposal of the material may have important environmental impacts on both the aquatic and terrestrial environments involved in the operations, since the physical, chemical, and biological properties of the environ-

---

[30] *U.S. Environmental Protection Agency, Methods for Identifying and Evaluating the Nature and Extent of Nonpoint Sources of Pollutants, EPA-430/9-73-014, October, 1973.*

[31] *Soils Conservation Service, USDA Soil Survey Laboratory Data and Descriptions For Some Soils of Wisconsin, Soil Survey Investigations Report No. 17, 1967.*

[32] *C. H. Wadleigh, Wastes in Relation to Agriculture and Forestry, USDA Misc. Pub. No. 1065, March, 1968.*

[33] *S. W. Buol, F. D. Hole, and R. J. McCracken, Soil Genesis and Classification, The Iowa State University Press, Ames, 1973, 360 pp.*

[34] *D. J. Basta and B. T. Bower, "Point and Nonpoint Sources of Degradable and Suspended Solids: Impacts on Water Quality Management", J. Soil and Wat. Cons. Vol. 31, No. 6, November-December, 1976.*

Table 121

ESTIMATED CHANNEL LOADING RATES FOR CONSTRUCTION ACTIVITIES

Pollutant	Loading Rate lbs/acre/year
Total Nitroten	60
Total Phosphorus	45
BOD_5	120
Sediment	150,000

Source: SEWRPC.

ments are drastically altered by the removal and deposition of dredging spoils. Hence, dredging activities must be considered to be potential sources of water pollution.

Most aquatic sediments are muck composed of inorganic sediments and the products of organic decomposition. Most sediment particles, especially in lake bottoms, are silt or clay-sized, and therefore, act as a reservoir for storage of dissolved chemicals which become adsorbed on these fine particles. The organic-rich sediments may include large concentrations of nutrients, metals, pesticides, and sewage sludge, all recognized water pollutants. The materials at the sediment-water interface are highly flocculant and may consist of 80 percent or more of water. Handling and control problems arise during dredging as these materials are readily resuspended in the water.

There are significant environmental effects from dredging operations on the aquatic environment which is being dredged. The physical alterations resulting from the disturbance and removal of bottom material include changes in the bottom geometry by the creation of deep water regions, creation of new open water areas, changes in bottom substrates and biological habitats, alterations in water velocity and current patterns, changes in future sediment distribution patterns, alteration of the sediment-water interface with the potential subsequent release of nutrients and toxic constituents, and the creation of increased turbidity.

Increased sediment resuspension is commonly associated with dredging and spoil disposal operations. Disturbance of the channel, harbor, lake or other water body results in the resuspension of solids in the dredged area. These particles vary in physical, chemical, and biological character and may result in both immediate and long-term effects on the quality of water at the site, or at times, at some distance from the actual operation. Materials such as heavy metals, nutrients, and pesticides sorbed or otherwise associated with sediment particles may be solubilized during dredging operations and the resultant sediment resuspension, and thus degrade water quality. The resuspension of organic materials resulting from disturbance may reduce the dissolved oxygen content of the water.

The most adverse effects of dredging on the aquatic ecology may result from maintenance dredging of stream channels and harbors and the disposal of spoils of which municipal and industrial debris content is high. Dredging spoils from these activities may contain considerable amounts of heavy metals, sulfides, and other toxic elements.

Disposal of the dredged material may occur on land or in water. Wetland disposal of dredging spoils has been common in the past because of accessibility and the inexpensive value of the land. However, wetlands are now usually avoided as disposal sites because of the potential ecological damages that may occur. Land disposal of dredge spoils may occur on upland areas or on bars or islands. The areas may be confined by dikes or natural barriers and are often equipped with spillways and settling basins with the water removed from the sediments usually being filtered before return to the lake, stream or harbor. Disposal sites located on land, unless carefully located, designed, and operated may be instrumental in polluting both adjacent water bodies and the groundwater environment underlying the disposal site. Disposal sites should prevent polluted leachate from entering the groundwater; provide adequate treatment or filtration of the return flow; and prevent polluted surface runoff from returning to the water body.

Dredging operations in the Region can be placed in two categories: stream, harbor and related channelization and maintenance; and inland lake dredging. Stream and harbor maintenance is conducted to improve navigation and for flood control and is usually performed by the U.S. Army Corps of Engineers in southeastern Wisconsin. Mechanical equipment, such as draglines, shovels, or trenching machines, are most often utilized, and the machinery can be operated from either dry land or from the water surface. The method of operation is analagous to land-based excavation procedures.

Channel modifications—or channelization as it is commonly termed—usually includes one or more of the following changes to the natural stream channel: straightening, channel deepening and the attendant lowering of the channel profile, channel widening, replacement of concrete invert or sidewalls, and reconstruction of selected bridges and culverts. Such projects may be undertaken to reduce flood-associated property damage and prevent their loss of life. However, such changes in the channels do have potential for aesthetic and ecological damage, increased streamflow velocities, and increased downstream peak flood discharges and stages, and the water quality problems associated with stream bank or streambed scouring due to the higher flows.

In the entire Region, 8,500 tons of sediment from streams, and 5,000 tons of sediments from lakes were removed by channelization and dredging operations in 1975.

The U.S. Army Corps of Engineers dredges the Milwaukee Harbor and disposes of the dredge spoils in a confined area specifically designed and built for this purpose and located in the outer harbor. The effects of dredging operations on Lake Michigan are beyond the scope of this report.

The primary reasons for dredging inland lakes are to remove excessive amounts of sediments as a plant substrate and nutrient source; to increase water depth; and to facilitate navigation and recreational use of the lake. In some instances, the principal benefits of dredging inland lakes may be aesthetic, with few significant benefits accruing to water quality. It should be noted, however, that the water quality of some lakes, especially shallow lakes wherein the bottom sediments are an active source of nutrients and contaminants to the overlying water, may be significantly improved by dredging operations if the deeper sediments have a lower concentration of nutrients.

Inland lake dredging operations require specialized procedures and equipment. The most common tool utilized for large-scale inland lake dredging is the hydraulic cutterhead dredge. It excavates, transports the material, and places it at the disposal site. Figure 67 shows the operation of a typical hydraulic dredge. The cutterhead itself rotates and swings from side to side, using negative pressure to suck up the material and discharge the spoils, along with a large amount of water, through a pipeline to a selected area. In soft, flocculant materials, excessive cutterhead activity creates a large turbulence which further disturbs the materials. The sediments settle out at the disposal site and the water is returned to the lake via drainage channels or pumps.

Among the problems often encountered in inland lake dredging operations are a lack of available, adequate disposal sites when large dredging operations are involved, and the presence of tree stumps, large boulders, and refuse in the sediment. These problems may result in excessive sediment disturbance and resuspension, and the utilization of inadequate disposal sites which may lead to groundwater pollution or insufficient filtration of the return flow.

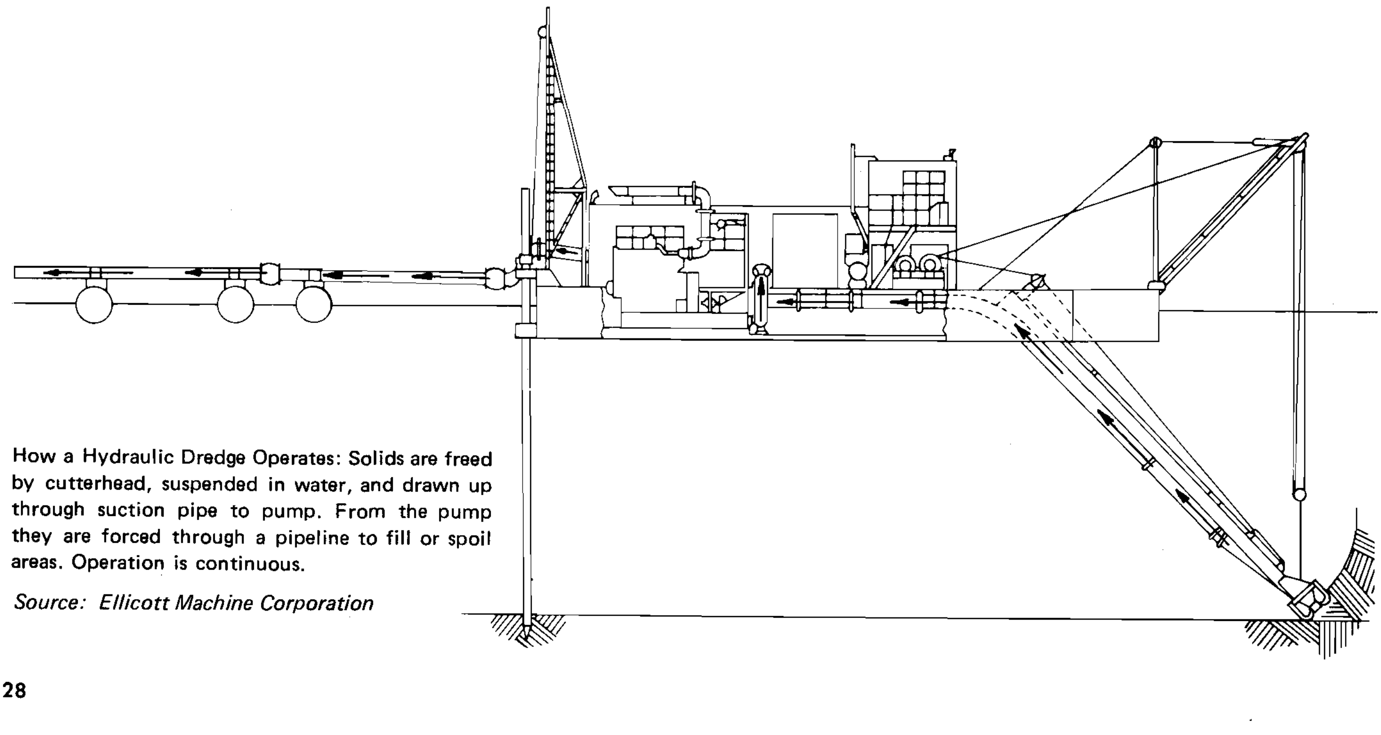
In southeastern Wisconsin, 5,000 tons of material was dredged from six inland lakes since 1974. As of 1975, lake dredging operations were being planned for Little Muskego Lake, Lilly Lake, Lake Elizabeth, Abbey Bay on Lake Geneva, and Bohners Lake. Map 41 shows the known locations of lakes dredged since 1974 and lakes for which dredging plans have been proposed.

It is exceedingly difficult to obtain accurate, detailed estimates of the water quality effects of hydrographic modifications from dredging and channelization activities, because of the variation between sites in the sediment composition, resuspension characteristics, sediment release rates of nutrient and organic matter, and the type and duration of modification activities themselves. In addition, there is very little data available on the general effects of dredging. However, in an effort to identify the relative importance of dredging activities in the Region, loading rates from these activities were estimated based on available data, and assumptions where necessary.

According to the provisions of Section 30.20(2) of the Wisconsin Statutes, the removal of bed material from a lake or a navigable stream requires a contract or permit from the Wisconsin Department of Natural Resources. Information on the area to be dredged and volume of material to be removed is provided on the application form. This information was used to determine the estimated area and sediment volume affected by proposed dredging activities for which permits were issued for the Region in 1975. Although not all of these projects actually were dredged in 1975, the permits are an indication of the average annual dredging activities. Therefore, for each watershed in which dredging permits were issued in

Figure 67

OPERATION OF A HYDRAULIC DREDGE

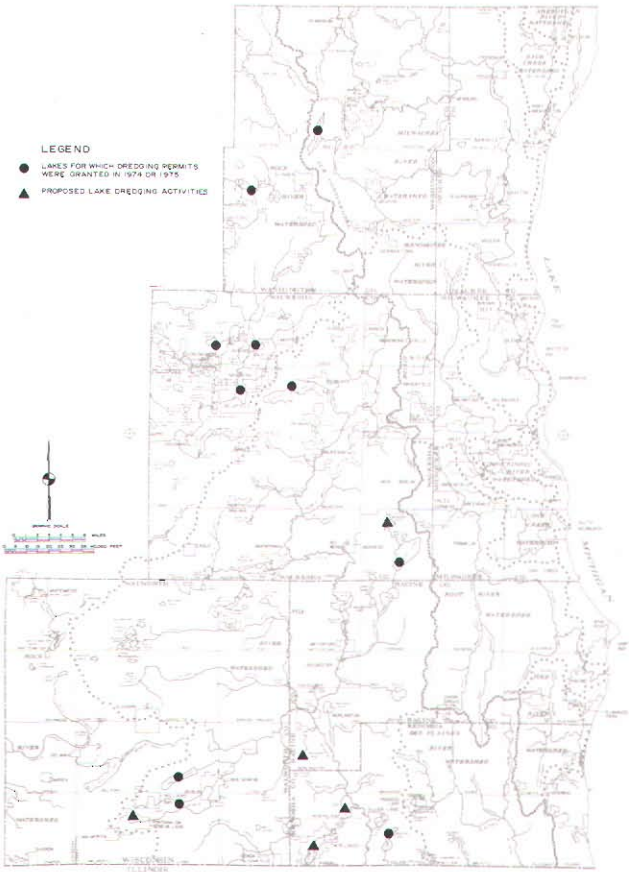


How a Hydraulic Dredge Operates: Solids are freed by cutterhead, suspended in water, and drawn up through suction pipe to pump. From the pump they are forced through a pipeline to fill or spoil areas. Operation is continuous.

Source: Ellicott Machine Corporation

Map 41

LAKE DREDGING ACTIVITIES
IN SOUTHEASTERN WISCONSIN



Dredging permits were issued by the Wisconsin Department of Natural Resources in 1974 and 1975 for 10 of the major inland lakes of the Region, of which six were subsequently dredged during this time period. For five additional lakes, dredging projects were known to have been locally proposed; however, permit applications had not been submitted. The disposal of dredged material, as well as the dredging operation itself, may have important effects on both the aquatic and terrestrial environments.

Source: SEWRPC.

1975, data on the total area dredged, the volume of material removed, the average depth of dredging and the nutrient and organic matter content of stream and lake sediments in the Region were used to estimate amounts of nutrient and organic matter released from resuspended sediments.

It was estimated that 30 percent of the sediments removed by dredging activities were resuspended in the water—either at the dredging site or disposal site—for a sufficient length of time to allow nutrient and organic matter to be released. Not all of the nutrients or organic matter associated with these resuspended sediments were assumed to be released to the water. A study showed that 31 percent of the total nitrogen present in aerated sediments of Lake Mendota, Wisconsin, were released upon mixing.[35] Leaching studies of sediments from Snake Lake, Wisconsin,[36] showed that more nitrate-nitrogen is released by aerobic sediments than by anaerobic sediments; whereas the release of ammonia-nitrogen is higher for anaerobic sediments. Since sediment analyses for Little Muskego Lake[37] have shown nitrate and ammonia concentrations to be similar, the estimated release rate of total nitrogen from aerobic sediments was assumed for anaerobic sediments as well. In addition, since most dredging activities cause mixing of the water column above the sediments, high levels of oxygen are introduced. Analysis of Big and Little Muskego Lake sediments indicate a solids content of 33.6 percent by weight, with 1.07 percent of the dry weight of the solids being nitrogen.[38] A total solids content of 33.6 percent by weight which computes to 24 percent by volume, assuming a sediment density of 100 pounds per cubic foot, was estimated for the Menomonee River Watershed, by the U.S. Soil Conservation Service.[39] Analysis of Menomonee River sediments indicated a 63.6 percent solids content by weight, or 52 percent by volume, and 0.12 percent nitrogen.[40]

The nitrogen content of stream sediments would be expected to be lower than the content in lake sediments, since stream sediments generally contain a greater proportion of larger sand particles, and hence less adsorbed nutrients. For lakes, a loading rate of 2.2 pounds of nitrogen per cubic foot of dredged sediment is estimated, if 30 percent of the dredged sediments are assumed resuspended during dredging, if 31 percent of the nitrogen within the resuspended sediments is released, if lake sediments have a nitrogen content of about 1 percent, and if total solids content is 24 percent by volume. For

---

[35]*E. R. Austin, Release of Nitrogenous Compounds from Lake Sediments, M. S. Thesis, Water Chemistry Program, University of Wisconsin-Madison, 1970.*

[36]*Wisconsin Department of Natural Resources, Dilutional Pumping at Snake Lake, Technical Bulletin No. 66.*

[37]*Muskego Lake Dredging Grant Application Submitted to the Wisconsin Department of Natural Resources and U.S. Environmental Protection Agency.*

[38]*Ibid.*

[39]*W. Mildner, Streambank Erosion in the Menomonee River Watershed, Wisconsin, U.S. Soil Conservation Service, USDA, January, 1976.*

[40]*R. Bannerman, Wisconsin Department of Natural Resources, Pers. Comm., April, 1977.*

streams, since the assumed total solids content of the sediments is 52 percent by volume and the nitrogen content is only 0.12 percent, the estimated nitrogen loading is 0.60 pounds of nitrogen per cubic foot of sediment.

Phosphorus loadings from dredging activities were estimated from aerobic leaching tests of sediments from Snake Lake, a eutrophic lake in norther Wisconsin. The tests revealed that a layer of sediment one centimeter thick in contact with water could provide soluble phosphorus of 0.06-0.13 mg/liter in a 10 meter column of overlying water. Again, assuming that 30 percent of the sediments removed by dredging activities are resuspended, a loading rate of 0.02 pounds of phosphorus per cubic foot of dredged sediment is estimated for lakes. Since Menomonee River sediments have a phosphorus content about half that of Muskego Lake sediments,[41,42] half this loading or 0.001 pounds of phosphorus per cubic foot of dredged sediment is estimated from stream dredging activities.

Seattle University[43] estimated that sediment resuspension can increase the maximum oxygen demand in the water by a multiple of 10. Basta and Bower[44] estimated that BOD_5 approximates 10 percent of the organic matter in soils. Muskego Lake sediments average 22 percent organic matter,[45] hence a BOD_5 content of 2.2 percent for lakes is estimated. It is assumed based on relative nitrogen and phosphorus concentrations, that stream sediments have an organic content approximately one-fifth of lake sediments, or a BOD_5 content of 0.22 percent. Assuming that 30 percent of the sediments are resuspended and that resuspension increases BOD_5 ten-fold, then the BOD_5 load is estimated at 1.58 pounds per cubic foot of sediment dredged for lakes and 0.158 pounds for streams.

The above loading values were applied to the total volume of sediments removed by dredging activities as estimated by data contained in the Wisconsin Department of Natural Resources 1975 permit applications, as presented in Table 122.

The total estimated annual loadings from dredging activities in the Region, 2,830,000 pounds of nitrogen, 3,700 pounds of phosphorus, 1,377,000 pounds of biochemical oxygen demand, and 27,000,000 pounds of sediments, indicate that dredging activities are significant sources of pollution to the Region's lakes and streams. The loadings are also of particular importance in that the disturbances usually occur within the lake or streams itself, and therefore, essentially all of the released pollutants directly affect the water body. However, because it may be rightly argued that the pollutants were already within the stream or lake system prior to the dredging activity, that the inventory data describe only planned activities and do not accurately quantify actual dredging activities, and that reliable data on the effects of dredging were unavailable, the potential pollutant loads estimated above are not included in the individual watershed summary loads presented in Chapter VI of this report. While recognizing the significance of dredging activities, the effects cannot justifiably be considered as pollution loads to a lake or stream.

---

[41] *Ibid.*

[42] *Muskego Lake Dredging Grant Application, op. cit.*

[43] *Seattle University, The Oxygen Uptake Demand of Resuspended Bottom Sediments, U.S. Environmental Protection Agency, 16070 DCD 1970.*

[44] *Basta and Bower, op. cit.*

[45] *Muskego Lake Dredging Grant Application, op. cit.*

Onsite Domestic Sewage Disposal Systems and Mound Systems

To approximately 14 percent of the residents of the Region, the benefits of centralized sanitary sewerage services are unavailable. As of 1975, the sanitary and household wastewaters from these unsewered areas were treated and disposed of predominantly through the use of onsite sewage disposal systems. Map 42 illustrates by U.S. Public Land Survey quarter section the estimated density and locations of the approximately 68,622 privately-owned, onsite sewage disposal systems in the Region as of 1975. An onsite sewage disposal system may be a conventional septic tank system, a mound system, or a holding tank. By far the most commonly used, the septic tank system consists of two components—a septic tank used to provide partial treatment of the raw wastes—by skimming, settling and anaerobic decomposition, and the soil absorption field for final treatment and disposal of liquid discharged from the septic tank. Both components are installed below the ground surface.

The septic tank is a water-tight basin intended to separate floating and settlable solids from the liquid fraction of domestic sewage and to discharge liquid, together with its burden of dissolved particulate solids, into the biologically active zone of the soil mantle to a subsurface percolation system. The discharge system may be a tile field, a seepage bed or an earth-covered sand filter. Liquid passing through the active soil zone percolates downward until it strikes an impervious layer or the groundwater. Thus, the purpose of the percolation system is to dispose of sewage effluents by utilizing the same natural phenomena which lead to the accumulation of groundwater.[46]

---

[46] *E. McCoy, and W. A. Ziebell, The Effects of Effluents on Groundwater Bacteriological Aspects, Department of Bacteriology and Civil and Environmental Engineering, University of Wisconsin-Madison.*

Table 122

ESTIMATED POTENTIAL POLLUTANT DISTURBANCE LOADINGS FOR MAJOR DREDGING ACTIVITIES: 1975

Watershed	Dredging Activities			Pollutant Loads (lbs/year)							
	Streams	Lakes		Nitrogen		Phosphorus		BOD_5		Sediment	
	Volume Sediments Removed (cubic feet)	Volume Sediments Removed (cubic feet)	Area Dredged (square feet)	Streams	Lakes	Streams	Lakes	Streams	Lakes	Streams	Lakes
Fox	985,000	643,000	33,000	590,000	1,400,000	985	1,300	156,000	1,000,000	7,000,000	10,000,000
Menomonee	14,000	--	--	8,400	--	14	--	2,200	--	100,800	--
Milwaukee	666,000	--	--	400,000	--	666	--	105,000	--	4,800,000	--
Rock	715,000	--	--	430,000	--	715	--	113,000	--	5,150,000	--
Root	2,000	--	--	1,200	--	2	--	320	--	14,400	--
Region Total	2,382,000	643,000	33,000	1,430,000	1,400,000	2,400	1,300	377,000	1,000,000	17,000,000	10,000,000

Source: SEWRPC.

Providing that the system is installed, used, and maintained properly, and there is an adequate depth of moderately permeable unsaturated soil to the depth of four or five feet below the drainage field, the system should operate with few problems for periods of up to 20 years. However, the rural residential housing is not always developed on areas having ideal soil conditions. Only 39 percent of the total land area within the Southeastern Wisconsin Region have soils suitable for the installation of septic tank systems on lots of one acre or less in size. (See Maps 43, 44 and 45.) Consequently, failure of a septic tank soil absorption system occurs when the soil surrounding the seepage area will no longer accept or properly stabilize the septic tank effluent, when the groundwater rises to levels which will no longer allow for uptake of liquid effluent by the soils, or when age or lack of proper maintenance cause the system to malfunction. Hence, septic system failure may result from their installation in unsuitable soils, improper design or installation of the system or inadequate maintenance. In many older or illicit installations, the septic effluent does not receive the benefit of soil filtration, but rather finds direct discharge from the septic tank to a drain tile or culvert.

Specifically, most common of these is the failure of percolation systems which create a hazard to health and an unacceptable nuisance as the result of ponding of decomposing sewage effluent on the surface of the ground. While the surface ponding may result in evaporation, it is not unusual for direct drainage to occur, allowing this highly offensive and hazardous effluent to reach road ditches and ultimately lakes and streams. The second and more serious situation in the context of groundwater quality is the direct discharge of untreated septic tank or cesspool effluent into the groundwater through coarse gravel beds, fractured rock or solution channels. A third situation occurs when percolation systems are located below the biologically active zone which typically is only a meter or so in depth. Such systems may be installed where the frost line is deeper than the biologically active zone, or they may be installed too deep below the surface simply because of lack of understanding of proper construction techniques. In such a situation, biodegradation in the system is confined to the partial degradation of organics under anerobic conditions. Therefore, the soluble products from the partial decomposition of organic matter may enter the groundwater and move with it. This limits the groundwater quality for water supply, as tastes and odors are introduced, and the organic fraction remains capable of supporting bacterial growth in the groundwater. At best, properly designed, located, installed and maintained, septic systems increase the total dissolved mineral solids in the groundwater. At worst, they may introduce bacteria, viruses, degradable organic compounds, and high concentration of nutrients, especially nitrates, to ground and surface waters. Nutrients that enter the groundwater may subsequently be discharged to lakes and streams.

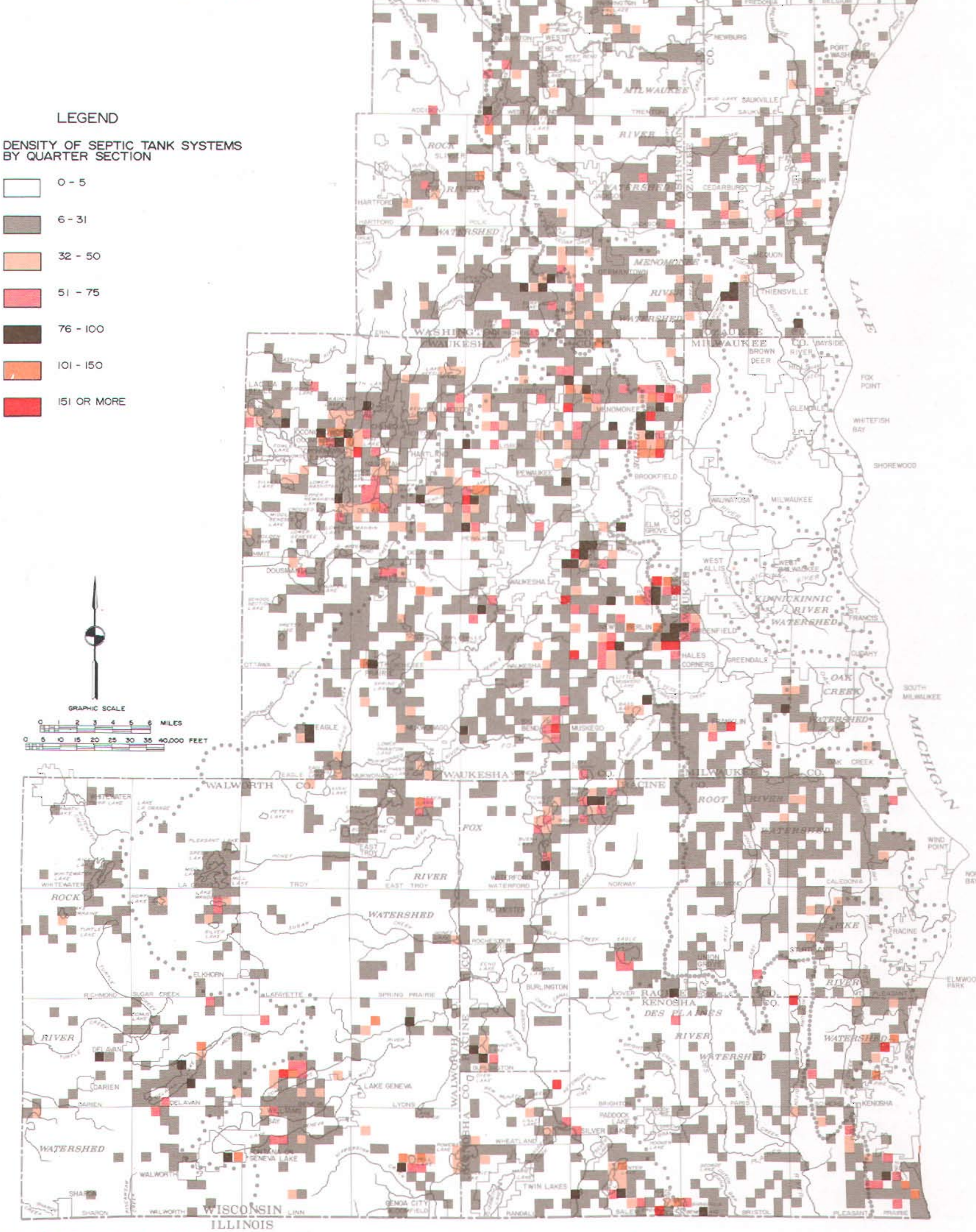
The groundwater and surface water pollutant loading from septic systems depends upon the design, the operational efficiency of the system, the soil characteristics, depth to bedrock or groundwater, the characteristics and amount of wastes discharged to the system, the distance to a lake or stream, and the immediate topography. It is generally agreed by involved public health and sanitary engineering personnel in the Southeastern Wisconsin Region that the maintenance of most septic tank systems is substandard if not non-existent. It was estimated by a survey of county sanitarians[47] that 24 percent of all septic systems in southeastern Wisconsin are

---

[47] *Wisconsin Department of Natural Resources "Report to the Department of Natural Resources Board by the Ad Hoc Private Wastewater Treatment Systems Committee", March, 1977.*

Map 42

PRIVATELY OWNED ONSITE SEWAGE DISPOSAL SYSTEMS IN SOUTHEASTERN WISCONSIN: 1975



An estimated 68,622 privately owned, onsite sewage disposal systems, predominantly septic tanks, served 242,583 persons, or about 14 percent of the regional population, in 1975. About 354 square miles, or about 13 percent of the Region, were served by centralized sanitary sewers as of 1975, but of the remaining land area, the densities of septic tanks per U. S. Public Land Survey Quarter Section were 5 or less for about 73.7 percent, 6 to 31 for about 21.5 percent, 32 to 50 for about 2.1 percent, 51 to 75 for about 1.4 percent, 76 to 100 for about 0.7 percent, 101 to 150 for about 0.4 percent, and more than 150 for about 0.2 percent. A localized failure rate of as high as 50 percent has been cited for older residential areas located on soils which are severely limited for such waste disposal methods.

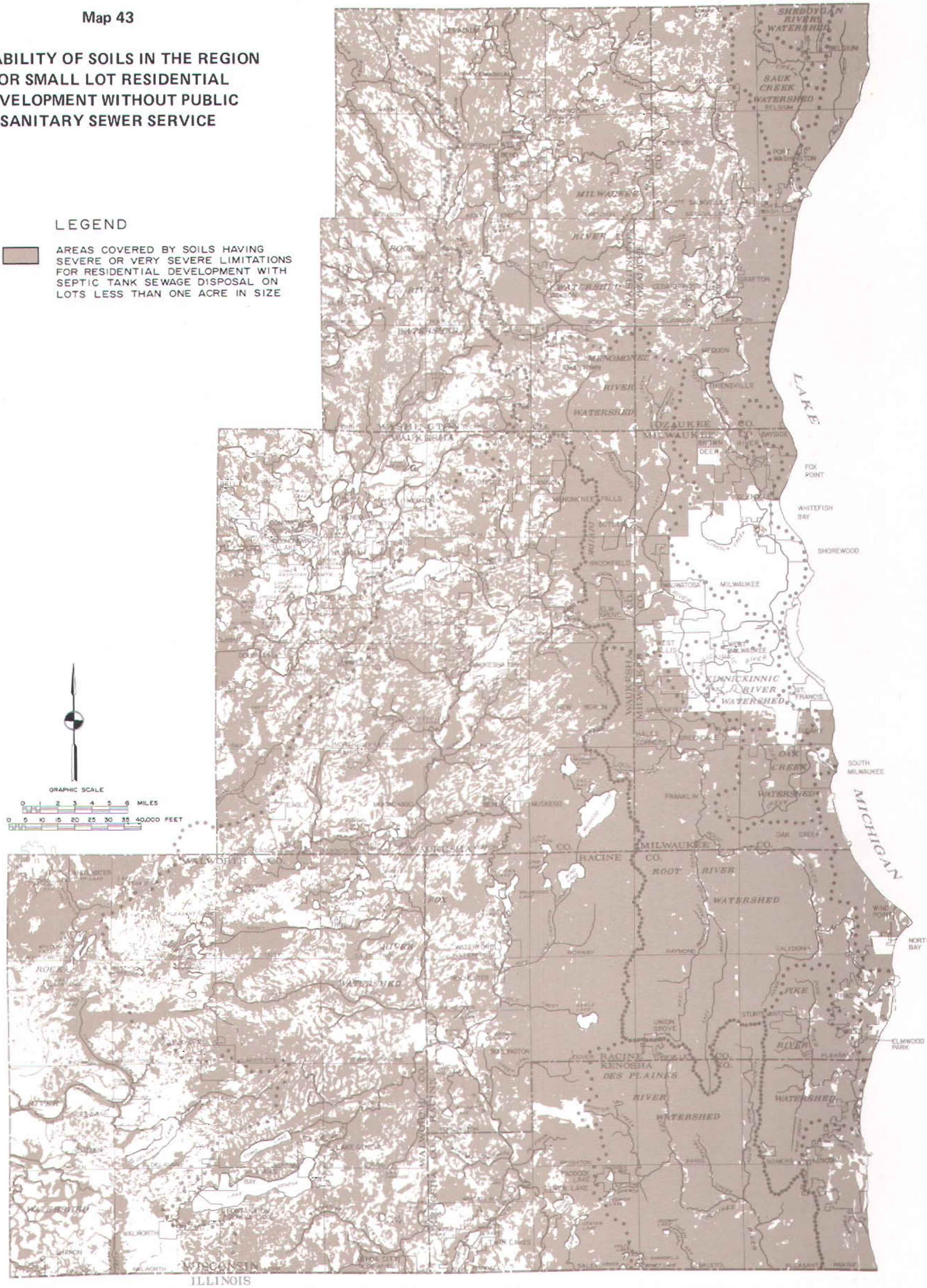
Source: SEWRPC.

Map 43

SUITABILITY OF SOILS IN THE REGION FOR SMALL LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS LESS THAN ONE ACRE IN SIZE



Approximately 1,637 square miles, or about 61 percent of the area of the Region, are covered by soils poorly suited for residential development on lots having an area smaller than one acre and not served by public sanitary sewerage facilities. Reliance on septic tank sewage disposal systems in these areas, which are covered by relatively impervious soils or are subject to seasonally high water tables, can only result in eventual malfunctioning of such systems and the consequent intensification of water pollution and public health problems in the Region.

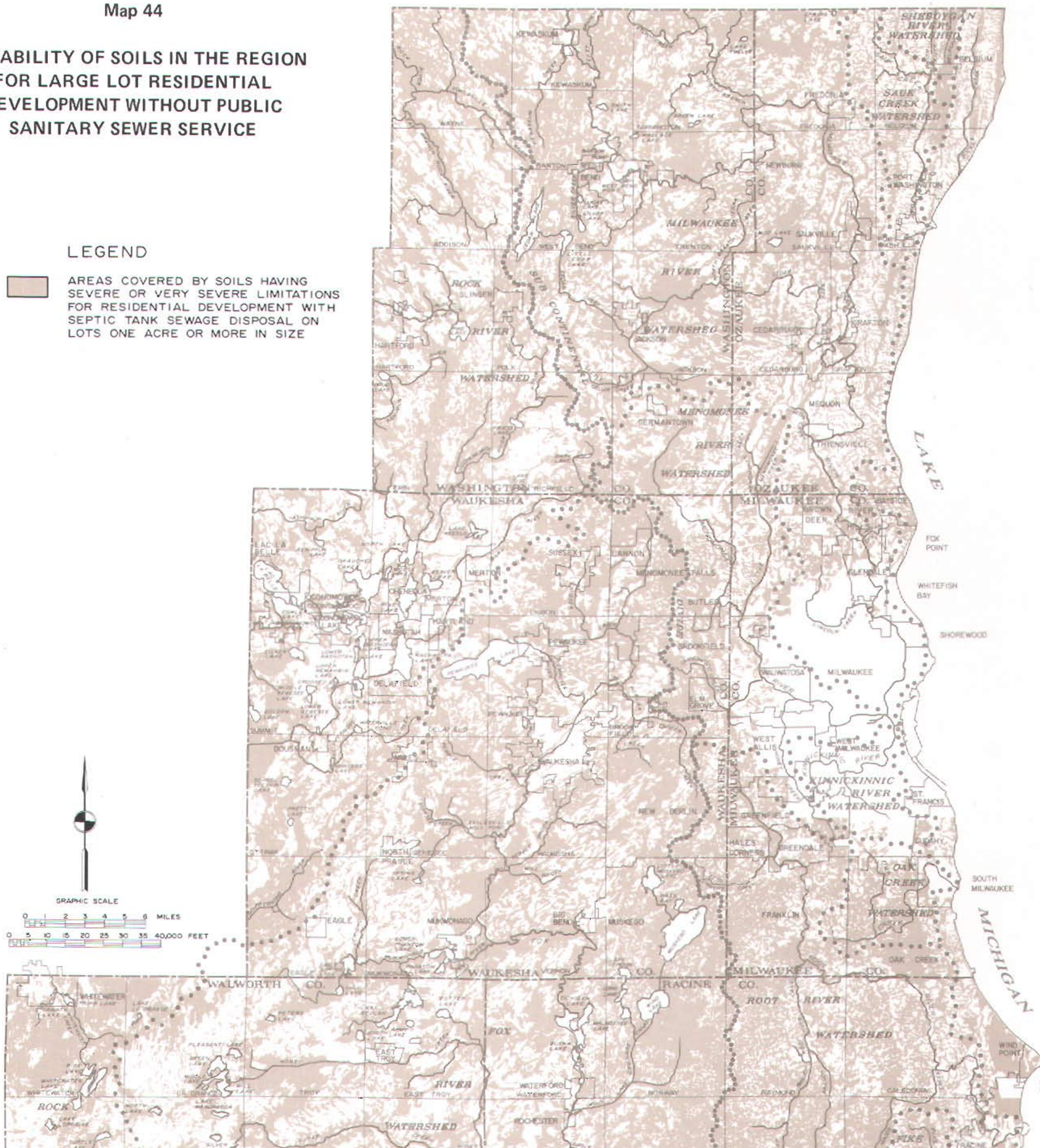
Source: SEWRPC.

Map 44

SUITABILITY OF SOILS IN THE REGION FOR LARGE LOT RESIDENTIAL DEVELOPMENT WITHOUT PUBLIC SANITARY SEWER SERVICE

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH SEPTIC TANK SEWAGE DISPOSAL ON LOTS ONE ACRE OR MORE IN SIZE



Approximately 1,181 square miles, or about 44 percent of the area of the Region, are covered by soils poorly suited for residential development on lots having an area of one acre or more and not served by public sanitary sewerage facilities. The inherent limitations of these soils for septic tank sewage disposal systems cannot be overcome simply by the provision of larger lots, and the use of such systems on these soils which cannot absorb the sewage effluent ultimately results in surface ponding and runoff of partially treated wastes into nearby watercourses.

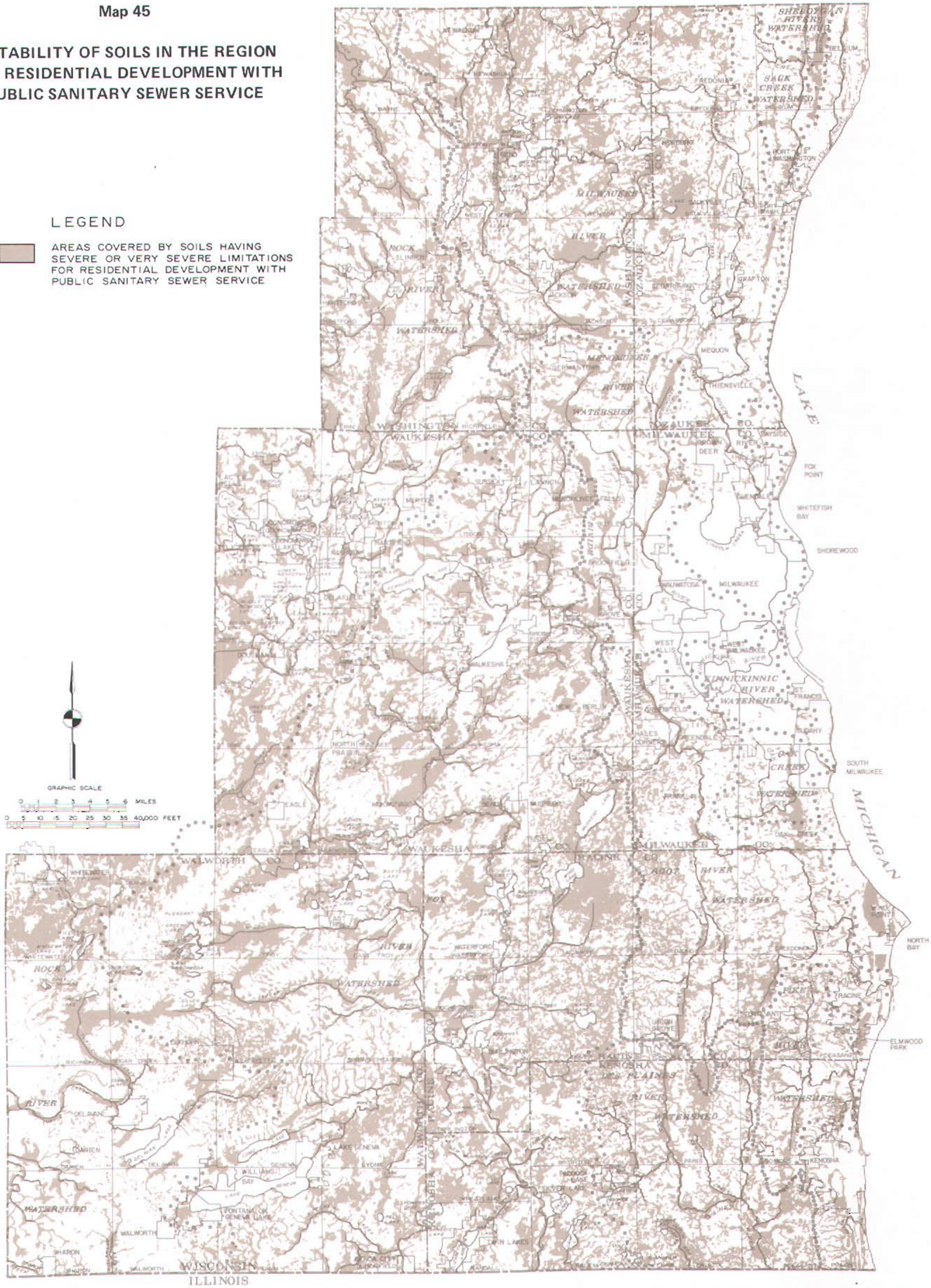
Source: SEWRPC.

Map 45

SUITABILITY OF SOILS IN THE REGION FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE

LEGEND

AREAS COVERED BY SOILS HAVING SEVERE OR VERY SEVERE LIMITATIONS FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER SERVICE



A recognition of the limitations inherent in the soil resource base is essential to the sound urban and rural development of the Region. About 716 square miles, or 27 percent of the area of the Region, are covered with soils which are poorly suited for residential development with public sanitary sewer service, or, more precisely, residential development of any kind. These soils, which include wet soils having a high water table or poor drainage, organic soils which are poorly drained and provide poor foundation support, and soils which have a flood hazard, are especially prevalent in the riverine areas of the Region.

Source: SEWRPC.

malfunctioning due to high groundwater or surface ponding at any given time. However, it has been reported[48], that in southeastern Wisconsin, approximately 50 percent of the septic systems in some areas are connected to agricultural drainage tiles or ditches, with nearly all of the septic wastes from these systems being directly discharged to drainage channels or surface waters. In areas having septic systems more than 15 or 20 years of age, as many as 75 percent have been so reported. In detailed sanitary surveys of lakeshore development conducted in Walworth County, as high as 95 percent of the residences surveyed revealed potential malfunction in the form of violations of the applicable plumbing codes,[49] with Little Muskego Lake in Waukesha County showing then-existing malfunctioning in 44 percent of all septic systems of the time of the survey. An analysis conducted by the Commission indicated that, in 1975, only about 12.6 percent of the septic systems in the Region were located in quarter sections adjoining lakes. To account for both the western-most portions of the Region which have soils more amenable to the use of septic systems, and the more recently developed and more closely regulated residential septic tank development, the estimated "failure" rate, or the proportion of all septic systems malfunctioning or improperly installed or directly contributing to drainage tile, ditches, culverts or storm sewers, was adjusted by watershed, as set forth in Table 123.

Uttormark, Chapin, and Green[50] reported that the average nutrient loads in household wastes were 3.31 pounds of phosphorus per capita per year and 14.33 pounds of nitrogen per capita per year. It has been estimated by Otis, Boyle, and Sauer[51] that typical septic tank effluent includes 204 pounds of BOD_5 per capita per year; 70 pounds of suspended solids per capita per year, and 2.5 x 10^{11} fecal coliform counts per capita per year. In malfunctioning septic systems, it is not uncommon—as noted above—for the drain fields to clog with solids filling the spaces between the soil particles, and cause surface ponding of the effluent, prompting the owner to connect the system directly to drainage tiles or ditches. If well drained and located near a continuously flowing stream, the drain tiles may contribute essentially all of the pollutants in the septic system effluent to the surface water, although a certain amount of soil filtration, evapotranspiration, infiltration, and plant uptake may occur in those instances where surface ponding and sheet runoff cause the pollutants to be

---

[48]*Personal communications of September, 1977 with various federal, state, and county agency staff members, and as documented in SEWRPC 208 Study Volume Memorandum No. 1900, Inventory Memo 22.*

[49]*Survey of Private Sewage Disposal Systems at Water Front Properties, Lake Como, Walworth County, State Division of Health, October 9, 1967.*

[50]*P. D. Uttormark, J. D. Chapin, and K. J. Green, Estimating Nutrient Loadings of Lakes from Non-point Sources, EPA-660/3-74-020, August, 1974.*

[51]*J. R. Otis, W. C. Boyle, and D. K. Sauer, "The Performance of Household Wastewater Treatment Units Under Field Conditions," Home Sewage Disposal, Proc. Nat. Home Sewage Disposal Symposium, ASAE Proc-175, December, 1974.*

Table 123

ESTIMATED CHANNEL LOADING RATES FOR SEPTIC SYSTEMS

Watershed	Estimated % Failure Rate	Pollutant Loading Rate (lbs. or counts/capita/year)				
		Nitrogen	Phosphorus	BOD	FC	Sed.
Des Plaines	40	5.7	1.32	81.6	1×10^{11}	28
Fox	20	2.9	0.66	40.8	5×10^{10}	14
Menomonee	30	4.3	0.99	61.4	7.5×10^{10}	21
Milwaukee	20	2.9	0.66	40.8	5×10^{10}	14
Minor Streams	40	5.7	1.32	81.6	1×10^{11}	28
Oak Creek	40	5.7	1.32	81.6	1×10^{11}	28
Pike	40	5.7	1.32	81.6	1×10^{11}	28
Rock	10	1.4	0.33	20.4	2.5×10^{10}	7
Root	40	5.7	1.32	81.6	1×10^{11}	28
Sauk	40	5.7	1.32	81.6	1×10^{11}	28
Sheboygan	40	5.7	1.32	81.6	1×10^{11}	28

Source: SEWRPC.

transported to surface waters. Accordingly, for purposes of this analysis, it has been estimated that all of the substances present in septic effluents from the systems estimated to be failing in the Region will ultimately reach the surface waters as a result of direct drainage connection, or due to contributions from malfunctioning systems.

Even properly operating septic systems release some pollutants to surface waters. However, Jones and Lee[52] demonstrated that phosphorus removal by properly operating septic systems, which depends to a great extent on soil chemistry and particle size, generally exceeds 95 percent at distances of 80 feet from effluent sources. Since the great majority of septic systems in the Region are farther than 80 feet from surface waters, the phosphorus contribution from properly operating systems is assumed to be negligible. Nitrogen, however, which enters septic tanks largely as ammonia, is nitrified under aerobic conditions into soluble nitrates not effectively filtered by the soil. In a study to evaluate the performance of septic systems in sands, Walker, Bouma, Keeney, and Olcott[53] found that nearly all nitrogen is converted to nitrate in sandy soils and transported to the groundwater. Since the soils in southeastern Wisconsin are not generally sandy and well aerated, and since only a portion of the nitrate in the groundwater will reach surface waters, only a small portion of the nitrogen processed through properly operating systems is assumed to reach surface waters. Organic compounds and fecal coliform are effectively removed by proper soil filtration and were assumed to have negligible loading rates from properly operating septic systems. Therefore, in comparison to malfunctioning septic systems or those connected to drain tiles or ditches, properly operating systems are assumed to contribute negligible amounts of pollutants to surface waters.

Based on the available data, the pollutant loading rates presented in Table 123 were used in the pollutant loading analysis and applied to septic systems in the Region.

Because the Commission's areawide water quality management program is, primarily, a surface water quality management study and not a groundwater quality management study, the loading rates estimated above are for surface water pollution only, not groundwater pollution. Although pollution of the groundwater may be a direct contributor to surface water pollution in some areas, most notably around inland lakes, these effects cannot be generally applied to the Region as a whole.

To relieve some of the water quality impacts of existing malfunctioning septic systems, the Wisconsin Department of Health and Social Services, in cooperation with the University of Wisconsin, approved the use of three experimental "septic tank" sewage disposal systems in June of 1975. These systems were designed to overcome natural soil limitations due to impermeability, high groundwater, or shallow bedrock. These three new package systems, the first in a proposed series of such systems, were developed by the Department of Health and Social Services and the University of Wisconsin after extensive research studies and in direct response to problems of surface and groundwater contamination caused by malfunctioning septic tank systems throughout the state, but most notoriously concentrated in Door County where shallow bedrock conditions are prevalent.

Unlike the conventional gravity flow septic tank system, all three new systems utilize mechanical facilities to pump septic tank effluent through one-inch-diameter perforated distribution pipes placed in fill on top of the natural soil. When in place, this fill takes on the appearance of a mound; hence the new systems are commonly called "mound systems." Figure 68 illustrates the placement of a mound system on a one-acre single-family residential parcel. In this typical installation, which is assumed to be designed to accommodate wastes from a four-bedroom single-family home, the mound would approximate an area 64 feet wide by 84 feet long, or 5,376 square feet, representing about 12 percent of the total area of the lot. At its highest point, the mound would be approximately five feet in height. Because of the relatively large size of the mound, and the need to reserve sufficient area for a replacement mound at some future date, the utilization of mound type septic tank systems dictates that the lots be at least one acre in area.

The first of the three packages recently approved for use is designed to be constructed on slowly permeable soils having seasonally high water tables. Under the rule adopted by the Department of Health and Social Services, this package may be used at the present time only to solve problems on existing developed parcels. The second and third packages are designed to overcome problems both with respect to existing and future development in those areas where soils are naturally permeable but were shallow and creviced bedrock, or highwater tables exist. The use of any of the package systems must be approved by the Department of Health and Social Services on a case-by-case basis, and is also subject to approval by the local units of government. All such systems must be monitored, with the monitoring results reported directly to the Department of Health and Social Services.

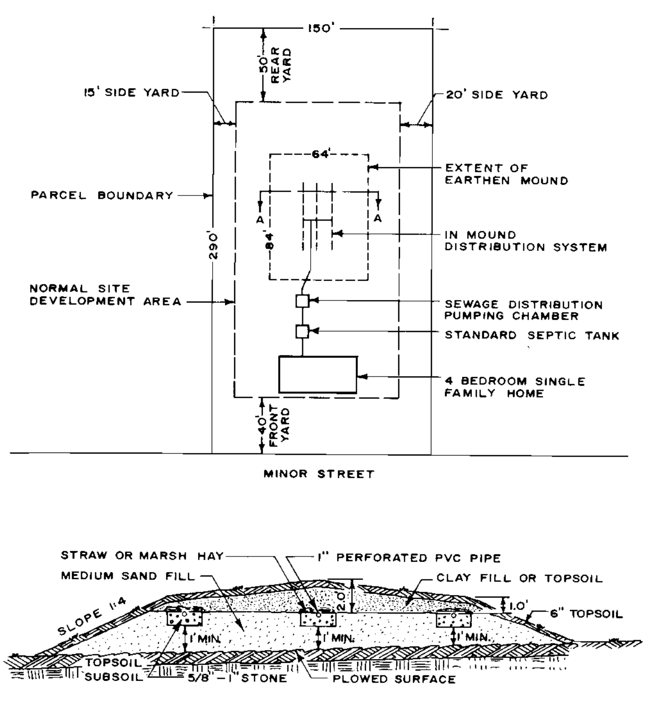
[52] *R. A. Jones, and G. F. Lee, Septic Tank Wastewater Disposal Systems—as Phosphorus Sources for Surface Waters, Draft, March, 1977.*

[53] *W. G. Walker, J. Bouma, D. R. Keeney, and P. G. Olcott, "Nitrogen Transformations During Subsurface Disposal of Septic Tank Effluents in Sands: II. Groundwater Quality," J. Env. Quality, Vol. 2, No. 4, October-December, 1973, pp. 521-525.*

While the rules adopted by the Department of Health and Social Services currently restrict the applicability of the mound systems, it is possible that if the mound systems prove to be operational on a widespread basis over the next few years, restrictions relating to such use may be lifted in the future. Similarly, it is highly likely that the additional package systems could be designed to overcome nearly all natural soil limitations that currently inhibit or restrict the utilization of onsite sewage disposal systems. The net result of these developments would be to significantly reduce the pollution loadings from malfunctioning systems in the Region. The new system would not replace conventional properly operating septic systems, however. Due to the insignificant number of mound systems presently constructed and in operation, the numerous inspections during their installation and the extreme effluent monitoring being conducted on these sites, loading rates to surface waters are considered to be negligible for purposes of this analysis. Table 124 presents the number of known mound systems installed in the Region as of 1975.

Figure 68

ILLUSTRATION OF A TYPICAL MOUND SYSTEM



As shown in the accompanying sketch, the mound system continues to utilize a standard septic tank, while adding a sewage distribution pumping chamber. The pump located in this chamber would function much like a sump pump, and would provide daily dosing of the septic tank effluent into the mound system. The mound itself would be constructed with sand fill covered by layers of clay and topsoil. The septic tank effluent distribution pipes would be placed in crushed stone trenches covered with straw or marsh hay.

Source: SEWRPC.

Still another method of handling sewage in a residential, commercial or industrial activity is the holding tank. This is a self-contained tank which is placed below ground surface to collect and temporarily store waste until such a time that disposal is convenient or the tank is filled to capacity. Waste is then intended to be pumped out of the holding tank into a truck and transported to a sewage treatment plant. The sewage therefore has the potential of becoming a significant hazard to water quality if it is improperly disposed of on land, spilled, pumped into a storm sewer or placed in an inadequate landfill or storage pond. It has been estimated that 40 to 50 percent of the total number of holding tanks presently existing in some portions of the Region have been installed without obtaining the proper state and county construction of sanitary permits, and therefore the State and the County or Town which has jurisdiction are unaware of the presence of the tanks. In addition, there are neither records nor inspections known to be required to assure that timely pumping and disposal at a suitable sewage treatment plant occurs. As noted above, it is possible—but not legal—for the owner to pump his own sewage and dispose of it on private land. This may include pumping the waste into his backyard, a nearby roadside ditch, culvert, storm sewer, stream or river flowing through his backyard. Similarly, it is generally assumed that some holding tank wastes although properly pumped by a licensed sanitary hauler, are improperly disposed of on land by surface spreading, though the irresponsible actions are from a minority of the sanitary haulers.

A survey conducted by the Commission on the number and type of known holding tanks in the Region indicated the county totals shown in Table 125 and located on Map 46.

Table 124

KNOWN MOUND SYSTEMS IN SOUTHEASTERN WISCONSIN: 1975*

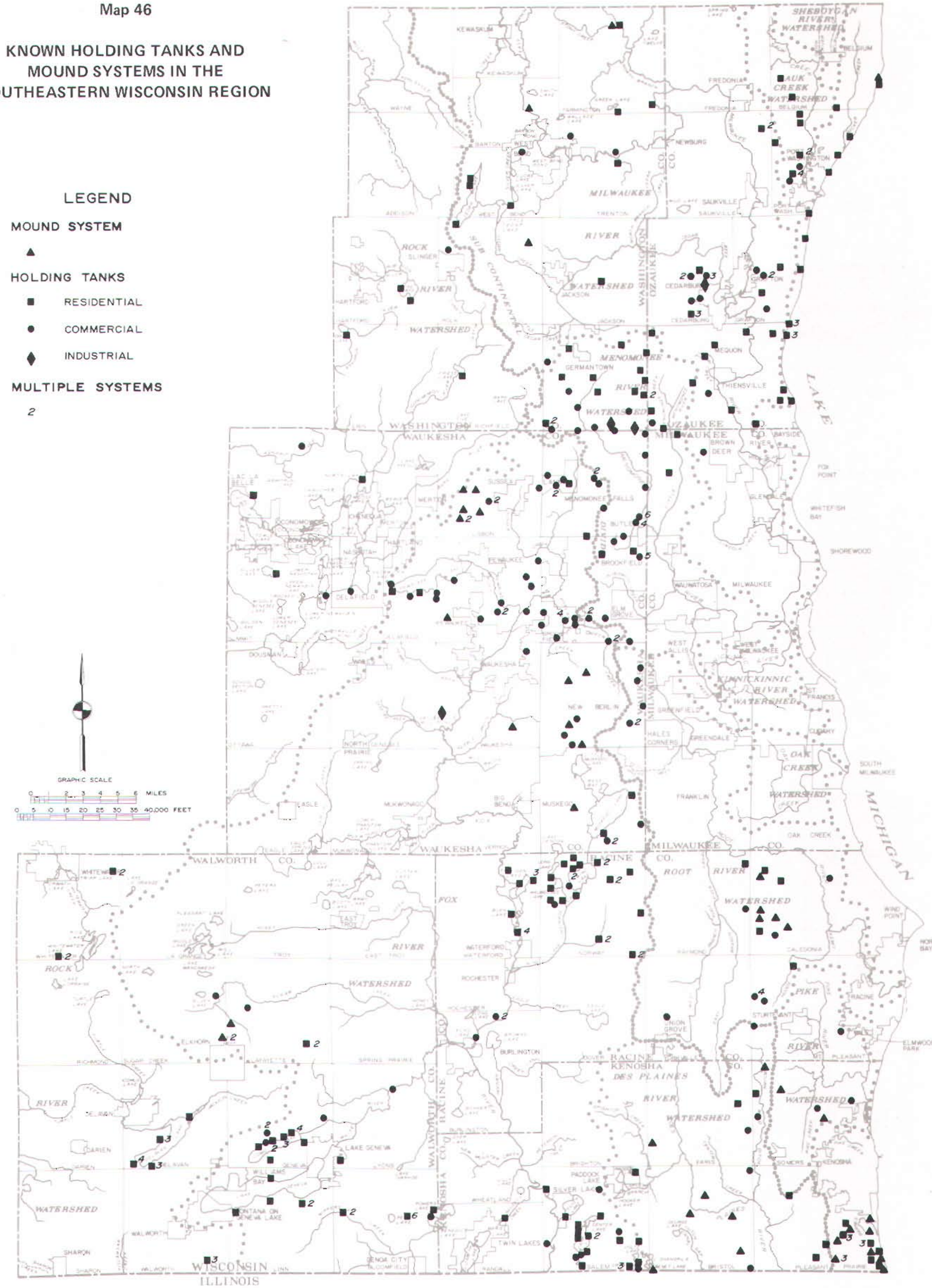
County	Number of Known Mound Systems
Kenosha	19
Milwaukee	0
Ozaukee	1
Racine	5
Walworth	3
Washington	3
Waukesha	13
Region Total	44

**Numbers are not comparable to watershed totals as watershed totals do not include those areas which are directly tributary to Lake Michigan.*

Source: SEWRPC.

Map 46

KNOWN HOLDING TANKS AND MOUND SYSTEMS IN THE SOUTHEASTERN WISCONSIN REGION



As of 1975 there were 351 known holding tanks and 44 known mound systems installed within the seven-county Region. Improperly located or constructed and inadequately maintained holding tanks and mound systems may contribute pollutants to the groundwater or to surface waters by seepage through the soil or by overland runoff of pollutants.

Source: SEWRPC.

Table 125

NUMBER OF KNOWN HOLDING TANKS IN SOUTHEASTERN WISCONSIN: 1975[a]

County	Number of Known Holding Tanks
Kenosha	46
Milwaukee	4
Ozaukee	63
Racine	51
Walworth	55
Washington	42
Waukesha	90
Region Total	351

[a] *Numbers are not comparable to watershed totals as watershed totals do not include those subwatersheds directly tributary to Lake Michigan.*

Source: SEWRPC.

In addition, local surveys indicate that other holding tanks constructed prior to the initiation of the permit system may exist. Due to the modest number of holding tanks within the Region, and the discharge of most of the associated wastes to sewage treatment plants or to dry land surfaces, no estimates of associated pollutant loadings to surface waters were made.

RURAL LAND USES AND ACTIVITIES

Livestock Operations

Presence of livestock and poultry manure in the environment is an inevitable result of animal husbandry and is a major potential source of water pollutants. Animal manure, composed of feces, urine, and sometimes bedding materials contributes suspended solids, nutrients, oxygen-demanding substances, bacteria, and viruses to surface waters. Historically, animal manure was deposited by wildlife in broad dispersion on the earth's surface where the organic matter was incorporated into the soil and the nutrients were utilized by growing vegetation. Although this process continues, most farm animals within the Region are raised and managed in barnyards or feedlots. For purposes of this report, and generally in southeastern Wisconsin, a feedlot is defined as a relatively small—generally less than five acres in size—confined land area, such as a fenced barnyard or a fenced portion of a pasture, for raising large numbers of livestock—generally 25 to 200 head—primarily by importing feed, as opposed to using pasture grazing; relying on the occasional export of accumulated manure and bedding materials from these so-called feeding or loafing areas; generally denuded of vegetative cover; and therefore subject to high rates of erosion and release of pollutants. The density of the animal population is the distinguishing feature of a feedlot. An example of a feedlot, poorly located with regard to surface water drainage, is presented in Figure 69.

The trend is to larger animal herds on smaller numbers of acres, along with an increasing concentration of animal wastes. Livestock feeding practice in the Region has gradually shifted from larger open grazing practices to barnyard, or even building-confined, animal operations. Animal waste constituents of pastureland and barnyard runoff, animal wastes deposited on pastureland and cropland, and in barnyards, feedlots, and manure piles can contaminate water by surface runoff, infiltration to the groundwater, and volatilization to the atmosphere. Groundwater under feedlots frequently contains nitrates, ammonia, and organic carbon. Atmospheric ammonia, which is soluble in water, can be as much as 20 to 30 times greater near feedlots than near control sites.[54] Willrich,[55] found that nitrate concentrations under feedlots were such that up to 5,137 pounds of nitrate per acre were present in a 20-foot depth. Groundwater pollutants may be a direct source of water pollution to nearby surface waters. Since the acreage used directly for feedlots is limited, widespread groundwater pollution due to infiltration from these areas is unlikely, but should be considered in other studies, since groundwater pollution is beyond the scope of this analysis.

Of major importance to the water quality within the Region are those animal operations which are located close to perennial streams, intermittent streams or inland lakes, thereby contributing significant amounts of animal wastes which can find entry into the surface water network. The Commission's 1975 inventory of agricultural practices indicated that 955 or about 41 percent, of the major livestock feeding operations in the Region are located within 500 feet of a perennial stream or a lake. This is attributed to historic methods of placing livestock as near as possible to a flowing stream for use as a water supply. The inventory results for each watershed, including the number and type of feedlots and livestock, and the distance from surface waters, are presented in the individual watershed discussions.

Dairy and beef cattle in southeastern Wisconsin are usually confined to buildings, barnyards, or pastures. The manure handling and disposal methods used for

---

[54] *U.S. Environmental Protection Agency, Methods for Identifying and Evaluating the Nature and Extent of Nonpoint Sources of Pollutants, U.S. Environmental Protection Agency, EPA 430/9-73-014, October, 1973.*

[55] *T. L. Willrich, et al, "Agricultural Practices and Water Quality," in Proceeding of a Conference Concerning the Role of Agriculture in Clean Water, November, 1969, Iowa State University, Ames, Iowa, November, 1970.*

Figure 69

EXAMPLE OF A POORLY LOCATED FEEDLOT IN THE REGION

Source: SEWRPC.

year-round, building-confined cattle or other large animal operations vary considerably from the procedures used at the other, more commonly occurring types of smaller livestock operations in the Region. A few dairy farming operations in the area have incorporated the slotted floor technique, whereby the manure is allowed to pass through floor grates into a large holding pit. The wastes are stored temporarily—until the pit is full or it is convenient to empty—and the slurry (semi-liquid) is pumped out of the pit and applied to the surface of cropland or pastureland with the aid of trucks, wagons, or manure spreaders. The majority of the farmers that incorporate confined building operations into their total farm operation have not converted to the more costly pit operation. Manure and other wastes are generally removed from the barn by means of a barn cleaner which is a motor-driven chain with attached paddles that runs the length of the barn in a trough containing collected manure. This allows the farmer to either stockpile the manure in an area near the barn for future land application or load the manure directly onto a spreading wagon for land application. Following manure removal from the barn the animal walkway and surrounding areas are dusted with approximately 50 to 150 pounds of lime to help control odor and disease. It should be noted that the highly alkaline lime probably has a positive effect, if any, on water quality since it counters the acidic effects of manure. Cleaning generally occurs daily during the winter months, when the animals are confined in buildings most of the time; less frequent cleaning occurs in the summer when the animals are in the barnyard or pasture. If the manure is not land spread within 1-2 days, washoff from stockpiled manure during periods of wet weather can result in large quantities of organic and inorganic material entering surface and groundwaters.

In contrast to runoff from animals confined to buildings, runoff from barnyard-confined animal operations yields similar amounts of animal feces and urine contamination, but may be less concentrated. As expected, the amount of runoff from paved barnyard lots is greater than that of unpaved barnyard lots, although the unpaved lots yield a considerably larger total solids runoff due to erosion and the high amounts of organic material from the manure residue accumulated from year to year. Similarly, steeper slopes increase the rates and amounts of runoff.

During the warmer seasons of the year some of the animals which were building or barnyard-confined may be put to pasture, providing that the operator has a sufficient amount of land available. The Commission inventory of agricultural practices indicates that this is a declining practice in the Region. Manure wastes from pastured animals does not cause as much impact on the stream and groundwater system as manure from barnyard or building confined wastes, since the density of pastureland animals is considerably less. In addition, the scattered waste material is more likely to be taken up by the vegetative growth composing the land cover as the manure decomposes and the nutrients percolate into the soils.

Until other and more cost-effective treatment methods are developed and proved worthy, the controlled use of cropland for animal waste disposal will remain the generally accepted method used by virtually all of the farmers in the Region. Land provides a natural treatment system for animal wastes which are a source of organic materials and nutrients for crops, and an effective means of minimizing surface water pollution. Pollutant reductions are especially high if the animal wastes are incorporated into the soil, and not spread on frozen ground which allows for excessive runoff and pollutant transport.

Existing data indicates a highly variable quality of runoff from annual feedlots dependent upon rainfall intensity, temperature, feedlot surface and slope, moisture content, and manure accumulation. Miner[56] showed that the feedlot runoff is a source of high bacterial concentrations and that the greatest pollutant concentrations were obtained during warm weather, during periods of low rainfall intensity, and when the manure had been made soluble by water soaking. In the runoff sampled during these studies, ammonia nitrogen ranged from 16 to 150 mg/l, suspended solids from 1,500 to 12,000 mg/l, and BOD_5 from 3,000 to 11,000 mg/l. Average chloride and phosphate concentrations were 300 and 50 mg/l, respectively, from lots with concrete surfaces. Ammonia may be released into the air from feedlot storage tanks, treatment facilities, and other manured surfaces. A study cited by Miner[57] showed significantly higher rates of ammonia adsorption by water near feedlots, as compared with samples collected in other rural areas.

The Commission's 1975 inventory of agricultural practices indicated approximately 249,000 animal units within the larger feeding operations in the Region. Table 126 shows the types, number, and equivalent animal units of agricultural animals in the Region by watershed.

The average composition and production of various animal wastes as estimated by the Soil Conservation Service[58] is shown in Table 127. A general animal waste composition and production rate was developed based on this information and the proportions of dairy cattle, beef cattle, hogs, fowl, sheep, and horses in the Region. An animal unit is defined as a measure of livestock numbers based on the equivalent of a mature feeding cow (approximately 1,000 pounds live weight). The number of animal units for any given animal feeding operation can be calculated by adding the following numbers: the number of slaughter and feeder cattle multipled by 1.0; plus the number of mature dairy cattle multiplied by 1.4; plus the number of swine weighing over 55 pounds multipled by 0.4; plus the number of sheep multiplied by 0.1; plus the number of horses multiplied by 2; plus the number of fowl (except ducks) multiplied by 0.01; plus the number of fur-bearing animals multiplied by 0.01; plus the number of ducks multiplied by 0.2. The composition and production of manure from an average animal unit in the Region was, therefore, computed as total nitrogen, 142 pounds per animal unit per year; total phosphorus, 33 pounds per animal unit per year; BOD_5, 556 pounds per animal unit per year; and sediment; 3,461 pounds per animal unit per year. Fecal coliform contributions from animal wastes was similarly estimated by multiplying the fecal coliform contributions for animal types,[59,60] by the animal unit proportion of that animal type within the Region. An average animal unit within the Region produces 3.2×10^{12} fecal coliform counts per year.

Madden and Dornbush[61] reported that 5 percent of the total waste generated in a commercial feedlot in South Dakota was carried to surface waters via surface runoff, with the remainder being removed

---

56 *J.R. Miner, "Agricultural Waste Management," Journal of the Environmental Engineering Division, Volume 100, American Society of Civil Engineers, April, 1974.*

57 *Ibid.*

58 *U.S. Soil Conservation Service, Agricultural Waste Management Field Manual, USDA, August, 1975.*

59 *E. E. Geldreich, "Sanitary Significance of Fecal Coliforms in the Environment" U.S. Dept. Int., FWPC Admin. Resch Series WP-20-3, 1966.*

60 *B. A. Kenner, H. F. Clark, P. W. Kabler, "Fecal Streptococci II. Quantification of Streptococci in Feces" Am. Journal of Public Health Vol. 50, 1960, pp. 1553-1559.*

61 *J. M. Madden, and J. N. Dornbush, Measurement of Runoff and Runoff Carried Wastes from Commercial Feedlots. Proc. Int. Sym. on Livestock Wastes, ASAE, St. Joseph, Michigan, 1971.*

Table 126

TYPE, NUMBER, AND EQUIVALENT ANIMAL UNITS OF ANIMAL OPERATIONS IN THE REGION

Watershed	Type of Animal																			
	Dairy		Beef		Hogs		Horses		Fowl		Sheep		Mink		Goats		Other		Total	
	Number	Units	Number	Units	Number	Units	Number	Units	Number	Units	Number	Units	Number	Units	Number	Units	Number	Units	Number	Units
Des Plaines	5,320	7,450	2,330	2,330	2,270	910	30	50	152,700	1,530	70	10	5,410	50	100	10	--	--	168,230	12,340
Fox	41,010	57,410	8,800	8,800	14,080	5,630	1,180	2,360	305,400	3,050	820	80	6,920	70	--	--	20	20	378,230	77,420
Kinnickinnic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Minor Streams																				
Barnes Creek	--	--	--	--	--	--	--	--	--	--	--	--	1,000	10	--	--	--	--	1,000	10
Pike Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sucker Creek	2,290	3,200	60	60	150	60	40	80	--	--	50	--	1,500	20	--	--	--	--	4,090	3,420
Menomonee	2,280	3,190	600	600	200	80	--	--	--	--	--	--	500	5	--	--	--	--	3,580	3,870
Milwaukee	25,980	36,370	1,860	1,860	1,880	750	510	1,020	71,800	720	--	--	6,500	70	--	--	--	--	108,530	40,790
Oak Creek	80	110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	80	110
Pike	450	630	280	280	130	50	--	--	--	--	--	--	2,440	20	--	--	--	--	3,300	980
Rock	40,570	56,800	6,980	6,980	4,580	1,830	490	970	68,000	680	370	40	--	--	10	--	--	--	121,000	67,300
Root	3,320	4,650	1,265	1,270	2,550	1,020	770	1,540	83,000	830	105	10	3,000	30	50	--	--	--	94,060	9,350
Sauk Creek	6,170	8,640	300	300	450	180	--	--	--	--	--	--	--	--	--	--	--	--	6,920	9,120
Sheboygan	960	1,350	150	150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,110	1,500
Total	128,430	179,800	22,625	22,625	26,290	10,510	3,020	6,020	680,900	6,810	1,415	140	27,270	275	160	10	20	20	890,130	226,210
Milwaukee Outside Region	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	23,040
Region Total																				249,250

Source: County Soil and Water Conservation Districts; U. S. Dept. of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

Table 127

DAILY PRODUCTION AND COMPOSITION OF LIVESTOCK MANURE

	Dairy Cattle	Beef Cattle	Feeder Swine	Breeder Swine	Poultry	Ducks[a]	Sheep	Horses	Catfish	People
	lb/day/1,000 lb live weight									
Manure	85	62	69	50	53	---	36	50	---	31.2
	72-90	41-88	50-90		32-67		30-40	40-60		
Total solids	9.3	8.9	7.2	4.3	13.9	[b]24	9.5	17.5	3.1	3.4
	6.8-13.5	6.0-11.1	6.0-9.0		9.0-17.4	[b]13-31	8.4-10.7		2.8-3.5	2.4-4.4
Volatile solids	6.9	6.9	5.7	3.2	10.8	[b]14.5	8.0	---	---	2.0
	5.7-7.9	4.8-8.2	4.0-7.0		8.0-12.9	[b]8.7-17.5	6.0-9.1			1.1-2.6
BOD_5	1.4	1.5	2.3	1.3	3.4	5.1	0.8	1.4	2.3	1.36
	0.8-1.8	1.0-1.8	2.0-2.8		1.6-5.5	4.1-7.6	0.7-0.9		1.1-4.9	0.6-2.10
COD	8.4	7.9	5.9	5.2	12.5	---	10.0	---	---	3.12
	4.2-13.3	6.6-9.0	4.7-7.1		9.5-158		7.5-12.0			1.0-3.5
Total nitrogen as N	0.37	0.43	0.45	---	0.86	1.42	0.40	0.30	1.6	0.20
	0.29-0.51	0.30-0.58	0.20-0.70		0.45-1.50	1.17-1.62	0.34-0.45		0.7-2.5	0.14-0.26
Total phosphorus as P	0.069	0.090	0.17	---	0.40	0.62	0.075	0.12	0.25	0.024
	0.026-0.100	0.023-0.170	0.09-0.27		0.20-0.75	0.4-0.9	0.040-0.120		0.24-0.26	
Total potassium as K	0.20	0.23	0.25	---	0.35	0.9	0.32	0.25	1.5	0.064
	0.08-0.35	0.11-0.38	0.10-0.60		0.12-0.50	0.6-1.2	0.24-0.40		0.7-2.4	

[a] *Based on production figures per 1,000 ducks and assuming an average weight of 4 pounds per duck on swim water.*

[b] *Suspended solids.*

NOTE: Upper figure is average; lower figures represent the range given in literature. Dashes indicate data not available or entry not appropriate.

Source: Agricultural Waste Management Field Manual, Soil Conservation Service, USDA, August, 1975.

either by cleaning operations or by decomposition on the feedlot surface. The proportion of the manure and decomposed bedding material which ultimately reaches the surface water is affected by the number and density of animals, the distance to a stream or lake and the intervening topography, the soil type and slope, the feedlot cleaning and storage practices, the proportion spread on frozen ground, the proportion lost from the field as a result of the characteristics of the field receiving the manure, and the precipitation patterns. Because feedlots on smaller farming operations are assumed to be cleaned more thoroughly by precipitation than are large commercial feedlots, because these smaller barnyard operations are generally not cleaned by the same mechanical means as are the larger commercial feedlots of the type reported in the cited study, because most livestock operations in the Region spread manure all year round, and because southeastern Wisconsin has a relatively dense stream drainage network, very few manure holding facilities and high amounts of precipitation, approximately 15 to 25 percent of the wastes from domestic livestock in southeastern Wisconsin are assumed to be transported to surface waters ultimately, either with storm runoff from feedlots and exercise pens, or from manured cropland. Therefore, estimated loading rates to surface waters from livestock operations that are used in the pollutant loading analysis are presented in Table 128, assuming that 20 percent of the manure ultimately reaches drainage channels.

It should be noted that wild animals, compared to domestic agricultural livestock, have a relatively insignificant effect on the overall water quality of the Region's surface waters. However, water fowl, particularly during the spring and fall migrations, may have a significant effect on the water quality of some water bodies through the direct contribution by defecation of nutrients and organic, oxygen-demanding substances. On the other hand, upland game birds such as pheasants and partridge; song bird populations; and terrestrial wildlife, such as deer, mink, racoons, squirrels, and mice are not likely to have a significant impact on water quality as these animals migrate over relatively large areas. Mammals such as the muskrat and the beaver are associated with the aquatic habitat and may have a limited effect on the Region's surface water quality. Aquatic wildlife other than beavers and muskrats which include fish, frogs, some salamanders, and most of Wisconsin's turtle and snake populations and the nutrients and organic substances contributed by these animals are part of the natural food cycle internal to this habitat. This system represents a generally closed food cycle, in that the existing materials within the aquatic system are utilized and may be returned via excrement or death of the organism, and therefore, under normal conditions cause no external stress to the quality of the Region's surface waters. The great variability of wildlife distribution, a lack of inventory data, and a lack of scientific knowledge about waste production by wildlife defies the estimation of loading rates from wildlife activities. The relative insignificance of wildlife as a pollution source is suggested by a Wisconsin Department of Natural Resources estimate that there are approximately 4,400 white-tailed deer in the Region in fall prior to the hunting season.[62] A conservative estimate would be that a deer is equivalent to 0.5 animal units, hence there would be an upper limit of 2,200 animal unit equivalents of deer in the Region. This is less than 1 percent of the domestic livestock animal units in the Region. Assuming 2 to 3 times this amount of animal units may be attributed to other wildlife, it is apparent that wildlife comprises less than 5 percent of the animal unit equivalents of domestic livestock in the Region. These wastes are also widely dispersed over the woodlands, wetlands, and fields, and therefore are considered minor in the gross loading estimates.

Table 128

ESTIMATED CHANNEL LOADING RATES FOR LIVESTOCK ACTIVITIES

Pollutant	Loading Rate lbs/animal unit/year
Total Nitrogen	28.4
Total Phosphorus	6.6
BOD_5	111.2
Fecal Coliform	6.4×10^{11} counts/animal unit/year
Sediment	700

Source: SEWRPC.

Crop Production

Cropland can have an adverse effect upon water quality within the Southeastern Wisconsin Region, contributing sediments, nutrients, organic matter and pesticides in the runoff to streams and lakes. The extent of water pollution from cropping practices varies considerably as a result of the soils, slopes, and crops, as well as the numerous methods of tillage, planting, fertilization, chemical treatment, and conservation practices. The topographic, hydrographic, meteorologic and hydrologic conditions within the Region are also very important factors. For example, just as inadequate handling of animal wastes from a confined feeding operation will pollute the stream system, excessive fertilizer, pesticide, and herbicide usage also has the potential to damage the water resources.

Croplands are herein defined as agricultural land used to grow and harvest plants which are sold, used as animal feed or used to improve soil conditions. Included in the Commission land cover inventory as cropland are row crop (corn, soybeans); small grain (wheat, oats); hay (clover, alfalfa, brome grass, orchard grass, timothy, canary grass); vegetables (peas, sweet corn, cabbage, beets, carrots, onions, tomatoes, cucumbers, potatoes); and specialty crops (sod, mint). A detailed description of cropping practices in each county of the Region, fertilizer application rates, and pesticide use is presented in Appendix L. The cropping practices determine the method, depth, and frequency of soil disturbance;

[62]*F. Wetzel, Southeast District Wildlife Manager, Wisconsin Department of Natural Resources, Pers. Com., October 8, 1976.*

type, amount and rate or frequency of chemicals applied; soil erosion; infiltration and runoff rates; soil fertility preservation or enhancement; and surface cover characteristics. These factors are important variables in controlling the magnitude and frequency of pollutant loadings to surface waters from agricultural lands.

Oats is the most popular small grain sown in the Region. It may be sown alone or as a nurse crop for hay. Hay generally cannot be harvested the same year it is sown, and needs the initial year to mature to the point where it can be cropped for the following three to seven years. Oats sown with the hay can be harvested the first year, thereby providing the farm operator with income from that field while the hay stand is being established. The seedbed for oats is generally prepared using the traditional tillage method of fall moldboard plowing, followed by spring tooth harrowing or disking in spring to break up the clods thrown up by the plow. Spring plowing is generally done only by necessity, with fall plowing the preferred practice. Recently developed conservation tillage methods—such as chisel plowing—are used by about 5 percent of the farmers within the Region as an alternative to moldboard plowing. Chisel plowing loosens the soil by forcing the chisel point through the upper layer of the soil to depths of up to 10 inches, rather than turning the soil over as traditional moldboard plowing does. The process leaves a portion of the residue from the previous crop on the surface to reduce surface soil erosion by water or wind. The residue also acts as a mulch over the cropland to reduce evaporative loss of moisture.

The oat crop is planted in the spring after secondary tillage operations. If additional fertilizer is to be added to the soil, it is done at this time, with up to 24 pounds of elemental nitrogen; 10 to 96 pounds of P_2O_5 and 30 to 126 pounds of K_2O per acre added annually. The three numbers used to designate a certain type of fertilizer indicate the percent, by weight, of elemental nitrogen, P_2O_5, and K_2O, which is present in the fertilizer applied. For example, a 5-20-20 fertilizer contains 5 percent elemental nitrogen; 20 percent P_2O_5 which is equivalent to 9 percent elemental phosphorus since elemental phosphorus is 43.7 percent of the P_2O_5; and 20 percent K_2O which is equivalent to 17 percent elemental potassium since elemental potassium is 83.0 percent of the K_2O. All references in this report utilize this traditional means of expressing fertilizer composition as the percent of elemental nitrogen, percent of P_2O_5, and the percent of K_2O. The application rates and element proportions of the fertilizer used depends on the chemical characteristics of the soil, and the nutrients required to support maximum crop growth. The required nutrients can be determined by a soil test, prepared with the assistance of the University of Wisconsin-Extension Service Soil Testing Program administered through the counties or by fertilizer dealers. No further agricultural management techniques are applied to the land until harvest time in late July or August. If an oats crop was seeded with hay, no fall tillage is required after the harvest. However, if the grain was seeded alone, plowing type and time will depend on the crop planned for the following year.

Hay is a general term used for all perennial crops which are harvested for animal consumption. Within the Region hay may consist of alfalfa, brome grass, orchard grass, timothy, canary grass, red clover, Alsike clover, Ladino clover, and combinations of the above. In any given year, hay can be distinguished in three ways—grain-seeded hay, hay seeded alone, and standing hay. Grain-seeded hay has been discussed above in conjunction with oats, which is the most commonly implemented method for establishing a new stand of hay. As noted above, hay is seldom seeded without a nurse crop, as that would take a field out of production for one year, whereas a grain crop could be grown and harvested during the initial year of hay growth. Further, a grain nurse crop for hay gives the new hay plants protection from the weather, and holds the soil in place during runoff periods. Both organic and inorganic fertilizers are applied at various times to existing hay stands. Manure may be applied after every harvest, but is generally only applied in early spring and in fall after the last harvest. Inorganic fertilizer, as elemental nitrogen at a rate of 0 to 63 pounds P_2O_5 at 0 to 138 pounds, and K_2O at 0 to 352 pounds per acre is applied to existing stands either in early spring or after the first harvest. Nitrogen fertilizer is generally deleted from fertilizers used on hay crops which include a leguminous plant because such plants are able to obtain nitrogen from the atmosphere through nitrogen-fixing bacteria associated symbiotically with their roots. Once a hay crop has been established, it remains on the same field for three to five years depending on the farmer's preferences and soil fertility. The hay is harvested by cutting, drying, and baling two to four times per season depending on weather conditions and the condition of the stand. If the hay is "green chopped" for immediate feeding or anaerobic storage as silage, it can be cropped up to four times in a growing season. After the final hay harvest in the last year of a hay crop, the hay sod is turned under the surface with the traditional moldboard plow. Chisel plowing is not popular for this purpose as it does not break up the hay sod sufficiently to allow for the planting of another crop the following spring.

Spring wheat crops are handled in much the same way as an oats crop which is seeded alone might be in that the method and timing of tillage, planting, harvest, and application of herbicide, manure and fertilizer are all similar to the procedure used for oats. Winter wheat differs from spring wheat only in planting and harvest time. Winter wheat is planted in September or October after the previous year's crop has been harvested. Harvest for winter wheat occurs in mid-July to early August and precedes the spring wheat harvest period by one to two weeks. Winter wheat does offer the dual advantage of providing winter cover to reduce soil loss, and reducing the farmer's work load at spring planting time.

Sudan grass is an annual forage crop planted like a grain crop and harvested during the growing season to provide a supplement to hay for animal feed. It can be either green chopped and fed directly to the animals, or cut, dried, baled and stored for later use as animal feed. Sudan grass is harvested two to four times per year, depending upon the weather conditions from June to the first frost. After the first frost the crop becomes poisonous and must be plowed under. Inorganic fertilizer can be applied at planting and after every cutting if necessary at the rate of 9 to 22 pounds per acre of elemental nitrogen, 36 to 72 pounds per acre of P_2O_5 and 36 to 72 pounds per acre of K_2O.

As the dairy herd population in the Region has declined in the past years, so has the acreage devoted to the growth of sudan grass. In addition, sudan grass is only grown as an emergency crop to replace winter-killed hay or to supplement a farmer's forage supply. Thus, sudan grass acreage fluctuates annually.

Corn is being planted in increasing amounts as a cash crop in the Region. It may be planted at two different times of the season—in spring or in summer. If the farmer also runs an animal operation, nitrogen in the form of manure may have been added to the soil before the soil was plowed the previous fall and again before the soil is worked in the spring preplanting stage. The corn may then be planted in April or in May. Some chisel plowing, as described above is used on corn acreage. However, more pesticides are required when chisel plowing is used for corn instead of traditional moldboard plowing, since chisel plowing leaves more residue from the past year's crop on the surface to harbor weed seeds and insects. Corn culture in a chisel tillage system generally includes no more than one cultivation for weed control thereby risking excessive weed growth, as compared to the repeated weed control cultivation practices used in conventional tillage systems. As corn requires an abundant supply of nitrogen for growth, farmers within the Region generally inject into the soil 60 to 300 pounds of nitrogen per acre, in the form of anhydrous ammonia, in addition to fertilizer containing 0 to 79 pounds of elemental nitrogen per acre, 40 to 230 pounds of P_2O_5 per acre, and 32 to 320 pounds of K_2O per acre. Harvesting takes place in the fall after the grain has dried to about 20-30 percent moisture, but before the ground is frozen and becomes too hard to plow.

Late corn follows the same pattern of treatment, except for the fertilizer application and harvesting techniques. Late corn, which constitutes an estimated 5 percent of all corn planted in an average year in the Region, is seeded in the soil of an old hay crop which was turn-plowed in late spring after severe damage to the hay crop from winter-kill has become apparent. In case of winter-kill, the use of the field for corn offers the only means a farmer has to produce a crop on the field that year. If the field is manured, it is spread before plowing in June. Herbicides and insecticides are applied in the same manner as for early field corn. Little or no nitrogen is added at this time as the previous hay crop is generally assumed to have supplied enough nitrogen to the soil to support the growth of a corn crop. Late corn is usually grown for silage feeding rather than for ear corn, as the ears or grain would not mature in the short amount of time remaining in the growing season. The corn is harvested and chopped from August through October and either fed directly to the animals or put into the silo for fermentation and storage for winter feeding.

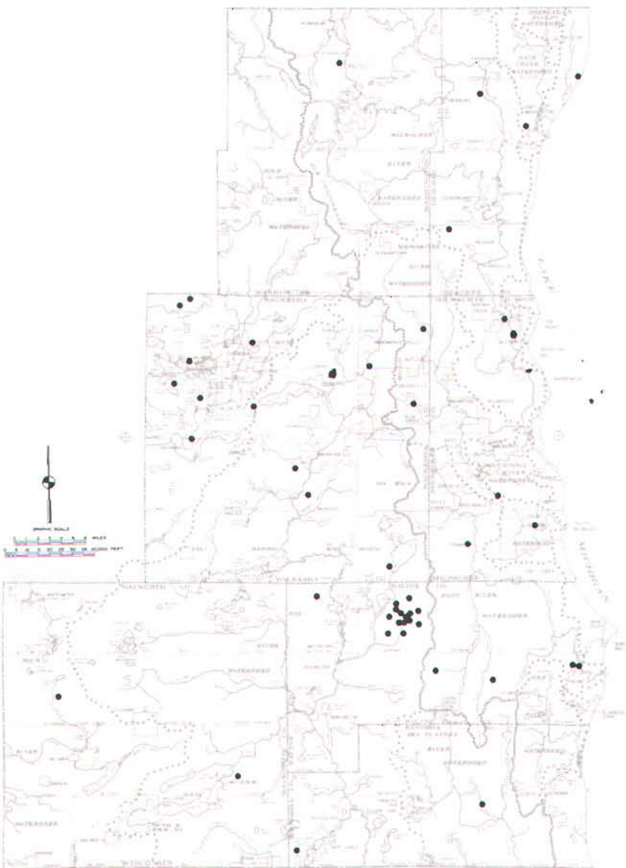
Soybeans are grown as a cash crop in the Region, predominantly in the southern two-thirds of the Region with increasing acreages planted every year. The crop is planted in spring or in summer in a manner similar to corn. Manure can be applied to the field the previous fall before plowing, and in spring before final use of a disk and/or spring tooth harrow. As insect pests are a minor problem, no insecticides are applied in a typical soybean operation. Fertilizer is added to the soil in the amount of 0 to 20 pounds per acre of elemental nitrogen, 10 to 90 pounds per acre of P_2O_5 and 10 to 160 pounds per acre of K_2O.

Crops grown for canning in the Region include peas, sweet corn, cabbage, and carrots. Fresh market produce include beets, onions and potatoes. With the exception of sweet corn, most of these crops are grown on low, wet soils or require a significant amount of irrigation. Map 47 shows the locations of the permitted high capacity wells utilized for irrigation in the Region as of 1975. Although the average annual precipitation in the Region exceeds 25 to 30 inches, from 3 to 20 additional inches of water may be provided by irrigation. All vegetable crops are planted in April or May on a smooth seedbed cleared of debris. This means that only the traditional moldboard plow, disk or spring tooth harrow, and drag can be used to prepare the seedbed. The fields designated for these canning vegetable varieties are heavily fertilized before planting. Table 129 presents the type, amounts, and rate of application of various fertilizers applied to each type of truck crop. Herbicides and insecticides commonly applied to these crops and the timing of their application are also illustrated in Table 129. The vegetables are harvested at their peak of ripeness which is July and August for peas and corn, and August to October for cabbage, beets, carrots, and onions.

Potatoes are grown on truck farms for direct sale to consumers, wholesalers and processors. Planting is in April or May, and harvest occurs from July to October. The seedbed is prepared using conventional tillage methods to keep the soil loose and free

Map 47

LOCATION OF HIGH CAPACITY IRRIGATION WELLS IN SOUTHEASTERN WISCONSIN



Under the State Statutes, the Wisconsin Department of Natural Resources must issue permits for wells having a capacity of 10,000 gallons per day or greater. The above map illustrates the location of the permitted high-capacity wells in the Region as of 1975.

Source: SEWRPC.

of debris. Potatoes in this Region are usually grown on poorly drained soils. Fertilizers, herbicides, and insecticides used, and timing of application are presented in Table 129.

Mint is a specialty crop grown in Walworth and Kenosha Counties in a rotation with sweet corn generally on low lying, muck soils. Cuttings are planted in late April and allowed to grow until harvest in August when the mint is mowed, dried and chopped like alfalfa, and distilled for mint oil. Terbacil (sinbar), is the major herbicide applied before planting to curb weed growth; additional weeds are removed by hand. As the mint is generally grown in muck soils, 300 pounds per acre of potash (K_2O) and 300 pounds per acre of 6-24-24 are applied as fertilizers.

Sod farms are generally located on low-lying soils throughout the Region. The sod crop is planted on carefully turned, cleared and smoothed soil in April or May. Proper growth is promoted by sprinkle irrigation when conditions warrant, herbicide application after planting to deter unwanted weed growth, and previous applications of 500 pounds per acre of 6-10-10 fertilizer before planting. The sod crop is harvested whenever the growth is sufficient to allow cutting. Properly done, the harvest cut is shallow enough for the remaining roots to spur regrowth, thereby allowing several sod crops per growing season to be harvested from each sod field.

The foregoing text described the general cropping practices common to the Southeastern Wisconsin Region. It should be noted that specific variations may result from county to county and farm to farm.

Fertilizer application rates in the United States have increased by as much as 230 percent from 1964 to 1974, as shown by a U.S. Department of Agriculture study.[63,64] This increase in fertilizer application rates has been attributed to increased demand for higher yields to maximize farm profits. It is predicted that fertilizer use will continue to escalate, but that with rising cost of energy farmers will more carefully evaluate the optimum amount of fertilizer necessary to achieve peak yields and eliminate excessive use. It is generally conceded by agronomists that the over-use of nitrogen fertilizer is undesirable. Over-use is uneconomical and enhances nitrogen losses to the environment. Nitrate-nitrogen is the most likely pollutant to emenate from fertilizer use, because it is soluble and moves readily with water. Nitrate generally makes up 85 to 95 percent of the total nitrogen in cropland drainage.[65]

The retention capacity of most agricultural soils for phosphorus is so great that fertilizer applications are not likely to have a significant effect on the phosphorus content of drainage waters. The exception is drainage from areas covered by muck, peat, and other highly organic soils. Since phosphorus is adsorbed to soil particles, most of the phosphorus carried into streams and lakes by runoff is attached to the sediment rather than in solution. Both dissolved phosphorus and phosphorus attached to sediment particles or organic matter can be available for biological utilization in the receiving lakes and streams.

---

[63] *U.S. Department of Agriculture Cropping Practices, SRS-17, Statistical Reporting Services.*

[64] *U.S. Department of Agriculture Fertilizer Situation, FS-5, Economic Research Services.*

[65] *L. Shrendar, Nonpoint Rural Sources of Water Pollution, Illinois State Water Survey, Urbana, 1972.*

Table 129

REPORTED PESTICIDE AND FERTILIZER USE PRACTICES POPULAR IN SOUTHEASTERN WISCONSIN

CROP	Insecticide			Herbicide			Fertilizer			Manure	
	Type	Amount (per acre)	Application	Type	Amount (per acre)	Application	Element*	Amount (pounds per acre)	Application	Applied	Amount (tons per acre)
Oats	--	--	--	-- to 2,4-D 2,4-DEster	½-2 pts. 1½ pts.	Late spring	N P K	0-24 10-96 30-126	at planting broadcast & topdressed	x	0-12
Wheat	--	--	--	-- to 2,4-D	½-2 pts.	Late spring	N N P K	0-40 0-48 20-78 36-100	topdress drift or broadcast	x	0-12
Hay	-- to Alfatox	3/4 lb.	--	-- to Tolban Eptam Prineep. 2,4-DAmine	½ gal. -- 1 qt. 1½ pt.	-- Spring Fall Early June	N P K	0-63 0-138 40-352	topdress broadcast	x	4-25
Sudan Grass	--	--	--	--	--	--	N P K	9-22 36-72 36-72	spring	x	10-30
Corn	Furadan Thimet Counter Dyfonate Disyston	5-10 lbs. 4-10 lbs. 6-10 lbs. ¾ lb. 5-8 lb.	At planting	Atrazine Lasso Bladex 2,4-D Sutan Banvel Aatrex Prowl	1-5 lbs. 1-2 qts. 2-3 lbs. ½-1pt. 2-2½ qts. ½ pt.-1qt. 2-4 lbs. 1-1½ qts.	May at planting	N P K N P K Nitrogen	0-41 0-132 0-231 0-46 0-96 10-91 60-200	plowdown starter sidedress	x	43-85
Soybeans	Buxten Sevin	10 lbs. --	-- July-August	Lasso Lorox Sencor Treflan Basagran Amiben	2-10 qts. 1-3 lbs. ¾-1 lb. 2 qts. 1 qt. 10 lbs.	Pre-plant Pre-emerge	N P K N P K	0-15 14-60 24-135 0-12 15-60 13-40	-- row	x x	-- 5
TRUCK CROPS & OTHER											
Sweet Corn	Counter Sevin Thimet Dyfonate	6-10 lbs. 2-4 lbs. 5-10 lbs. 7-10 lbs.	Postemergence July	Lasso Sutan Atrazine Bladex Prowl	2-10 lbs. 2 qts. 1-5 lbs. 2 lbs. 1-1/2 qt.	June-Aug. May	N P K Nitrogen	0-70 0-120 48-120 100-250	sidedress plowdown	x	2-85
Tomato, Pepper, Melon, Eggplant	Varies with crop	--	--	Varies with crop	--	--	N P K	30-60 60-120 60-120	--	--	--
Barley	--	--	--	2,4-D	1½ qts.	--	N P K	28 28 28	--	--	--
Cabbage	Monitor Lannate Parathion Dipel Diazinon Thiodan Sevin	1-2 pts. 1½ pts. ½ pt.-2½ gals. ½-¾ lbs. 1-5 lbs. -- --	2-8 applications 2 applications Periodic --	Treflan Tok Trylan Dacthol	1½-2 pts. --	-- May-July April-May	N P K Mg, Zn	21-204 40-216 40-324 Soil Test	broadcast & row, preplant	--	--
Beets, Carrots	--	--	--	Roneet Pyramine	4 lbs.	--	N P K Borate	0-49 0-175 0-175 8	--	--	--
Onions	Diazinon Ethion Parathion Dasanit Phosdrin	-- 15-20 lbs. 1 pt. -- --	At planting -- May-June	CIPC Dacthol Randox Tok	18-20 lbs. -- --	-- June	N P K Nitrogen	0-90 80-360 120-360 80-90	preplant broadcast & row	--	--
Potatoes	Parathion Monitor Sevin Thimet Manager Thiodan Furadan	2 lbs. 2 pts. 2 lbs. 10-30 lbs. 1 qt. -- --	4-5 times 3 times 1-2 times -- 2 times Periodic Periodic	Eptam Sencor Lorox Lasso Treflan	1 gal. 1-2 lbs. 1-3 lbs. ½ gal. --	-- May April-May	Nitrogen N P K	100 30-168 50-432 50-432	preplant	--	--
Peas	Sevin MCPB Diazinon Malathion	3 lb. 1 pt. -- --	June	Treflan MCPA	1 pt.-1½ ¼ pt. 1½	Pre-plant April	N P K	12-18 48-72 48-72			
Sod	Diazinon Chlordane	-- 3 lbs.	June-July As needed	2,4-D Cilvex Barvel	-- 1 qt. --	April-May Periodic	N P K	35-50 35-50 35-50	broadcast pre-plant	--	--
Mint	Diazinon	3 lbs.	--	--	--	--	N P K	18 72 72	--	--	--

** N = Elemental N*
P = P_2O_5
K = K_2O

Source: University of Wisconsin-Extension Service, and SEWRPC.

Use of insecticides, and more so of herbicides, has increased markedly over the past three decades and is still rising. Interviews were held with agricultural extension service personnel and farmers to determine which pesticides are commonly used in southeastern Wisconsin. Table 129 lists these pesticides by crop use; the chemical class; predominant transport mode; approximate persistence in soil; and general application rates in the Region.

More pesticides may be in solution in runoff water than attached to eroded soil particles since the amount of runoff water is greater than the amount of sediment transported. Pesticide residues dissolved in runoff are also more difficult to control and move greater distances in surface waters than do those adsorbed on sediments. Pesticides moving on sediment are primarily adsorbed on small particles entrained with organic soil colloids. These colloids remain in suspension with the stormwater longer than the larger soil particles.

The solubility and adsorption characteristics, and the biodegradability of a pesticide affect its potential hazard as a surface water and groundwater contaminant. For example, an extremely toxic pesticide may not reach the groundwater or surface water because its chemical composition is unstable; it is rapidly biodegradable; or it has a low solubility. A more detailed discussion of pesticides is presented in SEWRPC Technical Report No. 18, State of the Art of Water Pollution Control in Southeastern Wisconsin, Volume IV, Rural Storm Water Runoff, pages 27-31. A description of pesticide use by county is presented in Appendix L of this report.

Despite the general scientific knowledge of pesticides and their effects in the environment, little is known of the extent to which they are present in the inland lakes and streams of the Region. In addition, recommended levels or standards have been established for only a few of the chemicals. A review of the limited information available indicated that some pesticide levels may be higher than recommended in some watersheds of the Region; however, it is also apparent that additional field sampling is needed if a sound and complete assessment of pesticides in streams and bottom sediments is to be conducted.

Channel loading rates were estimated for selected pollutants from row crops, grain crops, hay, vegetables, and sod. Nutrient losses from row crops and hay were estimated from measured values from small watersheds reported by the U.S. Environmental Protection Agency.[66] Measured runoff nutrients from corn were applied as channel loads for row crops in general as 23.1 pounds of nitrogen/acre/year and 0.64 pounds phosphorus/acre/year. Row crop nutrient channel loads were also applied to vegetable crops because of the similar land cover, planting, and cropping practices. Nutrient channel loads measured for hay approximated 0.9 pounds nitrogen/acre/year and 0.09 pounds phosphorus/acre/year, and were applied to sod crops as well. Since no data on channel loads of nutrients from grain crops were available, the ratio of soil loss from continuous row crops to soil loss from wheat, as computed by the Universal Soil Loss Equation, was applied to the estimated channel loads of nutrients from the row crops to estimate the channel loads from grain crops. The estimated yield so computed was 4.7 pounds nitrogen/acre/year and 0.13 pounds phosphorus/acre/year.[67] Fecal coliform channel loads from cropland is included in the fecal coliform loads from livestock, since spread livestock manure is generally assumed to be an important source of fecal coliform.[68] Gross soil erosion from the row crops in each watershed was estimated by the application of this Universal Soil Loss Equation. It was necessary to estimate the proportion of row crops which are in rotation with other crops as opposed to being in continuous row crop. These percentages were estimated from the data provided in the sampling of 2 percent of the land in the Region in a 1977 Conservation Needs Inventory conducted by the U.S. Department of Agriculture Soil Conservation Service personnel within the Region, in cooperation with the Commission and the Wisconsin Department of Natural Resources. The soil loss from continuous row and vegetable crops was estimated assuming the crop residue was removed, and the application of conventional tillage methods in the fall, and using the average soil and slope factors for eight representative agricultural soils in the Region as reported in SEWRPC Technical Report No. 18. Soil loss from row crops in rotation, along with the other crops in rotation—essentially all of the small grain and hay, and approximately 10 percent of the vegetable crops—was estimated assuming the cover and management factor (C value) and the conservation practice factor (P value) for crop rotation patterns in the Region as applied in Volume 4 of SEWRPC Technical Report No. 18, State of the Art of Water Pollution Control for Southeastern Wisconsin. Soil loss from sod was estimated by adjusting the soil and slope factors to account for the relatively flat, low lying soil conditions associated with sod, and assuming a cover and management factor applicable to a meadow.

Because the Universal Soil Loss Equation estimates potential pollutant runoff in the form of gross soil erosion as derived from small plot samples, a delivery ratio was applied to these loads to

---

[66] *U.S. Environmental Protection Agency, Areawide Assessment Procedures Manual, Volume I. EPA-600/9-76-014, July, 1976, pp. 4-24.*

[67] *Ibid.*

[68] *CH_2M-Hill Consultants, Seattle Water Resources Management Study.*

estimate the pollutant loads to the stream channels. The factor of 0.37 was selected: the value chosen is a typical delivery ratio for a watershed of 150 acres in size,[69] the largest watershed size from which the nutrient load used in this analysis were measured.[70] Analysis of the soils in the Region indicated a typical organic matter content of about three percent. Basta and Bower[71] estimated that BOD_5 approximates 10 percent of the organic matter content of sediments. Hence, BOD_5 loadings were estimated by multiplying the sediment load by a factor of 0.003. The estimated crop percentages in rotation, and the estimated channel loading rates from cropland for nitrogen, phosphorus, BOD_5, and sediment are presented in Table 130.

Pasture land was defined for the purposes of this report as including wetlands and open lands, covered primarily by nonwoody vegetation—usually grasses—which are not harvested and which may or may not be grazed by livestock. Pasture land, therefore, includes livestock feeding pasture, unused rural open land, and natural or restored prairies. Generally, pasture lands consist of lands impractical to farm due to slope or soil type; lands reserved as pasture for grazing by livestock; and unused lands awaiting other development. Loading rates for sediment, nitrogen, phosphorus, and BOD_5 from pasture lands were estimated from representative values reported by the U.S. Environmental Protection Agency.[72] Fecal coliform runoff contributions from pastures are included in the fecal coliform loads from livestock. Pollutant loading rates utilized for pastures are set forth in Table 131.

Soil and Water Conservation Practices

In any complete characterization of agricultural pollution it is necessary to consider the pollution control benefits of good soil and water conservation practices and the attendant effect on pollutant loadings. Accordingly, the Commission conducted an inventory by county of conservation practices installed since 1965 in Southeastern Wisconsin. The inventory results, presented in Appendix M, were analyzed to determine the present level of agricultural pollution control in the Region.

Since the early 1930's it has been a national objective to preserve and protect agricultural soil from wind and water erosion. Federal programs have been developed to achieve this objective, with the primary

---

[69] *B. A. Stewart et al, Control of Water Pollution from Cropland, Volume I, A Manual for Guideline Development, U.S. Agricultural Research Service, November, 1975.*

[70] *U.S. Environmental Protection Agency, Areawide Assessment Procedures Manual, Volume I, EPA-600/9-76-014, July, 1976, pp. 4-24.*

[71] *Basta, and Bower, op. cit.*

[72] *U.S. Environmental Protection Agency, Areawide Assessment Procedures Manual, Volume I, EPA-600/9-76-014, July, 1976.*

Table 131

ESTIMATED CHANNEL LOADING RATES FOR PASTURES

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	4.6
Total Phosphorus	0.29
BOD_5	9.7
Fecal Coliform	Included in Livestock Load
Sediment	420

Source: SEWRPC.

Table 130

ESTIMATED CHANNEL LOADING RATES FOR CROPLAND[a] PRESENTED IN POUNDS PER ACRE PER YEAR

Watershed	Row Crops					Small Grain					Hay					Vegetable					Sod				
	Percent in Rotation	Estimated Loads				Percent in Rotation	Estimated Loads				Percent in Rotation	Estimated Loads				Percent in Rotation	Estimated Loads				Percent in Rotation	Estimated Loads			
		N	P	BOD_5	Sed.		N	P	BOD_5	Sed.		N	P	BOD_5	Sed.		N	P	BOD_5	Sed.		N	P	BOD_5	Sed.
Des Plaines	25	23.1	0.64	21.6	7,200	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Fox	35	23.1	0.64	19.9	6,600	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Kinnickinnic	30	23.1	0.64	20.7	6,900	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Menomonee	50	23.1	0.64	17.6	5,900	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Milwaukee	60	23.1	0.64	16.0	5,300	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Minor Streams	40	23.1	0.64	19.1	6,400	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Oak Creek	40	23.1	0.64	19.1	6,400	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Pike	30	23.1	0.64	20.7	6,900	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Rock	40	23.1	0.64	19.1	6,400	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Root	30	23.1	0.64	20.7	6,900	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Sauk	50	23.1	0.64	17.6	5,900	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700
Sheboygan	50	23.1	0.64	17.6	5,900	100	4.7	0.13	9.6	3,200	100	0.9	0.09	9.6	3,200	10	23.1	0.64	30.0	10,000	0	0.9	0.09	2.1	700

[a] *The percentages of various crops in rotation is estimated from data from the 1977 Conservation Needs Inventory, conducted by the U. S. Department of Agriculture Soil Conservation Service in cooperation with the Commission and the Wisconsin Department of Natural Resources. Fecal coliform loadings are included in the fecal coliform loads from livestock operations. The estimated loads for nutrients are based on reported studies of small drainage basin storm water runoff characteristics, while the estimated loads for sediment and fecal coliform are based on the estimated delivered proportion of the potential pollutant loads computed by generalized application of the Universal Soil Loss Equation. See Chapter I for detailed discussion of relationship between potential pollutant runoff and channel loads.*

Source: SEWRPC.

emphasis being on sound land management and cropping practices for soil conservation. An incidential benefit of these programs has been a reduction in the amount of eroded organic and inorganic material entering surface waters as sediment. Some practices are effective in both regards, while others may enhance the soil conditions with little benefit to surface water quality.

The major farm programs are generally available through the services provided by the U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS), and Agricultural Soil and Conservation Stabilization Service (ASCS) through the local Soil and Water Conservation District. The University of Wisconsin Extension Service also participates in the educational efforts required for the success of the programs. Although it is possible to use the services of the agencies involved separately, these agencies are structured, staffed, and funded to best provide services as a team. The U.S. Soil Conservation Service develops for each cooperating farm a conservation plan which considers the specific topography, hydrology, and soil characteristics of the farm together with the specific objectives of the farmer as the owner and manager of the land. The conservation plan indicates desirable tillage, cropping and rotation cycles for each field of the farm and recommends the best conservation practices. Limited federal funding is then available through the ASCS on a cost sharing basis to implement the recommended conservation practices, with technical assistance also provided by the Soil Conservation Service and the University of Wisconsin Extension Service.

Silviculture

Woodlands: Woodlands in the Region provide forestry products, scenic value, wildlife habitat, open space, educational and recreational opportunities, and watershed protection. A well-managed woodland contributes few pollutants to surface waters. Under poor management, however, woodlands may have detrimental water quality effects through release of sediments, nutrients, organic matter, and pesticides to nearby surface waters. If trees along streams are cut, thermal pollution may occur as the direct rays of the sun strike the water. The major sources of pollution from silvicultural practices are disturbances caused by tree harvesting, livestock grazing, growth promotion, disease prevention, fire prevention, and road and skid trail construction. Fortunately, most of these activities are seldom practiced in southeastern Wisconsin.

In 1975, about seven percent of the Region, or 163,573 acres, was in woodland use. About 73 percent of the woodlands were located in Walworth, Washington, and Waukesha Counties. Only seven percent were under public ownership. The woodlands consisted of six types recognized in the Region: southern upland hardwood, northern upland hardwood, southern lowland hardwood, northern lowland hardwood, northern upland conifers, and northern lowland conifers.

Woodland stands within the Region are largely composed of even-aged mature, or nearly mature, trees with relatively few seedlings and sapling. This lack of tree reproduction is primarily due to excessive grazing by livestock and endangers the continued survival of the forest stands. It was estimated in 1967 by the U.S. Soil Conservation Service[73] that approximately 25,000 acres, or 20 percent of the forest lands in the Region were excessively grazed. Livestock grazing also results in soil compaction with an attendant reduction in the infiltration rates of the soil by factors of from 40 to 100 fold,[74] greatly increasing surface runoff and erosion potential. The surface vegetation, as well as the roots which nourish and anchor the protective vegetative canopy may also be damaged or destroyed.

In southeastern Wisconsin, timber harvesting and thinning occurs on private and state owned land. In 1973, approximately 2.4 million board feet of timber in the Region[75] was removed for industrial roundwood. In the Kettle Moraine State Forest-Southern Unit, about 300 acres (4,000 cords) were harvested in 1975.[76] Very little skid trail and road construction is required for tree harvesting in the Region. Timber in mature stands is harvested by selectively cutting mature trees or groups of trees to reduce competition for soil moisture, nutrients, and light. Twenty-five to 40 percent of the canopy layer is usually harvested by the selected method. "Clearcutting" to remove all trees within a selected area is also occasionally practiced in the Region. Tree harvesting by clearcutting, or by the selective method in mature stands, may have adverse effects on surface water quality by destroying the protective cover, the soil structure, and the reproductive potential of the woodland. Tree thinning and pruning is conducted in immature stands as a timber stand improvement measure, but generally does not have an important impact on surface water quality.

Sediment is the major water pollutant produced from silvicultural activities in southeastern Wisconsin. Table 132 illustrates the potentially adverse effects of harvesting the woodland cover, in terms of sediment yield.

---

[73] *Soil Conservation Service, Conservation Needs Inventory, USDA, 1967.*

[74] *J. T. Curtis, Vegetation of Wisconsin, 1959.*

[75] *J. E. Blyth, E. F. Lant, J. W. Whipple, and J. T. Hahn, Primary Forest Products Industry and Timber Uses, Wisconsin, 1973, USDA Forest Service Resource Bulletin NC-31, 1976.*

[76] *Except as noted, this and other forestry information is based on personal communications with Mr. Richard Denney and Ms. Paula Patterson, foresters with the Southeast District Office of the Wisconsin Department of Natural Resources, 1976.*

Table 132

INFLUENCE OF FOREST COVER ON ANNUAL SEDIMENT YIELD

Land Area With Forest Cover (percent)	Annual Sediment Yield (tons/square mile)
20	400
40	200
60	90
80	45
100	22

Source: U. S. Environmental Protection Agency, Processes, Procedures, and Methods to Control Pollution Resulting from Silvicultural Activities, EPA 430/9-73-010, October, 1973.

Water quality degradation due to the release of nutrients from timber harvesting is probably minimal in Wisconsin.[77,78] Within the Region, logging debris, chips, bark, sawdust, leaf fall, and other forms of organic matter may increase the biochemical oxygen demand in some surface waters.

Fertilizers and fire retardent chemicals are not applied in significant amounts to forests in southeastern Wisconsin. A limited amount of pesticide use is practiced in the Region, with Princep; 2-4D; and Amitrol being the most commonly used pesticides.

Well-managed woodlands prevent the transport of pollutant to the aquatic environment as rainfall is deprived of most of its erosive force by the tree and ground cover. Moreover, infiltration rates of the surface litter and soil are high enough to allow absorption of the rain, thus nearly eliminating runoff and soil erosion. One to three inches of organic matter on a forest floor is usually sufficient to prevent runoff and the detachment and transport of sediment. However, Singer and Rust[79] determined that the principal source of phosphorus from woodlands was the litter layer which underwent freezing and thawing during the fall and spring. Whereas the phosphorus is often bound to sediment particles, most nitrogen contributions from woodlands are dissolved in runoff and not adsorbed to sediment particles.

Orchards and Nurseries: Orchards and nurseries require specific management practices that may have important impacts on water quality. There are 4,627 acres of orchards and nurseries in the Region. Apple orchards are the most common, but cherries, plums, and pears are also grown. The available data were assembled from information provided by the County Soil and Water Conservation Districts. The amount of fertilizer used on orchards in the Region varies with ownership, orchard type, soil, and primary practices, but also depends on tree size, with the older, larger trees requiring greater amounts. In general, fertilizer use on orchards is minimal with only approximately four to five pounds per acre per year of 10-10-10 fertilizer applied to older trees and about half that amount to younger seedlings and saplings.[80] However, pesticide use is extensive in orchards and nurseries. The effectiveness of pesticide treatments is determined by the method, timing, and amounts applied as well as the weather, type of tillage system and how well the treatment is matched to the pest problem and soils. If water pollution is to be avoided, proper consideration of all factors is essential—not only for maximizing the benefits of pesticide treatment, but also for minimizing the potentially adverse environmental effects on water quality. The general agricultural practice in all pesticide use in the Region is to follow the manufacturer's instructions. These instructions including recommendations, application rates, and spray intervals vary with the type and formulation of pesticide, as well as with the type of orchard, specific disease or insect problem, and the season of the year. Herbicides are applied at a rate of from one to six pounds mixed with 20 to 40 gallons of water to each acre. Herbicides are usually applied several times per year.

The use of fertilizers and pesticides on nurseries is highly variable depending on what plant is grown and the occurrence of plant disease outbreaks in the stock. Sufficient data were not available to enable the computation of specific pollutant loading rates from orchards and nurseries. Because of the similarities in land cover characteristics and the minimal amount of fertilizers applied to orchards and nurseries, the pollutant loading rates cited below for characterizing the water quality effects of woodlands were applied to orchards and nurseries as well. In orchards, and to an even greater extent in nurseries, the nutrients and pesticides are generally applied in accordance with soil test results and manufacturers instructions.

---

[77] *Task Force on Nonpoint Pollution, Forestry Subcommittee, Impact of Forest Management Practices on Water Quality in Wisconsin.*

[78] *W. E. Sopper, "Effects of Timber Harvesting and Related Management Practices on Water Quality in Forested Watersheds," J. Environ. Quality 4(1), 1975, pp. 24-29.*

[79] *M. J. Singer, and R. H. Rust, "Phosphorus in Surface Runoff from a Deciduous Forest," J. Environ. Qual., 4(3), 1975, pp. 307-311.*

[80] *Washington County University of Wisconsin Extention Service, Pers. Comm., April, 1977.*

Sediment, nitrogen, phosphorus, and BOD_5 runoff from woodlands and orchards were estimated from representative values for woodlands as reported by the U.S. Environmental Protection Agency.[81] Fecal coliform runoff from woodlands and orchards was assumed to approximate the lowest fecal coliform yield from cropland, namely from hay, because the bacterial contamination by wildlife as shown above is a modest even if uncontrollable, source of materials. Except in the case of grazed woodlands, fecal coliform loadings from woodlands are therefore assumed to be similar to that of other agricultural-use land which is not subjected to livestock grazing or heavy manure applications. The bacterial loading from grazing domestic livestock are considered explicitly under livestock operations, however. The loading rates from woodlands and orchards utilized in the pollutant loading analysis are set forth in Table 133.

Table 133

ESTIMATED CHANNEL LOADING RATES FOR WOODLANDS, ORCHARDS, AND NURSERIES

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	2.3
Total Phosphorus	0.14
BOD_5	4.6
Fecal Coliform	6.6×10^8 counts/acre/year
Sediment	251

Source: SEWRPC.

Wetlands

Wetlands, inclusive of swamps, marshes, wet meadows, bogs, and fens, are classified in terms of water level, soil type, and vegetative characteristics. Though a precise wetland definition is difficult—soil, vegetation types, and water levels vary considerably in time as well as space—wetlands may be defined generally as areas which have a water table near or above the soil surface for all or part of the year; are covered by wet soils which may be mineral, organic or acidic; and support specific plant communities which are adapted to the wet conditions.

Wetlands within the Region totaled 132,049 acres in 1975. Some have been drained and used as dumps for fill to make new land. Many of the remaining wetland areas are threatened by agricultural and urban expansion. Wetlands provide valuable wildlife and fishery habitat, flood water storage, and recreational and educational values.

There is disagreement over whether wetlands are a source of water pollution or serve to improve water quality. As a source of pollution, wetlands may release nutrients to lakes or streams during major runoff events or at the end of a growing season as vegetation dies or retreats to winter dormancy. Water quality benefits attributed to wetlands include sediment entrapment, uptake of particulate and dissolved nutrients, and prevention of downstream erosion by storing high water flows. Incoming sediments are trapped by the natural filtration in the plant and bottom materials, and by an increased sedimentation rate which results from the slowing of the water as it passes through the wetlands. The absorption and dispersion capacities of wetlands, enhanced by low surface relief, irregular surfaces, and flow restrictions, also serve as flood control measures, reducing peak flows and the resulting potential for streambank or bottom scouring downstream. The ability of wetlands to retain nutrients borne on soil particles is a function of the infiltration capacity, pore size distribution, and the decomposition status of the organic soil in the wetland. The potential to retain dissolved nutrients varies with the interactions of the nutrients with soil particles through physical adsorption-desorption and chemical reactions, and with the biological immobilization rate within the soil profile. Nitrogen, for example, is largely removed from the water by biological uptake and denitrification processes. The ability of a wetland to trap nutrients in the flow from a given storm event depends on the length and intensity of the storm event, the character of the incoming nutrients, and the previous conditions existing within the marsh.

A study by Janota and Loucks[82] indicated that phosphorus removal from a natural marsh ranged from 1.5 to 2.2 pounds of phosphorus per acre of marsh per year. Similarly, a study of the role of a marsh in controlling the amounts of nutrients transported by surface runoff into Lake Wingra, in Madison, Wisconsin, reported that approximately 25 percent of particulate phosphorus, which is commonly 60 to 80 percent of the total phosphorus, was retained by the marsh, during a portion of a year.[83]

---

[81] *U.S. Environmental Protection Agency, Areawide Assessment Procedures Manual, Volume 1, EPA-600/9-76-014, July, 1976, pp. 4-28.*

[82] *T. Janota, and O. L. Loucks, "An Analysis of the Value of Wetlands for Holding Inorganic Phosphorus", University of Wisconsin Center of Biotic Systems Mimeo, 1975.*

[83] *D. E. Armstrong, R. T. Bannerman, J. Perry, and D. Flatness, Land/Water Interactions Project-Lake Wingra Marsh, Progress Report, University of Wisconsin-Madison, Water Chemistry Program, 1976.*

Other studies, however, have questioned the net effect of wetlands on nutrient loadings. Bentley[84] studied four marshes in Wisconsin and estimated that on an annual basis, they neither contributed nor absorbed nutrients, but tended rather to accumulate nutrients during the growing season and release them during spring snowmelt and runoff. Moreover, even during active periods of photosynthesis, the marshes studied were not an absolute barrier to incoming nutrient transport with concentrations of dissolved inorganic phosphorus in discharge water typically exceeding 0.01 mgl.

Water quality characteristics of marshes managed for northern pike spawning adjacent to Houghton Lake, Michigan, were studied by Novy and Pecor.[85] Typical management operations were to pump lake water into the marshes in early spring and drain them about two months later. This operation was repeated in the fall. Nutrient budget computations showed that the marshes removed about 0.04 pounds per acre of incoming inorganic nitrogen; conversely, there was a net production of 0.04 pounds per acre of phosphorus from the marsh. However, since the operations within the study marsh were unlike that of a natural marsh system, it was estimated by the authors that under natural conditions there would be no net phosphorus input to the lake, and that the loss of inorganic nitrogen in the marsh would be somewhat larger than 0.4 pounds per acre.

Uttormark, Chapin, and Green[86] reported that the periodic occurrence of anaerobic conditions in wetlands increases the possibility for discharge of ammonia and soluble inorganic phosphorus, particularly in wetlands subject to high runoff flushing in spring and autumn. They further concluded from the limited data presented in the literature that no net pollutant contributions occurred for nitrogen or phosphorus.

The wetlands in southeastern Wisconsin are a valuable natural entity; their benefits may include favorable effects on the quality of water which passes through them. If a net deposition of sediments occurs within a wetland, then nutrients are effectively removed from the surface waters. Even if a net deposition does not occur, the nutrients may be stored for later release to downstream waters at a time when other factors, such as low temperature or light, will limit plant growth. Even though the technical literature is indeterminant on the water quality value of wetlands, it may be concluded that because of the timing of the nutrient storage and release functions, wetlands preservation should be encouraged for water quality maintenance. Since the research to date has not consistently found wetlands to contribute to water quality enhancement, no treatment benefits were attributed to wetlands in this study. Conversely, however, the literature appears to indicate that no net contribution of pollutants over a year's seasonal cycle should be presumed. Accordingly, it was assumed that no net annual loading of pollutants are contributed by wetlands to the lakes and streams of southeastern Wisconsin.

The filling of wetlands for purposes of urban use and the draining of wetlands for agricultural use may contribute directly to the pollution of surface waters. Such pollution may contribute suspended solids, sediment, and organic nutrients and other materials to the surface water network. In addition, the natural ability of wetlands to trap nutrients is destroyed, thereby making phosphorus and nitrogen loadings more readily available for plant and algae growth. It is not currently possible to specify pollutant loading rates for reclamation activities, but because of the magnitude of these activities, potential strength of the pollutants released, and continued long-term release of these substances to the lakes and streams, these pollution sources should be subject to further analyses after the initial areawide water quality management plan has been prepared. Major research efforts bearing on this question are underway within the United States.

Atmospheric Sources

Streams and lakes are subjected directly to the deposition of pollutants from the atmosphere via dry fallout and precipitation washout, and to pollutant loadings from internal processes, inclusive of streambank erosion, shoreline erosion, and resuspension of bottom sediments. Like the wastes from fish and other aquatic life, some of these materials are present within the water system and simply move from one chemical or biological form to another. To consider these cycles as pollution sources would be complex and unfruitful. Some pollutants, however, are contributed from outside the waterways as a result of the actions of lakes and streams, and therefore are considered here.

Atmospheric fallout and precipitation contamination have been determined to be significant diffuse sources of pollution to lakes and streams. Man's activities and the physical environment influence air pollution concentration, dispersal, and fallout rates. Air pollutants, in the form of smoke, dust, soot, flyash, fumes, mists, odors, seeds, pollens, spores, and

---

[84] *E. M. Bentley, The Effect of Marshes on Water Quality, Ph.D. Thesis, Water Chemistry Department, University of Wisconsin, Madison, Wisconsin, 1969.*

[85] *J. R. Novy, and C. H. Pecor, Impact of Northern Pike Spawning Marsh Operation on Water Quality, Tech. Bull. 73-2, Michigan Water Resources Com., and the Department of Natural Resources, Lansing, Michigan, 1973.*

[86] *P. D. Uttormark, J. D. Chapin, and K. N. Green, Estimated Nutrient Loadings of Lakes from Nonpoint Sources, EPA-660/3-74-020, August, 1974.*

contaminated precipitation, fall directly on surface waters and are direct sources of nutrients, sediments, oxygen demanding substances, heavy metals and chemicals. Some air pollutants present no threat to water quality, but others are significant contributors. Oxides of nitrogen may react with sodium, potassium, and other heavy metals to form soluble nitrates which, when washed out of the atmosphere by rain, may contribute to the fertility of surface waters. Phosphorus adsorbed on fine clay and silt-sized particles will be transported by wind erosion and deposited in surface waters.

Air contaminants may be deposited through dry fallout or precipitation washout directly into a body of water. In case ice covers a body of water, the various deposits still occur, but are stored until spring thaw. When the surface area of a body of water is small in relation to the volume, the direct contribution will be relatively smaller. Also, the relative importance of the contribution is greater for a clean body of water with a large surface area, than for a polluted body of water with a small surface area. Direct contribution of pollutants to surface water systems is of special concern because there is no intervening filtration by the land surface. The deposit of contaminants from the air to the water environment may be indirect, with transport, transformation, and storage of contaminants on land. This may introduce a substantial time delay between when a contaminant reaches the land and the time the contaminant shows up in the water. Storage of air contaminants deposited on land also provides opportunity for transformation of the contaminants into other chemical forms prior to their reaching the waterways. In many instances, the transformations and their rates are important to the amelioration or aggravation of water pollution problems. The indirect transfer of air pollutants through streets, drainageways, storm sewers, and surface runoff is discussed as an element of pollutant loadings from other sources in other appropriate sections of this report.

As shown in Table 134, air pollutants that may enter surface waters are produced by point, area and line sources from residential, industrial, agricultural, transportation-related, construction and utility-related land uses and activities. Air pollutants are released by the combustion of oil, gas, coal, and wood in the heating of residential buildings, and in heating and electric power generation for industrial, commercial, manufacturing, and extractive purposes. Disposal of solid waste produces air pollution through incineration, open burning, and wind erosion of sanitary landfill site areas. Volatilized ammonia and other substances from animal manure and crop fertilizers may be absorbed into nearby surface waters. Fuel combustion by farm machinery also contributes air pollutants. Wind erosion of the agricultural soils may increase the sediment load of surface waters. Pollution emissions by automobiles, buses, trucks, trains, and airplanes may have detrimental effects on water quality. Pollutants which settle on streets and other impervious areas are washed to surface waters by storm water runoff. Nitrogen oxides from transportation activities can be a significant source of nitrate to some surface waters. Particulate emissions from ships settles in the surrounding surface water. All types of building, transportation, water resource development, energy systems development, and recreational construction activity require fuel combustion for the equipment operation, and necessitates exposed soil conditions for various lengths of time. This soil, especially if not adequately covered with vegetation or mulch, is subject to wind erosion and the subsequent deposition in lakes and streams. Utilities such as power plants, especially if located near a water body, may contribute significant particulates and gases to the atmosphere which may enter water bodies.

Atmospheric contribution rates to surface waters were selected both for dry fallout and precipitation washout. Atmospheric contributions of nitrogen from dry fallout and precipitation washout were estimated by Chapin and Uttormark[87] to be 8.9 pounds/acre/year for rural areas of Wisconsin. Nitrogen contributions from precipitation in Wisconsin were reported to range from 3.6 to 26.5 pounds per acre per year.[88] Atmospheric contributions of phosphorus by dry fallout and precipitation washout were estimated by Chapin and Uttormark[89] to range from 0.09 and 0.9 pounds per acre per year. A literature review[90] indicated an average phosphorus contribution of 0.40 pounds per acre per year from rainfall in Wisconsin. Biochemical oxygen demand and sediment loading rates of 62 and 124 pounds per acre per year respectively from precipitation were calculated from data for rural Ohio.[91] A sediment deposition rate by dry fallout alone was estimated in 1971 by the Milwaukee County Department of Air Pollution Control[92] to

---

[87] *J. D. Chapin, and D. P. Uttormak, "Atmospheric Contributions of Nitrogen and Phosphorus," University of Wisconsin—Water Resources Center Madison, Wisconsin, February, 1973.*

[88] *D. P. Uttormark, J. D. Chapin and K. M. Green, Estimating Nutrient Loadings of Lakes from Nonpoint Sources, EPA-660/3-74-020, August, 1974.*

[89] *Chapin, and Uttormark, "Atmospheric Contributions of Nitrogen and Phosphorus."*

[90] *Uttormark, Chapin, and Green, Estimating Nutrient Loadings of Lakes from Nonpoint Sources.*

[91] *Nonpoint and Intermittent Point Source Controls-Development of Structural Control Techniques and Cost Information, prepared by Stanley Consultants for the Miami Conservancy District, January, 1976.*

[92] *Milwaukee County Department of Air Pollution Control, 1971 Report on Solids Deposition Rate in Milwaukee County, May, 1972.*

be 541.5 pounds per acre per year in the Region. Combustion analysis of the deposited solids showed the volatile content to range from 32 to 60 percent. A biochemical oxygen demand dry fallout loading rate was therefore estimated at 100 pounds per acre per year, since the combustible fraction (170 to 320 pounds) of the dry fallout probably includes chemical substances which would not be able to be oxidized by the biochemical processes.

The pollutant loading rates assumed from atmospheric contributions by dry fallout and precipitation washout are presented in Table 135. The above loading rates were applied to the surface water areas of lakes and streams in the Region, since air pollutants which fall on surface waters are direct contributors to water pollutant concentrations. Air pollutants which are deposited on terrestrial surfaces having various land uses and covers were implicitly considered in the loading rates for these land uses and covers.

The assumed loading rates are similar to estimated loading rates from atmosphere calculated by a method developed from data for the Northeastern Illinois Region, which has a land use pattern similar to that of Southeastern Wisconsin.

Table 134

SUMMARY OF AIR POLLUTANT EMISSIONS WITHIN THE REGION: 1973

Source Category	Total Emissions (tons per year)				
	Particulate Matter	Sulfur Dioxide	Carbon Monoxide	Nitrogen Dioxide	Hydro-Carbons
Area Emissions:					
Agricultural Equipment	578	393	19,787	4,506	1,527
Agricultural Tilling	59	--	--	--	--
Aircraft Operations	62	59	6,429	519	929
Commercial & Institutional Fuel Use	1,673	10,344	2,307	4,693	678
Dry Cleaning Operations	--	--	--	--	2,410
Forest Wildfires	22	--	177	5	30
Fugitive Dust[a]	823	--	--	--	--
Gas Marketing Operations	--	--	--	--	4,931
General Utility Engines	178	17	14,669	74	5,690
Incinerations	353	52	264	101	186
Industrial Fuel Use	265	844	363	3,056	64
Power Boat Operations	--[b]	40	20,507	41	6,972
Railroad Lines	21	47	183	300	139
Railroad Yards	63	139	705	1,045	404
Residential Fuel Use	1,327	4,079	1,430	3,495	615
Rock Handling and Storage	299	--	--	--	--
Small Point Sources	129	44	20	165	101
Snowmobile Operations	8	--	267	3	172
Vessels	10	24	37	95	20
Subtotal:	5,870	16,082	67,145	18,098	24,868
Line Emissions:					
Arterial and Highways	4,173	1,484	385,993	40,578	45,920
Collector and Feeder Streets	487	121	89,305	4,003	31,083
Subtotal:	4,660	1,605	475,298	44,581	77,003
Point Emissions:	17,974	191,905	20,795	48,506	26,034
Region Total:	28,504	209,592	563,238	111,185	127,905

a Fugitive dust emissions were calculated only for the industrialized area of the Menomonee River Valley.

b Less than 0.5 tons.

Source: SEWRPC.

Table 135

ESTIMATED CHANNEL LOADING RATES TO SURFACE WATERS FROM ATMOSPHERIC CONTRIBUTIONS

Pollutant	Loading Rate lbs/acre/year
Total Nitrogen	40.5
Total Phosphorus	0.5
BOD_5	162
Sediment	665

Source: SEWRPC.

Table 136

COMPARISON OF SEWRPC ASSUMED CHANNEL LOADING RATES AND LOADING RATES COMPUTED BY A METHOD DEVELOPED FOR THE NORTHEASTERN ILLINOIS PLANNING COMMISSION FOR ATMOSPHERIC CONTRIBUTIONS TO SURFACE WATERS

Pollutant	SEWRPC Assumed Channel Loading Rate	NIPC Method Loading Rate
Nitrogen	8.9	39.4
Phosphorus	0.5	0.63
BOD_5	162	153
Sediment	665	614

Note: All values in lbs/acre/year.

Source: SEWRPC.

Quon,[93] in a report on the contributions of air contaminants to water pollution prepared for the Northeastern Illinois Planning Commission, estimated precipitation washout and dry fallout pollutant loading rates to the land surface based on the total suspended particulates (TSP) in $\mu g/m^3$ in the air. The average 1973 TSP value in the Region was 44 $\mu g/m^3$. As shown in Table 136, the loading rates computed by this method are very similar to the estimated loads used in this pollutant loading analysis, with the exception that the nitrogen values were somewhat higher for the method developed in northeastern Illinois. This may be expected because of the higher intensity of motor vehicle use near Chicago.

Stream Processes

In-stream processes also affect the pollution transport loading of a stream. The tremendous amount of energy possessed by flowing water in a stream channel is dissipated along the stream length by turbulence, meandering, streambank and bed erosion, and sediment resuspension. Sediments and associated substances delivered to a stream may be stored, at least temporarily, on the streambed, particularly where obstructions or irregularities in the channel decrease the flow velocity or act as a particle trap or filter. Larger particles are intermittently stored by the pool-riffle sequence of medium sized meandering streams; finer sized suspended particles may be filtered by wetlands or removed by biological uptake. On an annual basis or on a long-term basis, streams may exhibit a net deposition, a net erosion, or no net change in internal sediment transport (equilibrium), depending on the tributary land uses, watershed hydrology, precipitation, and geology.

The participants in an International Joint Commission Task Group Study estimated that on a long term (50 year) basis essentially all of the sediment and phosphorus in the streamflow or bedload of a stream network will be transported to the mouth of the watershed.[94] The U.S. Soil Conservation Service[95] estimated that in 1975, 5 percent of the total erosion which occurred in the Menomonee River watershed was streambank erosion. It was further estimated that if 75 percent of the streambank erosion and 3 percent of the sheet and rill erosion reached Lake Michigan, presumably during the same year the erosion occurred, then the streambank erosion would represent 11 percent of the total annual sediment yield in the watershed. In Chapter VI of this report, the total sediment load of each of the primary streams in each watershed of the Region has been presented. Although the above discussion of streambank erosion in the Menomonee River watershed may be indicative of the magnitude of the problem in other watersheds, detailed data are not available to estimate the proportion of the total in-stream sediment load due to stream bank erosion.

Shoreline erosion in inland lakes of the Region may represent locally severe conditions—particularly in the reduction of wildlife habitat. However, it has been assumed for this analysis that these problems do not generally contribute major proportions of the organic or nutrient materials reaching the lakes. The greater magnitude of pollutants from more extensive land uses are assumed to be more important to this analysis. Lakeshore erosion, lake dumping, and filling of wetlands and waterways is an important local problem which must be addressed but is beyond

---

93 *J. E. Quon, The Potential Contributions of Air Contaminants to Water Pollution in the NIPC Six-County Area. A report prepared for the Northeastern Illinois Planning Commission. December, 1976.*

94 *International Joint Commission, Pollution from Land Use Activities, Stream Transport Group Report International Reference Group on Great Lakes, Task C Meeting, May 3-5, 1977.*

95 *W. Mildner, Streambanks Erosion in Menomonee River Watershed, Wisconsin, U.S. Soil Conservation Service, USDA, January, 1976.*

the scope of this Regional analysis. Accordingly, the streambank or bed erosion, lakeshore erosion, or sediment resuspension by natural processes have been addressed implicitly here as elements of the broader and more general pollutant loads to the streams and lakes from the tributary land uses.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE DES PLAINES RIVER WATERSHED

Physical Setting

The Des Plaines River watershed is a natural surface water drainage unit, 134 square miles in areal extent located in the southeast portion of the Region. The boundaries of the basin together with the locations of the main channel of the Des Plaines River and its five principal tributaries are shown on Map 26. The main stem of the Des Plaines River originates in the Town of Yorkville in Racine County and flows southeast to the Illinois-Wisconsin state line where it exits Wisconsin at Section 32 in the Town of Pleasant Prairie in Kenosha County. About 91 percent of the watershed is in rural land uses, with about 85 percent of this area still in agricultural use. Most of the urban related land use is located in the western portions of the watershed around Lakes Paddock, George, Hooker, Montgomery and Benet-Shangrila, and within the corporate limits of Union Grove and Kenosha. Map 48 sets forth the major land use categories and their spatial distributions within the Des Plaines River watershed as they were inventoried in 1975. Table 137 sets forth the extend and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north by the Root River watershed, on the west by the Fox River watershed, on the south by the State of Illinois, and the east by the Pike River and Pike Creek watersheds. The stream systems which drain the watershed are Center Creek, Kilbourn Road Ditch, and the Des Plaines River. Table 138 lists for the Des Plaines River watershed, each major stream reach, together with the location of the source and the length of the stream in miles. The watershed ranks sixth in size within the Region, but tenth in total resident population.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Wisconsin section of the Des Plaines River watershed lies within Racine and Kenosha Counties and in parts of the City of Kenosha and two villages and eight towns. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976, are shown in Table 139. The 1975 resident population of the watershed is estimated at 15,811 persons, or approximately 0.9 percent of the estimated 1975 total regional population. Table 140 presents the population distribution in the Des Plaines River watershed by civil division.

Surface water in the Des Plaines River watershed is comprised of streamflow, lakes, small ponds, flooded gravel pits and wetlands. There are no sites within the Region at which the streamflow of the Des Plaines River has been measured on a continuing basis, but a continuous recording gage has been maintained by the U.S. Geological Survey since 1962 at Russell Road approximately 0.5 miles west of Russell, Illinois, or one mile south of the Wisconsin-Illinois state line.

The soils within the Des Plaines River watershed consist of deep to moderately deep, brown to black silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high levels of nutrients in stream waters when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service, residential development without public sanitary sewer service, as shown on Maps 43, 44 and 45.

Urban Land Uses

Residential Activities: Residential land uses cover approximately 3,096 acres, or 4 percent of the watershed. In addition, there are 764 acres of residential land use under development and are so reflected in the pollution loading rates of the land under development category because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Des Plaines River watershed are estimated at 12,400 pounds of nitrogen, 1,000 pounds of phosphorus, 75,200 pounds of BOD_5, 5.0×10^{13} fecal coliform counts, and 850 tons of sediment during an average year. Table 141 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Des Plaines River watershed, approximately 380 acres or less than 1 percent of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Des Plaines River watershed are 3,400 pounds of nitrogen, 300 pounds of phosphorus, 37,100 pounds of biochemical oxygen demand, 1.3×10^{13} fecal coliform counts, and 140 tons of sediment. Table 142 presents the areal extent of commercial land uses within the Des Plaines River watershed along with the estimated

Table 137

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	4.84	3,096	3.66
Commercial[b]	0.59	380	0.45
Industrial			
Manufacturing	0.22	143	0.17
Landfill & Dump	0.22	143	0.17
Extractive	0.27	170	0.20
Transportation			
Streets & Highways	1.23	787	0.93
Airfields	0.07	45	0.05
Railroad Yards & Terminals	--	--	--
Recreation			
Golf Courses	0.57	367	0.43
Parks & Other Recreation	0.41	261	0.31
Land Under Development			
Residential Land Under Development[c]	1.19	764	0.90
Commercial Land Under Development	--	--	--
Industrial Land Under Development	0.14	88	0.10
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	6.87	4,396	5.19
Hay	10.45	6,689	7.90
Row Crops	69.60	44,543	52.63
Specialty Crops	1.60	1,026	1.21
Sod Farm	0.03	22	0.03
Other Open Space[d]	13.85	8,864	10.48
Silvicultural			
Woodlands	7.13	4,560	5.39
Orchards & Nurseries	0.18	115	0.14
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	1.76	1,127	1.33
Wetlands, Swamps, & Marshes	11.00	7,041	8.32
Total	132.22[e]	84,627	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2,000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

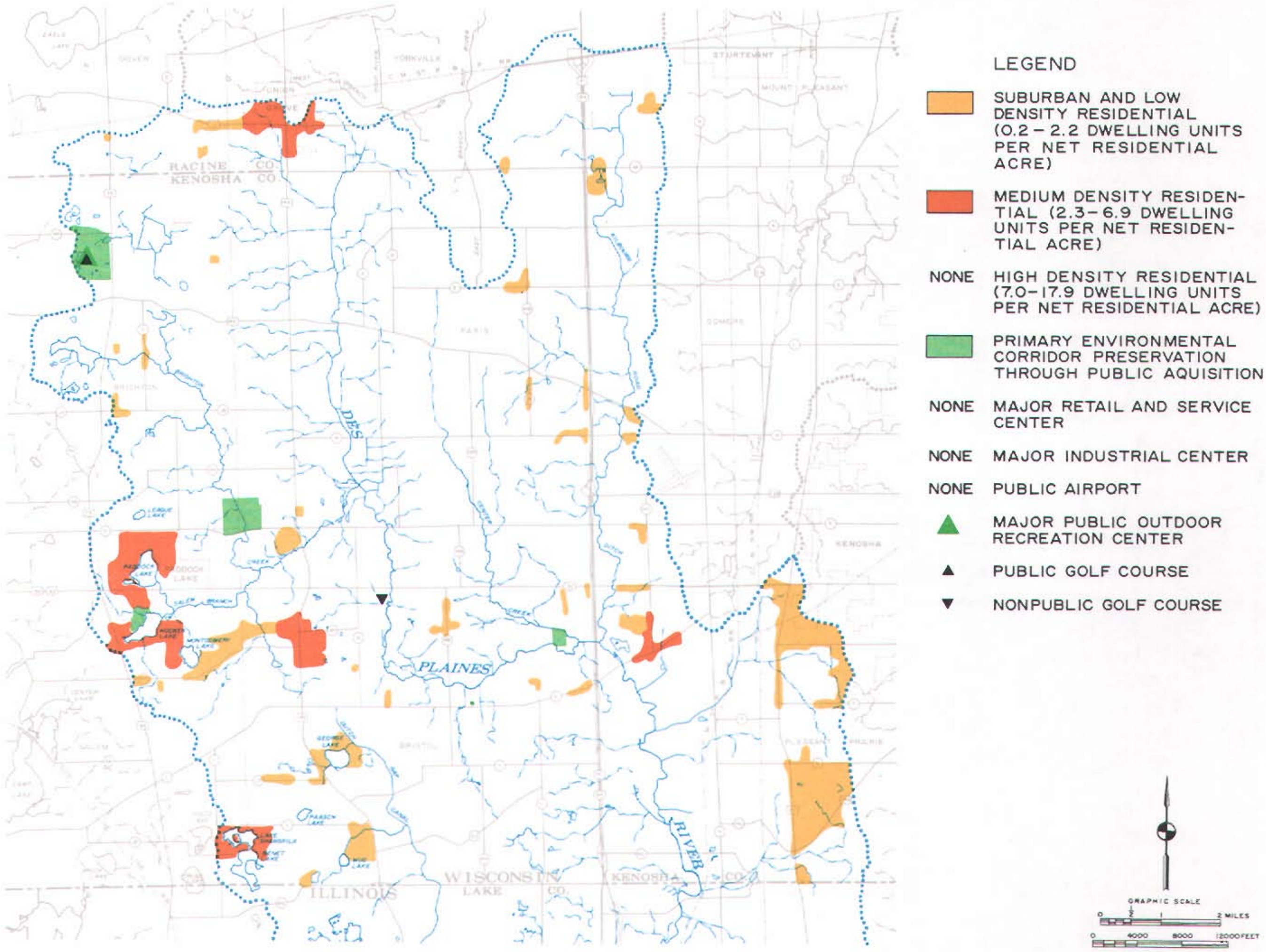
[d] *Includes: Pasture, unused urban and rural lands.*

[e] *The total area of the Des Plaines River watershed represented in this table is different than the total area of the Des Plaines River watershed identified in Table 139. This is due to the fact that the area set forth in Table 139 includes only that portion of the Des Plaines River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Des Plaines River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Map 48

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE DES PLAINES RIVER WATERSHED IN 1975



As of 1975 more than 91 percent of the area of the Des Plaines River watershed was devoted to rural land uses. The dominant rural land use in the watershed was agricultural, which encompassed 77 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by predominantly agricultural land uses with scattered enclaves of medium- to low-density residential land uses. There was one major park and two public or private golf courses in the watershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 138

LENGTHS OF STREAMS AND THEIR SOURCES IN THE DES PLAINES RIVER WATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Salem Branch	Village of Paddock Lake	T1N, R20E, Sec. 2, SE 1/4	2.3
Brighton Creek	Town of Brighton	T2N, R20E, Sec. 11, NW 1/4	9.0
Dutch Gap Canal	Town of Bristol	T1N, R21E, Sec. 20, SE 1/4	4.1
Des Plaines River	Town of Yorkville	T3N, R21E, Sec. 33, SW 1/4	20.7
Kilbourn Road Ditch	Town of Mt. Pleasant	T3N, R22E, Sec. 30, SE 1/4	12.1
Center Creek	Town of Paris	T2N, R21E, Sec. 27, NW 1/4	7.9

Source: SEWRPC.

Table 139

AREAL EXTENT OF CIVIL DIVISIONS IN THE DES PLAINES RIVER WATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Kenosha County			
City			
Kenosha	0.11	0.08	0.74
Village			
Paddock Lake	1.71	1.28	98.85
Towns			
Brighton	15.30	11.42	42.61
Bristol	36.20	27.02	100.00
Paris	33.79	25.22	93.96
Pleasant Prairie	21.88	16.33	59.67
Salem	6.97	5.20	21.10
Somers	6.65	4.96	19.35
County Subtotal	122.62	91.51	44.06
Racine County			
Village			
Union Grove	0.48	0.36	51.89
Towns			
Dover	2.49	1.86	6.88
Mount Pleasant	2.85	2.13	7.61
Yorkville	5.55	4.14	15.72
County Subtotal	11.37	8.49	3.34
Total	133.98	100.00	- -

Source: SEWRPC.

average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the watershed in 1975.

Industrial Activities: Industrial land uses cover 143 acres, or less than 1 percent of the Des Plaines River watershed. In addition, 88 acres, or less than 1 percent of the watershed, were under development for industrial land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. The industrial activities within the Des Plaines River watershed excluding land under development are estimated to contribute annually 1,200 pounds of nitrogen, 100 pounds of phosphorus, 5,300 pounds of BOD_5, 9.0 x 10^{12} fecal coliform counts, and 70 tons of sediment to surface runoff. Table 143 presents the areal extent of the industrial uses within the Des Plaines River watershed along with the estimated average annual diffuse source pollutant loadings from these activities.

There are six sites of sanitary landfill operations within the Des Plaines River watershed occupying a total of 143 acres, or less than 1 percent of the drainage area. These are included, along with their estimated pollutant loading rates, on Table 143. The landfill operations have an estimated annual pollutant load of 1,200 pounds of nitrogen, 100 pounds of phosphorus, 5,300 pounds of BOD_5, 9.0 x 10^{12} fecal coliform counts, and 70 tons of sediment. There were no significant sites of auto salvage and wrecking facilities in the drainage area in 1975.

Extractive Activities: There were 170 acres of extractive mining operations, consisting of gravel pits and attendant washing operations, in the

Table 140

ESTIMATED POPULATION OF DES PLAINES RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Kenosha County	
Brighton Town (Part)	733
Bristol Town	3,067
Kenosha City (Part)	0
Paddock Lake Village (Part)	1,875
Paris Town (Part)	1,720
Pleasant Prairie Town (Part)	3,774
Salem Town (Part)	1,678
Somers Town (Part)	721
Kenosha County (Part) Subtotal	13,568
Racine County	
Dover Town (Part)	438
Mount Pleasant Town (Part)	143
Union Grove Village (Part)	1,268
Yorkville Town (Part)	394
Racine County (Part) Subtotal	2,243
Des Plaines River Watershed Total	15,811

Source: Wisconsin Department of Administration and SEWRPC.

Des Plaines River watershed as of 1975. These operations contribute an estimated 10,200 pounds of nitrogen, 7,700 pounds of phosphorus, 20,400 pounds of BOD_5, and 12,750 tons of sediments annually. Table 144 presents the extent of the extraction operations and the estimated attendant diffuse source pollutant loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, and airfields. Table 145 presents the estimated pollutant contributions from the 832 acres, or 1.0 percent of the total watershed area, which is devoted to these land uses. It is estimated that 19,000 pounds of nitrogen, 1,200 pounds of phosphorus, 125,900 pounds of BOD_5, 5.3 x 10^{13} fecal coliform counts, and 16,840 tons of sediment are transported annually from transportation related activities within the Des Plaines River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve. There was no transportation land under development in the watershed in 1975.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 261 acres, or less than 1 percent of the total area of the watershed, and golf

Table 141

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	3,096	3.66	Total Nitrogen	4.0	12,380
			Total Phosphorus	0.32	990
			Biochemical Oxygen Demand	24.3	75,230
			Fecal Coliform	1.6 x 10^{10} counts/ac/yr.	5.0 x 10^{13} counts/yr.
			Sediment	545	845 tons

Source: SEWRPC.

Table 142

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial	380	0.45	Total Nitrogen	9.0	3,420
			Total Phosphorus	0.75	290
			Biochemical Oxygen Demand	97.6	37,090
			Fecal Coliform	3.3 x 10^{10} counts/ac/yr.	1.3 x 10^{13} counts/yr.
			Sediment	745	140 tons

Source: SEWRPC.

Table 143

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	143	0.17	Total Nitrogen	8.4	1,200
			Total Phosphorus	0.70	100
			Biochemical Oxygen Demand	36.9	5,280
			Fecal Coliform	6.2×10^{10} counts/ac/yr.	9.0×10^{12} counts/yr.
			Sediment	977	70 tons
Landfill	143	0.17	Total Nitrogen	8.4	1,200
			Total Phosphorus	0.70	100
			Biochemical Oxygen Demand	36.9	5,280
			Fecal Coliform	6.2×10^{10} counts/ac/yr.	9.0×10^{12} counts/yr.
			Sediment	977	70 tons
Total	286	0.34	Total Nitrogen	--	2,400
			Total Phosphorus	--	200
			Biochemical Oxygen Demand	--	10,550
			Fecal Coliform	--	1.8×10^{13} counts/yr.
			Sediment	--	140 tons

Source: SEWRPC.

Table 144

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive.	170	0.20	Total Nitrogen	60	10,200
			Total Phosphorus	45	7,650
			Biochemical Oxygen Demand	120	20,400
			Fecal Coliform	Negligible	--
			Sediment	150,000	12,750 tons

Source: SEWRPC.

Table 145

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	787	0.93	Total Nitrogen	23.4	18,400
			Total Phosphorus	1.4	1,100
			Biochemical Oxygen Demand	159.0	125,050
			Fecal Coliform	6.7×10^{10} counts/ac/yr.	5.3×10^{13} counts/yr.
			Sediment	42,600.	16,750 tons
Air Fields	45	0.05	Total Nitrogen	12	540
			Total Phosphorus	2.7	120
			Biochemical Oxygen Demand	17.6	790
			Fecal Coliform	Negligible	--
			Sediment	3,200	70 tons
Total	832	0.98	Total Nitrogen	--	18,960
			Total Phosphorus	--	1,220
			Biochemical Oxygen Demand	--	125,930
			Fecal Coliform	--	5.3×10^{13} counts/yr.
			Sediment	--	16,835 tons

Source: SEWRPC.

courses with a total area of 367 acres, or less than 1 percent of the total area of the watershed. Map 48 indicates the location of public and private golf courses within the Des Plaines River watershed as of 1975. Table 146 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 2,200 pounds of nitrogen, 90 pounds of phosphorus, 800 pounds of BOD_5, 9.4 x 10^{11} fecal coliform counts, and 130 tons of sediment are transported from parks and golf courses within the Des Plaines River watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development: The Des Plaines River watershed is undergoing conversion of land from rural to urban use in the areas near the major lakes of the watershed and near the Cities of Kenosha and Union Grove. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 764 acres, or about 1 percent of the total land area of the watershed. Similarly, an estimated 88 acres, or less than 1 percent of the total area of the watershed, was under development for industrial land uses in 1975. There were no significant recreational, commercial, or transportation related lands under development in the watershed in 1975. It is estimated that 51,100 pounds of nitrogen, 38,300 pounds of phosphorus, 102,200 pounds of BOD_5, and 63,900 tons of sediment were transported from these construction sites in 1975. Table 147 presents the estimated acreage of land under conversion from rural to urban use within the Des Plaines River watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were only 12 known holding tanks and seven mound systems in the watershed. (See Map 46.) Table 148 presents the estimated pollutant loadings from the approximately 2,697 septic tanks in the watershed as of 1975. It is estimated that 54,350 pounds of nitrogen, 12,600 pounds of phosphorus, 778,100 pounds of BOD_5, 9.5 x 10^{14} fecal coliform counts and 135 tons of sediment are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Des Plaines River watershed.

Rural Land Uses

Agricultural Activities: About 77 percent of the area of the Des Plaines River watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May 1975, 133 significant domestic livestock operations with a total of 168,240 animals, or 12,340 equivalent animal units, were known to exist within the watershed. Map 49 indicates the locations of these livestock operations. Thirty-five of these operations were located within 500 feet of the identified stream system of the watershed. Table 149 indicates the number of livestock present within

Table 146

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	261	0.31	Total Nitrogen	2.3	600
			Total Phosphorus	0.06	15
			Biochemical Oxygen Demand	1.3	340
			Fecal Coliform	3.6 x 10^9 counts/ac/yr.	9.4 x 10^{11} counts/yr.
			Sediment	420	50 tons
Golf Courses	367	0.43	Total Nitrogen	4.4	1,610
			Total Phosphorus	0.2	70
			Biochemical Oxygen Demand	1.3	480
			Fecal Coliform	Negligible	--
			Sediment	420	80 tons
Total	628	0.74	Total Nitrogen	--	2,220
			Total Phosphorus	--	90
			Biochemical Oxygen Demand	--	820
			Fecal Coliform	--	9.4 x 10^{11} counts/yr.
			Sediment	--	130 tons

Source: SEWRPC.

Table 147

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development. . .	764	0.90	Total Nitrogen	60	45,850
			Total Phosphorus	45	34,390
			Biochemical Oxygen Demand	120	91,700
			Fecal Coliform	Negligible	--
			Sediment	150,000	57,310 tons
Industrial Land Under Development. . . .	88	0.10	Total Nitrogen	60	5,280
			Total Phosphorus	45	3,960
			Biochemical Oxygen Demand	120	10,560
			Fecal Coliform	Negligible	--
			Sediment	150,000	6,600 tons
Total	852	1.00	Total Nitrogen	--	51,120
			Total Phosphorus	--	38,340
			Biochemical Oxygen Demand	--	102,240
			Fecal Coliform	--	--
			Sediment	--	63,900 tons

Source: SEWRPC.

Table 148

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	2,697	9,535	Total Nitrogen	5.7	54,350
			Total Phosphorus	1.32	12,590
			Biochemical Oxygen Demand	81.6	778,060
			Fecal Coliform	1.0×10^{11} counts/capita/yr.	9.5×10^{14} counts/yr.
			Sediment	28.0	135 tons

Source: SEWRPC.

the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 350,700 pounds of nitrogen, 81,400 pounds of phosphorus, 1,373,300 pounds of BOD_5, 7.9×10^{15} fecal coliform counts, and 4,300 tons of sediment are transported from livestock operations within the Des Plaines River watershed annually.

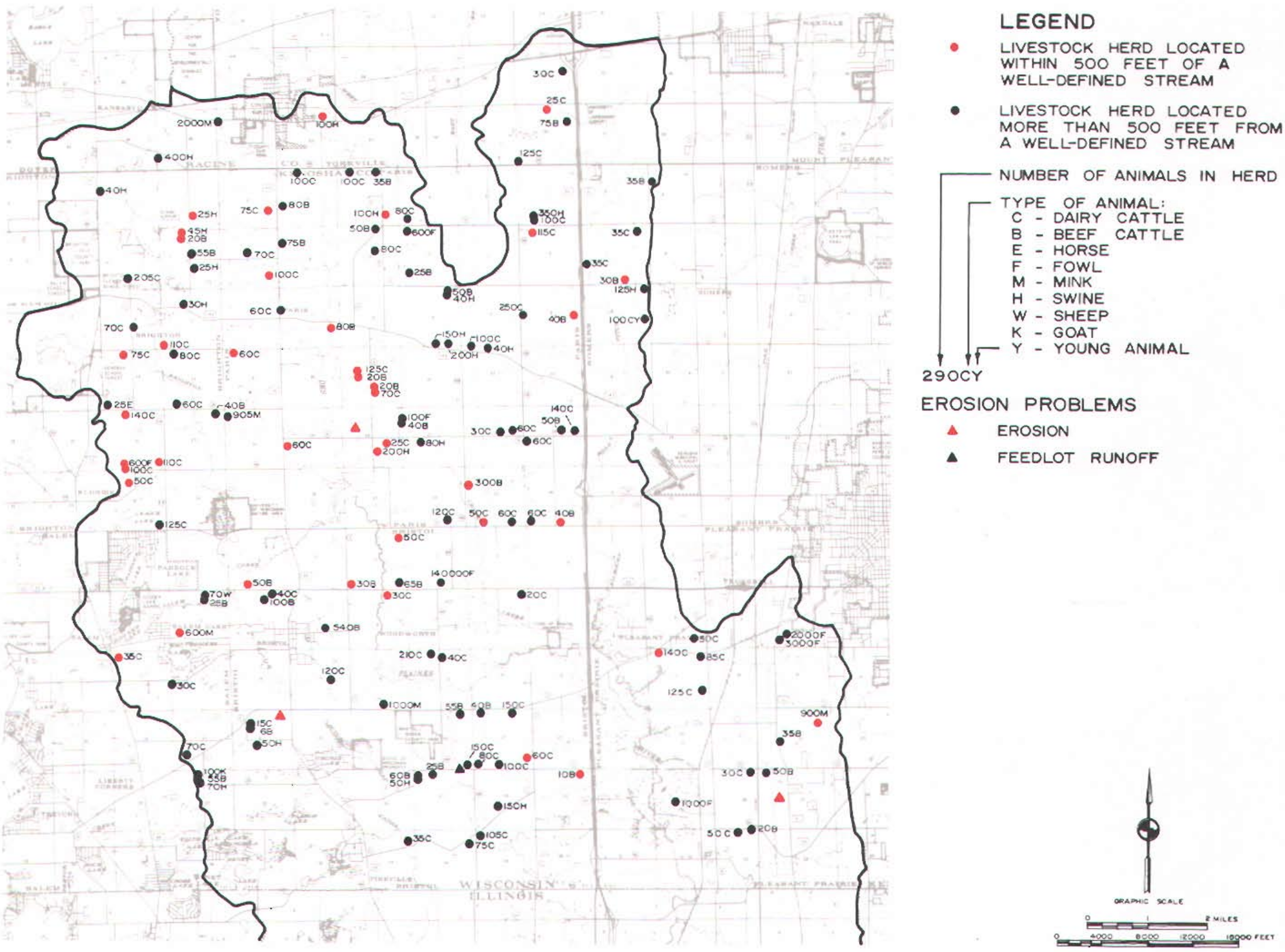
Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 150. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 4,396 acres, or 5 percent of the total area of the watershed, were planted in grain crops consisting of oats and wheat in 1975.

Average annual pollutant loadings from grain crops within the Des Plaines River watershed are accordingly estimated at 20,700 pounds of nitrogen, 600 pounds of phosphorus, 42,200 pounds of BOD_5, and 7,040 tons of sediment. Table 150 presents the estimated acreage of grain crops and the estimated diffuse source pollutant loading rates to drainage channels in an average year within the watershed.

Approximately 6,689 acres, or 8 percent of the total area of the watershed, were devoted to the growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Des Plaines River

Map 49

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE DES PLAINES RIVER WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 133 operations within the Des Plaines River watershed in 1975, 35 operations, or 26.3 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

watershed are 6,000 pounds of nitrogen, 600 pounds of phosphorus, 64,200 pounds of BOD_5, and 10,700 tons of sediment.

Major row crops grown within the Des Plaines River watershed are corn and soybeans which were planted on 44,543 acres, or 53 percent of the total area of the watershed. As shown in Table 150, an estimated 1,029,000 pounds of nitrogen, 28,500 pounds of phosphorus, 962,100 pounds of BOD_5, and 160,360 tons of sediment are transported annually from the row crop acreage within the Des Plaines River watershed.

Also, as shown in Table 150, specialty crops were grown on a total of 1,026 acres, or 1 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Des Plaines River watershed are 23,700 pounds of nitrogen, 700 pounds of phosphorus, 30,800 pounds of BOD_5, and 5,130 tons of sediment.

About 22 acres of land, or less than 1 percent of the total area within the watershed, were in sod farms in

Table 149

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	5,320	7,450	115,645	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	211,580 49,170 828,440 4.8×10^{15} counts/yr. 2,610 tons
Beef	2,330	2,330	26,350	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	66,170 15,380 259,100 1.5×10^{15} counts/yr. 815 tons
Hogs	2,270	910	11,445	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	25,840 6,010 101,190 5.8×10^{14} counts/yr. 20 tons
Horses	30	50	455	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	1,420 330 5,560 3.2×10^{13} counts/yr. 20 tons
Fowl	152,700	1,530	14,770	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	43,450 10,100 170,140 9.8×10^{14} counts/yr. 535 tons
Sheep	70	10	45	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	280 70 1,110 6.4×10^{12} counts/yr. 5 tons
Mink	5,410	50	490	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	1,420 330 5,560 3.2×10^{13} counts/yr. 20 tons
Goats	100	10	60	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	280 70 1,110 6.4×10^{12} counts/yr. 5 tons
Total	168,240	12,340	169,260	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	- - - - - - - - - -	350,460 81,440 1,392,210 7.9×10^{15} counts/yr. 4,325 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 150

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	4,396	5.19	Total Nitrogen	4.7	20,660
			Total Phosphorus	0.13	570
			Biochemical Oxygen Demand	9.6	42,200
			Fecal Coliform	Negligible	--
			Sediment	3,200	7,035 tons
Hay	6,689	7.90	Total Nitrogen	0.9	6,020
			Total Phosphorus	0.09	600
			Biochemical Oxygen Demand	9.6	64,210
			Fecal Coliform	Negligible	--
			Sediment	3,200	10,700 tons
Row	44,543	52.63	Total Nitrogen	23.1	1,028,950
			Total Phosphorus	0.64	28,510
			Biochemical Oxygen Demand	21.6	962,130
			Fecal Coliform	Negligible	--
			Sediment	7,200	160,355 tons
Specialty Crops					
Vegetable and Other Agricultural Crops	1,026	1.21	Total Nitrogen	23.1	23,700
			Total Phosphorus	0.64	660
			Biochemical Oxygen Demand	30.0	30,780
			Fecal Coliform	Negligible	--
			Sediment	10,000	5,130 tons
Sod	22	0.03	Total Nitrogen	0.9	20
			Total Phosphorus	0.09	--
			Biochemical Oxygen Demand	21	50
			Fecal Coliform	Negligible	--
			Sediment	700	10 tons
Pasture	8,864	10.48	Total Nitrogen	4.6	40,780
			Total Phosphorus	0.29	2,570
			Biochemical Oxygen Demand	9.7	86,000
			Fecal Coliform	Negligible	--
			Sediment	420	1,860 tons
Total	65,540	77.36	Total Nitrogen	--	1,120,120
			Total Phosphorus	--	32,910
			Biochemical Oxygen Demand	--	1,185,350
			Fecal Coliform	--	--
			Sediment	--	185,090 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

1975. Estimated average annual pollutant loading rates from these sod farms within the Des Plaines River watershed are 20 pounds of nitrogen, 50 pounds of BOD_5, and 10 tons of sediment. Of the total acres plowed for crop production each year, it is estimated that 90 percent are fall plowed.

Irrigation of cropland or golf courses was not known to be practiced within the watershed in 1975.

The second largest single land use category within the Des Plaines River watershed is that of pasture land and other open space—which accounts for 8,864 acres, or 10 percent of the total area of the watershed; row crops account for significantly more, with 44,543 acres. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 150. Annual loading rates from these areas are estimated at 40,800 pounds of nitrogen, 2,600 pounds of phosphorus, 86,000 pounds of BOD_5, and 1,860 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation service for 239 farms covering about 25,588 acres, or 39 percent of the agricultural land within the watershed.

A total of 482 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these

practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 50.

Table 151 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $858,299, or an equivalént $13.10 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $6.49 per acre of agricultural land, or about 50 percent of the total investment were related to those practices directly affecting water quality. This represents about 43 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans in the Region.

Table 151

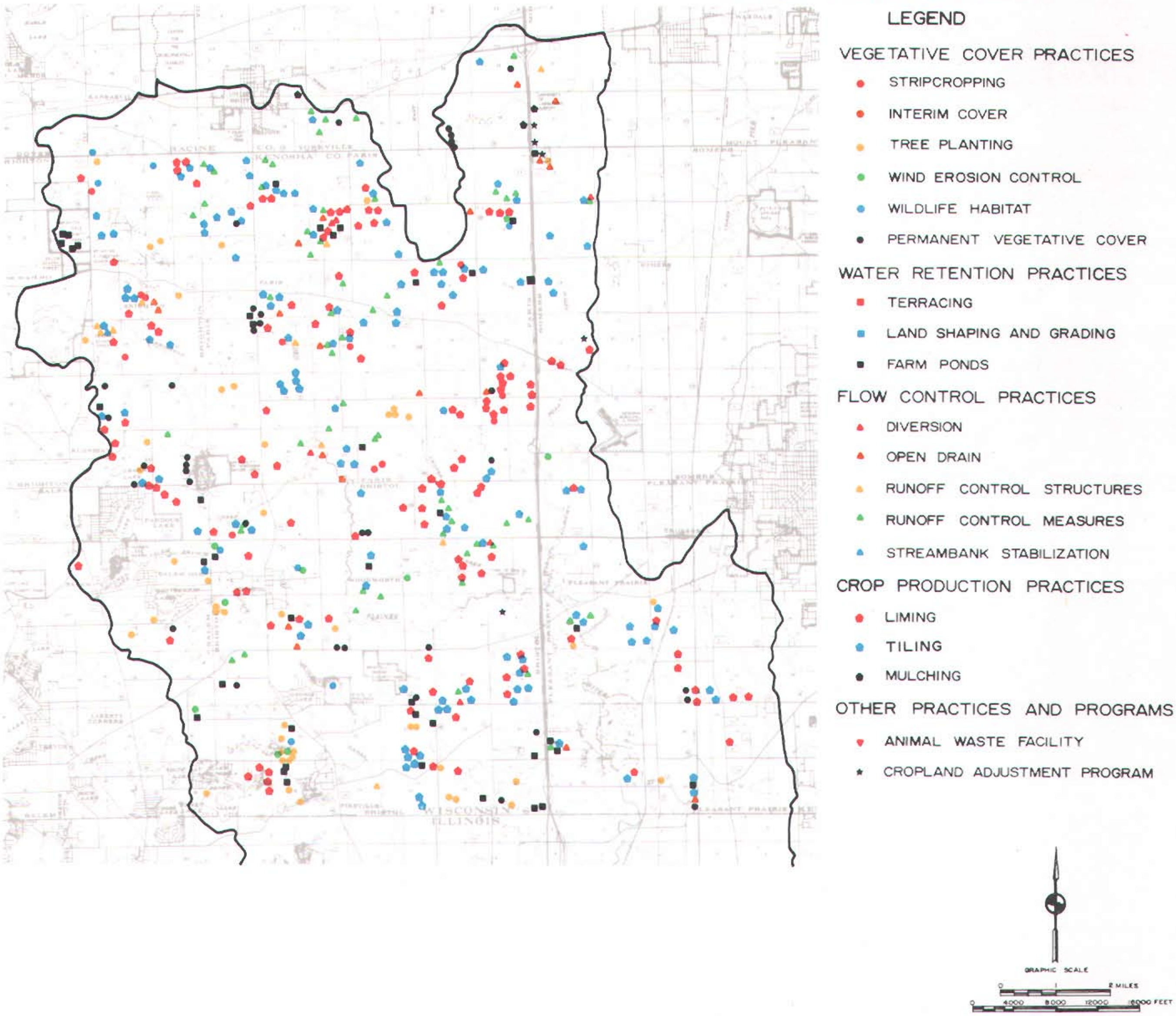
KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE DES PLAINES RIVER WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	563 acres	10.00/acre	5,630.00
Interim Cover	0	12.00/acre	0
Tree Stands	(41 units) (2 acres/unit) = 82 acres	100.00/acre	8,200.00
Wind Erosion Control	17,429 feet	0.60/foot	10,457.40
Wildlife Habitat	(7 units) (2 acres/unit) = 14 acres	25.00/acre	350.00
Permanent Vegetative Cover	520 acres	50.00/acre	26,000.00
Subtotal			50,637.40
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	40 units	4,000.00/unit	160.000.00
Subtotal			160.000.00
Flow Control Practices			
Diversions	3,780 feet	1.25/foot	4,725.00
Open Drains	24,545 feet	2,25/foot	55,226.25
Runoff Control Structures	9 units	2,500.00/unit	22,500.00
Runoff Control Measures	131,328 feet	1.00/foot	131,328.00
Streambank Stabilization	200 feet	3.50/foot	700.00
Subtotal			214,479.25
Crop Production Practices			
Liming	1,993 acres	20.00/acre	39,860.00
Tiling	557,089 feet	0.70/foot	389,962.30
Mulching	56 acres	60.00/acre	3,360.00
Subtotal			433,182.30
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$858,298.95

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service: and SEWRPC.

Map 50

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE DES PLAINES RIVER WATERSHED IN 1975



The above map illustrates the locations of the 482 known conservation practices installed in the Des Plaines River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Silvicultural Activities: About 4,675 acres, or approximately 6 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nursies. Table 152 presents the acreage of silvicultural activities within the Des Plaines River watershed and the estimated loading rates from these activities. About 10,800 pounds of nitrogen, 700 pounds of phosphorus, 21,500 pounds of BOD_5, 3.1 x 10^{12} fecal coliform counts, and 590 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 1,127 acres, or 1 percent of the total area of the watershed, is covered by surface water in the form of ponds, lakes and streams. As indicated in Table 153, 10,000 pounds of nitrogen, 600 pounds of phosphorus, 182,600

Table 152

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURE LAND USES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	4,560	5.39	Total Nitrogen	2.3	10,490
			Total Phosphorus	0.14	640
			Biochemical Oxygen Demand	4.6	20,980
			Fecal Coliform	6.6×10^8 counts/ac/yr.	3.0×10^{12} counts/yr.
			Sediment	251	570 tons
Orchards and Nurseries	115	0.14	Total Nitrogen	2.3	260
			Total Phosphorus	0.14	20
			Biochemical Oxygen Demand	4.6	530
			Fecal Coliform	6.6×10^8 counts/ac/yr.	7.6×10^{10} counts/yr.
			Sediment	251	10 tons
Total	4,675	5.53	Total Nitrogen	--	10,750
			Total Phosphorus	--	650
			Biochemical Oxygen Demand	--	21,510
			Fecal Coliform	--	3.1×10^{12} counts/yr.
			Sediment	--	585 tons

Source: SEWRPC.

Table 153

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE DES PLAINES RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams	1,127	1.33	Total Nitrogen	8.9	10,030
			Total Phosphorus	0.5	560
			Biochemical Oxygen Demand	162	182,570
			Fecal Coliform	Negligible	--
			Sediment	665	375 tons

Source: SEWRPC.

pounds of BOD_5, and 380 tons of sediment can be expected to be contributed to the surface waters of the Des Plaines River watershed annually be atmospheric dry fall and washout.

A total of 7,041 acres, or 8 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Des Plaines River watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Des Plaines River Watershed

The Des Plaines River watershed is primarily agricultural with storm water runoff from these lands contributing the largest diffuse source loads of nitrogen, and sediment. In addition, agricultural runoff is the second largest diffuse source of biochemical oxygen demand and the third largest diffuse source of phosphorus. Livestock operations are also a major source of pollution to the Des Plaines River and contribute the largest loads of phosphorus, biochemical oxygen demand and fecal coliform and the second largest loads of nitrogen. Construction activities are the second largest diffuse source of phosphorus and of sediment in the watershed. Onsite sewage disposal systems are the second largest producer of fecal coliform and the third largest producer of biochemical oxygen demand. Residential, commercial and industrial land uses, recreational activities, and silvicultural activities, each contribute less than 5 percent of the total diffuse source load of any pollutant. Total annual diffuse source loads are 1,646,400 pounds of nitrogen, 176,900 pounds of phosphorus, 3,912,000 pounds of biochemical oxygen demand, 9.0×10^{15} fecal coliform counts, and 285,250 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE FOX RIVER WATERSHED

Physical Setting

The Fox River watershed is a natural surface water drainage unit, 934 square miles in areal extent, located in the central and south central portion of the Region. The boundaries of the basin together with the locations of the main channel of the Fox River and its 24 principal tributaries which rise and join the Fox River within the Region are shown on Map 26. The mainstem of the Fox River originates near the Village of Lannon in northeastern Waukesha County and discharges beyond the Region's boundaries. About 83 percent of the watershed is in rural land uses, with about 77 percent of this area still in agricultural use. Most of the agricultural related land use is located in the southern and central portions of the watershed. Map 51 sets forth the major land use categories and their spatial distributions within the Fox River watershed as they were inventoried in 1975. Table 154 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north by the Menomonee and the Rock River watersheds, on the west by the Rock River watershed, on the south by the Wisconsin-Illinois State line, and the east by the Des Plaines, Menomonee, and Root River watersheds. Table 155 lists for the Fox River watershed, the streams and watercourses, together with the location of the source and the length of the stream in miles. The watershed ranks largest in size within the Region, but fourth in total resident population.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Fox River watershed occupies portions of six of the seven counties within the Southeastern Wisconsin Region—Kenosha, Milwaukee, Racine, Walworth, Washington, and Waukesha, and parts of nine cities, 19 villages, and 36 towns. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 156. The 1975 resident population of the watershed is estimated at 225,335 persons, or approximately 13 percent of the estimated 1975 total regional population. Table 157 presents the population distribution in the Fox River watershed by civil division.

Surface water in the Fox River watershed is comprised of streamflow, 46 major lakes of 50 acres or larger, numerous smaller lakes and ponds, flooded gravel pits and wetlands. The quantity of streamflow in the Fox River watershed, as in the Region generally, varies with seasonal changes in temperature, rainfall, soil moisture, agricultural operations, the growth cycle of vegetation, and groundwater levels. The streamflow of the Fox River has been measured at four locations: two on the Fox River mainstem at Waukesha and Wilmot since 1963 and 1939 respectively, and two located on the Fox River tributaries—the Mukwonago and White Rivers since 1973. The Fox River at Waukesha streamflow gage is located 20 feet downstream from the Prairie Street bridge in Waukesha, and the Fox River at Wilmot streamflow gage is located 100 feet downstream from the bridge on CTH C. The Mukwonago River near the Mukwonago streamflow gage is located 100 feet upstream from the bridge on STH 83 in Mukwonago, and the White River gage near Burlington is located 10 feet downstream from the bridge on STH 36. The continuous flow recording gage measurements were compiled by the U.S. Geological Survey in cooperation with the Washington, Waukesha, and Racine County Boards.

The soils within the Fox River watershed are deep to moderately deep, brown to black silt loams in the western portions of Racine and Kenosha Counties, along with Walworth County, and are noted primarily for their excellent productivity. Waukesha County and Washington County generally have grayish-brown rolling silt loams or gravelly to grayish-brown loams as their primary soil types. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high levels of nutrients in stream waters, when soil particles are carried with precipitation runoff.

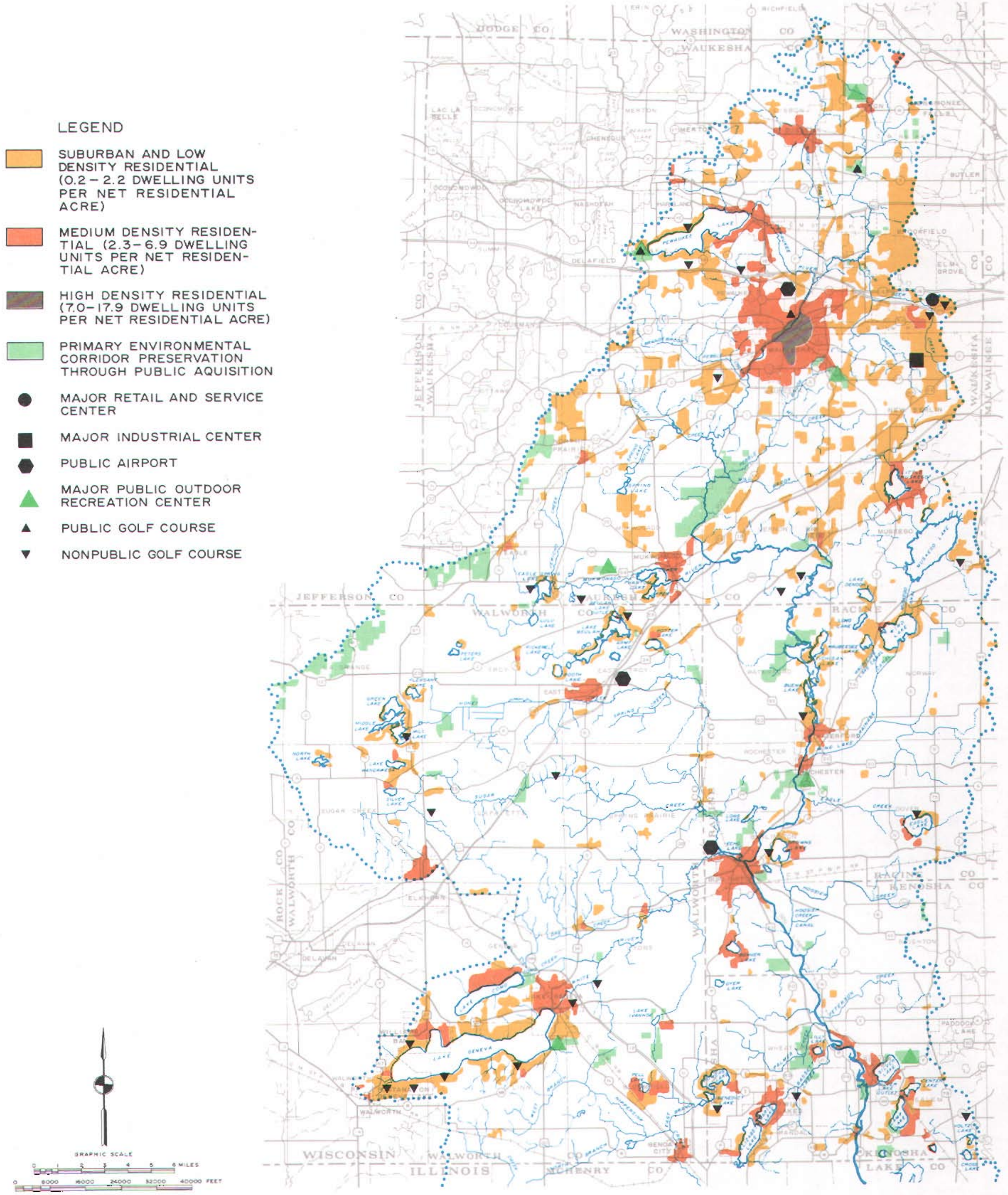
Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties as shown in Maps 43, 44 and 45, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service, or residential development without public sanitary sewer service on lots smaller than one acre in size. For residential development without public sanitary sewer service on lots one acre or larger in size, some areas are suitable for development. However, very severely limited conditions persist in most areas.

Urban Land Uses

Residential Activities: Residential land uses cover approximately 40,192 acres, or 7 percent of the watershed. In addition, there are 10,846 acres or 2 percent of the total watershed area in the residential land use under development category and are so reflected in the pollution loading rates for the land under development section, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Fox River watershed are estimated at 160,800 pounds of total nitrogen, 12,900 pounds of phosphorus, 976,700 pounds of BOD_5, 6.4 x 10^{14} fecal coliform counts and 10,950 tons of sediment during an average year. Table 158 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Map 51

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE FOX RIVER WATERSHED IN 1975



As of 1975 more than 83 percent of the area of the Fox River watershed was devoted to rural land uses. The dominant rural land use in the watershed was agricultural, which occupied 64 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural land uses with scattered concentrations of urban development primarily in the form of small cities and villages in the lower portion of the watershed, and by major concentrations of urban development in the upper portions of the watershed in and around the City of Waukesha and outward from the Milwaukee urbanized area. There were 30 public or private golf courses and six major parks in the watershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 154

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE FOX RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	62.80	40,192	6.62
Commercial[b]	7.69	4,924	0.81
Industrial			
Manufacturing	4.78	3,056	0.50
Landfill & Dump	0.81	518	0.09
Extractive	6.58	4,212	0.69
Transportation			
Streets & Highways	5.58	3,569	0.59
Airfields	1.28	817	0.13
Railroad Yards & Terminals	0.00	1	0.00
Recreation			
Golf Courses	6.42	4,110	0.68
Parks & Other Recreation	9.77	6,251	1.03
Land Under Development			
Residential Land Under Development[c]	0.15	10,846	1.79
Commercial Land Under Development	0.02	13	0.00
Industrial Land Under Development	0.38	245	0.04
Transportation Land Under Development	0.05	29	0.01
Recreation Land Under Development	0.15	96	0.02
Rural Land Use			
Agricultural			
Grain Crops	14.02	8,970	1.48
Hay	80.31	51,396	8.47
Row Crops	357.44	228,761	37.69
Specialty Crops	9.27	5,934	0.98
Sod Farm	6.47	4,139	0.68
Other Open Space[d]	135.82	86,927	14.32
Silvicultural			
Woodlands	95.75	61,282	10.10
Orchards & Nurseries	2.48	1,584	0.26
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	41.41	26,500	4.37
Wetlands, Swamps, & Marshes	82.11	52,548	8.66
Total	931.54[e]	606,920	100.0

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

[e] *The total area of the Fox River watershed represented in this table is different than the total area of the Fox River watershed identified in Table 156. This is due to the fact that the area set forth in Table 156 includes all that portion of the Fox River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Fox River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 155

LENGTH OF STREAMS AND THEIR SOURCES IN FOX RIVER WATERSHED

Stream or Watercourse	Sources		Length[a] (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Buelah Lake Outlet	Town of East Troy	T4N, R18E, Sec. 18, NW 1/4	1.1
Sussex Creek	Village of Sussex	T8N, R19E, Sec. 23, SE 1/4	5.5
Fox River[b]	Town of Menomonee Falls	T8N, R20E, Sec. 5, SE 1/4	81.2
Genesee Creek	Town of Genesee	T6N, R18E, Sec. 14, N 1/4	5.5
Long Lake Channel[c] (Kee Nong Go-Mong)	Town of Norway	T4N, R20E, Sec. 7, NE 1/4	0.9
Goose Lake Branch Canal	Town of Norway	T4N, R20E, Sec. 4, SE 1/4	8.7
Hoosier Creek Canal	Town of Burlington	T2N, R19E, Sec. 11, SE 1/4	7.5
Hoosier Creek	Town of Dover	T3N, R20E, Sec. 33, NW 1/4	3.5
New Munster Creek	Town of Wheatland	T2N, R19E, Sec. 32, NE 1/4	5.3
Jericho Creek	Town of Mukwonago	T5N, R18E, Sec. 6, NE 1/4	6.1
Trevor Creek	Town of Salem	T1N, R20E, Sec. 34, NW 1/4	3.3
Mill Brook	Town of Vernon	T5N, R19E, Sec. 3, SE 1/4	8.5
Mill Creek	Town of Waukesha	T6N, R19E, Sec. 25, SE 1/4	5.5
Brandy Brook	Town of Delafield	T7N, R18E, Sec. 35, SW 1/4	4.8
Mukwonago River[d]	Town of Eagle	T5N, R17E, Sec. 36, NE 1/4	16.9
Sugar Creek	Town of Sugar Creek	T3N, R16E, Sec. 21, NW 1/4	25.3
North Branch-Nippersink Creek	Town of Bloomfield	T1N, R18E, Sec. 20, SW 1/4	8.5
East Branch-Nippersink Creek	Town of Bloomfield	T1N, R18E, Sec. 1, NE 1/4 T1N, R18E, Sec. 14, NW 1/4	3.5
Nippersink Creek[b]	Town of Bloomfield	T1N, R18E, Sec. 26, SW 1/4	5.2
West Branch-Nippersink Creek	Town of Linn	T1N, R17E, Sec. 34, NE 1/4	7.4
Ore Creek	Town of Geneva	T2N, R17E, Sec. 13, NW 1/4	8.2
Como Creek	Town of Geneva	T2N, R17E, Sec. 11, NW 1/4	3.8
Pebble Creek	Town of Waukesha	T6N, R19E, Sec. 8, SW 1/4	5.0
Pebble Brook	Town of Waukesha	T6N, R19E, Sec. 14, NE 1/4	8.0
Pewaukee River	Town of Pewaukee	T7N, R19E, Sec. 4, SW 1/4	6.4
Honey Creek	Town of Troy	T4N, R17E, Sec. 19, SW 1/4 T4N, R16E, Sec. 36, SW 1/4	26.8
Peterson Creek	Town of Brighton	T2N, R20E, Sec. 29, SE 1/4	6.5
Eagle Lake Creek	Town of Dover	T3N, R20E, Sec. 21, SE 1/4	5.5
Poplar Creek	Town of New Berlin	T6N, R20E, Sec. 9, NW 1/4	7.5
Deer Creek	Town of New Berlin	T6N, R20E, Sec. 23, NE 1/4	7.8
Palmer Creek	Town of Wheatland	T1N, R19E, Sec. 6, NW 1/4	3.7
Basset Creek	Village of Twin Lakes	T1N, R19E, Sec. 22, SE 1/4	4.5
Bloomfield Creek	Town of Bloomfield	T1N, R18E, Sec. 9, NW 1/4	3.5
Tichigan Creek	Town of Waterford	T4N, R19E, Sec. 9, SW 1/4	1.6
White River	City of Lake Geneva	T2N, R17E, Sec. 36, NE 1/4	20.0
Spring Brook (Boehner Creek)	Town of Burlington	T2N, R19E, Sec. 17, SW 1/4	3.6
Spring Creek	Town of East Troy	T4N, R18E, Sec. 33, NW 1/4	8.5
Muskego Creek Canal[e] (Wind Lake Drainage Canal)	Town of Muskego	T5N, R20E, Sec. 33, NE 1/4	7.9
First Branch to Ore Creek	Town of Spring Prairie	T3N, R18E, Sec. 35, NW 1/4	2.7
Second Branch to Ore Creek	Town of Spring Prairie	T3N, R18E, Sec. 31 1/4	2.8
Indian Run Creek	Town of Spring Prairie	T3N, R18E, Sec. 34, NW 1/4	2.5
Artesian Brook	Town of Vernon	T5N, R19E, Sec. 13, NW 1/4	2.0
Redwing Creek	Town of Waukesha	T6N, R19E, Sec. 6 1/4	1.5
Upper Creek	Town of New Berlin	T6N, R20E, Sec. 33, NE 1/4	1.5
Spring Valley Creek	Town of Bloomfield	T1N, R18E, Sec. 1, SW 1/4	6.0
Spring Brook	Town of Spring Prairie	T3N, R18E, Sec. 24, NE 1/4	3.5
Lightbody Creek	Town of Linn	T1N, R17E, Sec. 9, SE 1/4	0.6

[a] *Total perennial stream length as shown on U. S. Geological Survey 7 1/2 minute quadrangle maps.*

[b] *Perennial stream length within Wisconsin.*

[c] *Includes 0.5 mile through Waubeesee Lake.*

[d] *Includes 0.5 mile through Lulu Lake, 1.3 miles through Eagle Spring Lake, and 1.8 miles through Lower Phantom Lake.*

[e] *Includes 2.4 miles through Wind Lake and 1.6 miles through Big Muskego Lake.*

Source: SEWRPC.

Table 156

AREAL EXTENT OF CIVIL DIVISIONS IN THE FOX RIVER WATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Kenosha County			
Villages			
Paddock Lake	0.03	--[a]	0.02
Silver Lake	1.43	0.15	100.00
Twin Lakes	5.94	0.64	100.00
Towns			
Brighton	20.61	2.21	57.39
Randall	18.18	1.94	100.00
Salem	26.07	2.79	78.87
Wheatland	24.07	2.58	100.00
County Subtotal	96.33	10.31	34.61
Milwaukee County			
City			
Franklin	0.46	0.05	1.33
County Subtotal	0.46	0.05	0.19
Racine County			
City			
Burlington	3.15	0.34	100.00
Villages			
Rochester	0.45	0.05	100.00
Waterford	1.67	0.18	100.00
Towns			
Burlington	38.79	4.15	100.00
Dover	31.11	3.33	86.01
Norway	35.69	3.82	99.75
Raymond	1.79	0.19	5.01
Rochester	17.25	1.85	100.00
Waterford	34.44	3.69	100.00
County Subtotal	164.34	17.59	48.29
Walworth County			
Cities			
Elkhorn	1.67	0.18	39.76
Lake Geneva	4.33	0.46	100.00
Villages			
East Troy	1.74	0.19	100.00
Fontana on Geneva Lake	3.48	0.37	94.05
Genoa City	1.00	0.11	100.00
Walworth	0.12	0.01	10.01
Williams Bay	2.66	0.28	91.10

Table 156 (continued)

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Walworth County (continued)			
Towns			
Bloomfield	35.06	3.75	100.00
Delavan	0.53	0.06	1.66
East Troy	34.15	3.66	100.00
Geneva	21.09	2.26	64.78
Lafayette	34.75	3.72	99.83
La Grange	28.11	3.01	78.89
Linn	31.41	3.36	93.37
Lyons	35.47	3.80	100.00
Richmond	0.33	0.04	0.92
Spring Prairie	35.90	3.84	100.00
Sugar Creek	26.35	2.82	75.54
Troy	35.58	3.81	100.00
Walworth	2.63	0.28	8.67
Whitewater	1.03	0.11	3.23
County Subtotal	337.39	36.12	58.53
Washington County			
Town			
Richfield	0.30	0.03	0.83
County Subtotal	0.30	0.03	0.07
Waukesha County			
Cities			
Brookfield	12.29	1.32	47.62
Delafield	0.19	0.02	1.81
Muskego	32.15	3.44	89.18
New Berlin	27.00	2.89	73.23
Waukesha	13.51	1.45	100.00
Villages			
Big Bend	0.71	0.08	100.00
Eagle	0.94	0.10	95.92
Hartland	0.23	0.02	7.96
Lannon	2.49	0.27	100.00
Menomonee Falls	14.78	1.58	44.29
Mukwonago	2.08	0.22	100.00
North Prairie	1.33	0.14	100.00
Pewaukee	2.77	0.30	100.00
Sussex	2.65	0.28	100.00
Wales	0.89	0.10	39.38
Towns			
Brookfield	6.72	0.72	97.11
Delafield	14.69	1.57	67.05
Eagle	20.45	2.19	57.87
Genesee	28.34	3.03	87.58
Lisbon	21.31	2.28	63.29
Merton	1.43	0.15	4.97
Mukwonago	33.96	3.63	100.00
Ottawa	3.16	0.34	8.84
Pewaukee	28.67	3.07	100.00
Vernon	35.20	3.77	100.00
Waukesha	27.50	2.94	100.00
County Subtotal	335.49	35.91	57.78
Total	934.31	100.00	--

[a] *Less than 0.01 percent.*

Source: SEWRPC.

Table 157

ESTIMATED POPULATION OF THE FOX RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Kenosha County	
Brighton Town (Part)	420
Paddock Lake Village (Part)	6
Randall Town	1,869
Salem Town (Part)	4,969
Silver Lake Village	1,317
Twin Lakes Village	3,115
Kenosha County (Part) Subtotal	14,097
Milwaukee County	
Franklin City (Part)	14
Milwaukee County (Part) Subtotal	14
Racine County	
Burlington City	8,705
Burlington Town	5,167
Dover Town (Part)	2,715
Norway Town (Part)	4,623
Raymond Town (Part)	294
Rochester Town	1,160
Rochester Village	612
Waterford Town	3,458
Waterford Village	2,335
Racine County (Part) Subtotal	29,069
Walworth County	
Bloomfield Town	2,772
Delavan Town (Part)	254
East Troy	3,044
East Troy Village	2,168
Elkhorn City (Part)	2,556
Fontana on Geneva Lake Village (Part)	1,631
Geneva Town (Part)	2,428
Genoa City Village	1,083
LaFayette Town (Part)	986
LaGrange Town (Part)	1,240
Lake Geneva City	5,323
Linn Town (Part)	2,113
Lyons Town	2,379
Richmond Town (Part)	7
Spring Prairie Town	1,469
Sugar Creek Town (Part)	1,846
Troy Town	1,351
Walworth Town (Part)	260
Walworth Village (Part)	53
Whitewater Town (Part)	21
Williams Bay Village (Part)	1,651
Walworth County (Part) Subtotal	34,635
Washington County	
Richfield Town	14
Washington County (Part) Subtotal	14
Waukesha County	
Big Bend Village	1,439
Brookfield City (Part)	14,437
Brookfield Town (Part)	3,944
Delafield City (Part)	40
Delafield Town (Part)	2,690
Eagle Town (Part)	1,155
Eagle Village (Part)	858
Genesee Town (Part)	3,099
Hartland Village (Part)	476
Lannon Village	1,161
Lisbon Town (Part)	5,740
Menomonee Falls Village (Part)	6,196
Merton Town (Part)	55
Mukwonago Town	2,799
Mukwonago Village	3,132
Muskego City (Part)	9,241
New Berlin City (Part)	16,534
North Prairie Village	793
Ottawa Town (Part)	448
Pewaukee Town	8,234
Pewaukee Village	4,379
Sussex Village	4,112
Vernon Town	3,511
Waukesha City	47,744
Waukesha Town	4,832
Wales Village (Part)	199
Waukesha County (Part) Subtotal	147,246
Fox River Watershed Total	225,075

Source: Wisconsin Department of Administration and SEWRPC.

Commercial Activities: Within the Fox River watershed, approximately 4,924 acres, or about 1 percent, of the total land surface is devoted to commercial activities. In addition, 13 acres, or less than 1 percent of the watershed, were under development for commercial land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. The estimated annual pollutant loadings from commercial activities excluding land under development within the Fox River watershed are 44,300 pounds of total nitrogen, 3,700 pounds of total phosphorus, 480,600 pounds of biochemical oxygen demand, 1.6 x 10^{14} fecal coliform counts, and 1,840 tons of sediment. Table 159 presents the areal extent of commercial land uses within the Fox River watershed along with the estimated average annual diffuse source pollutant loads from these areas.

Table 158

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	40,192	6.62	Total Nitrogen	4	160,770
			Total Phosphorus	0.32	12,860
			Biochemical Oxygen Demand	24.3	976,670
			Fecal Coliform	1.6×10^{10} counts/a/yr.	6.4×10^{14} counts/yr.
			Sediment	545	10,950 tons

Source: SEWRPC.

Table 159

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (*pounds/acre/year*)	Estimated Channel Load (pounds/year)
Commercial	4,924	0.81	Total Nitrogen	9.0	44,320
			Total Phosphorus	0.75	3,690
			Biochemical Oxygen Demand	97.6	480,580
			Fecal Coliform	3.3×10^{10} counts/a/yr.	1.6×10^{14} counts/yr.
			Sediment	745	1,835 tons

Source: SEWRPC.

Industrial Activities: Industrial land uses cover 3,056 acres, or less than 1 percent of the Fox River watershed. In addition, 245 acres, or less than 1 percent of the watershed, were under development for industrial land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. The industrial activities excluding land under development within the Fox River watershed are estimated to contribute annually 25,700 pounds of total nitrogen, 2,100 pounds of total phosphorus, 112,800 pounds of BOD_5, 1.9×10^{14} fecal coliform counts, and 1,490 tons of sediment to surface runoff. Table 160 presents the areal extent of the industrial uses within the Fox River watershed along with the estimated average annual diffuse source pollutant loadings from these activities. Industrial production and distribution are urban-related activities and are minimal within the watershed's rural areas, with the exception of the areas in which sand and salt are stored, and the areas in which gravel or stone are quarried.

There are 34 sites of sanitary landfill operations within the Fox River watershed occupying a total of 518 acres, or less than 1 percent of the drainage area. These are included, along with their estimated pollutant loading rates, on Table 160. The landfill operations have an estimated annual pollutant load of 4,400 pounds of total nitrogen, 400 pounds of total phosphorus, 19,100 pounds of BOD_5, 3.2×10^{13} fecal coliform counts, and 250 tons of sediment. In addition to the landfill and dump sites, there were 23 auto salvage and wrecking facilities which are included in this analysis of industrial activities.

Extractive Activities: There were 4,212 acres or less than 1 percent of the total watershed area in extractive mining operations, consisting of gravel pits and attendant washing operations, in the Fox River watershed as of 1975. These operations contribute an estimated 252,700 pounds of total nitrogen, 189,500 pounds of total phosphorus, 505,400 pounds of BOD_5, and 315,900 tons of sediment annually. Table 161 presents the extent of the extraction operations and the estimated attendant diffuse source pollutant loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, railroad yards and terminals, and airfields. In addition, 29 acres, or less than 1 percent of the watershed, were under development for transportation land use and are included as pollution sources in the land under development category, because of the increased loadings from lands under-

Table 160

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	3,056	0.50	Total Nitrogen	8.4	25,670
			Total Phosphorus	0.70	2,140
			Biochemical Oxygen Demand	36.9	112,770
			Fecal Coliform	6.2×10^{10} counts/a/yr.	1.9×10^{14} counts/yr.
			Sediment	977	1,490 tons
Landfill and Dump.	518	0.09	Total Nitrogen	8.4	4,360
			Total Phosphorus	0.70	360
			Biochemical Oxygen Demand	36.9	19,130
			Fecal Coliform	6.2×10^{10} counts/a/yr.	3.2×10^{13} counts/yr.
			Sediment	977	250 tons
Total	3,574	0.59	Total Nitrogen	--	30,020
			Total Phosphorus	--	2,500
			Biochemical Oxygen Demand	--	131,880
			Fecal Coliform	--	2.2×10^{14} counts/yr.
			Sediment	--	1,745 tons

Source: SEWRPC.

Table 161

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive.	4,212	0.69	Total Nitrogen	60	252,720
			Total Phosphorus	45	189,540
			Biochemical Oxygen Demand	120	505,440
			Fecal Coliform	Negligible	--
			Sediment	150,000	315,900 tons

Source: SEWRPC.

going conversion from rural to urban use. Table 162 presents the estimated pollutant contributions excluding land under development from the 4,387 acres, or about 1 percent of the total watershed area which is devoted to these land uses. It is estimated that 93,300 pounds of nitrogen, 7,200 pounds of phosphorus, 581,900 pounds of BOD_5, 2.4×10^{14} fecal coliform counts, and 77,330 tons of sediment are transported annually from transportation related activities within the Fox River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 6,251 acres, or 1 percent of the total area of the watershed, and golf courses with a total area of 4,110 acres, or about 1 percent of the total area of the watershed. In addition, 96 acres, or less than 1 percent of the watershed, were under development for recreational land use and are included as pollution sources in the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Map 51 indicates the location of public and private golf courses and major parks within the Fox River watershed as of 1975. Table 163 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants transported from these land uses, excluding land under development. It is estimated that 32,500 pounds of total nitrogen, 1,200 pounds of total phosphorus, 13,500 pounds of BOD_5, 2.3×10^{13} fecal coliform counts, and 2,180 tons of sediment are transported from parks and golf courses within the Fox River watershed annually.

Table 162

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	3,569	0.59	Total Nitrogen	23.4	83,510
			Total Phosphorus	1.4	5,000
			Biochemical Oxygen Demand	159.0	567,470
			Fecal Coliform	6.7×10^{10} counts/a/yr.	2.4×10^{14} counts/yr.
			Sediment	42,600	76,020 tons
Railroads & Terminals	1	0.0002	Total Nitrogen	8.4	10
			Total Phosphorus	1.17	0
			Biochemical Oxygen Demand	36.9	40
			Fecal Coliform	6.2×10^{10} counts/a/yr.	6.0×10^{10} counts/yr.
			Sediment	977	0 tons
Airfields	817	0.13	Total Nitrogen	12.0	9,800
			Total Phosphorus	2.7	2,200
			Biochemical Oxygen Demand	17.6	14,380
			Fecal Coliform	Negligible	--
			Sediment	3,200	1,310 tons
Total	4,387	0.722	Total Nitrogen	--	93,330
			Total Phosphorus	--	7,200
			Biochemical Oxygen Demand	--	581,890
			Fecal Coliform	--	2.4×10^{14} counts/yr.
			Sediment	--	77,330 tons

Source: SEWRPC.

Table 163

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation	6,251	1.03	Total Nitrogen	2.3	14,380
			Total Phosphorus	0.06	380
			Biochemical Oxygen Demand	1.3	8,130
			Fecal Coliform	3.6×10^{9} counts/a/yr.	2.3×10^{13} counts/yr.
			Sediment	420	1,315 tons
Golf Courses	4,110	89'0	Total Nitrogen	4.4	18,080
			Total Phosphorus	0.2	820
			Biochemical Oxygen Demand	1.3	5,340
			Fecal Coliform	Negligible	--
			Sediment	420	865 tons
Total	10,361	1.71	Total Nitrogen	--	32,460
			Total Phosphorus	--	1,200
			Biochemical Oxygen Demand	--	13,470
			Fecal Coliform	--	2.3×10^{13} counts/yr
			Sediment	--	2,175 tons

Source: SEWRPC.

Land Under Development: The Fox River watershed is undergoing conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 10,846 acres, or 2 percent of the total land area of the watershed. Similarly, an estimated 245 acres, or less than 1 percent of the total area of the watershed was under development for industrial land uses in 1975. Ninety-six acres, or less than 1 percent of recreational related lands, and 29 acres, or less than 1 percent of transportation related lands were under development in the watershed in 1975. In addition, 13 acres, or less than 1 percent of commercial related lands, were under development in the watershed in 1975. It is estimated that 673,700 pounds of total nitrogen, 505,300 pounds of total phosphorus, 1,347,500 pounds of BOD_5, and 842,180 tons of sediment were transported from these construction sites in 1975. Table 164 presents the estimated acreage of land under conversion from rural to urban use within the Fox River watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were only 145 known holding tanks and 15 mound systems in the watershed, as shown in Map 46. Table 165 presents the estimated pollutant loadings from the approximately 28,106 septic tanks in the watershed as of 1975. It is estimated that 283,020 pounds of nitrogen, 64,410 pounds of phosphorus, 3,981,840 pounds of BOD_5, 4.9 x 10^{15} fecal coliform counts, and 685 tons of sediment are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Fox River watershed.

Rural Land Uses

Agricultural Activities: About 64 percent of the area of the Fox River watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May 1975, 698 significant domestic livestock operations with a total of 344,580 animals, or 77,430 equivalent animal units, were known to exist within the watershed. This figure does not include one duck farm with 82,600 ducks or 826 equivalent animal units which are treated in the point source inventory of this report. Map 52 indicates the locations of these livestock operations. Of these operations, 299 were located within 500 feet of the identified stream system of the watershed. Table 166 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated

Table 164

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	10,846	1.79	Total Nitrogen	60	650,770
			Total Phosphorus	45	488,060
			Biochemical Oxgen Demand	120	1,301,520
			Fecal Coliform	Negligible	--
			Sediment	150,000	813,450 tons
Commercial	13	0.002	Total Nitrogen	60	780
			Total Phosphorus	45	590
			Biochemical Oxygen Demand	120	1,560
			Fecal Coliform	Negligible	--
			Sediment	150,000	975 tons
Industrial	245	0.04	Total Nitrogen	60	14,700
			Total Phosphorus	45	11,030
			Biochemical Oxygen Demand	120	29,400
			Fecal Coliform	Negligible	--
			Sediment	150,000	18,375 tons
Transportation	29	0.005	Total Nitrogen	60	1,740
			Total Phosphorus	45	1,310
			Biochemical Oxygen Demand	120	3,480
			Fecal Coliform	Negligible	--
			Sediment	150,000	2,175 tons
Recreational	96	0.02	Total Nitrogen	60	5,760
			Total Phosphorus	45	4,320
			Biochemical Oxygen Demand	120	11,520
			Fecal Coliform	Negligible	--
			Sediment	150,000	7,200 tons
Total	11,229	1.857	Total Nitrogen	--	673,740
			Total Phosphorus	--	505,310
			Biochemical Oxygen Demand	--	1,347,480
			Fecal Coliform	--	--
			Sediment	--	842,175 tons

Source: SEWRPC.

Table 165

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE FOX RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	28,106	97,594	Total Nitrogen	2.9	203,020
			Total Phosphorus	0.66	64,410
			Biochemical Oxygen Demand	40.8	3,981,840
			Fecal Coliform	5.0×10^{10} counts/capita/yr.	4.9×10^{15} counts/yr.
			Sediment	14.0	685 tons

Source: SEWRPC.

total wastes produced annually, and the total estimated pollutant loading rates. Approximately 2,198,700 pounds of nitrogen, 511,000 pounds of phosphorus, 8,609,100 pounds of BOD_5, 5.0×10^{16} fecal coliform counts, and 27,100 tons of sediment are transported from livestock operations within the Fox River watershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 167. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 8,970 acres, or about 2 percent of the total area of the watershed were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Fox River watershed are accordingly estimated at 42,200 pounds of nitrogen, 1,200 pounds of phosphorus, 86,100 pounds of BOD_5, and 14,350 tons of sediment. Table 167 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates to the land surface in an average year within the watershed.

Approximately 51,396 acres, or 8 percent of the total area of the watershed were devoted to growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Fox River watershed are 46,300 pounds of nitrogen, 4,600 pounds of phosphorus, 493,400 pounds of BOD_5, and 82,240 tons of sediment.

Major row crops grown within the Fox River watershed are corn and soybeans which were planted on 228,761 acres, or 38 percent of the total area of the watershed, making up the largest land use category within the watershed. As shown in Table 167 an estimated 5,284,400 pounds of nitrogen, 146,400 pounds of phosphorus, 4,552,300 pounds of BOD_5, and 754,910 tons of sediment are tranported annually from the row crop acreage within the Fox River watershed.

Also, as shown in Table 167, specialty crops were grown on a total of 5,934 acres, or 1 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, mint, and onions. The estimated annual pollutant loadings from these crops within the Fox River watershed are 137,100 pounds of nitrogen, 3,800 pounds of phosphorus, 178,000 pounds of BOD_5, and 29,670 tons of sediment.

About 4,139 acres, or about 1 percent of land within the watershed were in sod farms in 1975. Estimated average annual pollutant loading rates from these sod farms within the Fox River watershed are 3,700 pounds of nitrogen, 400 pounds of phosphorus, 8,700 pounds of BOD_5, and 1,450 tons of sediment.

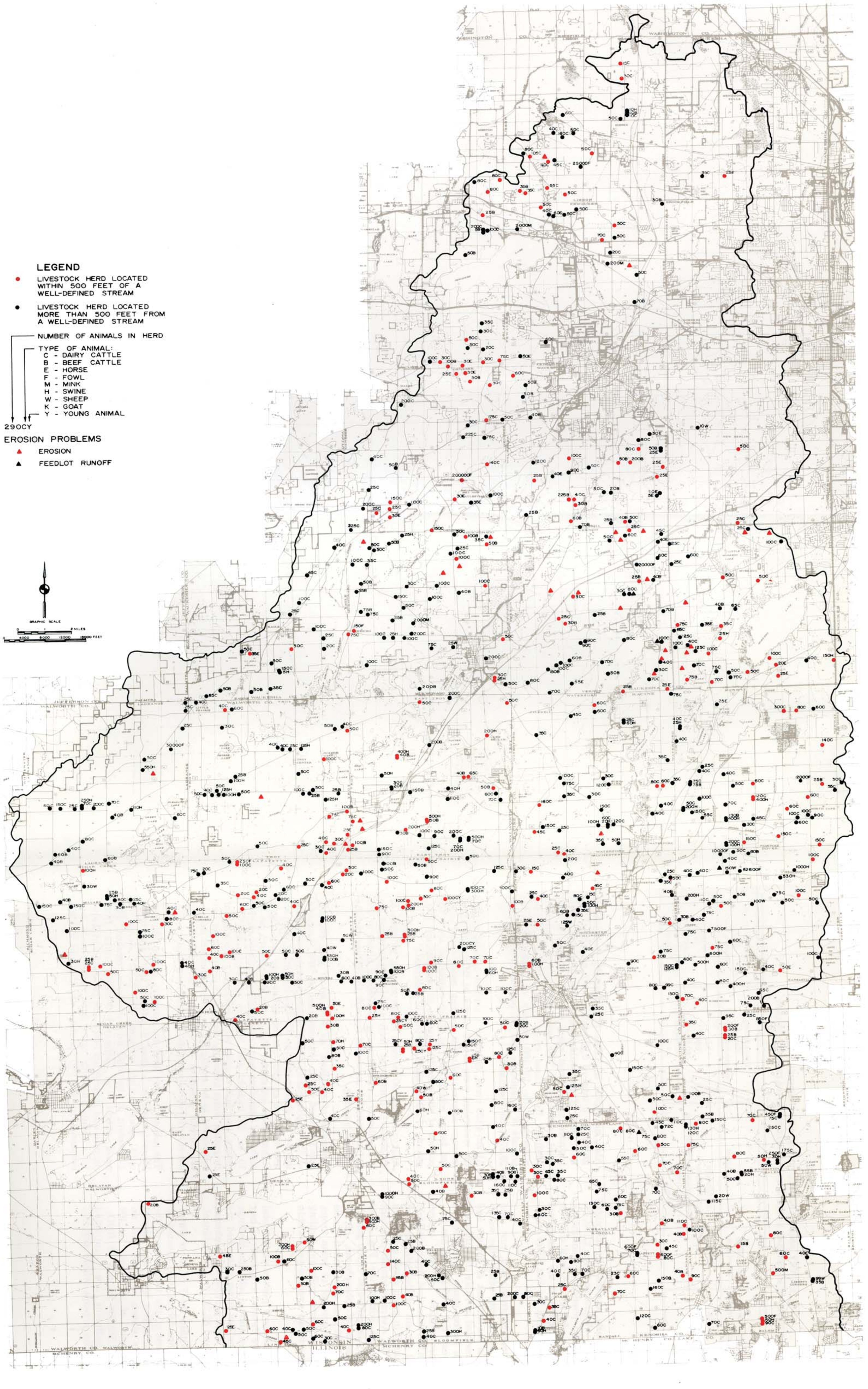
Approximately 90 percent of the annual plowing of cropland is considered likely to have been tilled by conventional methods, using moldboard plows in the autumn and left uncovered through the winter months and early spring.

Irrigation of cropland, as well as of golf courses, was practiced within the watershed in 1975. Location of the high-capacity wells which provide the water supply are shown on Map 47. The irrigation volumes are estimated at 6,927 million gallons per day (mgd). It has been estimated that corn receives up to 10 inches of irrigation water annually, vegetables receive 15 to 20 inches, sod receives approximately 18 inches, and golf courses receive varying amounts of irrigation water annually. Irrigation return flows are considered to be negligible in the watershed due to the careful practices of operators, as well as the use of aerial spray methods of application used.

The second largest land use category within the Fox River watershed is that of pasture land and other open space—which accounts for 86,927 acres, or 14 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 167. Annual loading rates from these areas are estimated at 399,900 pounds of nitrogen, 25,200

Map 52

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE FOX RIVER WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 698 operations within the Fox River watershed in 1975, 299 operations, or 42.8 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 166

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE FOX RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	41,010	57,410	890,573	Total Nitrogen	28.4	1,630,440
				Total Phosphorus	1.6	378,910
				Biochemical Oxygen Demand	111.2	6,383,990
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	3.7×10^{16} counts/yr.
				Sediment	700.0	20,095 tons
Beef	8,800	8,800	96,617	Total Nitrogen	28.4	249,920
				Total Phosphorus	6.6	58,080
				Biochemical Oxygen Demand	111.2	97,560
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	5.6×10^{15} counts/yr.
				Sediment	700.0	3,080 tons
Hogs	14,080	5,630	70,934	Total Nitrogen	28.4	159,890
				Total Phosphorus	6.6	37,160
				Biochemical Oxygen Demand	111.2	626,060
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	3.6×10^{15} counts/yr.
				Sediment	700.0	1,970 tons
Horses	1,180	2,360	21,535	Total Nitrogen	28.4	67,020
				Total Phosphorus	6.6	15,580
				Biochemical Oxygen Demand	111.2	262,430
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	1.5×10^{15} counts/yr.
				Sediment	700.0	825 tons
*Fowl	305,400	3,050	27,868	Total Nitrogen	28.4	86,620
				Total Phosphorus	6.6	20,130
				Biochemical Oxygen Demand	111.2	339,160
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	2.0×10^{15} counts/yr.
				Sediment	700.0	1,070 tons
Sheep	820	80	539	Total Nitrogen	28.4	2,270
				Total Phosphorus	6.6	530
				Biochemical Oxygen Demand	111.2	8,800
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	5.1×10^{13} counts/yr.
				Sediment	700.0	30 tons
Mink	6,920	70	630	Total Nitrogen	28.4	1,990
				Total Phosphorus	6.6	460
				Biochemical Oxygen Demand	111.2	7,780
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	4.5×10^{13} counts/yr.
				Sediment	700.0	25 tons
Other	20	20	226	Total Nitrogen	28.4	570
				Total Phosphorus	6.6	130
				Biochemical Oxygen Demand	111.2	2,220
				Fecal Coliforn	6.4×10^{11} counts/a.u./yr.	1.3×10^{13} counts/yr.
				Sediment	700.0	5 tons
Total	378,230	77,420	1,111,921	Total Nitrogen	--	2,198,730
				Total Phosphorus	--	510,970
				Biochemical Oxygen Demand	--	8,609,100
				Fecal Coliform	--	5.0×10^{16} counts/yr.
				Sediment	--	27,095 tons

*Does not include one duck farm with a total of 82,600 ducks or 826 equivalent animal units which are treated in the point source inventory.

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 167

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	8,970	1.48	Total Nitrogen	4.7	42,160
			Total Phosphorus	0.13	1,170
			Biochemical Oxygen Demand	9.6	86,110
			Fecal Coliform	Negligible	--
			Sediment	3,200	14,350 tons
Hay	51,396	8.47	Total Nitrogen	0.9	46,260
			Total Phosphorus	0.09	4,630
			Biochemical Oxygen Demand	9.6	493,400
			Fecal Coliform	Negligible	--
			Sediment	3,200	82,235 tons
Row	228,761	37.69	Total Nitrogen	23.1	5,284,380
			Total Phosphorus	0.64	146,410
			Biochemical Oxygen Demand	19.9	4,552,340
			Fecal Coliform	Negligible	--
			Sediment	6,600	754,910 tons
Specialty Crops					
Vegetable and Other Agricultural Crops. .	5,934	0.98	Total Nitrogen	23.1	137,070
			Total Phosphorus	0.64	3,800
			Biochemical Oxygen Demand	30.0	178,020
			Fecal Coliform	Negligible	--
			Sediment	10,000	29,670 tons
Sod	4,139	0.68	Total Nitrogen	0.9	3,730
			Total Phosphorus	0.09	370
			Biochemical Oxygen Demand	2.1	8,690
			Fecal Coliform	Negligible	--
			Sediment	700	1,450 tons
Pasture	86,927	14.32	Total Nitrogen	4.6	399,870
			Total Phosphorus	0.29	25,210
			Biochemical Oxygen Demand	9.7	843,190
			Fecal Coliform	Negligible	--
			Sediment	420	18,250 tons
Total	386,127	63.62	Total Nitrogen	--	5,913,460
			Total Phosphorus	--	181,580
			Biochemical Oxygen Demand	--	6,161,760
			Fecal Coliform	--	--
			Sediment	--	900,870 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

pounds of phosphorus, 843,200 pounds of BOD_5, and 18,250 tons of sediment.

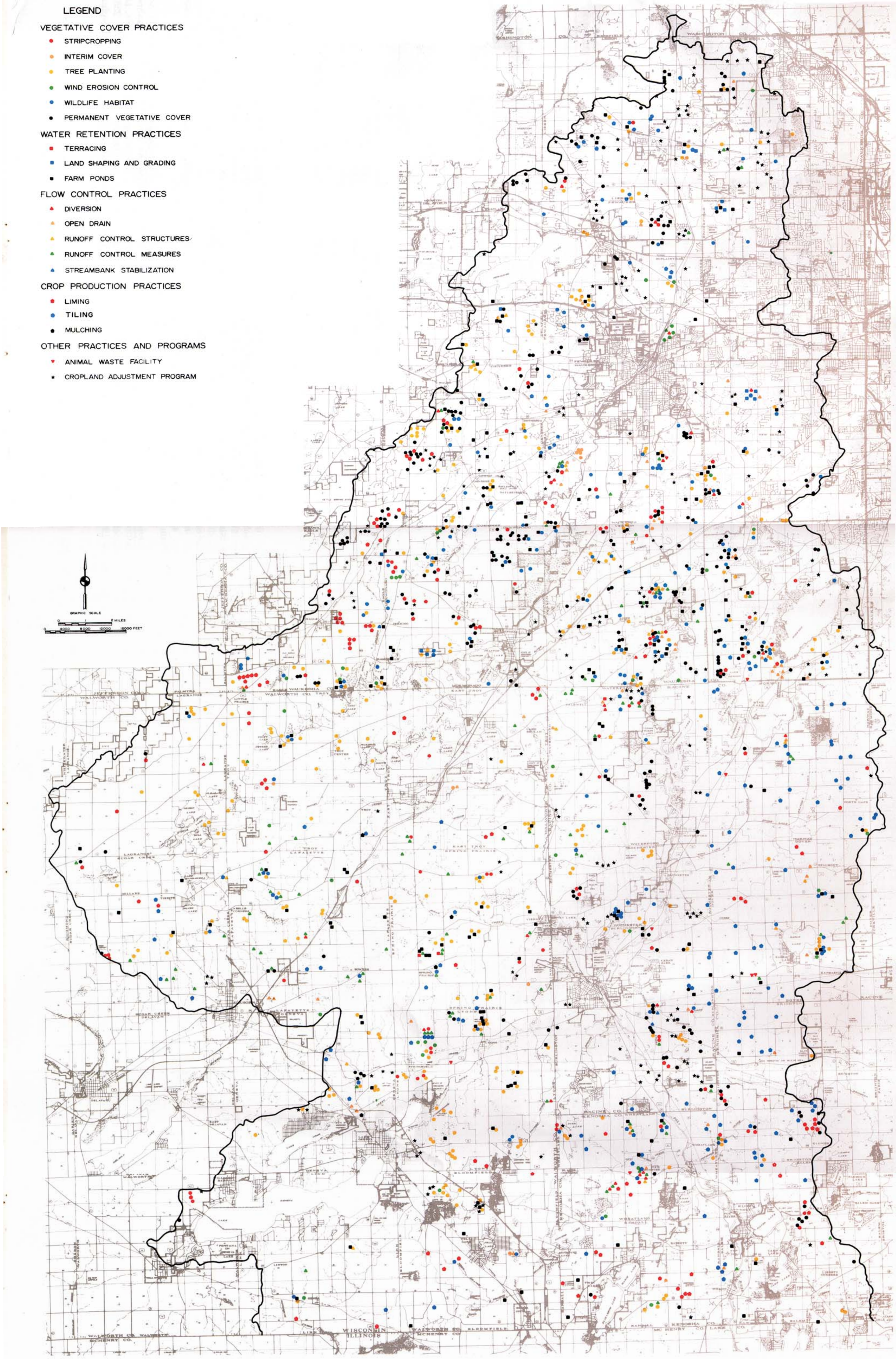
As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 947 farms covering about 123,788 acres, or 32 percent of the agricultural land within the watershed.

A total of 1,945 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 53.

Table 168 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $3,018,952, or an equivalent $7.82 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth.

Map 53

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE FOX RIVER WATERSHED IN 1975



The above map illustrates the locations of the 1,945 known conservation practices installed in the Fox River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Table 168

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE FOX RIVER WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value in 1976 Dollars
Vegetative Cover Practices			
Stripcropping	1,663 acres	10.00/acre	16,630.00
Interim Cover	279 acres	12.00/acre	3,348.00
Tree Stands	(305 units) (2 acres/unit) = 610 acres	100.00/acre	61,000.00
Wind Erosion Control	111,356 feet	0.60/foot	66,813.60
Wildlife Habitat	(159 units) (2 acres/unit) = 318 acres	25.00/acre	7,950.00
Permanent Vegetative Cover	4,435 acres	50.00/acre	221,750.00
Subtotal			377,491.60
Water Retention Practices			
Terracing	13,846 feet	0.70/foot	9,692.20
Farm Ponds	218 units	4,000.00/unit	872,000.00
Subtotal			881,692.20
Flow Control Practices			
Diversions	54,554 feet	1.25/foot	68,192.50
Open Drains	135,775 feet	2.25/foot	305,493.75
Runoff Control Structures	32 units	2,500.00/unit	80,000.00
Runoff Control Measures	461,425 feet	1.00/foot	461,425.00
Streambank Stabilization	13,418 feet	3.50/foot	46,963.00
Subtotal			962,074.25
Crop Production Practices			
Liming	2,810 acres	20.00/acre	56,200.00
Tiling	843,792 feet	0.70/foot	590,654.40
Mulching	114 acres	60.00/acre	6,840.00
Subtotal			653,694.40
Animal Waste Facilities	6 units	24,000.00/unit	144,000.00
Watershed Total			$3,018,952.40

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

Of the total estimated expenditures on conservation practices, about $6.13 per acre of agricultural land, or about 78 percent of the total investment were related to those practices directly affecting water quality. This represents about 41 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 62,866 acres, or approximately 10 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries.

Table 169 presents the acreage of silvicultural activities within the Fox River watershed and the estimated loading rates from these activities. About 144,600 pounds of nitrogen, 8,800 pounds of phosphorus, 289,200 pounds of BOD_5, 4.1 x 10^{13} fecal coliform counts, and 7,890 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 26,500 acres, or 4 percent of the total area of the watershed is covered by surface water in the form of ponds, lakes and streams. As indicated in Table 170, 235,900 pounds of nitrogen, 13,300 pounds of phosphorus,

Table 169

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	61,282	10.10	Total Nitrogen	2.3	140,950
			Total Phosphorus	0.14	8,580
			Biochemical Oxygen Demand	4.6	281,900
			Fecal Coliform	6.6×10^8 counts/a/yr.	4.0×10^{13} counts/yr.
			Sediment	251	7,690 tons
Orchards and Nurseries	1,584	0.26	Total Nitrogen	2.3	3,640
			Total Phosphorus	0.14	220
			Biochemical Oxygen Demand	4.6	7,290
			Fecal Coliform	6.6×10^8 counts/a/yr.	1.0×10^{12} counts/yr.
			Sediment	251	200 tons
Total	62,866	10.36	Total Nitrogen	--	144,590
			Total Phosphorus	--	8,800
			Biochemical Oxygen Demand	--	289,180
			Fecal Coliform	--	4.1×10^{13} counts/yr.
			Sediment	--	7,890 tons

Source: SEWRPC.

Table 170

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION IN THE FOX RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams	26,500	4.37	Total Nitrogen	8.9	235,850
			Total Phosphorus	0.5	13,250
			Biochemical Oxygen Demand	162	4,293,000
			Fecal Coliform	Negligible	--
			Sediment	665	8,810 tons

Source: SEWRPC.

4,293,000 pounds of BOD_5, and 8,810 tons of sediment can be expected to be contributed to the surface waters of the Fox River watershed annually by atmospheric dry fall and washout.

A total of 52,548 acres, or 9 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Fox River watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Fox River Watershed

The Fox River watershed is generally agricultural with storm water runoff from these lands contributing the largest diffuse source loads of nitrogen, and sediment. In addition, agricultural runoff is the second highest contributor of oxygen demand in the watershed. Livestock operations are also a major source of pollution to the Fox River and contribute the largest loads of phosphorus, biochemical oxygen demand, and fecal coliform, and the second largest load of nitrogen. Construction activities are also a major source of pollution to the Fox River and contribute the second largest diffuse source load of phosphorus and sediment to the Fox River. Other major diffuse sources of pollution include mining and extractive activities, which contribute the third largest load of phosphorus and the third highest load of sediment, air pollution loadings to surface waters with the fourth highest load of biochemical oxygen demand, and onsite sewage disposal systems, with the second largest load of fecal coliform and the fourth largest load of biochemical oxygen demand. Developed urban areas, inclusive of residential, commercial, and industrial land uses, contribute only about 2 percent of the nitrogen, 1 percent of the phosphorus, 6 percent of the BOD_5, 2 percent of the fecal coliform counts, and less than 1 percent of the sediment loads to the Fox River. Recreational and silvicultural land uses contribute less than one and one-half percent of any major pollutant. Total annual diffuse source loads are 10,063,000 pounds of nitrogen, 1,501,300 pounds of phosphorus, 27,372,300 pounds of biochemical oxygen demand, 5.6×10^{16} fecal coliform counts, and 2,197,450 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE KINNICKINNIC RIVER WATERSHED

Physical Setting

The Kinnickinnic River watershed is a natural surface water drainage unit, 25 square miles in areal extent, located in the east-central portion of the Region. The boundaries of the basin together with the locations of the main channel of the Kinnickinnic River and its six principal tributaries are shown on Map 26. The mainstem of the Kinnickinnic River originates near Howard Avenue and 51st Street in the City of Milwaukee and discharges to Lake Michigan at the Milwaukee River estuary in Milwaukee County. Only about 12 percent of the watershed is in rural land uses, with about 97 percent of this area still in agricultural use. Most of the agricultural related land use is dispersed throughout the southern portions of the watershed. Map 54 sets forth the major land use categories and their spatial distributions within the Kinnickinnic River watershed as they were inventoried in 1975. Table 171 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north and west by the Menomonee River watershed, on the south by the Oak Creek watershed, and on the east by Lake Michigan. The Kinnickinnic River system consists of Lyons Park Creek, S. 43rd Street ditch tributary, Wilson Park Creek, Cherokee Park Creek, Villa Mann Creek, Holmes Avenue Creek, and the Kinnickinnic River mainstem. Table 172 lists for the Kinnickinnic River watershed, each major stream reach, together with the location of the source and the length of the streams in miles. The watershed ranks smallest in size of the 12 watersheds within the Region, but fifth in total resident population.

Superimposed upon the natural meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Kinnickinnic River watershed lies totally within Milwaukee County and in parts of five cities and one village. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 173. The 1975 resident population of the watershed is estimated at 165,088 persons, or approximately 9.2 percent of the estimated 1975 total regional population. Table 174 presents the population distribution in the Kinnickinnic River watershed by civil division.

Surface water in the Kinnickinnic River watershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits, and wetlands make up the remainder of the surface water. The streamflow of the Kinnickinnic River has been measured since September 1976 at a continuous flow recording gage measured by the U.S. Geological Survey in cooperation with the Milwaukee-Metropolitan Sewerage District and the Commission at 7th Street.

Presently there is no available mapping to indicate the predominant soil types within the Kinnickinnic River watershed, due to the highly urbanized characteristics of the land surface, which includes artificial fill materials and paved surfaces over much of the area. However, knowledge of the area soils indicates that the basic soil types are of a heavy, clay-like character.

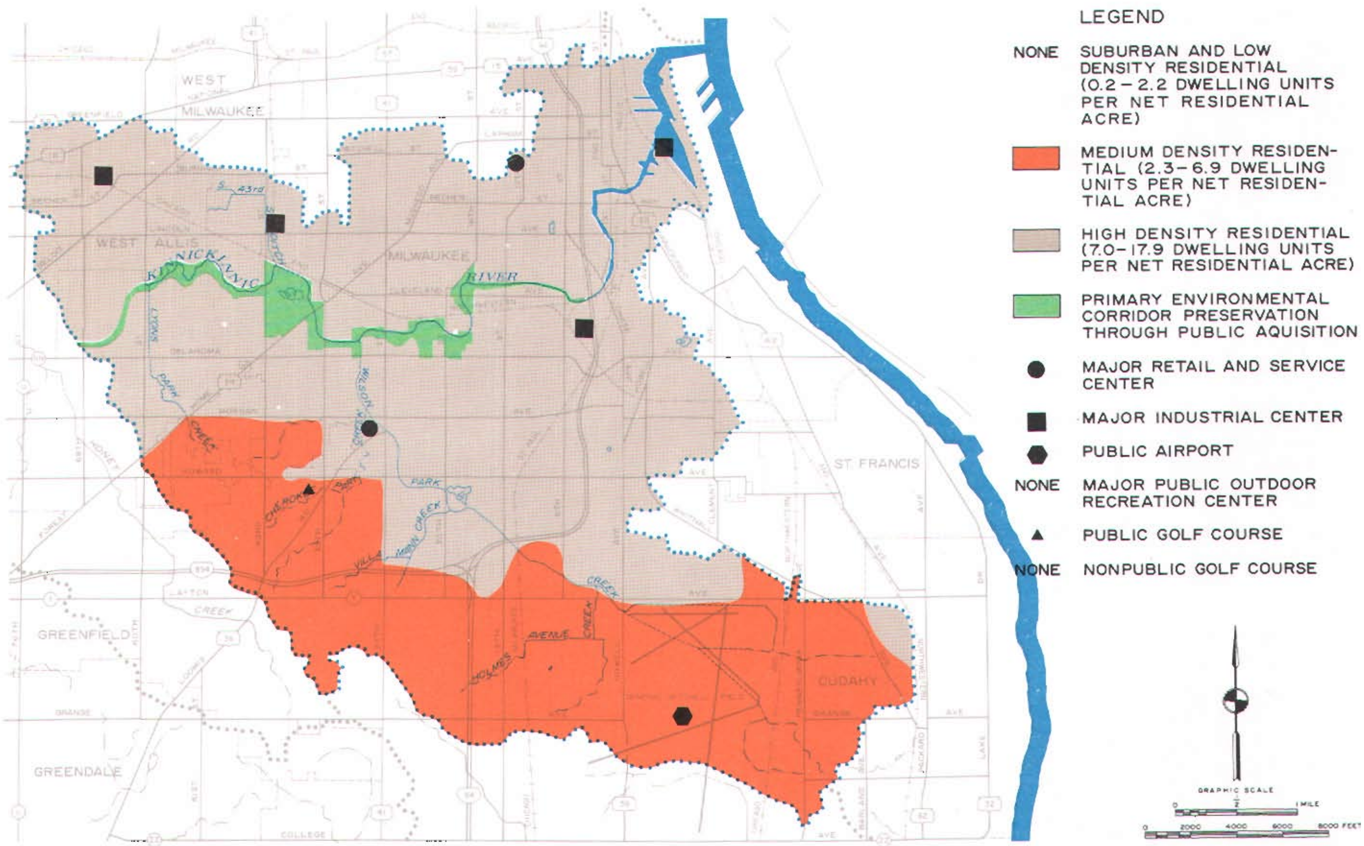
Urban Land Uses

Residential Activities: The areal extent of residential activities is greater than that of any other single land use category within the Kinnickinnic River watershed. Residential land uses cover approximately 7,559 acres, or 51 percent of the watershed. In addition, there are 266 acres of residential land use under development, a factor reflected in the estimated pollution loading rates of the land under development section, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Kinnickinnic River watershed are estimated at 30,200 pounds of nitrogen, 2,400 pounds of phosphorus, 183,700 pounds of BOD_5, 1.2×10^{14} fecal coliform counts, and 2,060 tons of sediment during an average year. Table 175 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Kinnickinnic River watershed, approximately 1,239 acres, or 8 percent of the total land surface is devoted to commercial

Map 54

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE KINNICKINNIC RIVER WATERSHED IN 1975



As of 1975 more than 88 percent of the area of the Kinnickinnic River watershed was devoted to urban land uses. The dominant urban land use in the watershed was residential, which occupied 51 percent of the watershed area. The spatial distribution of land use in the watershed was characterized by medium- to high-density residential land uses over most of the watershed, with several major concentrations of industrial land use located in the upper portions of the watershed. There was one public golf course and a major parkway in the watershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 171

AREAL EXTENT OF WATER QUALITY RELATED LAND USES
IN THE KINNICKINNIC RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	11.81	7,559	50.65
Commercial[b]	1.94	1,239	8.30
Industrial			
Manufacturing	2.12	1,354	9.07
Landfill & Dump	0.04	27	0.18
Extractive	0.02	15	0.10
Transportation			
Streets & Highways	0.88	563	3.77
Airfields	1.77	1,130	7.57
Railroad Yards & Terminals	0.03	16	0.11
Recreation			
Golf Courses	0.05	32	0.21
Parks & Other Recreation	1.31	839	5.62
Land Under Development			
Residential Land Under Development[c]	0.42	266	1.78
Commercial Land Under Development	--	--	--
Industrial Land Under Development	0.00	1	0.01
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	--	--	--
Hay	--	--	--
Row Crops	--	--	--
Specialty Crops	0.15	94	0.63
Sod Farm	--	--	--
Other Open Space[d]	2.66	1,703	11.41
Silvicultural			
Woodlands	0.03	20	0.13
Orchards & Nurseries	--	--	--
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	0.05	31	0.21
Wetlands, Swamps, & Marshes	0.06	36	0.24
Total	23.34	14,925	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01). The final control total for the area of the Kinnickinnic River watershed is shown in Table 173.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 172

LENGTH OF STREAMS AND THEIR SOURCES WITHIN THE KINNICKINNIC RIVER WATERSHED

Stream or Watercourse	Source		Length[a] (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Kinnickinnic River	City of Milwaukee	T6N, R21E, Sec. 10, NE 1/4	8.0
Wilson Park Creek	City of Milwaukee	T6N, R22E, Sec. 29, NE 1/4	3.7
Cherokee Park Creek[b]	City of Greenfield	T6N, R21E, Sec. 24, NW 1/4	1.8
Villa Mann Creek	City of Greenfield	T6N, R21E, Sec. 24, NW 1/4	0.9
	City of Milwaukee	T6N, R22E, Sec. 19, SW 1/4	
Holmes Avenue Creek	City of Milwaukee	T6N, R22E, Sec. 29, NW 1/4	1.2
S. 43rd Street Creek	Village of West Milwaukee	T6N, R21E, Sec. 2, SE 1/4	1.1
Lyons Park Creek	City of Milwaukee	T6N, R21E, Sec. 14, NW 1/4	1.3

[a] *Total perennial stream length as shown on U. S. Geological Survey quadrangle maps.*

[b] *Intermittent streams.*

Source: SEWRPC.

Table 173

AREAL EXTENT OF CIVIL DIVISIONS
IN THE KINNICKINNIC RIVER WATERSHED: JANUARY, 1976

Civil Division	Civil Division Area Within the Watershed (square miles)	Percent of Watershed Area Within the Civil Division	Percent of Civil Division Within the Watershed
Milwaukee County			
City of Cudahy	1.49	31.43	6.00
City of Greenfield	2.37	20.38	9.54
City of Milwaukee	18.76	19.41	75.49
City of St. Francis	0.11	4.30	0.44
City of West Allis	1.67	14.67	6.72
Village of West Milwaukee	0.45	40.54	1.81
Total	24.85	100.00	100.00

Source: SEWRPC.

activities. The estimated annual pollutant loadings from commercial activities within the Kinnickinnic River watershed are 11,200 pounds of nitrogen, 900 pounds of phosphorus, 120,900 pounds of BOD_5, 4.1 x 10^{13} fecal coliform counts, and 460 tons of sediment. Table 176 presents the areal extent of commercial land uses within the Kinnickinnic River watershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the watershed in 1975.

Industrial Activities: Industrial land uses cover 1,354 acres, or 9 percent of the Kinnickinnic River watershed. In addition, one acre, or less than 1 percent of the watershed, was under development for industrial land use and is included as a pollution source under the land under development category because of the increased loadings from land undergoing conversion from rural to urban use. The industrial activities within the Kinnickinnic River watershed, excluding land under development, are estimated to contribute annually 11,400 pounds of nitrogen, 1,000 pounds of phosphorus, 50,000 pounds of BOD_5, 8.3 x 10^{13} fecal coliform counts, and 660 tons of sediment to surface runoff. Table 177 presents the areal extent of the industrial uses within the Kinnickinnic River watershed along with the estimated average annual diffuse source pollutant loadings from these activities.

There are two sanitary landfill operations within the Kinnickinnic River watershed occupying a total of 27 acres, or less than 1 percent of the drainage area.

These are included, along with their estimated pollutant loading rates, on Table 177. The landfill operations have an estimated annual pollutant load of 200 pounds of nitrogen, 20 pounds of phosphorus, 1,000 pounds of BOD_5, 1.7 x 10^{12} fecal coliform counts, and 10 tons of sediment.

In addition to the sanitary landfill sites in the watershed, there are also eight auto salvage and wrecking facilities which are included in the analysis under industrial activities.

Extractive Activities: There were 15 acres of extractive mining operations consisting of gravel pits and attendant washing operations in the Kinnickinnic River watershed as of 1975. These operations contribute an estimated 900 pounds of nitrogen, 700 pounds of phosphorus, 1,800 pounds of BOD_5, and 1,130 tons of sediment annually. Table 178 presents the extent of the extractive operations and the estimated attendant diffuse source pollutant loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, railroad yards and terminals, and airfields. Table 179 presents the estimated pollutant contributions from the 1,709 acres, or 11 percent of the total watershed area which is devoted to these land uses. It is estimated that 28,600 pounds of nitrogen, 3,700 pounds of phosphorus, 172,600 pounds of BOD_5, 3.9 x 10^{13} fecal coliform counts, and 13,640 tons of sediment are transported annually from transportation related activities within the Kinnickinnic River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant

Table 174

ESTIMATED POPULATION OF KINNICKINNIC RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Milwaukee County	
Cudahy City (Part)	5,534
Greenfield City (Part)	12,800
Milwaukee City (Part)	128,568
St. Francis City (Part)	670
West Allis City (Part)	16,959
West Milwaukee Village (Part)	557
Milwaukee County (Part) Subtotal	165,088
Kinnickinnic River Watershed	165,088

Source: Wisconsin Department of Administration and SEWRPC.

Table 175

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	7,559	50.65	Total Nitrogen	4.0	30,240
			Total Phosphorus	0.32	2,420
			Biochemical Oxygen Demand	24.3	183,680
			Fecal Coliform	1.6 x 10^{10} counts /ac/yr.	1.2 x 10^{14} counts/yr.
			Sediment	545	2,060 tons

Source: SEWRPC.

Table 176

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial	1,239	8.30	Total Nitrogen	9.0	11,150
			Total Phosphorus	0.75	930
			Biochemical Oxygen Demand	97.6	120,930
			Fecal Coliform	3.3 x 10^{10} counts/ac/yr.	4.1 x 10^{13} counts/yr.
			Sediment	745	460 tons

Source: SEWRPC.

Table 177

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	1,354	9.07	Total Nitrogen	8.4	11,370
			Total Phosphorus	0.70	950
			Biochemical Oxygen Demand	36.9	49,960
			Fecal Coliform	6.2×10^{10} counts/ac/yr.	8.3×10^{13} counts/yr.
			Sediment	977	660 tons
Landfill	27	0.18	Total Nitrogen	8.4	230
			Total Phosphorus	1.70	20
			Biochemical Oxygen Demand	36.9	1,000
			Fecal Coliform	6.2×10^{10} counts/ac/yr.	1.7×10^{12} counts/yr.
			Sediment	977	10 tons
Total	1,381	9.25	Total Nitrogen	--	11,600
			Total Phosphorus	--	970
			Biochemical Oxygen Demand	--	50,960
			Fecal Coliform	--	8.6×10^{13} counts/yr.
			Sediment	--	670 tons

Source: SEWRPC.

Table 178

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive	15	0.10	Total Nitrogen	60	900
			Total Phosphorus	45	680
			Biochemical Oxygen Demand	120	1,800
			Fecal Coliform	--	--
			Sediment	150,000	1,125 tons

Source: SEWRPC.

contributions from these types of streets are included within the land uses which they serve. There was no transportation land under development in the watershed in 1975.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 839 acres, or approximately 6 percent of the total area of the watershed, and golf courses with a total area of 32 acres, or less than 1 percent of the total area of the watershed. Map 54 indicates the location of public and private golf courses and major parks within the Kinnickinnic River watershed as of 1975. Table 180 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 2,100 pounds of nitrogen, 60 pounds of phosphorus, 1,100 pounds of BOD_5, 3.0×10^{12} fecal coliform counts, and 190 tons of sediment are transported from parks and golf courses within the Kinnickinnic River watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development: The Kinnickinnic River watershed is undergoing fairly rapid conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 266 acres, or 2 percent of the total land area of the watershed. Similarly, it is estimated that only about one acre of the total area of the watershed was under development for industrial land uses in 1975. There were no significant recreational or transportation related lands under development in the watershed

Table 179

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	563	3.77	Total Nitrogen	23.4	13,170
			Total Phosphorus	1.4	790
			Biochemical Oxygen Demand	159	89,520
			Fecal Coliform	6.7×10^{10} counts/ac/yr.	3.8×10^{13} counts/yr.
			Sediment	42,600	11,990 tons
Railroad Yards & Terminals	16	0.11	Total Nitrogen	8.4	130
			Total Phosphorus	1.17	20
			Biochemical Oxygen Demand	36.9	590
			Fecal Coliform	6.2×10^{10} counts/ac/yr.	9.9×10^{11} counts/yr.
			Sediment	977	10 tons
Airfields.	1,130	7.57	Total Nitrogen	13.5	15,250
			Total Phosphorus	2.6	2,940
			Biochemical Oxygen Demand	73.0	82,490
			Fecal Coliform	Negligible	--
			Sediment	2,900	1,640 tons
Total	1,709	11.45	Total Nitrogen	--	28,560
			Total Phosphorus	--	3,740
			Biochemical Oxygen Demand	--	172,600
			Fecal Coliform	--	3.9×10^{13} counts/yr.
			Sediment	--	13,640 tons

Source: SEWRPC.

Table 180

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	839	5.62	Total Nitrogen	2.3	1,930
			Total Phosphorus	0.06	50
			Biochemical Oxygen Demand	1.3	1,090
			Fecal Coliform	3.6×10^{9} counts/ac/yr.	3.0×10^{12} counts/yr.
			Sediment	420	180 tons
Golf Courses	32	0.21	Total Nitrogen	4.4	140
			Total Phosphorus	0.20	5
			Biochemical Oxygen Demand	1.3	40
			Fecal Coliform	--	--
			Sediments	420	10 tons
Total	871	5.82	Total Nitrogen	--	2,070
			Total Phosphorus	--	60
			Biochemical Oxygen Demand	--	1,130
			Fecal Coliform	--	3.0×10^{12} counts/yr.
			Sediment	--	185 tons

Source: SEWRPC.

in 1975. It is estimated that 16,000 pounds of nitrogen, 12,000 pounds of phosphorus, 32,000 pounds of BOD_5, and 20,030 tons of sediment were transported from these residential and industrial construction sites in 1975. Table 181 presents the estimated acreage of land under conversion from rural to urban use within the Kinnickinnic River watershed, along with the estimated annual diffuse source pollutant loadings from these lands.

Rural Land Uses

Agricultural Activities: About 12 percent of the area of the Kinnickinnic River watershed is devoted to agricultural land uses. Although agricultural activities in the Region usually consist of domestic livestock operations and cropland, there were no significant domestic livestock operations known to exist within the watershed as of May 1975. Unlike the other watersheds of the Region, the Kinnickinnic River watershed includes virtually no agricultural lands devoted to small grains, hay, or row crops, such as corn and soybeans.

Estimates of the amounts of specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 182. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 94 acres, or about 1 percent of the total area of the watershed were planted in specialty crops consisting of peas, sweet corn, cabbage, beets, carrots, and onions in 1975. Of this acreage, 100 percent is considered likely to have been tilled by conventional methods using moldboard plows in the autumn and left uncovered through the winter months and the early spring. Minimum tillage methods are considered inadequate for vegetable crops, as these procedures leave too much debris on the surface. Average annual pollutant loadings from crops within the Kinnickinnic River watershed are accordingly estimated at 2,200 pounds of nitrogen, 60 pounds of phosphorus, 2,800 pounds of BOD_5, and 470 tons of sediment. Table 182 presents the estimated acreage of specialty crops, and the estimated diffuse source pollutant loading rates to the land surface in an average year within the watershed.

Pasture land and other open space accounts for 1,703 acres, or 11 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 182. Annual loading rates from these areas are estimated at 7,800 pounds of nitrogen, 500 pounds of phosphorus, 16,500 pounds of BOD_5, and 360 tons of sediment.

Silvicultural Activities: About 20 acres, or approximately 1 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, specifically, woodlands. Table 183 presents the acreage of silvicultural activities within the Kinnickinnic River watershed and the estimated loading rates from these activities. About 50 pounds of nitrogen, 90 pounds of BOD_5, 1.3×10^{10} fecal coliform counts, and five tons of sediment are

Table 181

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development	266	1.78	Total Nitrogen	60	15,960
			Total Phosphorus	45	11,970
			Biochemical Oxygen Demand	120	31,920
			Fecal Coliform	Negligible	--
			Sediment	150,000	19,950 tons
Industrial Land Under Development	1	0.01	Total Nitrogen	60	60
			Total Phosphorus	45	45
			Biochemical Oxygen Demand	120	120
			Fecal Coliform	Negligible	--
			Sediment	150,000	80 tons
Total	267	1.79	Total Nitrogen	--	16,020
			Total Phosphorus	--	12,020
			Biochemical Oxygen Demand	--	32,040
			Fecal Coliform	--	--
			Sediment	--	20,030 tons

Source: SEWRPC.

Table 182

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Specialty Crops — Vegetable and Other Agricultural Crops	94	0.63	Total Nitrogen	23.1	2,180
			Total Phosphorus	0.64	60
			Biochemical Oxygen Demand	30.0	2,820
			Fecal Coliform	Negligible	--
			Sediment	10,000	470 tons
Pasture	1,703	11.41	Total Nitrogen	4.6	7,830
			Total Phosphorus	0.29	490
			Biochemical Oxygen Demand	9.7	16,520
			Fecal Coliform	Negligible	--
			Sediment	420	360 tons
Total	1,797	12.04	Total Nitrogen	--	10,010
			Total Phosphorus	--	550
			Biochemical Oxygen Demand	--	19,340
			Fecal Coliform	--	--
			Sediment	--	830 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 183

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	20	0.13	Total Nitrogen	2.3	50
			Total Phosphorus	0.14	~ 0
			Biochemical Oxygen Demand	4.6	90
			Fecal Coliform	6.6×10^8 counts /ac/yr.	1.3×10^{10} counts/yr.
			Sediment	251	5 tons

Source: SEWRPC.

transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 31 acres, or less than 1 percent of the total area of the watershed is covered by surface water in the form of ponds, lakes, and streams. As indicated in Table 184, 300 pounds of nitrogen, 20 pounds of phosphorus, 5,000 pounds of BOD_5, and 10 tons of sediment can be expected to be contributed to the surface waters of the Kinnickinnic River watershed annually by atmospheric dry fall and washout.

A total of 36 acres, or less than 1 percent of the total area of the watershed, is covered by surface water in the form of swamps, marshes, or wetlands. From these areas, only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Kinnickinnic River watershed annually by atmospheric dry fall and washout since these wetlands tend to trap many pollutants.

Summary Discussion of the Kinnickinnic River Watershed

The Kinnickinnic River watershed is primarily urban with urban storm water runoff contributing the largest diffuse source loads of all major pollutants. Construction activities produce the largest loads of phosphorus and sediment, and transportation activities yield the second largest loads of nitrogen, biochemical oxygen demand, and sediment. Residential land uses contribute the largest load of biochemical oxygen demand. Runoff from developed urban areas inclusive of residential, commercial, and industrial land uses,

Table 184

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams.	31	0.21	Total Nitrogen	8.9	280
			Total Phosphorus	0.5	20
			Biochemical Oxygen Demand	162	5,020
			Fecal Coliform	Negligible	--
			Sediment	665	10 tons

Source: SEWRPC.

produces from 20 percent to more than 85 percent of the total diffuse source loads of nitrogen, phosphorus, biochemical oxygen demand, and fecal coliform, but less than 10 percent of the total sediment load. No onsite sewage disposal systems or livestock operations are known to exist in the watershed. All rural diffuse sources contribute less than 10 percent of the diffuse source load of any major pollutant. Total annual diffuse source loads are 110,900 pounds of nitrogen, 21,400 pounds of phosphorus, 587,600 pounds of biochemical oxygen demand, 2.9 x 10^{14} fecal coliform counts, and 39,010 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE MENOMONEE RIVER WATERSHED

Physical Setting

The Menomonee River watershed is a natural surface water drainage unit, 136 square miles in areal extent located in the east-central portion of the Region. The boundaries of the basin together with the locations of the main channel of the Menomonee River and its principal tributaries are shown on Map 26. The mainstem of the Menomonee River originates in the Village of Germantown in Washington County and discharges to Lake Michigan at the Milwaukee Harbor estuary in downtown Milwaukee. The four principal tributaries of the watershed are the Little Menomonee River, Lilly Creek, Underwood Creek and Honey Creek. About 42 percent of the watershed is in rural land uses, with about 80 percent of this area still in agricultural use. Most of the agricultural related land use is located in the northern half of the watershed. Map 55 sets forth the major land uses categories and their spatial distributions within the Menomonee River watershed as they were inventoried in 1975. Table 185 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north and east by the Milwaukee River watershed, on the west by the subcontinental divide which separates the Rock and Fox River watersheds from the Menomonee, and on the south by the Kinnickinnic River, Root River, and Oak Creek watersheds. In addition to the four principal tributaries, the stream network of the watershed includes the North and West Branch of the Menomonee River, Willow Creek, Dousman Ditch, Nor-X-Way Channel, Butler Ditch, Little Menomonee Creek, South Menomonee Canal, Burnham Street Canal, and the South Branch of Underwood Creek. Table 186 lists for the Menomonee River watershed, each major stream reach, together with the location of the source and the length of the stream in miles. The watershed ranks fifth in size within the Region, but second in total resident population.

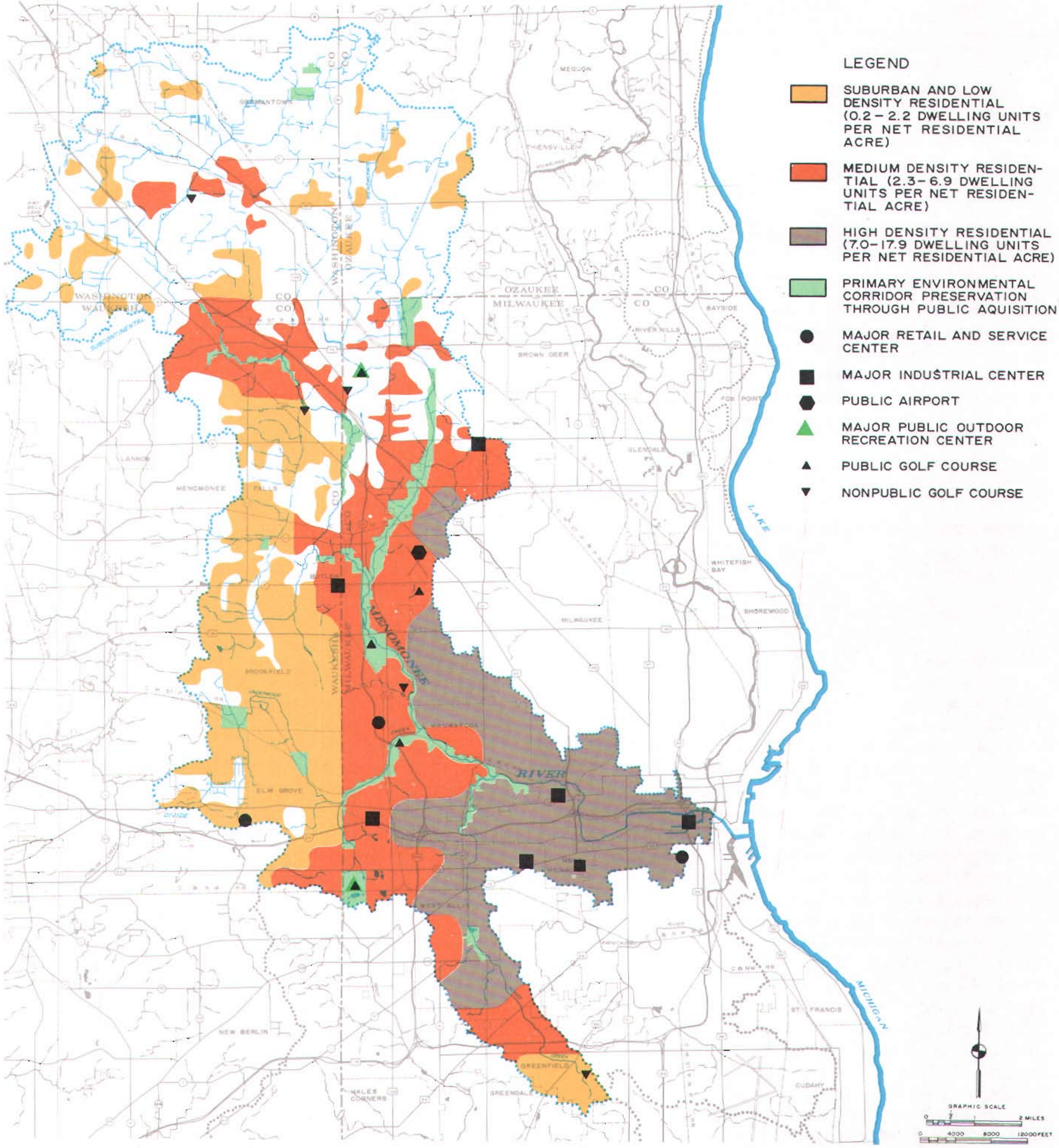
Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Menomonee River watershed lies within four counties—Milwaukee, Ozaukee, Washington, and Waukesha—and in parts of seven cities, five villages, and three towns. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 187. The 1975 resident population of the watershed is estimated at 336,824 persons, or approximately 18.8 percent of the estimated 1975 total regional population. Table 188 presents the population distribution in the Menomonee River watershed by civil division.

Surface water in the Menomonee River watershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water. The streamflow of the Menomonee River has been measured at 11 continuous flow recording gages measured cooperatively by the U.S. Geological Survey, the Wisconsin Department of Natural Resources, the U.S. Environmental Protection Agency, the International Joint Commission, and the Commission. The site location and period of record for each of the 11 sites is presented in Table 189.

The soils within the Menomonee River watershed are generally grayish-brown rolling silt loams or

Map 55

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTIONS IN THE MENOMONEE RIVER WATERSHED IN 1975



As of 1975 more than 58 percent of the area of the Menomonee River watershed was devoted to urban land uses. The dominant urban land use in the watershed was residential, which occupied 27 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural and scattered low-density urban uses, primarily residential, in the headwater portions of the watershed, contiguous low- and medium-density urban land uses in the middle portions of the watershed, and high-density urban land uses, including industrial, retail, and service uses, in the lower portions of the watershed. There were 10 public or private golf courses and two major parks in the watershed, as well as major parkway segments.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 185

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	36.12	23,112	26.52
Commercial[b]	7.76	4,968	5.70
Industrial			
Manufacturing	3.51	2,247	2.58
Landfill & Dump	0.46	296	0.34
Extractive	0.59	378	0.43
Transportation			
Streets & Highways	17.54	11,227	12.88
Airfields	0.58	372	0.43
Railroad Yards & Terminals	1.96	1,256	1.44
Recreation			
Golf Courses	1.84	1,177	1.35
Parks & Other Recreation	4.33	2,774	3.18
Land Under Development			
Residential Land Under Development[c]	3.01	1,926	2.20
Commercial Land Under Development	0.03	21	0.02
Industrial Land Under Development	0.75	481	0.55
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	3.70	2,365	2.71
Hay	6.76	4,329	4.96
Row Crops	13.45	8,610	9.88
Specialty Crops	3.67	2,346	2.69
Sod Farm	0.14	88	0.10
Other Open Space[d]	17.97	11,502	13.20
Silvicultural			
Woodlands	6.53	4,179	4.79
Orchards & Nurseries	0.75	481	0.55
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	0.73	469	0.54
Wetlands, Swamps, & Marshes	3.99	2,552	2.93
Total	136.17	87,156	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01). The final control total in the area of the Menomonee River Watershed is shown in Table 187.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 186

LENGTHS OF STREAMS AND THEIR SOURCES WITHIN THE MENOMONEE RIVER WATERSHED

Stream or Watercourse	Source		Length[a] (in miles)
	By Civil Division	By U.S. Public Land Survey System	
North Branch Menomonee River	Village of Germantown	T9N, R20E, Section 8, NW 1/4	1.83
West Branch Menomonee River	Village of Germantown	T9N, R20E, Section 19, SE 1/4	2.05
Willow Creek	Village of Menomonee Falls	T8N, R20E, Section 6, SW 1/4	1.65
Nor-X-Way Channel	Village of Menomonee Falls	T9N, R20E, Section 25, NE and NW 1/4	2.08
Lilly Creek	Village of Butler	T8N, R20E, Section 35, SW 1/4	3.29
Butler Ditch	City of Brookfield	T7N, R20E, Section 10, NE 1/4	2.37
Little Menomonee Creek	City of Mequon	T9N, R21E, Section 17, NW 1/4	2.25
Little Menomonee River	City of Mequon	T9N, R21E, Section 20, SW 1/4	10.18
Dousman Ditch	City of Brookfield	T7N, R20E, Section 28, SE 1/4	0.64
Honey Creek	City of Greenfield	T6N, R21E, Section 36, NW 1/4	7.55
Menomonee River	Village of Germantown	T9N, R20E, Section 11, SE 1/4	29.41
Underwood Creek	City of Brookfield	T7N, R20E, Section 15, NW 1/4	7.47
South Menomonee Canal	City of Milwaukee	T7N, R22E, Section 32, NW 1/4	0.87
Burnham Street Canal	City of Milwaukee	T7N, R22E, Section 32, NW 1/4	0.55
South Branch Underwood Creek	City of West Allis	T6N, R21E, Section 6, NW 1/4	1.08

[a] *Total perennial stream length as shown on U. S. Geological Survey quadrangle maps.*

Source: SEWRPC.

gravelly to grayish-brown loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the unsewered northern and western portions of the watershed area exhibit severe or very severe limitations for residential development without public sanitary sewer service as shown on Maps 43 and 44. This area also exhibits moderate limitations for residential development with public sanitary sewer service, as shown on Map 45.

Urban Land Uses

Residential Activities: The areal extent of residential activities in larger than any other single land use category within the Menomonee River watershed. Residential land uses cover approximately 23,112 acres, or 27 percent of the watershed. In addition, 1,926 acres or 2 percent of the watershed were under development for residential land use and are included as pollution sources under the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities, excluding land under development within the Menomonee River watershed, are estimated at 92,500 pounds of nitrogen, 7,400 pounds of phosphorus, 561,600 pounds of BOD_5, 3.7 x 10^{14} fecal coliform counts, and 6,300 tons of sediment during an average year. Table 190 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse sources pollutant loadings from residential land.

Commercial Activities: Within the Menomonee River watershed, approximately 4,968 acres, or 6 percent, of the total land surface is devoted to commercial activities. In addition, 21 acres, or less than 1 percent of the watershed, were under development for commercial land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. The estimated annual pollutant loadings from commercial activities excluding land under development within the Menomonee River watershed are 44,700 pounds of nitrogen, 3,700 pounds of phosphorus, 484,900 pounds of biochemical oxygen demand, 1.6 x 10^{14} fecal coliform counts, and 1,850 tons of sediment. Table 191 presents the areal extent of commercial land uses within the Menomonee River watershed along with the estimated average annual diffuse source pollutant loads from these areas.

Industrial Activities: Industrial land uses cover 2,247 acres, or 3 percent of the Menomonee River watershed. In addition, 481 acres, or about 1 percent of the watershed, were under development for industrial

Table 187

AREAL EXTENT OF CIVIL DIVISIONS IN THE MENOMONEE RIVER WATERSHED: JANUARY 1, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Milwaukee County			
Cities			
Greenfield	2.77	2.04	23.82
Milwaukee	31.50	23.17	32.60
Wauwatosa	13.28	9.77	100.00
West Allis	6.76	4.97	59.40
Villages			
Greendale	0.11	0.08	1.97
West Milwaukee	0.66	0.48	59.46
County Subtotal	55.08	40.52	22.70
Ozaukee County			
City			
Mequon	11.76	8.65	25.00
County Subtotal	11.75	8.65	5.00
Washington County			
City			
Milwaukee	0.02	0.01	100.00
Village			
Germantown	29.41	21.63	85.25
Towns			
Germantown	0.75	0.55	44.38
Richfield	1.57	1.15	4.35
County Subtotal	31.75	23.35	7.29
Waukesha County			
Cities			
Brookfield	13.52	9.94	52.38
New Berlin	0.67	0.49	1.82
Villages			
Butler	0.80	0.59	100.00
Elm Grove	3.30	2.43	100.00
Menomonee Falls	18.56	13.65	55.62
Towns			
Brookfield	0.20	0.15	2.89
Lisbon	0.30	0.22	0.89
County Subtotal	37.35	27.48	6.43
Total	135.94	100.00	--

Source: SEWRPC.

Table 188

ESTIMATED POPULATION OF MENOMONEE RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Milwaukee County	
Greendale Village (Part)	495
Greenfield City (Part)	8,752
Milwaukee City (Part)	159,819
Wauwatosa City	55,712
West Allis City (Part)	38,753
West Milwaukee Village (Part)	3,230
Milwaukee County (Part) Subtotal	266,761
Ozaukee County	
Mequon City (Part)	2,026
Ozaukee County (Part) Subtotal	2,026
Washington County	
Germantown Town (Part)	375
Germantown Village (Part)	8,317
Milwaukee City, Washington County Portion	2
Richfield Town (Part)	383
Washington County (Part) Subtotal	9,077
Waukesha County	
Brookfield City (Part)	18,934
Brookfield Town (Part)	173
Butler Village	2,230
Elm Grove Village	7,692
Lisbon Town (Part)	41
Menomonee Falls Village (Part)	27,233
New Berlin City (Part)	2,657
Waukesha County (Part) Subtotal	58,960
Menomonee River Watershed Total	336,824

Source: Wisconsin Department of Administration and SEWRPC.

land use and are included as pollution sources under the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. The industrial activities within the Menomonee River watershed excluding land under development are estimated to contribute annually 18,900 pounds of nitrogen, 1,600 pounds of phosphorus, 82,900 pounds of BOD_5, 1.4 x 10^{14} fecal coliform counts, and 1,100 tons of sediment to surface runoff. Table 192 presents the areal extent of the industrial uses within the Menomonee River watershed along with the estimated average annual diffuse source pollutant loadings from these activities. Industrial production and distribution are urban-related activities and are minimal within the watershed's rural areas, with the exception of the areas in which sand and salt are stored, and the areas in which gravel or stone are quarried.

There are 11 active sanitary landfill operations within the Menomonee River watershed occupying a total of 296 acres, or less than 1 percent of the drainage area. These are included, along with their estimated pollutant loading rates, on Table 192. The landfill operations have an estimated annual load of 2,500 pounds of nitrogen, 200 pounds of phosphorus, 10,900 pounds of BOD_5, 1.8 x 10^{13} fecal coliform counts, and 140 tons of sediment.

In addition, there were 19 auto salvage and wrecking facilities which are included in the analysis under industrial activities.

Extractive Activities: There were 378 acres, or less than 1 percent of the watershed area, consisting of extractive mining operations which were gravel pits, and their attendant washing operations in the Menomonee River watershed as of 1975. These operations contribute an estimated 22,700 pounds of nitrogen, 17,000 pounds of phosphorus, 45,400 pounds of BOD_5, and 28,350 tons of sediment annually. Table 193 presents the extent of the extractive operations and the estimated attendant diffuse source pollutant loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, railroad yards and terminals, and airfields. Table 194 presents the estimated pollutant contributions from the 12,855 acres, or 15 percent of the total watershed area which is devoted to these land uses. It is estimated that 277,700 pounds of nitrogen, 18,200 pounds of phosphorus, 1,838,000 pounds of BOD_5, 8.3 x 10^{14} fecal coliform counts, and 240,350 tons of sediment are transported annually from transportation related activities within the Menomonee River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve. There was no transportation land under development in the watershed in 1975.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 2,774 acres, or 3 percent of the total area of the watershed, and golf courses with a total area of 1,177 acres, or 1 percent of the total area of the watershed. Map 55 indicates the location of public and private golf courses within the Menomonee River watershed as of 1975. Table 195 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 11,600 pounds of nitrogen, 400 pounds of phosphorus, 5,100 pounds of BOD_5, 1.0 x 10^{13} fecal coliform

Table 189

LOCATION AND PERIOD OF RECORD FOR THE SAMPLING SITES IN THE MENOMONEE RIVER WATERSHED

Site	Location	Period of Record
Menomonee River at Germantown, Wis.	Lat 43° 13′ 17″ long 88° 07′ 58″, in SE ¼ Sec. 21, T.9 N., R.20 E., Washington County, on right bank about 80 ft. (24 M) downstream from River Lane Road, about 150 ft. (46 M) northwest of junction of River Lane Road and Mequon Road, 2.0 Mi. (3.2 KM) north of Washington and Waukesha County line.	1974 to 1977
Menomonee River at Menomonee Falls, Wis.	Lat 43° 10′22″, long 88° 06′14″, in SE ¼ Sec. 10, T. 8 N., R20 E., Waukesha County, on right bank, 150 ft. (46 M) upstream from Pilgrim Road (County Truck Highway 44) bridge in Menomonee Falls.	1974 to 1977
Menomonee River at Butler, Wis.	Lat 43° 12′24″, long 88° 02′18″, in NE ¼ Sec. 32, T.9., R.21 E., Waukesha County, at northwest corner of 124th Street bridge in Butler.	1974 to 1977
Little Menomonee River near Freistadt, Wis.	Lat 43° 12′24″, long 88° 02′18″, in NE ¼ NW ¼ Sec. 32, T.9 N., R.21 E., Ozaukee County, on right bank, 75 ft. (23 M) downstream from bridge on Donges Bay Road, 2.0 Mi. (3.2 KM) south of Freistadt.	1974 to 1977
Noyes Creek at Milwaukee, Wis.	Lat 43° 08′27″, long 88° 01′30″, in NW ¼ SW¼ Sec. 21, T.8., R.21 E., Milwaukee County, on right bank, 200 ft. (61 M) west of 91st Street near the intersection of 91st Street and W. Denver Street in Milwaukee.	1974 to 1977
Little Menomonee River at Milwaukee, Wis.	Lat 43° 07′28″, long 88° 02′34″, in NW ¼ SW ¼ Sec. 29, T.8 N., R.21 E., Milwaukee County, on right spoil bank about 200 ft. (61 M) from bridge on U. S. Highway 41, on Milwaukee County Park Commission property.	1974 to 1977
Underwood Creek at Wauwatosa, Wis.	Lat 43° 03′17″, long 88° 02′46″, in SW ¼ NW ¼ Sec. 20, T.7 N., R.21 E., Milwaukee County, at U. S. Highway 45, on the northeast corner of bridge on the Chicago, Milwaukee, St. Paul & Pacific Railroad, 0.75 Mi (1.21 KM) above mouth of the Menomonee River, on Milwaukee County Park Commission property, at Wauwatosa.	1974 to 1977
Honey Creek at Wauwatosa, Wis.	Lat 43° 02′38″, long 88° 00′10″, in NW ¼ NW ¼ Sec. 27, T.7 N., R.21 E., Milwaukee County, on right bank near mouth of Honey Creek in Honey Creek Parkway, on Milwaukee County Park Commission property, 150 ft. (45.7 M) west of intersection of Honey Creek Parkway and 72nd Street, 500 ft. (152 M) above mouth of the Menomonee River, at Wauwatosa.	1974 to Present[a]
Menomonee River at Wauwatosa, Wis.	Lat 43° 02′44″, long 87° 59′59″, in NW ¼ Sec. 27, T.7 N., R.21 E., Milwaukee County, on left bank near upstream side of 70th Street bridge in Wauwatosa, 800 ft. (244 M) downstream from Honey Creek, and 6.2 Mi. (10.0 KM) upstream from mouth.	1961 to Present[a]
Schoonmaker Creek at Wauwatosa, Wis.	Lat 43° 03′02″, long 87° 59′23″, in NE ¼ SE ¼ Sec. 22, T.7 N., R.21 E., Milwaukee County, about 100 ft. (30.5 M) northwest of intersection of Martha Washington Drive and Milwaukee Avenue, in Wauwatosa, 0.51 Mi. (0.82 KM) above mouth at the Menomonee River.	1974 to Present[a]
Hawley Road Storm Sewer (sampled during wet weather flows ony)	Lat 43° 2′34″, long 87° 58′59″ NW ½ Sec. 26, T.7 N., R.21 E., under Hawley Road viaduct adjacent to railroad spurline and roadway.	1975 to 1977

[a] *Dates to 1978 publication of this report.*

Source: SEWRPC.

Table 190

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	23,112	26.52	Total Nitrogen	4.0	92,450
			Total Phosphorus	0.32	7,400
			Biochemical Oxygen Demand	24.3	561,620
			Fecal Coliform	1.6×10^{10} counts/ac/yr.	3.7×10^{14} counts/yr.
			Sediment	545	6,300 tons

Source: SEWRPC.

Table 191

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial	4,968	5.70	Total Nitrogen	9.0	44,710
			Total Phosphorus	0.75	3,730
			Biochemical Oxygen Demand	97.6	484,880
			Fecal Coliform	3.3×10^{10} counts/ac/yr.	1.6×10^{14} counts/yr.
			Sediment	745	1,850 tons

Source: SEWRPC.

Table 192

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	2,247	2.58	Total Nitrogen	8.4	18,870
			Total Phosphorus	0.70	1,570
			Biochemical Oxygen Demand	36.9	82,910
			Fecal Coliform	6.2×10^{10} counts/a/yr.	1.4×10^{14} counts/yr.
			Sediment	977	140 tons
Landfill	296	0.34	Total Nitrogen	8.4	2,490
			Total Phosphorus	0.70	210
			Biochemical Oxygen Demand	36.9	10,920
			Fecal Coliform	6.2×10^{10} counts/a/yr.	1.8×10^{13} counts/yr.
			Sediment	977	140 tons
Total	2,543	2.92	Total Nitrogen	--	21,360
			Total Phosphorus	--	1,780
			Biochemical Oxygen Demand	--	93,840
			Fecal Coliform	--	1.6×10^{14} counts/yr.
			Sediment	--	1,240 tons

Source: SEWRPC.

Table 193

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive	378	0.43	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	60.0 45.0 120.0 Negligible 150,000.0	22,680 17,010 45,360 -- 28,350 tons

Source: SEWRPC.

Table 194

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	11,227	12.88	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	23.4 1.4 159.0 6.7×10^{10} counts/a/yr. 42,600	262,710 15,720 1,785,090 7.5×10^{14} counts/yr. 239,135 tons
Railroad Yards and Terminals	1,256	1.44	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.4 1.17 36.9 6.2×10^{10} counts/a/yr. 977	10,550 1,470 46,350 7.8×10^{13} counts/yr. 615 tons
Airfields	372	0.43	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	12 2.7 17.6 Negligible 3,200	4,460 1,000 6,550 -- 595 tons
Total	12,855	14.75	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	-- -- -- -- --	277,730 18,190 1,837,990 8.3×10^{14} counts/yr. 240,345 tons

Source: SEWRPC.

counts, and 830 tons of sediment are transported from parks and golf courses within the Menomonee River watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development: The Menomonee River watershed is undergoing conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 1,926 acres, or 2 percent of the total land area of the watershed. Similarly, an estimated 481 acres, or less than 1 percent of the total area of the watershed was under development for industrial land uses and an estimated 21 acres, or less than 1 percent of the watershed were under development for commercial land uses in 1975. No significant amount of recreational or transportation related lands were under development in the watershed in 1975. It is estimated that 145,700 pounds of nitrogen, 109,300 pounds of phosphorus, 291,400 pounds of BOD_5, and 182,100 tons of sediment were transported from these construction sites in 1975. Table 196 presents the estimated acreage of land under conversion from rural to urban use within the Menomonee River watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Table 195

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	2,774	3.18	Total Nitrogen	2.3	6,380
			Total Phosphorus	0.06	170
			Biochemical Oxygen Demand	1.3	3,610
			Fecal Coliform	3.6×10^9 counts/a/yr.	1.0×10^{13} counts/yr.
			Sediment	420	580 tons
Golf Courses	1,177	1.35	Total Nitrogen	4.4	5,180
			Total Phosphorus	0.20	240
			Biochemical Oxygen Demand	1.3	1,530
			Fecal Coliform	Negligible	--
			Sediment	420	250 tons
Total	3,951	4.53	Total Nitrogen	--	11,560
			Total Phosphorus	--	400
			Biochemical Oxygen Demand	--	5,140
			Fecal Coliform	--	1.0×10^{13} counts/yr.
			Sediment	--	830 tons

Source: SEWRPC.

Table 196

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial Land Under Development. . . .	481	0.55	Total Nitrogen	60	28,830
			Total Phosphorus	45	21,630
			Biochemical Oxygen Demand	120	57,720
			Fecal Coliform	Negligible	--
			Sediment	150,000	36,040 tons
Residential Land Under Development. . .	1,926	2.2	Total Nitrogen	60	115,560
			Total Phosphorus	45	86,670
			Biochemical Oxygen Demand	120	231,120
			Fecal Coliform	Negligible	--
			Sediment	150,000	144,450 tons
Commercial Land Under Development . .	21	0.02	Total Nitrogen	60	1,280
			Total Phosphorus	45	960
			Biochemical Oxygen Demand	120	2,520
			Fecal Coliform	Negligible	--
			Sediment	150,000	1,600 tons
Total	2,428	2.77	Total Nitrogen	--	145,680
			Total Phosphorus	--	109,260
			Biochemical Oxygen Demand	--	291,360
			Fecal Coliform	--	--
			Sediment	--	182,100 tons

Source: SEWRPC.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were 55 known holding tanks and one mound system in the watershed, as shown on Map 46. Table 197 presents the estimated pollutant loadings from the approximately 4,325 septic tanks in the watershed as of 1975. It is estimated that 76,400 pounds of nitrogen, 17,600 pounds of phosphorus, 1,090,500 pounds of BOD_5, 185 tons of sediment, and 1.3 x 10^{15} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Menomonee River watershed.

Rural Land Uses

Agricultural Activities: About 34 percent of the area of the Menomonee River watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May 1975, 49 significant domestic livestock operations with a total of 3,570 animals, or 3,870 equivalent animal units were known to exist within the watershed. Map 56 indicates the locations of these livestock operations. Twenty-five of these operations were located within 500 feet of the identified stream system of the watershed. Table 198 indicates the estimated number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 109,900 pounds of nitrogen, 25,500 pounds of phosphorus, 430,300 pounds of BOD_5, 2.5 x 10^{15} fecal coliform counts, and 1,360 tons of sediment are transported from livestock operations within the Menomonee River watershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 199. Although crop rotations and other factors cause these acreages to vary from year-to-year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 2,365 acres, or 3 percent of the total area of the watershed, were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Menomonee River watershed are accordingly estimated at 11,100 pounds of nitrogen, 300 pounds of phosphorus, 22,700 pounds of BOD_5, and 3,790 tons of sediment. Table 199 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates to the land surface in an average year within the watershed.

Approximately 4,300 acres, or 5 percent of the total area of the watershed, were devoted to growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Menomonee River watershed are 3,900 pounds of nitrogen, 400 pounds of phosphorus, 41,600 pounds of BOD_5, and 6,930 tons of sediment.

Major row crops grown within the Menomonee River watershed are corn and soybeans which were planted on 8,610 acres, or 10 percent of the total area of the watershed. As shown in Table 199, an estimated 198,900 pounds of nitrogen, 5,500 pounds of phosphorus, 151,500 pounds of BOD_5, and 25,400 tons of sediment are transported annually from the row crop acreage within the Menomonee River watershed.

As shown in Table 199, specialty crops were grown on a total of 2,346 acres, or 3 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Menomonee River watershed are 54,200 pounds of nitrogen, 1,500 pounds of phosphorus, 70,400 pounds of BOD_5, and 11,730 tons of sediment.

About 88 acres, or less than 1 percent of land within the watershed, were in sod farms in 1975. Estimated average annual pollutant loading rates from these

Table 197

TYPE, EXTENT, AND ESTIMATED TOTAL POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	4,325	17,760	Total Nitrogen	4.3	76,370
			Total Phosphorus	0.99	17,580
			Biochemical Oxygen Demand	61.4	1,090,460
			Fecal Coliform	7.5×10^{10} counts/capita/yr.	1.3×10^{15} counts/yr.
			Sediment	21.0	185 tons

Source: SEWRPC.

Table 198

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	2,280	3,190	49,516	Total Nitrogen	28.4	90,600
				Total Phosphorus	6.6	21,050
				Biochemical Oxygen Demand	111.2	354,730
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	2.0×10^{15} counts/yr.
				Sediment	700.0	1,115 tons
Beef	600	600	6,732	Total Nitrogen	28.4	17,040
				Total Phosphorus	6.6	3,960
				Biochemical Oxygen Demand	111.2	66,720
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	3.8×10^{14} counts/yr.
				Sediment	700.0	210 tons
Hogs	190	80	957	Total Nitrogen	28.4	2,270
				Total Phosphorus	6.6	530
				Biochemical Oxygen Demand	111.2	8,900
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	5.1×10^{13} counts/yr.
				Sediment	700.0	30 tons
Mink	500	5	46	Total Nitrogen	28.4	--
				Total Phosphorus	6.6	--
				Biochemical Oxygen Demand	111.2	--
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	--
				Sediment	700.0	--
Total	3.570	3,870	57,251	Total Nitrogen	--	109,910
				Total Phosphorus	--	25,540
				Biochemical Oxygen Demand	--	430,340
				Fecal Coliform	--	2.5×10^{15} counts/yr.
				Sediment	--	1,355 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

sod farms within the Menomonee River watershed are 80 pounds of nitrogen, 10 pounds of phosphorus, 180 pounds of BOD_5, and 30 tons of sediment.

Irrigation of cropland and golf courses was practiced within the watershed in 1975. The location of the high-capacity wells which provide the water supply are shown on Map 47. The irrigation volumes are estimated at 0.591 million gallons per day (mgd). It has been estimated that corn receives up to 10 inches of irrigation water annually, vegetables receive 15 to 20 inches, sod receives approximately 18 inches, and golf courses receive varying amounts of irrigation water annually. Irrigation return flows are considered to be negligible in the watershed due to the careful practices of operators, as in the use of aerial spray methods of application used.

The second largest single land use category within the Menomonee River watershed is that of pasture land and other open space—which accounts for 11,502 acres, or 13 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 199. Annual loading rates from these areas are estimated at 52,900 pounds of nitrogen, 3,300 pounds of phosphorus, 111,600 pounds of BOD_5, and 2,420 tons of sediment.

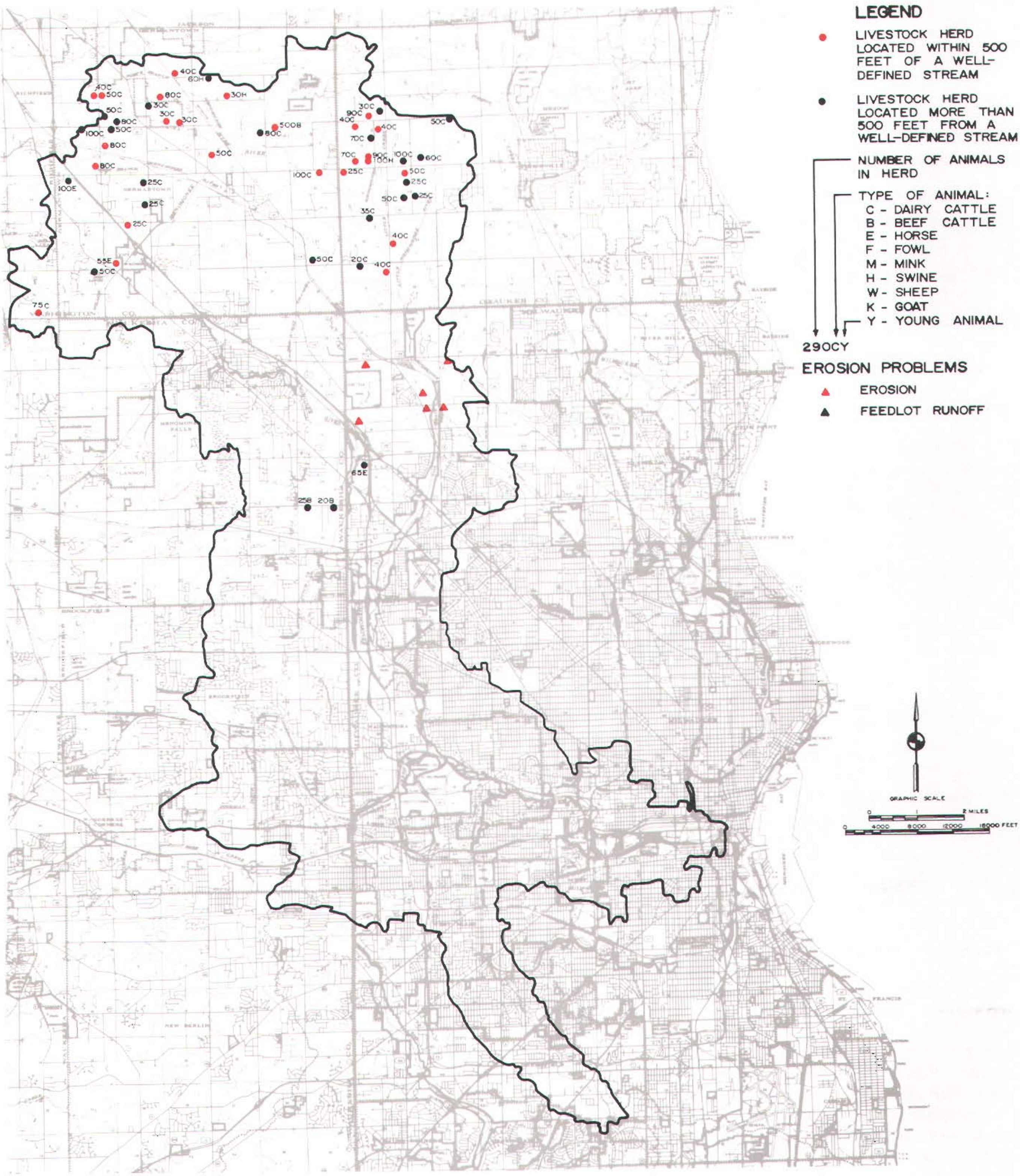
As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 52 farms covering about 3,340 acres, or 11.4 percent of the agricultural land within the watershed.

A total of 110 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 57.

Table 200 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent

Map 56

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE MENOMONEE RIVER WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 49 operations within the Menomonee River watershed in 1975, 25 operations, or 50 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 199

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	2,365	2.71	Total Nitrogen	4.7	11,120
			Total Phosphorus	0.13	310
			Biochemical Oxygen Demand	9.6	22,700
			Fecal Coliform	Negligible	--
			Sediment	3,200	3,785 tons
Hay	4,329	4.96	Total Nitrogen	0.9	3,900
			Total Phosphorus	0.09	390
			Biochemical Oxygen Demand	9.6	41,560
			Fecal Coliform	Negligible	--
			Sediment	3,200	6,925 tons
Row	8,610	9.88	Total Nitrogen	23.1	198,880
			Total Phosphorus	0.64	5,510
			Biochemical Oxygen Demand	17.6	151,540
			Fecal Coliform	Negligible	--
			Sediment	5,900	25,400 tons
Specialty Crops					
Vegetable and Other Agricultural Crops. .	2,346	2.69	Total Nitrogen	23.1	54,190
			Total Phosphorus	0.64	1,500
			Biochemical Oxygen Demand	30.0	70,380
			Fecal Coliform	Negligible	--
			Sediment	10,000	11,730 tons
Sod	88	0.1	Total Nitrogen	0.9	80
			Total Phosphorus	0.09	10
			Biochemical Oxygen Demand	2.1	180
			Fecal Coliform	Negligible	--
			Sediment	700	30 tons
Pasture	11,502	13.2	Total Nitrogen	4.6	52,910
			Total Phosphorus	0.29	3,340
			Biochemical Oxygen Demand	9.7	111,570
			Fecal Coliform	Negligible	--
			Sediment	420	2,415 tons
Total	29,240	33.54	Total Nitrogen	--	321,080
			Total Phosphorus	--	11,050
			Biochemical Oxygen Demand	--	397,930
			Fecal Coliform	--	--
			Sediment	--	50,285 tons

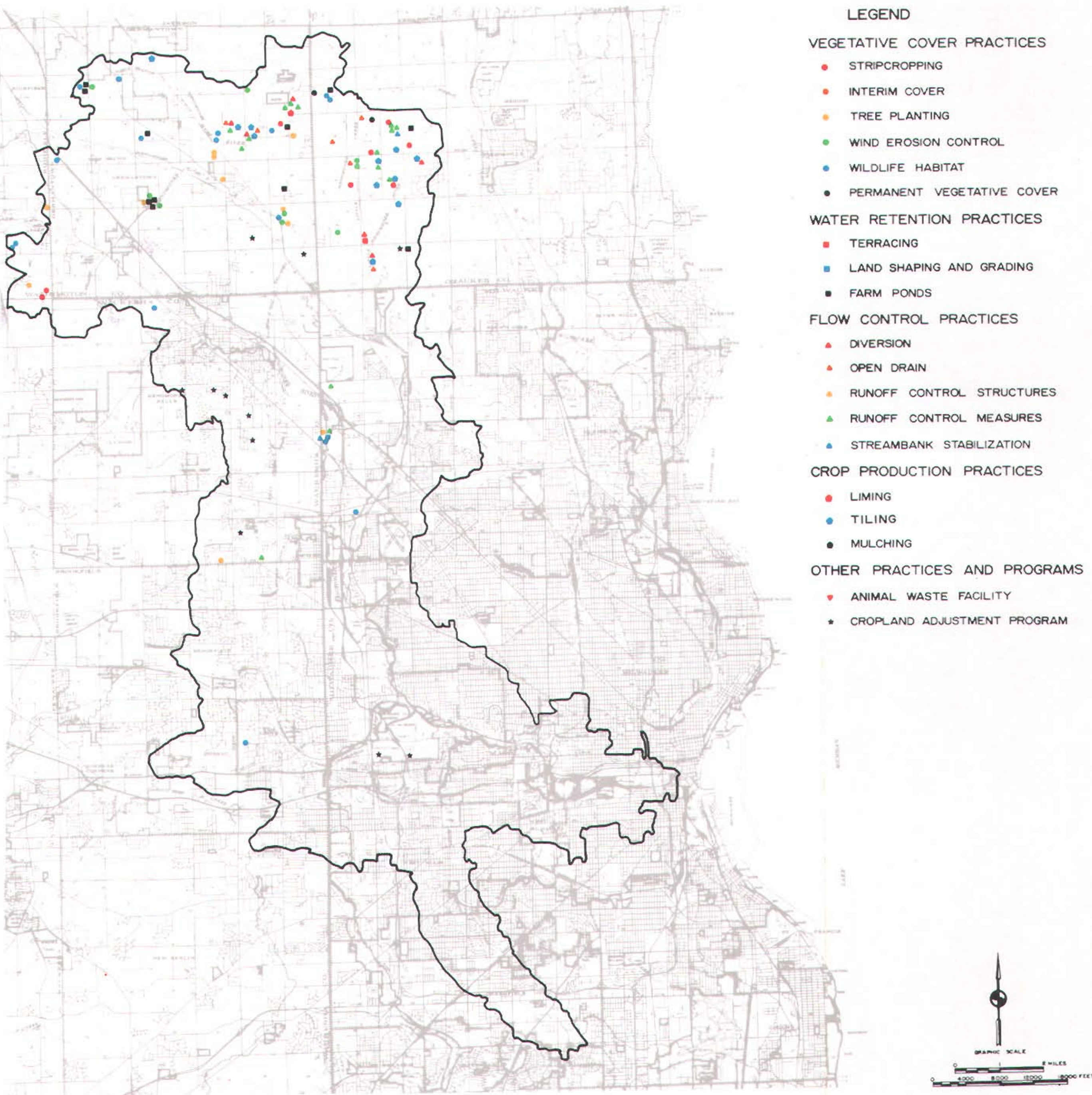
Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

and the 1976 replacement costs of those practices, which total $247,066 or an equivalent $8.44 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $6.96 per acre of agricultural land, or about 83 percent of the total investment were related to those practices directly affecting water quality. This represents about 46 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 1,660 acres, or approximately 5.3 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 201 presents the acreage of silvicultural activities within the Menomonee River watershed and the estimated loading rates from these activities. About 10,700 pounds of nitrogen, 700 pounds of phosphorus, 21,400 pounds of BOD_5, 3.1 x 10^{12} fecal coliform counts, and 590 tons of sediment are transported annually from silvicultural land uses in the watershed.

Map 57

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE MENOMONEE RIVER WATERSHED IN 1975



The above map illustrates the locations of the 110 known conservation practices installed in the Menomonee River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching, which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Table 200

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE MENOMONEE RIVER WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value in 1976 Dollars
Vegetative Cover Practices			
Stripcropping	326 acres	10.00/acre	3,260.00
Interim Cover	0	12.00/acre	0
Tree Stands	(11 units) (2 acres/unit) = 22 acres	100.00/acre	2,200.00
Wind Erosion Control	13,219 feet	0.60/foot	7,931.40
Wildlife Habitat	(15 units) (2 acres/unit) = 30 acres	25.00/acre	750.00
Permanent Vegetative Cover	90 acres	50.00/acre	4,500.00
Subtotal			18,641.40
Water Retention Practices			
Terracing	14,915 feet	0.70/foot	10,440.50
Farm Ponds	23 units	4,000.00/unit	92,000.00
Subtotal			102,440.50
Flow Control Practices			
Diversions	19,898 feet	1.25/foot	24,872.50
Open Drains	14,120 feet	2.25/foot	31,770.00
Runoff Control Structures	0	2,500.00/unit	0
Runoff Control Measures	56,163 feet	1.00/foot	13,090.00
Streambank Stabilization	3,700 feet	3.50/foot	12,950.00
Subtotal			82,682.50
Crop Production Practices			
Liming	0	20.00/acre	0
Tiling	76,774 feet	0.70/foot	43,301.30
Mulching	0	60.00/acre	0
Subtotal			43,301.30
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$247,065.70

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

Atmospheric Contribution: A total of 469 acres, or less than 1 percent of the total area of the watershed is covered by surface water in the form of ponds, lakes and streams. As indicated in Table 202, 4,200 pounds of nitrogen, 200 pounds of phosphorus, 76,000 pounds of BOD_5, and 160 tons of sediment can be expected to be contributed to the surface waters of the Menomonee River watershed annually by atmospheric dry fall and washout.

A total of 2,552 acres, or 3 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Menomonee River watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Menomonee River Watershed

The Menomonee River watershed is rapidly urbanizing, with storm water runoff from urban land contributing the largest diffuse source loads of nitrogen, phosphorus, biochemical oxygen demand, fecal coliform, and sediment. Onsite sewage disposal

Table 201

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	4,179	4.79	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	2.3 0.14 4.6 6.6×10^8 counts/a/yr. 251	9,610 590 19,220 2.8×10^{12} counts/yr. 520 tons
Orchards and Nurseries	481	0.55	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	2.3 0.14 4.6 6.6×10^8 counts/a/yr. 251	1,110 70 2,210 3.2×10^{11} counts/yr. 60 tons
Total	4,660	5.34	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	-- -- -- -- --	10,720 650 21,440 3.1×10^{12} counts/yr. 585 tons

Source: SEWRPC.

Table 202

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION IN THE MENOMONEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams	469	0.54	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.9 0.5 162.0 Negligible 665	4,170 230 75,980 -- 155 tons

Source: SEWRPC.

systems and transportation account for the largest loads of biochemical oxygen demand. Transportation activities are the largest source of sediment, and the second largest contributor of nitrogen. Construction activities are the largest source of phosphorus, the second largest source of sediment and the third largest source of nitrogen. Runoff from developed urban areas inclusive of residential, commercial, and industrial land uses, ranges up to 19 percent of total diffuse source loads. Recreation activities contribute less than 1 percent of the total load of any pollutant. Agricultural runoff contributes the largest diffuse source nitrogen load, the fourth largest biochemical oxygen demand load, and the third largest sediment load. Livestock operations contribute the largest diffuse source fecal coliform load. All other rural diffuse sources, inclusive of silvicultural activities and air pollution loadings to surface waters, produce 1 percent or less of the total diffuse source load of any major pollutant. Total annual diffuse source loads are 1,138,400 pounds of nitrogen, 212,800 pounds of phosphorus, 5,336,300 pounds of biochemical oxygen demand, 5.3×10^{15} fecal coliform counts, and 513,600 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE MILWAUKEE RIVER WATERSHED

Physical Setting

The Milwaukee River watershed is a natural surface water drainage unit with 433 square miles of the total 683 square miles located in the northeast and north central portions of the Region. The boundaries of the basin, together with the locations of the main channels of the Milwaukee River and its tributaries, are shown on Map 26. The mainstem of the Milwaukee River originates outside of the Region and discharges to Lake Michigan via the harbor in the estuary in the City of Milwaukee. There are 30 major tributaries in the watershed, all of which are listed in Table 204. About 87 percent of the watershed is in rural land uses, with about 82 percent of this area still in agricultural use. Most of the agricultural related land use is located in the north and central portions of the watershed. Map 58 sets forth the major land use categories and their spatial distributions within the Milwaukee River watershed as they were inventoried in 1975. Table 203 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

Within the Region, the watershed is bounded on the north by the Fond du Lac and Sheboygan County lines, on the west by the Upper Rock and Menomonee River watersheds, on the south by the Kinnickinnic River watershed, and on the east by the Sauk Creek watershed and Lake Michigan. The principal tributaries of the Milwaukee River system which drain the watershed include the West Branch of the Milwaukee River, the East Branch of the Milwaukee River, Crooked Lake Creek, Silver Creek (West Bend Township), the North Branch of the Milwaukee River, Cedar Creek, Lincoln Creek, and the Milwaukee River mainstem. Table 204 lists for the Milwaukee River watershed, each major stream reach, together with the location of the source and the length of the stream in miles. The watershed ranks third in size within the Region, but first in total resident population.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Milwaukee River watershed lies within Milwaukee, Ozaukee, and Washington Counties in the southeastern Region and in parts of 51 cities, villages, and towns. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 205. The 1975 resident population of the watershed within the Region is estimated at 483,193 persons, or approximately 27 percent of the estimated 1975 total regional population. Total 1975 watershed population is estimated at 496,236 persons. Table 206 presents the population distribution in the Milwaukee River watershed by civil division.

Surface water in the Milwaukee River watershed is comprised almost entirely of streamflow and lake storage. Some small ponds, flooded gravel pits, and wetlands make up the remainder of the surface water. The streamflow of the Milwaukee River has been measured since 1964 at six continuous flow recording gages within the Region measured by the U.S. Geological Survey in cooperation with the Milwaukee Metropolitan Sewerage District and the Commission, the six gages being located on the left bank at the small dam in Kewaskum; downstream of bridge on County Trunk S southwest of New Fane; downstream from County Trunk Highway M south of Fillmore; 800 feet downstream from recreation pond, 1.9 miles north of Cedarburg; 6.6 miles upstream from the mouth; and the last on the left bank near the northeast city limits of Milwaukee in Estabrook Park.

The soils within the Milwaukee River watershed within the Region are brown to black silt loams in Ozaukee County, grayish-brown rolling silt loams or gravelly to grayish-brown loams in Washington County, and a clay-type soil in Milwaukee County. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service, or residential development without public sanitary sewer, as shown on Maps 43, 44 and 45.

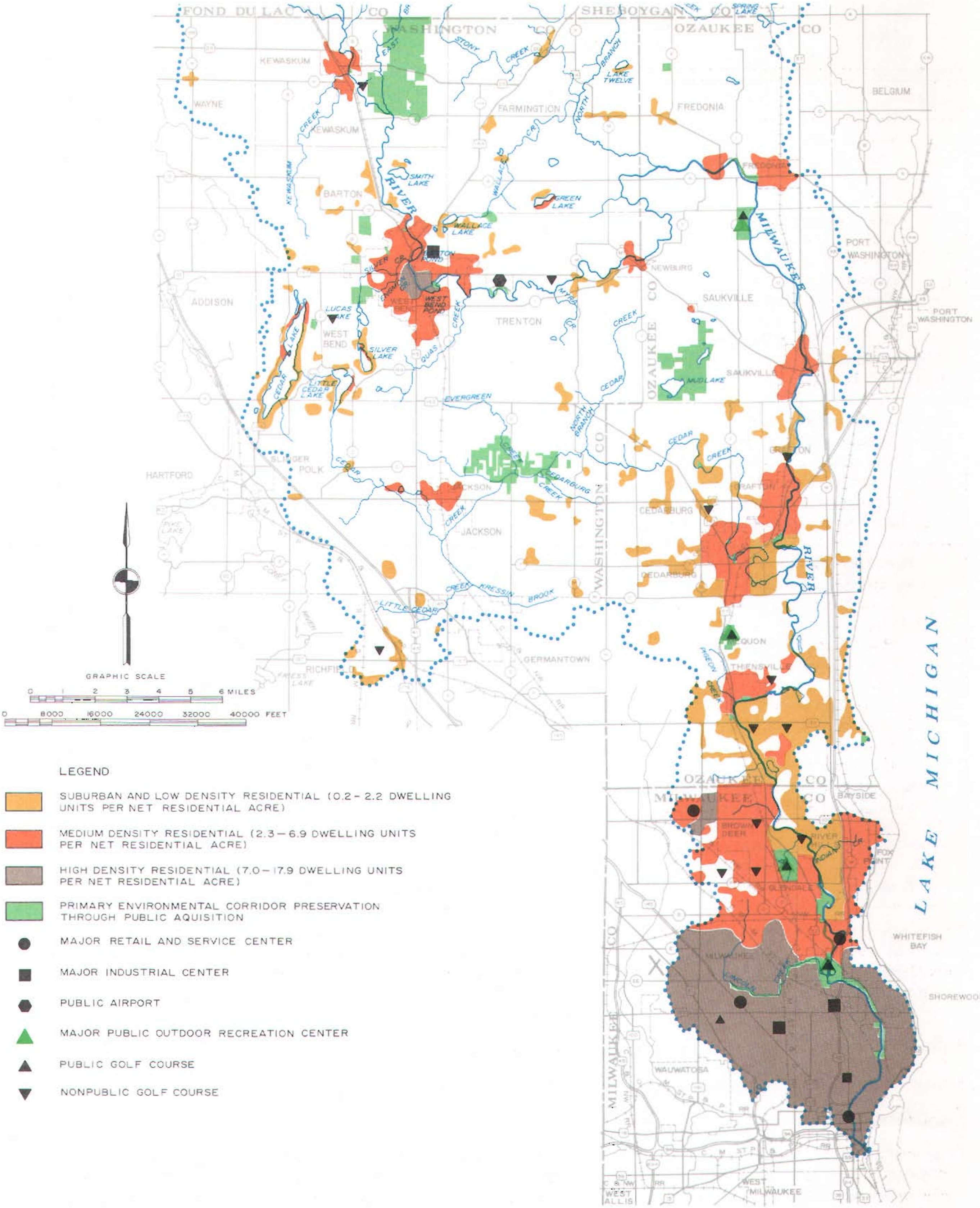
Urban Land Uses

Residential Activities: Residential land uses cover approximately 29,129 acres, or 7 percent of the watershed. In addition, 4,742 acres, or 1 percent of the watershed, were under development for residential land use and are included as pollution sources under the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Milwaukee River watershed are estimated at 116,500 pounds of nitrogen, 9,300 pounds of phosphorus, 707,800 pounds of BOD_5, 4.7 x 10^{14} fecal coliform counts, and 7,940 tons of sediment during an average year. Table 207 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Milwaukee River watershed, approximately 5,454 acres, or 1 percent of the total land surface, is devoted to commercial activities. In addition, 175 acres, or less than 1 percent of the watershed, were under development for commercial land use and are included as pollution sources under the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. The estimated annual pollutant loadings from commercial activities excluding land under development within the Milwaukee River watershed are 49,100 pounds of nitrogen, 4,090 pounds of phosphorus, 532,300 pounds of BOD_5, 1.8 x 10^{14} fecal coliform counts, and 2,030 tons of sediment. Table 208 presents the areal extent of commercial land uses within the Milwaukee River watershed along with the estimated average annual diffuse source pollutant loads from these areas.

Map 58

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE MILWAUKEE RIVER WATERSHED IN 1975



As of 1975 more than 87 percent of the Milwaukee River watershed was in rural land uses. The dominant rural land use in the watershed was agricultural, which occupied 82 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural land uses with scattered concentrations of urban development primarily in the form of individual cities and villages in the headwater portions of the watershed, and by major concentrations of urban development in the lower portions of the watershed, a part of the Milwaukee urbanized area. There were 18 public or private golf courses and four major parks in the watershed, as well as segments of a major parkway.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 203

AREAL EXTENT OF WATER QUALITY RELATED LAND USES
IN THE MILWAUKEE RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	45.51	29.129	6.66
Commercial[b]	8.52	5,454	1.25
Industrial			
Manufacturing	4.59	2,936	0.67
Landfill & Dump	0.12	78	0.02
Extractive	1.67	1,107	0.24
Transportation			
Streets & Highways	3.26	2,086	0.48
Airfields	0.40	255	0.06
Railroad Yards & Terminals	0.14	90	0.02
Recreation			
Golf Courses	3.50	2,242	0.51
Parks & Other Recreation	5.65	3,616	0.83
Land Under Development			
Residential Land Under Development[c]	7.41	4,742	1.08
Commercial Land Under Development	0.27	175	0.04
Industrial Land Under Development	0.04	23	0.01
Transportation Land Under Development	0.24	156	0.04
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	63.38	40,565	9.28
Hay	135.67	86,828	19.86
Row Crops	164.34	105,177	24.05
Specialty Crops	19.83	12,689	2.90
Sod Farm	0.22	143	0.03
Other Open Space[d]	104.65	66,978	15.32
Silvicultural			
Woodlands	61.05	39,070	8.94
Orchards & Nurseries	1.45	930	0.21
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	7.99	5,112	1.17
Wetlands, Swamps, & Marshes	43.31	27,720	6.34
Total	683.21[e]	437,211	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

[e] *The total area of the Milwaukee River watershed represented in this table is different than the total area of the Milwaukee River watershed identified in Table 205. This is due to the fact that the area set forth in Table 205 includes all that portion of the Milwaukee River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Milwaukee River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 204

LENGTH OF STREAMS AND THEIR SOURCES WITHIN THE MILWAUKEE RIVER WATERSHED

Stream or Watercourse	Source		Length[a] (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Batavia Creek	Town of Scott	T13N, R20E, Sec. 14, SW 1/4	5.0
Cedar Creek	Town of West Bend	T11N, R19E, Sec. 17, SW 1/4	31.5
Cedarburg Creek	Town of Jackson	T10N, R20E, Sec. 24, NE 1/4	3.0
Chambers Creek	Town of Mitchell	T14N, R20E, Sec. 25, SW 1/4	2.9
East Branch Milwaukee River	Town of Mitchell	T14N, R20E, Sec. 17, NE 1/4	14.3
Engmon Creek	City of West Bend	T11N, R19E, Sec. 15, SE 1/4	1.5
Evergreen Creek	Town of Jackson	T10N, R19E, Sec. 6, NE 1/4	4.9
Gooseville Creek	Town of Sherman	T13N, R21E, Sec. 16, NW 1/4	1.8
Indian Creek	Village of River Hills	T 8N, R22E, Sec. 8, NE 1/4	1.9
Kewaskum Creek	Town of Barton	T11N, R19E, Sec. 5, SE 1/4	6.4
Kressin Brook	Town of Germantown	T 9N, R20E, Sec. 2, NW 1/4	4.7
Lake Fifteen Creek	Town of Osceola	T14N, R19E, Sec. 26, NE 1/4	7.4
Lincoln Creek	City of Glendale	T 8N, R21E, Sec. 23, NE 1/4	7.1
Little Cedar Creek	Town of Richfield	T 9N, R19E, Sec. 2, NE 1/4	6.0
Melius Creek	Town of Scott	T13N, R20E, Sec. 11, SW 1/4	3.3
Milwaukee River	Town of Osceola	T14N, R19E, Sec. 7, NE 1/4	101.0
Mink Creek	Town of Mitchell	T14N, R20E, Sec. 26, NW 1/4	17.3
Myra Creek	Town of Trenton	T11N, R20E, Sec. 27, NE 1/4	2.6
Nichols Creek	Town of Mitchell	T14N, R20E, Sec. 12, SE 1/4	3.3
North Branch Cedar Creek	Town of Saukville	T11N, R21E, Sec. 19, NW 1/4	7.3
North Branch Milwaukee River	Town of Mitchell	T14N, R20E, Sec. 12, SE 1/4	30.0
Pigeon Creek	City of Mequon	T 9N, R21E, Sec. 10, SE 1/4	2.4
Quas Creek	Town of West Bend	T11N, R19E, Sec. 34, SE 1/4	5.9
Silver Creek	Town of Sherman	T13N, R21E, Sec. 24, NW 1/4	7.1
Silver Creek	Town of West Bend	T11N, R19E, Sec. 34, NW 1/4	4.0
Stony Creek	Town of Scott	T13N, R20E, Sec. 31, NW 1/4	10.0
Virgin Creek	Town of Osceola	T14N, R19E, Sec. 33, SE 1/4	4.5
Wallace Creek	Town of Farmington	T12N, R 2E, Sec. 33, SW 1/4	8.6
Water Cress Creek	Town of Greenbush	T15N, R20E, Sec. 33, SW 1/4	6.5
West Branch Milwaukee River	Town of Byron	T14N, R17E, Sec. 24, SW 1/4	20.1

[a] *Total perennial stream length as shown on U. S. Geological Survey quadrangel maps.*

Source: SEWRPC.

Industrial Activities: Industrial land uses cover 2,936 acres, or about 1 percent of the Milwaukee River watershed. In addition, 23 acres, or less than 1 percent of the watershed were under development for industrial land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. The industrial activities within the Milwaukee River watershed excluding land under development are estimated to contribute annually 24,700 pounds of nitrogen, 2,060 pounds of phosphorus, 108,300 pounds of BOD_5, 1.8 x 10^{14} fecal coliform counts, and 1,440 tons of sediment to surface runoff. Table 209 presents the areal extent of the industrial uses within the Milwaukee River watershed along with the estimated average annual diffuse source pollutant loadings from these activities. Sanitary landfill operations within the Milwaukee River watershed occupy a total of 78 acres, or less than 1 percent of the drainage area. These are included, along with their estimated pollutant loading rates, on Table 209. The landfill operations have an estimated annual pollutant load of 700 pounds of nitrogen, 50 pounds of phosphorus, 2,900 pounds of BOD_5, 4.8 and 10^{12} fecal coliform counts, and 40 tons of sediment.

In addition to the sanitary landfill sites in the watershed, there are also 10 auto salvage and wrecking facilities which are included in the analysis under industrial activities.

Extractive Activities: There were 1,017 acres of extractive mining operations consisting of gravel pits and attendant washing operations in the Milwaukee River watershed as of 1975. These operations

Table 205

AREAL EXTENT OF CIVIL DIVISIONS IN THE MILWAUKEE RIVER WATERSHED WITHIN THE REGION, JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Milwaukee County			
Cities			
Glendale	5.93	1.37	99.33
Milwaukee	38.69	8.94	40.04
Villages			
Bayside	0.35	0.08	15.15
Brown Deer	4.35	1.00	100.00
Fox Point	1.56	0.36	54.17
River Hills	4.21	0.97	79.43
Shorewood	1.58	0.36	92.94
Whitefish Bay	0.73	0.17	34.27
County Subtotal	57.40	13.25	23.65
Ozaukee County			
Cities			
Cedarburg	2.84	0.66	100.00
Mequon	31.28	7.22	66.51
Villages			
Fredonia	1.18	0.27	89.39
Grafton	2.25	0.52	100.00
Saukville	2.06	0.48	100.00
Thiensville	1.03	0.24	100.00
Newburg	0.07	0.02	100.00
Towns			
Cedarburg	27.13	6.27	100.00
Fredonia	27.96	6.46	80.04
Grafton	17.96	4.15	82.54
Port Washington	2.46	0.57	12.73
Saukville	34.40	7.94	99.97
County Subtotal	150.62	34.79	64.10
Washington County			
City			
West Bend	7.51	1.73	100.00
Villages			
Germantown	5.09	1.18	14.75
Jackson	1.42	0.33	100.00
Kewaskum	1.24	0.29	100.00
Newburg	0.68	0.16	100.00
Towns			
Addison	0.12	0.03	0.33
Barton	19.54	4.51	93.67
Farmington	36.72	8.48	100.00
Germantown	0.94	0.22	55.62
Jackson	35.04	8.09	100.00
Kewaskum	23.10	5.33	100.00
Polk	24.39	5.63	71.02
Richfield	5.66	1.31	15.67
Trenton	34.66	8.00	100.00
Wayne	9.25	2.14	25.70
West Bend	19.62	4.53	95.33
County Subtotal	224.98	51.96	51.64
Total	433.00	100.00	--

Source: SEWRPC.

Table 206

ESTIMATED POPULATION OF THE MILWAUKEE RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Dodge County	
Lomira Town	160
Dodge County (Part) Subtotal	160
Fond du Lac County	
Ashford Town (Part)	1,340
Auburn Town	1,416
Byron Town (Part)	250
Campbellsport Village	1,857
Eden Town (Part)	492
Forest Town (Part)	25
Osceola Town (Part)	1,100
Fond du Lac County (Part) Subtotal	6,480
Milwaukee County	
Bayside Village (Part)	1,010
Brown Deer Village	13,570
Fox Point Village (Part)	6,032
Glendale City (Part)	13,453
Milwaukee City (Part)	337,769
River Hills Village (Part)	1,170
Shorewood Village (Part)	14,088
Whitefish Bay Village (Part)	6,467
Milwaukee County (Part) Subtotal	393,559
Ozaukee County	
Cedarburg City	9,766
Cedarburg Town	4,619
Fredonia Town (Part)	1,713
Fredonia Village (Part)	1,269
Grafton Town (Part)	2,889
Grafton Village (Part)	7,983
Mequon City (Part)	9,860
Newburg Village (Part, Ozaukee County)	82
Port Washington Town (Part)	378
Saukville Town (Part)	1,514
Saukville Village	2,483
Thiensville Village	3,189
Ozaukee County (Part) Subtotal	46,375
Sheboygan County	
Adell Village	509
Cascade Village	576
Greenbush Town (Part)	50
Lyndon Town (Part)	510
Mitchell Town (Part)	750
Random Lake Village	1,233
Scott Town	1,550
Sherman Town (Part)	1,225
Sheboygan County (Part) Subtotal	6,403
Washington County	
Addison Town (Part)	16
Barton Town (Part)	1,556
Farmington Town	1,889
Germantown Town (Part)	97
Germantown Village (Part)	222
Jackson Town	3,178
Jackson Village	1,895
Kewaskum Town	1,303
Kewaskum Village	2,329
Newburg Village (Part, Washington County)	562
Polk Town (Part)	2,379
Richfield Town (Part)	1,319
Trenton Town	2,956
Wayne Town (Part)	328
West Bend City	20,296
West Bend Town (Part)	2,934
Washington County (Part) Subtotal	43,259
Milwaukee River Watershed Total	496,236[a]

[a] *Indicates population outside the SEWRPC seven-county Region. In-Region population is estimated at 483,193 persons.*

Source: Wisconsin Department of Administration and SEWRPC.

contribute an estimated 61,000 pounds of nitrogen, 45,800 pounds of phosphorus, 122,000 pounds of BOD_5, and 76,300 tons of sediments annually. Table 210 presents the extent of the extractive operations and the estimated attendant diffuse source pollutant loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, railroad yards and terminals, and airfields. In addition, 156 acres, or less than 1 percent of the watershed, were under development for transportation land use and are included as pollution sources under the development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Table 211 presents the estimated pollutant contributions, excluding land under development, from the 2,431 acres, or less than 1 percent of the total watershed area which is devoted to these land uses. It is estimated that 52,600 pounds of nitrogen, 3,700 pounds of phosphorus, 339,500 pounds of BOD_5, 1.5×10^{14} fecal coliform counts, and 44,890 tons of sediment are transported annually from transportation related activities within the Milwaukee River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential,

Table 207

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	29,129	666	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	4.0 0.32 24.3 1.6×10^{10} counts/ac/yr. 545	116,520 9,320 707,830 4.7×10^{14} counts/yr. 7,940 tons

Source: SEWRPC.

Table 208

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commerical	5,454	1.25	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	9.0 0.75 97.6 3.3×10^{10} counts/ac/yr. 745	49,090 4,090 532,310 1.8×10^{14} counts/yr. 2,030 tons

Source: SEWRPC.

Table 209

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industry	2,936	0.67	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.4 0.70 36.9 6.2×10^{10} counts/a/yr. 977	24,660 2,060 108,340 1.8×10^{14} counts/yr. 1,435 tons
Landfill	78	0.02	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.4 0.70 36.9 6.2×10^{10} counts/a/yr. 977	660 50 2,880 4.8×10^{12} counts/yr. 40 tons
Total	3,014	0.69	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	-- -- -- -- --	25,320 2,110 111,220 1.9×10^{14} counts/yr. 1,470 tons

Source: SEWRPC.

Table 210

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive	1,017	0.24	Total Nitrogen	60	61,020
			Total Phosphorus	45	45,770
			Biochemical Oxygen Demand	120	122,040
			Fecal Coliform	Negligible	--
			Sediment	150,000	76,275 tons

Source: SEWRPC.

Table 211

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	2,086	0.48	Total Nitrogen	23.4	48,810
			Total Phosphorus	1.4	2,920
			Biochemical Oxygen Demand	159	331,670
			Fecal Coliform	6.7×10^{10} counts/a/yr.	1.4×10^{14} counts/yr.
			Sediment	42,600	44,430 tons
Railroad Yards and Terminals	90	0.02	Total Nitrogen	8.4	760
			Total Phosphorus	1.17	110
			Biochemical Oxygen Demand	369	3,320
			Fecal Coliform	6.2×10^{10} counts/a/yr.	5.6×10^{12} counts/yr.
			Sediment	977	45 tons
Airfields	255	0.06	Total Nitrogen	12	3,060
			Total Phosphorus	2.7	690
			Biochemical Oxygen Demand	17.6	4,490
			Fecal Coliform	Negligible	--
			Sediment	3,200	410 tons
Total	2,431	0.56	Total Nitrogen	--	52,630
			Total Phosphorus	--	3,710
			Biochemical Oxygen Demand	--	339,480
			Fecal Coliform	--	1.5×10^{14} counts/yr.
			Sediment	--	44,885 tons

Source: SEWRPC.

commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve.

Recreational Activities

The major recreational facilities within the watershed as of 1975 included parks with a total area of 3,616 acres, or 1 percent of the total area of the watershed; and golf courses with a total area of 2,242 acres, or less than 1 percent of the total area of the watershed. Map 58 indicates the location of public and private golf courses and major parks within the Milwaukee River watershed as of 1975. Table 212 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 18,200 pounds of nitrogen, 700 pounds of phosphorus, 7,600 pounds of BOD_5, 1.3×10^{13} fecal coliform counts, and 1,230 tons of sediment are transported from parks and golf courses within the Milwaukee River watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development

The Milwaukee River watershed is undergoing conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 4,742 acres, or 1 percent of the total

Table 212

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	3,616	0.83	Total Nitrogen	2.3	8,320
			Total Phophorus	0.06	220
			Biochemical Oxygen Demand	1.3	4,700
			Fecal Coliform	3.6×10^9 counts/a/yr.	1.3×10^{13} counts/yr.
			Sediment	420	760 tons
Golf Courses	2,242	0.51	Total Nitrogen	4.4	9,860
			Total Phosphorus	0.2	450
			Biochemical Oxygen Demand	1.3	2,910
			Fecal Coliform	Negligible	--
			Sediment	420	470 tons
Total	5,858	1.34	Total Nitrogen	--	18,180
			Total Phosphorus	--	670
			Biochemical Oxygen Demand	--	7,620
			Fecal Coliform	--	1.3×10^{13} counts/yr.
			Sediment	--	1,230 tons

Source: SEWRPC.

land area of the watershed. Similarly, an estimated 23 acres, or less than 1 percent of the total area of the watershed was under development for industrial land uses in 1975. An estimated 175 acres of commercial related lands, or less than 1 percent of total land uses, and 156 acres of transportation related lands, or less than 1 percent of total land uses were under development in the watershed in 1975. It is estimated that 305,800 pounds of nitrogen, 229,300 pounds of phosphorus, 611,500 pounds of BOD_5, and 382,220 tons of sediment were transported from these construction sites in 1975. Table 213 presents the estimated acreage of land under conversion from rural to urban use within the Milwaukee River watershed along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975, there were only 48 known holding tanks and two mound systems in existence in the in-Region portion of the watershed, as shown on Map 46. Table 214 presents the estimated pollutant loadings from the approximately 10,535 septic tanks in the watershed as of 1975. It is estimated that 86,300 pounds of nitrogen, 19,700 pounds of phosphorus, 210 tons of sediment, 1,214,600 pounds of BOD_5, and 1.5×10^{15} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Milwaukee River watershed.

Rural Land Uses

Agricultural Activities: About 71 percent of the area of the Milwaukee River watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May, 1975, 479 significant domestic livestock operations with a total of 108,530 animals, or 40,790 equivalent animal units were known to exist within the watershed in the Region. Map 59 indicates the locations of these livestock operations. Of these operations, 242 were located within 500 feet of the identified stream system of the watershed. Table 215 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates within the Region and outside the Region. Approximately 1,812,800 pounds of nitrogen, 421,300 pounds of phosphorus, 7,097,900 pounds of BOD_5, 4.1×10^{16} fecal coliform counts, and 22,340 tons of sediment are transported from livestock operations within the whole Milwaukee River watershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in the Region in 1975, as well as the amount of pasture and other open lands, are presented in Table 216. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 40,565 acres, or 9 percent of the total area of the watershed were planted in grain crops consisting of oats and wheat in 1975. Average

Table 213

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Under Construction	4,742	1.08	Total Nitrogen	60	284,520
			Total Phosphorus	45	213,390
			Biochemical Oxygen Demand	120	569,040
			Fecal Coliform	Negligible	- -
			Sediment	150,000	355,650 tons
Commercial.	175	0.04	Total Nitrogen	60	10,500
			Total Phosphorus	45	7,880
			Biochemical Oxygen Demand	120	21,000
			Fecal Coliform	Negligible	- -
			Sediment	150,000	13,130 tons
Industrial	23	0.01	Total Nitrogen	60	1,380
			Total Phosphorus	45	1,040
			Biochemical Oxygen Demand	120	2,760
			Fecal Coliform	Negligible	- -
			Sediment	150,000	1,730 tons
Transportation	156	0.04	Total Nitrogen	60	9,360
			Total Phosphorus	45	7,020
			Biochemical Oxygen Demand	120	18,720
			Fecal Coliform		- -
			Sediment		11,700 tons
Total	5,096	1.17	Total Nitrogen	- -	305,760
			Total Phosphorus	- -	229,320
			Biochemical Oxygen Demand	- -	611,520
			Fecal Coliform	- -	- -
			Sediment	- -	382,200 tons

Source: SEWRPC.

Table 214

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	10,535	38,780	Total Nitrogen	2.9	86,330
			Total Phosphorus	0.66	19,650
			Biochemical Oxygen Demand	40.8	1,214,580
			Fecal Coliform	5.0×10^{10} counts/capita/yr.	1.5×10^{15} counts/yr.
			Sediment	14.0	210 tons

Source: SEWRPC.

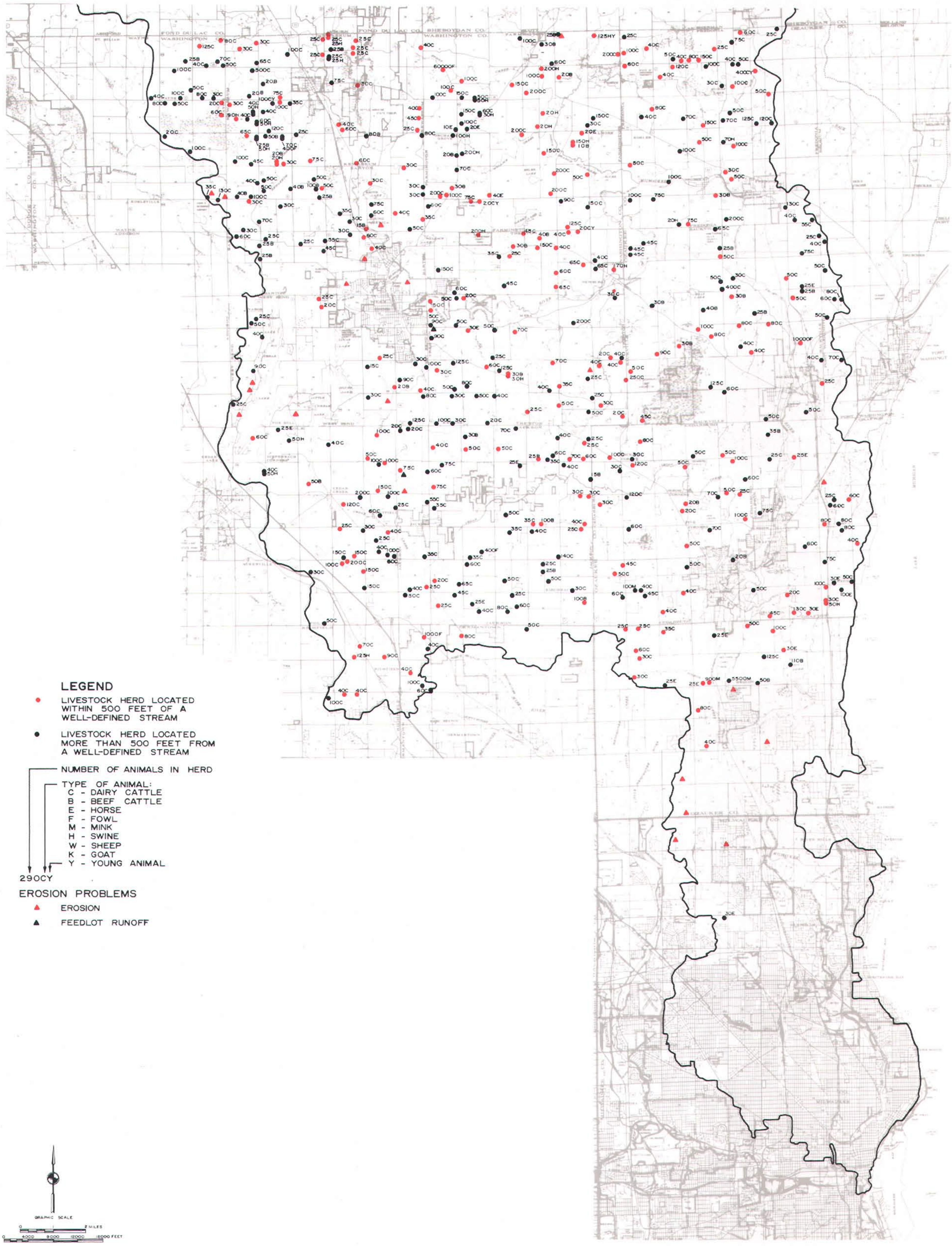
annual pollutant loadings from grain crops within the Milwaukee River watershed are accordingly estimated at 190,700 pounds of nitrogen, 5,300 pounds of phosphorus, 389,400 pounds of BOD_5, and 64,900 tons of sediment. Table 216 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates to the land surface in an average year within the watershed.

Approximately 86,828 acres, or 20 percent of the total area of the watershed were devoted to growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Milwaukee River watershed are 78,200 pounds of nitrogen, 7,800 pounds of phosphorus, 833,600 pounds of BOD_5, and 138,900 tons of sediment.

Major row crops grown within the Milwaukee River watershed are corn and soybeans which were planted on 105,177 acres, or 24 percent of the total area of the watershed, making it the largest single land use category. As shown on Table 216, an estimated

Map 59

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE MILWAUKEE RIVER WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 479 operations within the Milwaukee River watershed in 1975, 242 operations, or 50.5 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 215

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	25,980	36,370	564,166	Total Nitrogen	28.4	1,032,910
				Total Phosphorus	6.6	240,040
				Biochemical Oxygen Demand	111.2	4,044,340
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	2.3×10^{16} counts/yr.
				Sediment	700.0	12,730 tons
Beef	1,860	1,860	21,046	Total Nitrogen	28.4	52,820
				Total Phosphorus	6.6	12,280
				Biochemical Oxygen Demand	111.2	206,830
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	1.2×10^{15} counts/yr.
				Sediment	700.0	650 tons
Hogs	1,880	750	9,470	Total Nitrogen	28.4	21,300
				Total Phosphorus	6.6	4,950
				Biochemical Oxygen Demand	111.2	83,400
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	4.8×10^{14} counts/yr.
				Sediment	700.0	265 tons
Horses	510	1,020	9,308	Total Nitrogen	28.4	28,970
				Total Phosphorus	6.6	6,730
				Biochemical Oxygen Demand	111.2	113,420
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	6.5×10^{14} counts/yr.
				Sediment	700.0	355 tons
Fowl	71,800	720	6,945	Total Nitrogen	28.4	20,450
				Total Phosphorus	6.6	4,750
				Biochemical Oxygen Demand	111.2	80,060
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	4.6×10^{14} counts/yr.
				Sediment	700.0	250 tons
Mink	6,500	70	593	Total Nitrogen	28.4	1,990
				Total Phosphorus	6.6	460
				Biochemical Oxygen Demand	111.2	7,780
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	4.5×10^{13} counts/yr.
				Sediment	700.0	25 tons
Total Animals In Region	108,530	40,790	611,528	Total Nitrogen	- -	1,558,440
				Total Phosphorus	- -	269,210
				Biochemical Oxygen Demand	- -	4,535,830
				Fecal Coliform	- -	2.6×10^{16} counts/yr.
				Sediment	- -	14,275 tons
Total Animals Outside Region[a]	- -	23,040	345,502	Total Nitrogen	28.4	654,340
				Total Phosphorus	6.6	152,060
				Biochemical Oxygen Demand	111.2	2,562,050
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	1.5×10^{16} counts/yr.
				Sediment	700.0	8,065 tons
Total Animals	- -	63,830	957,030	Total Nitrogen	- -	1,812,770
				Total Phosphorus	- -	421,280
				Biochemical Oxygen Demand	- -	7,097,900
				Fecal Coliform	- -	4.1×10^{16} counts/yr.
				Sediment	- -	22,340 tons

[a] *Figure for Outside Region based on assessor's report ratio to SEWRPC in Region acerage and extrapolated to out of Region acreage.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

Table 216

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	40,565	9.28	Total Nitrogen	4.7	190,660
			Total Phosphorus	0.13	5,270
			Biochemical Oxygen Demand	9.6	389,420
			Fecal Coliform	Negligible	--
			Sediment	3,200	64,905 tons
Hay	86,828	19.86	Total Nitrogen	0.9	78,150
			Total Phosphorus	0.09	7,820
			Biochemical Oxygen Demand	9.6	833,550
			Fecal Coliform	Negligible	--
			Sediment	3,200	138,925 tons
Row	105,177	24.05	Total Nitrogen	23.1	2,429,590
			Total Phosphorus	0.64	67,310
			Biochemical Oxygen Demand	16.0	1,682,830
			Fecal Coliform	Negligible	--
			Sediment	5,300	278,720
Specialty Crops – Vegetable and Other Agricultural Crops	12,689	2.90	Total Nitrogen	23.1	293,120
			Total Phosphorus	0.64	8,120
			Biochemical Oxygen Demand	30.0	380,670
			Fecal Coliform	Negligible	--
			Sediment	10,000	63,445 tons
Sod	143	0.03	Total Nitrogen	0.9	130
			Total Phosphorus	0.09	10
			Biochemical Oxygen Demand	2.1	300
			Fecal Coliform	Negligible	--
			Sediment	700	50 tons
Pasture	66,978	15.32	Total Nitrogen	4.6	308,100
			Total Phosphorus	0.29	19,420
			Biochemical Oxygen Demand	9.7	649,690
			Fecal Coliform	Negligible	--
			Sediment	420	14,065 tons
Total	312,380	71.44	Total Nitrogen	--	3,299,730
			Total Phosphorus	--	107,960
			Biochemical Oxygen Demand	--	3,936,460
			Fecal Coliform	--	--
			Sediment	--	560,110 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

2,429,600 pounds of nitrogen, 67,300 pounds of phosphorus, 1,682,800 pounds of BOD_5, and 278,720 tons of sediment are transported annually from the row crop acreage within the Milwaukee River watershed.

Also, as shown in Table 216, specialty crops were grown on a total of 12,689 acres, or 3 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Milwaukee River watershed are 293,100 pounds of nitrogen, 8,100 pounds of phosphorus, 380,670 pounds of BOD_5, and 63,445 tons of sediment.

About 143 acres, or less than 1 percent of land within the watershed, were in sod farms in 1975. Estimated average annual pollutant loading rates from these sod farms within the Milwaukee River watershed are 100 pounds of nitrogen, 10 pounds of phosphorus, 300 pounds of BOD_5, and 50 tons of sediment.

Irrigation of cropland, as well as golf courses, was practiced within the watershed in 1975. The location of the high-capacity wells which provide the water supply are shown on Map 47. The irrigation volumes are estimated at 0.188 million gallons per day (mgd). It has been estimated that corn receives up to 10 inches of irrigation water annually, vegetables receive 15-20 inches, sod receives approximately 18 inches, and golf courses receive varying amounts of irrigation water annually. Irrigation return flows are considered to be negligible in the watershed due to the careful practices of operators, as well as the use of aerial spray methods of application.

The third largest single land use category within the Milwaukee River watershed is that of pasture land and other open space—which accounts for 66,978 acres, or 15 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 216. Annual loading rates from these areas are estimated at 308,100 pounds of nitrogen, 19,400 pounds of phosphorus, 649,700 pounds of BOD_5, and 14,070 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 656 farms in the Region covering about 54,199 acres, or 17 percent of the agricultural land within the watershed in the Region.

A total of 1,496 known soil and water conservation practices were applied within the in-Region watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 60.

Table 217 presents the major categories of conservation practices known to be installed as of 1975 within the watershed within the Region, along with

Table 217

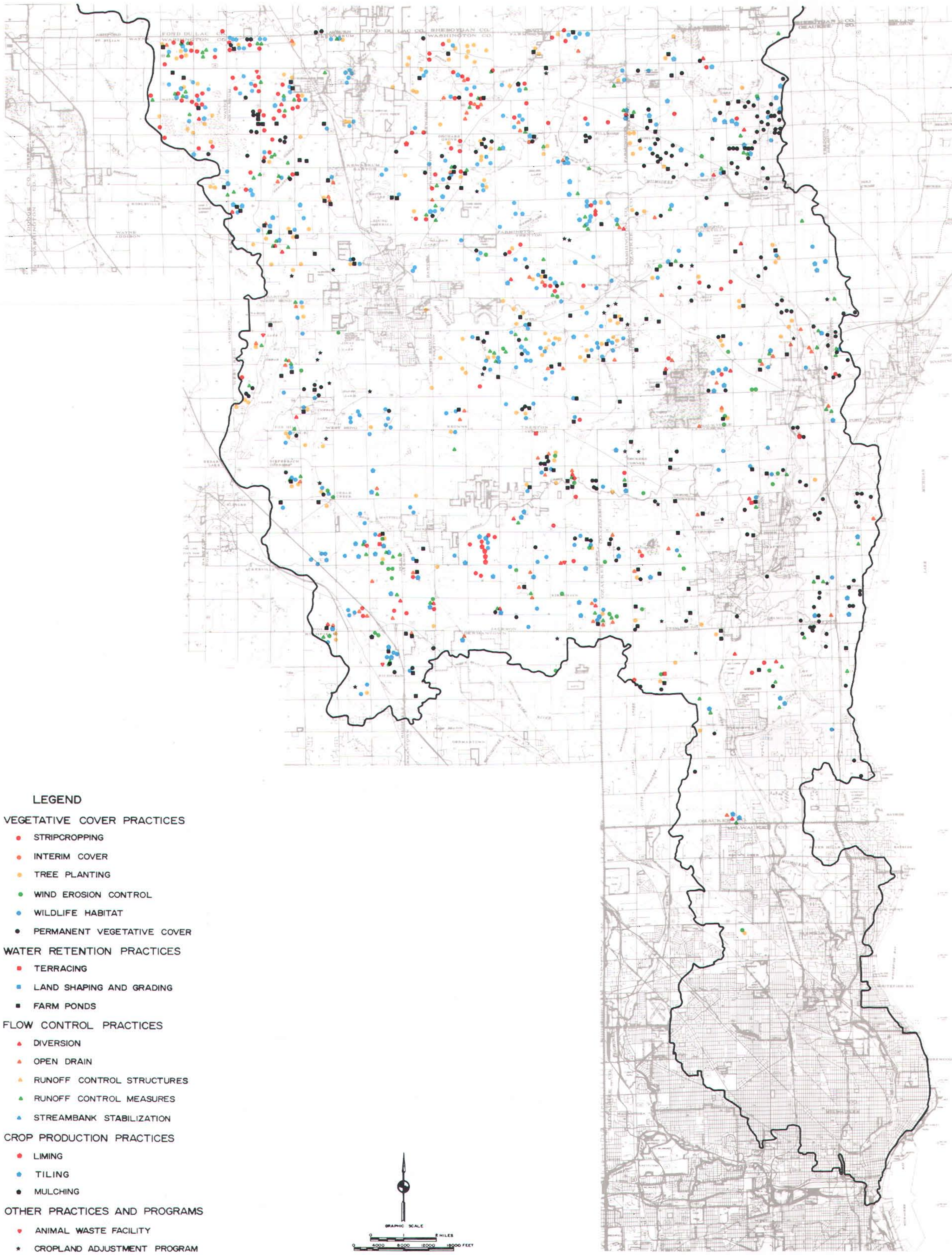
KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE MILWAUKEE RIVER WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value in 1976 Dollars
Vegetative Cover Practices			
Stripcropping	4,456 acres	10.00/acre	44,560.00
Interim Cover	0	12.00/acre	0
Tree Stands	(209 units) (2 acres/unit) = 418 acres	100.00/acre	41,800.00
Wind Erosion Control	67,927 feet	0.60/foot	40,756.20
Wildlife Habitat	(235 units) (2 acres/unit) = 470 acres	25.00/acre	11,750.00
Permanent Vegetative Cover	2,327 acres	50.00/acre	116,350.00
Subtotal			255,216.20
Water Retention Practices			
Terracing	5,355 feet	0.70/foot	3,748.50
Farm Ponds	195 units	4,000.00/unit	780,000.00
Subtotal			783,748.50
Flow Control Practices			
Diversions	41,379 feet	1.25/foot	51,723.75
Open Drains	262,066 feet	2.25/foot	589,648.50
Runoff Control Structures	2 units	2,500.00/unit	5,000.00
Runoff Control Measures	225,561 feet	1.00/foot	225,561.00
Streambank Stabilization	0	3.50/foot	0
Subtotal			871,933.25
Crop Production Practices			
Liming	25 acres	20.00/acre	500.00
Tiling	765,164 feet	0.70/foot	535,614.80
Mulching	93 acres	60.00/acre	5,580.00
Subtotal			541,694.80
Animal Waste Facilities	1	24,000.00/unit	24,000.00
Watershed Total			$2,476,592.75

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service, and SEWRPC.

Map 60

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE MILWAUKEE RIVER WATERSHED IN 1975



The above map illustrates the locations of the 1,496 known conservation practices installed in the Milwaukee River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Servicnd Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching, which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

their physical extent and the 1976 replacement costs of those practices, which total $2,476,593, or an equivalent $7.93 per acre of that portion of the total agricultural land within the watershed which lies within the Region. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $6.19 per acre of agricultural land within the Region, or about 78 percent of the total investment were related to those practices directly affecting water quality. This represents about 41 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 40,000 acres, or approximately 9 percent of the total area of the watershed were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 218 presents the acreage of silvicultural activities within the Milwaukee River watershed and the estimated loading rates from these activities. About 92,000 pounds of nitrogen, 5,600 pounds of phosphorus, 184,000 pounds of BOD_5, 2.6×10^{13} fecal coliform counts, and 5,020 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 5,112 acres, or 1 percent of the total area of the watershed is covered by surface water in the form of lakes, streams, and ponds. As indicated in Table 219, 45,500 pounds of nitrogen, 2,600 pounds of phosphorus,

Table 218

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	39,070	8.94	Total Nitrogen	2.3	89,860
			Total Phosphorus	0.14	5,470
			Biochemical Oxygen Demand	4.6	179,720
			Fecal Coliform	6.6×10^8 counts/a/yr.	2.6×10^{13} counts/yr.
			Sediment	251	4,900 tons
Orchards and Nurseries	930	0.21	Total Nitrogen	2.3	2,140
			Total Phosphorus	0.14	130
			Biochemical Oxygen Demand	4.6	4,280
			Fecal Coliform	6.6×10^8 counts/a/yr.	6.1×10^{11} counts/yr.
			Sediment	251	115 tons
Total	40,000	9.15	Total Nitrogen	--	92,000
			Total Phosphorus	--	5,600
			Biochemical Oxygen Demand	--	184,000
			Fecal Coliform	--	2.6×10^{13} counts/yr.
			Sediment	--	5,020 tons

Source: SEWRPC.

Table 219

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams	5,112	1.17	Total Nitrogen	8.9	45,500
			Total Phosphorus	0.5	2,560
			Biochemical Oxygen Demand	162	828,140
			Fecal Coliform	Negligible	--
			Sediment	665	1,700 tons

Source: SEWRPC.

828,100 pounds of BOD_5, and 1,700 tons of sediment can be expected to be contributed to the surface waters of the Milwaukee River watershed annually by atmospheric dry fall and washout.

A total of 27,720 acres, or 6 percent of the total area of the watershed, is covered by surface water in the form of swamps, marshes, or wetlands, From these areas, only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Milwaukee River watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Milwaukee River Watershed

The Milwaukee River watershed is primarily agricultural with storm water runoff from agricultural lands contributing the largest diffuse source loads of nitrogen, and sediment, the second largest load of biochemical oxygen demand, and the third largest load of phosphorus. In addition, livestock operations are the major diffuse source contributor of fecal coliform, biochemical oxygen demand and phosphorus, and the second largest contributor of nitrogen. Other rural diffuse sources, inclusive of silvicultural activities and air pollution loadings to surface waters, contribute less than 4 percent of all diffuse source loads. Construction activities produce the second largest phosphorus load from diffuse sources and the second largest load of sediment. Onsite sewage disposal systems contribute the third largest load of biochemical oxygen demand. All other urban diffuse sources contribute less than 5 percent of the diffuse source loads of the major pollutants. Total annual diffuse source loads are 5,964,900 pounds of nitrogen, 852,600 pounds of phosphorus, 15,693,100 pounds of biochemical oxygen demand, 4.3×10^{16} fecal coliform counts, and 1,105,410 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE BARNES CREEK SUBWATERSHED OF THE WATERSHED OF MINOR STREAMS DIRECTLY TRIBUTARY TO LAKE MICHIGAN

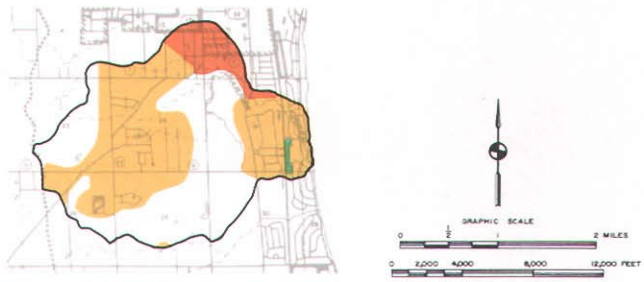
Physical Setting

The Barnes Creek subwatershed is a natural surface water drainage unit five square miles in areal extent located in the southeastern portion of the Region along the western shore of Lake Michigan. The boundaries of the basin together with the locations of the main channel of Barnes Creek are shown on Map 26. The main stem of Barnes Creek originates two miles north of the Illinois State Line and less than one mile from Lake Michigan in Kenosha County and discharges to Lake Michigan in Kenosha County. In addition to Barnes Creek itself, the subwatershed only contains small, intermittent streams. About 65 percent of the subwatershed is in rural land uses, with about 84 percent of this area still in agricultural use. Most of the agricultural related land use is located in the southwestern portions of the watershed. Map 61 sets forth the major land use categories and their spatial distributions within the Barnes Creek subwatershed as they were inventoried in 1975. Table 220 sets forth the extent and proportion of the major land use categories within the subwatershed as they relate to water quality conditions in 1975.

The subwatershed is bounded on the north by the Minor Streams watershed, on the west by the Des Plaines watershed, on the south by Minor Streams

Map 61

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE BARNES CREEK SUBWATERSHED IN 1975



LEGEND

- SUBURBAN AND LOW DENSITY RESIDENTIAL (0.2-2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- MEDIUM DENSITY RESIDENTIAL (2.3-6.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- NONE HIGH DENSITY RESIDENTIAL (7.0-17.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- PRIMARY ENVIRONMENTAL CORRIDOR PRESERVATION THROUGH PUBLIC AQUISITION
- NONE MAJOR RETAIL AND SERVICE CENTER
- NONE MAJOR INDUSTRIAL CENTER
- NONE PUBLIC AIRPORT
- NONE MAJOR PUBLIC OUTDOOR RECREATION CENTER
- NONE PUBLIC GOLF COURSE
- NONE NONPUBLIC GOLF COURSE

As of 1975 more than 65 percent of the Barnes Creek subwatershed was devoted to rural land uses. The dominant rural land use in the subwatershed was agricultural, which occupied 54 percent of the subwatershed area. The overall spatial distribution of land use in the subwatershed was characterized by rural land uses with scattered areas of low- and medium-density urban uses, primarily residential. There were no major parks, parkways, or golf courses in the subwatershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 220

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE BARNES CREEK SUBWATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	0.89	567	18.91
Commercial[b]	0.14	89	2.96
Industrial			
Manufacturing	0.01	3	0.10
Landfill & Dump	0.00	2	0.07
Extractive	0.09	54	1.80
Transportation			
Streets & Highways	--	--	--
Airfields	--	--	--
Railroad Yards & Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks & Other Recreation	0.02	13	0.43
Land Under Development			
Residential Land Under Development[c]	0.50	319	10.63
Commercial Land Under Development	--	--	--
Industrial Land Under Development	--	--	--
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	0.16	100	3.35
Hay	0.03	19	0.63
Row Crops	1.40	895	29.82
Specialty Crops	0.06	38	1.27
Sod Farm	--	--	--
Other Open Space[d]	0.91	583	19.42
Silvicultural			
Woodlands	0.24	155	5.16
Orchards & Nurseries	0.01	9	0.30
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	--	--	--
Wetlands, Swamps, & Marshes	0.24	154	5.14
Total	4.70	3,000	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the area of the Barnes Creek watershed is shown in Table 222.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 221

LENGTH OF STREAMS AND THEIR SOURCES WITHIN THE BARNES CREEK SUBWATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Barnes Creek	Town of Somers	T1N, R23E, Sec. 19, SW 1/4	3.7

Source: SEWRPC.

watershed, and on the east by Lake Michigan. Table 221 lists for Barnes Creek the location of the source and the length of the stream in miles.

Superimposed upon the natural, meandering subwatershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Barnes Creek subwatershed lies totally within Kenosha County and in parts of three cities and towns. The area and proportion of the subwatershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 222. The 1975 resident population of the subwatershed is estimated at 2,816 persons, or approximately 0.2 percent of the estimated 1975 total regional population. Table 223 presents the population distribution in the Barnes Creek subwatershed by civil division.

Surface water in the Barnes Creek subwatershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water. The soils within the Barnes Creek subwatershed are characterized by soil types which consist of deep to moderately deep, brown to black silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the subwatershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service and residential development without public sanitary sewer service, as shown on Maps 43, 44 and 45.

Urban Land Uses

Residential Activities: Residential land uses cover approximately 567 acres, or 19 percent of the subwatershed. In addition, 319 acres, or 11 percent of the watershed, were under development for residential land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Barnes Creek subwatershed are estimated at 2,300 pounds of nitrogen, 200 pounds of phosphorus, 13,800 pounds of BOD_5, 9.1 x 10^{12} fecal coliform counts, and 160 tons of sediment during an average year. Table 224 presents the areal extent of residential land use within the subwatershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Barnes Creek subwatershed, approximately 89 acres, or 3 percent of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Barnes Creek subwatershed are 800 pounds of nitrogen, 70 pounds of phosphorus, 8,700 pounds of BOD_5, 2.9 x 10^{12} fecal coliform counts, and 40 tons of sediment. Table 225 presents the areal extent of commercial land uses within the Barnes Creek subwatershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the Barnes Creek subwatershed.

Industrial Activities: Industrial land uses cover five acres or less than 1 percent of the Barnes Creek subwatershed. The industrial activities within the Barnes Creek subwatershed are estimated to contribute annually 40 pounds of nitrogen, three pounds of phosphorus, 200 pounds of BOD_5, 3.1 and 10^{11} fecal coliform counts, and an insignificant amount of sediment to surface runoff. Table 226 presents the areal extent of the industrial uses within the Barnes Creek subwatershed along with the estimated average annual diffuse source pollutant loadings from these activities. There was no industrial land under development in the Barnes Creek subwatershed.

There was only a modest amount of land used for landfill operations in the subwatershed as of 1975. In addition, there were also two auto salvage and wrecking facilities which are included in the analysis under industrial activities.

Extractive Activities: There were 54 acres of extractive mining operations consisting of gravel pits, and attendant washing operations in the Barnes Creek subwatershed as of 1975. These operations contribute an estimated 3,200 pounds of nitrogen, 2,400 pounds of phosphorus, 6,500 pounds of BOD_5, and 4,050 tons of sediment annually. Table 227 presents the extent of the extraction operations and the estimated attendant diffuse source pollutant loadings.

Table 222

AREAL EXTENT OF CIVIL DIVISIONS IN THE BARNES CREEK SUBWATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Kenosha County			
City			
Kenosha	0.11	2.44	0.74
Town			
Pleasant Prairie	4.39	97.56	11.97
Total	4.50	100.00	--

Source: SEWRPC.

Table 223

ESTIMATED POPULATION IN THE BARNES CREEK SUBWATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Kenosha County	
Kenosha City (Part)	63
Pleasant Prairie Town (Part)	2,753
Kenosha County (Part) Subtotal	2,816
Barnes Creek Subwatershed Total	2,816

Source: Wisconsin Department of Administration and SEWRPC.

Transportation: No expressways or major highways of significant acreage existed in the Barnes Creek subwatershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve. Further, there was no transportation land under development in the Barnes Creek subwatershed.

Recreational Activities: The major recreational facilities within the watershed as of 1975, as shown on Map 61, included parks with a total area of 13 acres, or less than one percent of the total area of the watershed. Table 228 sets forth the acreage of

Table 224

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	567	18.91	Total Nitrogen	4.0	2,270
			Total Phosphorus	0.32	180
			Biochemical Oxygen Demand	24.3	13,780
			Fecal Coliform	1.6×10^{10} counts/ac/yr.	9.1×10^{12} counts/yr.
			Sediment	545	155 tons

Source: SEWRPC.

Table 225

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial	89	2.96	Total Nitrogen	9.0	800
			Total Phosphorus	0.75	70
			Biochemical Oxygen Demand	97.6	8,690
			Fecal Coliform	3.3×10^{10} counts/ac/yr.	2.9×10^{12} counts/yr.
			Sediment	745	35 tons

Source: SEWRPC.

Table 226

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	3	0.10	Total Nitrogen	8.4	25
			Total Phosphorus	0.70	2
			Biochemical Oxygen Demand	36.9	110
			Fecal Coliform	6.2×10^{10} counts/a/yr.	1.9×10^{11} counts/yr.
			Sediment	977	2 tons
Landfill	2	0.07	Total Nitrogen	8.4	15
			Total Phosphorus	0.70	1
			Biochemical Oxygen Demand	36.9	70
			Fecal Coliform	6.2×10^{10} counts/a/yr.	1.2×10^{11} counts/yr.
			Sediment	977	1 ton
Total	5	0.17	Total Nitrogen	--	40
			Total Phosphorus	--	3
			Biochemical Oxygen Demand	--	180
			Fecal Coliform	--	3.1×10^{11} counts/yr.
			Sediment	--	--

Source: SEWRPC.

Table 227

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive	54	1.80	Total Nitrogen	60	3,240
			Total Phosphorus	45	2,430
			Biochemical Oxygen Demand	120	6,480
			Fecal Coliform	Negligible	--
			Sediment	150,000	4,050 tons

Source: SEWRPC.

Table 228

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks.	13	0.43	Total Nitrogen	2.3	30
			Total Phosphorus	0.06	0
			Biochemical Oxygen Demand	1.3	20
			Fecal Coliform	3.6×10^9 counts/ac/yr.	8.7×10^{10} counts/yr.
			Sediment	420	5 tons

Source: SEWRPC.

parks and the estimated amount of diffuse source pollutants transported from this land use. It is estimated that 30 pounds of nitrogen, 20 pounds of biochemical oxygen demand, 8.7×10^{10} counts of fecal coliform counts, and five tons of sediment are transported from parks within the Barnes Creek watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development: The Barnes Creek subwatershed is undergoing rapid conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the subwatershed was estimated at 319 acres, or 11 percent of the total land area of the subwatershed. There was no significant area of industrial, commercial, recreational or transportation related lands under development in the subwatershed in 1975. It is estimated that 19,100 pounds of nitrogen, 14,400 pounds of phosphorus, 38,300 pounds of BOD_5, and 23,930 tons of sediment were transported from these residential construction sites in 1975. Table 229 presents the estimated acreage of land under conversion from rural to urban use within the Barnes Creek subwatershed along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the subwatershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975, there were only four known holding tanks and three mound systems in the subwatershed, as shown on Map 46. Table 230 presents the estimated pollutant loadings from the approximately 515 septic tanks in the subwatershed as of 1975. It is estimated that 10,600 pounds of nitrogen, 2,460 pounds of phosphorus, 151,780 pounds of BOD_5, 25 tons of sediment and 1.9×10^{14} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Barnes Creek subwatershed.

Rural Land Uses

Agricultural Activities: About 55 percent of the area of the Barnes Creek subwatershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May, 1975, only one significant domestic animal operation with a total of 1,000 animals, or 10 equivalent animal units were known to exist within the subwatershed. Map 62 indicates the location of this animal operation. This operation

Table 229

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development. . .	319	10.63	Total Nitrogen	60	19,140
			Total Phosphorus	45	14,360
			Biochemical Oxygen Demand	120	38,280
			Fecal Coliform	Negligible	--
			Sediment	150,000	23,925 tons

Source: SEWRPC.

Table 230

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	515	1,860	Total Nitrogen	5.7	10,600
			Total Phosphorus	1.32	2,460
			Biochemical Oxygen Demand	81.6	151,780
			Fecal Coliform	1.0×10^{11} counts/capita/yr.	1.9×10^{14} counts/yr.
			Sediment	28.0	25 tons

Source: SEWRPC.

was not located within 500 feet of the identified stream system of the subwatershed. Table 231 indicates the number of livestock present within the subwatershed as well as the equivalent animal units, the estimated total waste produced annually, and the total estimated pollutant loading rates. Approximately 300 pounds of nitrogen, 70 pounds of phosphorus, 1,100 pounds of BOD_5, 6.4 x 10^{12} fecal coliform counts, and five tons of sediment are transported from livestock operations within the Barnes Creek subwatershed annually.

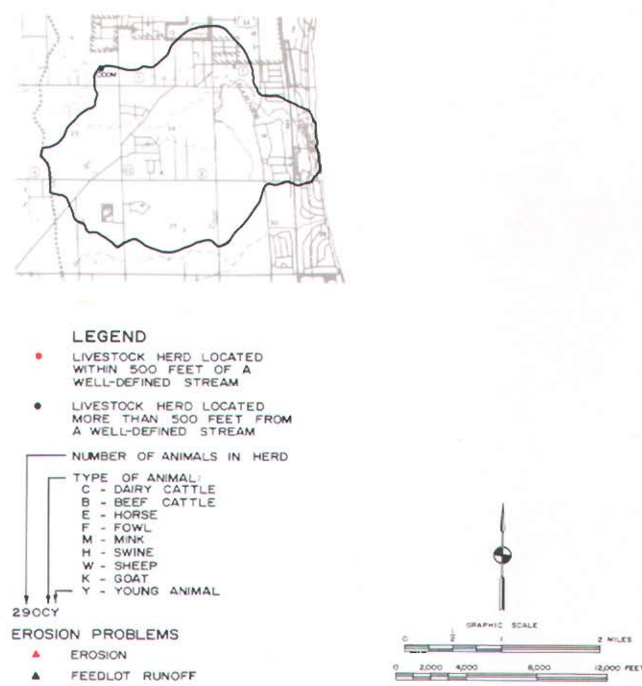
Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the subwatershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 232. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the subwatershed. Approximately 100 acres, or 3 percent of the total area of the subwatershed, were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Barnes Creek subwatershed are accordingly estimated at 500 pounds of nitrogen, 10 pounds of phosphorus, 1,000 pounds of BOD^5, and 160 tons of sediment. Table 232 presents the estimated acreage of grain crops; and the estimated diffuse source pollutant loading rates, to the land surface in an average year within the subwatershed.

Approximately 19 acres, or less than 1 percent of the total area of the subwatershed, were devoted to the growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Barnes Creek subwatershed are 20 pounds of nitrogen, an insignificant amount of phosphorus, 180 pounds of BOD_5, and 30 tons of sediment.

Major row crops grown within the Barnes Creek subwatershed are corn and soybeans which were planted on 895 acres, or 30 percent of the total area of the subwatershed. As shown in Table 232, an estimated 20,700 pounds of nitrogen, 600 pounds of

Map 62

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE BARNES CREEK SUBWATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. The operation located within the Barnes Creek subwatershed in 1975 was not located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 231

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Mink	1,000	10	91.25	Total Nitrogen	28.4	280
				Total Phosphorus	6.6	70
				Biochemical Oxygen Demand	111.2	1,110
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	6.4×10^{12} counts/yr.
				Sediment	700.0	5 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 232

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	100	3.35	Total Nitrogen	4.7	470
			Total Phosphorus	0.13	10
			Biochemical Oxygen Demand	9.6	960
			Fecal Coliform	Negligible	--
			Sediment	3,200	160 tons
Hay	19	0.63	Total Nitrogen	0.9	20
			Total Phosphorus	0.09	0
			Biochemical Oxygen Demand	9.6	180
			Fecal Coliform	Negligible	--
			Sediment	3,200	30 tons
Row	895	29.82	Total Nitrogen	23.1	20,670
			Total Phosphorus	0.64	570
			Biochemical Oxygen Demand	19.1	17,090
			Fecal Coliform	Negligible	--
			Sediment	6,400	2,865 tons
Specialty Crops					
Vegetable and Other Agricultural Crops. .	38	1.27	Total Nitrogen	23.1	880
			Total Phosphorus	0.64	20
			Biochemical Oxygen Demand	30.0	1,140
			Fecal Coliform	Negligible	--
			Sediment	10,000	190 tons
Pasture	583	19.42	Total Nitrogen	4.6	2,680
			Total Phosphorus	0.29	170
			Biochemical Oxygen Demand	9.7	5,650
			Fecal Coliform	Negligible	--
			Sediment	420	120 tons
Total	1,635	54.49	Total Nitrogen	--	24,720
			Total Phosphorus	--	780
			Biochemical Oxygen Demand	--	25,030
			Fecal Coliform	--	--
			Sediment	--	3,365 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Services; University of Wisconsin Extension Service, and SEWRPC.

phosphorus, 17,100 pounds of BOD_5, and 2,870 tons of sediment are transported annually from the row crop acreage within the Barnes Creek subwatershed.

Also, as shown in Table 232, specialty crops were grown on a total of 38 acres, or 1 percent of the total area of the subwatershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Barnes Creek subwatershed are 900 pounds of nitrogen, 20 pounds of phosphorus, 1,100 pounds of BOD_5, and 190 tons of sediment.

The second largest single land use category within the Barnes Creek subwatershed is that of pasture land and other open space—which accounts for 583 acres, or 19 percent of the total area of the watershed. Row cropping activities account for only slightly more, with 895 acres. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 232. Annual loading rates from these areas are estimated at 2,700 pounds of nitrogen, 200 pounds of phosphorus, 5,700 pounds of BOD_5, and 120 tons of sediment.

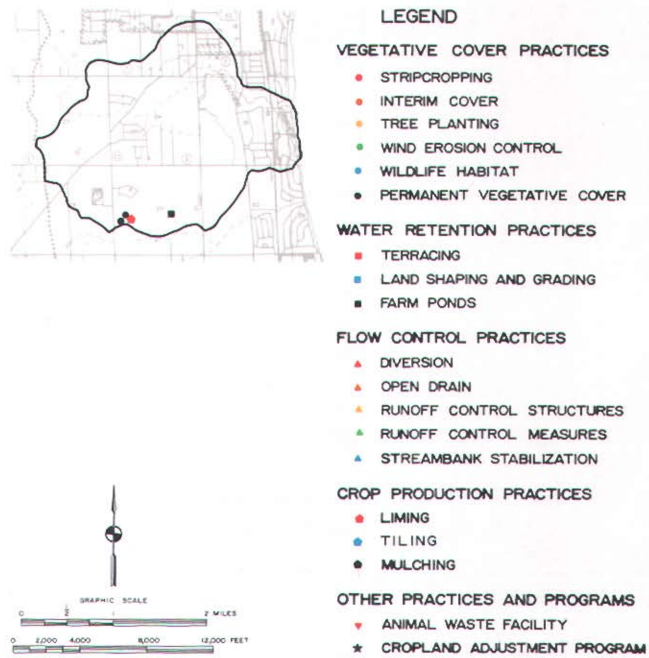
As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for four farms covering about 219 acres, or 3 percent of the agricultural land within the subwatershed.

A total of four known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agriculture Stabilization and Conservation Service are set forth on Map 63.

Table 233 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $12,900, or an equivalent $7.89 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $6.78 per acre of agricultural land, or about 86 percent of the total investment were related to those practices directly affecting water quality. This represents about 45 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Map 63

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE BARNES CREEK SUBWATERSHED IN 1975



The above map illustrates the locations of the four known conservation practices installed in the Barnes Creek subwatershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Silvicultural Activities: About 155 acres, or approximately 5 percent of the total area of the subwatershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 234 presents the acreage of silvicultural activities within the Barnes Creek subwatershed and the estimated loading rates from these activities. About 400 pounds of nitrogen, 20 pounds of phosphorus, 700 pounds of BOD_5, 1.0×10^{11} fecal coliform counts, and 20 tons of sediment are transported annually from silvicultural land uses in the subwatershed.

Table 233

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE BARNES CREEK SUBWATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value in 1976 Dollars
Vegetative Cover Practices			
Stripcropping	7 acres	10.00/acre	70.00
Interim Cover	0	12.00/acre	0
Tree Stands	0	100.00/acre	0
Wind Erosion Control	0	0.60/foot	0
Wildlife Habitat	0	25.00/acre	0
Permanent Vegetative Cover	21 acres	50.00/acre	1,050.00
Subtotal			1,120.00
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	2 units	4,000.00/unit	8,000.00
Subtotal			8,000.00
Flow Control Practices			
Diversions	0	1.25/foot	0
Open Drains	0	2.25/foot	0
Runoff Control Structures	0	2,500.00/unit	0
Runoff Control Measures	2,000 feet	1.00/foot	2,000.00
Streambank Stabilization	0	3.50/foot	0
Subtotal			2,000.00
Crop Production Practices			
Liming	19 acres	20.00/acre	380.00
Tiling	2,000 feet	0.70/foot	1,400.00
Mulching	0	60.00/acre	0
Subtotal			1,780.00
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$12,900.00

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

Atmospheric Contribution: A total of 154 acres, or 5 percent of the total area of the subwatershed, is covered by surface water in the form of swamps, marshes, or wetlands. From these areas, only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Barnes Creek subwatershed annually by atmospheric dry fall and washout; since these wetlands tend to trap many pollutants.

Summary Discussion of the Barnes Creek Subwatershed

The Barnes Creek subwatershed is rapidly undergoing urbanization. Urban storm water runoff, especially from construction activities, is the largest diffuse source of pollution. Construction activities produce 71 percent of the phosphorus load, 75 percent of the sediment, and approximately 32 percent of the nitrogen loads. Onsite sewage disposal systems contribute 91 percent of the total diffuse source fecal coliform load and 62 percent of the biochemical oxygen demand load. Runoff from developed urban areas, inclusive of residential, commercial, and industrial land uses, contributes less than 10 percent of all pollutant loads. Mining and extractive activities contribute 5 to 13 percent of the diffuse nitrogen, phosphorus, and sediment loads. Agricultural runoff is the largest single diffuse source contributor of nitrogen, and the third largest source of biochemical oxygen demand and sediment. All

Table 234

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE BARNES CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodland	155	5.16	Total Nitrogen	2.3	360
			Total Phosphorus	.14	20
			Biochemical Oxygen Demand	4.6	710
			Fecal Coliform	6.6×10^8 counts/a/yr.	1.0×10^{11} counts/yr.
			Sediment	251	20 tons
Orchards and Nurseries	9	0.30	Total Nitrogen	2.3	20
			Total Phosphorus	0.14	1
			Biochemical Oxygen Demand	4.6	40
			Fecal Coliform	6.6×10^8 counts/a/yr.	5.9×10^9 counts/yr.
			Sediment	251	1 ton
Total	164	5.46	Total Nitrogen	--	380
			Total Phosphorus	--	20
			Biochemical Oxygen Demand	--	750
			Fecal Coliform	--	1.1×10^{11} counts/yr.
			Sediment	--	20 tons

Source: SEWRPC.

other rural diffuse sources, inclusive of silvicultural activities and air pollution loads to surface waters, produce less than 2 percent of the diffuse source loads. Total annual diffuse source loads are 61,500 pounds of nitrogen, 20,400 pounds of phosphorus, 246,100 pounds of biochemical oxygen demand, 2.0 x 10^{14} fecal coliform counts, and 31,590 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE PIKE CREEK SUBWATERSHED OF THE WATERSHED OF MINOR STREAMS DIRECTLY TRIBUTARY TO LAKE MICHIGAN

Physical Setting

The Pike Creek subwatershed is a natural surface water drainage unit, seven square miles in areal extent located in the southeastern portion of the Region. The boundaries of the basin together with the locations of the main channel of Pike Creek are shown on Map 26. The main stem of Pike Creek originates in the north central portion of the City of Kenosha in Kenosha County and discharges to Lake Michigan at Kenosha harbor in the City of Kenosha. The lower reaches of Pike Creek flow through a large diameter subterranean culvert. The single principal stream of the subwatershed is Pike Creek itself. About 27 percent of the subwatershed is in rural land uses, with about 96 percent of this area still in land uses categorized as agricultural. Map 64 sets forth the major land use categories and their spatial distributions within the Pike Creek subwatershed as they were inventoried in 1975. Table 235 sets forth the extent and proportion of the major land use categories within the subwatershed as they relate to water quality conditions in 1975.

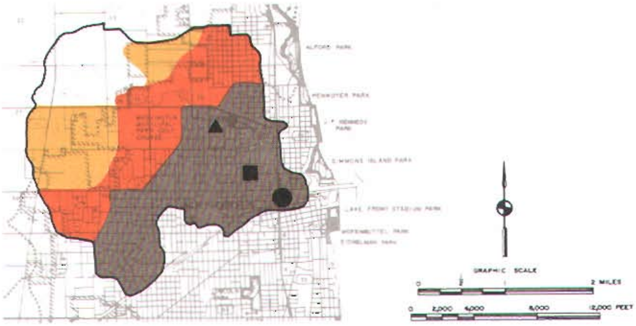
The subwatershed is bounded on the north and west by the Pike River watershed, on the south by Barnes Creek subwatershed, and on the east by Lake Michigan. Table 236 lists for the Pike Creek subwatershed the major stream reach, together with the location of the source and the length of the stream in miles.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Pike Creek subwatershed lies totally within Kenosha County and in parts of the City of Kenosha and Towns of Somers and Pleasant Prairie. The area and proportion of the subwatershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 237. The resident population of the subwatershed is estimated at 31,260 persons, or approximately 0.03 percent of the estimated 1975 total regional population. Table 238 presents the population distribution in the Pike Creek subwatershed by civil division.

Surface water in the Pike Creek subwatershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water. The soils within the Pike Creek subwatershed are, in general, characterized by deep to moderately deep, brown to black silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Map 64

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION IN THE PIKE CREEK SUBWATERSHED IN 1975



LEGEND

- SUBURBAN AND LOW DENSITY RESIDENTIAL (0.2-2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- MEDIUM DENSITY RESIDENTIAL (2.3-6.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- HIGH DENSITY RESIDENTIAL (7.0-17.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- NONE PRIMARY ENVIRONMENTAL CORRIDOR PRESERVATION THROUGH PUBLIC AQUISITION
- ● MAJOR RETAIL AND SERVICE CENTER
- ■ MAJOR INDUSTRIAL CENTER
- NONE PUBLIC AIRPORT
- NONE MAJOR PUBLIC OUTDOOR RECREATION CENTER
- ▲ PUBLIC GOLF COURSE
- NONE NONPUBLIC GOLF COURSE

As of 1975 more than 71 percent of the Pike Creek subwatershed was devoted to urban land uses. The dominant urban land use in the subwatershed was residential, which occupied 43 percent of the subwatershed area. The overall spatial distribution of land use in the subwatershed was characterized by medium- and high-density urban uses—primarily residential—with an area of agricultural land use located in the northwest portion of the subwatershed. There were no major parks or parkways and only one public golf course in the subwatershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the subwatershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service or residential development without public sanitary sewer service as shown on Maps 43, 44, and 45.

Urban Land Uses

Residential Activities: The areal extent of residential activities is larger than any other single land use category within the Pike Creek subwatershed. Residential land uses cover approximately 1,957 acres, or 43 percent of the subwatershed. In addition, there are 254 acres of residential land use, or 6 percent of the subwatershed under development reflected in the pollution loading rates in the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Pike Creek subwatershed are estimated at 7,800 pounds of nitrogen, 600 pounds of phosphorus, 47,600 pounds of BOD_5, 3.1 x 10^{13} fecal coliform counts, and 540 tons of sediment during an average year. Table 239 presents the areal extent of residential land use within the subwatershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Pike Creek subwatershed, approximately 323 acres, or 7 percent of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Pike Creek subwatershed are 2,900 pounds of nitrogen, 200 pounds of phosphorus, 31,500 pounds of biochemical oxygen demand, 1.1 x 10^{13} fecal coliform counts, and 120 tons of sediment. Table 240 presents the areal extent of commercial land uses within the Pike Creek subwatershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the subwatershed in 1975.

Industrial Activities: Industrial land uses cover 546 acres or 12 percent of the Pike Creek subwatershed. The industrial activities within the Pike Creek subwatershed are estimated to contribute annually 4,600 pounds of nitrogen, 400 pounds of phosphorus, 20,200 pounds of BOD_5, 3.4 x 10^{13} fecal coliform counts, and 270 tons of sediment to surface runoff. Table 241 presents the areal extent of the industrial land uses within the Pike Creek subwatershed along with the estimated average annual diffuse source pollutant loadings from these activities. There were no industrial lands under development in the subwatershed in 1975.

Transportation: Transportation land uses within the subwatershed include freeways and other arterial streets and highways. Table 242 presents the estimated pollutant contributions from the 42 acres, or 1 percent of the total subwatershed area which is devoted to these land uses. It is estimated that 1,000 pounds of nitrogen, 60 pounds of phosphorus, 6,700 pounds of BOD_5, 2.8 x 10^{12} fecal coliform counts, and 900 tons of sediment are transported annually from transportation related activities within the Pike Creek subwatershed. Additional transportation facilities are present in the form of local collector and land access streets in residential,

Table 235

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE PIKE CREEK SUBWATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	2.94	1,957	43.05
Commercial[b]	0.51	323	7.11
Industrial			
Manufacturing	0.85	546	12.01
Landfill & Dump	--	--	--
Extractive	--	--	--
Transportation			
Streets & Highways	0.07	42	0.92
Airfields	--	--	--
Railroad Yards	--	--	--
Recreation			
Golf Courses	--	--	--
Parks & Other Recreation	0.22	141	3.10
Land Under Development			
Residential Land Under Development[c]	0.09	254	5.59
Commercial Land Under Development	--	--	--
Industrial Land Under Development	--	--	--
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	0.16	102	2.24
Hay	0.12	75	1.65
Row Crops	1.00	641	14.10
Specialty Crops	0.03	16	0.35
Sod Farm	--	--	--
Other Open Space[d]	0.52	330	7.26
Silvicultural			
Woodlands	0.08	51	1.12
Orchards & Nurseries	--	--	--
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	--	--	--
Wetlands, Swamps, & Marshes	0.11	68	1.50
Total	6.70	4,546	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the area of the Pike Creek watershed is shown in Table 237.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 236

LENGTH OF STREAMS AND THEIR SOURCES WITHIN THE PIKE CREEK SUBWATERSHED

Stream or Watercourse	Source: By Civil Division	Source: By U.S. Public Land Survey System	Length (in miles)
Pike Creek	Town of Somers	T2N, R22E, Sec. 26, NE 1/4	4.2

Source: SEWRPC.

Table 237

AREAL EXTENT OF CIVIL DIVISIONS IN THE PIKE CREEK SUBWATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Kenosha County			
City			
Kenosha	5.32	74.93	36.02
Town			
Somers	1.78	25.07	5.18
Total	7.10	100.00	--

Source: SEWRPC.

Table 238

ESTIMATED POPULATION OF THE PIKE CREEK SUBWATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Kenosha County	
Kenosha City (Part)	30,513
Somers Town (Part)	747
Kenosha County (Part) Subtotal	31,260
Pike Creek Subwatershed Total	31,260

Source: Wisconsin Department of Administration and SEWRPC.

commercial, and industrial areas. The pollutant contribution from these types of streets are included within the land uses which they serve. There was no transportation land under development in the subwatershed in 1975.

Recreational Activities: The major recreational facilities within the subwatershed as of 1975 included parks with a total area of 141 acres, or 3 percent of the total area of the subwatershed and are located on Map 64. Table 243 sets forth the acreage of parks and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 300 pounds of nitrogen, 10 pounds of phosphorus, 200 pounds of BOD_5, 5.1 x 10^{11} fecal coliform counts, and 30 tons of sediment are transported from parks within the Pike Creek subwatershed annually.

Land Under Development: The Pike Creek subwatershed is undergoing rapid conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the subwatershed was estimated at 254 acres, or 6 percent of the total land area of the subwatershed. No significant recreational, industrial, commercial, or transportation related lands were under development in the subwatershed in 1975. It is estimated that 15,200 pounds of nitrogen, 11,400 pounds of phosphorus, 30,500 pounds of BOD_5, and 19,100 tons of sediment were transported from these residential construction sites in 1975. Table 244 presents the estimated acreage of land under conversion from rural to urban use within the Pike Creek subwatershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter

Table 239

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	1,957	43.05	Total Nitrogen	4.0	7,830
			Total Phosphorus	0.32	630
			Biochemical Oxygen Demand	24.3	47,560
			Fecal Coliform	1.6×10^{10} counts/ac/yr.	3.1×10^{13} counts/yr.
			Sediment	545	535 tons

Source: SEWRPC.

Table 240

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial.	323	7.11	Total Nitrogen	9.0	2,910
			Total Phosphorus	0.75	240
			Biochemical Oxygen Demand	97.6	31,520
			Fecal Coliform	3.3×10^{10} counts/ac/yr.	1.1×10^{13} counts/yr.
			Sediment	745	120 tons

Source: SEWRPC.

Table 241

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	546	12.01	Total Nitrogen	8.4	4,590
			Total Phosphorus	0.70	380
			Biochemical Oxygen Demand	36.9	20,150
			Fecal Coliform	6.2×10^{10} counts/ac/yr.	3.4×10^{13} counts/yr.
			Sediment	977	265 tons

Source: SEWRPC.

Table 242

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	42	0.92	Total Nitrogen	23.4	980
			Total Phosphorus	1.4	60
			Biochemical Oxygen Demand	159.0	6,680
			Fecal Coliform	6.7×10^{10} counts/ac/yr.	2.8×10^{12} counts/yr.
			Sediment	42,600	895 tons

Source: SEWRPC.

Table 243

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	141	3.10	Total Nitrogen	2.3	320
			Total Phosphorus	.06	10
			Biochemical Oxygen Demand	1.3	180
			Fecal Coliform	3.6×10^9 counts/ac/yr.	5.1×10^{11} counts/yr.
			Sediment	420	30 tons

Source: SEWRPC.

Table 244

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Construction . . .	254	5.59	Total Nitrogen	60	15,240
			Total Phosphorus	45	11,430
			Biochemical Oxygen Demand	120	30,480
			Fecal Coliform	Negligible	--
			Sediment	150,000	19,050 tons

Source: SEWRPC.

sections of the subwatershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975, there were no known holding tanks or

mound systems in the subwatershed. Table 245 presents the estimated pollutant loadings from the approximately 161 septic tanks in the watershed as of 1975. It is estimated that 2,400 pounds of nitrogen, 600 pounds of phosphorus, 34,700 pounds of BOD_5, five tons of sediments and 4.3×10^{13} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Pike Creek subwatershed.

Rural Land Uses

Agricultural Activities: About 26 percent of the area of the Pike Creek subwatershed is devoted to agricultural land uses, primarily to cropland. As of May, 1975, no significant domestic livestock operations were known to exist within the watershed.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the subwatershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 246. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the subwatershed. Approximately 102 acres, or 2 percent of the total area of the subwatershed were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Pike Creek subwatershed are accordingly estimated at 500 pounds of nitrogen, 10 pounds of phosphorus, 1,000 pounds of BOD_5, and 170 tons of sediment. Table 246 presents the estimated diffuse source pollutant loading rates to the land surface in an average year within the subwatershed.

Approximately 75 acres, or 2 percent of the total area of the subwatershed, were devoted to the growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Pike Creek subwatershed are 70 pounds of nitrogen, 10 pounds of phosphorus, 700 pounds of BOD_5, and 120 tons of sediment.

Major row crops grown within the Pike Creek subwatershed are corn and soybeans which were planted on 641 acres, or 14 percent of the total area of the subwatershed. As shown in Table 246, an estimated 14,800 pounds of nitrogen, 400 pounds of phosphorus, 12,200 pounds of BOD_5, and 2,050 tons of sediment are transported annually from the row crop acreage within the Pike Creek subwatershed.

As shown in Table 246, specialty crops were grown on a total of 16 acres, or less than 1 percent of the total area of the subwatershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings

Table 245

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	161	425	Total Nitrogen	5.7	2,420
			Total Phosphorus	1.32	560
			Biochemical Oxygen Demand	81.6	34,680
			Fecal Coliform	1.0×10^{11} counts/capita/yr.	4.3×10^{13} counts/yr.
			Sediment	28.0	5 tons

Source: SEWRPC.

Table 246

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	102	2.24	Total Nitrogen	4.7	480
			Total Phosphorus	0.13	10
			Biochemical Oxygen Demand	9.6	980
			Fecal Coliform Counts	Negligible	--
			Sediment	3,200	165 tons
Hay	75	1.65	Total Nitrogen	0.9	70
			Total Phosphorus	0.09	10
			Biochemical Oxygen Demand	9.6	720
			Fecal Coliform Counts	Negligible	--
			Sediment	3,200	120 tons
Row	641	14.1	Total Nitrogen	23.1	14,810
			Total Phosphorus	0.64	410
			Biochemical Oxygen Demand	19.1	12,240
			Fecal Coliform Counts	Negligible	--
			Sediment	6,400	2,050 tons
Specialty Crops					
Vegetables and Other Agricultural Crops .	16	0.35	Total Nitrogen	23.1	370
			Total Phosphorus	0.64	10
			Biochemical Oxygen Demand	30.0	480
			Fecal Coliform Counts	Negligible	--
			Sediment	10,000	80 tons
Pasture	330	7.26	Total Nitrogen	4.6	1,520
			Total Phosphorus	.29	100
			Biochemical Oxygen Demand	9.7	3,200
			Fecal Coliform Counts	Negligible	--
			Sediment	420	70 tons
Total	1,164	25.60	Total Nitrogen	--	17,240
			Total Phosphorus	--	540
			Biochemical Oxygen Demand	--	17,620
			Fecal Coliform	--	--
			Sediment	--	2,485 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

from these crops within the Pike Creek subwatershed are 400 pounds of nitrogen, 10 pounds of phosphorus, 500 pounds of BOD_5, and 80 tons of sediment. There were no known sod farms of significant size within the subwatershed as of 1975.

Pasture land and other open space accounts for 330 acres, or 7 percent of the total area of the subwatershed. The areal extent and extimated loading rates from pasture and other open lands are presented in Table 246. Annual loading rates from these areas are estimated at 1,500 pounds of nitrogen, 100 pounds of phosphorus, 3,200 pounds of BOD_5, and 70 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for one farm covering about 12 acres, or 1 percent of the agricultural land within the subwatershed.

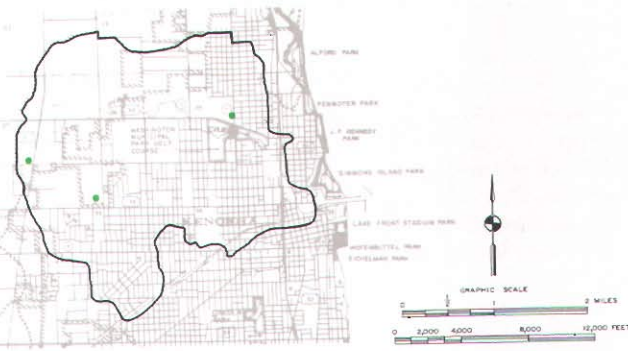
A total of three known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 65.

Table 247 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $3,690, or an equivalent $3.00 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. The total estimated expenditures on conservation practices, about $3.00 per acre of agricultural land, was related to those practices directly affecting water quality. This represents about 20 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 51 acres, or approximately 1 percent of the total area of the subwatershed, were devoted to silvicultural activities in 1975, namely woodlands. Table 248 presents the acreage of silvicultural activities within the Pike Creek subwatershed and the estimated loading rates from these activities. About 100 pounds of nitrogen, 10 pounds of phosphorus, 200 pounds of BOD_5, 3.4 x 10^{10} fecal coliform counts, and five tons of sediment are transported annually from silvicultural land uses in the subwatershed.

Map 65

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE PIKE CREEK SUBWATERSHED IN 1975



LEGEND

VEGETATIVE COVER PRACTICES
- STRIPCROPPING
- INTERIM COVER
- TREE PLANTING
- WIND EROSION CONTROL
- WILDLIFE HABITAT
- PERMANENT VEGETATIVE COVER

WATER RETENTION PRACTICES
- TERRACING
- LAND SHAPING AND GRADING
- FARM PONDS

FLOW CONTROL PRACTICES
- DIVERSION
- OPEN DRAIN
- RUNOFF CONTROL STRUCTURES
- RUNOFF CONTROL MEASURES
- STREAMBANK STABILIZATION

CROP PRODUCTION PRACTICES
- LIMING
- TILING
- MULCHING

OTHER PRACTICES AND PROGRAMS
- ANIMAL WASTE FACILITY
- ★ CROPLAND ADJUSTMENT PROGRAM

The above map illustrates the locations of the three known conservation practices installed in the Pike Creek subwatershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Atmospheric Contribution: A total of 68 acres, or about 1 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Pike Creek subwatershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Table 247

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE PIKE CREEK SUBWATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value in 1976 Dollars
Vegetative Cover Practices			
Stripcropping	0	10.00/acre	0
Interim Cover	0	12.00/acre	0
Tree Stands	0	100.00/acre	0
Wind Erosion Control	6,150 feet	0.60/foot	3,690.00
Wildlife Habitat	0	25.00/acre	0
Permanent Vegetative Cover	0	50.00/acre	0
Subtotal			3,690.00
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	0	4,000.00/unit	0
Subtotal			0
Flow Control Practices			
Diversions	0	1.25/foot	0
Open Drains	0	2.25/foot	0
Runoff Control Structures	0	2,500.00/unit	0
Runoff Control Measures	0	1.00/foot	0
Streambank Stabilization	0	3.50/foot	0
Subtotal			0
Crop Production Practices			
Liming	0	20.00/acre	0
Tiling	0	0.70/foot	0
Mulching	0	60.00/acre	0
Subtotal			0
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$3,690.00

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

Table 248

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE PIKE CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	51	1.12	Total Nitrogen	2.3	120
			Total Phosphorus	0.14	10
			Biochemical Oxygen Demand	4.6	230
			Fecal Coliform	6.6×10^8 counts/ac/yr.	3.4×10^{10} counts/yr.
			Sediment	251	5 tons

Source: SEWRPC.

Summary Discussion of the Pike Creek Subwatershed

The Pike Creek subwatershed is generally urban with storm water runoff from urban land contributing the largest diffuse source loads of all major pollutants. Construction activities are the major diffuse source contributor of phosphorus and sediment and the second largest contributor of nitrogen. Onsite sewage disposal systems are the largest contributor of fecal coliform. Runoff from developed urban areas inclusive of residential, commercial, and industrial land uses, produces 30 percent of the nitrogen, 9 percent of the phosphorus, 52 percent of the biochemical oxygen demand, 62 percent of the fecal coliform, and 4 percent of the sediment from diffuse sources. Agricultural runoff is the largest single source contributor of nitrogen and the second largest source of sediment. Transportation activities, recreation activities, and silvicultural activities each contribute less than 5 percent of the total diffuse source load of any major pollutant, and there were no reported significant livestock operations in the watershed as of 1975. Total annual diffuse source loads are 51,700 pounds of nitrogen, 13,900 pounds of phosphorus, 189,100 pounds of biochemical oxygen demand, 1.2×10^{14} fecal coliform counts, and 23,390 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE SUCKER CREEK SUBWATERSHED OF THE WATERSHED OF MINOR STREAMS DIRECTLY TRIBUTARY TO LAKE MICHIGAN

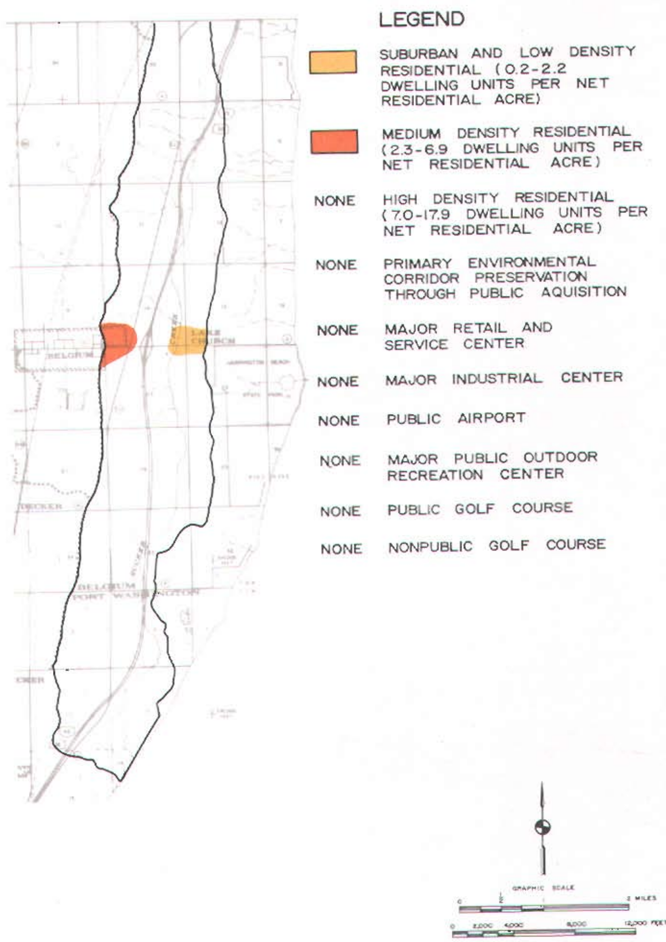
Physical Setting

The Sucker Creek subwatershed is a natural surface water drainage unit, 10 square miles in areal extent located in the northeast portion of the Region. The boundaries of the basin together with the locations of the main channel of Sucker Creek are shown on Map 26. The mainstem of Sucker Creek originates in the northeast corner of Ozaukee County and discharges to Lake Michigan three miles north of the harbor at the City of Port Washington in the same county. About 93 percent of the subwatershed is in rural land uses, with about 87 percent of this area in agricultural use. Most of the urban land use is located at the southern tip of the subwatershed. Map 66 sets forth the major land use categories and their spatial distributions within the Sucker Creek subwatershed as they were inventoried in 1975. Table 249 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The subwatershed is bounded on the east by Lake Michigan, on the west by the Sheboygan River watershed and the Sauk Creek watershed, on the south by the Sauk Creek watershed, and on the north by the Sheboygan County line. The stream system consists solely of Sucker Creek which has no major tributaries within the regional portion of the subwatershed. Table 250 lists for Sucker Creek the location of the source and the length of the stream in miles.

Map 66

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE SUCKER CREEK SUBWATERSHED IN 1975



As of 1975 more than 93 percent of the area of the Sucker Creek subwatershed was devoted to rural land uses. The dominant rural land use in the subwatershed was agricultural, which occupied 87 percent of the subwatershed area. The overall spatial distribution of land use in the subwatershed was characterized by rural land uses with a small concentration of urban development located in and around the Village of Belgium. There were no major parks, parkways, or golf courses in the subwatershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Superimposed upon the natural, meandering subwatershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Sucker Creek subwatershed lies totally within Ozaukee County and in parts of two cities. The area and porportion of the subwatershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976, are shown in Table 251. The 1975 resident population of the

Table 249

AREAL EXTENT OF WATER QUALITY RELATED LAND USES
IN THE SUCKER CREEK SUBWATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	0.09	61	0.85
Commercial[b]	0.03	22	0.30
Industrial			
Manufacturing	0.01	5	0.07
Landfill & Dump	--	--	--
Extractive	--	--	--
Transportation			
Streets & Highways	0.17	109	1.53
Airfields	--	--	--
Railroad Yards & Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks & Other Recreation	--	--	--
Land Under Development			
Residential Land Under Development[c]	0.01	3	0.05
Commercial Land Under Development	--	--	--
Industrial Land Under Development	--	--	--
Transportation Land Under Development	0.43	273	3.81
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	1.39	890	12.40
Hay	2.66	1,703	23.74
Row Crops	3.05	1,953	27.22
Specialty Crops	2.37	1,514	21.10
Sod Farm	--	--	--
Other Open Space[d]	0.33	210	2.92
Silvicultural			
Woodlands	0.39	250	3.49
Orchards & Nurseries	--	--	--
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	--	--	--
Wetlands, Swamps, & Marshes	0.28	180	2.51
Total	11.21[e]	7,173	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

[e] *The total area of the Sucker Creek watershed represented in this table is different than the total area of the Sucker Creek watershed identified in Table 251. This is due to the fact that the area set forth in Table 251 includes all that portion of the Sucker Creek watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Sucker Creek watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 250

LENGTH OF STREAMS AND THEIR SOURCES WITHIN THE SUCKER CREEK SUBWATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Sucker Creek	Town of Belgium	T12N, R22E, Sec. 1, SW 1/4	8.8

Source: SEWRPC.

subwatershed is estimated at 553 persons, or approximately 0.03 percent of the estimated 1975 total regional population. Table 252 presents the population distribution in the Sucker Creek subwatershed by civil division.

Surface water in the Sucker Creek subwatershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water. The streamflow of Sucker Creek has not been measured at a flow recording gage on any continuing basis known to the Commission.

The soils within the Sucker Creek subwatershed are deep to moderately deep, brown to black silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, most of the subwatershed area exhibits no limitations for residential development with public sanitary sewer service excepting the land along Sucker Creek and portions of the lakefront. In contrast, the soils of nearly the entire subwatershed are limited or severely limited for residential development without public sanitary sewer service on lots smaller than one acre in size. Approximately half of the subwatershed is composed of soils which have severe or very severe limitations for residential development without public sanitary sewer service on lots one acre or larger in size, (See Maps 43, 44 and 45.)

Urban Land Uses

Residential Activities: Residential land uses cover approximately 62 acres, or about 1 percent of the Sucker Creek subwatershed. In addition, three acres, or less than 1 percent of the watershed were under development for residential land use and are included

Table 251

AREAL EXTENT OF CIVIL DIVISIONS IN THE SUCKER CREEK SUBWATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Ozaukee County			
Village			
Belgium	0.10	0.96	15.15
Towns			
Belgium	7.64	73.46	20.65
Port Washington	2.66	25.58	13.76
Total	10.40	100.00	--

Source: SEWRPC.

as pollution sources under the land under development category because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Sucker Creek subwatershed are estimated at 200 pounds of nitrogen, 20 pounds of phosphorus, 1,500 pounds of BOD_5, 9.8 x 10^{11} fecal coliform counts, and 20 tons of sediment during an average year. Table 253 presents the areal extent of residential land use within the subwatershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Sucker Creek subwatershed, approximately 22 acres, or less than 1 percent, of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Sucker Creek subwatershed are 200 pounds of nitrogen, 20 pounds of phosphorus, 2,100 pounds of biochemical oxygen demand, 7.3 x 10^{11} fecal coliform counts, and 10 tons of sediment. Table 254 presents the areal extent of commercial land uses within the Sucker Creek subwatershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the subwatershed.

Table 252

ESTIMATED POPULATION OF SUCKER CREEK SUBWATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Ozaukee County	
Belgium Town (Part)	275
Belgium Village (Part)	182
Port Washington Town (Part)	96
Ozaukee County (Part) Subtotal	553
Sucker Creek Subwatershed Total	553

Source: Wisconsin Department of Administration and SEWRPC.

Industrial Activities: Industrial land uses cover five acres, or less than 1 percent of the Sucker Creek subwatershed. The industrial activities within the Sucker Creek subwatershed are estimated to contribute annually 40 pounds of nitrogen, 200 pounds of BOD_5, 3.1 x 10^{11} fecal coliform counts, and an insignificant amount of sediment to surface runoff. Table 255 presents the areal extent of the industrial uses within the Sucker Creek subwatershed along with the estimated average annual diffuse source pollutant loadings from these activities. There was no industrial land under development in the Sucker Creek subwatershed.

There were no significant sanitary landfill, auto salvage and wrecking facilities, for extractive operations in the watershed as of 1975.

Transportation: Transportation land uses within the subwatershed include freeways and other arterial streets and highways. In addition, 273 acres, or 4 percent of the watershed, were under development for transportation land uses and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. Table 256 presents the estimated pollutant contributions from the 109 acres, or 2 percent of the total subwatershed area which is devoted to these land uses. It is estimated that 2,600 pounds of nitrogen, 200 pounds of phosphorus, 17,300 pounds of BOD_5, 7.3 x 10^{12} fecal coliform counts, and 2,320 tons of sediment are transported annually from transportation related activities within the Sucker Creek subwatershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve.

Recreational Activities: There were no major recreational facilities in the form of parks or golf courses located within the subwatershed as of 1975.

Table 253

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	61	0.85	Total Nitrogen	4.0	240
			Total Phosphorus	0.32	20
			Biochemical Oxygen Demand	24.30	1,480
			Fecal Coliform	1.6 x 10^{10} counts/ac/yr.	9.8 x 10^{11} counts/yr.
			Sediment	545	15 tons

Source: SEWRPC.

Table 254

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial	22	0.30	Total Nitrogen	9.0	200
			Total Phosphorus	0.75	20
			Biochemical Oxygen Demand	97.6	2,150
			Fecal Coliform	3.3×10^{10} counts/ac/yr.	7.3×10^{11} counts/yr.
			Sediment	745	10 tons

Source: SEWRPC.

Table 255

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	5	0.07	Total Nitrogen	8.4	40
			Total Phosphorus	0.70	--
			Biochemical Oxygen Demand	36.9	180
			Fecal Coliform	6.2×10^{10} counts/ac/yr.	3.1×10^{11} counts/yr.
			Sediment	977	0 tons

Source: SEWRPC.

Table 256

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	109	1.53	Total Nitrogen	23.4	2,550
			Total Phosphorus	1.4	150
			Biochemical Oxygen Demand	159.0	17,330
			Fecal Coliform	6.7×10^{10} counts/ac/yr.	7.3×10^{12} counts/yr.
			Sediment	42,600.0	2,320 tons

Source: SEWRPC.

Land Under Development: The Sucker Creek subwatershed is experiencing a slow urbanization process. The total number of acres of land under development for residential use in 1975 within the subwatershed was estimated at three acres, or less than 1 percent of the total land area of the subwatershed. Similarly, an estimated 273 acres, or approximately 4 percent of the total area of the subwatershed was under development for transportation land uses in 1975. No significant recreational, commercial or industrial related lands were under development in the subwatershed in 1975. It is estimated that 16,600 pounds of nitrogen, 12,400 pounds of phosphorus, 33,100 pounds of BOD_5, and 20,700 tons of sediment were transported from these residential and transportation construction sites in 1975. Table 257 presents the estimated acreage of land under conversion from rural to urban use within the Sucker Creek subwatershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the subwatershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were only two known holding tanks and no mound systems in the subwatershed, as shown on Map 46. Table 258 presents the estimated pollutant loadings from the approximately 138 septic tanks in the subwatershed as of 1975. It is estimated that 2,700 pounds of nitrogen, 600 pounds of phosphorus, five tons of sediment, 38,800 pounds of BOD_5, and 4.8 x 10^{13} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Sucker Creek subwatershed.

Rural Land Uses

Agricultural Activities: About 87 percent of the area of the Sucker Creek subwatershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May, 1975, 34 significant domestic livestock operations with a total of 4,080 animals, or 3,420 equivalent animal units were known to exist within the subwatershed. Map 67 indicates the locations of these livestock operations. Twenty of these operations were located within 500 feet of the identified stream system of the subwatershed. Table 259 indicates the number of livestock present within the subwatershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 97,100 pounds of nitrogen, 22,600 pounds of phosphorus, 380,300 pounds of BOD_5, 2.2 x 10^{15} fecal coliform counts, and 1,200 tons of sediment are transported from livestock operations within the Sucker Creek subwatershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the subwatershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 260.

Table 257

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Under Development	3	0.05	Total Nitrogen	60.0	200
			Total Phosphorus	45.0	150
			Biochemical Oxygen Demand	120.0	390
			Fecal Coliform	Negligible	--
			Sediment	150,000.0	250 tons
Transportation Under Development. . . .	273	3.81	Total Nitrogen	60.0	16,380
			Total Phosphorus	45.0	12,290
			Biochemical Oxygen Demand	120.0	32,760
			Fecal Coliform	Negligible	--
			Sediment	150,000.0	20,480 tons
Total	276	3.86	Total Nitrogen	--	16,580
			Total Phosphorus	--	12,440
			Biochemical Oxygen Demand	--	33,150
			Fecal Coliform	--	
			Sediment	--	20,730 tons

Source: SEWRPC.

Table 258

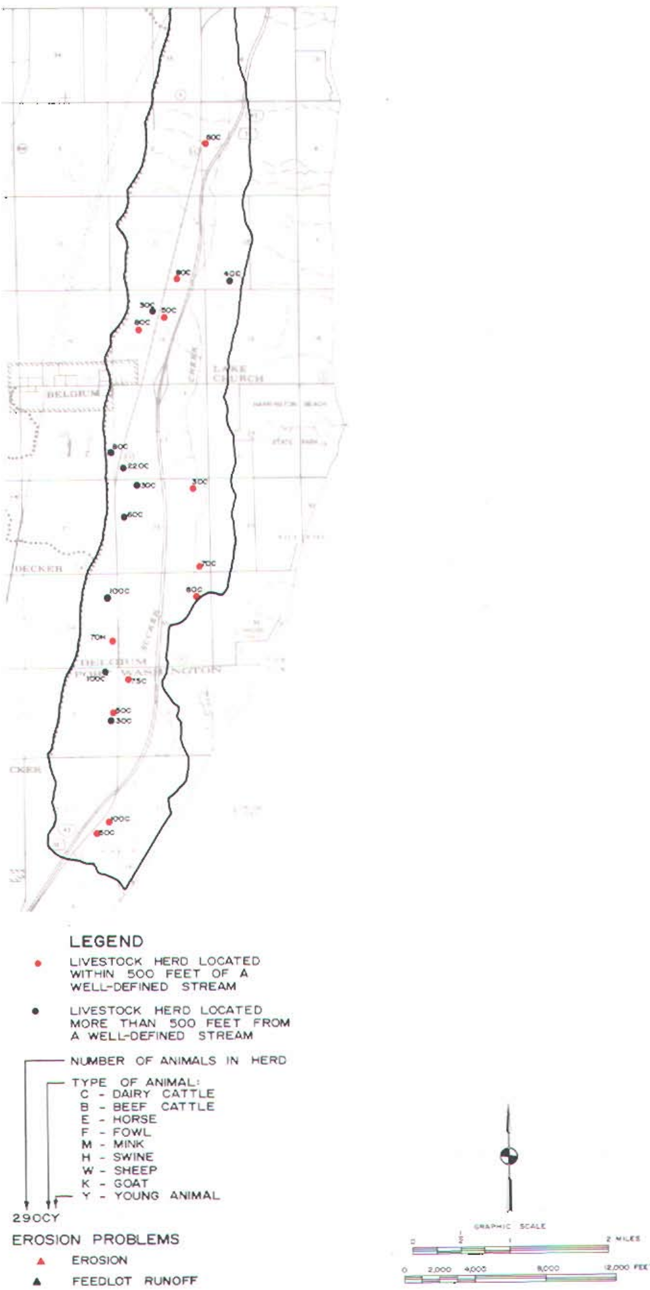
TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	138	476	Total Nitrogen	5.7	2,710
			Total Phosphorus	1.32	630
			Biochemical Oxygen Demand	81.6	38,840
			Fecal Coliform	1.0×10^{11} counts/capita/yr.	4.8×10^{13} counts/yr.
			Sediment	28.0	5 tons

Source: SEWRPC.

Map 67

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE SUCKER CREEK SUBWATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 34 operations within the Sucker Creek subwatershed in 1975, 20 operations, or 58.8 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the subwatershed. Approximately 890 acres, or 12 percent of the total area of the subwatershed were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Sucker Creek subwatershed are accordingly estimated at 4,200 pounds of nitrogen, 100 pounds of phosphorus, 8,500 pounds of BOD_5, 1,430 tons of sediment. Table 260 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates to the land surface in an average year within the subwatershed.

Approximately 1,703 acres, or 24 percent of the total area of the subwatershed were devoted to growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Sucker Creek subwatershed are 1,500 pounds of nitrogen, 150 pounds of phosphorus, 16,400 pounds of BOD_5, and 2,730 tons of sediment.

Major row crops grown within the Sucker Creek subwatershed are corn and soybeans which were planted on 1,953 acres, or 27 percent of the total area of the subwatershed. As shown in Table 260, an estimated 45,100 pounds of nitrogen, 1,300 pounds of phosphorus, 37,300 pounds of BOD_5, and 6,250 tons of sediment are transported annually from the row crop acreage within the Sucker Creek subwatershed.

Also, as shown in Table 260, specialty crops were grown on a total of 1,514 acres, or 21 percent of the total area of the subwatershed. These specialty crops included peas, sweet corn, cabbage, and carrots. The estimated annual pollutant loadings from these crops within the Sucker Creek subwatershed are 35,000 pounds of nitrogen, 1,000 pounds of phosphorus, 45,400 pounds of BOD_5, and 7,570 tons of sediment.

There were no sod farms of significant acreage in the Sucker Creek subwatershed in 1975.

Pasture land accounts for 210 acres, or 3 percent of the total area of the subwatershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 260. Annual loading rates from these areas are estimated at 1,000 pounds of nitrogen, 60 pounds of phosphorus, 2,000 pounds of BOD_5, and 40 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 31 farms covering about 2,857 acres, or 45.6 percent of the agricultural land within the subwatershed.

A total of 73 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these

Table 259

TYPE, EXTENT, AND ESTIMATED LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	2,290	3,200	49,624	Total Nitrogen	28.4	90,880
				Total Phosphorus	6.6	21,120
				Biochemical Oxygen Demand	111.2	355,840
				Fecal Coliform	$6.4x10^{11}$ counts/a.u./yr.	$2.0x10^{15}$ counts/yr.
				Sediment	700.0	1,120 tons
Beef	60	60	679	Total Nitrogen	28.4	1,700
				Total Phosphorus	6.6	400
				Biochemical Oxygen Demand	111.2	6,670
				Fecal Coliform	$6.4x10^{11}$ counts/a.u./yr.	$3.8x10^{13}$ counts/yr.
				Sediment	700.0	20 tons
Hogs	140	60	706	Total Nitrogen	28.4	1,700
				Total Phosphorus	6.6	400
				Biochemical Oxygen Demand	111.2	6,670
				Fecal Coliform	$6.4x10^{11}$ counts/a.u./yr.	$3.8x10^{13}$ counts/yr.
				Sediment	700.0	20 tons
Horses	40	80	730	Total Nitrogen	28.4	2,270
				Total Phosphorus	6.6	530
				Biochemical Oxygen Demand	111.2	8,900
				Fecal Coliform	$6.4x10^{11}$ counts/a.u./yr.	$5.1x10^{13}$ counts/yr.
				Sediment	700.0	30 tons
Sheep	50	5	33	Total Nitrogen	--	--
				Total Phosphorus	--	--
				Biochemical Oxygen Demand	--	--
				Fecal Coliform	--	--
				Sediment	--	--
Mink	1,500	20	137	Total Nitrogen	28.4	570
				Total Phosphorus	6.6	130
				Biochemical Oxygen Demand	111.2	2,220
				Fecal Coliform	$6.4x10^{11}$ counts/a.u./yr.	$1.3x10^{13}$ counts/yr.
				Sediment	700.0	5 tons
Total	4,080	3,420	51,909	Total Nitrogen	--	97,130
				Total Phosphorus	--	22,580
				Biochemical Oxygen Demand	--	380,300
				Fecal Coliform	--	$2.2x10^{15}$ counts/yr.
				Sediment	--	1,195 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 68.

Table 261 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $100,900, or an equivalent $16.09 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $11.83 per acre of agricultural land, or about 74 percent of the total investment were related to those practices directly affecting water quality. This represents about 78 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 250 acres, or approximately 4 percent of the total area of the subwatershed, were devoted to silvicultural activities in 1975, namely woodlands. Table 262 presents the acreage

Table 260

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE SUCKER CREEK SUBWATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	890	12.40	Total Nitrogen	4.7	4,180
			Total Phosphorus	0.13	120
			Biochemical Oxygen Demand	9.6	8,540
			Fecal Coliform	Negligible	--
			Sediment	3,200	1,425 tons
Hay	1,703	23.74	Total Nitrogen	0.9	1,530
			Total Phosphorus	0.09	150
			Biochemical Oxygen Demand	9.6	16,350
			Fecal Coliform	Negligible	--
			Sediment	3,200	2,725 tons
Row	1,953	27.22	Total Nitrogen	23.1	45,110
			Total Phosphorus	0.64	1,250
			Biochemical Oxygen Demand	19.1	37,300
			Fecal Coliform	Negligible	--
			Sediment	6,400	6,250 tons
Specialty Crops					
Vegetables and Other Agricultural Crops	1,514	21.10	Total Nitrogen	23.1	34,970
			Total Phosphorus	0.64	970
			Biochemical Oxygen Demand	30.0	45,420
			Fecal Coliform	Negligible	--
			Sediment	10,000	7,570 tons
Pasture	210	2.92	Total Nitrogen	4.6	970
			Total Phosphorus	0.29	60
			Biochemical Oxygen Demand	9.7	2,040
			Fecal Coliform	Negligible	--
			Sediment	420	45 tons
Total	6,270	87.38	Total Nitrogen	--	86,760
			Total Phosphorus	--	2,550
			Biochemical Oxygen Demand	--	109,650
			Fecal Coliform	--	--
			Sediment	--	18,015 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

of silvicultural activities within the Sucker Creek subwatershed and the estimated loading rates from these activities. About 600 pounds of nitrogen, 40 pounds of phosphorus, 1,200 pounds of BOD_5, 1.7 x 10^{11} fecal coliform counts, and 30 tons of sediment are transported annually from silvicultural land uses in the subwatershed.

Atmospheric Contribution: A total of 180 acres, or about 3 percent of the total area of the subwatershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Sucker Creek subwatershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Sucker Creek Subwatershed

The Sucker Creek subwatershed is predominantly agricultural with storm water runoff from these lands contributing the largest diffuse source load of sediment. Livestock operations are also a major source of pollution to Sucker Creek and contribute the largest loads of nitrogen, phosphorus, biochemical oxygen demand, and fecal coliform. Agriculture produces the second highest loads of nitrogen, biochemical oxygen demand, and sediment. Silvicultural activities contribute less than one-half of 1 percent of all diffuse source loads. Of the urban diffuse sources, construction activities are the greatest potential polluter, contributing the second largest load of phosphorus and the largest load of sediment. Transportation activities produce 6 percent

Table 261

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE SUCKER CREEK SUBWATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	15 acres	10.00/acre	150.00
Interim Cover	0	12.00/acre	0
Tree Stands	(1 unit) (2 acres/unit) = 2 acres	100.00/acre	200.00
Wind Erosion Control	2,720 feet	0.60/foot	1,632.00
Wildlife Habitat	0	25.00/acre	0
Permanent Vegetative Cover	517 acres	50.00/acre	25,850.00
Subtotal			27,832.00
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	1 unit	4,000.00/unit	4,000.00
Subtotal			4,000.00
Flow Control Practices			
Diversions	0	1.25/foot	0
Open Drains	5,940 feet	2.25/foot	13,365.00
Runoff Control Structures	1 unit	2,500.00/unit	2,500.00
Runoff Control Measures	26,461 feet	1.00/foot	26,461.00
Streambank Stabilization	0	3.50/foot	0
Subtotal			42,326.00
Crop Production Practices			
Liming	20 acres	20.00/acre	400.00
Tiling	37,631 feet	0.70/foot	26,341.70
Mulching	0	60.00/acre	0
Subtotal			26,741.70
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$100,899.70

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

Table 262

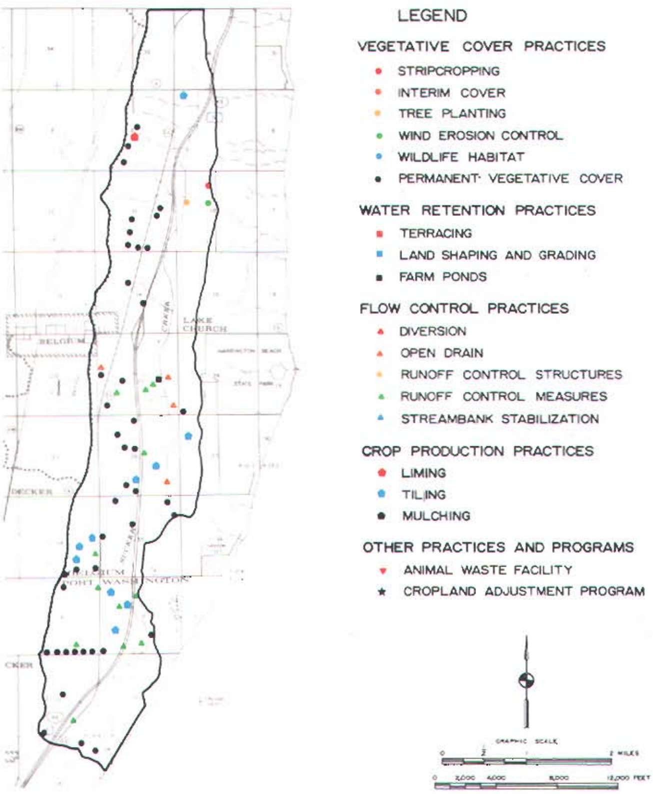
TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE SUCKER CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	250	3.49	Total Nitrogen	2.3	580
			Total Phosphorus	0.14	40
			Biochemical Oxygen Demand	4.6	1,150
			Fecal Coliform	6.6×10^8 counts/ac/yr.	1.7×10^{11} counts/yr.
			Sediment	251	30 tons

Source: SEWRPC.

Map 68

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE SUCKER CREEK SUBWATERSHED IN 1975



The above map illustrates the locations of the 73 known conservation practices installed in the Sucker Creek subwatershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

of the sediment and 3 percent of the biochemical oxygen demand from diffuse sources, and onsite sewage disposal systems contribute 7 percent of the biochemical oxygen demand load and 2 percent of the fecal coliform. All other urban diffuse sources, inclusive of residential, commercial, and industrial land uses produce 1 percent or less of the total diffuse source loads. Total annual diffuse source loads are 206,800 pounds of nitrogen, 38,490 pounds of phosphorus, 584,200 pounds of biochemical oxygen demand, 2.2 x 10^{15} fecal coliform counts, and 42,300 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE OAK CREEK WATERSHED

Physical Setting

The Oak Creek watershed is a natural surface water drainage unit, 26 square miles in areal extent located in the east central portion of the Region. The boundaries of the basin together with the locations of the main channel of Oak Creek and its single principal tributary are shown on Map 26. The main stem of Oak Creek originates in the City of Franklin in Milwaukee County and discharges to Lake Michigan at Grant Park in the City of South Milwaukee. The single principal tributary of the watershed is the North Branch of Oak Creek. About 50 percent of the watershed is in rural land uses, with about two-thirds of this area still in agricultural use. Most of the agricultural related land use is located in the southwestern portions of the watershed. Map 69 sets forth the major land use categories and their spatial distributions within the Oak Creek watershed as they were inventoried in 1975. Table 263 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north by the Kinnickinnic River watershed, on the west and south by the Root River watershed and on the east by Lake Michigan. In addition to Oak Creek, and the North Branch of Oak Creek, the stream system of the watershed includes the Mitchell Field drainage ditch, a minor tributary which has measurable flow only during or following precipitation events. Table 264 lists for Oak Creek the location of the source and the length of the stream in miles. The watershed ranks tenth in size within the Region, but eighth in total resident population.

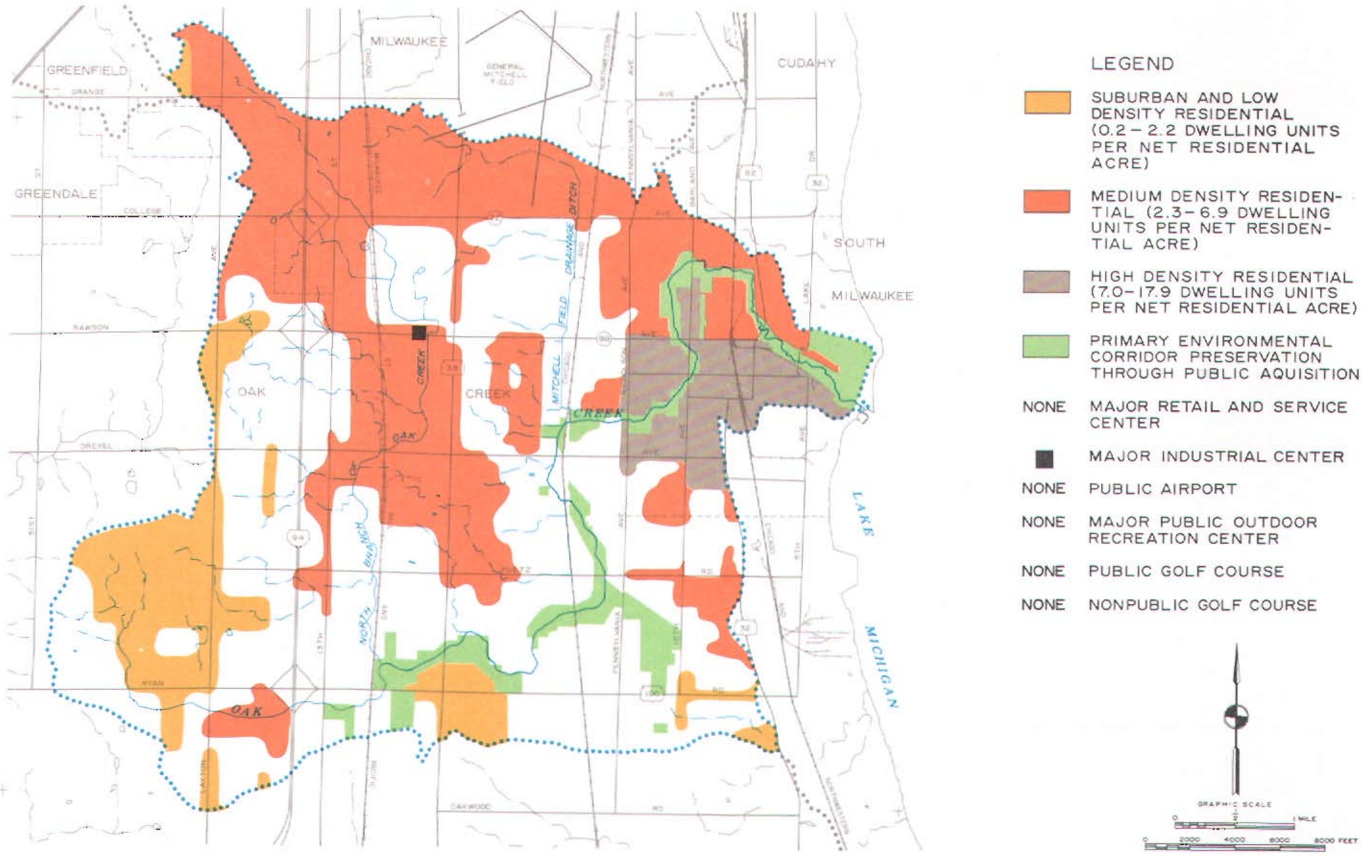
Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Oak Creek watershed lies totally within Milwaukee County and in parts of six cities. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976, are shown in Table 265. The 1975 resident population of the watershed is estimated at 39,519 persons, or approximately 2 percent of the estimated 1975 total regional population. Table 266 presents the population distribution in the Oak Creek watershed by civil division.

Surface water in the Oak Creek watershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water.

The streamflow of Oak Creek has been measured since 1963 at a continuous flow recording gage measured by the U.S. Geological Survey in cooperation with the Milwaukee Metropolitan Sewerage District and the Commission, at the 15th Avenue bridge in South Milwaukee.

Map 69

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE OAK CREEK WATERSHED IN 1975



As of 1975 approximately 50 percent of the area of the Oak Creek watershed was devoted to urban land uses and 50 percent to rural land uses. The dominant urban land use in the watershed was residential and the dominant rural land use in the watershed was open land, each of the two dominant uses occupying 21 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural land use and scattered areas of low- and medium-density residential land uses. High-density residential land use was prevalent in the northeastern, or lower, portion of the watershed near and in the City of South Milwaukee. There were no major parks and no public or private golf courses in the watershed, but there were segments of a major parkway.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

The soils within the Oak Creek watershed are silty clay loams, loams, and sandy loams and are developed on glacial till on gently sloping or rolling morainal topography. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service, and on residential development without public sanitary sewer service as shown on Maps 43, 44, and 45.

Urban Land Uses

Residential Activities: The areal extent of residential activities is second largest of the land use categories within the Oak Creek watershed. Residential land uses cover approximately 3,508 acres, or 21 percent of the watershed. In addition, 614 acres, or 4 percent of the watershed were under development for residential land use and are included as pollution sources under the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Oak Creek watershed are estimated at 14,000 pounds of nitrogen, 1,100 pounds of phosphorus, 85,200 pounds of BOD_5, 5.6×10^{13} fecal coliform counts, and 960 tons of sediment during an average year. Table 267 presents the areal extent of residential land use within the

Table 263

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE OAK CREEK WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	5.48	3,508	20.83
Commercial[b]	1.03	661	3.92
Industrial			
Manufacturing	0.96	614	3.64
Landfill & Dump	0.03	20	0.12
Extractive	0.09	55	0.33
Transportation			
Streets & Highways	0.73	465	2.76
Airfields	0.77	493	2.93
Railroad Yards & Terminals	--	--	--
Recreation			
Golf Courses	0.15	98	0.58
Parks & Other Recreation	1.10	703	4.17
Land Under Development			
Residential Land Under Development[c]	0.96	614	3.65
Commercial Land Under Development	--	--	--
Industrial Land Under Development	0.02	12	0.07
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	1.64	1,047	6.22
Hay	1.30	832	4.94
Row Crops	3.92	2,509	14.89
Specialty Crops	0.59	378	2.25
Sod Farm	0.10	64	0.38
Other Open Space[d]	5.62	3,596	21.35
Silvicultural			
Woodlands	0.82	521	3.09
Orchards & Nurseries	0.24	155	0.92
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	0.03	19	0.12
Wetlands, Swamps, & Marshes	0.75	478	2.83
Total	26.33	16,842	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2.000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 264

LENGTH OF STREAMS AND THEIR SOURCES IN THE OAK CREEK WATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Oak Creek	City of Franklin	T5N, R21E, Sec. 24, NW 1/4	12.8
North Branch to Oak Creek	City of Milwaukee	T6N, R22E, Sec. 31, SE 1/4	15.5

Source: SEWRPC.

Table 265

AREAL EXTENT OF CIVIL DIVISIONS WITHIN THE OAK CREEK WATERSHED: 1975

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Milwaukee County			
Cities			
Cudahy	0.22	0.84	4.64
Franklin	2.53	9.61	7.21
Greenfield	0.24	0.91	2.06
Milwaukee	2.81	10.67	2.91
Oak Creek	17.30	65.70	60.89
South Milwaukee	3.23	12.27	66.60
Total	26.33	100.00	--

Source: SEWRPC.

Table 266

ESTIMATED POPULATION OF THE OAK CREEK WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Milwaukee County	
Cudahy City (Part)	515
Franklin City (Part)	2,013
Greenfield City (Part)	1,644
Milwaukee City (Part)	7,340
Oak Creek City (Part)	11,688
South Milwaukee City (Part)	16,319
Milwaukee County (Part) Subtotal	39,519
Oak Creek River Watershed Total	39,519

Source: Wisconsin Department of Administration and SEWRPC.

watershed along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Oak Creek watershed, approximately 661 acres, or 4 percent, of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Oak Creek watershed are 6,000 pounds of nitrogen, 500 pounds of phosphorus, 64,500 pounds of biochemical oxygen demand, 2.2 x 10^{13} fecal coliform counts, and 250 tons of sediment. Table 268 presents the areal extent of commercial land uses within the Oak Creek watershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the watershed in 1975.

Industrial Activities: Industrial land uses cover 614 acres, or 4 percent of the Oak Creek watershed. Twelve acres, or less than 1 percent of the watershed, were under development for industrial land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. The industrial activities within the

Table 267

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	3,508	20.83	Total Nitrogen	4.0	14,030
			Total Phosphorus	0.32	1,120
			Biochemical Oxygen Demand	24.3	85,240
			Fecal Coliform	1.6×10^{10} counts/ac/yr.	5.6×10^{13} counts/yr.
			Sediment	545	955 tons

Source: SEWRPC.

Table 268

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial.	661	3.92	Total Nitrogen	9.0	5,950
			Total Phosphorus	0.75	500
			Biochemical Oxygen Demand	97.6	64,510
			Fecal Coliform	3.3×10^{10} counts/ac/yr.	2.2×10^{13} counts/yr.
			Sediment	745	245 tons

Source: SEWRPC.

Oak Creek watershed excluding land under development are estimated to contribute annually 5,200 pounds of nitrogen, 400 pounds of phosphorus, 22,700 pounds of BOD_5, 3.8×10^{13} fecal coliform counts, and 300 tons of sediment to surface runoff. Table 269 presents the areal extent of the industrial uses within the Oak Creek watershed along with the estimated average annual diffuse source pollutant loadings from these activities.

There are five sites of sanitary landfill operations within the Oak Creek watershed occupying a total of 20 acres, or less than 1 percent of the drainage area. These are included, along with their estimated pollutant loading rates, on Table 269. The landfill operations have an estimated annual pollutant load of 200 pounds of nitrogen, 10 pounds of phosphorus, 700 pounds of BOD_5, 1.2×10^{12} fecal coliform counts, and 10 tons of sediment.

In addition, there were also four auto salvage and wrecking facilities which are included in the analysis under industrial activities.

Extractive Activities: There were 55 acres, or less than 1 percent of the total watershed area in extractive mining operations, consisting of gravel pits and attendant washing operations, in the Oak Creek watershed as of 1975. These operations contribute an estimated 3,300 pounds of nitrogen, 2,500 pounds of phosphorus, 6,600 pounds of BOD_5, and 4,130 tons of sediments annually. Table 270 presents the extent of the extractive operations and the estimated attendant pollutant diffuse source loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, and airfields. Table 271 presents the estimated pollutant contributions from the 958 acres, or 6 percent of the total watershed area, which is devoted to these land uses. It is estimated that 17,500 pounds of nitrogen, 1,900 pounds of phosphorus, 109,920 pounds of BOD_5, 3.1×10^{13} fecal coliform counts, and 10,620 tons of sediment are transported annually from transportation related activities within the Oak Creek watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve. There was no transportation land under development in the watershed in 1975.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 703 acres, or 4 percent of the total area of the watershed, and portions of two golf courses with a total area of 98 acres, or less than 1 percent of the total area of the watershed. Map 69 indicates the location of public and private golf courses and major parks within the Oak Creek

Table 269

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	614	3.64	Total Nitrogen	8.4	5,160
			Total Phosphorus	0.70	430
			Biochemical Oxygen Demand	36.9	22,650
			Fecal Coliform	6.2×10^{10} counts/a/yr.	3.8×10^{13} counts/yr.
			Sediment	977	300 tons
Landfill	20	0.12	Total Nitrogen	8.4	170
			Total Phosphorus	0.70	10
			Biochemical Oxygen Demand	36.9	740
			Fecal Coliform	6.2×10^{10} counts/a/yr.	1.2×10^{12} counts/yr.
			Sediment	977	10 tons
Total	634	3.76	Total Nitrogen	--	5,330
			Total Phosphorus	--	440
			Biochemical Oxygen Demand	--	23,390
			Fecal Coliform	--	3.9×10^{13} counts/yr.
			Sediment	--	310 tons

Source: SEWRPC.

Table 270

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive	55	0.33	Total Nitrogen	60	3,300
			Total Phosphorus	45	2,480
			Biochemical Oxygen Demand	120	6,600
			Fecal Coliform	Negligible	--
			Sediment	150,000	4,125 tons

Source: SEWRPC.

watershed as of 1975. Table 272 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 2,100 pounds of nitrogen, 60 pounds of phosphorus, 1,000 pounds of BOD_5, 2.5 x 10^{12} fecal coliform counts, and 170 tons of sediment are transported from parks and golf courses within the Oak Creek watershed annually. There was no recreation land under development in the watershed in 1975.

Land Under Development: The Oak Creek watershed is undergoing moderate conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 614 acres, or 4 percent of the total land area of the watershed. Similarly, an estimated 12 acres, or less than 1 percent of the total area of the watershed was under development for industrial land uses in 1975. No recreational, commercial, or transportation related lands were under development in the watershed in 1975. It is estimated that 37,600 pounds of nitrogen, 28,200 pounds of phosphorus, 75,100 pounds of BOD_5, and 46,950 tons of sediment were transported from these construction sites in 1975. Table 273 presents the estimated acreage of land under conversion from rural to urban use within the Oak Creek watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed outside of the areas served by centralized sanitary sewerage systems. As of 1975 there was only one known holding tank and no mound systems in the watershed, as shown on Map 46. Table 274 presents the estimated pollutant loadings from the approximately 308 septic tanks in the watershed as of 1975. It is estimated that 6,700 pounds of nitrogen, 15 tons of sediment, 1,550 pounds of phosphorus, 95,900 pounds of BOD_5, and 1.2 x 10^{14} fecal coliform counts are transported via surface

Table 271

TYPE, EXTENT, AND ESTIMATED POLLUTION LOADINGS FROM TRANSPORTATION LAND USES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	465	2.76	Total Nitrogen	23.4	10,870
			Total Phosphorus	1.4	650
			Biochemical Oxygen Demand	159.0	73,940
			Fecal Coliform	6.7×10^{10} counts/a/yr.	3.1×10^{13} counts/yr.
			Sediment	42,600	9,895 tons
Air Fields	493	2.93	Total Nitrogen	13.5	6,660
			Total Phosphorus	2.6	1,280
			Biochemical Oxygen Demand	73	35,990
			Fecal Coliform	Negligible	--
			Sediment	2,900	715 tons
Total	958	5.69	Total Nitrogen	--	17,540
			Total Phosphorus	--	1,930
			Biochemical Oxygen Demand	--	109,920
			Fecal Coliform	--	3.1×10^{13} counts/yr.
			Sediment	--	10,620 tons

Source: SEWRPC.

Table 272

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	703	4.17	Total Nitrogen	2.3	1,620
			Total Phosphorus	.06	40
			Biochemical Oxygen Demand	1.3	910
			Fecal Coliform	3.6×10^{9} counts/a/yr.	2.5×10^{12} counts/yr.
			Sediment	420	150 tons
Golf Courses	98	0.58	Total Nitrogen	4.4	430
			Total Phosphorus	.20	20
			Biochemical Oxygen Demand	1.3	130
			Fecal Coliform	Negligible	--
			Sediment	420	20 tons
Total	801	4.75	Total Nitrogen	--	2,050
			Total Phosphorus	--	60
			Biochemical Oxygen Demand	--	1,040
			Fecal Coliform	--	2.5×10^{12} counts/yr.
			Sediment	--	170 tons

Source: SEWRPC.

runoff or enter surface waters via groundwater pollution from septic systems annually within the Oak Creek watershed.

Rural Land Uses

Agricultural Activities: About 50 percent of the area of the Oak Creek watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May, 1975, two significant domestic livestock operations with a total of 80 animals, or 110 equivalent animal units were known to exist within the watershed. Map 70 indicates the locations of these livestock operations. One of these operations was located within 500 feet of the identified stream system of the watershed. Table 275 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 3,100 pounds of nitrogen, 730 pounds of phosphorus, 12,200 pounds of BOD_5, 7.0×10^{13} fecal coliform counts, and 40 tons of sediment are transported from livestock operations within the Oak Creek watershed annually.

Table 273

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Under Development	614	3.65	Total Nitrogen	60	36,850
			Total Phosphorus	45	27,640
			Biochemical Oxygen Demand	120	73,710
			Fecal Coliform	Negligible	--
			Sediment	150,000	46,070 tons
Industrial Under Development	12	0.07	Total Nitrogen	60	720
			Total Phosphorus	45	540
			Biochemical Oxygen Demand	120	1,440
			Fecal Coliform	Negligible	--
			Sediment	150,000	900 tons
Total	626	3.72	Total Nitrogen	--	37,560
			Total Phosphorus	--	28,170
			Biochemical Oxygen Demand	--	75,120
			Fecal Coliform	--	--
			Sediment	--	46,950 tons

Source: SEWRPC.

Table 274

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE OAK CREEK WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	308	1,175	Total Nitrogen	5.7	6,700
			Total Phosphorus	1.32	1,550
			Biochemical Oxygen Demand	81.6	95,880
			Fecal Coliform	1.0×10^{11} counts/capita/yr.	1.2×10^{14} counts/yr.
			Sediment	28.0	15 tons

Source: SEWRPC.

Table 275

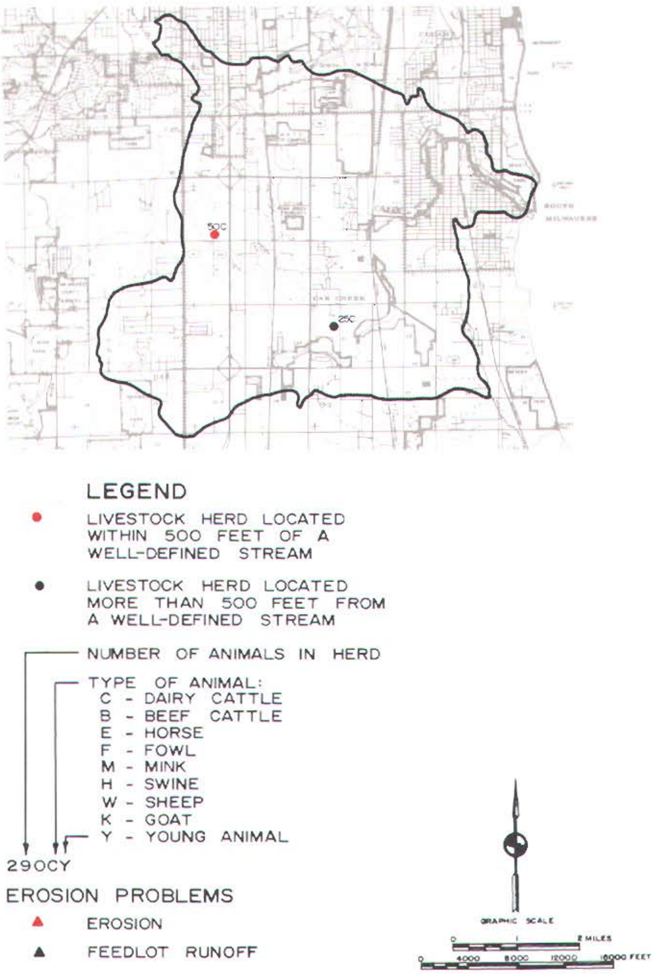
TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE OAK CREEK WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	80	110	1,629	Total Nitrogen	28.4	3,120
				Total Phosphorus	6.6	730
				Biochemical Oxygen Demand	111.2	12,230
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	7.0×10^{13} counts/yr.
				Sediment	700.0	40 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Map 70

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE OAK CREEK WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated two operations within the Oak Creek watershed in 1975, one was located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 276. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 1,047 acres, or 6 percent of the total area of the watershed were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Oak Creek watershed are accordingly estimated at 4,900 pounds of nitrogen, 140 pounds of phosphorus, 10,100 pounds of BOD_5, and 1,680 tons of sediment. Table 176 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates, to the land surface in an average year within the watershed.

Approximately 832 acres, or 5 percent of the total area of the watershed were devoted to growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Oak Creek watershed are 800 pounds of nitrogen, 70 pounds of phosphorus, 8,000 pounds of BOD_5, and 1,330 tons of sediment.

Major row crops grown within the Oak Creek watershed are corn and soybeans which were planted on 2,509 acres, or 15 percent of the total area of the watershed. As shown in Table 276 an estimated 58,000 pounds of nitrogen, 1,600 pounds of phosphorus, 48,000 pounds of BOD_5, and 8,030 tons of sediment are transported annually from the row crop acreage within the Oak Creek watershed.

Also, as shown in Table 276, specialty crops were grown on a total of 378 acres, or 2 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Oak Creek watershed are 8,700 pounds of nitrogen, 240 pounds of phosphorus, 11,300 pounds of BOD_5, and 1,890 tons of sediment.

About 64 acres, or less than 1 percent of land within the watershed were in sod farms in 1975. Estimated average annual pollutant loading rates from these sod farms within the Oak Creek watershed are 100 pounds of nitrogen, 10 pounds of phosphorus, 130 pounds of BOD_5, and 20 tons of sediment.

Approximately 90 percent of the annual plowing of cropland is considered likely to have been tilled by conventional methods, using moldboard plows in the autumn and left uncovered through the winter months and early spring.

Irrigation of cropland, as well as of the golf courses, was practiced within the watershed in 1975. The locations of the high-capacity wells which provide the water supply are shown on Map 47. The irrigation volumes are estimated at 0.164 million gallons per day (mgd). It has been estimated that corn receives up to 10 inches of irrigation water annually, vegetables receive 15-20 inches, sod receives approxi-

Table 276

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	1,047	6.22	Total Nitrogen	4.7	4,920
			Total Phosphorus	0.13	140
			Biochemical Oxygen Demand	9.6	10,050
			Fecal Coliform	Negligible	--
			Sediment	3,200	1,675 tons
Hay	832	4.94	Total Nitrogen	0.9	750
			Total Phosphorus	0.09	70
			Biochemical Oxygen Demand	9.6	7,990
			Fecal Coliform	Negligible	--
			Sediment	3,200	1,330 tons
Row	2,509	14.89	Total Nitrogen	23.1	57,950
			Total Phosphorus	0.64	1,610
			Biochemical Oxygen Demand	19.1	47,920
			Fecal Coliform	Negligible	--
			Sediment	6,400	8,030 tons
Specialty Crops					
Vegetable and Other Agricultural Crops	378	2.25	Total Nitrogen	23.1	8,740
			Total Phosphorus	0.64	240
			Biochemical Oxygen Demand	30.0	11,340
			Fecal Coliform	Negligible	--
			Sediment	10,000	1,890 tons
Sod	64	0.38	Total Nitrogen	0.9	60
			Total Phosphorus	0.09	10
			Biochemical Oxygen Demand	2.1	130
			Fecal Coliform	Negligible	--
			Sediment	700	20 tons
Pasture	3,596	21.35	Total Nitrogen	4.6	16,540
			Total Phosphorus	0.29	1,040
			Biochemical Oxygen Demand	9.7	34,880
			Fecal Coliform	Negligible	--
			Sediment	420	760 tons
Total	8,426	50.03	Total Nitrogen	--	88,960
			Total Phosphorus	--	3,110
			Biochemical Oxygen Demand	--	112,320
			Fecal Coliform	--	--
			Sediment	--	13,705 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

mately 18 inches, and golf courses receive varying amounts of irrigation water annually. Irrigation return flows are considered to be negligible in the watershed due to the careful practices of operators, as in the use of aerial spray methods of application.

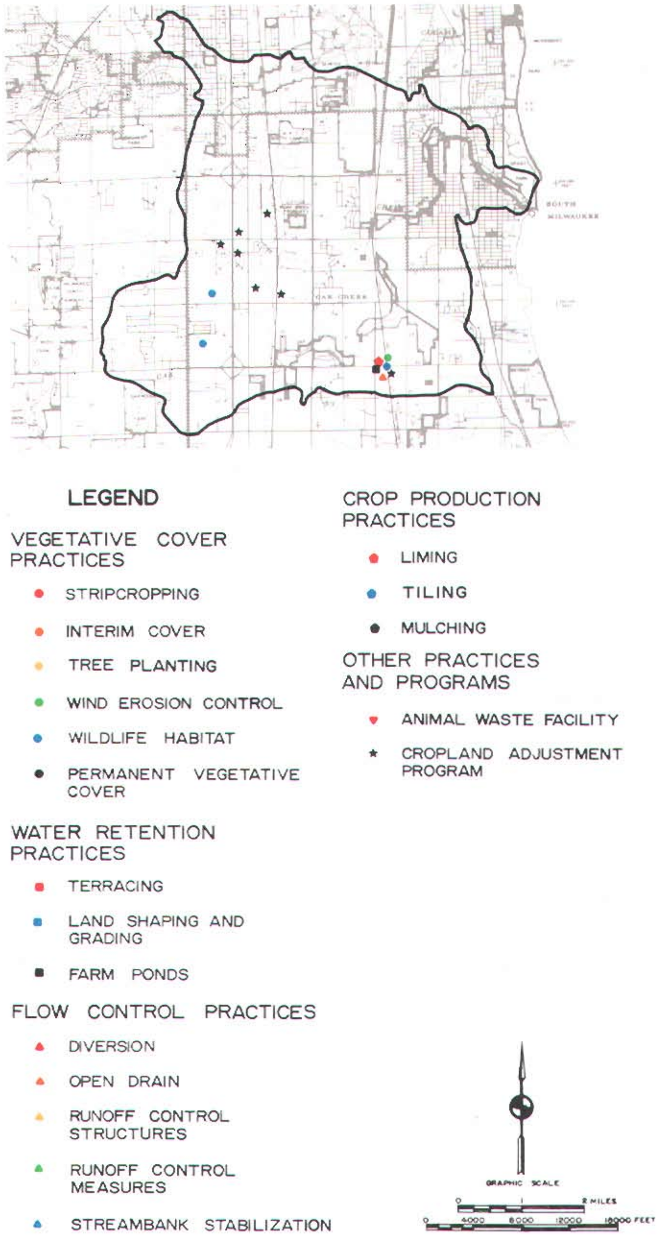
The largest single land use category within the Oak Creek watershed is that of pasture land and other open space, which accounts for 3,596 acres or 21 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 276. Annual loading rates from these areas are estimated at 16,500 pounds of nitrogen, 1,000 pounds of phosphorus, 34,900 pounds of BOD_5, and 760 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for six farms covering about 465 acres or 6 percent of the agricultural land within the watershed.

A total of 14 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 71.

Map 71

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE OAK CREEK WATERSHED IN 1975



The above map illustrates the locations of the 14 known conservation practices installed in the Oak Creek watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Table 277 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $2,330, or an equivalent $0.28 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $0.26 per acre of agricultural land, or about 93 percent of the total investment were related to those practices directly affecting water quality. This represents about 2 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 676 acres, or approximately 4 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 278 presents the acreage of silvicultural activities within the Oak Creek watershed and the estimated loading rates from these activities. About 1,600 pounds of nitrogen, 90 pounds of phosphorus, 3,100 pounds of BOD^5, 4.5×10^{11} fecal coliform counts and 90 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 19 acres, or less than 1 percent of the total area of the watershed is covered by surface water. As indicated in Table 279, 200 pounds of nitrogen, 10 pounds of phosphorus, 3,100 pounds of BOD_5, and five tons of sediment can be expected to be contributed to the surface waters of the watershed annually by atmospheric dry fall and washout.

A total of 478 acres, or 3 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Oak Creek watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Oak Creek Watershed

Oak Creek is an urbanizing watershed, and storm water runoff from urban land contributes the largest diffuse source loads of nitrogen, phosphorus, biochemical oxygen demand, fecal coliform, and sediment. Of all diffuse sources, construction activities are the largest contributor of phosphorus and sediment. Onsite sewage disposal systems are the largest contributor of fecal coliform and the third largest contributor of biochemical oxygen demand. Runoff from developed urban areas inclusive of residential, commercial, and industrial land uses, is the second largest producer of fecal coliform and the largest producer of biochemical oxygen demand. Transportation activities yield from 4 to 14 percent of the total load of all pollutants. Runoff from agri-

Table 277

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE OAK CREEK WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	0	10.00/acre	0
Interim Cover	0	12.00/acre	0
Tree Stands	0	100.00/acre	0
Wind Erosion Control	2,100 feet	0.60/foot	1,260.00
Wildlife Habitat	(3 units) (2 acres/unit) = 6 acres	25.00/acre	150.00
Permanent Vegetative Cover	16 acres	50.00/acre	800.00
Subtotal			2,210.00
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	0	4,000.00/unit	0
Subtotal			0
Flow Control Practices			
Diversions	0	1.25/foot	0
Open Drains	0	2.25/foot	0
Runoff Control Structures	0	2,500.00/unit	0
Runoff Control Measures	0	1.00/foot	0
Streambank Stabilization	0	3.50/foot	0
Subtotal			0
Crop Production Practices			
Liming	6 acres	20.00/acre	120.00
Tiling	0	0.70/foot	0
Mulching	0	60.00/acre	0
Subtotal			120.00
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$2,330.00

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

cultural land contributes the largest load of nitrogen and is the largest single source of biochemical oxygen demand. In addition, agricultural runoff is the second largest diffuse source of sediment and is the third largest single source of phosphorus. Livestock operations account for the second largest single source load of fecal coliform. Recreational activities, silvicultural land uses and air pollution loadings to surface waters each contribute 1 percent or less of the total load of any pollutant. Total annual diffuse source loads are 186,300 pounds of nitrogen, 40,200 pounds of phosphorus, 592,400 pounds of biochemical oxygen demand, 3.4 x 10^{14} fecal coliform counts, and 77,225 tons of sediment.

Table 278

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	521	3.09	Total Nitrogen	2.3	1,200
			Total Phosphorus	0.14	70
			Biochemical Oxygen Demand	4.6	2,400
			Fecal Coliform	6.6×10^8 counts/a/yr.	3.4×10^{11} counts/yr.
			Sediment	251	70 tons
Orchards and Nurseries	155	0.92	Total Nitrogen	2.3	360
			Total Phosphorus	0.14	20
			Biochemical Oxygen Demand	4.6	710
			Fecal Coliform	6x6 $\times 10^8$ counts/a/yr.	1.0×10^{11} counts/yr.
			Sediment	251	20 tons
Total	676	4.01	Total Nitrogen	--	1,550
			Total Phosphorus	--	90
			Biochemical Oxygen Demand	--	3,110
			Fecal Coliform	--	4.5×10^{11} counts/yr.
			Sediment	--	85 tons

Source: SEWRPC.

Table 279

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE OAK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams.	19.00	0.12	Total Nitrogen	8.9	170
			Total Phosphorus	0.5	10
			Biochemical Oxygen Demand	162.0	3,080
			Fecal Coliform	Negligible	--
			Sediment	665.0	5 tons

Source: SEWRPC.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE PIKE RIVER WATERSHED

Physical Setting

The Pike River watershed is a natural surface water drainage unit, 51 square miles in areal extent located in the southeastern portion of the Region. The boundaries of the basin together with the locations of the main channel of the Pike River and its principal tributaries are shown on Map 26. The main stem of the Pike River originates two miles north of the Village of Sturtevant in Racine County and discharges to Lake Michigan at Pennoyer Park in the City of Kenosha. The single principal tributary of the watershed is Pike Creek. About 79 percent of the watershed is in rural land uses, with about 93 percent of this area still in agricultural use. Most of the urban related land use is located in Sturtevant and along the eastern portions of the watershed. Map 72 sets forth the major land use categories and their spatial distributions within the Pike River watershed as they were inventoried in 1975. Table 280 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north by the Root River watershed, on the west and southwest by the Des Plaines watershed, on the southeast by the Pike Creek subwatershed, and on the east by Lake Michigan. The stream system which drains the watershed consists of the Pike River, Pike Creek, Somers Branch, School tributary, Sturtevant tributary and Waxdale Creek. Table 281 lists for the Pike River watershed each major stream reach, together with the location of the source and the length of the stream in miles. The watershed ranks eighth in size within the Region, but ninth in total resident population.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Pike River

Table 280

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE PIKE RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	4.89	3,127	9.66
Commercial[b]	1.08	690	2.13
Industrial			
Manufacturing	1.03	657	2.03
Landfill & Dump	0.15	95	0.29
Extractive	0.14	92	0.28
Transportation			
Streets & Highways	0.17	110	0.34
Airfields	0.26	167	0.52
Railroad Yards & Terminals	0.07	42	0.13
Recreation			
Golf Courses	0.96	617	1.91
Parks & Other Recreation	0.31	200	0.62
Land Under Development			
Residential Land Under Development[c]	1.07	687	2.12
Commercial Land Under Development	--	--	--
Industrial Land Under Development	0.15	93	0.28
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	2.94	1,881	5.81
Hay	2.15	1,404	4.34
Row Crops	23.05	14,749	45.55
Specialty Crops	3.45	2,207	6.82
Sod Farm	0.27	170	0.53
Other Open Space[d]	5.36	3,431	10.64
Silvicultural			
Woodlands	1.47	940	2.90
Orchards & Nurseries	0.43	273	0.84
Natural and Manmade Water Areas—Subject to Atmospheric Pollution Contributions			
Ponds, Lakes & Streams	0.13	82	0.25
Wetlands, Swamps, & Marshes	1.03	662	2.04
Total	50.56	32,376	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2,000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the area of the Pike River watershed is shown in Table 282.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

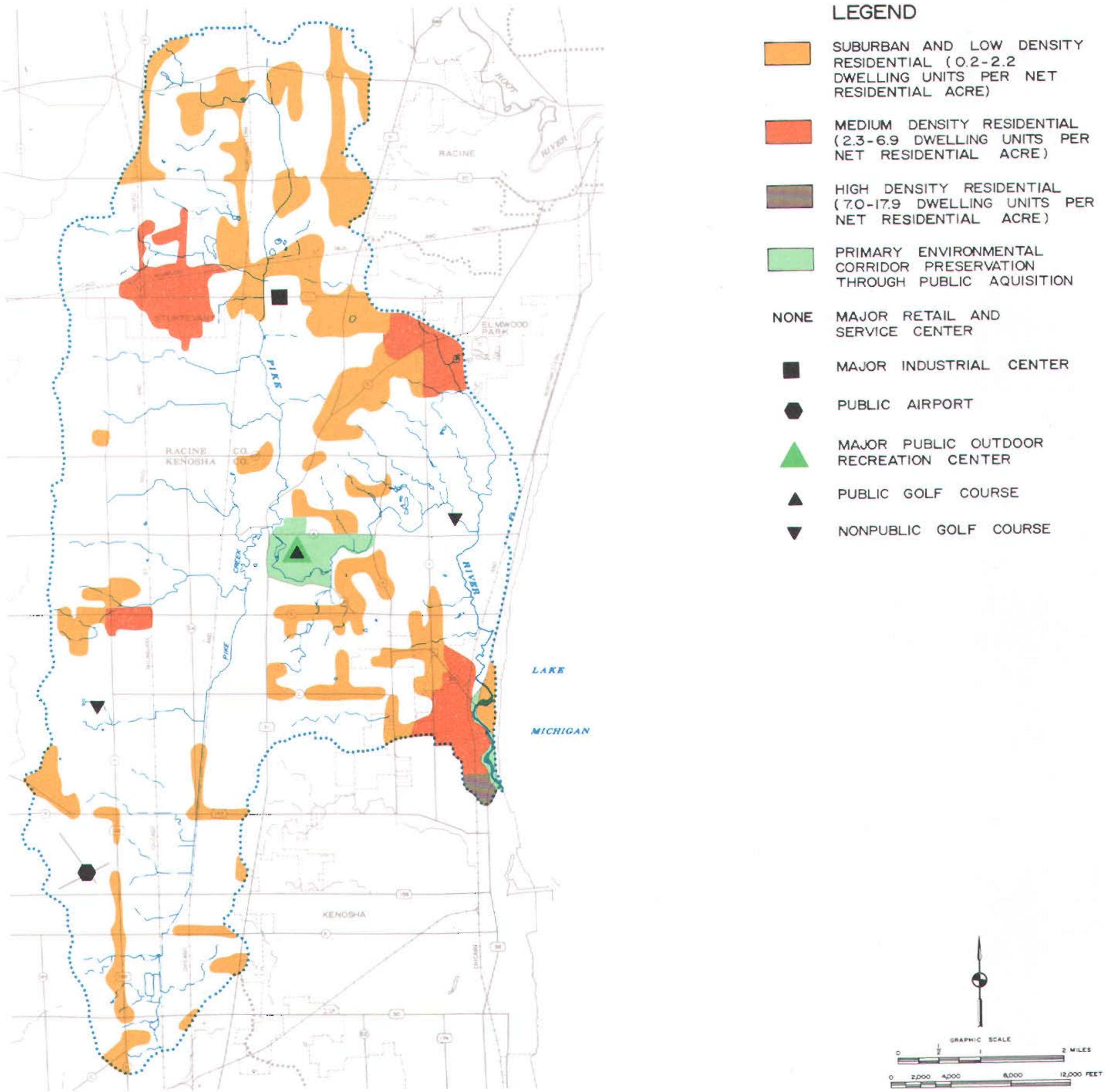
[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Map 72

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE PIKE RIVER WATERSHED IN 1975



As of 1975 more than 79 percent of the area of the Pike River watershed was devoted to rural land uses. The dominant rural land use in the watershed was agricultural, which occupied 74 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural land uses with scattered low- and medium-density residential areas in the headwater portion of the watershed and contiguous low-density residential land uses in the middle and lower portions. There were three public or private golf courses and one major park in the watershed.

Source: SEWRPC.

Table 281

LENGTH OF STREAMS AND THEIR SOURCES IN THE PIKE RIVER WATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Pike River	Town of Mount Pleasant	T3N, R22E, Sec. 10, NW 1/4	18.39
Waxdale Creek	Town of Mount Pleasant	T3N, R22E, Sec. 21, NW 1/4	2.17
Chicory Creek	Town of Mount Pleasant	T3N, R22E, Sec. 28, SW 1/4	1.17
School Tributary	Town of Somers	T2N, R22E, Sec. 5, SE 1/4	2.77
Somers Branch	Town of Somers	T2N, R22E, Sec. 9, SW 1/4	2.22
Pike Creek	Town of Somers	T2N, R22E, Sec. 33, NE 1/4	3.44

Source: SEWRPC and Wisconsin Department of Natural Resources.

Table 282

AREAL EXTENT OF CIVIL DIVISIONS IN THE PIKE RIVER WATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Kenosha County			
City			
Kenosha	2.03	4.01	13.74
Towns			
Pleasant Prairie	2.66	5.25	7.25
Somers	25.33	50.00	73.72
County Subtotal	30.02	59.26	10.79
Racine County			
City			
Racine	0.35	0.69	2.60
Village			
Sturtevant	1.56	3.08	100.00
Town			
Mount Pleasant	18.73	36.87	50.01
County Subtotal	20.64	40.74	6.06
Total	50.66	100.00	--

Source: SEWRPC.

watershed lies totally within Racine and Kenosha Counties and in parts of Racine and Kenosha Cities. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 282. The 1975 resident population of the watershed is estimated at 27,800 persons, or approximately 1.6 percent of the estimated 1975 total regional population. Table 283 presents the population distribution in the Pike River watershed by civil division.

Surface water in the Pike River watershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water.

The streamflow of the Pike River has been measured since 1971 at a continuous flow recording gage measured by the U.S. Geological Survey in cooperation with the Milwaukee Metropolitan Sewerage District, Kenosha County, the University of Wisconsin-

Table 283

ESTIMATED POPULATION OF THE PIKE RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Kenosha County	
Kenosha City (Part)	7,446
Pleasant Prairie Town (Part)	641
Somers Town (Part)	5,151
Kenosha County (Part) Subtotal	13,238
Racine County	
Mount Pleasant Town (Part)	8,668
Racine City (Part)	1,540
Sturtevant Village	4,354
Racine County (Part) Subtotal	14,562
Pike River Watershed Total	27,800

Source: Wisconsin Department of Administration and SEWRPC.

Parkside, and the Commission, at a location 1.7 miles downstream from the confluence of Pike Creek near Petrifying Springs Park.

The soils within the Pike River watershed consist of deep to moderately deep brown to black silt loams with some sections of western Racine and Kenosha Counties noted primarily for this brown to black prairie loam soils. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service or residential development without public sanitary sewer service, as shown on Maps 43, 44, and 45.

Urban Land Uses

Residential Activities: Residential land uses covered approximately 3,127 acres, or 10 percent of the watershed in 1975. In addition, there were about 687 acres of residential land use under development, which are so reflected in the pollution loading rates

Table 284

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	3,127	9.66	Total Nitrogen	4.0	12,510
			Total Phosphorus	0.32	1,000
			Biochemical Oxygen Demand	24.3	75,990
			Fecal Coliform	1.6×10^{10} counts/ac/yr.	5.0×10^{13} counts/yr.
			Sediment	545	850 tons

Source: SEWRPC.

Table 285

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial	690	2.13	Total Nitrogen	9.0	6,210
			Total Phosphorus	0.75	520
			Biochemical Oxygen Demand	97.6	67,340
			Fecal Coliform	3.3×10^{10} counts/ac/yr.	2.3×10^{13} counts/yr.
			Sediment	745	255 tons

Source: SEWRPC.

of the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Pike River watershed are estimated at 12,500 pounds of nitrogen, 1,000 pounds of phosphorus, 76,000 pounds of BOD_5, 5.0 x 10^{13} fecal coliform counts, and 850 tons of sediment during an average year. Table 284 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Pike River watershed, approximately 690 acres, or 2 percent of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Pike River watershed are 6,200 pounds of nitrogen, 500 pounds of phosphorus, 67,300 pounds of biochemical oxygen demand, 2.3 x 10^{13} fecal coliform counts, and 260 tons of sediment. Table 285 presents the areal extent of commercial land uses within the Pike River watershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the watershed in 1975.

Industrial Activities: Industrial land uses cover 657 acres, or 2 percent of the Pike River watershed. In addition, 93 acres, or less than 1 percent of the watershed were under development for industrial land use and are included as pollution sources under the land under development category because of the increased loadings from lands undergoing conversion from rural to urban use. The industrial activities within the Pike River watershed excluding land under development are estimated to contribute annually 5,500 pounds of nitrogen, 500 pounds of phosphorus, 24,200 pounds of BOD_5, 4.0 x 10^{13} fecal coliform counts, and 320 tons of sediment to surface runoff. Table 286 presents the areal extent of the industrial land uses within the Pike River watershed along with the estimated average annual diffuse source pollutant loadings from these activities.

There are two sites of sanitary landfill operations within the Pike River watershed occupying a total of 95 acres, or less than 1 percent of the drainage area. These are included, along with their estimated pollutant loading rates, on Table 286. The landfill operations have an estimated annual pollutant load of 800 pounds of nitrogen, 70 pounds of phosphorus, 3,500 pounds of BOD_5, 5.9 x 10^{13} fecal coliform counts, and 50 tons of sediment.

In addition to the sanitary landfill sites, there are also three auto salvage and wrecking facilities in the watershed which are included in the analysis under industrial activities.

Extractive Activities: There were 92 acres or less than 1 percent of the total watershed area in extractive mining operations consisting of gravel pits and attendant washing operations, in the Pike River watershed as of 1975. These operations contribute an estimated 5,500 pounds of nitrogen, 4,100 pounds of phosphorus, 11,000 pounds of BOD_5, and 6,900 tons of sediment annually. Table 287 presents the extent of the extractive operations and the estimated attendant diffuse loadings.

Table 286

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	657	2.03	Total Nitrogen	8.4	5,520
			Total Phosphorus	0.70	460
			Biochemical Oxygen Demand	36.9	24,240
			Fecal Coliform	6.2 x 10^{10} counts/a/yr.	4.0 x 10^{13} counts/yr.
			Sediment	977	320 tons
Landfill	95	0.29	Total Nitrogen	8.4	800
			Total Phosphorus	0.70	70
			Biochemical Oxygen Demand	36.9	3,510
			Fecal Coliform	6.2 x 10^{10} counts/a/yr.	5.9 x 10^{13} counts/yr.
			Sediment	977	45 tons
Total	752	2.32	Total Nitrogen	--	6,320
			Total Phosphorus	--	530
			Biochemical Oxygen Demand	--	27,750
			Fecal Coliform	--	4.7 x 10^{13} counts/yr.
			Sediment	--	365 tons

Source: SEWRPC.

Table 287

TYPE, EXTENT, AND ESTIMATED TOTAL POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive	92	0.28	Total Nitrogen	60	5,520
			Total Phosphorus	45	4,140
			Biochemical Oxygen Demand	120	11,040
			Fecal Coliform	Negligible	--
			Sediment	150,000	6,900 tons

Source: SEWRPC.

Table 288

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	110	0.34	Total Nitrogen	23.4	2,570
			Total Phosphorus	1.4	150
			Biochemical Oxygen Demand	159.0	17,490
			Fecal Coliform	6.7×10^{10} counts/a/yr.	7.4×10^{12} counts/yr.
			Sediment	42,600	2,340 tons
Railroad Yards & Terminals	42	0.13	Total Nitrogen	8.4	350
			Total Phosphorus	1.17	50
			Biochemical Oxygen Demand	369	1,550
			Fecal Coliform	6.2×10^{10} counts/a/yr.	2.6×10^{12} counts/yr.
			Sediment	977	20 tons
Air Fields	167	0.52	Total Nitrogen	12	2,000
			Total Phosphorus	2.7	450
			Biochemical Oxygen Demand	17.6	2,940
			Fecal Coliform	Negligible	--
			Sediment	3,200	270 tons
Total	319	0.99	Total Nitrogen	--	4,930
			Total Phosphorus	--	650
			Biochemical Oxygen Demand	--	21,980
			Fecal Coliform	--	1.0×10^{13} counts/yr.
			Sediment	--	2,630 tons

Source: SEWRPC.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, railroad yards and terminals, and airfields. Table 288 presents the estimated pollutant contributions from the 152 acres, or less than 1 percent of the total watershed area which is devoted to these land uses. It is estimated that 4,900 pounds of nitrogen, 700 pounds of phosphorus, 22,000 pounds of BOD_5, 1.0×10^{13} fecal coliform counts, and 2,630 tons of sediment are transported annually from transportation related activities within the Pike River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve. There was no transportation land under development in the watershed in 1975.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 200 acres, or less than 1 percent of the total area of the watershed, and three golf courses with a total area of 617 acres, or 2 percent of the total area of the watershed. Map 72 indicates the location of public and private golf courses within the Pike River watershed as of 1975. Table 289 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 3,200 pounds of nitrogen, 100 pounds of phosphorus, 1,100 pounds of BOD_5, 7.2×10^{11}

Table 289

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	200	0.62	Total Nitrogen	2.3	460
			Total Phosphorus	0.06	10
			Biochemical Oxygen Demand	1.3	260
			Fecal Coliform	3.6×10^9 counts/a/yr.	7.2×10^{11} counts/yr.
			Sediment	420	40 tons
Golf Courses	617	1.91	Total Nitrogen	4.4	2,720
			Total Phosphorus	0.20	120
			Biochemical Oxygen Demand	1.3	800
			Fecal Coliform	Negligible	---
			Sediment	420	130 tons
Total	817	2.53	Total Nitrogen	--	3,170
			Total Phosphorus	--	140
			Biochemical Oxygen Demand	--	1,060
			Fecal Coliform	--	7.2×10^{11} counts/yr.
			Sediment	--	170 tons

Source: SEWRPC.

fecal coliform counts, and 170 tons of sediment are transported from parks and golf courses within the Pike River watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development: The Pike River watershed is undergoing fairly rapid conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 687 acres, or 2 percent of the total land area of the watershed. Similarly, an estimated 93 acres, or less than 1 percent of the total area of the watershed was under development for industrial land uses in 1975. No significant recreational, commercial, or transportation related lands were under development in the watershed in 1975. It is estimated that 46,800 pounds of nitrogen, 35,100 pounds of phosphorus, 93,600 pounds of BOD_5, and 58,500 tons of sediment were transported from these construction sites in 1975. Table 290 presents the estimated acreage of land under conversion from rural to urban use within the Pike River watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were only four known holding tanks and two mound systems in the watershed, as shown on Map 46. Table 291 presents the estimated pollutant loadings from the approximately 1,387 septic tanks in the watershed as of 1975. It is estimated that 23,900 pounds of nitrogen, 60 tons of sediment, 5,500 pounds of phosphorus, 342,700 pounds of BOD_5, and 4.2×10^{14} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Pike River watershed.

Rural Land Uses

Agricultural Activities: About 74 percent of the area of the Pike River watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May, 1975, 13 significant domestic livestock operations with a total of 3,300 animals, or 980 equivalent animal units were known to exist within the watershed. Map 73 indicates the locations of these livestock operations. Three of these operations were located within 500 feet of the identified stream system of the watershed. Table 292 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 27,800 pounds of nitrogen, 6,500 pounds of phosphorus, 109,000 pounds of BOD_5, 6.3×10^{14} fecal coliform counts, and 350 tons of sediment are transported from livestock operations within the Pike River watershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 293. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 1,881 acres, or 6 percent of the total area of the watershed were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant

Table 290

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development. . .	687	2.12	Total Nitrogen	60	41,220
			Total Phosphorus	45	30,920
			Biochemical Oxygen Demand	120	82,440
			Fecal Coliform	Negligible	--
			Sediment	150,000	51,530 tons
Industrial Land Under Development. . . .	93	0.28	Total Nitrogen	60	5,580
			Total Phosphorus	45	4,190
			Biochemical Oxygen Demand	120	11,160
			Fecal Coliform	Negligible	--
			Sediment	150,000	6,980 tons
Total	780	2.40	Total Nitrogen	--	46,800
			Total Phosphorus	--	35,100
			Biochemical Oxygen Demand	--	93,600
			Fecal Coliform	--	--
			Sediment	--	58,500 tons

Source: SEWRPC.

Table 291

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE PIKE RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	1,387	4,200	Total Nitrogen	5.7	23,940
			Total Phosphorus	1.32	5,540
			Biochemical Oxygen Demand	81.6	342,720
			Fecal Coliform	$1.0x10^{11}$ counts/capita/yr.	$4.2x10^{14}$ counts/yr.
			Sediment	28.0	60 tons

Source: SEWRPC.

loadings from grain crops within the Pike River watershed are accordingly estimated at 8,800 pounds of nitrogen, 300 pounds of phosphorus, 18,100 pounds of BOD_5, and 3,000 tons of sediment. Table 293 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates, to the land surface in an average year within the watershed.

Approximately 1,404 acres, or 4 percent of the total area of the watershed were devoted to the growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Pike River watershed are 1,300 pounds of nitrogen, 100 pounds of phosphorus, 13,500 pounds of BOD_5, and 2,200 tons of sediment.

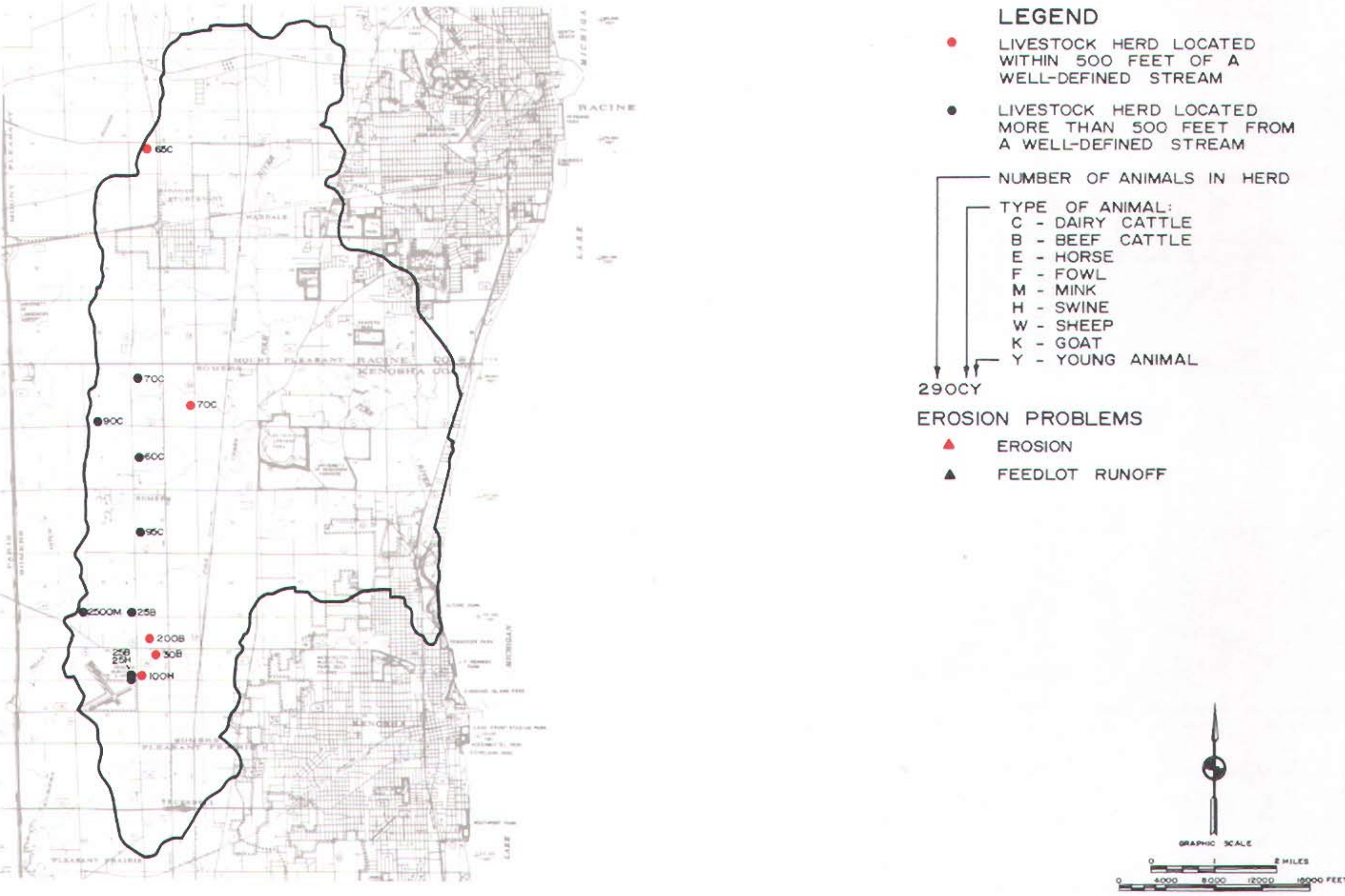
Major row crops grown within the Pike River watershed are corn and soybeans which were planted on 14,749 acres, or 46 percent of the total area of the watershed, making up the largest land use category within the watershed. As shown in Table 293, an estimated 340,700 pounds of nitrogen, 9,400 pounds of phosphorus, 305,300 pounds of BOD_5, and 50,890 tons of sediment are transported annually from the row crop acreage within the Pike River watershed.

Also, as shown in Table 293, specialty crops were grown on a total of 2,200 acres, or 7 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Pike River watershed are 51,000 pounds of nitrogen, 1,400 pounds of phosphorus, 66,200 pounds of BOD_5, and 11,000 tons of sediment.

About 170 acres, or less than 1 percent, of land within the watershed were in sod farms in 1975. Estimated average annual pollutant loading rates from these sod farms within the Pike River watershed are 200 pounds of nitrogen, 20 pounds of phosphorus, 400 pounds of BOD_5, and 60 tons of sediment.

Map 73

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS IN THE PIKE RIVER WATERSHED IN 1975 OF 25 UNITS OR GREATER



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 13 operations within the Pike River watershed in 1975, three operations, or 23 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Irrigation of cropland, as well as of golf courses, was reportedly not practiced within the watershed in 1975.

The second largest single land use category within the Pike River watershed is that of pasture land and other open space, which accounts for 3,431 acres, or 11 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 293. Annual loading rates from these areas are estimated at 15,800 pounds of nitrogen, 1,000 pounds of phosphorus, 33,300 pounds of BOD_5, and 720 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 49 farms covering about 5,019 acres, or 21 percent of the agricultural land within the watershed.

A total of 35 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 74.

Table 292

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	450	630	9,780	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	17,890 4,160 70,060 4.0×10^{14} counts/yr. 220 tons
Beef	280	280	3,170	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	7,950 1,850 31,140 1.8×10^{14} counts/yr. 100 tons
Hogs	130	50	630	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	1,420 330 5,560 3.2×10^{13} counts/yr. 20 tons
Mink	2,440	20	180	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	570 130 2,220 1.3×10^{13} counts/yr. 10 tons
Total	3,300	980	13,760	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	-- -- -- -- --	27,830 6,470 108,980 6.3×10^{14} counts/yr. 345 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 294 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $124,927, or an equivalent $5.24 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $1.20 per acre of agricultural land, or about 23 percent of the total investment were related to those practices directly affecting water quality. This represents about 8 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 1,213 acres, or approximately 4 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 295 presents the acreage of silvicultural activities within the Pike River watershed and the estimated loading rates from these activities. About 2,800 pounds of nitrogen, 200 pounds of phosphorus, 5,600 pounds of BOD_5, 8.0 x 10^{11} fecal coliform counts, and 150 tons of sediment are transported annually from silvicultural land uses in the watershed.

Table 293

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	1,881	5.81	Total Nitrogen	4.7	8,840
			Total Phosphorus	0.13	250
			Biochemical Oxygen Demand	9.6	18,060
			Fecal Coliform	Negligible	--
			Sediment	3,200	3,010 tons
Hay	1,404	4.34	Total Nitrogen	0.9	1,260
			Total Phosphorus	0.09	130
			Biochemical Oxygen Demand	9.6	13,480
			Fecal Coliform	Negligible	--
			Sediment	3,200	2,245 tons
Row	14,749	45.55	Total Nitrogen	23.1	340,700
			Total Phosphorus	0.64	9,440
			Biochemical Oxygen Demand	20.7	305,300
			Fecal Coliform	Negligible	--
			Sediment	6,900	50,885 tons
Specialty Crops — Vegetable and Other Agricultural Crops	2,207	6.82	Total Nitrogen	23.1	50,980
			Total Phosphorus	0.64	1,410
			Biochemical Oxygen Demand	30.0	66,210
			Fecal Coliform	Negligible	--
			Sediment	10,000	11,035 tons
Sod	170	0.53	Total Nitrogen	0.9	150
			Total Phosphorus	0.09	20
			Biochemical Oxygen Demand	2.1	360
			Fecal Coliform	Negligible	--
			Sediment	700	60 tons
Pasture	3,430	10.64	Total Nitrogen	4.6	15,780
			Total Phosphorus	0.29	990
			Biochemical Oxygen Demand	9.7	33,280
			Fecal Coliform	Negligible	--
			Sediment	420	720 tons
Total	23,842	73.69	Total Nitrogen	--	417,720
			Total Phosphorus	--	12,230
			Biochemical Oxygen Demand	--	436,690
			Fecal Coliform	--	--
			Sediment	--	67,955 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

Atmospheric Contribution: A total of 82 acres, or less than 1 percent of the total area of the watershed is covered by surface water. As indicated in Table 296, 700 pounds of nitrogen, 40 pounds of phosphorus, 13,300 pounds of BOD_5, and 30 tons of sediment can be expected to be contributed to the surface waters of the Pike River watershed annually by atmospheric dry fall and washout.

A total of 662 acres, or 2 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Pike River watershed annually be atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Pike River Watershed

The Pike River watershed is generally agricultural with storm water runoff from these lands contributing the largest diffuse source loads of nitrogen and sediment. Livestock operations are also a major source of pollution in the Pike River watershed and contribute the largest diffuse source load of fecal coliform. Diffuse source runoff from agriculture contribute the largest source of biochemical oxygen demand in the watershed. Construction activities are the largest producer of phosphorus, and contribute the second largest diffuse source load of nitrogen and

Table 294

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE PIKE RIVER WATERSHED FOR 1965-1975

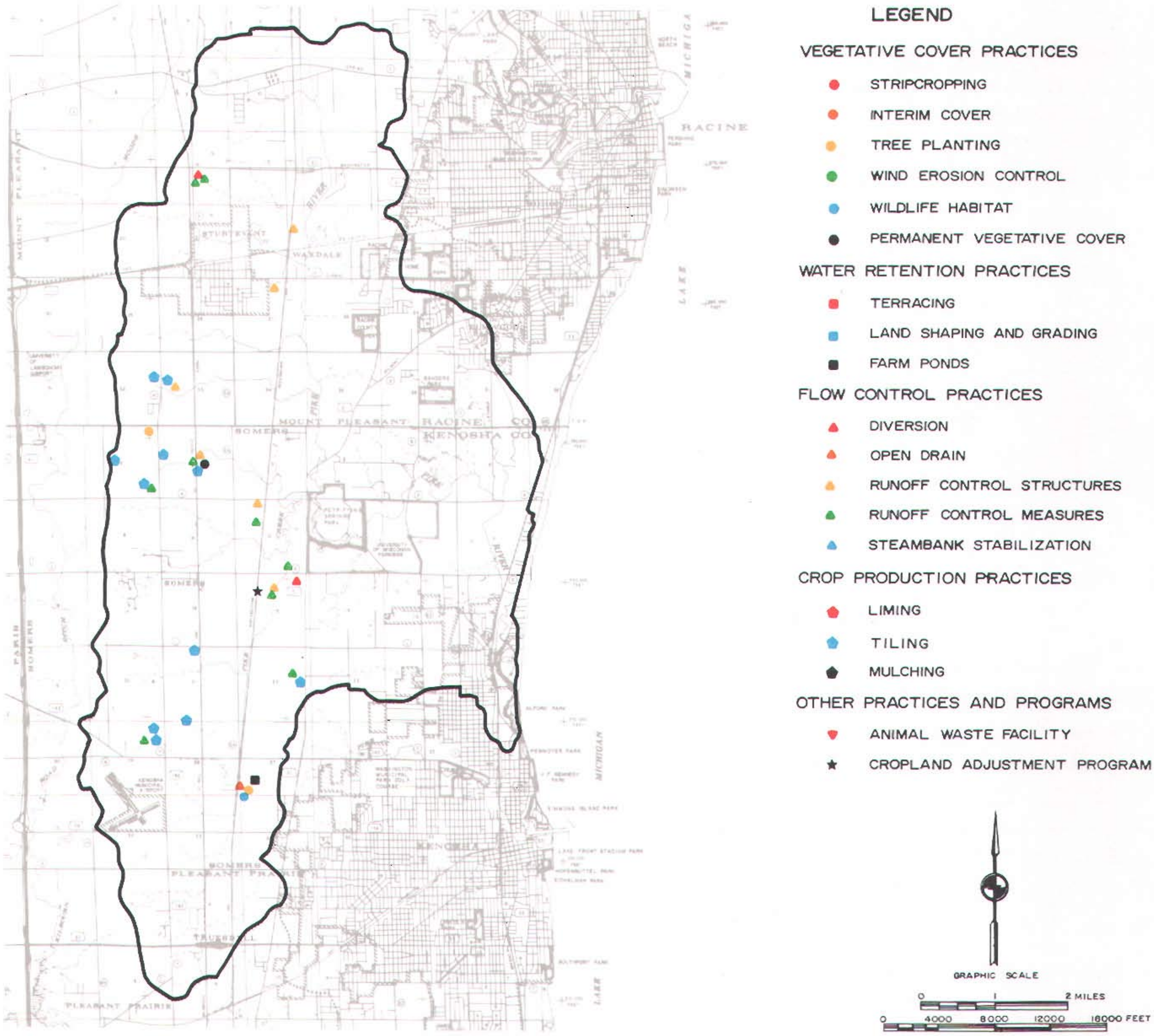
Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	0	10.00/acre	0
Interim Cover	0	12.00/acre	0
Tree Stands	(1 unit) (2 acres/unit) = 2 acres	100.00/acre	200.00
Wind Erosion Control	0	0.60/foot	0
Wildlife Habitat	(1 unit) (2 acres/unit) = 2 acres	25.00/acre	50.00
Permanent Vegetative Cover	13 acres	50.00/acre	650.00
Subtotal			900.00
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	1 unit	4,000.00/unit	4,000.00
Subtotal			4,000.00
Flow Control Practices			
Diversions	90 feet	1.25/foot	112.50
Open Drains	500 feet	2.25/foot	1,125.00
Runoff Control Structures	5 units	2,500.00/unit	12,500.00
Runoff Control Measures	9,990 feet	1.00/foot	9,990.00
Streambank Stabilization	0	3.50/foot	0
Subtotal			23,727.50
Crop Production Practices			
Liming	113 acres	20.00/acre	2,260.00
Tiling	134,342 feet	0.70/foot	94,039.40
Mulching	0	60.00/acre	0
Subtotal			96,299.40
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$124,926.90

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

sediment. Onsite sewage disposal systems contribute the second largest diffuse source load of biochemical oxygen demand, and fecal coliform and the fourth largest loads of nitrogen and phosphorus. Runoff from developed urban areas, inclusive of residential, commercial, and industrial land uses, contributes less than 12 percent of the diffuse source load of any pollutant. Transportation and recreation activities each produce 2 percent or less of the total diffuse source load of any major pollutant. Total annual diffuse source loads are 558,500 pounds of nitrogen, 66,500 pounds of phosphorus, 1,206,000 pounds of biochemical oxygen demand, 1.2 x 10^{15} fecal coliform counts, and 138,205 tons of sediment.

Map 74

LOCATION OF KNOWN CONSERVATION PRACTICES
IN THE PIKE RIVER WATERSHED IN 1975



The above map illustrates the locations of the 35 known conservation practices installed in the Pike River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Table 295

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	940	2.90	Total Nitrogen	2.3	2,160
			Total Phosphorus	0.14	130
			Biochemical Oxygen Demand	4.6	4,320
			Fecal Coliform	6.6×10^8 counts/a/yr.	6.2×10^{11} counts/yr.
			Sediment	251	115 tons
Orchards and Nurseries	273	0.84	Total Nitrogen	2.3	630
			Total Phosphorus	0.14	40
			Biochemical Oxygen Demand	4.6	1,260
			Fecal Coliform	6.6×10^8 counts/a/yr.	1.8×10^{11} counts/yr.
			Sediment	251	35 tons
Total	1,213	3.74	Total Nitrogen	--	2,790
			Total Phosphorus	--	170
			Biochemical Oxygen Demand	--	5,580
			Fecal Coliform	--	8.0×10^{11} counts/yr.
			Sediment	--	150 tons

Source: SEWRPC.

Table 296

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE PIKE RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams	82	0.25	Total Nitrogen	8.9	730
			Total Phosphorus	0.5	40
			Biochemical Oxygen Demand	162	13,280
			Fecal Coliform	Negligible	--
			Sediment	665	25 tons

Source: SEWRPC.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE ROCK RIVER WATERSHED

Physical Setting

The Rock River watershed is a natural surface water drainage unit, 612 square miles in areal extent located in the western portion of the Region. The watershed is only partly contained in the Region, the main stem originating in the marshy areas of southern Fond du Lac County, and flowing southerly through Dodge, Jefferson and Rock Counties outside the Region as well as Washington, Waukesha and Walworth Counties within the Region. As shown on Map 26, 17 tributaries of the Rock River originate in the Region and drain that portion of the Rock River Basin located within Walworth, Washington and Waukesha Counties. About 89 percent of the watershed is in rural land uses, with about 80 percent of this area still in agricultural use. Most of the agricultural related land use is dispersed throughout the watershed. Map 75 sets forth the major land use categories and their spatial distributions within the Rock River watershed as they were inventoried in 1975. Table 297 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

Within the Region, the watershed is bounded on the east by the Milwaukee and Fox River watersheds, on the west by the Dodge, Jefferson and Rock County lines, on the south by the Illinois—Wisconsin state

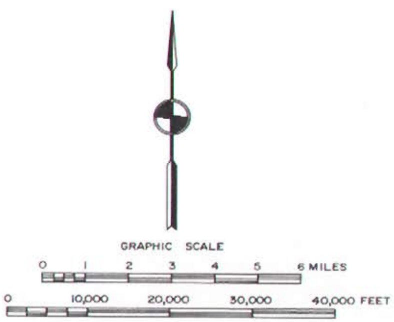
Map 75

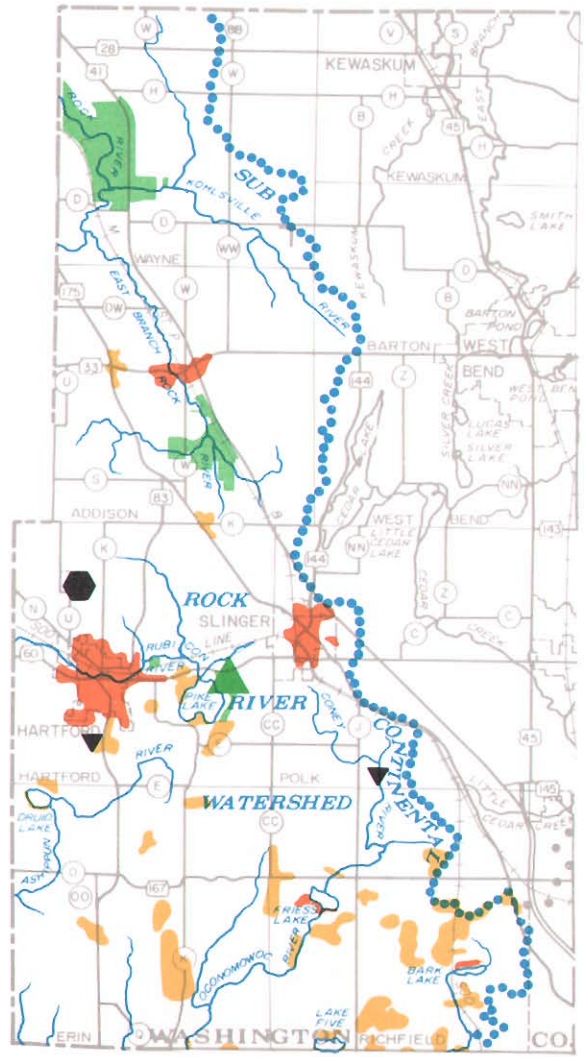
MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE ROCK RIVER WATERSHED IN 1975

Washington County

LEGEND

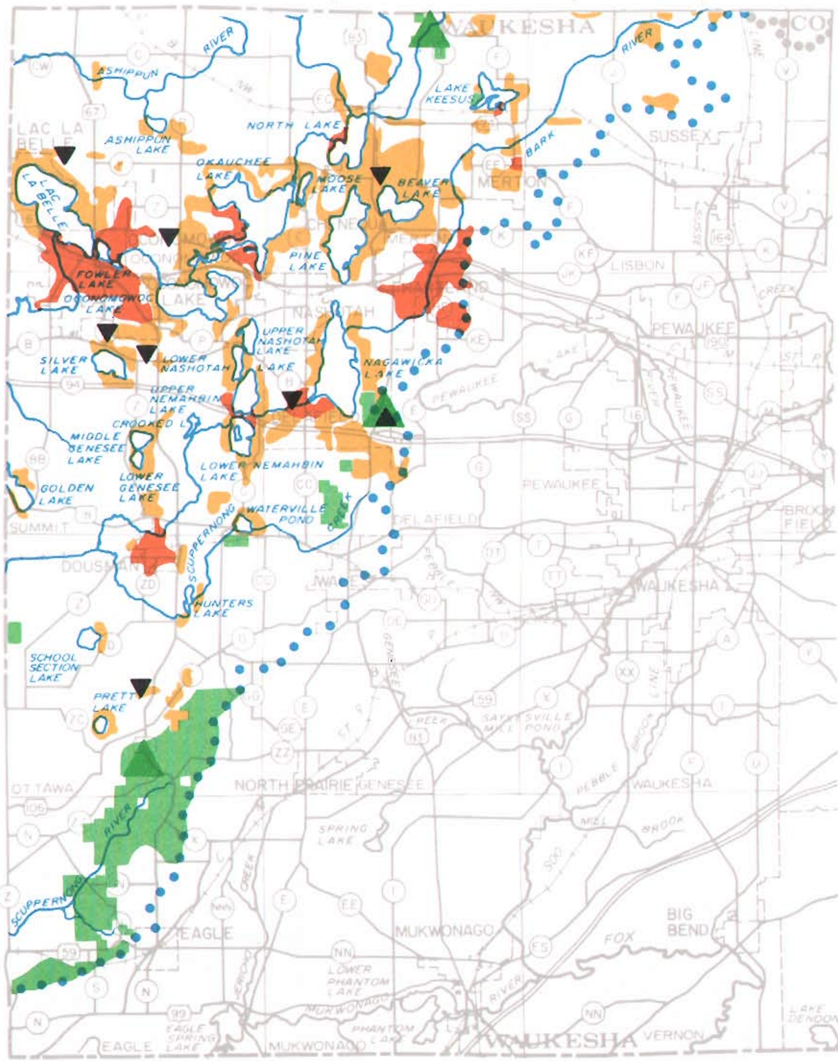
- (orange box) SUBURBAN AND LOW DENSITY RESIDENTIAL (0.2–2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- (red box) MEDIUM DENSITY RESIDENTIAL (2.3–6.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- NONE — HIGH DENSITY RESIDENTIAL (7.0–17.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
- (green box) PRIMARY ENVIRONMENTAL CORRIDOR PRESERVATION THROUGH PUBLIC AQUISITION
- NONE — MAJOR RETAIL AND SERVICE CENTER
- NONE — MAJOR INDUSTRIAL CENTER
- (hexagon) PUBLIC AIRPORT
- (large triangle) MAJOR PUBLIC OUTDOOR RECREATION CENTER
- (small triangle) PUBLIC GOLF COURSE
- (inverted triangle) NONPUBLIC GOLF COURSE



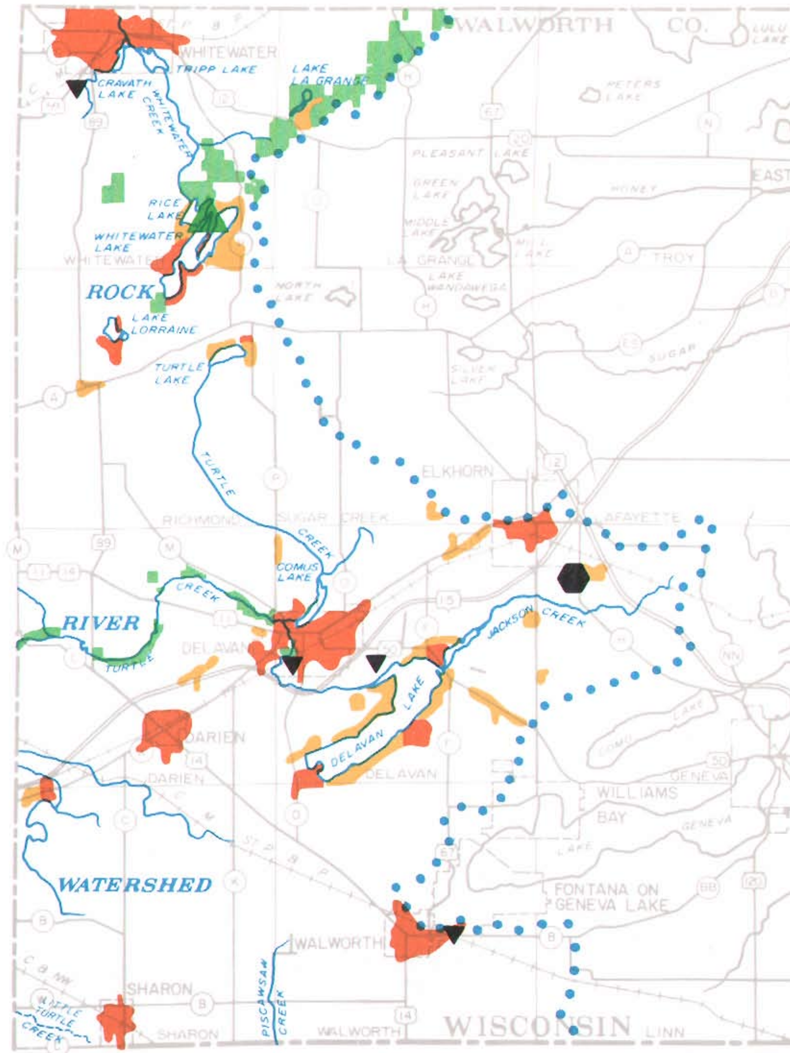


Map 75 (continued)

Waukesha County



Walworth County



As of 1975 more than 89 percent of the Rock River watershed was in rural land uses. The dominant rural land use in the watershed was agricultural, which occupied 80 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural land uses with scattered concentrations of urban development, primarily in the form of small cities and villages throughout the watershed. There were 14 public or private golf courses and five major parks in the watershed.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; Univeristy of Wisconsin Extension Service and SEWRPC.

Table 297

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE ROCK RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	27.96	17,896	4.09
Commercial[b]	4.30	2,750	0.63
Industrial			
Manufacturing	1.56	997	0.22
Landfill & Dump	.38	244	0.06
Extractive	2.49	1,595	0.36
Transportation			
Streets & Highways	1.71	1,096	0.25
Airfields	0.26	165	0.04
Railroad Yards & Terminals	--	--	--
Recreation			
Golf Courses	2.60	1,665	0.38
Parks & Other Recreation	4.01	2,567	0.59
Land Under Development			
Residential Land Under Development[c]	7.08	4,989	1.14
Commercial Land Under Development	--	--	--
Industrial Land Under Development	0.18	118	0.03
Transportation Land Under Development	0.75	479	0.11
Recreation Land Under Development	0.03	20	0.00
Rural Land Use			
Agricultural			
Grain Crops	25.64	16,407	3.75
Hay	94.06	60,200	13.76
Row Crops	289.40	185,219	42.34
Specialty Crops	11.73	7,509	1.72
Sod Farm	1.21	774	0.18
Other Open Space[d]	65.28	41,777	9.55
Silvicultural			
Woodlands	63.98	40,949	9.36
Orchards & Nurseries	0.65	417	0.09
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	22.27	14,256	3.25
Wetlands, Swamps, & Marshes	55.25	35,360	8.08
Total	682.78[e]	437,449	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2,000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

[e] *The total area of the Rock River watershed represented in this table is different than the total area of the Rock River watershed identified in Table 299. This is due to the fact that the area set forth in Table 299 includes all that portion of the Rock River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Rock River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

line, and in the north by the Fond du Lac County line. Table 298 lists for the Rock River watershed each major stream reach within the Region, and the length of the reaches in miles. The watershed ranks second in size within the Region, but seventh in total resident population.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Rock River watershed lies partially within Washington, Waukesha, and Walworth Counties and in parts of 48 cities, villages and towns within the Region. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 299. The 1975 resident population of the watershed is estimated at 97,334 persons, or approximately 5 percent of the estimated 1975 total regional population. Table 300 presents the population distribution in the Rock River watershed by civil division.

Surface water in the Rock River watershed is comprised almost entirely of streamflow, 46 major lakes of 50 acres or larger, small lakes, small ponds, flooded gravel pits and wetlands. The quantity of streamflow in the Rock River watershed, as in the Region generally, varies with seasonal changes in temperature, rainfall, soil moisture, agricultural operations, the growth cycle of vegetation and groundwater levels.

The soils within the Rock River watershed are generally grayish-brown rolling silt loams or gravelly to grayish-brown loams in Washington and Waukesha Counties and gradually change to the brown to black prairie loam soils which exist in Walworth County. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service and residential development without public sanitary sewer service as shown on Maps 43, 44, and 45.

Urban Land Uses

Residential Activities: Residential land uses cover approximately 17,896 acres, or 4 percent of the watershed. In addition, there are 4,989 acres of residential land use under development and are so reflected in the pollution loading rates of the land under development category because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Rock River watershed are estimated

Table 298

LENGTH OF STREAMS AND THEIR SOURCES WITHIN THE ROCK RIVER WATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Bluff Creek	Town of Whitewater	T 4N, R15E, Sec. 14, NE 1/4	2.0
Scuppernong River	Town of Ottawa	T 6N, R17E, Sec. 27, NE 1/4	5.50
Limestone Creek	Town of Addison	T11N, R18E, Sec. 30, NW 1/4	5.80
Allenton Creek	Town of Addison	T11N, R18E, Sec. 14, NW 1/4	2.50
Kohlsville River	Town of Barton	T11N, R19E, Sec. 7, NE 1/4	7.90
East Branch Rock River	Town of Wayne	T12N, R18E, Sec. 18, NW 1/4	15.50
Delavan Lake Outlet	Town of Delavan	T 2N, R16E, Sec. 20, SE 1/4	7.0
Turtle Creek	Town of Richmond	T 3N, R15E, Sec. 14, NE 1/4	13.00
Mason Creek	Town of Erin	T 9N, R18E, Sec. 30, NW 1/4	5.20
Sharon Creek	(Intermittent in the Region)		
Piscasaw Creek	Town of Walworth	T 1N, R16E, Sec. 19, SW 1/4	2.20
Scuppernong Creek	Town of Ottawa	T 6N, R17E, Sec. 14, SE 1/4	13.20
Rubicon River	Town of Polk	T10N, R19E, Sec. 7, NW 1/4	5.70
Ashippun River	Town of Hartford	T10N, R18E, Sec. 26, NE 1/4	19.10
Oconomowoc River	Town of Richfield	T 9N, R19E, Sec. 10, NE 1/4	23.40
Bark River	Town of Richfield	T 9N, R19E, Sec. 25, NE 1/4	27.10
Whitewater Creek	Town of Whitewater	T 4N, R15E, Sec. 26, NW 1/4	4.3
Jackson Creek	Town of Geneva	T 2N, R17E, Sec. 9, SW 1/4	7.0

Source: SEWRPC.

Table 299

AREAL EXTENT OF CIVIL DIVISIONS IN THE ROCK RIVER WATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Walworth County			
Cities			
Delavan	3.19	0.52	100.00
Elkhorn	2.53	0.41	60.24
Whitewater	4.15	0.68	100.00
Villages			
Darion	0.65	0.11	100.00
Fontana	0.22	0.04	5.95
Sharon	0.87	0.14	100.00
Walworth	1.07	0.17	89.92
Williams Bay	0.26	0.04	8.90
Towns			
Darion	35.14	5.74	100.00
Delaven	31.34	5.12	98.34
Geneva	11.45	1.87	35.19
Lafeyette	0.06	0.01	0.17
LaGrange	7.52	1.23	21.11
Linn	2.23	0.36	6.63
Richmond	35.58	5.81	99.08
Sharon	35.74	5.83	100.00
Sugar Creek	8.53	1.39	24.46
Walworth	27.71	4.52	91.33
Whitewater	30.82	5.03	96.77
County Subtotal	239.06	39.03	41.47
Washington County			
City			
Hartford	2.53	0.41	100.00
Village			
Slinger	1.80	0.29	100.00
Towns			
Addison	36.21	5.91	99.67
Barton	1.32	0.22	6.33
Erin	36.41	5.94	100.00
Hartford	34.18	5.58	100.00
Polk	9.95	1.62	28.97
Richfield	28.58	4.67	79.15
Wayne	26.74	4.37	74.30
West Bend	0.96	0.16	4.66
County Subtotal	178.68	29.18	41.01

Table 299 (continued)

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Waukesha County			
Cities			
Delafield	10.29	1.68	98.09
Oconomowoc	5.49	0.90	100.00
Villages			
Chenequa	4.63	0.75	100.00
Dousman	0.77	0.13	100.00
Eagle	0.04	0.01	4.08
Hartland	2.66	0.43	92.04
Lac La Belle	0.48	0.08	100.00
Merton	2.27	0.37	100.00
Nashotah	1.63	0.27	100.00
Oconomowoc Lake	3.13	0.51	100.00
Wales	1.37	0.22	60.62
Towns			
Delafield	7.22	1.18	32.95
Eagle	14.89	2.43	42.13
Genesee	4.01	0.65	12.39
Lisbon	12.06	1.97	35.82
Merton	27.34	4.46	95.03
Oconomowoc	33.57	5.48	100.00
Ottawa	32.59	5.32	91.16
Summit	30.23	4.94	100.00
County Subtotal	194.67	31.79	33.53
Total	612.41	100.00	--

Source: SEWRPC.

at 71,600 pounds of nitrogen, 5,700 pounds of phosphorus, 434,900 pounds of BOD_5, 2.9 x 10^{14} fecal coliform counts, and 4,880 tons of sediment during an average year. Table 301 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Rock River watershed, approximately 2,750 acres, or 1 percent of the total land surface is devoted to commercial activities. The estimated annual pollutant loading from commercial activities within the Rock River watershed are 24,800 pounds of nitrogen, 21,100 pounds of phosphorus, 268,400 pounds of biochemical oxygen demand, 9.1 x 10^{13} fecal coliform counts, and 1,030 tons of sediment. Table 302 presents the areal extent of commercial land uses within the Rock River watershed along with the estimated average annual diffuse source pollutant loads from these areas. There were no commercial lands under development in the Rock River watershed in 1975.

Industrial Activities: Industrial land uses cover 997 acres or less than 1 percent of the Rock River watershed. In addition, 118 acres, or less than 1 percent of the watershed, were under development for industrial land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. The industrial activities within the Rock River watershed excluding land under development are estimated to contribute annually 8,400 pounds of nitrogen, 700 pounds of phosphorus, 36,800 pounds of BOD_5, 6.2 x 10^{13} fecal coliform counts, and 490 tons of sediment to surface runoff. Table 303 presents the areal extent of the industrial uses within the Rock River watershed along with the estimated average annual diffuse source pollutant loadings from these activities.

There are 16 sanitary landfill operations within the Rock River watershed occupying a total of 244 acres or less than 1 percent of the drainage area. These

Table 300

ESTIMATED POPULATION OF THE ROCK RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Walworth County	
Darien Town	1,461
Darien Village	1,014
Delavan City	5,786
Delavan Town (Part)	3,935
Elkhorn City (Part)	1,789
Fontana on Geneva Lake Village (Part)	168
Geneva Town (Part)	1,124
LaFayette Town (Part)	7
LaGrange Town (Part)	164
Linn Town (Part)	44
Richmond Town (Part)	1,357
Sharon Town	1,070
Sharon Village	1,301
Sugar Creek Town (Part)	219
Walworth Town (Part)	1,269
Walworth Village (Part)	1,640
Whitewater City	9,247
Whitewater Town (Part)	1,267
Williams Bay Village (Part)	14
Walworth County Subtotal	32,876
Washington County	
Addison Town (Part)	2,669
Barton Town (Part)	209
Erin Town	1,950
Hartford City	7,225
Hartford Town	2,619
Polk Town (Part)	777
Richfield Town (Part)	6,149
Slinger Village	1,548
Wayne Town (Part)	973
West Bend Town (Part)	110
Washington County (Part) Subtotal	24,229
Waukesha County	
Chenequa Village	547
Delafield City (Part)	3,440
Delafield Town (Part)	893
Dousman Village	768
Eagle Town (Part)	234
Eagle Village (Part)	0
Genesee Town (Part)	418
Hartland Village (Part)	3,620
Lac La Belle Village	216
Lisbon Town (Part)	509
Merton Town (Part)	4,782
Merton Village	799
Nashotah Village	623
Oconomowoc City	10,337
Oconomowoc Town	6,194
Oconomowoc Lake Village	563
Ottawa Town (Part)	1,672
Summit Town	3,632
Wales Village (Part)	982
Waukesha County (Part)	40,229
Rock River Watershed Total	97,334

Source: Wisconsin Department of Administration and SEWRPC.

are included, along with their estimated pollutant loading rates, on Table 303. The landfill operations have an estimated annual pollutant load of 2,100 pounds of nitrogen, 200 pounds of phosphorus, 9,000 pounds of BOD_5, 1.5 x 10^{13} fecal coliform counts, and 120 tons of sediment.

In addition, there are also six auto salvage and wrecking facilities which are included in this analysis of industrial activities.

Extractive Activities: There were 1,595 acres or less than 1 percent of the total watershed area in extractive mining operations, consisting of gravel pits and attendant washing operations, in the Rock River watershed as of 1975. These operations contribute an estimated 95,700 pounds of nitrogen, 71,800 pounds of phosphorus, 191,400 pounds of BOD_5, and 119,630 tons of sediment annually. Table 304 presents the extent of the extraction operations and the estimated attendant diffuse source pollutant loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, airfields. In addition, 479 acres, or less than 1 percent of the watershed, were under development for transportation land use and are included as pollution sources under the land under development category, because of the increased loadings from land undergoing conversion from rural to urban use. Table 305 presents the estimated pollutant contributions excluding land under development from the 1,261 acres, or less than 1 percent of the total watershed area which is devoted to these land uses. It is estimated that 27,600 pounds of nitrogen, 2,000 pounds of phosphorus, 177,000 pounds of BOD_5, 7.3 x 10^{13} fecal coliform counts, and 23,610 tons of sediment are transported annually from transportation related activities within the Rock River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 2,567 acres, or approximately 1 percent of the total area of the watershed, and 14 golf courses with a total area of 1,665 acres, or less than 1 percent of the total area of the watershed. In addition, 20 acres, or less than 1 percent of the watershed, were under development for recreational land use and are included as pollution sources under development category, because of the increased loadings from land undergoing conversion from rural to urban use. Map 75 indicates the location of public and private golf courses and major parks within the Rock River watershed as of 1975. Table 306 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source

Table 301

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	17,896	4.09	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	4.0 0.32 24.3 1.6×10^{10} counts/a/yr. 545	71,580 5,730 434,870 2.9×10^{14} counts/yr. 4,875 tons

Source: SEWRPC.

Table 302

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial.	2,750	0.63	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	9.0 0.75 97.6 3.3×10^{10} counts/a/yr. 745	24,750 2,060 268,400 9.1×10^{13} counts/yr. 1,025 tons

Source: SEWRPC.

Table 303

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	997	0.22	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.4 0.70 36.9 6.2×10^{10} counts/a/yr. 977	8,370 700 36,790 6.2×10^{13} counts/yr. 485 tons
Landfill	244	0.06	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.4 0.70 36.9 6.2×10^{10} counts/a/yr. 977	2,050 170 9,000 1.5×10^{13} counts/yr. 120 tons
Total	1,241	0.28	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	- - - - - - - - - -	10,420 870 45,790 7.7×10^{13} counts/yr. 605 tons

Source: SEWRPC.

Table 304

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive	1,595	0.36	Total Nitrogen	60	95,700
			Total Phosphorus	45	71,780
			Biochemical Oxygen Demand	120	191,400
			Fecal Coliform	--	--
			Sediment	150,000	119,625 tons

Source: SEWRPC.

Table 305

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	1,096	0.25	Total Nitrogen	23.4	25,650
			Total Phosphorus	1.4	1,530
			Biochemical Oxygen Demand	159	174,260
			Fecal Coliform	6.7×10^{10} counts/a/yr.	7.3×10^{13} counts/yr.
			Sediment	42,600	23,345 tons
Air Fields	165	0.04	Total Nitrogen	12	1,980
			Total Phosphorus	2.7	450
			Biochemical Oxygen Demand	17.6	2,900
			Fecal Coliform	Negligible	--
			Sediment	3,200	265 tons
Total	1,261	0.29	Total Nitrogen	--	27,630
			Total Phosphorus	--	1,980
			Biochemical Oxygen Demand	--	177,170
			Fecal Coliform	--	7.3×10^{13} counts/yr.
			Sediment	--	23,610 tons

Source: SEWRPC.

Table 306

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation	2,567	0.59	Total Nitrogen	2.3	5,900
			Total Phosphorus	0.06	150
			Biochemical Oxygen Demand	1.3	3,340
			Fecal Coliform	3.6×10^{9} counts/a/yr.	9.2×10^{12} counts/yr.
			Sediment	420	540 tons
Golf Courses	1,665	0.38	Total Nitrogen	4.4	7,330
			Total Phosphorus	0.20	330
			Biochemical Oxygen Demand	1.3	2,170
			Fecal Coliform	--	--
			Sediment	420	350 tons
Total	4,232	0.97	Total Nitrogen	--	13,230
			Total Phosphorus	--	490
			Biochemical Oxygen Demand	--	5,500
			Fecal Coliform	--	9.2×10^{12} counts/yr.
			Sediment	--	890 tons

Source: SEWRPC.

pollutants excluding land under development transported from these land uses. It is estimated that 13,200 pounds of nitrogen, 500 pounds of phosphorus, 5,500 pounds of BOD_5, 9.2 x 10^{12} fecal coliform counts, and 890 tons of sediment are transported from parks and golf courses within the Rock River watershed annually.

Land Under Development: The Rock River watershed is undergoing conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 4,989 acres, or 1 percent of the total land area of the watershed. Similarly, an estimated 118 acres, or less than 1 percent of the total area of the watershed was under development for industrial land uses in 1975. No commercial related lands were under development in the watershed in 1975. However, 479 acres, or less than 1 percent of the total land area of the watershed, were under development for transportation related land uses, and 20 acres, or less than 1 percent of the total land area of the watershed, were under development for recreation related land uses. It is estimated that 336,400 pounds of nitrogen, 252,300 pounds of phosphorus, 672,700 pounds of BOD_5, and 420,450 tons of sediment were transported from these construction sites in 1975. Table 307 presents the estimated acreage of land under conversion from rural to urban use within the Rock River watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were 30 known holding tanks and one mound system in the watershed, as shown on Map 46. Table 308 presents the estimated pollutant loadings from the approximately 14,699 septic tanks in the watershed as of 1975. It is estimated that 71,300 pounds of nitrogen, 16,800 pounds of phosphorus, 1,039,200 pounds of BOD_5, 180 tons of sediment, and 1.3 x 10^{15} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Rock River watershed.

Rural Land Used

Agricultural Activities: About 71 percent of the area of the Rock River watershed is devoted to agricultural land uses. Agricultural activities consist primarily

Table 307

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development. . .	4,989	1.14	Total Nitrogen	60	299,330
			Total Phosphorus	45	224,500
			Biochemical Oxygen Demand	120	598,660
			Fecal Coliform	--	--
			Sediment	150,000	374,175 tons
Industrial Land Under Development. . . .	118	0.03	Total Nitrogen	60	7,080
			Total Phosphorus	45	5,310
			Biochemical Oxygen Demand	120	14,160
			Fecal Coliform	--	--
			Sediment	150,000	8,850 tons
Transportation Land Under Development .	479	0.11	Total Nitrogen	60	28,740
			Total Phosphorus	45	21,560
			Biochemical Oxygen Demand	120	57,480
			Fecal Coliform	--	--
			Sediment	150,000	35,925 tons
Recreation Land Under Development. . .	20	0.00	Total Nitrogen	60	1,200
			Total Phosphorus	45	900
			Biochemical Oxygen Demand	120	2,400
			Fecal Coliform	--	--
			Sediment	150,000	1,500 tons
Total	5,606	1.28	Total Nitrogen	--	336,360
			Total Phosphorus	--	252,270
			Biochemical Oxygen Demand	--	672,720
			Fecal Coliform	--	--
			Sediment	--	420,450 tons

Source: SEWRPC.

Table 308

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE ROCK RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	14,699	50,942	Total Nitrogen	1.4	71,320
			Total Phosphorus	0.33	16,810
			Biochemical Oxygen Demand	20.4	1,039,220
			Fecal Coliform	2.5×10^{10} counts/capita/yr.	1.3×10^{15} counts/yr.
			Sediment	7.0	180 tons

Source: SEWRPC.

of domestic livestock operations and cropland. As of May, 1975, 692 significant domestic livestock operations with a total of 116,860 animals, or 67,300 equivalent animal units were known to exist within the watershed. Map 76 indicates the locations of these livestock operations. Of these operations, 244 were located within 500 feet of the identified stream system of the watershed. Table 309 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 1,911,300 pounds of nitrogen, 444,200 pounds of phosphorus, 7,483,800 pounds of BOD_5, 4.3 x 10^{16} fecal coliform counts, and 23,560 tons of sediment are transported from livestock operations within the Rock River watershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 310. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 16,407 acres, or 4 percent of the total area of the watershed, were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Rock River watershed are accordingly estimated at 77,100 pounds of nitrogen, 2,100 pounds of phosphorus, 157,500 pounds of BOD_5, and 26,250 tons of sediment. Table 310 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates, to the land surface in an average year within the watershed.

Approximately 60,200 acres, or 14 percent of the total area of the watershed were devoted to growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Rock River watershed are 54,200 pounds of nitrogen, 5,400 pounds of phosphorus, 577,900 pounds of BOD_5, and 96,320 tons of sediment.

Major row crops grown within the Rock River watershed are corn and soybeans, which were planted in 185,219 acres, or 42 percent of the total area of the watershed. As shown in Table 310, an estimated 4,278,600 pounds of nitrogen, 118,500 pounds of phosphorus, 3,537,700 pounds of BOD_5, and 592,700 tons of sediment are transported annually from the row crop acreage within the Rock River watershed.

Also, as shown in Table 310, specialty crops were grown on a total of 7,509 acres, or 2 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Rock River watershed are 173,500 pounds of nitrogen, 4,800 pounds of phosphorus, 225,300 pounds of BOD_5, and 37,550 tons of sediment.

About 774 acres of land within the watershed were in sod farms in 1975. Estimated average annual pollutant loading rates from these sod farms within the Rock River watershed are 700 pounds of nitrogen, 70 pounds of phosphorus, 1,600 pounds of BOD_5, and 270 tons of sediment.

Approximately 90 percent of the annual plowing of cropland is considered likely to have been tilled by conventional methods, using moldboard plows in the autumn and left uncovered through the winter months and early spring.

Irrigation of cropland, as well as of golf courses, was practiced within the watershed in 1975. The locations of the high-capacity wells which provide the water supply are shown on Map 47. The irrigation volumes are estimated at 4.77 million gallons per day (mgd). It has been estimated that corn receives up to 10 inches of irrigation water annually, vegetables receive 15 to 20 inches, sod receives approximately 18 inches, and golf courses receive varying amounts of irrigation water annually. Irrigation return flows are considered to be negligible in the watershed due to the careful practices of operators, as in the use of aerial spray methods of application used.

Table 309

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE ROCK RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	40,570	56,800	881,090	Total Nitrogen	28.4	1,613,120
				Total Phosphorus	6.6	374,880
				Biochemical Oxygen Demand	111.2	6,316,160
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	3.6×10^{16} counts/yr.
				Sediment	700.0	19,880 tons
Beef	6,980	6,980	78,922	Total Nitrogen	28.4	198,230
				Total Phosphorus	6.6	46,070
				Biochemical Oxygen Demand	111.2	776,180
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	4.5×10^{15} counts/yr.
				Sediment	700.0	2,445 tons
Hogs	4,560	1,830	22,979	Total Nitrogen	28.4	51,970
				Total Phosphorus	6.6	12,080
				Biochemical Oxygen Demand	111.2	203,500
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	1.2×10^{15} counts/yr.
				Sediment	700.0	640 tons
Horses	490	970	8,851	Total Nitrogen	28.4	27,550
				Total Phosphorus	6.6	6,400
				Biochemical Oxygen Demand	111.2	107,860
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	6.2×10^{14} counts/yr.
				Sediment	700.0	340 tons
Fowl	68,000	680	6,577	Total Nitrogen	28.4	19,310
				Total Phosphorus	6.6	4,490
				Biochemical Oxygen Demand	111.2	75,620
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	4.4×10^{14} counts/yr.
				Sediment	700.0	240 tons
Sheep	370	40	245	Total Nitrogen	28.4	1,140
				Total Phosphorus	6.6	260
				Biochemical Oxygen Demand	111.2	4,450
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	2.6×10^{13} counts/yr.
				Sediment	700.0	15 tons
Total	116,870	67,300	998,664	Total Nitrogen	--	1,911,320
				Total Phosphorus	--	444,180
				Biochemical Oxygen Demand	--	7,483,760
				Fecal Coliform	--	4.3×10^{16} counts/yr.
				Sediment	--	23,555

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

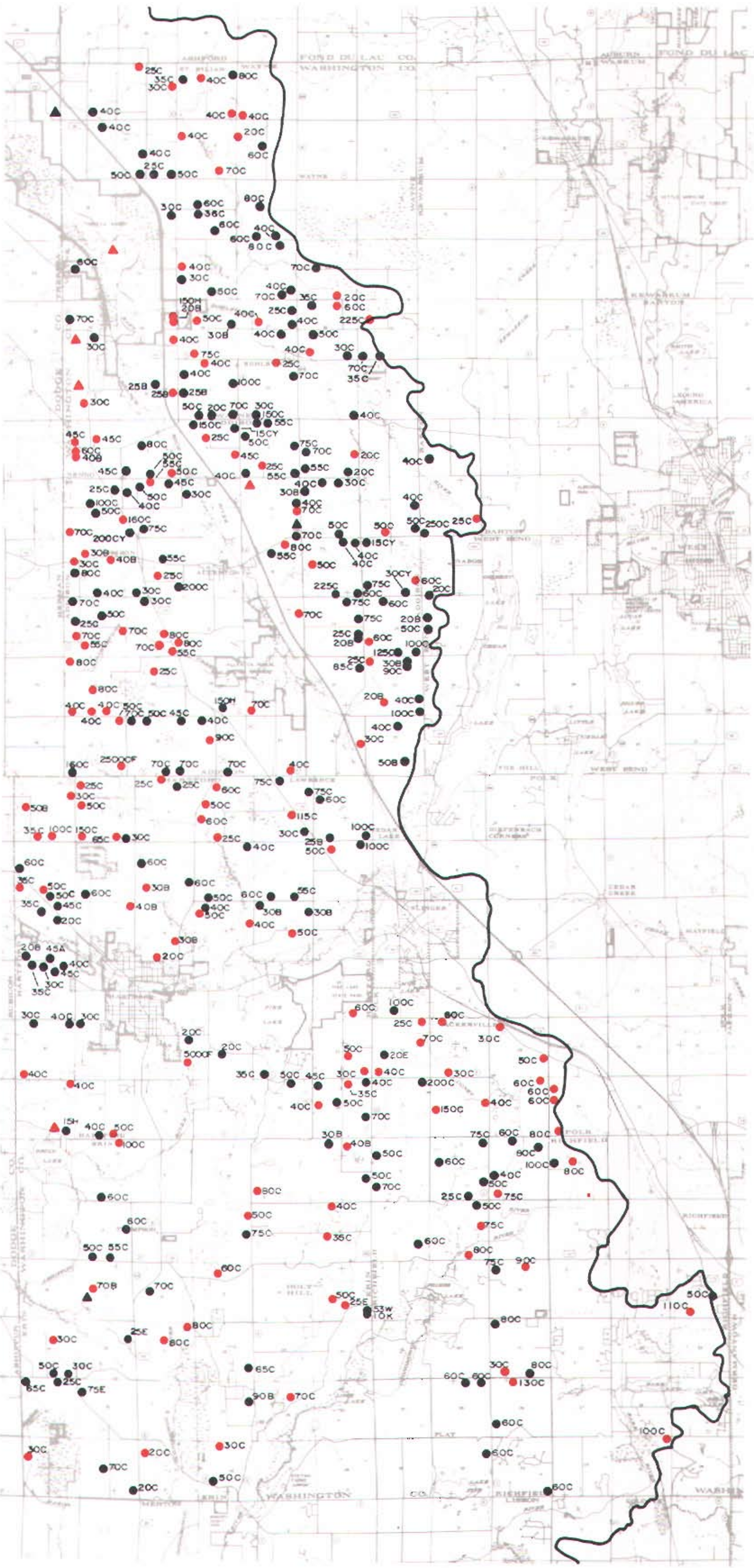
The third largest single land use category within the Rock River watershed is that of pasture land and other open space—which accounts for 41,777 acres, or approximately 10 percent of the total area of the watershed. Row and hay activities account for only slightly more. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 310. Annual loading rates from these areas are estimated at 192,200 pounds of nitrogen, 12,100 pounds of phosphorus, 405,200 pounds of BOD_5, and 8,780 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 728 farms covering about 85,254 acres, or 27 percent of the agricultural land within the watershed.

Map 76

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE ROCK RIVER WATERSHED IN 1975

Washington County



LEGEND

- ● (red) LIVESTOCK HERD LOCATED WITHIN 500 FEET OF A WELL-DEFINED STREAM
- ● (black) LIVESTOCK HERD LOCATED MORE THAN 500 FEET FROM A WELL-DEFINED STREAM

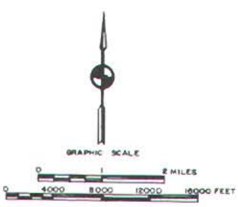
NUMBER OF ANIMALS IN HERD

TYPE OF ANIMAL:
- C - DAIRY CATTLE
- B - BEEF CATTLE
- E - HORSE
- F - FOWL
- M - MINK
- H - SWINE
- W - SHEEP
- K - GOAT
- Y - YOUNG ANIMAL

290CY

EROSION PROBLEMS

- ▲ (red) EROSION
- ▲ (black) FEEDLOT RUNOFF

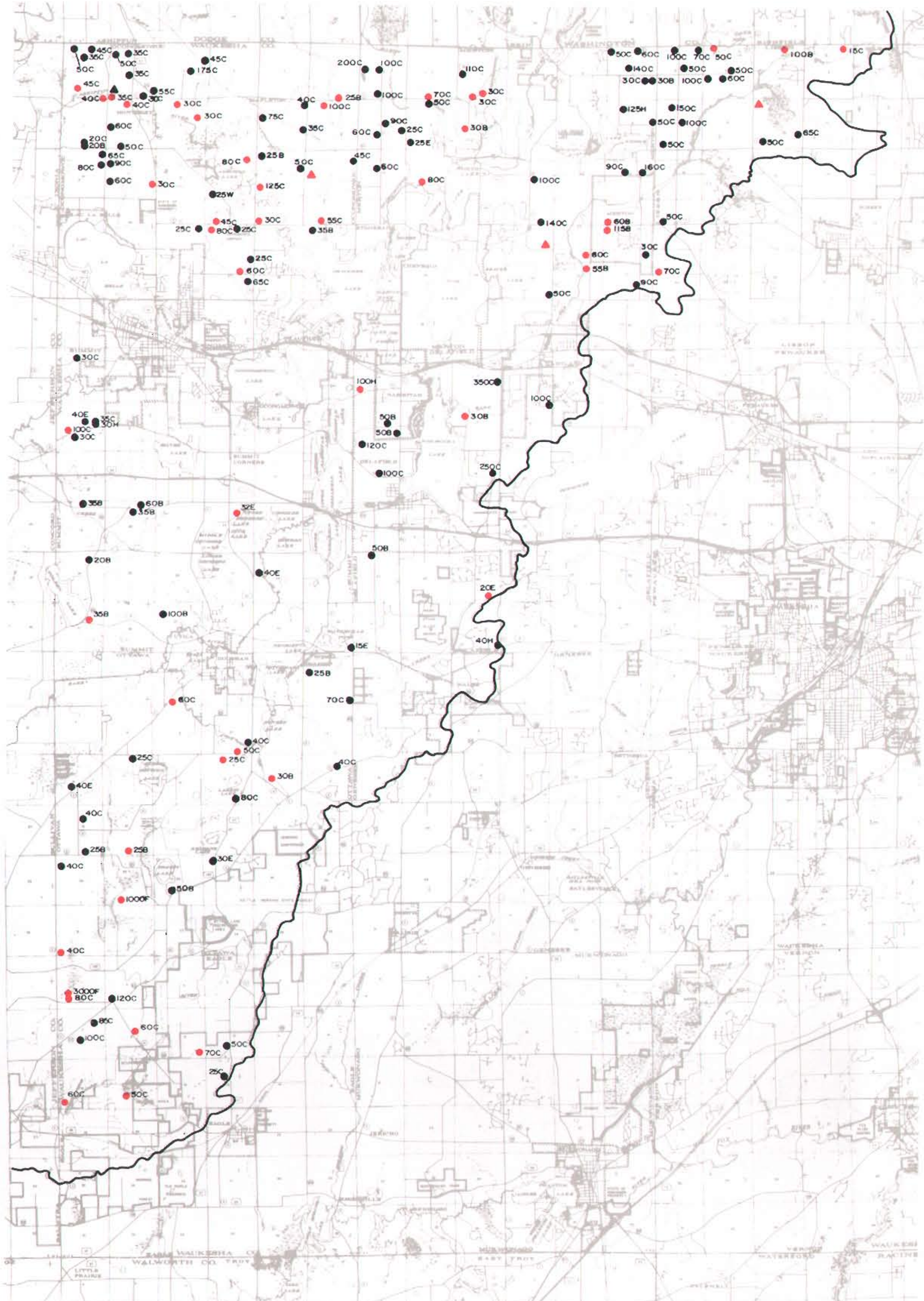


The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 692 operations within the Rock River watershed in 1975, 244 operations, or 35.3 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Map 76 (continued)

Waukesha County



Walworth County

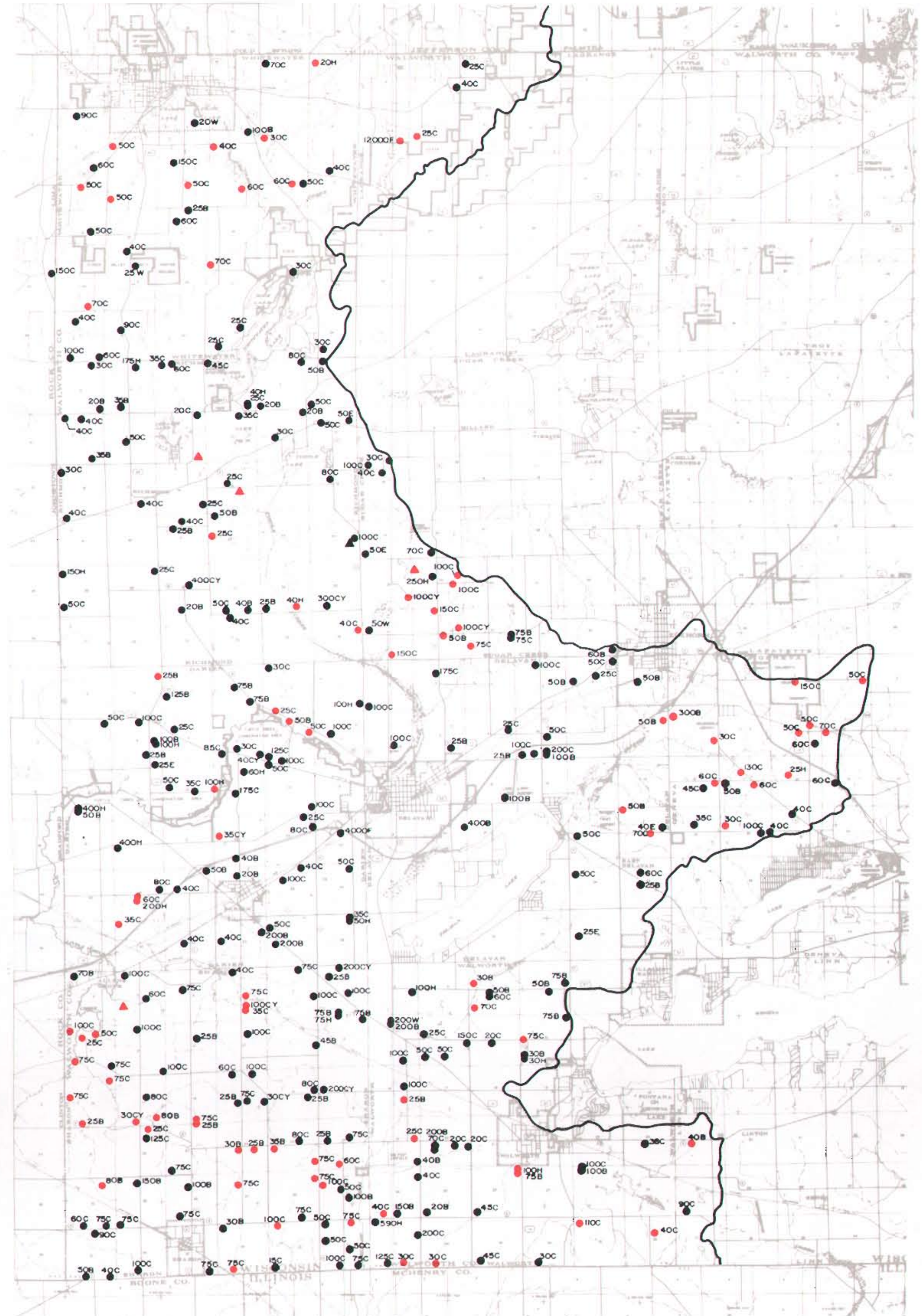


Table 310

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	16,407	3.75	Total Nitrogen	4.7	77,110
			Total Phosphorus	0.13	2,130
			Biochemical Oxygen Demand	9.6	157,510
			Fecal Coliform	Negligible	--
			Sediment	3,200	26,250 tons
Hay	60,200	13.76	Total Nitrogen	0.9	54,180
			Total Phosphorus	0.09	5,420
			Biochemical Oxygen Demand	9.6	577,920
			Fecal Coliform	Negligible	--
			Sediment	3,200	96,320 tons
Row	185,219	42.34	Total Nitrogen	23.1	4,278,560
			Total Phosphorus	0.64	118,540
			Biochemical Oxygen Demand	19.1	3,537,680
			Fecal Coliform	Negligible	--
			Sediment	6,400	592,700 tons
Specialty Crops –					
Vegetable and Other Agricultural Crops	7,509	1.72	Total Nitrogen	23.1	173,460
			Total Phosphorus	0.64	4,810
			Biochemical Oxygen Demand	30.0	225,270
			Fecal Coliform	Negligible	--
			Sediment	10,000	37,545 tons
Sod	774	0.18	Total Nitrogen	0.9	700
			Total Phosphorus	0.09	70
			Biochemical Oxygen Demand	2.1	1,630
			Fecal Coliform	Negligible	--
			Sediment	700	270 tons
Pasture and Other Open Space	41,777	9.55	Total Nitrogen	4.6	192,170
			Total Phosphorus	0.29	12,120
			Biochemical Oxygen Demand	9.7	405,240
			Fecal Coliform	Negligible	--
			Sediment	420	8,775 tons
Total	311,886	71.30	Total Nitrogen	--	4,776,180
			Total Phosphorus	--	143,080
			Biochemical Oxygen Demand	--	4,905,240
			Fecal Coliform	--	--
			Sediment	--	761,860 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

A total of 1,586 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 77.

Table 311 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $1,919,504, or an equivalent $6.80 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $5.15 per acre of agricultural land, or about 76 percent of the total investment were related to those practices directly affecting water quality. This represents about 34 percent of the estimated average cost per acre of agricultural land

Table 311

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE ROCK RIVER WATERSHED IN 1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	3,881 acres	10.00/acre	38,810.00
Interim Cover	310 acres	12.00/acre	3,720.00
Tree Stands	(265 units) (2 acres/unit) = 530 acres	100.00/acre	53,000.00
Wind Erosion Control	62,771 feet	0.60/foot	37,662.60
Wild Life Habitat	(242 units) (2 acres/unit) = 484 acres	25.00/acre	12,100.00
Permanent Vegetative Cover	2,052 acres	50.00/acre	102,600.00
Subtotal			247,892.60
Water Retention Practices			
Terracing	18,372 feet	0.70/foot	12,860.40
Farm Ponds	158 units	4,000.00/unit	632,000.00
Subtotal			644,860.40
Flow Control Practices			
Diversions	43,655 feet	1.25/foot	54,568,75
Open Drains	114,126 feet	2.25/foot	256,783.50
Runoff Control Structures	9 units	2,500.00/unit	22,500.00
Runoff Control Measures	106,789 feet	1.00/foot	106,789.00
Streambank Stabilization	253 feet	3.50/foot	885.50
Subtotal			441,526.75
Crop Production Practices			
Liming	1,332 acres	20.00/acre	26,640.00
Tiling	610,777 feet	0.70/foot	433,843.90
Mulching	79 acres	60.00/acre	4,740.00
Subtotal			465,223.90
Animal Waste Facilities	5 units	24,000.00/unit	120,000.00
Watershed Total			$1,919,503.65

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service, and SEWRPC.

to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

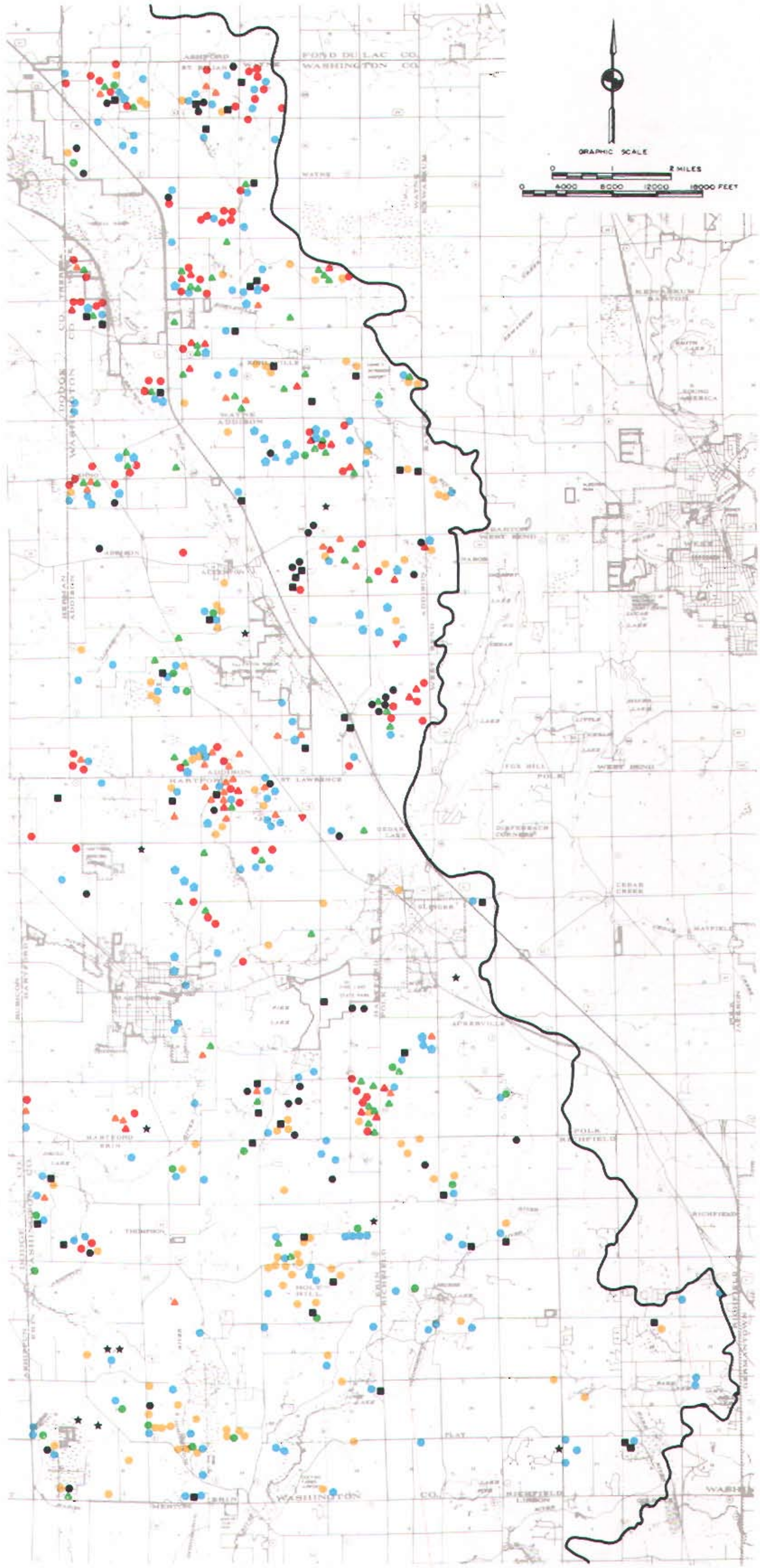
Silvicultural Activities: About 41,366 acres, or approximately 9 percent of the total area of the watershed were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 312 presents the acreage of silvicultural activities within the Rock River watershed and the estimated loading rates from these activities. About 95,100 pounds of nitrogen, 5,800 pounds of phosphorus, 190,300 pounds of BOD_5, 2.7 x 10^{13} fecal coliform counts, and 5,190 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 14,256 acres, or 3 percent of the total area of the watershed is covered by surface water in the form of ponds, lakes, and streams. As indicated in Table 313, 126,900 pounds of nitrogen, 7,100 pounds of phosphorus, 2,309,500 pounds of BOD_5, and 4,750 tons of sediment can be expected to be contributed to the surface waters of the Rock River watershed annually by atmospheric dry fall and washout.

Map 77

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE ROCK RIVER WATERSHED IN 1975

Washington County



LEGEND

VEGETATIVE COVER PRACTICES

- STRIPCROPPING
- INTERIM COVER
- TREE PLANTING
- WIND EROSION CONTROL
- WILDLIFE HABITAT
- PERMANENT VEGETATIVE COVER

WATER RETENTION PRACTICES

- TERRACING
- LAND SHAPING AND GRADING
- FARM PONDS

FLOW CONTROL PRACTICES

- DIVERSION
- OPEN DRAIN
- RUNOFF CONTROL STRUCTURES
- RUNOFF CONTROL MEASURES
- STREAMBANK STABILIZATION

CROP PRODUCTION PRACTICES

- LIMING
- TILING
- MULCHING

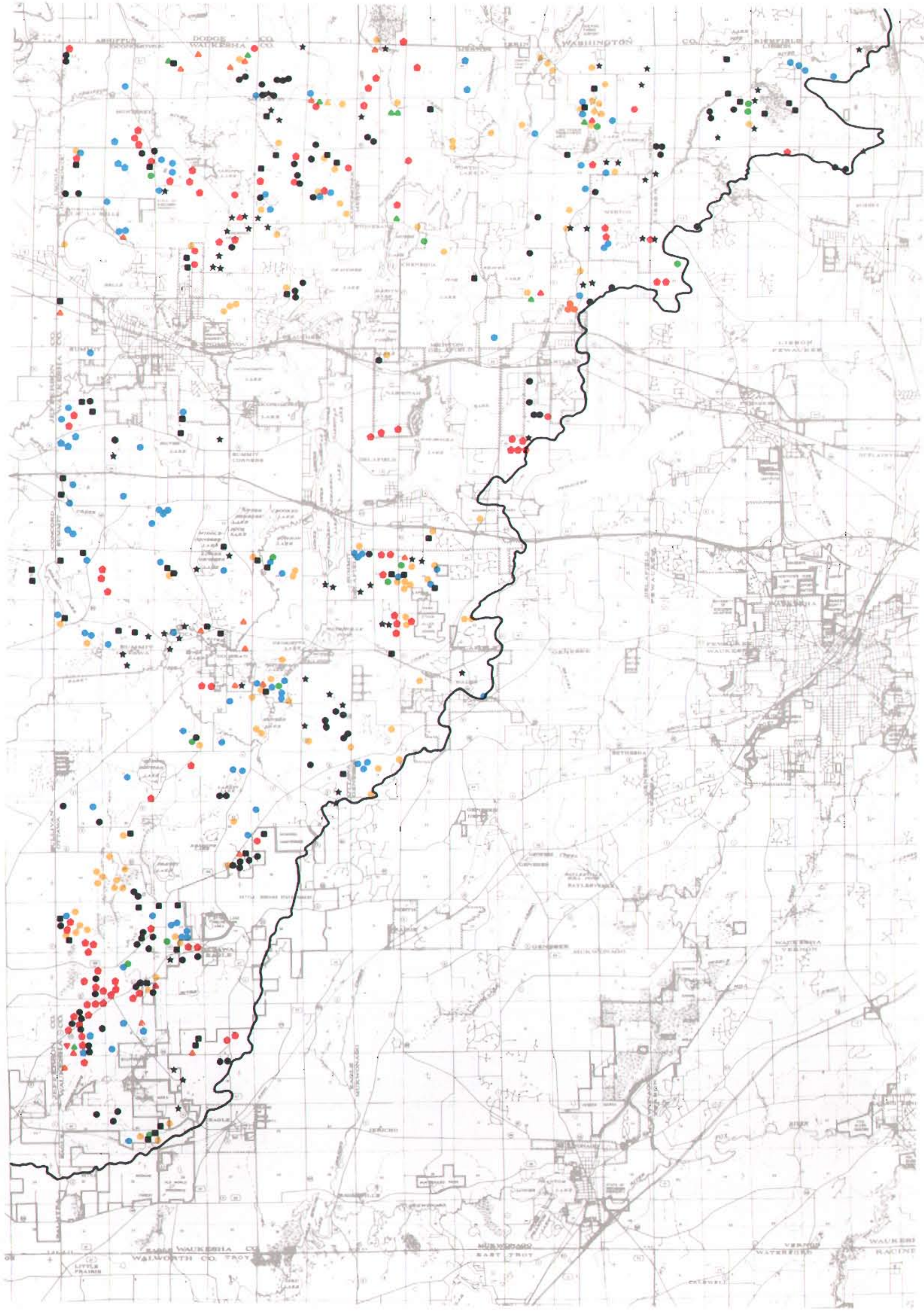
OTHER PRACTICES AND PROGRAMS

- ANIMAL WASTE FACILITY
- CROPLAND ADJUSTMENT PROGRAM

The above map illustrates the locations of the 1,586 known conservation practices installed in the Rock River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes other agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Waukesha County



Walworth County

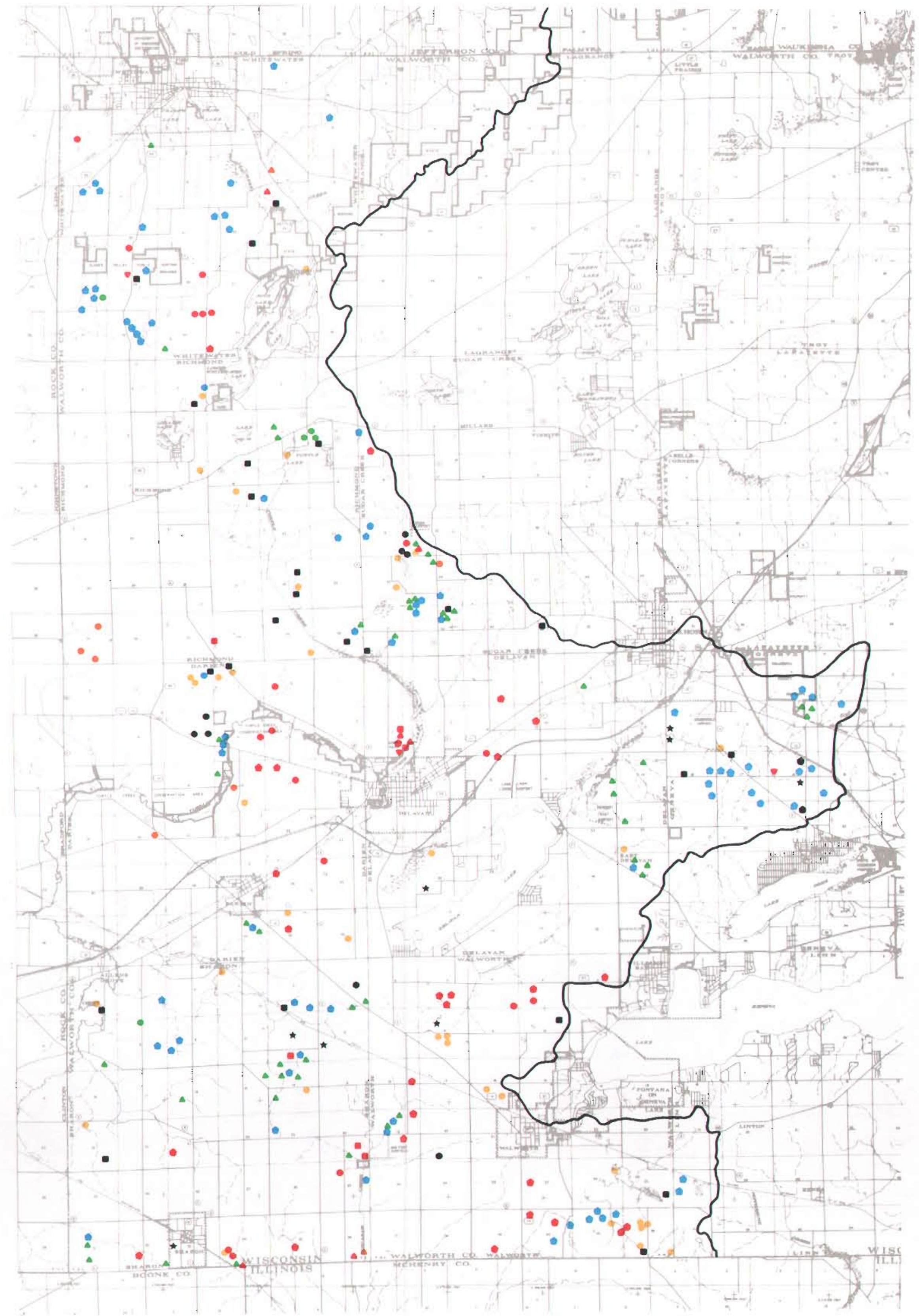


Table 312

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	40,949	9.36	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	2.3 0.14 4.6 6.6×10^{8} counts/a/yr. 251	94,180 5,730 188,370 2.7×10^{13} counts/yr. 5,140 tons
Orchard & Nursery	417	0.09	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	2.3 0.14 4.6 6.6×10^{8} counts/a/yr. 251	960 60 1,920 2.7×10^{11} counts/yr. 50 tons
Total	41,366	9.45	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	-- -- -- -- --	95,140 5,790 190,280 2.7×10^{13} counts/yr. 5,190 tons

Source: SEWRPC.

Table 313

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE ROCK RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streams and Lakes	14,256	3.25	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.9 0.5 162 Negligible 665	126,880 7,130 2,309,470 -- 4,740 tons

Source: SEWRPC.

A total of 35,360 acres, or 8 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Rock River watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Rock River Watershed

The Rock River watershed is primarily agricultural with storm water runoff from these lands contributing the largest diffuse source loads of nitrogen, and sediment, the second largest source of biochemical oxygen demand, and the third largest load of phosphorus. In addition, livestock operations contribute the largest diffuse source loads of phosphorus, biochemical oxygen demand, and fecal coliform. Other rural diffuse sources, inclusive of silvicultural activities and air pollution loadings to surface waters, contribute 2 percent or less of all diffuse source loads, except that air pollution contributes 13 percent of the biochemical oxygen demand load. Construction activities are the second largest diffuse source of phosphorus and sediment. Runoff from developed urban areas inclusive of residential, commercial, and industrial land uses, contributes less than 4 percent of all diffuse source pollutants. Total annual diffuse source loads are 7,560,500 pounds of nitrogen, 952,200 pounds of phosphorus, 17,723,800 pounds of biochemical oxygen demand, 4.5×10^{16} fecal coliform counts, and 1,366,605 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE ROOT RIVER WATERSHED

Physical Setting

The Root River watershed is a natural surface water drainage unit, 197 square miles in areal extent located in the east-central portion of the Region. The boundaries of the basin together with the locations of the main channels of the Root River and its principal tributaries are shown on Map 26. The main stem of the Root River originates in the City of New Berlin in Waukesha County and discharges to Lake Michigan through the City of Racine. The four principal tributaries of the watershed are Hoods Creek and the East and West Branches of the Root River Canal and the North Branch of the Root River. About 77 percent of the watershed is in rural land uses, with about 88 percent of this area still in agricultural use. Most of the agricultural related land use is located in the central and southwestern portion of the watershed. Map 78 sets forth the major land use categories and their spatial distributions within the Root River watershed as they were inventoried in 1975. Table 314 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north by the Menomonee and Kinnickinnic River watersheds, on the west by the subcontinental divide which separates the Fox River watershed from the Root, on the south by the Des Plaines and Pike River watersheds, and the east by the Oak Creek watershed and Lake Michigan. The streams of the Root River watershed include the North Branch of the Root River, Upper Creek, Hales Corners Creek, Tess Corners-Whitnall Creek, Ryan Creek, Root River Canal, East Branch of the Root River Canal, West Branch of the Root River Canal, the Root River Main Stem and Hoods Creek. Table 315 lists for the Root River watershed, each perennial stream reach, together with the location of the source and the length of the stream in miles. The watershed ranks fourth in size within the Region, but sixth in total resident population.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Root River watershed lies within Kenosha, Milwaukee, Racine, and Waukesha Counties and in parts of 18 cities, villages and towns. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976, are shown in Table 316. The 1975 resident population of the watershed is estimated at 152,431 persons, or approximately 8 percent of the estimated 1975 total regional population. Table 317 presents the population distribution in the Root River watershed by civil division.

Surface water in the Root River watershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water. The streamflow of the Root River has been measured since 1963 at three continuous flow recording gages by the U.S. Geological Survey in cooperation with the Racine and Waukesha County Boards, the Milwaukee Metropolitan Sewerage District and the Commission, the three gages being located 400 feet upstream from State Highway 100, 5.5 miles southeast of the intersection of U.S. 45 with State Highway 100 in the City of Franklin and 30 feet downstream from the State Highway 38 bridge in the City of Racine.

The soils within the Root River watershed are deep to moderately deep, brown to black silt loams in the eastern parts of Racine, Kenosha, and Milwaukee Counties. Brown to black prairie loam soils appear in the western areas of these counties. Soils in Waukesha County generally consist of grayish-brown rolling silt loams or gravelly to grayish-brown loams. Parts of Milwaukee County also consist of a clay type soil. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high levels of nutrients in stream waters, when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service or residential development without public sanitary sewer service, as shown on Maps 43, 44, and 45.

Urban Land Uses

Residential Activities: Residential land uses covered approximately 16,751 acres, or 13 percent of the watershed in 1975. In addition, there were about 2,332 acres or 2 percent of residential land use under development and are so reflected in the pollution loading rates in the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities, excluding land under development within the Root River watershed, are estimated at 67,000 pounds of nitrogen, 5,400 pounds of phosphorus, 407,100 pounds of BOD_5, 2.7 x 10^{14} fecal coliform counts, and 4,560 tons of sediment during an average year. Table 318 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Root River watershed, approximately 2,830 acres, or 2 percent, of the total land surface is devoted to commercial

Table 314

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE ROOT RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	26.17	16,751	13.42
Commercial[b]	4.42	2,830	2.27
Industrial			
Manufacturing	0.10	580	0.47
Landfill & Dump	0.42	271	0.22
Extractive	0.69	441	0.35
Transportation			
Streets & Highways	2.05	1,309	1.05
Airfields	0.37	237	0.19
Railroad Yards & Terminals	0.00	1	0.00
Recreation			
Golf Courses	3.79	2,424	1.94
Parks & Other Recreation	2.54	1,628	1.30
Land Under Development			
Residential Land Under Development[c]	3.64	2,332	1.87
Commercial Land Under Development	0.06	41	0.03
Industrial Land Under Development	--	--	--
Transportation Land Under Development	--	--	--
Recreation Land Under Development	0.07	46	0.00
Rural Land Use			
Agricultural			
Grain Crops	9.78	6,259	5.02
Hay	10.34	6,618	5.30
Row Crops	83.50	53,438	42.82
Specialty Crops	3.61	2,313	1.85
Sod Farm	0.55	349	0.28
Other Open Space[d]	23.86	15,272	12.24
Silvicultural			
Woodlands	9.46	6,054	4.85
Orchards & Nurseries	0.86	553	0.44
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	0.70	447	0.36
Wetlands, Swamps, & Marshes	7.17	4,590	3.68
Total	194.15	124,784	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the preliminary control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent. The final control total for the area of the Root River watershed is shown in Table 316.*

[b] *Includes: Retail, communication, utilities, administrative, and institutional.*

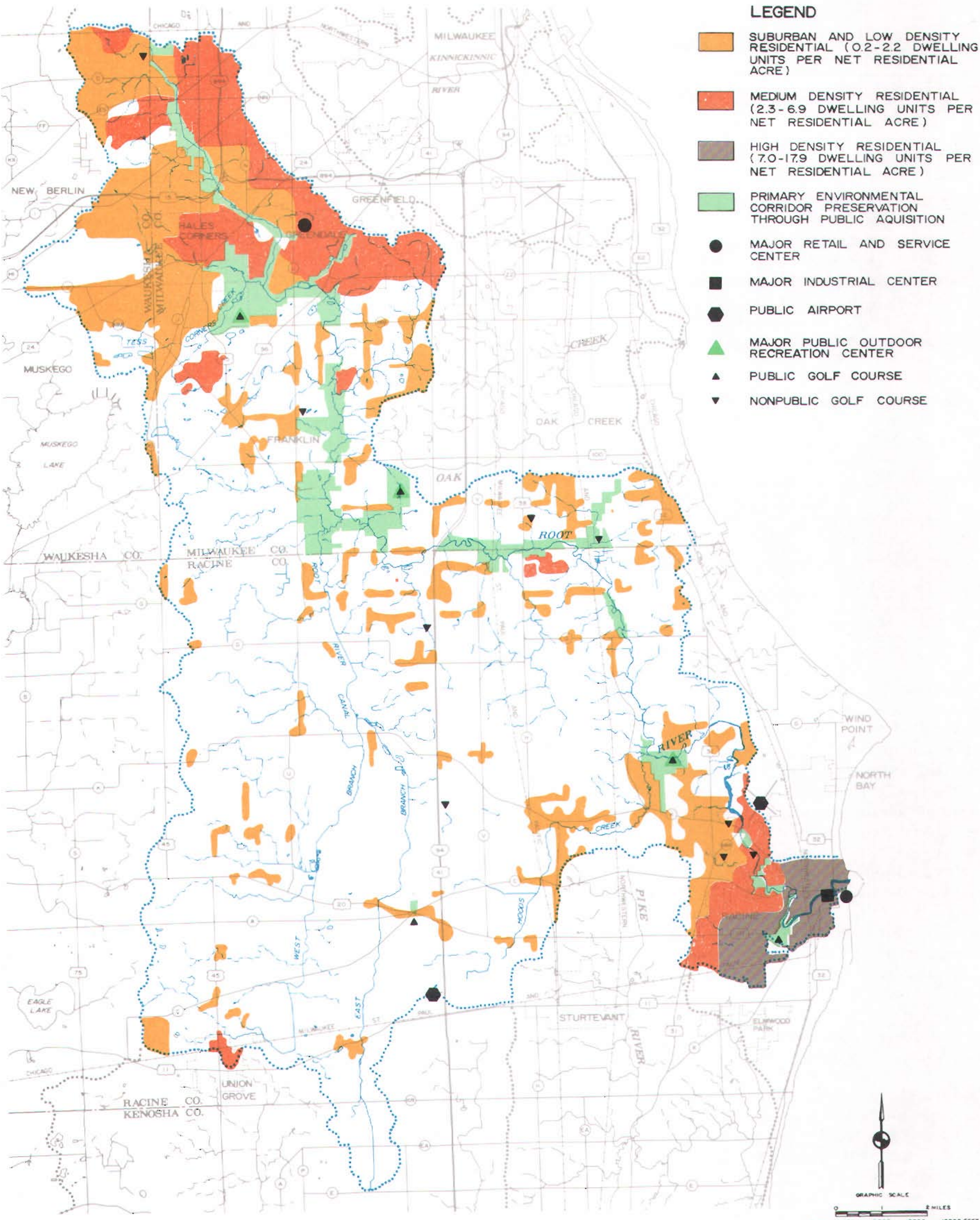
[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service; County Soil and Water Conservation Districts; University of Wisconsin Extension Service; and SEWRPC.

Map 78

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE ROOT RIVER WATERSHED IN 1975



As of 1975 more than 77 percent of the area of the Root River watershed was devoted to rural land uses. The dominant rural land use in the watershed was agricultural, which occupied 68 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural land use in the area drained by the South Branch; medium-density urban development in the area drained by the North Branch; rural and suburban development along the middle reaches of the main stem; and an intensive concentration of urban development in the form of the City of Racine in the lower reaches of the basin. There were 14 public or private golf courses and three major parks in the watershed, as well as segments of a major parkway.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 315

LENGTH OF STREAMS AND THEIR SOURCES WITHIN THE ROOT RIVER WATERSHED

Stream or Watercourse	Source: By Civil Division	Source: By U.S. Public Land Survey System	Length[a] (in miles)
North Branch of Root River	City of West Allis	T 6N, R21E, Sec. 7, NW 1/4	44.8
Upper Creek[b]	City of New Berlin	T 6N, R20E, Sec. 13, SW 1/4	2.3
Hales Corners Creek	Village of Hales Corners	T 6N, R21E, Sec. 31, SE 1/4	0.8
Tess Corners - Whitnall Park	City of Franklin	T 5N, R21E, Sec. 8, NW 1/4	3.3
Tributary (1) to West Branch of Root River[b]	City of Franklin	T 5N, R21E, Sec. 20, NW 1/4	1.6
Tributary to East Branch of Root River	City of Franklin	T 5N, R21E, Sec. 1, NE 1/4	2.4
Tributary (2) to West Branch of Root River[b]	City of Franklin	T 5N, R21E, Sec. 22, NW 1/4	0.6
Ryan Creek[b]	City of Franklin	T 5N, R21E, Sec. 28, NE 1/4	3.0
Root River Canal	Town of Raymond	T 4N, R21E, Sec. 23, SW 1/4	2.9
West Branch of Root River Canal	Village of Union Grove	T 3N, R21W, Sec. 29, NW1/4	10.6
Raymond Creek	Town of Raymond	T 4N, R21E, Sec. 22, NW 1/4	2.9
East Branch of Root River Canal	Town of Paris	T 2N, R21E, Sec. 11, SW 1/4	11.6
Husher Creek	Town of Caledonia	T 4N, R22E, Sec. 21, NW 1/4	3.4
Hoods Creek	Town of Mount Pleasant	T 3N, R22E, Sec. 19, NW 1/4	8.6

[a]*Total perennial stream length as shown on U. S. Geological Survey quadrangle maps.*

[b]*Intermittent streams*

Source: Wisconsin Department of Natural Resources (Shoreline Development Study), and SEWRPC.

activities. In addition, there were 41 acres, or less than 1 percent of the total watershed area, under development for commercial land uses in the Root River watershed. The pollution loading rate for commercial land under development are reflected in the land under development category. The estimated annual pollutant loadings from commercial activities excluding land under development within the Root River watershed are 25,500 pounds of nitrogen, 2,100 pounds of phosphorus, 276,200 pounds of biochemical oxygen demand, 9.3 x 10^{13} fecal coliform counts, and 1,060 tons of sediment. Table 319 presents the areal extent of commercial land uses within the Root River watershed along with the estimated average annual diffuse source pollutant loads from these areas.

Industrial Activities: Industrial land uses cover 580 acres or less than 1 percent of the Root River watershed. Excluding land under development, the industrial activities within the Root River watershed are estimated to contribute annually 4,900 pounds of nitrogen, 400 pounds of phosphorus, 21,400 pounds of BOD_5, 3.6 x 10^{13} fecal coliform counts, and 290 tons of sediment to surface runoff. Table 320 presents the areal extent of the industrial uses within the Root River watershed along with the estimated average annual diffuse source pollutant loadings from these activities. There was no industrial land under development in the Root River watershed.

There are nine sites of sanitary landfill operations within the Root River watershed occupying a total of 271 acres, or less than 1 percent of the drainage area. These are included, along with their estimated pollutant loading rates, on Table 320. The landfill operations have an estimated annual pollutant load of 2,300 pounds of nitrogen, 200 pounds of phosphorus, 10,000 pounds of BOD_5, 1.7 x 10^{13} fecal coliform counts, and 130 tons of sediment.

In addition, there were six auto salvage and wrecking facilities which are included in the analysis under industrial activities.

Extractive Activities: There were 441 acres or less than 1 percent of extractive mining operations, consisting of gravel pits and associated gravel washing operations, in the Root River watershed as of 1975. These operations contribute an estimated 26,500 pounds of nitrogen, 19,900 pounds of phosphorus, 52,900 pounds of BOD_5, and 33,080 tons of sediment annually. Table 321 presents the extent of the extractive operations and the estimated attendant diffuse source pollutant loadings.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, railroad yards and terminals, and airfields. Table 322 presents the estimated pollutant

Table 316

AREAL EXTENT OF CIVIL DIVISIONS IN THE ROOT RIVER WATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Kenosha County			
Town			
Paris	2.18	1.11	6.06
County Subtotal	2.18	1.11	0.78
Milwaukee County			
Cities			
Franklin	31.70	16.10	91.38
Greenfield	6.25	3.17	53.74
Milwaukee	1.04	0.53	1.08
Oak Creek	8.08	4.10	28.44
West Allis	2.95	1.50	25.92
Villages			
Greendale	5.46	2.77	98.02
Hales Corners	3.17	1.61	100.00
County Subtotal	58.65	29.79	24.17
Racine County			
City			
Racine	6.27	3.18	46.62
Village			
Union Grove	0.44	0.22	47.83
Towns			
Caledonia	36.18	18.37	77.54
Dover	2.57	1.30	7.11
Mt. Pleasant	13.70	6.96	36.58
Norway	0.10	0.05	0.28
Raymond	33.93	17.23	14.99
Yorkville	29.75	15.11	84.28
County Subtotal	122.94	62.45	36.12
Waukesha County			
Cities			
Muskego	3.90	1.98	10.82
New Berlin	9.20	4.67	24.28
County Subtotal	13.19	6.65	2.26
Total	196.87	100.00	--

Source: SEWRPC.

Table 317

ESTIMATED POPULATION OF ROOT RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Kenosha County	
Paris Town (Part)	62
Kenosha County (Part) Subtotal	62
Milwaukee County	
Franklin City (Part)	11,923
Greendale Village (Part)	16,349
Greenfield City (Part)	8,455
Hales Corners Village	8,773
Milwaukee City (Part)	8,376
Oak Creek City (Part)	3,014
West Allis City (Part)	13,254
Milwaukee County (Part) Subtotal	70,144
Racine County	
Caledonia Town (Part)	9,394
Dover Town (Part)	779
Mt. Pleasant Town (Part)	4,276
Norway Town (Part)	31
Racine City (Part)	43,286
Raymond Town (Part)	3,583
Union Grove Village (Part)	1,752
Yorkville Town (Part)	2,813
Racine County (Part) Subtotal	65,914
Waukesha County	
Muskego City (Part)	4,169
New Berlin City (Part)	12,142
Waukesha County (Part) Subtotal	16,311
Root River Watershed Total	152,431

Source: Wisconsin Department of Administration and SEWRPC.

contributions from the 1,548 acres, or 1 percent of the total watershed area which is devoted to these land uses. It is estimated that 33,500 pounds of nitrogen, 2,500 pounds of phosphorus, 212,300 pounds of BOD_5, 8.8 x 10^{13} fecal coliform counts, and 28,260 tons of sediment are transported annually from transportation related activities within the Root River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and indsutrial areas. The pollutant contributions from these types of streets are included within the land uses which they serve. There was no transportation land under development in the Root River watershed.

Recreational Activities: The major recreational facilities within the watershed as of 1975 included parks with a total area of 1,628 acres, or 1 percent of the total area of the watershed, and 14 golf courses with a total area of 2,424 acres, or 2 percent of the total area of the watershed. In addition, there were 46 acres, or less than 1 percent of the total watershed, for recreational land uses in the watershed in 1975. The pollution loading rates are reflected in the land under development category. Map 78 indicates the location of public and private golf courses and major parks within the Root River watershed as of 1975. Table 323 sets forth the acreage of parks and golf courses and the estimated amount of diffuse source pollutants, excluding land under development, transported from these land uses. It is estimated that 14,400 pounds of nitrogen, 600 pounds of phosphorus, 5,300 pounds of BOD_5, 5.9 x 10^{12} fecal coliform counts, and 850 tons of sediment are transported from parks and golf courses within the Root River watershed annually.

Land Under Development: The Root River watershed is undergoing conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 2,332 acres, or 2 percent of the total land area of the watershed. Forty-six acres, or less than 1 percent of total land area in recreational related lands and 41 acres, or less than 1 percent of total land area in commercial related lands, were under development in the watershed in 1975. It is estimated that 145,100 pounds of nitrogen, 108,900 pounds of phosphorus, 290,300 pounds of BOD_5, and 181,430 tons of sediment were transported from these construction sites in 1975. Table 324 presents the estimated acreage of land under conversion from rural to urban use within the Root River watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were 21 known holding tanks and five mound systems in the watershed, as shown on Map 46. Table 325 presents the estimated pollutant loadings from the approximately 6,686 septic tanks in the watershed as of 1975. It is estimated that 157,100 pounds of nitrogen, 36,380 pounds of phosphorus, 2,249,100 pounds of BOD_5, 385 tons of sediment, and 2.8 x 10^{15} fecal coliform counts are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Root River watershed.

Rural Land Uses

Agricultural Activities: About 68 percent of the area of the Root River watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As

Table 318

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	16,751	13.42	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	4.0 0.32 24.3 1.6×10^{10} counts/ac/yr. 545	67,000 5,360 407,050 2.7×10^{14} counts/yr. 4,565 tons

Source: SEWRPC.

Table 319

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial.	2,830	2.27	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	9.0 0.75 97.6 3.3×10^{10} counts/a/yr. 745	25,470 2,120 276,210 9.3×10^{13} counts/yr. 1,055 tons

Source: SEWRPC.

Table 320

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	580	0.47	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.4 0.70 36.9 6.2×10^{10} counts/a/yr. 977	4,880 410 21,400 3.6×10^{13} counts/yr. 285 tons
Landfill and Dump.	271	0.22	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	8.4 0.70 36.9 6.2×10^{10} counts/a/yr. 977	2,280 190 10,000 1.7×10^{13} counts/yr. 130 tons
Total	852	0.69	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	- - - - - - - - - -	7,150 600 31,400 5.3×10^{13} counts/yr. 415 tons

Source: SEWRPC.

Table 321

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM EXTRACTIVE LAND USES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Extractive.	441	0.35	Total Nitrogen	60	26,460
			Total Phosphorus	45	19,850
			Biochemical Oxygen Demand	120	52,920
			Fecal Coliform	Negligible	--
			Sediment	150,000	33,075 tons

Source: SEWPRC.

Table 322

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets and Highways	1,309	1.05	Total Nitrogen	23.4	30,630
			Total Phosphorus	1.4	1,830
			Biochemical Oxygen Demand	159	208,130
			Fecal Coliform	6.7×10^{10} counts/a/yr.	8.8×10^{13} counts/yr.
			Sediment	42,600	27,880 tons
Railroad Yards and Terminals	1	0.00	Total Nitrogen	8.4	10
			Total Phosphorus	1.17	0
			Biochemical Oxygen Demand	36.9	40
			Fecal Coliform	6.2×10^{10} counts/a/yr.	9.2×10^{10} counts/yr.
			Sediment	977	1 ton
Airfields.	237	0.19	Total Nitrogen	12	2,840
			Total Phosphorus	2.7	640
			Biochemical Oxygen Demand	17.6	4,170
			Fecal Coliform	Negligible	--
			Sediment	3,200	380 tons
Total	1,549	1.24	Total Nitrogen	--	33,480
			Total Phosphorus	--	2,470
			Biochemical Oxygen Demand	--	212,340
			Fecal Coliform	--	8.8×10^{13} counts/yr.
			Sediment	--	28,260 tons

Source: SEWRPC.

of May, 1975, 102 significant domestic livestock operations with a total of 94,060 animals, or 9,350 equivalent animal units were known to exist within the watershed. This figure does not include three duck farms with a total of 230,900 ducks or 2,309 equivalent animal units which are treated in the point sources section of this report because they have wastewater treatment plants. Map 79 indicates the locations of these livestock operations. Forty-seven of these operations were located within 500 feet of the identified stream system of the watershed. Table 326 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 265,500 pounds of nitrogen, 61,700 pounds of phosphorus, 1,039,700 pounds of BOD_5, 6.0×10^{15} fecal coliform counts, and 3,300 tons of sediment are transported from livestock operations within the Root River watershed annually.

Table 323

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Golf Courses	2,424	1.94	Total Nitrogen	4.4	10,670
			Total Phosphorus	0.20	480
			Biochemical Oxygen Demand	1.3	3,150
			Fecal Coliform	Negligible	--
			Sediment	420	510 tons
Parks and Other Recreation	1,628	1.30	Total Nitrogen	2.3	3,740
			Total Phosphorus	0.06	100
			Biochemical Oxygen Demand	1.3	2,120
			Fecal Coliform	3.6×10^{9} counts/a/yr.	5.9×10^{12} counts/yr.
			Sediment	420	340 tons
Total	4,052	3.24	Total Nitrogen	--	14,410
			Total Phosphorus	--	580
			Biochemical Oxygen Demand	--	5,270
			Fecal Coliform	--	5.9×10^{12} counts/yr.
			Sediment	--	850 tons

Source: SEWRPC.

Table 324

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development	2,332	1.87	Total Nitrogen	60	139,920
			Total Phosphorus	45	104,940
			Biochemical Oxygen Demand	120	279,840
			Fecal Coliform	Negligible	--
			Sediment	150,000	174,900 tons
Commercial Land Under Development	41	0.03	Total Nitrogen	60	2,460
			Total Phosphorus	45	1,850
			Biochemical Oxygen Demand	120	4,920
			Fecal Coliform	Negligible	--
			Sediment	150,000	3,075 tons
Recreational Land Under Development	46	0.04	Total Nitrogen	60	2,760
			Total Phosphorus	45	2,070
			Biochemical Oxygen Demand	120	5,520
			Fecal Coliform	Negligible	--
			Sediment	150,000	3,450 tons
Total	2,419	1.94	Total Nitrogen	--	145,140
			Total Phosphorus	--	108,860
			Biochemical Oxygen Demand	--	290,280
			Fecal Coliform	--	--
			Sediment	--	181,425 tons

Source: SEWRPC.

Table 325

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEM IN THE ROOT RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	6,686	27,562	Total Nitrogen	5.7	157,100
			Total Phosphorus	1.32	36,380
			Biochemical Oxygen Demand	81.6	2,249,060
			Fecal Coliform	1.0×10^{11} counts/capita/yr.	2.8×10^{15} counts/yr.
			Sediment	28.0	385 tons

Source: SEWRPC.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 327. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 6,260 acres, or 5 percent of the total area of the watershed were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Root River watershed are accordingly estimated at 29,400 pounds of nitrogen, 800 pounds of phosphorus, 60,100 pounds of BOD_5, and 10,000 tons of sediment. Table 327 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates to the land surface in an average year within the watershed.

Approximately 6,618 acres, or 5 percent of the total area of the watershed were devoted to growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Root River watershed are 6,000 pounds of nitrogen, 600 pounds of phosphorus, 63,500 pounds of BOD_5, and 10,600 tons of sediment.

Major row crops grown within the Root River watershed in 1975 were corn and soybeans, planted on about 53,438 acres, or 43 percent of the total area of the watershed. As shown in Table 327, an estimated 1,234,400 pounds of nitrogen, 34,200 pounds of phosphorus, 1,106,200 pounds of BOD_5, and 184,400 tons of sediment are transported annually from the row crop acreage within the Root River watershed.

Also, as shown in Table 327, specialty crops were grown on a total of about 2,313 acres, or 2 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Root River watershed are 53,400 pounds of nitrogen, 1,500 pounds of phosphorus, 69,400 pounds of BOD_5, and 11,570 tons of sediment.

About 349 acres, or less than 1 percent of land within the watershed, were in sod farms in 1975. Estimated average annual pollutant loading rates from these sod farms within the Root River watershed are 300 pounds of nitrogen, 30 pounds of phosphorus, 700 pounds of BOD_5, and 120 tons of sediment.

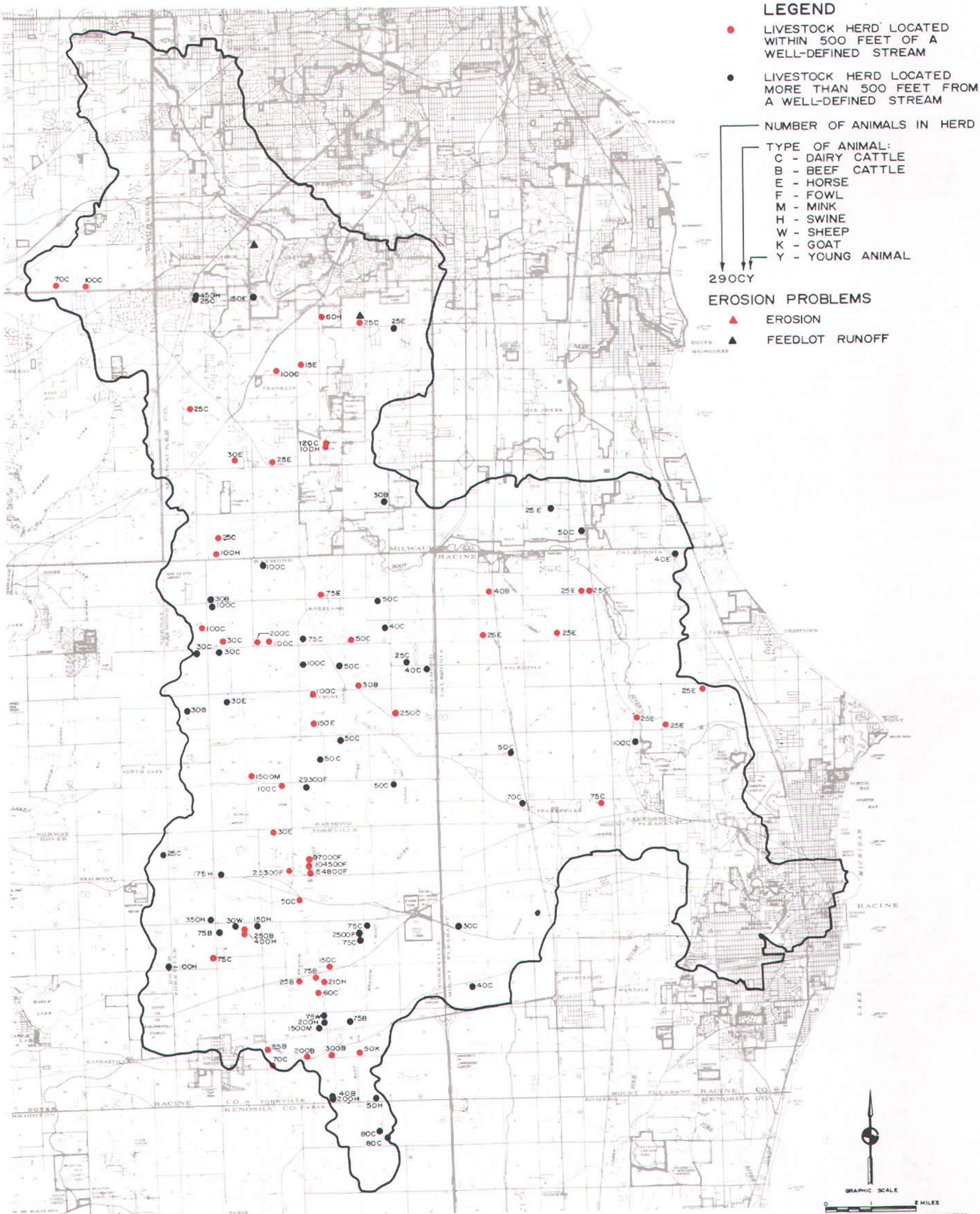
Irrigation of cropland, as well as of golf courses, was practiced within the watershed in 1975. The location of the high-capacity wells which provide the water supply are shown on Map 47. The irrigation volumes are estimated at 0.685 million gallons per day (mgd). It has been estimated that corn receives up to 10 inches of irrigation water annually, and vegetables receive varying amounts of irrigation water. Irrigation return flows are considered to be negligible in the watershed due to the careful practices of operators, as in the use of aerial spray methods of application.

The third largest single land use category within the Root River watershed is that of pasture land and other open space, which accounts for about 15,272 acres, or 12 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 327. Annual loading rates from these areas are estimated at 70,300 pounds of nitrogen, 4,400 pounds of phosphorus, 148,100 pounds of BOD_5, and 3,210 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 169 farms covering about 13,245 acres, or 16 percent of the agricultural land within the watershed.

A total of 285 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 80.

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE ROOT RIVER WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 102 operations within the Root River watershed in 1975, 47 operations, or 41.2 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 326

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE ROOT RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	3,325	4,650	72,133	Total Nitrogen	28.4	132,060
				Total Phosphorus	6.6	30,690
				Biochemical Oxygen Demand	111.2	517,080
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	3.0×10^{15} counts/yr.
				Sediment	700.0	1,630 tons
Beef	1,265	1,270	14,313	Total Nitrogen	28.4	36,070
				Total Phosphorus	6.6	8,380
				Biochemical Oxygen Demand	111.2	141,220
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	8.1×10^{14} counts/yr.
				Sediment	700.0	445 tons
Hogs	2,545	1,020	12,819	Total Nitrogen	28.4	28,970
				Total Phosphorus	6.6	6,730
				Biochemical Oxygen Demand	111.2	113,420
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	6.5×10^{14} counts/yr.
				Sediment	700.0	355 tons
Horses	770	1,540	14,053	Total Nitrogen	28.4	43,740
				Total Phosphorus	6.6	10,160
				Biochemical Oxygen Demand	111.2	171,250
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	9.9×10^{14} counts/yr.
				Sediment	700.0	540 tons
*Fowl	83,000	830	7,537	Total Nitrogen	28.4	23,570
				Total Phosphorus	6.6	5,480
				Biochemical Oxygen Demand	111.2	92,300
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	5.3×10^{14} counts/yr.
				Sediment	700.0	290 tons
Sheep	105	10	69	Total Nitrogen	28.4	280
				Total Phosphorus	6.6	70
				Biochemical Oxygen Demand	111.2	1,110
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	6.4×10^{12} counts/yr.
				Sediment	700.0	5 tons
Mink	3,000	30	274	Total Nitrogen	28.4	850
				Total Phosphorus	6.6	200
				Biochemical Oxygen Demand	111.2	3,340
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	1.9×10^{13} counts/yr.
				Sediment	700.0	10 tons
Goats	50	5	30	Total Nitrogen	28.4	--
				Total Phosphorus	6.6	--
				Biochemical Oxygen Demand	111.2	--
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	--
				Sediment	700.0	--
Total	94,060	9,350	121,228	Total Nitrogen	--	265,540
				Total Phosphorus	--	61,710
				Biochemical Oxygen Demand	--	1,039,720
				Fecal Coliform	--	6.0×10^{15} counts/yr.
				Sediment	--	3,275 tons

*Does not include 3 duck farms, with a total of 230,900 ducks, which have waste treatment processes and are included under the point source inventory.

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 327

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	6,260	5.02	Total Nitrogen	4.7	29,420
			Total Phosphorus	0.13	810
			Biochemical Oxygen Demand	9.6	60,100
			Fecal Coliform	Negligible	--
			Sediment	3,200	10,015 tons
Hay	6,618	5.30	Total Nitrogen	0.9	5,960
			Total Phosphorus	0.09	600
			Biochemical Oxygen Demand	9.6	63,530
			Fecal Coliform	Negligible	--
			Sediment	3,200	10,590 tons
Row	53,438	42.82	Total Nitrogen	23.1	1,234,420
			Total Phosphorus	0.64	34,200
			Biochemical Oxygen Demand	20.7	1,106,170
			Fecal Coliform	Negligible	--
			Sediment	6,900	184,360 tons
Specialty Crops—					
Vegetable and Other Agricultural Crops. .	2,313	1.85	Total Nitrogen	23.1	53,430
			Total Phosphorus	0.64	1,480
			Biochemical Oxygen Demand	30.0	69,390
			Fecal Coliform	Negligible	--
			Sediment	10,000	11,565 tons
Sod	349	0.28	Total Nitrogen	0.9	310
			Total Phosphorus	0.09	30
			Biochemical Oxygen Demand	2.1	730
			Fecal Coliform	Negligible	--
			Sediment	700	120 tons
Pasture	15,272	12.24	Total Nitrogen	4.6	70,250
			Total Phosphorus	0.29	4,430
			Biochemical Oxygen Demand	9.7	148,140
			Fecal Coliform	Negligible	--
			Sediment	420	3,210 tons
Total	84,250	67.51	Total Nitrogen	--	1,393,790
			Total Phosphorus	--	41,550
			Biochemical Oxygen Demand	--	1,448,050
			Fecal Coliform	--	--
			Sediment	--	219,860 tons

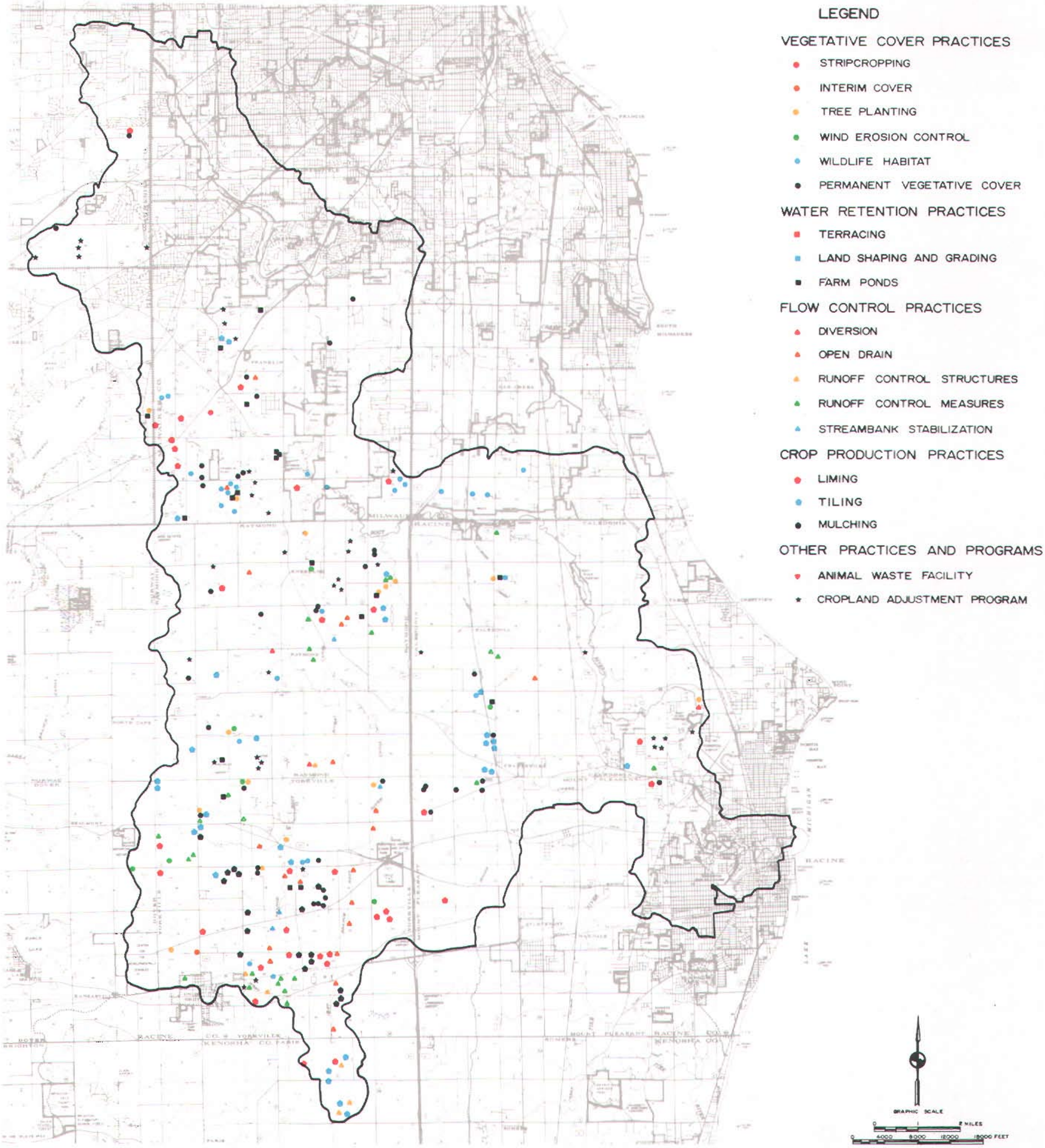
Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

Table 328 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $386,328, or an equivalent $4.59 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $3.49 per acre of agricultural land, or about 76 percent of the total investment were related to those practices directly affecting water quality. This represents about 23 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 6,606 acres, or approximately 5 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 329 presents the acreage of silvicultural activities within the Root River watershed

Map 80

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE ROOT RIVER WATERSHED IN 1975



The above map illustrates the locations of the 285 known conservation practices installed in the Root River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

Table 328

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE ROOT RIVER WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	14 acres	10.00/acre	140.00
Interim Cover	23 acres	12.00/acre	276.00
Tree Stands	(12 units) (2 acres/unit) = 24 acres	100.00/acre	2,400.00
Wind Erosion Control	13,067 feet	0.60/foot	7,840.20
Wildlife Habitat	(29 units) (2 acres/unit) = 58 acres	25.00/acre	1,450.00
Permanent Vegetative Cover	666 acres	50.00/acre	33,300.00
Subtotal			45,406.20
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	25 units	4,000.00/unit	100,000.00
Subtotal			100,000.00
Flow Control Practices			
Diversions	2,090 feet	1.25/foot	2,612.50
Open Drains	27,556 feet	2.25/foot	62,001.00
Runoff Control Structures	10 units	2,500.00/unit	25,000.00
Runoff Control Measures	49,342 feet	1.00/foot	49,342.00
Streambank Stabilization	2,725 feet	3.50/foot	9,537.50
Subtotal			148,493.00
Crop Production Practices			
Liming	932 acres	20.00/acre	18,640.00
Tiling	67,955 feet	0.70/foot	47,568.50
Mulching	437 acres	60.00/acre	26,220.00
Subtotal			92,428.50
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$386,327.70

Source: United States Department of Agriculture Soil conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

and the estimated loading rates from these activities. About 15,200 pounds of nitrogen, 900 pounds of phosphorus, 30,400 pounds of BOD_5, 4.4 x 10^{12} fecal coliform counts, and 830 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of about 447 acres, or less than 1 percent of the total area of the watershed is covered by surface water. As indicated in Table 330, 4,000 pounds of nitrogen, 200 pounds of phosphorus, 72,400 pounds of BOD_5, and 150 tons of sediment can be expected to be contributed to the surface waters of the Root River watershed annually by atmospheric dry fall and washout.

A total of 4,590 acres, or 4 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Root River watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Root River Watershed

The Root River watershed is generally agricultural although significant portions of its northern headwaters and the area near the mouth of the river are urban. Storm water runoff from agricultural land

Table 329

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams	447	0.36	Total Nitrogen	8.9	3,980
			Total Phosphorus	0.5	220
			Biochemical Oxygen Demand	162.0	72,410
			Fecal Coliform	Negligible	--
			Sediment	665.0	150 tons

Source: SEWPRC.

Table 330

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE ROOT RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	6,054	4.85	Total Nitrogen	2.3	13,920
			Total Phosphorus	0.14	850
			Biochemical Oxygen Demand	4.6	27,850
			Fecal Coliform	6.6×10^8 counts/a/yr.	4.0×10^{12} counts/yr.
			Sediment	251	760 tons
Orchards and Nurseries	553	0.44	Total Nitrogen	2.3	1,270
			Total Phosphorus	0.14	80
			Biochemical Oxygen Demand	4.6	2,540
			Fecal Coliform	6.6×10^8 counts/a/yr.	3.6×10^{11} counts/yr.
			Sediment	251.0	70 tons
Total	6,607	5.29	Total Nitrogen	--	15,200
			Total Phosphorus	--	930
			Biochemical Oxygen Demand	--	30,390
			Fecal Coliform	--	4.4×10^{12} counts/yr.
			Sediment	--	830 tons

Source: SEWRPC.

contributes the largest diffuse source load of nitrogen and sediment. Livestock operations are the largest diffuse source of fecal coliform in the watershed and the second largest diffuse source of nitrogen and phosphorus. Construction activities contribute the largest load of phosphorus from diffuse sources, and the second largest load of sediment. Onsite sewage disposal systems contribute the highest load of biochemical oxygen demand and the second largest load of fecal coliform. Runoff from developed urban areas, inclusive of residential, commercial, and industrial land uses, contributes from 2 to 9 percent of all pollutants except sediment, where the contribution from all three when land uses totals only 1 percent of the total diffuse source sediment load. Runoff from transportation, recreation, and silvicultural activities, and air pollution loadings to surface waters each contribute less than 6 percent of the total diffuse source load of any pollutant. Total annual diffuse source loads are 2,154,700 pounds of nitrogen, 280,600 pounds of phosphorus, 6,115,100 pounds of biochemical oxygen demand, 9.3×10^{15} fecal coliform counts, and 474,145 tons of sediment.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE SAUK CREEK WATERSHED

Physical Setting

The Sauk Creek watershed is a natural surface water drainage unit, 34 square miles in areal extent located in the northern portion of the Region. The boundaries of the basin together with the locations of the main channel of Sauk Creek are shown on Map 26. The main stem of Sauk Creek originates just north of the Region's boundary in the Town of Holland in southwest Sheboygan County and discharges to Lake Michigan at the harbor area in the City of Port Washington. About 94 percent of the watershed is in rural land uses, with about 95 percent of this area still in agricultural use. Most of the urban related land use is located in the southern portions of the watershed, near Fredonia where Sauk Creek discharges into Lake Michigan. Map 81 sets forth the major land use categories and their spatial distributions within the Sauk Creek watershed as they were inventoried in 1975. Table 331 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

The watershed is bounded on the north by the Sheboygan River watershed, on the west and south by the Milwaukee River watershed, and on the east by the Sucker Creek and Lake Michigan watershed. Table 332 lists for the Sauk Creek watershed, the major stream reach, together with the location of the source and the length of the stream in miles. The watershed ranks ninth in size within the Region, but eleventh in total resident population.

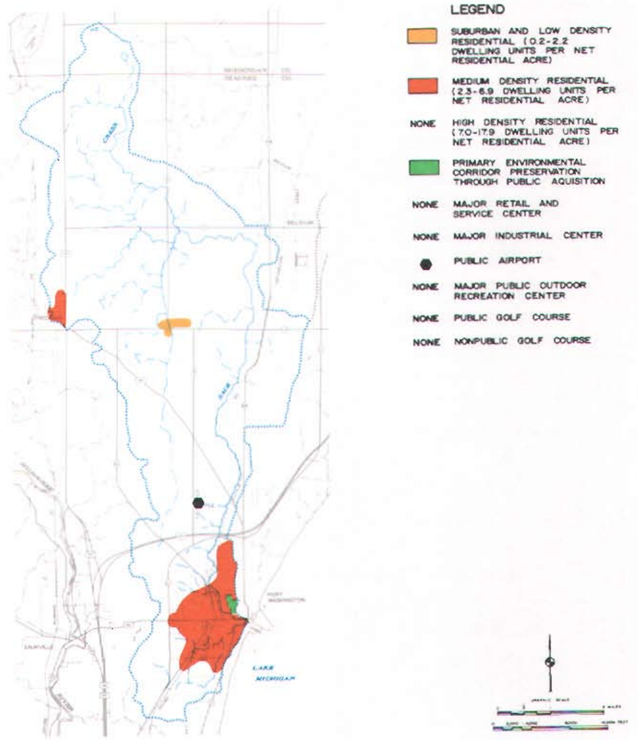
Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The in-region portion of the Sauk Creek watershed lies totally within Ozaukee County and within one city, two villages and five towns. Only a small area of approximately 560 acres extends into Sheboygan County. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976 are shown in Table 333. The 1975 resident population of the watershed is estimated at 7,377 persons, or approximately 1 percent of the estimated 1975 total regional population. Table 334 presents the population distribution in the Sauk Creek watershed by civil division.

Surface water in the Sauk Creek watershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water. No streamflow data are known to be collected on a continuing basis from Sauk Creek. The soils within the Sauk Creek watershed consist of deep to moderately deep, brown to black silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils' properties as shown in Maps 43, 44, and 45, much of the watershed area exhibits severe or very severe limitations for residential development with public sanitary sewer service or residential development without public sanitary sewer service on lots smaller than one acre in size. For residential development without public sanitary sewer service on lots one acre or larger in size, some areas are

Map 81

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE SAUK CREEK WATERSHED IN 1975



As of 1975 more than 94 percent of the area of the Sauk Creek watershed was devoted to rural land uses. The dominant rural land use in the watershed was agricultural, which occupied 87 percent of the watershed area. The overall spatial distribution was characterized by rural land uses with a concentration of urban development in and around the City of Port Washington. There were no major parks or golf courses in the watershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

suitable for development. However, severely limited or very severely limited conditions persist in most areas.

Urban Land Uses

Residential Activities: Residential land uses cover approximately 597 acres, or 3 percent of the watershed. In addition, there are 45 acres of residential

Table 331

AREAL EXTENT OF WATER QUALITY RELATED LAND USES
IN THE SAUK CREEK WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	0.93	597	2.70
Commercial[b]	0.34	218	0.99
Industrial			
Manufacturing	0.20	128	0.58
Landfill & Dump	0.02	12	0.05
Extractive	--	--	--
Transportation			
Streets & Highways	0.19	118	0.54
Airfields	0.09	57	0.26
Railroad Yards	--	--	--
Recreation			
Golf Courses	--	--	--
Parks & Other Recreation	0.13	72	0.33
Land Under Development			
Residential Land Under Development[c]	0.07	45	0.20
Commercial Land Under Development	--	--	--
Industrial Land Under Development	0.02	10	0.05
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	4.16	2,665	12.06
Hay	9.53	6,099	27.60
Row Crops	12.93	8,275	37.43
Specialty Crops	1.84	1,178	5.33
Sod Farm	--	--	--
Other Open Space[d]	1.67	1,070	4.84
Silvicultural			
Woodlands	1.34	859	3.89
Orchards & Nurseries	0.17	110	0.50
Natural and Manmade Water Area—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	0.03	18	0.08
Wetlands, Swamps, & Marshes	0.88	563	2.55
Total	34.54[e]	22,094	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2,000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

[e] *The total area of the Sauk Creek watershed represented in this table is different than the total area of the Sauk Creek watershed identified in Table 333. This is due to the fact that the area set forth in Table 333 includes all that portion of the Sauk Creek watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Sauk Creek watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 332

LENGTH OF STREAMS AND THEIR SOURCES IN THE SAUK CREEK WATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Sauk Creek	Town of Belgium	T21N, R22E, Sec. 6, NW 1/4	16.58

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 333

AREAL EXTENT OF CIVIL DIVISIONS IN THE SAUK CREEK WATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Ozaukee County			
City			
Port Washington	1.99	5.90	64.61
Villages			
Belgium	0.02	0.06	3.03
Fredonia	0.14	0.41	10.61
Towns			
Belgium	12.84	38.09	34.70
Fredonia	6.97	20.68	19.95
Grafton	0.89	2.64	4.09
Port Washington	10.85	32.19	56.13
Saukville	0.01	0.03	0.03
County Subtotal	33.71	100.00	14.34
Total	33.71	100.00	--

Source: SEWRPC.

Table 334

ESTIMATED POPULATION OF THE SAUK CREEK RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Ozaukee County	
Belgium Town (Part)	266
Belgium Village (Part)	15
Fredonia Town (Part)	189
Fredonia Village (Part)	122
Grafton Town (Part)	23
Port Washington City (Part)	6,194
Port Washington Town (Part)	565
Saukville Town (Part)	3
Ozaukee County (Part) Subtotal	7,377
Sauk Creek River Watershed Total	7,377

Source: Wisconsin Department of Administration and SEWRPC.

land use under development specially reflected in the pollution loading rates of the land under development section, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities, excluding land under development within the Sauk Creek watershed, are estimated at 2,400 pounds of nitrogen, 200 pounds of phosphorus, 14,500 pounds of BOD_5, 9.6 x 10^{12} fecal coliform counts, and 170 tons of sediment during an average year. Table 335 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Sauk Creek watershed, approximately 218 acres, or 1 percent, of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Sauk Creek watershed are 2,000 pounds of nitrogen, 200 pounds of phosphorus, 21,300 pounds of biochemical oxygen demand, 7.2 x 10^{12} fecal coliform counts, and 80 tons of sediment. Table 336 presents the areal extent of commercial land uses within the Sauk Creek watershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the watershed in 1975.

Industrial Activities: Industrial land uses, specifically manufacturing, cover 128 acres, or less than 1 percent of the Sauk Creek watershed. The industrial activities within the Sauk Creek watershed are estimated to contribute annually 1,100 pounds of nitrogen, 90 pounds of phosphorus, 4,700 pounds of BOD_5, 7.9 x 10^{12} fecal coliform counts, and 70 tons of sediment to surface runoff. Table 337 presents the areal extent of the industrial uses within the Sauk Creek watershed along with the estimated average annual diffuse source pollutant loadings from these activities. There was no industrial land under development in the watershed in 1975.

There is one sanitary landfill operation within the Sauk Creek watershed occupying a total of 12 acres, or less than 1 percent of the drainage area. This is included, along with its estimated pollutant loading rates, on Table 337. The landfill operation has an estimated annual pollutant load of 100 pounds of nitrogen, 10 pounds of phosphorus, 400 pounds of BOD_5, 7.4 x 10^{11} fecal coliform counts, and five tons of sediment. There were five auto salvage and wrecking facilities in the watershed in 1975.

Extractive Activities: There were no major extractive mining operations consisting of gravel pits, and attendant washing operations in the Sauk Creek watershed as of 1975.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways, railroads, and airports. Table 338 presents the estimated pollutant contributions from the 175 acres, or approximately 1 percent of the total watershed area which is devoted to these land uses. It is estimated that 3,500 pounds of nitrogen, 300 pounds of phosphorus, 19,800 pounds of BOD_5, 8.0 x 10^{12} fecal coliform counts, and 2,610 tons of sediment are transported annually from transportation related activities within the Sauk Creek watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contribution from these types of streets are included within the land uses which they serve. There was no transportation land under development in the watershed in 1975.

Table 335

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	597	2.70	Total Nitrogen	4.0	2,390
			Total Phosphorus	0.32	190
			Biochemical Oxygen Demand	24.3	14,510
			Fecal Coliform	1.6 x 10^{10} counts/a/yr.	9.6 x 10^{12} counts/yr.
			Sediment	545	165 tons

Source: SEWRPC.

Table 336

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial	218	0.99	Total Nitrogen	9.0	1,960
			Total Phosphorus	0.75	160
			Biochemical Oxygen Demand	97.6	21,280
			Fecal Coliform	3.3 x 10^{10} counts/a/yr.	7.2 x 10^{12} counts/yr.
			Sediment	745	80 tons

Source: SEWRPC.

Table 337

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	128	0.58	Total Nitrogen	8.4	1,080
			Total Phosphorus	0.70	90
			Biochemical Oxygen Demand	36.9	4,730
			Fecal Coliform	6.2×10^{10} counts/a/yr.	7.9×10^{12} counts/yr.
			Sediment	977	65 tons
Landfill	12	0.05	Total Nitrogen	8.4	100
			Total Phosphorus	0.70	10
			Biochemical Oxygen Demand	36.9	440
			Fecal Coliform	6.2×10^{10} counts/a/yr.	7.4×10^{11} counts/yr.
			Sediment	977	5 tons
Total	140	0.63	Total Nitrogen	--	1,180
			Total Phosphorus	--	100
			Biochemical Oxygen Demand	--	5,170
			Fecal Coliform	--	8.7×10^{12} counts/yr.
			Sediment	--	70 tons

Source: SEWRPC.

Table 338

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets & Highways	118	0.54	Total Nitrogen	23.4	2,770
			Total Phosphorus	1.4	170
			Biochemical Oxygen Demand	159.0	18,770
			Fecal Coliform	6.7×10^{10} counts/a/yr.	7.9×10^{12} counts/yr.
			Sediment	42,600	2,515 tons
Airfields.	57	0.26	Total Nitrogen	12.0	680
			Total Phosphorus	2.7	150
			Biochemical Oxygen Demand	17.6	1,000
			Fecal Coliform	Negligible	--
			Sediment	3,200	90 tons
Total	175	0.80	Total Nitrogen	--	3,450
			Total Phosphorus	--	320
			Biochemical Oxygen Demand	--	19,770
			Fecal Coliform	--	8.0×10^{12} counts/yr.
			Sediment	--	2,605 tons

Source: SEWRPC.

Recreational Activities: The major recreational facilities within the watershed as of 1975, as shown on Map 81, included parks with a total area of 72 acres, or less than 1 percent of the total area of the watershed. Table 339 sets forth the acreage of parks and the estimated amount of diffuse source pollutants transported from this land use. It is estimated that 200 pounds of nitrogen, 90 pounds of BOD_5, 2.6×10^{11} fecal coliform counts, and 15 tons of sediment are transported from parks within the Sauk Creek watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development: The Sauk Creek Watershed is undergoing conversion of land from rural to urban use. The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 45 acres, or less than 1 percent of the total land area of the watershed. No significant recreational, industrial, commercial, or transportation related lands were under development in the watershed in 1975. It is estimated that 3,300 pounds of nitrogen, 2,500 pounds of phosphorus, 6,600 pounds of BOD_5, and 4,130 tons of sediment were transported from these residential construction sites in 1975. Table 340 presents the estimated acreage of land under conversion from rural to urban use within the Sauk Creek watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were only 12 known holding tanks and no mound systems in the watershed, as shown on Map 46. Table 341 presents the estimated pollutant loadings from the approximately 305 septic tanks in the watershed as of 1975. It is estimated that 6,100 pounds of nitrogen, 1,400 pounds of phosphorus, 87,200 pounds of BOD_5, 1.1 x 10^{14} fecal coliform counts, and 15 tons of sediment are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Sauk Creek watershed.

Rural Land Uses

Agricultural Activities: About 90 percent of the area of the Sauk Creek watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May, 1975, 110 significant domestic livestock operations with a total of 6,930 animals, or 9,120 equivalent animal units were known to exist within the watershed. Map 82 indicates the locations of these livestock operations. Twenty-three of these operations were located within 500 feet of the identified stream system of the watershed. Table 342 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually, and the total estimated pollutant loading rates. Approximately 259,000 pounds of nitrogen, 60,200 pounds of phosphorus, 1,014,100 pounds of BOD_5, 5.8 x 10^{15} fecal coliform counts, and 3,190 tons of sediment are transported from livestock operations within the Sauk Creek watershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 343. Although crop rotations and other factors cause these acreages to vary from year-to-year, the 1975 figures are

Table 339

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	72	0.33	Total Nitrogen	2.3	170
			Total Phosphorus	0.06	0
			Biochemical Oxygen Demand	1.3	90
			Fecal Coliform	3.6 x 10^9 counts/a/yr.	2.6 x 10^{11} counts/yr.
			Sediment	420	15 tons

Source: SEWRPC.

Table 340

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development. . .	55	0.20	Total Nitrogen	60	3,300
			Total Phosphorus	45	2,480
			Biochemical Oxygen Demand	120	6,600
			Fecal Coliform	Negligible	--
			Sediment	150,000	4,125 tons

Source: SEWRPC.

Table 341

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE SAUK CREEK WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	305	1,069	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	5.7 1.32 81.6 1.0×10^{11} counts/capita/yr. 28.0	6,090 1,410 87,230 1.1×10^{14} counts/yr. 15 tons

Source: SEWRPC.

Table 342

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE SAUK CREEK WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	6,170	8,640	134,030	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	245,380 57,020 960,770 5.5×10^{15} counts/yr. 3,025 tons
Beef	300	300	3,390	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	8,520 1,980 33,360 1.9×10^{14} counts/yr. 105 tons
Hogs	460	180	2,320	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	28.4 6.6 111.2 6.4×10^{11} counts/a.u./yr. 700.0	5,110 1,190 20,020 1.2×10^{14} counts/yr. 65 tons
Total	6,930	9,120	139,740	Total Nitrogen Total Phosphorus Biochemical Oxygen Demand Fecal Coliform Sediment	-- -- -- -- --	259,010 60,190 1,014,140 5.8×10^{15} counts/yr. 3,190 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

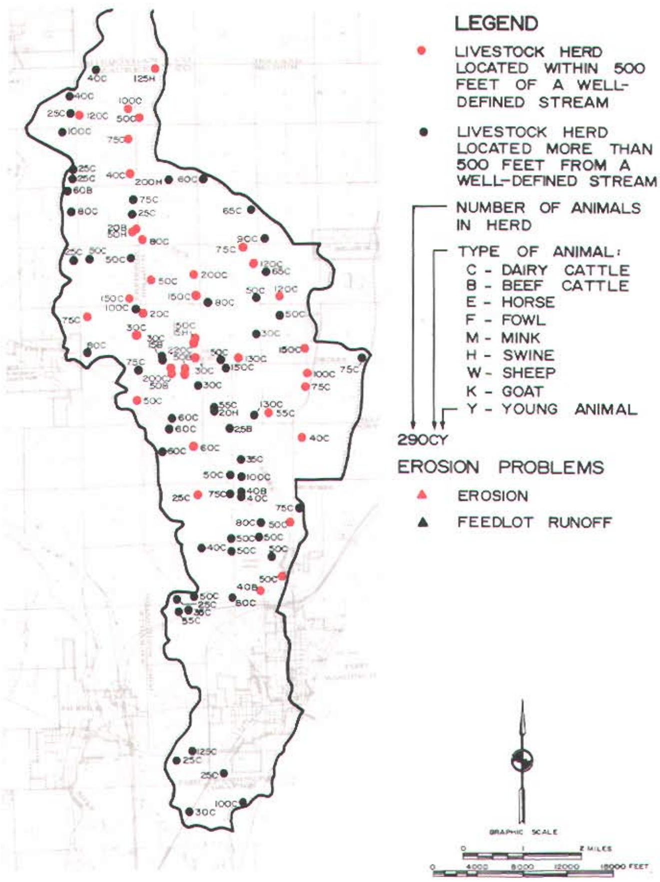
considered generally representative of the typical cropping patterns within the watershed. Approximately 2,665 acres, or 12 percent of the total area of the watershed, were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Sauk Creek watershed are accordingly estimated at 12,500 pounds of nitrogen, 400 pounds of phosphorus, 25,600 pounds of BOD_5, and 4,270 tons of sediment. Table 343 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates, to the land surface in an average year within the watershed.

Approximately 7,000 acres, or 28 percent of the total area of the watershed were devoted to the growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Sauk Creek watershed are 5,500 pounds of nitrogen, 600 pounds of phosphorus, 58,600 pounds of BOD_5, and 9,760 tons of sediment.

Major row crops grown within the Sauk Creek watershed are corn and soybeans, which were planted on 8,275 acres, or 38 percent of the total area of the watershed. As shown in Table 343, an estimated 191,200 pounds of nitrogen, 5,300 pounds of phos-

Map 82

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE SAUK CREEK WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 110 operations within the Sauk Creek watershed in 1975, 22 operations, or 20 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

phorus, 145,600 pounds of BOD_5, and 24,410 tons of sediment are transported annually from the row crop acreage within the Sauk Creek watershed.

Also, as shown in Table 343, specialty crops were grown on a total of 1,178 acres, or 5 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Sauk Creek watershed are 27,200 pounds of nitrogen, 800 pounds of phosphorus, 35,300 pounds of BOD_5, and 5,890 tons of sediment.

Approximately 90 percent of the annual plowing of cropland is considered likely to have been tilled by conventional methods, using moldboard plows in the autumn and left uncovered through the winter months and early spring.

Irrigation of cropland was practiced within the watershed in 1975. The location of the high-capacity well which provides the water supply is shown on Map 47. The irrigation volume is estimated at 0.100 million gallons per day (mgd). It has been estimated that corn receives up to 10 inches of irrigation water annually, and vegetables receive 15-20 inches annually. Irrigation return flows are assumed to be negligible in the watershed due to the careful practices of operators, as in the use of aerial spray methods of application.

Pasture land and other open space accounts for 1,070 acres, or 5 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 343. Annual loading rates from these areas are estimated at 4,900 pounds of nitrogen, 300 pounds of phosphorus, 10,400 pounds of BOD_5, and 220 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 63 farms covering about 8,371 acres, or 43 percent of the agricultural land within the watershed.

A total of 249 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 83.

Table 344 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $346,512, or an equivalent $17.97 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $8.92 per acre of agricultural land,

Table 343

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	2,665	12.06	Total Nitrogen	4.7	12,530
			Total Phosphorus	0.13	350
			Biochemical Oxygen Demand	9.6	25,580
			Fecal Coliform	Negligible	--
			Sediment	3,200	4,265 tons
Hay	6,099	27.60	Total Nitrogen	0.9	5,490
			Total Phosphorus	0.09	550
			Biochemical Oxygen Demand	9.6	58,550
			Fecal Coliform	Negligible	--
			Sediment	3,200	9,760 tons
Row	8,275	37.46	Total Nitrogen	23.1	191,150
			Total Phosphorus	0.64	5,300
			Biochemical Oxygen Demand	17.6	145,640
			Fecal Coliform	Negligible	--
			Sediment	5,900	24,410 tons
Specialty Crops —					
Vegetable and Other Agricultural Crops	1,178	5.33	Total Nitrogen	23.1	27,210
			Total Phosphorus	0.64	750
			Biochemical Oxygen Demand	30.0	35,340
			Fecal Coliform	Negligible	--
			Sediment	10,000	5,890 tons
Pasture	1,070	4.84	Total Nitrogen	4.6	4,920
			Total Phosphorus	0.29	310
			Biochemical Oxygen Demand	9.7	10,380
			Fecal Coliform	Negligible	--
			Sediment	420	220 tons
Total	19,287	87.29	Total Nitrogen	--	241,300
			Total Phosphorus	--	7,260
			Biochemical Oxygen Demand	--	275,490
			Fecal Coliform	--	--
			Sediment	--	44,550 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

or about 50 percent of the total investment were related to those practices directly affecting water quality. This represents about 59 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementaition costs of 56 farm plans.

Silvicultural Activities: About 969 acres, or approximately 4 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. Table 345 presents the acreage of silvicultural activities within the Sauk Creek watershed and the estimated loading rates from these activities. About 2,200 pounds of nitrogen, 100 pounds of phosphorus, 4,500 pounds of BOD_5, 6.4 x 10^{11} fecal coliform counts, and 120 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 18 acres, or less than 1 percent of the total area of the watershed is covered by surface water in the form of ponds, lakes, and streams. As indicated in Table 346, 200 pounds of nitrogen, 10 pounds of phosphorus, 2,900 pounds of BOD_5, and five tons of sediment can be expected to be contributed to the surface waters of the Sauk Creek watershed annually by atmospheric dry fall and washout.

A total of 563 acres, or less than 1 percent of the total area of the watershed is covered by surface

Table 344

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE SAUK CREEK WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	233 acres	10.00/acre	2,330.00
Interim Cover	0	12.00/acre	0
Tree Stands	(3 units) (2 acres/unit) = 6 acres	100.00/acre	600.00
Wind Erosion Control	3,560 feet	0.60/foot	2,136.00
Wildlife Habitat	(4 units) (2 acres/unit) = 8 acres	25.00/acre	200.00
Permanent Vegetative Cover	1,056 acres	50.00/acre	52,800.00
Subtotal			58,066.00
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	2 units	4,000.00/unit	8,000.00
Subtotal			8,000.00
Flow Control Practices			
Diversions	5,620 feet	1.25/foot	7,025.00
Open Drains	6,300 feet	2.25/foot	14,175.00
Runoff Control Structures	1 unit	2,500.00/unit	2,500.00
Runoff Control Measures	77,558 feet	1.00/foot	77,558.00
Streambank Stabilization	1,350 feet	3.50/foot	4,725.00
Subtotal			105,983.00
Crop Production Practices			
Liming	34 acres	20.00/acre	680.00
Tiling	248,262 feet	0.70/foot	173,783.40
Mulching	0	60.00/acre	0
Subtotal			174,463.40
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$346,512.40

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; and SEWRPC.

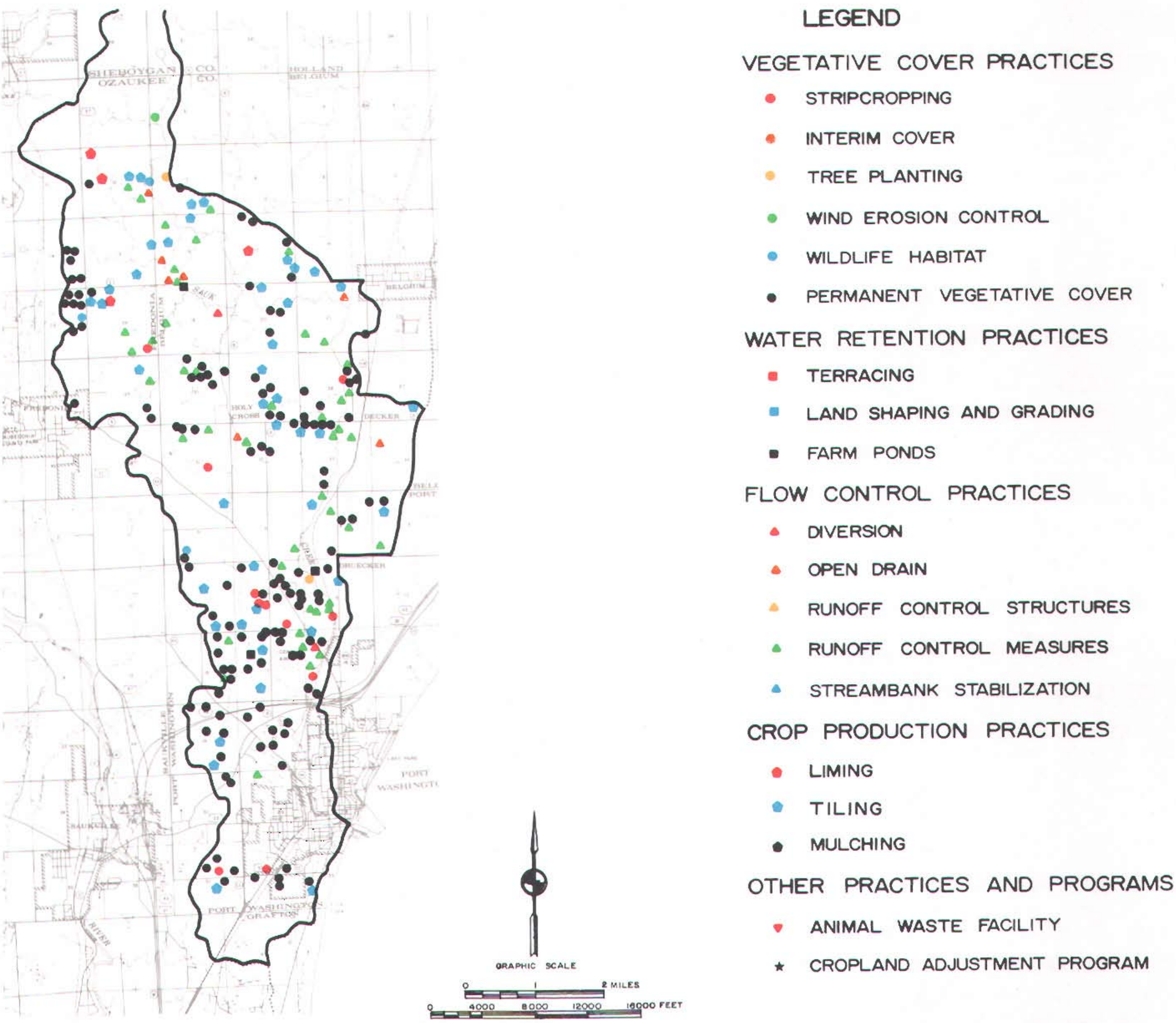
water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Sauk Creek watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Sauk Creek Watershed

The Sauk Creek watershed is generally agricultural with storm water runoff from agricultural land and livestock operations contributing the largest diffuse source loads of nitrogen, phosphorus, biochemical oxygen demand, fecal coliform, and sediment. Livestock operations contribute more than 50 percent of the total diffuse source loads of phosphorus, biochemical oxygen demand, and fecal coliform. Agricultural runoff contributes the largest load of sediment and the second largest loads of nitrogen, phosphorus, and biochemical oxygen demand. Silvicultural activities and air pollution loadings to surface waters produce less than 1 percent of the total load of any major pollutant. All urban diffuse sources contribute less than 13 percent of the total diffuse source loads of any pollutant. Total annual diffuse source loads are 521,200 pounds of nitrogen, 72,300 pounds of phosphorus, 1,451,700 pounds of biochemical oxygen demand, 6.0 x 10^{15} fecal coliform counts, and 54,940 tons of sediment.

Map 83

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE SAUK CREEK WATERSHED IN 1975



The above map illustrates the locations of the 249 known conservation practices installed in the Sauk Creek watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service and SEWRPC.

DIFFUSE SOURCES OF WATER POLLUTION WITHIN THE SHEBOYGAN RIVER WATERSHED

Physical Setting

The Sheboygan River watershed is a natural surface water drainage unit, 11 square miles in areal extent within the northern portion of the Region. The boundaries of the basin together with the location of Belgium Creek, the only major perennial stream, are shown on Map 26. The main stem of the Sheboygan River originates and discharges outside the Region. About 97 percent of the watershed is in rural land uses, with about 90 percent of this area still in agricultural use. The agricultural related land use is dispersed over the watershed. Map 84 sets forth the major land use categories and their spatial distributions within the Sheboygan River watershed as they were inventoried in 1975. Table

Table 345

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	859	3.89	Total Nitrogen	2.3	1,980
			Total Phosphorus	0.14	120
			Biochemical Oxygen Demand	4.6	3,950
			Fecal Coliform	6.6×10^8 counts/a/yr.	5.7×10^{11} counts/yr.
			Sediment	251	110 tons
Orchards and Nurseries	110	0.50	Total Nitrogen	2.3	250
			Total Phosphorus	0.14	20
			Biochemical Oxygen Demand	4.6	510
			Fecal Coliform	6.6×10^8 counts/a/yr.	7.3×10^{10} counts/yr.
			Sediment	251	10 tons
Total	969	4.39	Total Nitrogen	--	2,230
			Total Phosphorus	--	140
			Biochemical Oxygen Demand	--	4,460
			Fecal Coliform	--	6.4×10^{11} counts/yr.
			Sediment	--	120 tons

Source: SEWRPC.

Table 346

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE SAUK CREEK WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams.	18	0.08	Total Nitrogen	8.9	160
			Total Phosphorus	0.5	10
			Biochemical Oxygen Demand	162.0	2,920
			Fecal Coliform	Negligible	--
			Sediment	665	5 tons

Source: SEWRPC.

347 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions in 1975.

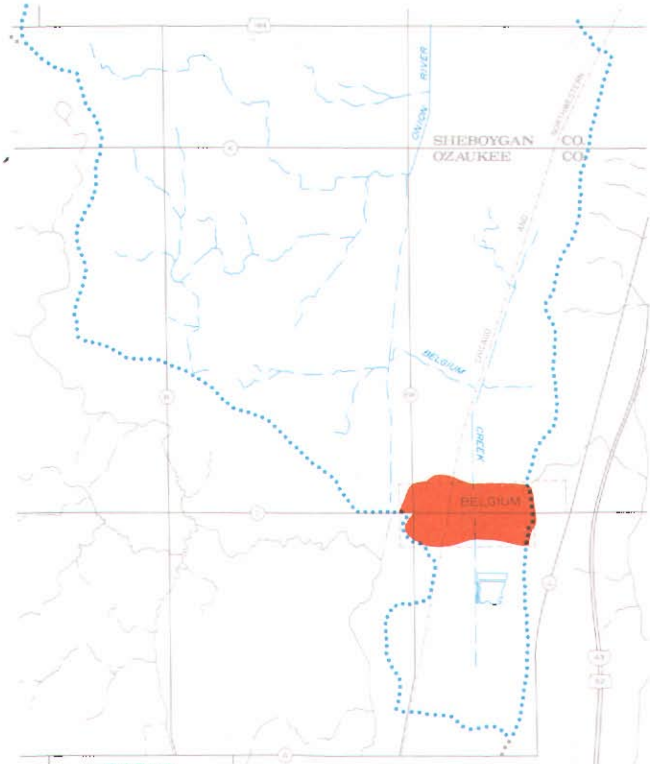
The watershed is bounded on the north by the Sheboygan County line, on the west and south by the Sauk Creek watershed, and on the east by the watershed of minor streams directly tributary to Lake Michigan. Table 348 lists for the Sheboygan River watershed, the location of the source and the length of the only major stream. Within the Region, the watershed ranks twelfth both in size and in total resident population.

Superimposed upon the natural, meandering watershed boundaries is a rectilinear pattern of local political boundaries, as shown on Map 26. The Sheboygan River watershed lies totally within Ozaukee County and in part of the Town and Village of Belgium. The area and proportion of the watershed lying within the jurisdiction of each of these general purpose local units of government as of January 1, 1976, are shown in Table 349. The 1975 resident population of the watershed is estimated at 1,005 persons, or approximately 1 percent of the estimated 1975 total regional population. Table 350 presents the population distribution in the Sheboygan River watershed by civil division.

Surface water in the Sheboygan River watershed is comprised almost entirely of streamflow. Some small ponds, flooded gravel pits and wetlands make up the remainder of the surface water. No streamflow data are known to be collected on a continuing basis within the Sheboygan River watershed in the Region. The soils within the Sheboygan River watershed consist of deep to moderately deep, brown to black silt loams. Most of the soils are relatively fertile and produce high crop yields if managed correctly. However, they also encourage high nutrient levels in stream water when soil particles are carried with precipitation runoff.

Map 84

MAJOR LAND USE CATEGORIES AND THEIR SPATIAL DISTRIBUTION WITHIN THE SHEBOYGAN RIVER WATERSHED IN 1975



LEGEND

NONE	SUBURBAN AND LOW DENSITY RESIDENTIAL (0.2 – 2.2 DWELLING UNITS PER NET RESIDENTIAL ACRE)
(red)	MEDIUM DENSITY RESIDENTIAL (2.3 – 6.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
NONE	HIGH DENSITY RESIDENTIAL (7.0 – 17.9 DWELLING UNITS PER NET RESIDENTIAL ACRE)
NONE	PRIMARY ENVIRONMENTAL CORRIDOR PRESERVATION THROUGH PUBLIC AQUISITION
NONE	MAJOR RETAIL AND SERVICE CENTER
NONE	MAJOR INDUSTRIAL CENTER
NONE	PUBLIC AIRPORT
NONE	MAJOR PUBLIC OUTDOOR RECREATION CENTER
NONE	PUBLIC GOLF COURSE
NONE	NONPUBLIC GOLF COURSE

As of 1975 more than 96 percent of the area of the Sheboygan River watershed within the Region was devoted to rural land uses. The dominant rural land use in the watershed was agricultural, which occupied 87 percent of the watershed area. The overall spatial distribution of land use in the watershed was characterized by rural land uses with a concentration of urban development in and around the Village of Belgium. There were no major parks or golf courses in the watershed.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Particularly important to watershed planning are the soil suitability interpretations for specified types of urban development. Based upon the interpretations of the soils properties, much of the watershed area exhibits severe or very severe limitations for residential development without public sanitary sewer service, as shown on Maps 43 and 44. Residential development with public sanitary sewer service is limited primarily in the eastern portion of the watershed, as shown on Map 45.

Urban Land Uses

Residential Activities: Residential land uses cover approximately 100 acres, or 1 percent of the watershed. In addition, there are 10 acres of residential land use under development reflected as such in the pollution loading table for the land under development category, because of the increased loadings from lands undergoing conversion from rural to urban use. Total pollutant loads from residential activities excluding land under development within the Sheboygan River watershed are estimated at 400 pounds of nitrogen, 30 pounds of phosphorus, 2,400 pounds of BOD_5, 1.6 x 10^{12} fecal coliform counts, and 30 tons of sediment during an average year. Table 351 presents the areal extent of residential land use within the watershed, along with the estimated average annual diffuse source pollutant loadings from residential land.

Commercial Activities: Within the Sheboygan River watershed, approximately 20 acres, or less than 1 percent of the total land surface is devoted to commercial activities. The estimated annual pollutant loadings from commercial activities within the Sheboygan River watershed are 200 pounds of nitrogen, 20 pounds of phosphorus, 2,000 pounds of biochemical oxygen demand, 6.6 x 10^{11} fecal coliform counts, and five tons of sediment. Table 352 presents the areal extent of commercial land uses within the Sheboygan River watershed along with the estimated average annual diffuse source pollutant loads from these areas. There was no commercial land under development in the Sheboygan River watershed in 1975.

Industrial Activities: Industrial land uses cover 25 acres, or less than 1 percent of the Sheboygan River watershed. The industrial activities within the Sheboygan River watershed are estimated to contribute annually 200 pounds of nitrogen, 20 pounds of phosphorus, 900 pounds of BOD_5, 1.6 x 10^{12} fecal coliform counts, and 10 tons of sediments to surface runoff. Table 353 presents the areal extent of the industrial uses within the Sheboygan River watershed along with the estimated average annual diffuse source pollutant loadings from these activities. There was no industrial land under development in the watershed in 1975.

There were no significant sites of sanitary landfills or extractive mining operations in the Sheboygan River watershed for 1975. There were also no auto salvage or wrecking facilities in the watershed in 1975.

Table 347

AREAL EXTENT OF WATER QUALITY RELATED LAND USES IN THE SHEBOYGAN RIVER WATERSHED IN 1975[a]

Land Use	Square Miles	Acres	Percent
Urban Land Use			
Residential	0.16	100	1.21
Commercial[b]	0.03	20	0.24
Industrial			
Manufacturing	0.04	25	0.31
Landfill & Dump	--	--	--
Extractive	--	--	--
Transportation			
Streets & Highways	0.14	90	1.10
Airfields	--	--	--
Railroad Yards & Terminals	--	--	--
Recreation			
Golf Courses	--	--	--
Parks & Other Recreation	0.01	6	0.08
Land Under Development			
Residential Land Under Development[c]	0.02	10	0.12
Commercial Land Under Development	--	--	--
Industrial Land Under Development	--	--	--
Transportation Land Under Development	--	--	--
Recreation Land Under Development	--	--	--
Rural Land Use			
Agricultural			
Grain Crops	1.61	1,030	12.54
Hay	3.08	1,971	24.00
Row Crops	4.60	2,942	35.82
Specialty Crops	1.56	997	12.13
Sod Farm	--	--	--
Other Open Space[d]	0.32	202	2.45
Silvicultural			
Woodlands	1.07	685	8.34
Orchards & Nurseries	--	--	--
Natural and Manmade Water Areas—Subject to Atmospheric Pollutant Contributions			
Ponds, Lakes & Streams	0.06	40	0.49
Wetlands, Swamps, & Marshes	0.15	97	1.18
Total	12.85	8,215	100.00

[a] *These special land use categories, defined primarily according to their land cover characteristics and effects on the quality of stormwater runoff were delineated at a scale of 1" = 400' on aerial photographs taken in May, 1975, and were measured to the nearest full acre, using dot-counting overlays. The total acreages measured within hydrologic subbasins were then adjusted to the control totals measured by the digitizer from base maps of hydrologic subbasins at a scale of 1" = 2,000'. Both the "square miles" and the "percent" shown above were then computed and rounded to the nearest hundredth (0.01) of a percent.*

[b] *Includes: Retail, Communication, Utilities, Administrative, Institutional.*

[c] *Based on 1975 total residential lands, adjusted by the 1970 ratio between residential lands and residential lands under development.*

[d] *Includes: Pasture, unused urban and rural lands.*

[e] *The total area of the Sheboygan River watershed represented in this table is different than the total area of the Sauk Creek watershed identified in Table 349. This is due to the fact that the area set forth in Table 349 includes all that portion of the Sheboygan River watershed lying within the civil boundaries that comprise the Southeastern Wisconsin Region. The area of the Sheboygan River watershed represented in this table represents an aggregation of subbasins, the boundaries of which do not always coincide with the civil boundaries of the Region.*

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

Table 348

LENGTH OF STREAMS AND THEIR SOURCES IN THE SHEBOYGAN RIVER WATERSHED

Stream or Watercourse	Source		Length (in miles)
	By Civil Division	By U.S. Public Land Survey System	
Belgium Creek	Village of Belgium	T12N, R22E, Sec. 3, NW 1/4	0.23

Source: Wisconsin Department of Natural Recources and SEWRPC.

Table 349

AREAL EXTENT OF CIVIL DIVISIONS IN THE SHEBOYGAN RIVER WATERSHED: JANUARY, 1976

Civil Division	Area Within Watershed (square miles)	Percent of Watershed Area Within Civil Division	Percent of Civil Division Area Within Watershed
Ozaukee County			
Village			
Belgium	0.54	4.72	81.82
Town			
Belgium	10.89	95.28	29.43
Total	11.43	100.00	--

Source: SEWRPC.

Table 350

ESTIMATED POPULATION OF SHEBOYGAN RIVER WATERSHED BY CIVIL DIVISION: 1975

Civil Division	1975 Population
Ozaukee County	
Belgium Town (Part)	360
Belgium Village (Part)	645
Ozaukee County (Part) Subtotal	1,005
Sheboygan River Watershed Total	1,005

Source: Wisconsin Department of Administration and SEWRPC.

Transportation: Transportation land uses within the watershed include freeways, other arterial streets and highways. Railroad yards and terminals did not consume significant acreage in the watershed. Table 354 presents the estimated pollutant contributions from the 90 acres, or 1 percent of the total watershed area which is devoted to these land uses. It is estimated that 2,100 pounds of nitrogen, 100 pounds of phosphorus, 14,300 pounds of BOD_5, 6.0 x 10^{12} fecal coliform counts, and 1,920 tons of sediment are transported annually from transportation related activities within the Sheboygan River watershed. Additional transportation facilities are present in the form of local collector and land access streets in residential, commercial, and industrial areas. The pollutant contributions from

Table 351

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RESIDENTIAL LAND USES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential	100	1.21	Total Nitrogen	4	400
			Total Phosphorus	0.32	30
			Biochemical Oxygen Demand	24.3	2,430
			Fecal Coliform	1.6 x 10^{10} counts/a/yr.	1.6 x 10^{12} counts/yr.
			Sediment	545	25 tons

Source: SEWRPC.

Table 352

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM COMMERCIAL LAND USES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Commercial.	20	0.24	Total Nitrogen	9	180
			Total Phosphorus	0.75	20
			Biochemical Oxygen Demand	97.6	1,950
			Fecal Coliform	3.3×10^{10} counts/a/yr.	6.6×10^{11} counts/yr.
			Sediment	745	5 tons

Source: SEWRPC.

Table 353

TYPE, EXTENT, AND ESTIMATED TOTAL POLLUTANT LOADINGS FROM INDUSTRIAL LAND USES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Industrial	25	0.31	Total Nitrogen	8.4	210
			Total Phosphorus	0.70	20
			Biochemical Oxygen Demand	36.9	920
			Fecal Coliform	6.2×10^{10} counts/a/yr.	1.6×10^{12} counts/yr.
			Sediment	977	10 tons

Source: SEWRPC.

Table 354

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM TRANSPORTATION LAND USES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Streets & Highways	90	1.1	Total Nitrogen	23.4	2,110
			Total Phosphorus	1.4	130
			Biochemical Oxygen Demand	159	14,310
			Fecal Coliform	6.7×10^{10} counts/a/yr.	6.0×10^{12} counts/yr.
			Sediment	42,600	1,915 tons

Source: SEWRPC.

Table 355

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM RECREATIONAL LAND USES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Parks and Other Recreation.	6	0.08	Total Nitrogen	2.3	10
			Total Phosphorus	0.06	0
			Biochemical Oxygen Demand	1.3	10
			Fecal Coliform	3.6×10^{9} counts/a/yr.	2.2×10^{10} counts/yr.
			Sediment	420	0 tons

Source: SEWRPC.

these types of streets are included within the land uses which they serve. There was no transportation land under development in the watershed in 1975.

Recreational Activities: The major recreational facilities within the watershed as of 1975, as shown on Map 84, included parks with a total area of six acres. Table 355 sets forth the acreage of parks and the estimated amount of diffuse source pollutants transported from these land uses. It is estimated that 10 pounds of nitrogen, an insignificant amount of phosphorus, 10 pounds of BOD_5, 2.2 x 10^{12} fecal coliform counts, and an insignificant amount of sediment are transported from parks within the Sheboygan River watershed annually. There was no recreational land under development in the watershed in 1975.

Land Under Development: The total number of acres of land under development for residential use in 1975 within the watershed was estimated at 10 acres, or less than 1 percent of the total land area of the watershed. In 1975, there were no significant recreational, transportation or commercial related lands under development in the Sheboygan River watershed. It is estimated that 600 pounds of nitrogen, 500 pounds of phosphorus, 1,200 pounds of BOD_5, and 750 tons of sediment were transported from these residential construction sites in 1975. Table 356 presents estimated acreage of land under conversion from rural to urban use within the Sheboygan River watershed, along with the estimated annual diffuse source pollutant loadings from this land.

Onsite Domestic Sewage Disposal Systems: Map 42 indicates the estimated densities of septic tank systems within the U.S. Public Land Survey quarter sections of the watershed, outside of the areas served by centralized sanitary sewerage systems. As of 1975 there were no known holding tanks or mound systems in the watershed. Table 357 presents the estimated pollutant loadings from the approximately 71 septic tanks in the watershed as of 1975. It is estimated that 1,200 pounds of nitrogen, 300 pounds of phosphorus, 17,600 pounds of BOD_5, 2.2 x 10^{13} fecal coliform counts, and 5 tons of sediment, are transported via surface runoff or enter surface waters via groundwater pollution from septic systems annually within the Sheboygan River watershed.

Rural Land Uses

Agricultural Activities: About 87 percent of the area of the Sheboygan River watershed is devoted to agricultural land uses. Agricultural activities consist primarily of domestic livestock operations and cropland. As of May, 1975, 22 significant domestic livestock operations with a total of 1,100 animals, or 1,500 equivalent animal units were known to exist within the watershed. Map 85 indicates the locations of these livestock operations. Seventeen of these operations were located within 500 feet of the identified stream system of the watershed. Table 358 indicates the number of livestock present within the watershed as well as the equivalent animal units, the estimated total wastes produced annually,

Table 356

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM LAND UNDER DEVELOPMENT IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Residential Land Under Development. . .	10	0.12	Total Nitrogen	60	600
			Total Phosphorus	45	450
			Biochemical Oxygen Demand	120	1,200
			Fecal Coliform	Negligible	--
			Sediment	150,000	750 tons

Source: SEWRPC.

Table 357

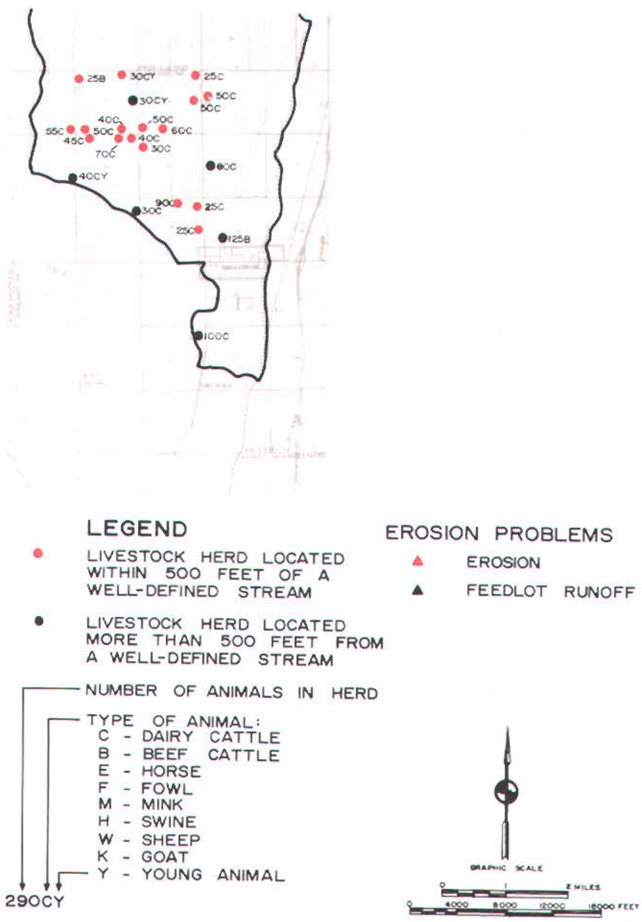
TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ONSITE SEWAGE DISPOSAL SYSTEMS IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Septic Systems	Unsewered Population	Pollutant	Unit Loading Rate (pounds/capita/year)	Estimated Channel Load (pounds/year)
Septic Tanks	71	216	Total Nitrogen	5.7	1,230
			Total Phosphorus	1.32	280
			Biochemical Oxygen Demand	81.6	17,630
			Fecal Coliform	1.0×10^{11} counts/capita/yr.	2.2×10^{13} counts/yr.
			Sediment	28.0	5 tons

Source: SEWRPC.

Map 85

LOCATION, TYPE, AND NUMBER OF LIVESTOCK IN DOMESTIC HERDS OF 25 UNITS OR GREATER IN THE SHEBOYGAN RIVER WATERSHED IN 1975



The location, type, and size of known domestic livestock herds as of 1975 were determined by a Commission inventory conducted with the assistance of the local Soil and Water Conservation Districts, county agricultural agents, and knowledgeable local farmers of each of the seven counties in the Region. Of the estimated 23 operations within the Sheboygan River watershed in 1975, 17 operations, or 73.9 percent, were located within 500 feet of a continuous or intermittent watercourse.

Source: County Soil and Water Conservation Districts; U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service; University of Wisconsin Extension Service; and SEWRPC.

and the total estimated pollutant loading rates. Approximately 42,600 pounds of nitrogen, 9,900 pounds of phosphorus, 166,800 pounds of BOD_5, 9.6 x 10^{14} fecal coliform counts, and 530 tons of sediment are transported from livestock operations within the Sheboygan River watershed annually.

Estimates of the amounts of grain, hay, row, and specialty crops which were grown within the watershed in 1975, as well as the amount of pasture and other open lands, are presented in Table 359. Although crop rotations and other factors cause these acreages to vary from year to year, the 1975 figures are considered generally representative of the typical cropping patterns within the watershed. Approximately 1,030 acres, or 13 percent of the total area of the watershed were planted in grain crops consisting of oats and wheat in 1975. Average annual pollutant loadings from grain crops within the Sheboygan River watershed are accordingly estimated at 4,800 pounds of nitrogen, 100 pounds of phosphorus, 9,900 pounds of BOD_5, and 1,650 tons of sediment. Table 359 presents the estimated acreage of grain crops, and the estimated diffuse source pollutant loading rates to the land surface in an average year within the watershed.

Approximately 1,971 acres, or 24 percent of the total area of the watershed, were devoted to the growth of hay crops in 1975. The estimated annual pollutant loadings from hay grown within the Sheboygan River watershed are 1,800 pounds of nitrogen, 200 pounds of phosphorus, 18,900 pounds of BOD_5, and 3,160 tons of sediment.

Major row crops grown within the Sheboygan River watershed are corn and soybeans, which were planted on 2,942 acres, or 36 percent of the total area of the watershed. As shown in Table 359 an estimated 68,000 pounds of nitrogen, 1,900 pounds of phosphorus, 51,800 pounds of BOD_5, and 8,680 tons of sediment are transported annually from the row crop acreage within the Sheboygan River watershed.

As shown in Table 359, specialty crops were grown on a total of 997 acres, or 12 percent of the total area of the watershed. These specialty crops included peas, sweet corn, cabbage, beets, carrots, and onions. The estimated annual pollutant loadings from these crops within the Sheboygan River watershed are 23,000 pounds of nitrogen, 600 pounds of phosphorus, 29,900 pounds of BOD_5, and 4,990 tons of sediment.

Approximately 90 percent of the annual plowing of cropland is considered likely to have been by conventional methods, using moldboard plows in the autumn and left uncovered through the winter months and early spring.

Pasture land and other open space accounts for 202 acres, or 3 percent of the total area of the watershed. The areal extent and estimated loading rates from pasture and other open lands are presented in Table 359. Annual loading rates from these areas are estimated at 900 pounds of nitrogen, 60 pounds of phosphorus, 2,000 pounds of BOD_5, and 40 tons of sediment.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service for 17 farms covering about 2,316 acres, or 32 percent of the agricultural land within the watershed.

A total of 81 known soil and water conservation practices were applied within the watershed during the 10-year period ending in 1975. Some of these

Table 358

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM ANIMAL OPERATIONS OF 25 UNITS OR GREATER IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Diffuse Source Category	Number of Animals	Number of Animal Units(a.u.)	Total Amount of Manure Generated (tons/year)	Pollutant	Unit Loading Rate (pounds/a.u./year)	Estimated Channel Load (pounds/year)
Dairy	960	1,350	20,914	Total Nitrogen	28.4	38,340
				Total Phosphorus	6.6	8,910
				Biochemical Oxygen Demand	111.2	150,120
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	8.6×10^{14} counts/yr.
				Sediment	700.0	475 tons
Beef	150	150	1,697	Total Nitrogen	28.4	4,260
				Total Phosphorus	6.6	990
				Biochemical Oxygen Demand	111.2	16,680
				Fecal Coliform	6.4×10^{11} counts/a.u./yr.	9.6×10^{13} counts/yr.
				Sediment	700.0	55 tons
Total	1,110	1,500	22,611	Total Nitrogen	--	42,600
				Total Phosphorus	--	9,900
				Biochemical Oxygen Demand	--	166,800
				Fecal Coliform	--	9.6×10^{14} counts/yr.
				Sediment	--	530 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service and SEWRPC.

Table 359

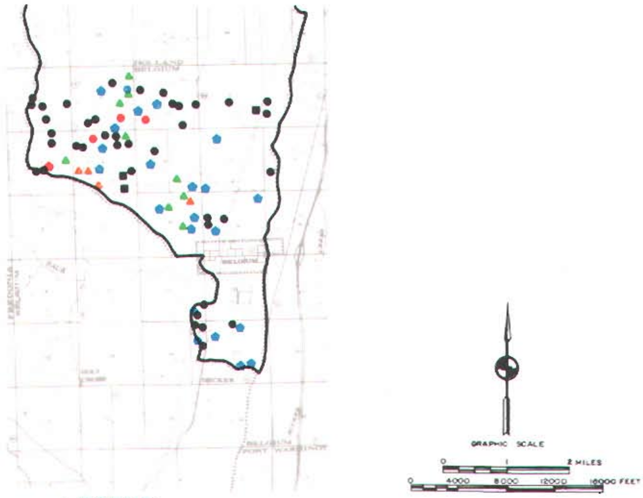
TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM CROPPING PRACTICES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Grain	1,030	12.54	Total Nitrogen	4.7	4,840
			Total Phosphorus	0.13	130
			Biochemical Oxygen Demand	9.6	9,890
			Fecal Coliform	Negligible	--
			Sediment	3,200	1,650 tons
Hay	1,971	24.00	Total Nitrogen	0.9	1,770
			Total Phosphorus	0.09	180
			Biochemical Oxygen Demand	9.6	18,920
			Fecal Coliform	Negligible	--
			Sediment	3,200	3,155 tons
Row	2,942	35.82	Total Nitrogen	23.1	67,970
			Total Phosphorus	0.64	1,880
			Biochemical Oxygen Demand	17.6	51,780
			Fecal Coliform	Negligible	--
			Sediment	5,900	8,680 tons
Specialty Crops					
Vegetable and Other Agricultural Crops. .	997	12.13	Total Nitrogen	23.1	23,020
			Total Phosphorus	0.64	640
			Biochemical Oxygen Demand	30.0	29,910
			Fecal Coliform	Negligible	--
			Sediment	10,000	4,985 tons
Pasture	202	2.45	Total Nitrogen	4.6	930
			Total Phosphorus	0.29	60
			Biochemical Oxygen Demand	9.7	1,960
			Fecal Coliform	Negligible	--
			Sediment	420.0	40 tons
Total	7,142	86.94	Total Nitrogen	--	98,540
			Total Phosphorus	--	2,890
			Biochemical Oxygen Demand	--	112,460
			Fecal Coliform	--	--
			Sediment	--	18,510 tons

Source: County Soil and Water Conservation Districts; United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Service; University of Wisconsin Extension Service, and SEWRPC.

Map 86

LOCATION OF KNOWN CONSERVATION PRACTICES IN THE SHEBOYGAN RIVER WATERSHED IN 1975



The above map illustrates the locations of the 81 known conservation practices installed in the Sheboygan River watershed between 1965 and 1975 with the assistance of the U. S. Department of Agriculture, Soil Conservation Service and Agricultural Stabilization and Conservation Service. Practices installed may represent one of the five following major categories: vegetative cover practices, water retention practices, flow control practices, animal waste facilities, and crop production practices. Also shown on the map are the locations of lands included in the 1965-1975 Cropland Adjustment Program under the U.S.D.A. Agricultural Stabilization and Conservation Service. The map includes agricultural land management practices, such as liming, tiling, or mulching which were also installed with U.S.D.A. assistance, but serve primarily for purposes of crop production, with little or no water quality benefits.

Source: U. S. Department of Agriculture, Soil Conservation Service and Agricultural, Stabilization, and Conservation Service and SEWRPC.

practices were implemented on lands for which no farm conservation plans were prepared. The locations of known conservation practices which were installed with the assistance of the U.S. Department of Agriculture Soil Conservation Service or Agricultural Stabilization and Conservation Service are set forth on Map 86.

Table 360 presents the major categories of conservation practices known to be installed as of 1975 within the watershed, along with their physical extent and the 1976 replacement costs of those practices, which total $166,036, or an equivalent $23.38 per acre of the total agricultural land within the watershed. The table further identifies the categories of practices which are likely to reduce the water pollution effects of storm water runoff, as opposed to those practices which serve primarily to enhance the productivity of the land surface for crop growth. Of the total estimated expenditures on conservation practices, about $8.71 per acre of agricultural land, or about 37 percent of the total investment were related to those practices directly affecting water quality. This represents about 58 percent of the estimated average cost per acre of agricultural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

Silvicultural Activities: About 685 acres, or approximately 8 percent of the total area of the watershed, were devoted to silvicultural activities in 1975, including woodlands. Table 361 presents the acreage of silvicultural activities within the Sheboygan River watershed and the estimated loading rates from these activities. About 1,600 pounds of nitrogen, 100 pounds of phosphorus, 3,200 pounds of BOD_5, 4.5×10^{11} fecal coliform counts, and 90 tons of sediment are transported annually from silvicultural land uses in the watershed.

Atmospheric Contribution: A total of 40 acres, or less than 1 percent of the total area of the watershed is covered by surface water in the form of streams, lakes, and ponds. As indicated in Table 362, 400 pounds of nitrogen, 20 pounds of phosphorus, 6,500 pounds of BOD_5, and 15 tons of sediment can be expected to be contributed to the surface waters of the Sheboygan River watershed annually by atmospheric dry fall and washout.

A total of 97 acres, or 1 percent of the total area of the watershed is covered by surface water in the form of swamps, marshes or wetlands. From these areas only negligible amounts of pollutants can be expected to be contributed to the surface waters of the Sheboygan River watershed annually by atmospheric dry fall and washout, since these wetlands tend to trap many pollutants.

Summary Discussion of the Sheboygan River Watershed

The Sheboygan River watershed is generally agricultural, with storm water runoff from these lands

Table 360

KNOWN SOIL AND WATER CONSERVATION PRACTICES INSTALLED IN THE SHEBOYGAN RIVER WATERSHED FOR 1965-1975

Practice Category	Number of Units	Cost Per Unit(in $)	Estimated Replacement Value In 1976 Dollars
Vegetative Cover Practices			
Stripcropping	46 acres	10.00/acre	460.00
Interim Cover	0	12.00/acre	0
Tree Stands	0	100.00/acre	0
Wind Erosion Control	0	0.60/foot	0
Wildlife Habitat	(1 unit) (2 acres/unit) = 2 acres	25.00/acre	50.00
Permanent Vegetative Cover	491 acres	50.00/acre	24,500.00
Subtotal			25,060.00
Water Retention Practices			
Terracing	0	0.70/foot	0
Farm Ponds	2 units	4,000.00/unit	8,000.00
Subtotal			8,000.00
Flow Control Practices			
Diversions	0	1.25/foot	0
Open Drains	4,100 feet	2.25/foot	9,225.00
Runoff Control Structures	0	2,500.00/unit	0
Runoff Control Measures	18,929 acres	1.00/foot	18,929.00
Streambank Stabilization	0	3.50/foot	0
Subtotal			28,154.00
Crop Production Practices			
Liming	10 acres	20.00/acre	200.00
Tiling	149,461 feet	0.70/foot	104,622.70
Mulching	0	60.00/acre	0
Subtotal			104,822.70
Animal Waste Facilities	0	24,000.00/unit	0
Watershed Total			$166,036.70

Source: United States Department of Agriculture Soil Conservation Service, and Agricultural Stabilization and Conservation Services; and SEWRPC.

Table 361

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM SILVICULTURAL LAND USES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Woodlands	685	8.34	Total Nitrogen	2.3	1,580
			Total Phosphorus	0.14	100
			Biochemical Oxygen Demand	4.6	3,150
			Fecal Coliform	6.6×10^8 counts/a/yr.	4.5×10^{11} counts/yr.
			Sediment	251	85 tons

Source: SEWRPC.

Table 362

TYPE, EXTENT, AND ESTIMATED POLLUTANT LOADINGS FROM AIR POLLUTION SOURCES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Major Land Use Category	Extent (acres)	Percent of Watershed	Pollutant	Unit Loading Rate (pounds/acre/year)	Estimated Channel Load (pounds/year)
Lakes and Streams	40	0.49	Total Nitrogen	8.9	360
			Total Phosphorus	0.5	20
			Biochemical Oxygen Demand	162	6,480
			Fecal Coliform	Negligible	--
			Sediment	665	15 tons

Source: SEWRPC.

and livestock operations contributing the largest loads of all pollutants. Agricultural runoff produces the largest diffuse source loads of nitrogen and sediment, along with the second largest load of phosphorus and biochemical oxygen demand. In addition, livestock operations produce the largest loads of phosphorus, biochemical oxygen demand, and fecal coliform. Silvicultural activities and air pollution loadings to surface waters produce less than 2 percent of all diffuse source loads. All individual urban diffuse sources produce less than 8 percent of the total diffuse source loads of nitrogen, phosphorus, biochemical oxygen demand, fecal coliform, and sediment. Urban diffuse sources total only 3 percent of the nitrogen, 7 percent of the phosphorus, 12 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and 12 percent of the sediment contributed from diffuse sources. Total annual diffuse source loads are 147,800 pounds of nitrogen, 13,900 pounds of phosphorus, 327,300 pounds of biochemical oxygen demand, 9.9×10^{14} fecal coliform counts, and 21,850 tons of sediment.

SUMMARY

To properly assess the water quality of lakes and streams, all sources of water pollution, inclusive of point and diffuse sources, must be identified, quantified, and their effects evaluated. Although methods for the identification and quantification of point sources of pollution are well developed, the state of the art of diffuse source analysis is in its infancy. However, based on other Commission studies, diffuse pollution sources appear to have a sufficiently adverse effect on water quality to violate the water quality standards in many streams, regardless of point source controls. Accordingly, an analysis of the characteristics, magnitude, relative importance, and distribution of every significant diffuse source of water pollution in the Region and that portion of the Milwaukee River watershed out of the Region was prepared. In addition to identifying and enumerating all known kinds of diffuse sources for which data are available, this chapter describes the conditions under which pollution problems may occur; presents and documents the assumed channel loading rates for each source; and estimates the diffuse source pollution loadings for each watershed, to determine the potential of each source to contribute to water pollution problems.

Many parameters or indicators are available for measuring and describing water quality. The five parameters chosen for the Commission's analysis—total nitrogen, total phosphorus, biochemical oxygen demand, fecal coliform, and sediment—were analyzed in detail because these pollutants have been demonstrated to be indicative of general water quality, because existing water quality standards can be related to these parameters, and because sufficient data were available to enable the estimation of loadings of these pollutants from diffuse sources in the Region. Other parameters which affect water quality, such as heavy metals, pesticides, hydrogen ion concentration, chloride, and temperature, are discussed for those conditions for which data are available from pertinent studies reported. although no unit loadings are estimated, due to the paucity of data available and the generally inconsistent levels of detail for which research results are reported.

The diffuse sources discussed in this chapter are dichotomized into urban and rural categories. The urban sources include residential, commercial, and industrial land uses; extraction, transportation, recreation, and construction activities; and onsite sewage disposal systems. Rural sources include livestock operations, cropland, pastureland, woodlands, orchards and nurseries, and air pollution fallout and washout directly to surface waters.

Potential mass pollutant runoff amounts were used to determine the potential pollutant contributions from some diffuse sources. Reported ranges in the amounts of potential mass pollutant runoff are presented in Table 363.

Channel loading rates from diffuse sources were estimated to determine the relative amounts of pollutants generated from the various sources and to enable computation of the total potential pollution load to surface waters within a watershed. The

Table 363

RANGES OF POTENTIAL MASS POLLUTANT RUNOFF REPORTED IN TECHNICAL STUDIES

Pollution Source	Reporting Units	Total Nitrogen	Total Phosphorus	Biochemical Oxygen Demand	Fecal Coliform	Sediment
Residential Land Use	lbs. per acre per year, except fecal coliform in counts per acre per year	31-577	5.6-105	245-4,600	1.4×10^{8}- 2.7×10^{9}[b]	55,600- 1,049,000[a]
Commercial Land Use	lbs. per acre per year, except fecal coliform in counts per acre per year	24-29	4.3-5.2	189-230	1.1×10^{8}- 1.4×10^{8}[b]	43,000- 52,500[a]
Industrial Land Use	lbs. per acre per year, except fecal coliform in counts per acre per year	45-1,400	8.3-254	365-11,200	2.1×10^{8}- 6.6×10^{9}[b]	82,700- 2,544,000[a]
Onsite Sewage Disposal Systems	lbs. per capita (served) per year, except fecal coliform in counts per per capita per year	0-14.33	0-3.31	0-204	0- 2.5×10^{11}	0-70
Livestock Operations	lbs. per equivalent animal unit per year except fecal coliform in counts per animal unit per year	73-255	8-98	290-1,000	9.9×10^{11}- 8.1×10^{12}	2,190- 4,900[a]
Agricultural Land Use	lbs. per acre per year	N/A	N/A	N/A	N/A	1,920- 27,000

NOTE; N/A indicates data not available.

[a] *Values apply to total solids.*

[b] *Values presented are only the street surface accumulations and are lower than channel pollutant loads applied, since the more pervious surfaces of these land uses are assumed to contribute more heavily to the storm water runoff.*

Source: SEWRPC.

loading rates applied, along with ranges of loading values from other studies, are presented in Table 364. The loading rates were reviewed for reasonableness and for consistency of the results from these many studies reviewed. The resulting pollutant loading rates are considered to be approximations of the potential loads from diffuse sources of water pollution in southeastern Wisconsin. The unit loads were applied to each watershed to estimate the total potential load to the stream system and to identify major pollution sources.

Based on the assumed unit loading rates, total potential loadings from diffuse sources were estimated for each watershed in the Region including that portion of the Milwaukee River watershed outside the Region. This data provides an indication of the relative importance of specific diffuse sources with regard to the predominant water quality problems confronting the Region, along with an identification and quantification of the major potential contributors of specific pollutants.

Residential land uses covered approximately 147,700 acres, or 8 percent of the Region in 1975. Total potential pollutant loads from residential land uses within the Region excluding land under development are estimated at 590,600 pounds of nitrogen, 47,300 pounds of phosphorus, 3,587,900 pounds of BOD_5, 2.4×10^{15} fecal coliform counts, and 40,240 tons of sediment per year. Approximately 24,600 acres, or 1 percent of the total surface was devoted to commercial land uses in 1975. The estimated potential pollutant loadings from these areas on an annual basis were 221,100 pounds of nitrogen, 18,400 pounds of phosphorus, 2,397,800 pounds of BOD_5, 8.1×10^{14} fecal coliform counts, and 9,150 tons of sediment.

Industrial land uses covered 15,000 acres, or 1 percent of the Region in 1975, and contributed a potential estimated annual load of 126,000 pounds of nitrogen, 10,500 pounds of phosphorus, 553,400 pounds of BOD_5, 9.3×10^{14} fecal coliform counts, and 7,310 tons of sediment to the surface waters of the Region. The 8,000 acres of extractive mining operations consisting of gravel pits and attendant washing operations in the Region contribute a potential annual load of 481,700 pounds of nitrogen, 361,300 pounds of phosphorus, 963,500 pounds of BOD_5, and 602,180 tons of sediment.

Transportation related land uses assessed within the Region include freeways, other arterial streets and highways, railroads and shipping yards, and airports. The estimated potential annual pollutant loads contributed from the 26,700 acres, or 2 percent of the Region in 1975 of transportation related land uses are 563,900 pounds of nitrogen, 41,800 pounds of phosphorus, 3,637,400 pounds of BOD_5, 1.5×10^{15} fecal coliform counts, and 465,890 tons of sediment. Additional transportation facilities are present in the

Table 364

SUMMARY OF REPORTED POLLUTANT CHANNEL LOADING RATES FROM DIFFUSE SOURCES

Category of Diffuse Pollution Sources	Total Nitrogen	Rate of Pollution Loading[a] (given in lbs./acre/yr. except for MFFCC given in counts/acre/yr.) Total Phosphorus	Biochemical Oxygen Demand	Membrane Filter Fecal Coliform Counts	Sediment
Urban					
Residential Land Use	4.0	0.32	24.3	1.6×10^{10}	545
	(1.9-11.5)	(0.32-7.3)	(10.2-95.9)		(356-7,360)
Commercial Land Use	9.0	0.75	97.6	3.3×10^{10}	745
	(9.0-77.4)	(0.75-4.1)	(16-168)		
Industrial Land Use	8.4	0.70	36.9	6.2×10^{10}	977
	(8.4-76.4)	(0.82-9.4)	(16-188)		
Construction Activities	60.0	45.0	120.0	Negligible	150,000
	(60-150)	(45-120)	(120-4,500)		(3,000-380,000)
Extractive Activities	60.0	45.0	120.0	Negligible	150,000
	(60-150)	(45-120)	(120-4,500)		(3,000-380,000)
Transportation—Freeways and Highways	23.4	1.4	159.0	6.7×10^{10}	42,600
Airports—Mitchell Field	13.5	2.6	73.0	Negligible	2,900
—Other	12.0	2.7	17.6	Negligible	3,200
Recreation—Parks	2.3	0.06	1.3	3.6×10^{9}	420
	(2.3-26.1)	(0.06-1.53)			(420-750)
—Golf Courses	4.4	0.20	1.3	Negligible	420
	(4.4-26.1)	(0.20-1.53)			(420-750)
Onsite Sewage Disposal Systems[b] (lbs/capita/yr.)	1.4-5.7	2.33-1.32	20.4-81.6	-- 2.5×10^{10}-1.0×10^{11}	7-28
Rural					
Livestock Operations (lbs./animal unit/yr.)	28.4	6.6	111.2	6.4×10^{11}	700
Orchards	2.3	0.14	4.6	6.6×10^{8}	251
	(0.7-9.1)	(0.01-0.80)	(3.6-6.3)		(45-389)
Pastures	4.6	0.29	9.7	Included in Livestock Load	420
	(1.0-7.6)	(0.22-0.57)	(5.4-15.4)		(12-828)
Woodlands	2.3	0.14	4.6	6.6×10^{8}	251
	(0.7-9.1)	(0.01-0.80)	(3.6-6.3)		(45-389)
Air Pollution to Surface Waters	8.9	0.5	162.0	Negligible	665
	(4.4-39.4)	(0.045-1.60)	(153-162)		(614-1,500)
Croplands[b]	0.9-23.1	0.09-0.64	2.1-30.0	Included in Livestock Load	700-10,000)
General Agricultural Land	(0.03-23.1)	(0.09-2.59)	(Not Available)		(680-51,000)

[a] *Numbers in parentheses are the range of loadings available in the literature. If only one literature value was available, or if the loading value was computed from regional data and no additional values were available, no loading range is presented. The literature sources from which the loading rates were developed and a description of the procedures used to estimate loading rates are presented in this Chapter in the individual sections discussing the various diffuse sources.*

[b] *Channel loading rates assumed for septic tanks and for croplands varied by watershed, and are discussed in this Chapter.*

Source: SEWRPC.

Region in the form of local collector and land access streets in residential, commercial, industrial, and rural areas. The pollutant contributions from these types of streets are included in the land uses which they serve.

The major recreational facilities within the Region as of 1975 included parks and golf courses with a total area of 31,800 acres, or 2 percent of the Region. It is estimated that recreational facilities contribute a potential annual pollutant load of 99,900 pounds of nitrogen, 3,700 pounds of phosphorus, 41,400 pounds of BOD_5, 6.9 x 10^{13} fecal coliform counts, and 6,680 tons of sediment.

The total number of acres of land under construction in 1975 within the Region was estimated at 30,200 acres, or 2 percent of the Region. It is estimated that 1,813,000 pounds of nitrogen, 1,359,800 pounds of phosphorus, 3,626,000 pounds of BOD_5, and 2,266,280 tons of sediment are transported from these construction sites annually.

As of 1975, there were 334 known holding tanks and 36 known mound systems in the Region, and 68,622 septic systems in the Region. It is estimated that a potential load of 782,200 pounds of nitrogen, 179,900 pounds of phosphorus, 11,122,000 pounds of BOD_5, 1.4 x 10^{16} fecal coliform counts, and 1,910 tons of sediment are contributed annually by septic systems in the Region.

As of May, 1975, there were 2,350 livestock operations with a total of 852,320 animals, or 227,374 equivalent animal units known to exist within the Region. Of these operations, 963 were located within 500 feet of a stream. A potential load of 7,078,700 pounds of nitrogen, 1,645,100 pounds of phosphorus, 27,716,600 pounds of BOD_5, 1.6 x 10^{17} fecal coliform counts, and 87,240 tons of sediment from livestock operations are estimated to reach surface waters annually within the Region.

Agricultural land within the Region consists of grain, hay, row, and specialty crops, pasture, and open lands. In 1975, there were 1,259,000 acres of agricultural land which comprised 72 percent of the Region. A potential annual pollutant loading of 17,809,600 pounds of nitrogen, 548,000 pounds of phosphorus, 19,143,400 pounds of BOD_5, and 2,847,490 tons of sediment are contributed from agricultural land uses.

As of 1975, farm conservation plans had been prepared by the U.S. Soil Conservation Service (SCS) for 2,962 farms covering about 324,673 acres, or 22 percent of the rural lands within the Region. A total of 6,363 soil and water conservation practices were applied within the Region during the 10-year period ending in 1975. Some of these practices were implemented on lands for which no farm conservation plans were prepared.

The 1976 replacement costs of conservation practices within the Region totaled $9,660,347, or an equivalent $6.57 per acre of the total rural land within the Region. Of the total estimated expenditures on conservation practices, about $4.07 per acre of rural land, or about 62 percent of the total investment were related to those practices directly affecting water quality, the remainder being for practices which serve primarily to enhance the productivity of the land surface for crop growth. This represents about 27 percent of the estimated average cost per acre of rural land to implement conventional SCS farm plans, based on an analysis of the implementation costs of 56 farm plans.

About 164,200 acres, or 9 percent of the Region, were devoted to silvicultural activities in 1975, including woodlands, orchards, and nurseries. An estimated load of 377,700 pounds of nitrogen, 23,000 pounds of phosphorus, 755,300 pounds of BOD_5, 1.1 x 10^{14} fecal coliform counts, and 20,600 tons of sediment are contributed annually from silvicultural land uses in the Region.

A total of 48,100 acres, or 3 percent of the Region is covered by surface water. It is estimated that 428,100 pounds of nitrogen, 24,100 pounds of phosphorus, 7,792,400 pounds of BOD_5, and 15,990 tons of sediment may be contributed to the surface waters of the Region annually by direct atmospheric fallout and precipitation washout.

An analysis of the watershed loadings indicates that, for the Region, runoff from cropland is the major diffuse source contributor of nitrogen and sediment. Livestock operations are estimated to contribute the greatest number of fecal coliform organisms and the highest loads of phosphorus and biochemical oxygen demand. Runoff from construction activities is estimated to be the single diffuse category contributing the second largest amount of phosphorus and sediment. In the predominantly agricultural watersheds—the Fox River, Root River, Milwaukee River, Rock River, Des Plaines River, Sauk Creek, Pike River, Sucker Creek, and Sheboygan River watersheds the major sources of pollutants are cropland runoff and livestock operations.

The urban and urbanizing watersheds have a greater variety of major pollution sources. Oak Creek watershed and Barnes Creek subwatershed remain agricultural in nature, but urbanizing construction activities are estimated to be of sufficient magnitude to contribute a larger amount of sediment and phosphorus than cropland. In the Pike Creek subwatershed, construction activities contribute the greatest amount of phosphorus and sediment, while industrial areas contribute the largest number of fecal coliform organisms. In the Menomonee River watershed, the analyses indicated that cropland runoff is the major contributor only for total nitrogen, while transportation land uses, which serve the urbanized area, contribute the largest amounts of biochemical oxygen demand and sediment. Only in the Kinnickinnic River watershed, the most urbanized watershed, are agricultural sources not the major source of one or more pollutants. Estimates indicate that runoff from residential areas contributes the largest amount of nitrogen and biochemical oxygen demand, and construction activities are the largest contributor of phosphorus and sediment.

Based on the available studies of diffuse sources of pollution and the land uses within the Region, the total loadings of water pollutants from diffuse sources, activated and transported by storm water runoff or by groundwater, were estimated to quantify the importance of these sources, and to compare them to the contributions from the known municipal, private and industrial wastewater treatment facilities, and from flow relief devices. The total estimated loadings were found to be significant in themselves within each of the 12 watersheds of the Region and are compared to point sources in each watershed in Chapter VI, which follows.

(This page intentionally left blank)

Chapter VI

COMPARISON OF POLLUTION SOURCES

INTRODUCTION

All sources of water pollution within the Region, including municipal and private sewage treatment facilities and flow relief devices, industrial wastewaters, and diffuse sources, contribute materials to the lakes and streams which degrade the chemical, physical, and biological quality of the water and impair the utility of the water as a valuable natural resource entity. The pollutants, regardless of their source, are ultimately transported in common natural drainage networks with continual and intermittent mixing, deposition, erosion, biological uptake and release, and chemical transformation activities constantly altering the concentrations, chemical and physical status, and biological availability of the pollutants. Water quality depends upon these cultural sources of pollutants to the stream or lake and the management practices which are implemented to control, reduce or eliminate the pollution sources. Whether the stream is a nauseating muddy flow, nourished by man's wastes, or a relatively clean stream reflecting only runoff from the watershed soils and natural vegetation, its water quality is a function of the management and mis-management of the land and water resources, waste treatment practices, artificial drainage systems, and the degree of use of surface water protection and preservation measures in its tributary watershed.

Recognizing this, the Commission has prepared this report as part of its areawide water quality management planning program, to identify and quantify all sources of water pollution to the inland surface waters of the Region.[1] Together with SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975, this report supports the formulation, development, and implementation of a water quality management plan for southeastern Wisconsin. Chapter II of this report describes the characteristics, effects, and transport mechanisms of the major pollutants in the Region. Chapter III discusses sanitary sewers and their appurtenant flow relief devices, sewage treatment plants, combined sewer overflows and industrial waste outfalls as sources of pollution. Storm sewer outflow quantities are considered in Chapter IV. Finally, diffuse pollution sources, including land runoff and man's activities which discharge wastes through some means other than a point source, are discussed in Chapter V. Pollutant loadings to inland surface waters from point and nonpoint sources are described and estimated in each of the cited chapters as appropriate, and are summarized by watershed in this chapter.

The Commission estimated potential pollution loading rates from diffuse sources to enable the estimation of total annual loads to each watershed river system. In addition to the gross pollutant loads, however, the analysis offers the means of identifying the relative pollution runoff rates, thus distinguishing the most important sources of pollution from the relatively minor sources. This quantification and comparison of the various pollution sources will permit the areawide water quality management plan to be developed more effectively and will allow the concentration of initial control measures on the most severe pollution sources. The management plan should thus have the greatest impact practicable on water quality improvement. The pollutant loading summary tables enable the estimation of the average loading from a unit of land surface area in a given watershed, to provide for the comparison and ranking of water pollution problems of the different watersheds.

INVENTORY AND ANALYSIS FINDINGS

Wet Year/Dry Year Analysis

In an effort to evaluate the effects of annual precipitation variations on water pollution sources, a wet year and dry year analysis is included in the loading

---

[1] *The only significant exclusion from the sources of pollution considered is groundwater inflow to surface waters. This report does identify most, if not all, of the potential sources of groundwater pollution, but the analytical procedures used in the studies on which the report is based do not permit full consideration of groundwater quality phenomena. Although a detailed analysis of groundwater flow as a pollution source is beyond the scope of this report, such flow is being considered in other aspects of the areawide water quality management planning program. The studies of water quality in inland lakes conducted under the program have included groundwater quality sampling at approximately 510 sampling sites. The stream and inland lake water quality simulation model activities conducted under the program are supported by in-stream sampling which included samples taken at times of low streamflows, when groundwater inflow and in some cases, wastewaters from industrial and sanitary sewers outfalls of known strength and rates of flow are the only known sources of pollution. Finally, the Commission staff has compiled from U.S. Geological Survey sources, a map of the potential for groundwater pollution. For more complete discussion of these topics, see SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000.*

rate summaries. Specifically, the analysis quantifies the variations in total pollution loadings and in relative loadings from point and diffuse sources as a function of precipitation amounts and the resulting runoff. The typical dry and wet years were selected by determining the average, the maximum, and the minimum annual precipitation, with the 36-year period of weather records available from the Milwaukee first order weather station. The resulting precipitation amounts of 29.69 inches, 40.71 inches, and 19.10 inches per year were then applied as appropriate to estimate the relative importance of the different pollution sources under different annual weather conditions. A wet year factor of 1.371 and a dry year factor of 0.643 were computed from the relative precipitation amounts. It should be noted, however, that runoff amounts do not vary proportionately with precipitation amounts. For instance, when 40.71 inches of precipitation fell in 1960, about 35 percent, or 14 inches was transported by the stream network as runoff, based on analyses of U.S. Geological Survey Milwaukee River, and Fox River discharge data. In 1963, when 19.10 inches of precipitation occured, only 16 percent, or 3 inches ran off the land surface in the Fox and Milwaukee River watersheds, due to drier antecedent moisture conditions of the soil. Therefore, these wet year and dry year factors provide a conservative estimate, and the contributions during extreme wet and dry conditions could be even greater than was indicated by the assumed factors. The pollution loadings from diffuse sources, which were considered to be greatly influenced by precipitation runoff, were multiplied by these factors to estimate loadings during relatively wet and dry years. Average year point source loadings from sewage flow relief devices were similarly multiplied by the wet and dry year factors to estimate the expected range of annual loadings due to annual precipitation variations. The remaining point source categories, including municipal sewage treatment plants, private sewage treatment plants, and industrial wastewater discharges, were assumed not to be significantly influenced by precipitation runoff; therefore neither a dry year nor wet year factor was applied to the average year loads.

Pollutant Transport Analysis

To determine the amount of pollutants actually being transported by the inland streams in the Region, thus allowing comparison with estimated channel loads and the water quality simulation model output, a pollutant transport analysis was conducted. The transport loads were estimated by application of a technique developed in the International Joint Commission's Pilot Study of the Menomonee River Watershed, being conducted by the Wisconsin Department of Natural Resources, with participation by the Commission. The procedure applies a stratified random sampling technique to distinguish between wet-weather and dry-weather estimates of instantaneous pollutant transport in order to evaluate annual loads and variance estimates for each watershed for which sufficient data were available. For a detailed description of the modeling technique used in the transport analysis, see Final Summary Pilot Watershed Report, International Joint Commission Menomonee River Pilot Watershed Study, December 1, 1977. The transport loading analysis provides a measure of the actual stream transport, as opposed to drainage channel loads. Measurements of suspended solids, total nitrogen, total phosphorus, and BOD_5 concentrations and streamflow were available for the Root River at Racine, with a 187 square mile drainage area; for the Fox River at Wilmot, which drains 868 square miles; for the Milwaukee River at Estabrook Park-Milwaukee, with a 686 square mile drainage area; for the Pike River near Racine and the STH 38 bridge, with a drainage area of 39 square miles; for the Des Plaines River at Pleasant Prairie, with a tributary area of 123 square miles; and for Oak Creek downstream from the 15th Avenue bridge, which drains 25 square miles. Data on suspended solids, total nitrogen, total phosphorus, and streamflow were available for the Menomonee River at 70th Street in Wauwatosa, with a 123 square mile drainage area. Table 365 presents the sources of data used in the transport analysis. Inasmuch as suspended solids data were used in the analysis, 10 percent was added to the watershed yield to account for bedload which consists of the coarser sediments transported along the stream bottom, as opposed to the finer sediments transported in suspension in the streamflow and therefore included in suspended solids samples.

It is expected that the in-stream transport loads estimated from field measurements will be lower than the estimated channel loads from diffuse sources presented in the summary tables, since the channel loading rates were computed on the basis of small scale studies, which sampled runoff quality from snall watersheds. Such research studies have historically been limited and have sought to characterize the water quality effects of areas of uniform land use—just as they should—which generally does not occur over an entire large watershed. A notable departure from this approach is the Menomonee River Pilot Watershed Study, and similar studies currently being conducted by the International Joint Commission. When the runoff loading rates developed from such studies of very small watersheds are applied to a larger watershed, the actual loads are overestimated because the land and stream processes which retard or remove pollutants during transport over the land surface or within the stream system are not taken into account. These removal processes include particle deposition or entrapment on the land surface, in floodplains, lakes and wetlands; stream channel deposition or "aggradation"; biological uptake; and chemical precipitation and transformation.

Although preliminary findings of the International Joint Commission studies suggest that over a long period of time—perhaps 50 years—a stream system

Table 365

SOURCES OF DATA USED IN THE TRANSPORT ANALYSIS

		SOURCES OF DATA SAMPLES				
Watershed	Parameter	Annual Low Flow Data SEWRPC T.R. No. 17 1968-1975	SEWRPC's Index Site Sampling Program 3/12/76-11/19/76	Wisconsin Dept. of Natural Resources Monthly Sampling Program	U.S. Geological Survey Continued Streamflow Monitoring Program	U.S. Geological Survey Water Quality Monitoring Program
Des Plaines River . . .	Flow				X	
	Nitrogen	X	X	X		
	Phosphorus	X	X	X		
	BOD_5		X	X		
	Suspended Solids			X		
Fox River.	Flow				X	
	Nitrogen	X	X	X		
	Phosphorus	X	X	X		
	BOD_5		X	X		
	Suspended Solids		X	X		
Monomonee River[b]. .	Flow			X	X	
	Nitrogen	X		X		
	Phosphorus	X		X		
	BOD_5[a]					
	Suspended Solids			X		X
Milwaukee River . . .	Flow				X	
	Nitrogen	X	X			X
	Phosphorus	X	X			X
	BOD_5		X			
	Suspended Solids					X
Oak Creek	Flow				X	
	Nitrogen	X	X			
	Phosphorus	X	X			
	BOD_5		X			
	Suspended Solids			X		
Pike River	Flow				X	
	Nitrogen	X	X			
	Phosphorus	X	X			
	BOD_5		X			
	Suspended Solids[c]					
Root River	Flow				X	
	Nitrogen	X	X	X		
	Phosphorus	X	X	X		
	BOD_5		X	X		
	Suspended Solids			X		

[a] *BOD_5 data were not available for the Menomonee River.*

[b] *Water quality data were available for the Menomonee River from the Wisconsin Department of Natural Resources and the International Joint Commission, Menomonee River Pilot Watershed Study.*

[c] *A suspended solids analysis of the Pike River was previously conducted by the U.S. Geological Survey.*

Source: SEWRPC.

in equilibrium results in no net deposition[2], in-stream processes are assumed, on a short-term or annual basis, to remove a significant amount of pollutants from the water. Coleman[3] et al reported that most sediment delivered by surface runoff to streams is stored, at least temporarily, in the stream channel, and studies of small streams have indicated that obstructions and irregularities in the stream channel may store considerable quantities of sediment. Furthermore, a study of a stream in Wisconsin indicated that long-term deposition may be considerable and represents an essentially permanent loss of sediments from the streamflow.[4] It is further expected that dissolved substances, such as nitrate and soluble ortho-phosphate, are less affected by deposition processes than are particulate substances. Therefore, a greater proportion of these pollutants contained in soluble form in surface runoff will be transported to downstream sites. Figure 70 illustrates the pollutant storage and removal processes which can occur on land surfaces, and within streams, lakes and wetlands. The efficiency of a watershed's

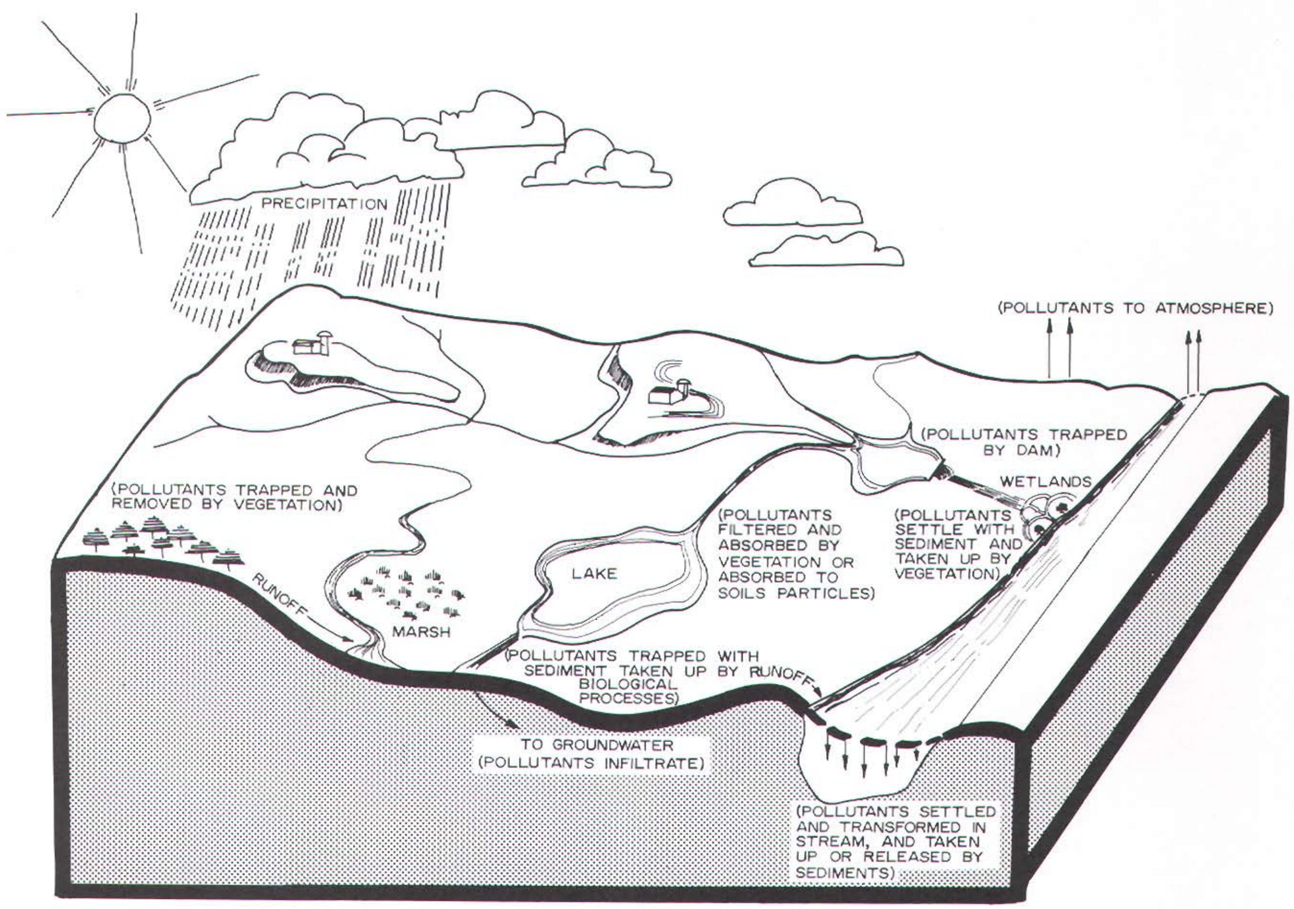
[2] *International Reference Group on Great Lakes Pollution from Land Use Activities, Stream Transport Group Report, International Joint Commission, Task C Meeting, May 3-5, 1977.*

[3] *N. L. Coleman, G. C. Bolton, and A. J. Bowie, "An Attempt to Predict Channel Sediment-Transport Capacity with Similitude Principles," ARS, Present and Prospective Technology for Predicting Sediment Yields and Sources, ARS-S-40, 1975, pp. 231-243.*

[4] *S. W. Trimble, Sedimentation in Coon Creek Valley, Wisconsin, Water Resources Council, Proc. Third Fed. Interagency Sed. Conf., March 22-25, 1976, pp. 5, and 100-112.*

Figure 70

POLLUTANT STORAGE AND REMOVAL PROCESSES WHICH OCCUR ON LAND SURFACES AND WITHIN STREAMS, LAKES, AND WETLANDS



Source: SEWRPC.

drainage channel network in transporting pollutants can be indicated by a comparison of the estimated channel loads to the watershed transport loads.

Pollution Loading Summary

The loading summary tables for the watersheds are presented in this chapter. The tables include total watershed channel loadings for an average year, wet year and dry year, and subtotal loadings for urban diffuse sources, rural diffuse sources, and point sources. It should be noted here, that, for purposes of classification and the analyses in this report, residential subdivisions in outlying areas are considered as urban land use, and therefore, the pollutant contributions from septic systems are reported as urban diffuse sources. With regard to the relative importance of nonpoint sources, the exclusion-of the largest municipal sewage treatment plant discharges and other point source discharges which are released to Lake Michigan must be considered in any interpretation of the results of these analyses. The Commission's 1975 inventory data indicated that of the total pollutant contributions to both inland and Lake Michigan shoreline waters, the 832 point source discharges to Lake Michigan comprise 27 percent of the nitrogen, 24 percent of the phosphorus, 20 percent of the BOD_5, 6 percent of the fecal coliform, and less than 1 percent of the sediment. The following discussions of the major watersheds of the Region present the estimated relative contributions of the pollutant sources to the inland lakes and streams of the Region. By comparison, the point and non-point source loads to the inland waters contribute 72 percent of the nitrogen, 74 percent of the phosphorus, 79 percent of the BOD, 94 percent of the fecal coliform and 95 percent of the sediment contributed by all sources to all inland lakes and streams and to Lake Michigan directly.

DES PLAINES RIVER WATERSHED

A summary of the loadings to the Des Plaines River is presented in Table 366 and depicted in Figure 71. Urban sources of pollution are estimated to contribute 11 percent of the nitrogen, 38 percent of the phosphorus, 30 percent of the biochemical oxygen demand, 12 percent of the fecal coliform, and 33 percent of the sediment which occur as water pollutants to the Des Plaines River. Of the urban contribution, the point sources of pollution contribute 11 percent of the nitrogen, 13 percent of the phosphorus, 2 percent of the biochemical oxygen demand, 1 percent of the fecal coliform, and less than one-tenth of one percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 89 percent of the nitrogen, 87 percent of the phosphorus, 98 percent of the biochemical oxygen demand, 99 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources. Of the total pollutant loads, rural pollution sources contribute an estimated 89 percent of the nitrogen, 62 percent of the phosphorus, 70 percent of the biochemical oxygen demand, 88 percent of the fecal coliform, and 67 percent of the sediment from all sources within the watershed. There are no rural point sources of pollution since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 24 percent of the nitrogen, 71 percent of the phosphorus, 50 percent of the biochemical oxygen demand, virtually all of the fecal coliform, and 2 percent of the sediment attributed from rural sources. The remainder of the estimated rural pollution load, or 76 percent of the nitrogen, 29 percent of the phosphorus, 50 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 98 percent of the sediment, is contributed by other rural diffuse sources, namely stormwater runoff from rural land uses and atmospheric loadings to surface waters. Figure 71 presents the relative pollution loadings discussed above within the Des Plaines River watershed.

The dry year and wet year analyses, as shown in Table 366, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since point sources of fecal coliform and sediment are insignificant in the Des Plaines River watershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors. For biochemical oxygen demand, nitrogen, and phosphorus, however, the effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and municipal and private sewage treatment plant discharges of these pollutants are unaffected. The proportion of phosphorus contributed by point sources ranges from 4 percent during a wet year to 7 percent during a dry year. Of the total nitrogen load, point sources contribute from 1 percent of the total load during a wet year to 2 percent during a dry year. Biochemical oxygen demand point source contributions ranged from one-half to 1 percent during a wet year and dry year, respectively.

The quantity of pollutants transported in the Des Plaines River at Pleasant Prairie were estimated by a transport analysis based on streamflow and pollutant concentration measurements. Streamflow data were available for the Des Plaines River at Russell, Illinois, 0.8 miles from the state line, from the U.S. Geological Survey USGS for the years 1967 to 1975 as part of its routine sampling program. Total phosphorus, total nitrogen, and biochemical oxygen demand concentration measurements were available from SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975, and from the Commission's index site sampling program. Suspended solids

Table 366

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE DES PLAINES RIVER WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants	5	Total Nitrogen	16,110.0	1.0	1.000	16,110.0	1.5	1.000	16,110.0	0.7
	5	Total Phosphorus	5,880.0	3.2	1.000	5,880.0	4.8	1.000	5,880.0	2.3
	5	Biochemical Oxygen Demand	13,580.0	0.3	1.000	13,580.0	0.5	1.000	13,580.0	0.3
	5	Fecal Coliform	10,000.0	0.0	1.000	10,000.0	0.0	1.000	10,000.0	0.0
	5	Sediment	15.0	0.0	1.000	15.0	0.0	1.000	15.0	0.0
Private Sewage Treatment Plants	6	Total Nitrogen	2,780.0	0.2	1.000	2,780.0	0.3	1.000	2,780.0	0.1
	6	Total Phosphorus	2,600.0	1.4	1.000	2,600.0	2.1	1.000	2,600.0	1.0
	6	Biochemical Oxygen Demand	11,070.0	0.3	1.000	11,070.0	0.4	1.000	11,070.0	0.2
	6	Fecal Coliform	32,000.0	0.0	1.000	32,000.0	0.1	1.000	32,000.0	0.0
	6	Sediment	15.0	0.0	1.000	15.0	0.0	1.000	15.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	6	Total Nitrogen	970.0	0.1	1.000	970.0	0.1	1.000	970.0	0.0
	6	Total Phosphorus	640.0	0.3	1.000	640.0	0.5	1.000	640.0	0.3
	6	Biochemical Oxygen Demand	780.0	0.0	1.000	780.0	0.0	1.000	780.0	0.0
	6	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	6	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Sanitary Sewer Flow Relief Devices	3	Total Nitrogen	50.0	0.0	.643	30.0	0.0	1.371	70.0	0.0
	3	Total Phosphorus	20.0	0.0	.643	10.0	0.0	1.371	30.0	0.0
	3	Biochemical Oxygen Demand	500.0	0.0	.643	320.0	0.0	1.371	690.0	0.0
	3	Fecal Coliform	76,000.0	0.1	.643	48,868.0	0.1	1.371	104,196.0	0.1
	3	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	19,910.0	1.2		19,890.0	1.8		19,930.0	0.9
		Total Phosphorus	9,140.0	4.9		9,130.0	7.4		9,150.0	3.6
		Biochemical Oxygen Demand	25,930.0	0.7		25,750.0	1.0		26,120.0	0.5
		Fecal Coliform	118,000.0	0.1		90,868.0	0.2		146,196.0	0.1
		Sediment	30.0	0.0		30.0	0.0		30.0	0.0
Urban Diffuse Sources										
Residential	3096	Total Nitrogen	12,380.0	0.7	.643	7,960.0	0.7	1.371	16,970.0	0.7
	3096	Total Phosphorus	990.0	0.5	.643	640.0	0.5	1.371	1,360.0	0.5
	3096	Biochemical Oxygen Demand	75,230.0	1.9	.643	48,370.0	1.9	1.371	103,140.0	1.9
	3096	Fecal Coliform	495,360.0	0.6	.643	318,516.5	0.6	1.371	679,138.6	0.6
	3096	Sediment	845.0	0.3	.643	545.0	0.3	1.371	1,160.0	0.3
Commercial	380	Total Nitrogen	3,420.0	0.2	.643	2,200.0	0.2	1.371	4,690.0	0.2
	380	Total Phosphorus	290.0	0.2	.643	190.0	0.2	1.371	400.0	0.2
	380	Biochemical Oxygen Demand	37,090.0	0.9	.643	23,850.0	0.9	1.371	50,850.0	0.9
	380	Fecal Coliform	125,400.0	0.1	.643	80,632.2	0.1	1.371	171,923.4	0.1
	380	Sediment	140.0	0.0	.643	90.0	0.0	1.371	190.0	0.0
Industrial	286	Total Nitrogen	2,400.0	0.1	.643	1,540.0	0.1	1.371	3,290.0	0.1
	286	Total Phosphorus	200.0	0.1	.643	130.0	0.1	1.371	270.0	0.1
	286	Biochemical Oxygen Demand	10,550.0	0.3	.643	6,780.0	0.3	1.371	14,460.0	0.3
	286	Fecal Coliform	177,320.0	0.2	.643	114,016.8	0.2	1.371	243,105.7	0.2
	286	Sediment	140.0	0.0	.643	90.0	0.0	1.371	190.0	0.0
Extractive	170	Total Nitrogen	10,200.0	0.6	.643	6,560.0	0.6	1.371	13,980.0	0.6
	170	Total Phosphorus	7,650.0	4.1	.643	4,920.0	4.0	1.371	10,490.0	4.2
	170	Biochemical Oxygen Demand	20,400.0	0.5	.643	13,120.0	0.5	1.371	27,970.0	0.5
	170	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	170	Sediment	12,750.0	4.5	.643	8,200.0	4.5	1.371	17,480.0	4.5
Transportation	832	Total Nitrogen	18,960.0	1.1	.643	12,190.0	1.1	1.371	25,990.0	1.1
	832	Total Phosphorus	1,220.0	0.7	.643	780.0	0.6	1.371	1,670.0	0.7
	832	Biochemical Oxygen Demand	125,930.0	3.2	.643	80,970.0	3.2	1.371	172,650.0	3.2
	832	Fecal Coliform	527,290.0	0.6	.643	339,047.5	0.6	1.371	722,914.6	0.6
	832	Sediment	16,835.0	5.9	.643	10,825.0	5.9	1.371	23,080.0	5.9
Recreation	628	Total Nitrogen	2,220.0	0.1	.643	1,430.0	0.1	1.371	3,040.0	0.1
	628	Total Phosphorus	90.0	0.0	.643	60.0	0.0	1.371	120.0	0.0
	628	Biochemical Oxygen Demand	820.0	0.0	.643	530.0	0.0	1.371	1,120.0	0.0
	628	Fecal Coliform	9,396.0	0.0	.643	6,041.6	0.0	1.371	12,881.9	0.0
	628	Sediment	130.0	0.0	.643	85.0	0.0	1.371	180.0	0.0
Construction	852	Total Nitrogen	51,120.0	3.1	.643	32,870.0	3.0	1.371	70,090.0	3.1
	852	Total Phosphorus	38,340.0	20.6	.643	24,650.0	20.1	1.371	52,560.0	20.9
	852	Biochemical Oxygen Demand	102,240.0	2.6	.643	65,740.0	2.6	1.371	140,170.0	2.6
	852	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	852	Sediment	63,900.0	22.4	.643	41,090.0	22.4	1.371	87,605.0	22.4
Septic Systems	9535	Total Nitrogen	54,350	3.3	.643	34,950	3.2	1.371	74,510	3.3
	9535	Total Phosphorus	12,590	6.8	.643	8,100	6.6	1.371	17,260	6.9
	9535	Biochemical Oxygen Demand	778,060	19.8	.643	500,290	19.7	1.371	1,066,720	19.8
	9535	Fecal Coliform	9,535,000	10.6	.643	6,131,005	10.6	1.371	13,072,485	10.6
	9535	Sediment	135	0.0	.643	85	0.0	1.371	185	0.0

Table 366 (continued)

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Diffuse Source Totals		Total Nitrogen	155,050.0	9.3		99,700.0	9.2		212,560.0	9.3
		Total Phosphorus	61,370.0	33.0		39,470.0	32.1		84,130.0	33.4
		Biochemical Oxygen Demand	1,150,320.0	29.2		739,650.0	29.1		1,577,080.0	29.3
		Fecal Coliform	10,869,766.0	12.1		6,989,259.6	12.1		14,902,449.2	12.1
		Sediment	94,875.0	33.3		61,010.0	33.3		130,070.0	33.3
Urban Source Totals		Total Nitrogen	174,960.0	10.5		119,590.0	11.1		232,490.0	10.2
		Total Phosphorus	70,510.0	37.9		48,600.0	39.5		93,280.0	37.1
		Biochemical Oxygen Demand	1,176,250.0	29.9		765,400.0	30.1		1,603,200.0	29.7
		Fecal Coliform	10,987,766.0	12.2		7,080,127.6	12.2		15,048,645.2	12.2
		Sediment	94,905.0	33.3		61,040.0	33.3		130,100.0	33.3
Rural Diffuse Sources										
Livestock Operations	12340	Total Nitrogen	350,460.0	21.0	.643	225,350.0	20.9	1.371	480,480.0	21.1
	12340	Total Phosphorus	81,440.0	43.8	.643	52,370.0	42.6	1.371	111,650.0	44.4
	12340	Biochemical Oxygen Demand	1,372,210.0	34.8	.643	882,330.0	34.7	1.371	1,881,300.0	34.9
	12340	Fecal Coliform	78,976,000.0	87.8	.643	50,781,568.0	87.7	1.371	108,276,096.0	87.8
	12340	Sediment	4,320.0	1.5	.643	2,780.0	1.5	1.371	5,925.0	1.5
Cropland, Pasture, and Unused Rural Land	65540	Total Nitrogen	1,120,120.0	67.2	.643	720,240.0	66.8	1.371	1,535,680.0	67.4
	65540	Total Phosphorus	32,910.0	17.7	.643	21,160.0	17.2	1.371	45,120.0	17.9
	65540	Biochemical Oxygen Demand	1,185,350.0	30.1	.643	762,180.0	30.0	1.371	1,625,110.0	30.2
	65540	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	65540	Sediment	185,090.0	64.9	.643	119,015.0	64.9	1.371	253,760.0	64.9
Silvicultural	4675	Total Nitrogen	10,750.0	0.6	.643	6,910.0	0.6	1.371	14,740.0	0.6
	4675	Total Phosphorus	650.0	0.3	.643	420.0	0.3	1.371	890.0	0.4
	4675	Biochemical Oxygen Demand	21,510.0	0.5	.643	13,830.0	0.5	1.371	29,490.0	0.5
	4675	Fecal Coliform	30,855.0	0.0	.643	19,839.8	0.0	1.371	42,302.2	0.0
	4675	Sediment	585.0	0.2	.643	375.0	0.2	1.371	800.0	0.2
Air Pollution to Surface Water	1127	Total Nitrogen	10,030.0	0.6	.643	6,450.0	0.6	1.371	13,750.0	0.6
	1127	Total Phosphorus	560.0	0.3	.643	360.0	0.3	1.371	770.0	0.3
	1127	Biochemical Oxygen Demand	182,570.0	4.6	.643	117,390.0	4.6	1.371	250,300.0	4.6
	1127	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1127	Sediment	375.0	0.1	.643	240.0	0.1	1.371	515.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	1,491,360.0	89.5		958,950.0	88.9		2,044,650.0	89.8
		Total Phosphorus	115,560.0	62.1		74,310.0	60.5		158,430.0	62.9
		Biochemical Oxygen Demand	2,761,640.0	70.1		1,775,730.0	69.9		3,786,200.0	70.3
		Fecal Coliform	79,006,855.0	87.8		50,801,407.8	87.8		108,318,398.2	87.8
		Sediment	190,370.0	66.7		122,410.0	66.7		261,000.0	66.7
Diffuse Source Totals		Total Nitrogen	1,646,410.0	98.8		1,058,650.0	98.2		2,257,210.0	99.1
		Total Phosphorus	176,930.0	95.1		113,780.0	92.6		242,560.0	96.4
		Biochemical Oxygen Demand	3,911,960.0	99.3		2,515,380.0	99.0		5,363,280.0	99.5
		Fecal Coliform	89,876,621.0	99.9		57,790,667.4	99.8		123,220,847.4	99.9
		Sediment	285,245.0	100.0		183,420.0	100.0		391,070.0	100.0
Total Sources		Total Nitrogen	1,666,320.0	100.0		1,078,540.0	100.0		2,277,140.0	100.0
		Total Phosphorus	186,070.0	100.0		122,910.0	100.0		251,710.0	100.0
		Biochemical Oxygen Demand	3,937,890.0	100.0		2,541,130.0	100.0		5,389,400.0	100.0
		Fecal Coliform	89,994,621.0	100.0		57,881,535.4	100.0		123,367,043.4	100.0
		Sediment	285,275.0	100.0		183,450.0	100.0		391,100.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

concentration data were available from the Wisconsin Department of Natural Resources monthly sampling program. In the Des Plaines River, at Pleasant Prairie, it is estimated from these in-stream measurements that about 580,000 pounds of nitrogen, 50,000 pounds of phosphorus, 600,000 pounds of biochemical oxygen demand, and 6,964,000 pounds of sediment are transported annually. Table 367 presents a comparison of pollutant transport loads, based on streamflow samples, to channel loads as estimated from regional data and general studies. As noted above, the transport loads, as computed from in-stream measurements, are, as expected, significantly less than the channel loads because of the physical, chemical, and biological processes occurring on the land surface and within the stream itself which serve to effectively remove the pollutants temporarily or permanently.

Figure 71

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE DES PLAINES RIVER WATERSHED

NITROGEN

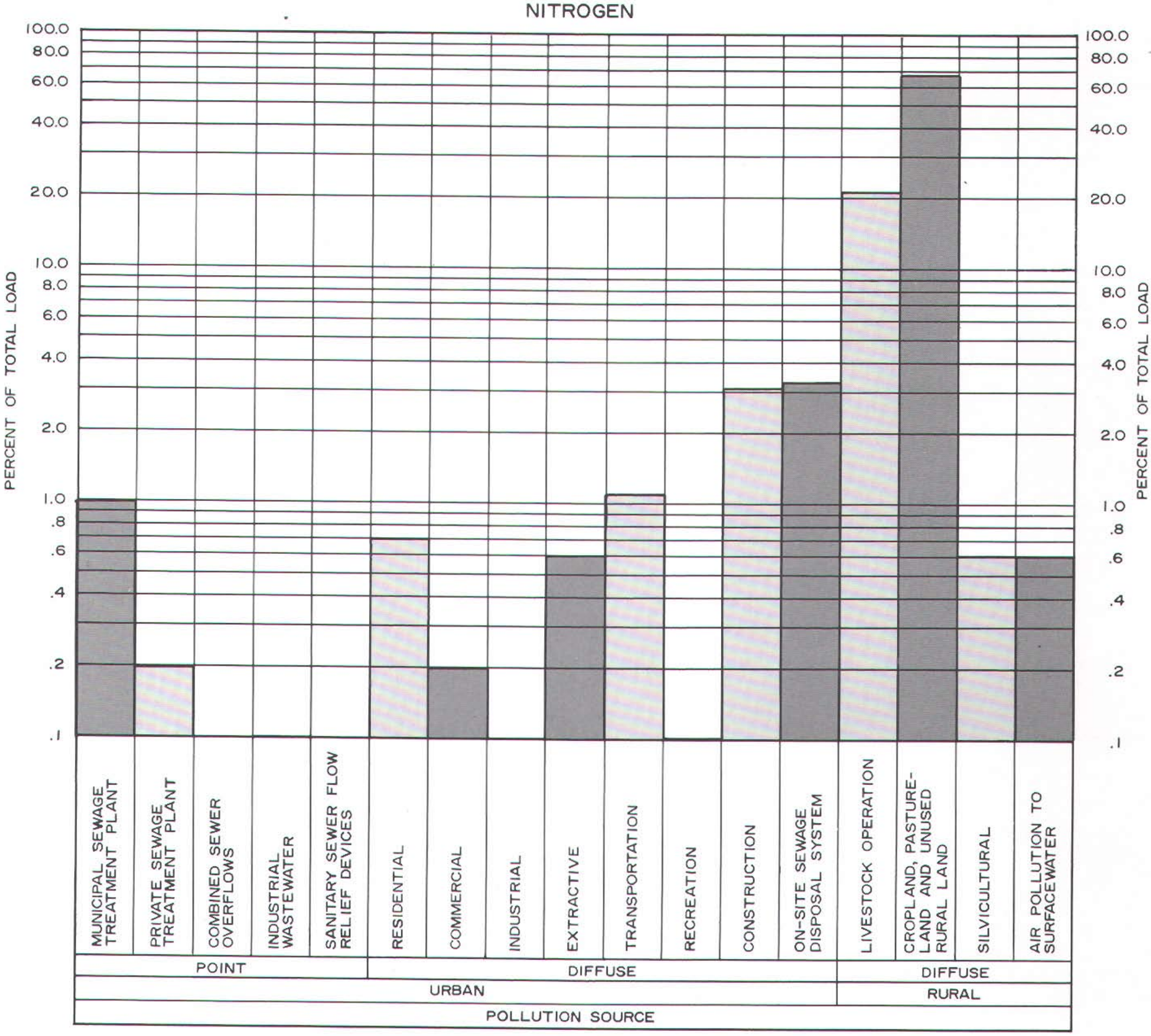


Figure 71 (continued)

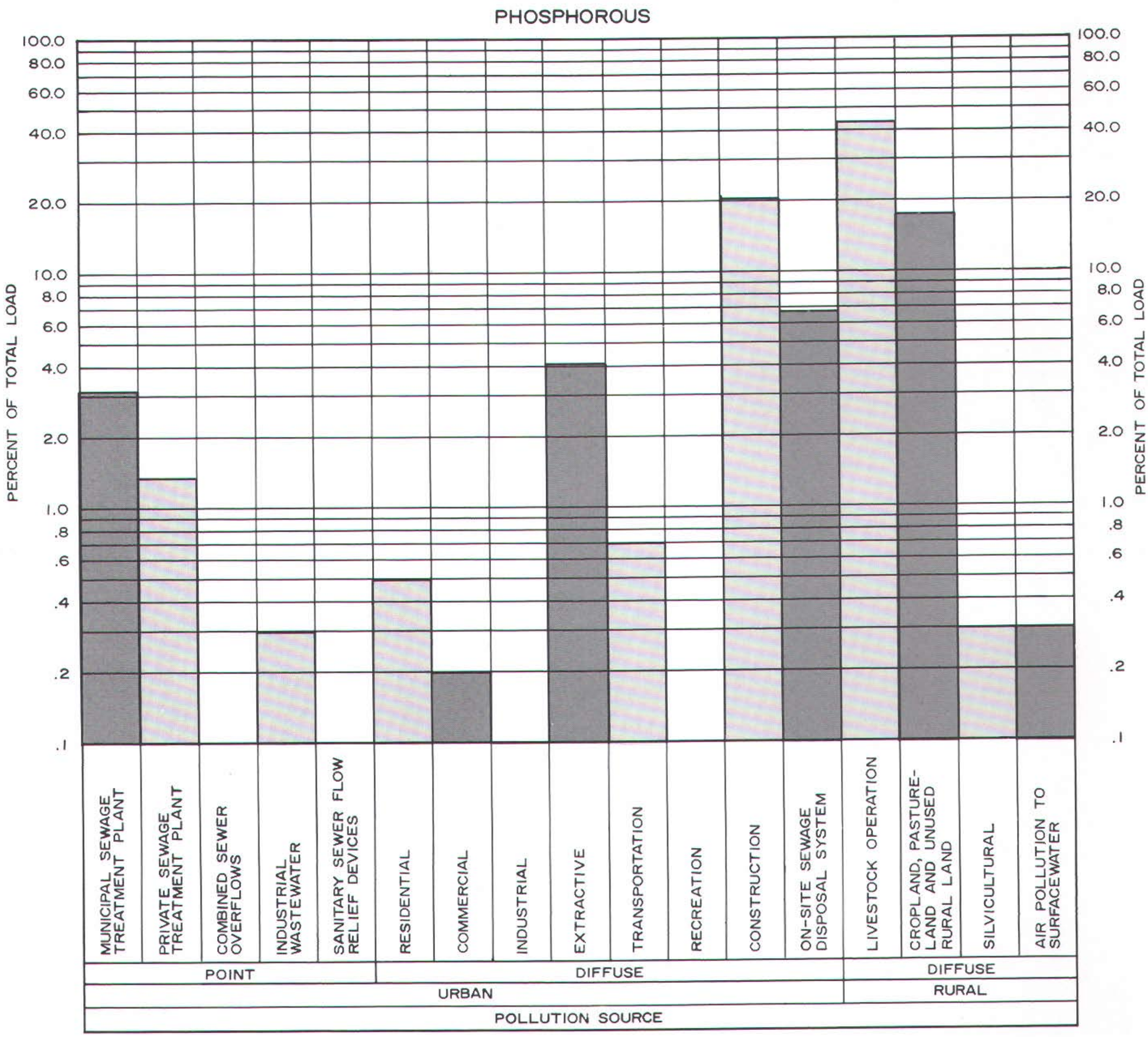


Figure 71 (continued)

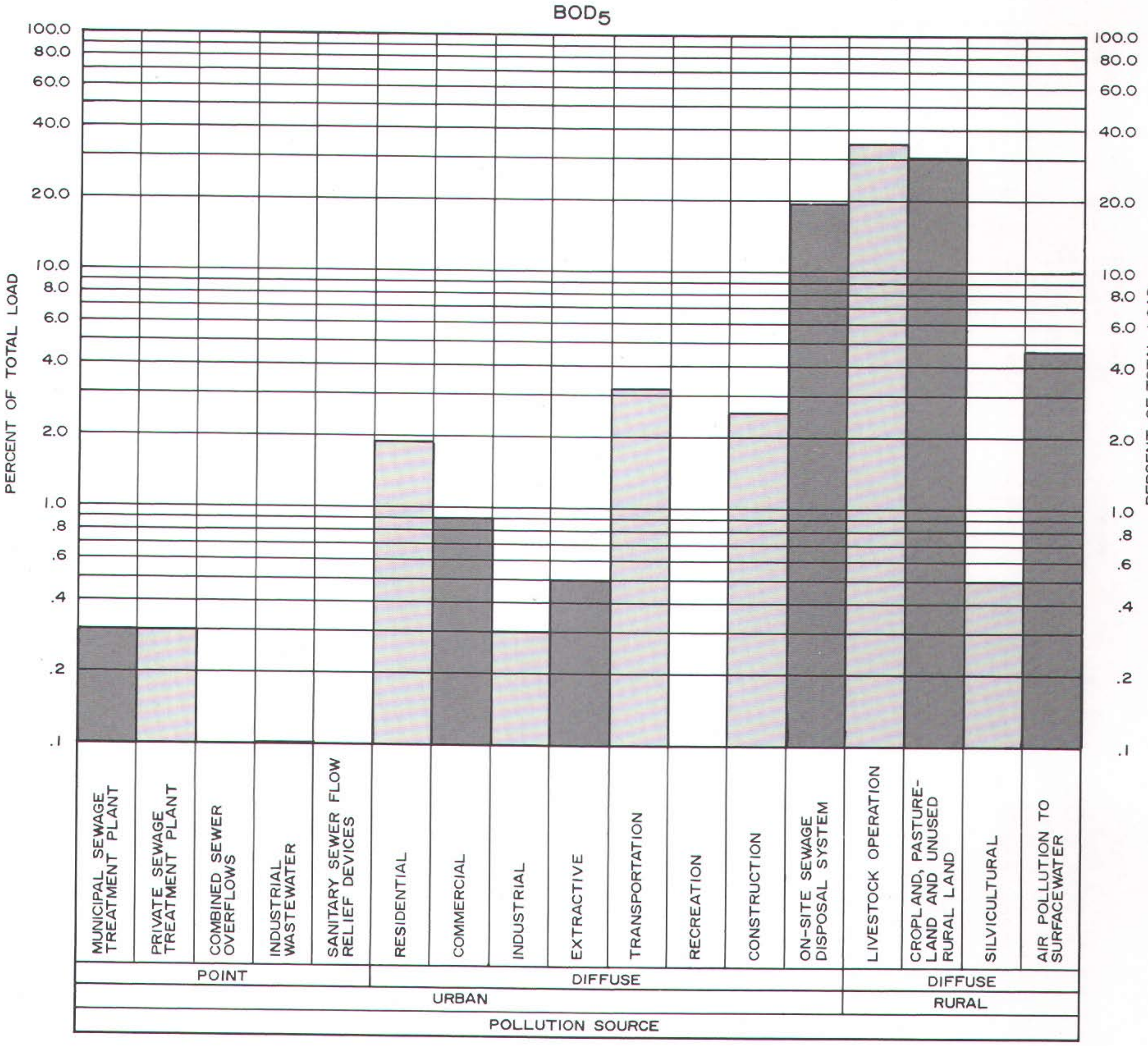


Figure 71 (continued)

FECAL COLIFORM

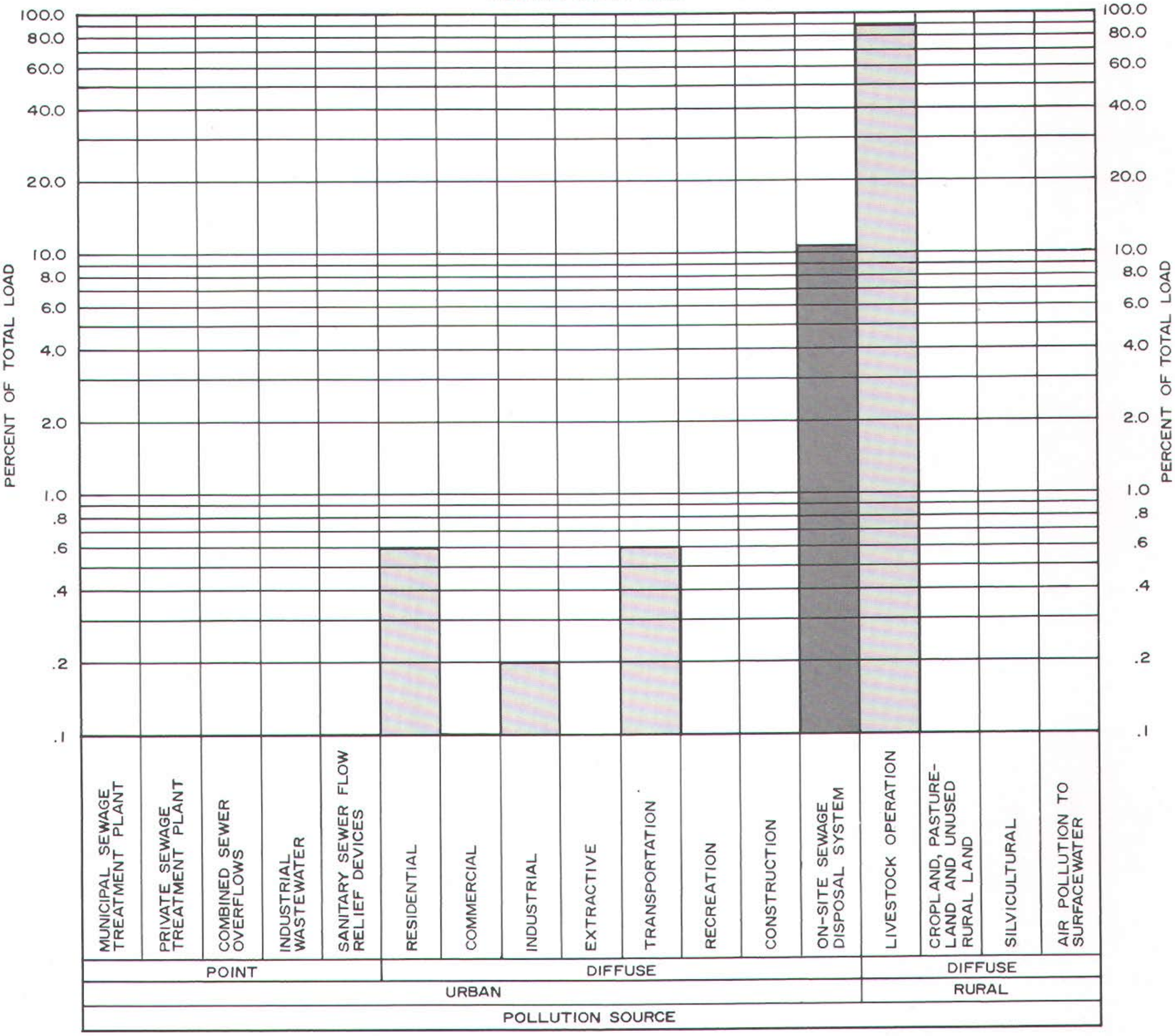
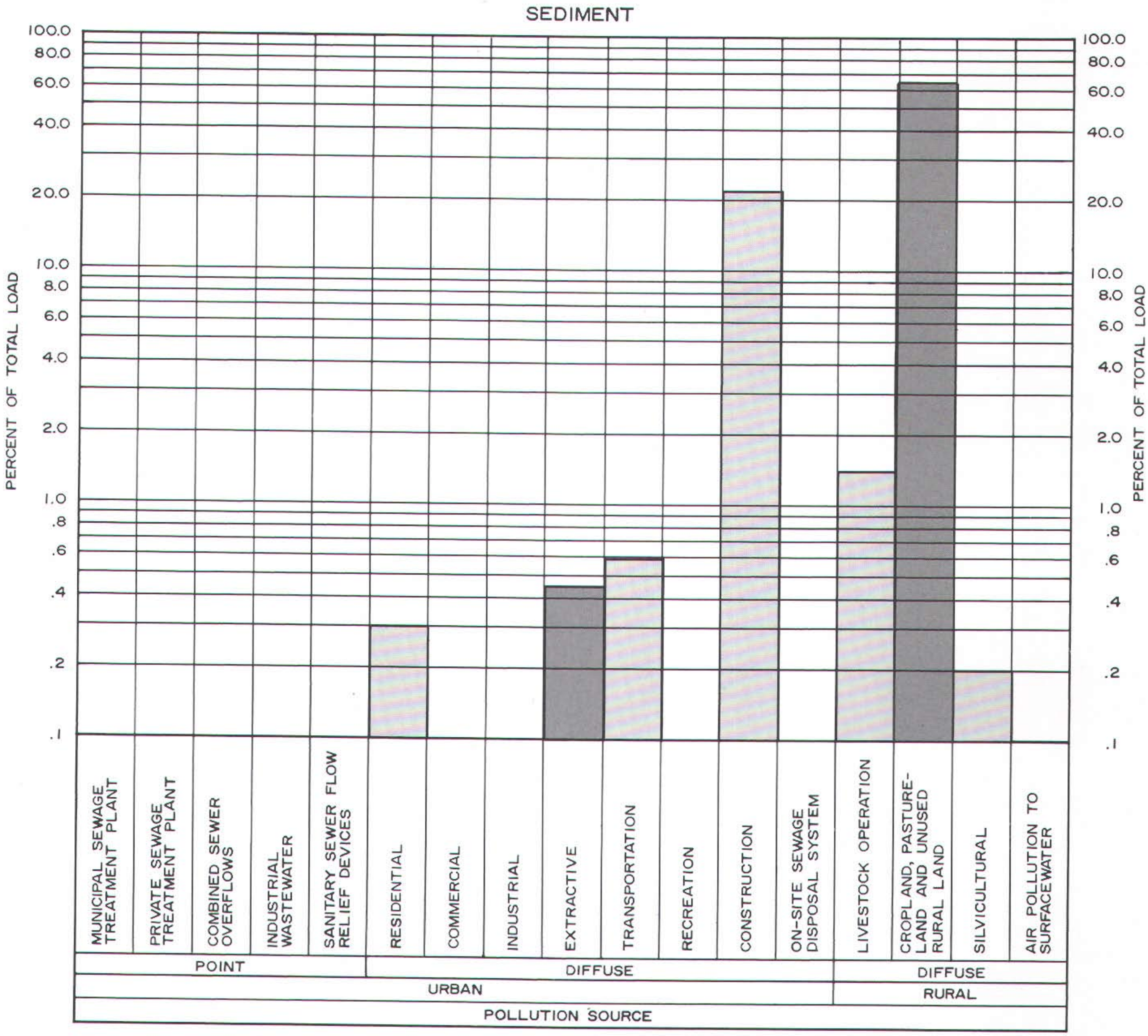


Figure 71 (continued)



Source: SEWRPC.

Table 367

COMPARISON OF ESTIMATED TRANSPORT LOADS TO ESTIMATED POLLUTANT CHANNEL LOADS IN THE DES PLAINES RIVER

Pollutant	Channel Load	Transport Analysis Load	
	Thousands of Pounds/Year	Thousands of Pounds/Year	
		Annual Load	Variance[a]
Nitrogen	1,646	580	± 628
Phosphorus . . .	177	50	± 16
BOD_5	3,938	600	± 176
Sediment	570,550	6,964	± 2,728

[a] *Variance significant at a 95% confidence level.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

FOX RIVER WATERSHED

A summary of the loadings to the Fox River is presented in Table 368 and depicted in Figure 72. Urban sources of pollution are estimated to contribute 23 percent of the nitrogen, 58 percent of the phosphorus, 32 percent of the biochemical oxygen demand, 11 percent of the fecal coliform, and 57 percent of the sediment which occur as water pollutants to the Fox River. Of the urban contribution, the point sources of pollution contribute 36 percent of the nitrogen, 21 percent of the phosphorus, 9 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and one-tenth of one percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 64 percent of the nitrogen, 79 percent of the phosphorus, 91 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 77 percent of the nitrogen, 42 percent of the phosphorus, 68 percent of the biochemical oxygen demand, 89 percent of the fecal coliform, and 43 percent of the sediments from all sources within the watershed. There are no rural sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 26 percent of the nitrogen, 72 percent of the phosphorus, 45 percent of the biochemical oxygen demand, virtually all of the fecal coliform, and 3 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 74 percent of the nitrogen, 28 percent of the phosphorus, 55 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 97 percent of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 72 presents the relative pollution loadings discussed above within the Fox River watershed.

The dry year and wet year analyses, as shown in Table 368, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since point sources of sediment are relatively minor in the Fox River watershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors. For biochemical oxygen demand, nitrogen, phosphorus, and fecal coliform, however, the effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and municipal and private sewage treatment plant discharges of these pollutants are unaffected. The proportion of phosphorus contributed by point sources ranges from 9 percent during a wet year to 18 percent during a dry year. Of the total nitrogen demand load, point sources contribute from 6 percent of the total load during a wet year to 12 percent during a dry year. Biochemical oxygen demand and fecal coliform point source annual loads range from 2 to 4 percent, and from 0.4 to 0.5 percent of the total loads, respectively.

The quantity of pollutants transported in the Fox River at Wilmot were estimated by a transport analysis based on streamflow and pollutant concentration measurements. Streamflow data were available for the Fox River at Wilmot from the U.S. Geological Survey for the years 1939 to 1975 as part of its routine sampling program. Total phosphorus and total nitrogen concentrations measurements were available from SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975, and total nitrogen, total phosphorus, and biochemical oxygen demand measurements were available from the Commission's index site sampling program. Suspended solids, total nitrogen, total phosphorus, and biochemical oxygen demand concentration data were available from the Wisconsin Department of Natural Resources monthly sampling program. In the Fox River at Wilmot, it is estimated from these in-stream measurements that about 3,783,000 pounds of nitrogen, 453,000 pounds of phosphorus, 6,073,000 pounds of biochemical oxygen demand, and 54,974,000 pounds of sediment are transported annually. Table 369 presents a comparison of pollutant transport loads, based on streamflow samples, to potential pollutant loads as estimated from regional data and general studies. As noted above, the downstream transport loads, as computed from in-stream measurements, are, as expected, significantly less than the channel loads because of the physical, chemical, and biological

Table 368

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE FOX RIVER WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	15	Total Nitrogen	875,730.0	8.0	1.000	875,730.0	11.9	1.000	875,730.0	6.0
	15	Total Phosphorus	204,520.0	11.9	1.000	204,520.0	17.4	1.000	204,520.0	9.0
	15	Biochemical Oxygen Demand	723,920.0	2.6	1.000	723,920.0	3.9	1.000	723,920.0	1.9
	15	Fecal Coliform	790,000.0	0.1	1.000	790,000.0	0.2	1.000	790,000.0	0.1
	15	Sediment	680.0	0.0	1.000	680.0	0.0	1.000	680.0	0.0
Private Sewage Treatment Plants	12	Total Nitrogen	9,380.0	0.1	1.000	9,380.0	0.1	1.000	9,380.0	0.1
	12	Total Phosphorus	2,860.0	0.2	1.000	2,860.0	0.2	1.000	2,860.0	0.1
	12	Biochemical Oxygen Demand	11,100.0	0.0	1.000	11,100.0	0.1	1.000	11,100.0	0.0
	12	Fecal Coliform	6,400.0	0.0	1.000	6,400.0	0.0	1.000	6,400.0	0.0
	12	Sediment	5.0	0.0	1.000	5.0	0.0	1.000	5.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges.	33	Total Nitrogen	8,460.0	0.1	1.000	8,460.0	0.1	1.000	8,460.0	0.1
	33	Total Phosphorus	3,330.0	0.2	1.000	3,330.0	0.3	1.000	3,330.0	0.1
	33	Biochemical Oxygen Demand	14,650.0	0.1	1.000	14,650.0	0.1	1.000	14,650.0	0.0
	33	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	33	Sediment	435.0	0.0	1.000	435.0	0.0	1.000	435.0	0.0
Sanitary Sewer Flow Relief Devices . .	20	Total Nitrogen	930.0	0.0	.643	600.0	0.0	1.371	1,280.0	0.0
	20	Total Phosphorus	310.0	0.0	643	200.0	0.0	1.371	430.0	0.0
	20	Biochemical Oxygen Demand	9,260.0	0.0	.643	5,950.0	0.0	1.371	12,700.0	0.0
	20	Fecal Coliform	1,400,000.0	0.3	.643	900,200.0	0.2	1.371	1,919,400.0	0.3
	20	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Urban Point Source Totals		Total Nitrogen	894,500.0	8.2		894,170.0	12.1		894,850.0	6.1
		Total Phosphorus	211,020	12.3		210,910.0	17.9		211,140.0	9.3
		Biochemical Oxygen Demand	758,930.0	2.7		755,620.0	4.1		762,370.0	2.0
		Fecal Coliform	2,196,400.0	0.4		1,696,600.0	0.5		2,715,800.0	0.4
		Sediment	1,125.0	0.1		1,125.0	0.1		1,125.0	0.0
Urban Diffuse Sources										
Residential	40192	Total Nitrogen	160,770.0	1.5	.643	103,380.0	1.4	1.371	220,420.0	1.5
	40192	Total Phosphorus	12,860.0	0.8	.643	8,270.0	0.7	1.371	17,630.0	0.8
	40192	Biochemical Oxygen Demand	976,670.0	3.5	.643	628,000.0	3.4	1.371	1,339,010.0	3.5
	40192	Fecal Coliform	6,430,720.0	1.1	.643	4,134,953.0	1.1	1.371	8,816,517.1	1.1
	40192	Sediment	10,950.0	0.5	.643	7,040.0	0.5	1.371	15,015.0	0.5
Commercial	4924	Total Nitrogen	44,320.0	0.4	.643	28,500.0	0.4	1.371	60,760.0	0.4
	4924	Total Phosphorus	3,690.0	0.2	.643	2,370.0	0.2	1.371	5,060.0	0.2
	4924	Biochemical Oxygen Demand	480,580.0	1.7	.643	309,010.0	1.7	1.371	658,880.0	1.7
	4924	Fecal Coliform	1,624,920.0	0.3	.643	1,044,823.6	0.3	1.371	2,227,765.3	0.3
	4924	Sediment	1,835.0	0.1	.643	1,180.0	0.1	1.371	2,515.0	0.1
Industrial	3574	Total Nitrogen	30,020.0	0.3	.643	19,300.0	0.3	1.371	41,160.0	0.3
	3574	Total Phosphorus	2,500.0	0.1	.643	1,610.0	0.1	1.371	3,430.0	0.2
	3574	Biochemical Oxygen Demand	131,880.0	0.5	.643	84,800.0	0.5	1.371	180,810.0	0.5
	3574	Fecal Coliform	2,215,880.0	0.4	.643	1,424,810.8	0.4	1.371	383,791.5	0.4
	3574	Sediment	1,745.0	0.1	.643	1,120.0	0.1	1.371	2,390.0	0.1
Extractive	4212	Total Nitrogen	252,720.0	2.3	.643	162,500.0	2.2	1.371	346,480.0	2.4
	4212	Total Phosphorus	189,540.0	11.1	.643	121,870.0	10.4	1.371	259,860.0	11.5
	4212	Biochemical Oxygen Demand	505,440.0	1.8	.643	325,000.0	1.8	1.371	692,960.0	1.8
	4212	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	4212	Sediment	315,900.0	14.4	.643	203,125.0	14.4	1.371	433,100.0	14.4
Transportation	4387	Total Nitrogen	93,330.0	0.9	.643	60,010.0	0.8	1.371	127,960.0	0.9
	4387	Total Phosphorus	7,200.0	0.4	.643	4,630.0	0.4	1.371	9,870.0	0.4
	4387	Biochemical Oxygen Demand	581,890.0	2.1	.643	374,160.0	2.0	1.371	797,770.0	2.1
	4387	Fecal Coliform	2,391,850.0	0.4	.643	1,537,959.6	0.4	1.371	3,279,226.4	0.4
	4387	Sediment	77,325.0	3.5	.643	49,720.0	3.5	1.371	106,015.0	3.5
Recreation	10361	Total Nitrogen	32,460.0	0.3	.643	20,870.0	0.3	1.371	44,500.0	0.3
	10361	Total Phosphorus	1,200.0	0.1	.643	770.0	0.1	1.371	1,650.0	0.1
	10361	Biochemical Oxygen Demand	13,470.0	0.0	.643	8,660.0	0.0	1.371	18,470.0	0.0
	10361	Fecal Coliform	225,036.0	0.0	.643	144,698.1	0.0	1.371	308,524.4	0.0
	10361	Sediment	2,175.0	0.1	.643	1,400.0	0.1	1.371	2,980.0	0.1
Construction	11229	Total Nitrogen	673,740.0	6.1	.643	433,210.0	5.9	1.371	923,700.0	6.3
	11229	Total Phosphorus	505,310.0	29.5	.643	324,910.0	27.6	1.371	692,780.0	30.5
	11229	Biochemical Oxygen Demand	1,347,480.0	4.8	.643	866,430.0	4.7	1.371	1,847,400.0	4.8
	11229	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	11229	Sediment	842,185.0	38.3	.643	541,520.0	38.3	1.371	1,154,620.0	38.3
Septic Systems	97594	Total Nitrogen	283,020.0	2.6	.643	181,980.0	2.5	1.371	388,020.0	2.6
	97594	Total Phosphorus	64,410.0	3.8	.643	41,420.0	3.5	1.371	88,310.0	3.9
	97594	Biochemical Oxygen Demand	3,981,840.0	14.2	.643	2,560,320.0	13.9	1.371	5,459,100.0	14.3
	97594	Fecal Coliform	48,797,000.0	8.7	.643	31,376,471.0	8.7	1.371	66,900,687.0	8.7
	97594	Sediment	685.0	0.0	.643	440.0	0.0	1.371	940.0	0.0

Table 368 (continued)

			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
Source	Extent[a]	Parameter	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	1,570,380.0	14.3		1,009,750.0	13.7		2,153,000.0	14.7
		Total Phosphorus	786,710.0	45.9		505,850.0	43.0		1,078,590.0	47.5
		Biochemical Oxygen Demand	8,019,250.0	28.5		5,156,380.0	28.1		10,994,400.0	28.7
		Fecal Coliform	61,685,406.0	11.0		39,663,716.1	11.0		84,570,691.7	11.0
		Sediment	1,252,790.0	57.0		805,545.0	57.0		1,717,575.0	57.0
Urban Source Totals		Total Nitrogen	2,464,880.0	22.5		1,903,920.0	25.9		3,047,850.0	20.7
		Total Phosphorus	997,730.0	58.3		716,760.0	60.9		1,289,730.0	56.8
		Biochemical Oxygen Demand	8,778,180.0	31.2		5,912,000.0	32.2		11,756,770.0	30.7
		Fecal Coliform	63,881,806.0	11.4		41,360,316.1	11.5		87,286,491.7	11.4
		Sediment	1,253,915.0	57.0		806,670.0	57.0		1,718,700.0	57.0
Rural Diffuse Sources										
Livestock Operations	77420	Total Nitrogen	2,198,730.0	20.1	.643	1,413,780.0	19.2	1.371	3,014,460.0	20.5
	77420	Total Phosphorus	510,970.0	29.8	.643	328,550.0	27.9	1.371	700,540.0	30.9
	77420	Biochemical Oxygen Demand	8,609,100.0	30.6	.643	5,535,650.0	30.2	1.371	11,803,080.0	30.8
	77420	Fecal Coliform	495,488,000.0	88.5	.643	318,598,784.0	88.4	1.371	679,314,048.0	88.5
	77420	Sediment	27,095.0	1.2	.643	17,420.0	1.2	1.371	37,145.0	1.2
Cropland, Pasture and Unused Rural Land	386127	Total Nitrogen	5,913,460.0	54.0	.643	3,802,350.0	51.6	1.371	8,107,350.0	55.2
	386127	Total Phosphorus	181,580.0	10.6	.643	116,760.0	9.9	1.371	248,950.0	11.0
	386127	Biochemical Oxygen Demand	6,161,760.0	21.9	.643	3,962,010.0	21.6	1.371	8,447,770.0	22.1
	386127	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	386127	Sediment	900,870.0	41.0	.643	579,260.0	41.0	1.371	1,235,095.0	41.0
Silivicultural	62866	Total Nitrogen	144,590.0	1.3	.643	92,970.0	1.3	1.371	198,230.0	1.3
	62866	Total Phosphorus	8,800.0	0.5	.643	5,660.0	0.5	1.371	12,060.0	0.5
	62866	Biochemical Oxygen Demand	289,180.0	1.0	.643	185,940.0	1.0	1.371	396,470.0	1.0
	62866	Fecal Coliform	414,915.6	0.1	.643	266,790.7	0.1	1.371	568,849.3	0.1
	62866	Sediment	7,890.0	0.4	.643	5,075.0	0.4	1.371	10,815.0	0.4
Air Pollution to Surface Water	26500	Total Nitrogen	235,850.0	2.2	.643	151,650.0	2.1	1.371	323,350.0	2.2
	26500	Total Phosphorus	13,250.0	0.8	.643	8,520.0	0.7	1.371	18,170.0	0.8
	26500	Biochemical Oxygen Demand	4,293,000.0	15.3	.643	2,760,400.0	15.0	1.371	5,885,700.0	15.4
	26500	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	26500	Sediment	8,810.0	0.4	.643	5,665.0	0.4	1.371	12,080.0	0.4
Rural Diffuse Source Totals		Total Nitrogen	8,492,630.0	77.5		5,460,750.0	74.1		11,643,390.0	79.3
		Total Phosphorus	714,600.0	41.7		459,490.0	39.1		979,720.0	43.2
		Biochemical Oxygen Demand	19,353,040.0	68.8		12,444,000.0	67.8		26,533,020.0	69.3
		Fecal Coliform	495,902,915.6	88.6		318,865,574.7	88.5		679,882,897.3	88.6
		Sediment	944,665.0	43.0		607,420.0	43.0		1,295,135.0	43.0
Diffuse Source Totals		Total Nitrogen	10,063,010.0	91.8		6,470,500.0	87.9		13,796,390.0	93.9
		Total Phosphorus	1,501,310.0	87.7		965,340.0	82.1		2,058,310.0	90.7
		Biochemical Oxygen Demand	27,372,290.0	97.3		17,600,380.0	95.9		37,527,420.0	98.0
		Fecal Coliform	557,588,321.6	99.6		358,529,290.8	99.5		764,453,589.0	99.6
		Sediment	2,197,455.0	99.9		1,412,965.0	99.9		3,012,710.0	100.0
Total Sources		Total Nitrogen	10,957,510.0	100.0		7,364,670.0	100.0		14,691,240.0	100.0
		Total Phosphorus	1,712,330.0	100.0		1,176,250.0	100.0		2,269,450.0	100.0
		Biochemical Oxygen Demand	28,131,220.0	100.0		18,356,000.0	100.0		38,289,790.0	100.0
		Fecal Coliform	559,784,721.6	100.0		360,225,890.8	100.0		767,169,389.0	100.0
		Sediment	2,198,580.0	100.0		1,414,090.0	100.0		3,013,835.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

Figure 72

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES
FOR AN AVERAGE YEAR IN THE FOX RIVER WATERSHED

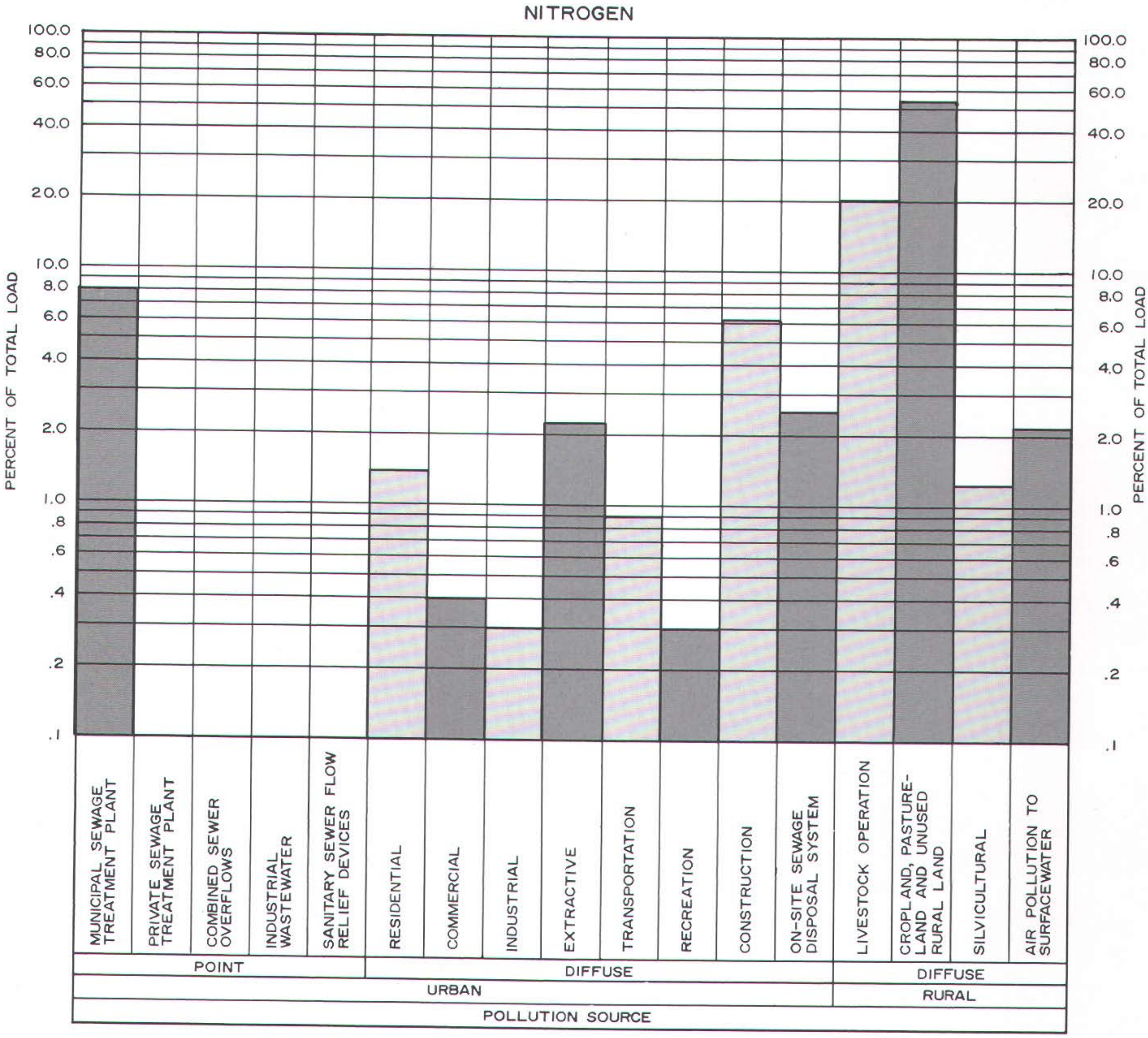


Figure 72 (continued)

PHOSPHOROUS

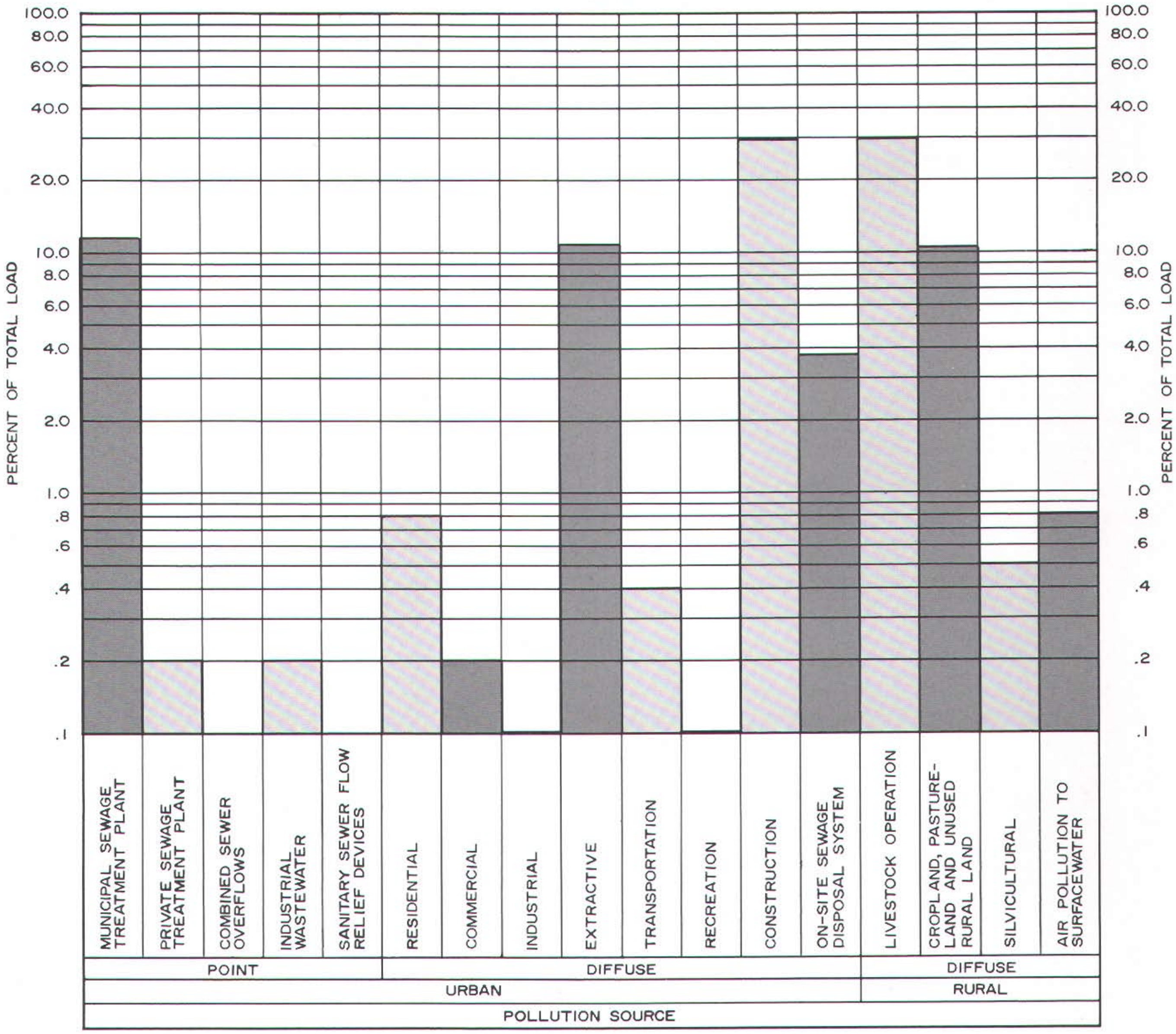


Figure 72 (continued)

BOD_5

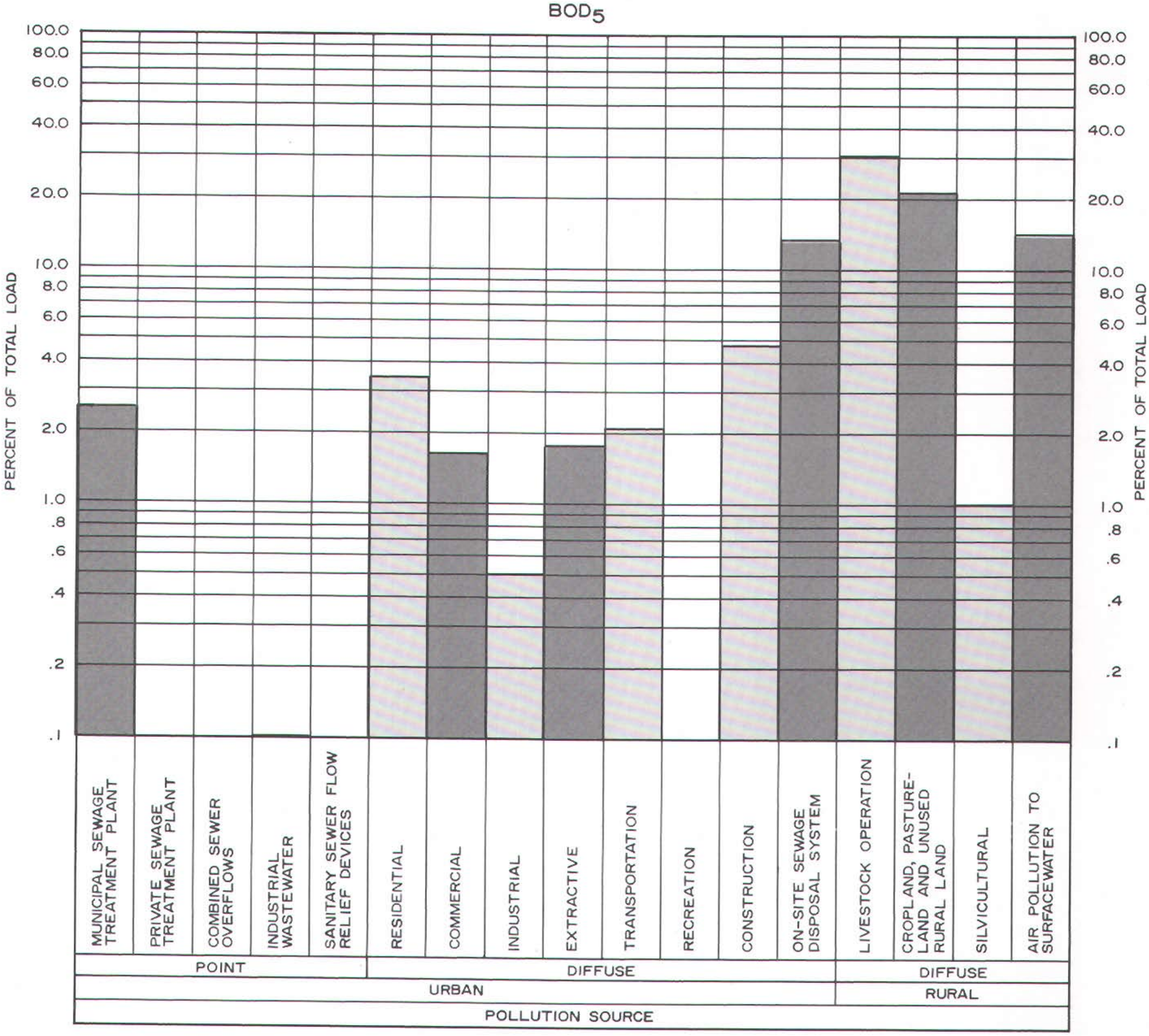


Figure 72 (continued)

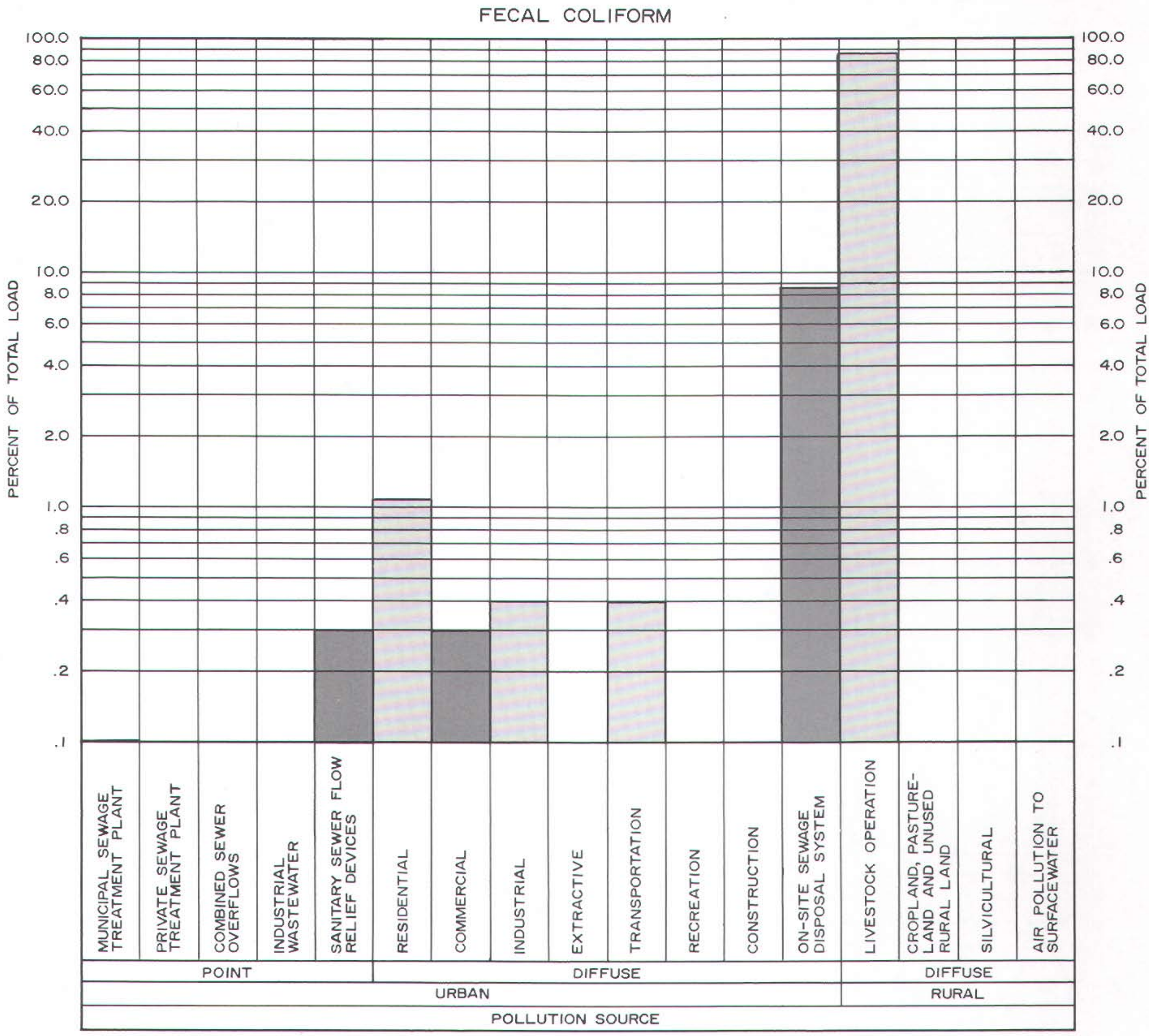
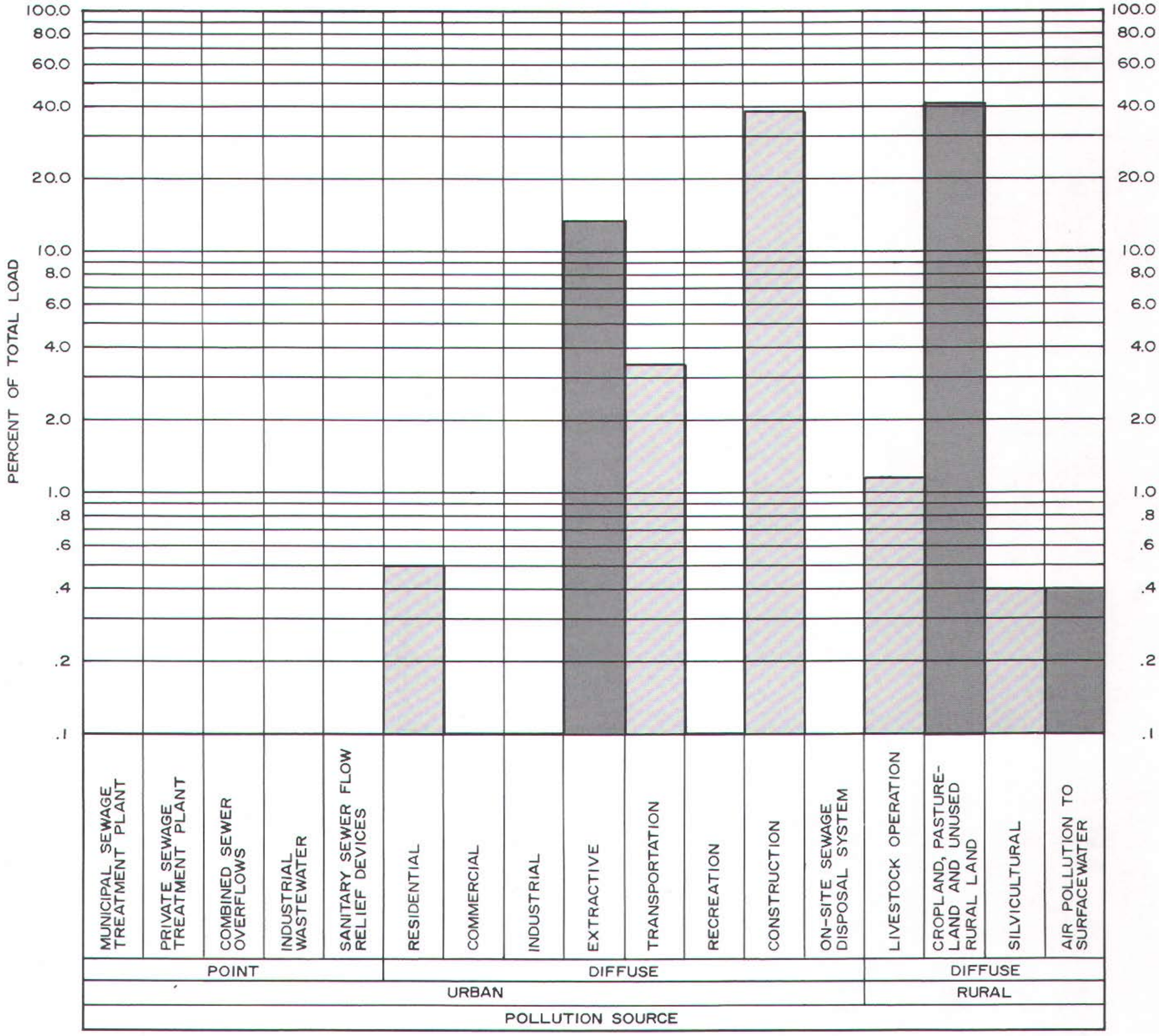


Figure 72 (continued)

SEDIMENT



Source: SEWRPC.

Table 369

COMPARISON OF ESTIMATED TRANSPORT LOADS TO ESTIMATED POLLUTANT CHANNEL LOADS IN THE FOX RIVER

Pollutant	Channel Load (Thousands of Pounds/Year)	Transport Analysis Load (Thousands of Pounds/Year) Annual Load	Variance[a]
Nitrogen	10,958	3,783	± 760
Phosphorus . . .	1,712	453	± 231
BOD_5	28,131	6,073	± 1,475
Sediment	4,397,200	54,974	± 20,456

[a] *Variance significant at a 95% confidence level.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

processes occurring on the land surface and within the stream itself which serve to effectively remove the pollutants temporarily or permanently.

KINNICKINNIC RIVER WATERSHED

A summary of the loadings to the Kinnickinnic River is presented in Table 370 and depicted in Figure 73. Urban sources of pollution are estimated to contribute 94 percent of the nitrogen, 99 percent of the phosphorus, 99 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 98 percent of the sediment which occur as water pollutants to the Kinnickinnic River. Of the urban contribution, the point sources of pollution contribute 37 percent of the nitrogen, 63 percent of the phosphorus, 68 percent of the biochemical oxygen demand, 98 percent of the fecal coliform, and 10 percent of the sediment. Diffuse sources account for the remaining 63 percent of the nitrogen, 37 percent of the phosphorus, 32 percent of the biochemical oxygen demand, 2 percent of the fecal coliform, and 90 percent of the sediment contributed from urban sources.

Rural pollution sources contribute the remaining estimated 6 percent of the nitrogen, 1 percent of the phosphorus, 1 percent of the biochemical oxygen demand, less than one-tenth of 1 percent of the fecal coliform, and 2 percent of the sediment from all sources within the watershed. Of the rural pollution sources, no livestock operations exist in the watershed and the estimated rural pollution loads are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 73 presents the relative pollution loadings discussed above within the Kinnickinnic River watershed.

The dry year and wet year analyses, as shown in Table 370, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. The effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and municipal and private sewage treatment plant discharges of pollutants are unaffected. The proportion of the total phosphorus load contributed by point sources ranges from 60 percent during a wet year to 67 percent during a dry year. Of the total nitrogen load, point sources contribute from 33 percent of the total load during a wet year to 38 percent during a dry year. Biochemical oxygen demand, and sediment point source contributions similarly range from 63 to 73 percent, and 8 to 15 percent of the total loads, respectively. Fecal coliform loads from point sources account for 98 percent of the total load during a wet year or a dry year since essentially all of the fecal coliform are contributed from flow relief devices, which are affected by precipitation variations as are diffuse sources.

Data were not available to enable a transport analysis, based on in-stream pollutant concentration and flow measurements, to be conducted for the Kinnickinnic River.

MENOMONEE RIVER WATERSHED

A summary of the loadings to the Menomonee River is presented in Table 371 and depicted in Figure 74. Urban sources of pollution are estimated to contribute 68 percent of the nitrogen, 88 percent of the phosphorus, 87 percent of the biochemical oxygen demand, 94 percent of the fecal coliform, and 90 percent of the sediment which occur as water pollutants to the Menomonee River. Of the urban contribution, the point sources of pollution contribute 27 percent of the nitrogen, 36 percent of the phosphorus, 28 percent of the biochemical oxygen demand, 93 percent of the fecal coliform, and 1 percent of the sediment. Diffuse sources—including the estimated septic tank, and construction-related contributions in the drainage area—account for the remaining 73 percent of the nitrogen, 64 percent of the phosphorus, 72 percent of the biochemical oxygen demand, 7 percent of the fecal coliform, and 99 percent of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 32 percent of the nitrogen, 12 percent of the phosphorus, 13 percent of the biochemical oxygen demand, 6 percent of the fecal coliform, and 10 percent of the sediment from all sources within the watershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 25 percent of the nitrogen, 68 percent of the phosphorus, 47 percent of the biochemical oxygen

Table 370

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE KINNICKINNIC RIVER WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	23	Total Nitorgen	43,030.0	25.4	.643	27,670.0	24.2	1.371	58,990.0	26.0
	23	Total Phosphorus	21,520.0	37.9	.643	13,840.0	33.4	1.371	29,500.0	40.5
	23	Biochemical Oxygen Demand	430,340.0	24.1	.643	276,710.0	19.5	1.371	590,000.0	27.2
	23	Fecal Coliform	140,000,000.0	97.4	.643	90,020,000.0	97.4	1.371	191,940,000.0	97.4
	23	Sediment	645.0	1.5	.643	415.0	1.4	1.371	885.0	1.5
Industrial Discharges	30	Total Nitrogen	15,190.0	9.0	1.000	15,190.0	13.3	1.000	15,190.0	6.7
	30	Total Phosphorus	13,750.0	24.2	1.000	13,750.0	33.2	1.000	13,750.0	18.9
	30	Biochemical Oxygen Demand	763,240.0	42.7	1.000	763,240.0	53.7	1.000	763,240.0	35.2
	30	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	30	Sediment	3,840.0	8.8	1.000	3,840.0	13.1	1.000	3,840.0	6.6
Sanitary Sewer Flow Relief Devices . .	29	Total Nitrogen	580.0	0.3	.643	370.0	0.3	1.371	800.0	0.4
	29	Total Phosphorus	190.0	0.3	.643	120.0	0.3	1.371	260.0	0.4
	29	Biochemical Oxygen Demand	5,760.0	0.3	.643	3,700.0	0.3	1.371	7,900.0	0.4
	29	Fecal Coliform	870,000.0	0.6	.643	559,410.0	0.6	1.371	1,192,770.0	0.6
	29	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Urban Point Source Totals		Total Nitrogen	58,800.0	34.7		43,230.0	37.7		74,980.0	33.0
		Total Phosphorus	35,460.0	62.4		27,710.0	66.8		43,510.0	59.7
		Biochemical Oxygen Demand	1,199,340.0	67.1		1,043,650.0	73.4		1,361,140.0	62.8
		Fecal Coliform	140,870,000.0	98.0		90,579,410.0	98.0		193,132,770.0	98.0
		Sediment	4,490.0	10.3		4,260.0	14.5		4,730.0	8.1
Urban Diffuse Sources										
Residential	7559	Total Nitrogen	30,240.0	17.8	.643	19,440.0	17.0	1.371	41,460.0	18.3
	7559	Total Phosphorus	2,420.0	4.3	.643	1,560.0	3.8	1.371	3,320.0	4.6
	7559	Biochemical Oxygen Demand	183,680.0	10.3	.643	118,110.0	8.3	1.371	251,830.0	11.6
	7559	Fecal Coliform	1,209,440.0	0.8	.643	777,669.0	0.8	1.371	1,658,142.2	0.8
	7559	Sediment	2,060.0	4.7	.643	1,325.0	4.5	1.371	2,825.0	4.9
Commercial	1239	Total Nitrogen	11,150.0	6.6	.643	7,170.0	6.3	1.371	15,290.0	6.7
	1239	Total Phosphorus	930.0	1.6	.643	600.0	1.4	1.371	1,280.0	1.8
	1239	Biochemical Oxygen Demand	120,930.0	6.8	.643	77,760.0	5.5	1.371	165,800.0	7.7
	1239	Fecal Coliform	408,870.0	0.3	.643	262,903.4	0.3	1.371	560,560.8	0.3
	1239	Sediment	460.0	1.1	.643	295.0	1.0	1.371	630.0	1.1
Industrial	1381	Total Nitrogen	11,600.0	6.8	.643	7,460.0	6.5	1.371	15,900.0	7.0
	1381	Total Phosphorus	970.0	1.7	.643	620.0	1.5	1.371	1,330.0	1.8
	1381	Biochemical Oxygen Demand	50,960.0	2.9	.643	32,770.0	2.3	1.371	69,870.0	3.2
	1381	Fecal Coliform	856,220.0	0.6	.643	550,549.5	0.6	1.371	1,173,877.6	0.6
	1381	Sediment	675.0	1.6	.643	435.0	1.5	1.371	925.0	1.6
Extractive	15	Total Nitrogen	900.0	0.5	.643	580.0	0.5	1.371	1,230.0	0.5
	15	Total Phosphorus	680.0	1.2	.643	440.0	1.1	1.371	930.0	1.3
	15	Biochemical Oxygen Demand	1,800.0	0.1	.643	1,160.0	0.1	1.371	2,470.0	0.1
	15	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	15	Sediment	1,125.0	2.6	.643	725.0	2.5	1.371	1,540.0	2.6
Transportation	1709	Total Nitrogen	28,560.0	16.8	.643	18,360.0	16.0	1.371	39,160.0	17.3
	1709	Total Phosphorus	3,740.0	6.6	.643	2,400.0	5.8	1.371	5,130.0	7.0
	1709	Biochemical Oxygen Demand	172,600.0	9.7	.643	110,980.0	7.8	1.371	236,630.0	10.9
	1709	Fecal Coliform	387,130.0	0.3	.643	248,924.6	0.3	1.371	530,755.2	0.3
	1709	Sediment	13,640.0	31.4	.643	8,770.0	29.9	1.371	18,700.0	32.1
Recreation	871	Total Nitrogen	2,070.0	1.2	.643	1,330.0	1.2	1.371	2,840.0	1.3
	871	Total Phosphorus	60.0	0.1	.643	40.0	0.1	1.371	80.0	0.1
	871	Biochemical Oxygen Demand	1,130.0	0.1	.643	730.0	0.1	1.371	1,550.0	0.1
	871	Fecal Coliform	30,204.0	0.0	.643	19,421.2	0.0	1.371	41,409.7	0.0
	871	Sediment	185.0	0.4	.643	120.0	0.4	1.371	255.0	0.4
Construction	267	Total Nitrogen	16,020.0	9.4	.643	10,300.0	9.0	1.371	21,960.0	9.7
	267	Total Phosphorus	12,020.0	21.1	.643	7,730.0	18.6	1.371	16,480.0	22.6
	267	Biochemical Oxygen Demand	32,040.0	1.8	.643	20,600.0	1.4	1.371	43,930.0	2.0
	267	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	267	Sediment	20,025.0	46.0	.643	12,875.0	43.9	1.371	27,455.0	47.2
Septic Systems	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0

Table 370 (continued)

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Diffuse Source Totals		Total Nitrogen	100,540.0	59.3		64,640.0	56.4		137,840.0	60.7
		Total Phosphorus	20,820.0	36.6		13,390.0	32.3		28,550.0	39.2
		Biochemical Oxygen Demand	536,140.0	31.5		362,110.0	25.5		772,080.0	35.6
		Fecal Coliform	2,891,864.0	2.0		1,859,468.6	2.0		3,964,745.5	2.0
		Sediment	38,170.0	87.7		24,545.0	83.6		52,330.0	89.9
Urban Source Totals		Total Nitrogen	159,340.0	93.9		107,870.0	94.2		212,820.0	93.8
		Total Phosphorus	56,280.0	99.0		41,100.0	99.1		72,060.0	98.9
		Biochemical Oxygen Demand	1,762,480.0	98.6		1,405,760.0	98.9		2,133,220.0	98.5
		Fecal Coliform	143,761,864.0	100.0		92,438,878.6	100.0		197,097,515.5	100.0
		Sediment	42,660.0	98.1		28,805.0	98.1		57,060.0	98.0
Rural Diffuse Sources										
Livestock Operation	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Cropland, Pasture, and Unusea Rural Land	1797	Total Nitrogen	10,010.0	5.9	.643	6,440.0	5.6	1.371	13,720.0	6.0
	1797	Total Phosphorus	550.0	1.0	.643	350.0	0.8	1.371	750.0	1.0
	1797	Biochemical Oxygen Demand	19,340.0	1.1	.643	12,440.0	0.9	1.371	26,520.0	1.2
	1797	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1797	Sediment	830.0	1.9	.643	535.0	1.8	1.371	1,140.0	2.0
Silvicultural	20	Total Nitrogen	50.0	0.0	.643	30.0	0.0	1.371	70.0	0.0
	20	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	20	Biochemical Oxygen Demand	90.0	0.0	.643	60.0	0.0	1.371	120.0	0.0
	20	Fecal Coliform	132.0	0.0	.643	84.9	0.0	1.371	181.0	0.0
	20	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Air Pollution to Surface Water	31	Total Nitrogen	280.0	0.2	.643	180.0	0.2	1.371	380.0	0.2
	31	Total Phosphorus	20.0	0.0	.643	10.0	0.0	1.371	30.0	0.0
	31	Biochemical Oxygen Demand	5,020.0	0.3	.643	3,230.0	0.2	1.371	6,880.0	0.3
	31	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	31	Sediment	10.0	0.0	.643	5.0	0.0	1.371	15.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	10,340.0	6.1		6,650.0	5.8		14,170.0	6.2
		Total Phosphorus	570.0	1.0		360.0	0.9		780.0	1.1
		Biochemical Oxygen Demand	24,450.0	1.4		15,730.0	1.1		33,520.0	1.5
		Fecal Coliform	132.0	0.0		84.9	0.0		181.0	0.0
		Sediment	845.0	1.9		545.0	1.9		1,160.0	2.0
Diffuse Source Totals		Total Nitorgen	110,880.0	65.3		71,290.0	62.3		152,010.0	67.0
		Total Phosphorus	21,390.0	37.6		13,750.0	33.2		29,330.0	40.3
		Biochemical Oxygen Demand	587,590.0	32.9		377,840.0	26.6		805,600.0	37.2
		Fecal Coliform	2,891,996.0	2.0		1,859,553.5	2.0		3,964,926.5	2.0
		Sediment	39,015.0	89.7		25,090.0	85.5		53,490.0	91.9
Total Sources		Total Nitrogen	169,680.0	100.0		114,520.0	100.0		226,990.0	100.0
		Total Phosphorus	56,850.0	100.0		41,460.0	100.0		72,840.0	100.0
		Biochemical Oxygen Demand	1,786,930.0	100.0		1,421,490.0	100.0		2,166,740.0	100.0
		Fecal Coliform	143,761,996.0	100.0		92,438,963.5	100.0		197,097,696.5	100.0
		Sediment	43,505.0	100.0		29,350.0	100.0		58,220.0	100.0

[a]Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.

Source: SEWRPC.

Figure 73

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE KINNICKINNIC RIVER WATERSHED

NITROGEN

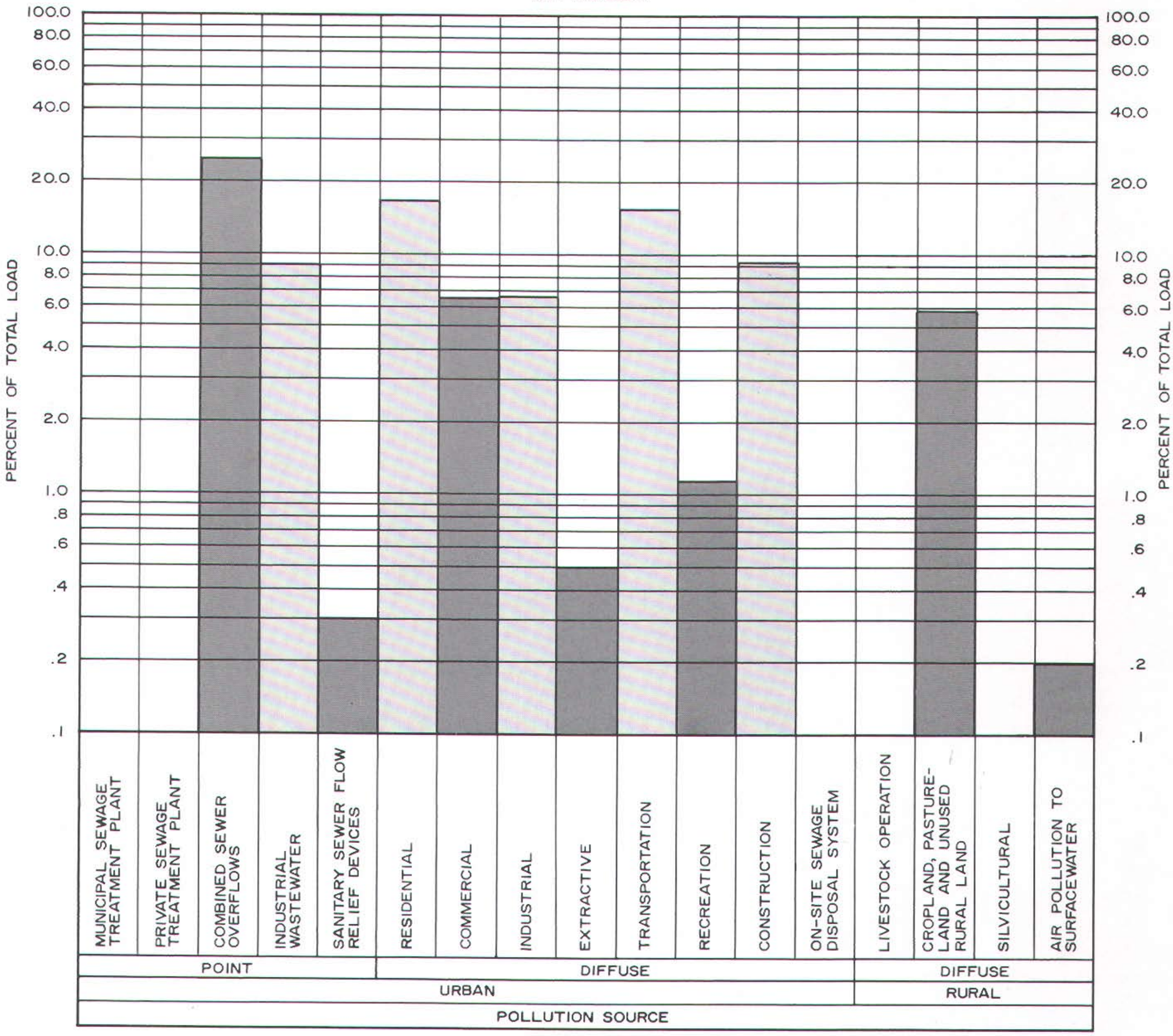


Figure 73 (continued)

PHOSPHOROUS

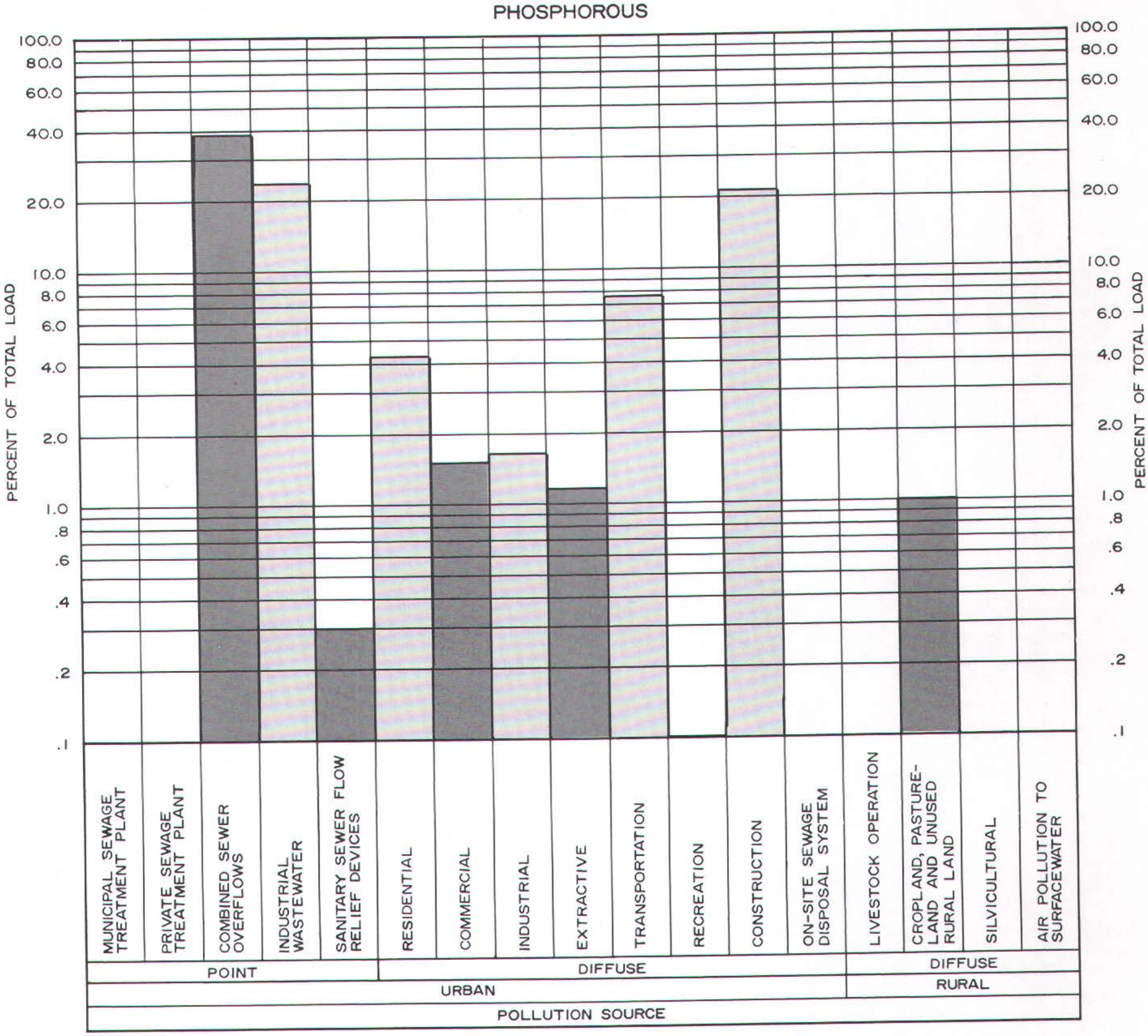


Figure 73 (continued)

BOD5

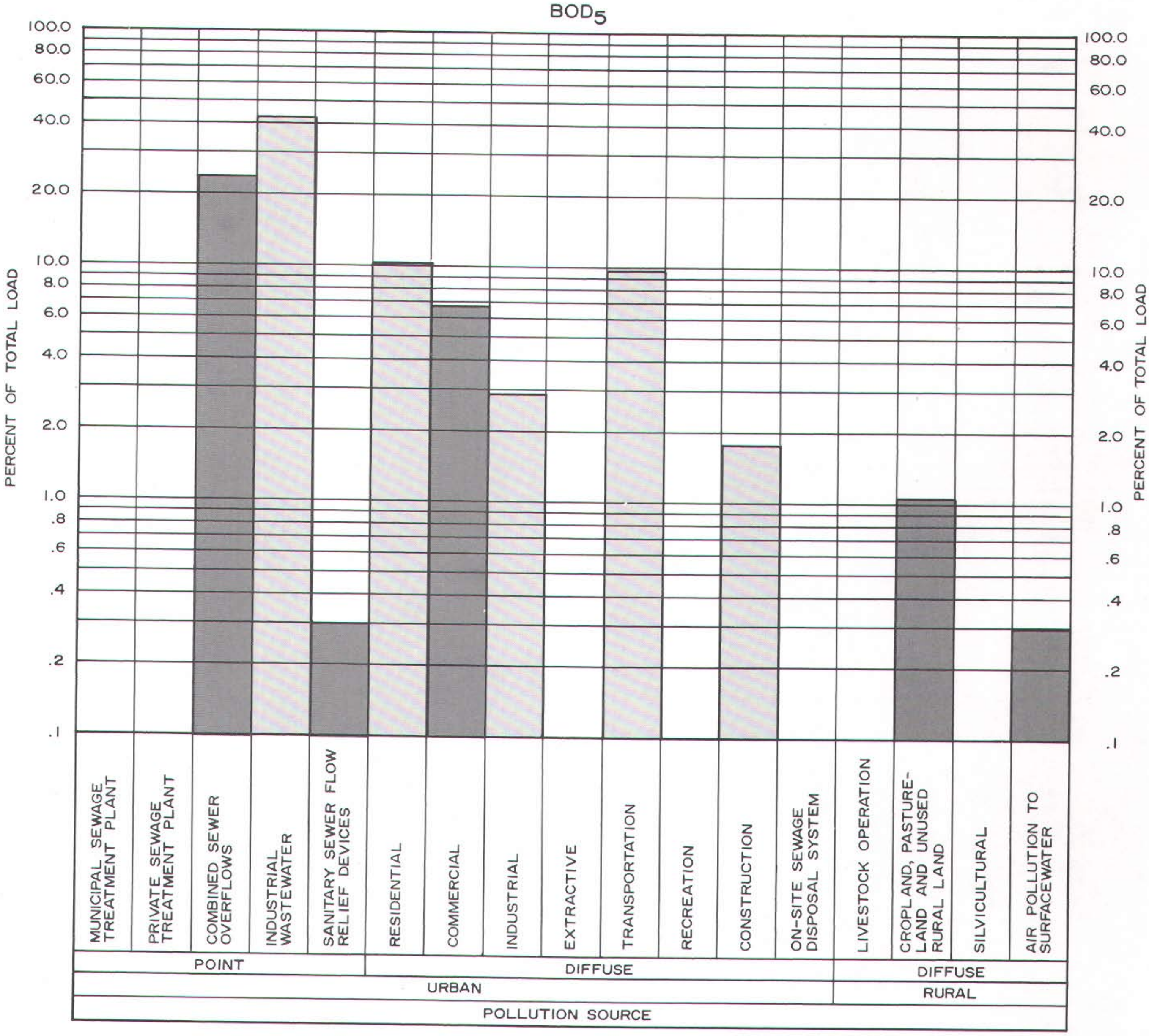


Figure 73 (continued)

FECAL COLIFORM

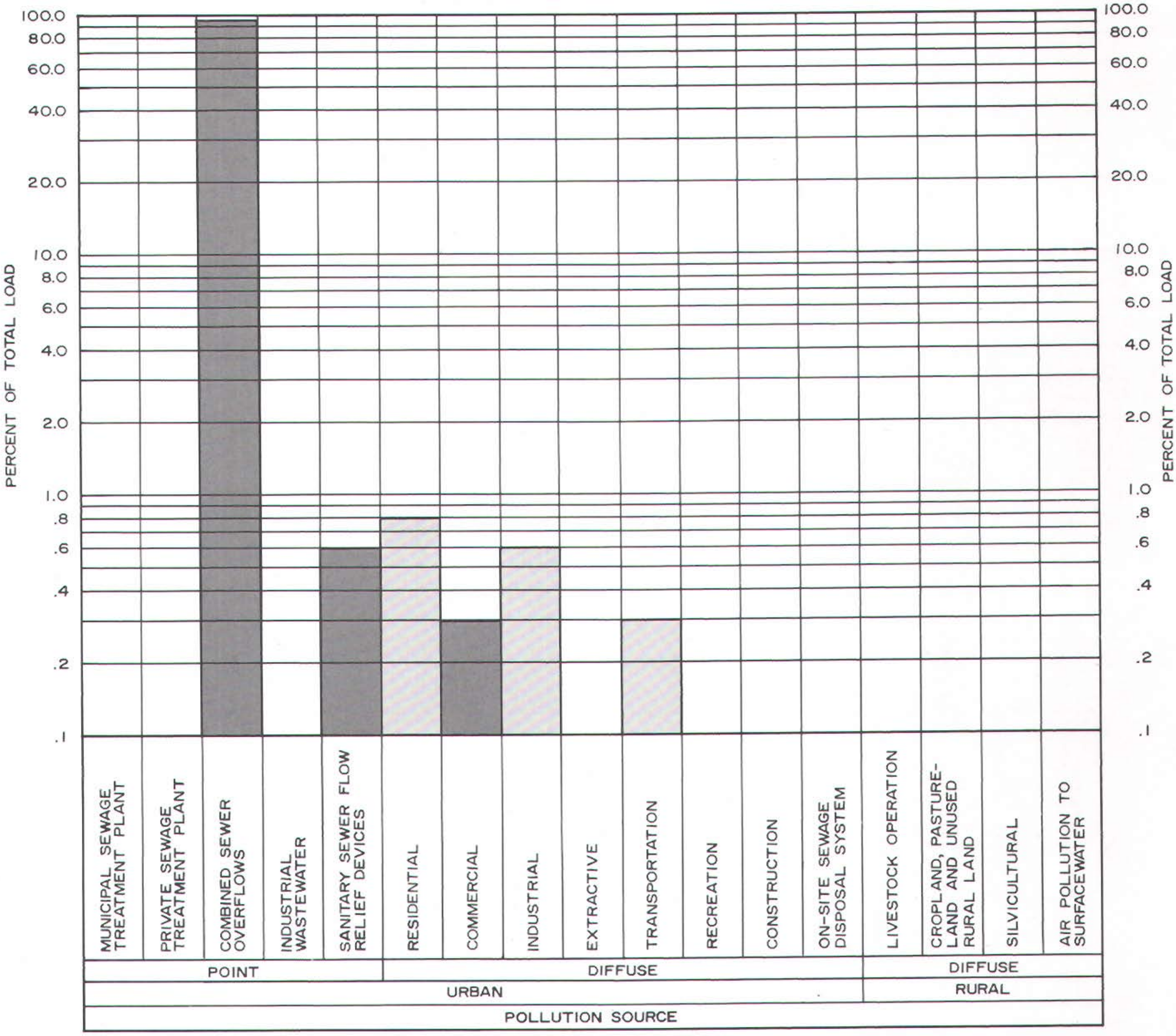
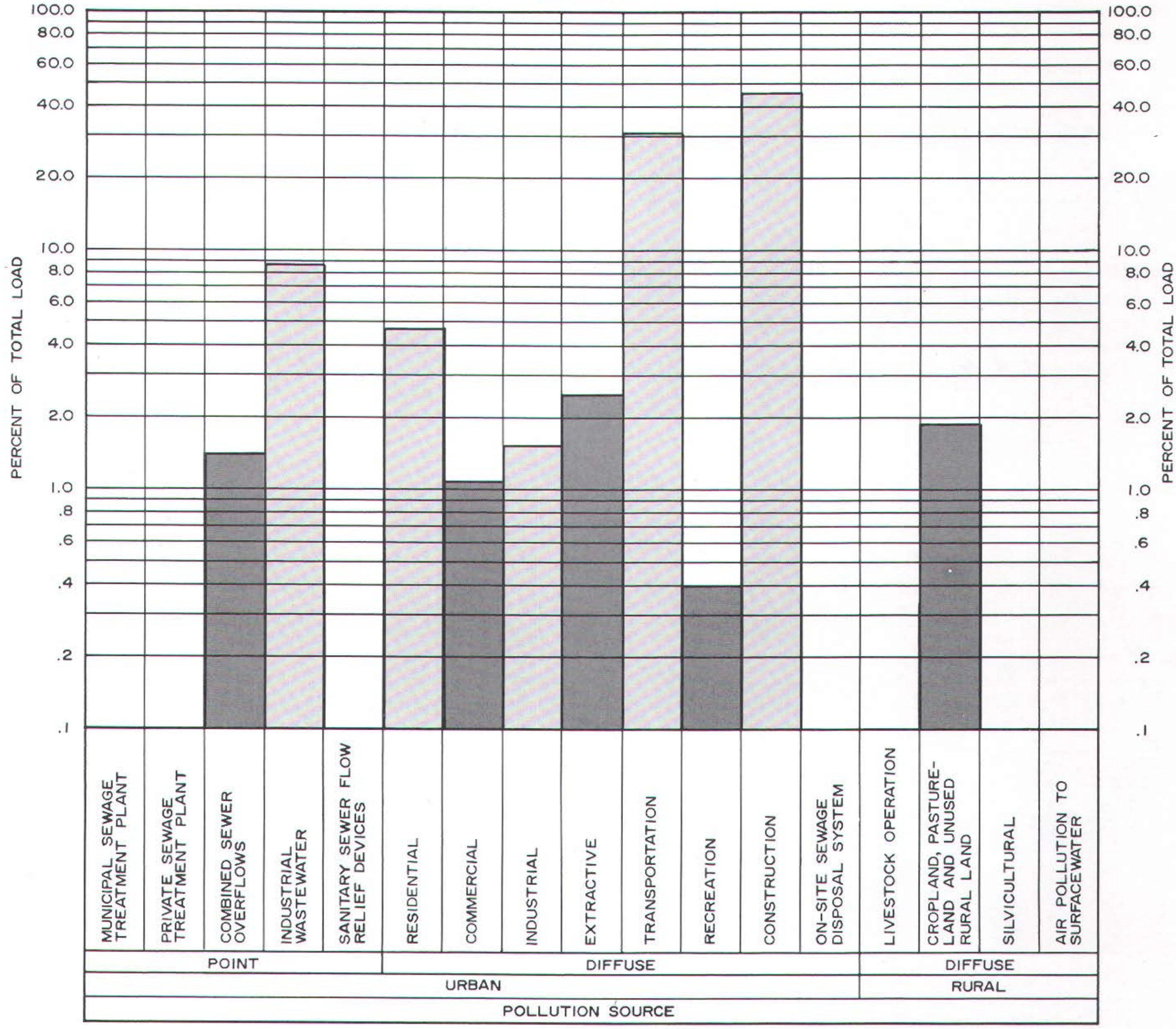


Figure 73 (continued)
SEDIMENT



Source: SEWRPC.

Figure 74

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE MENOMONEE RIVER WATERSHED

NITROGEN

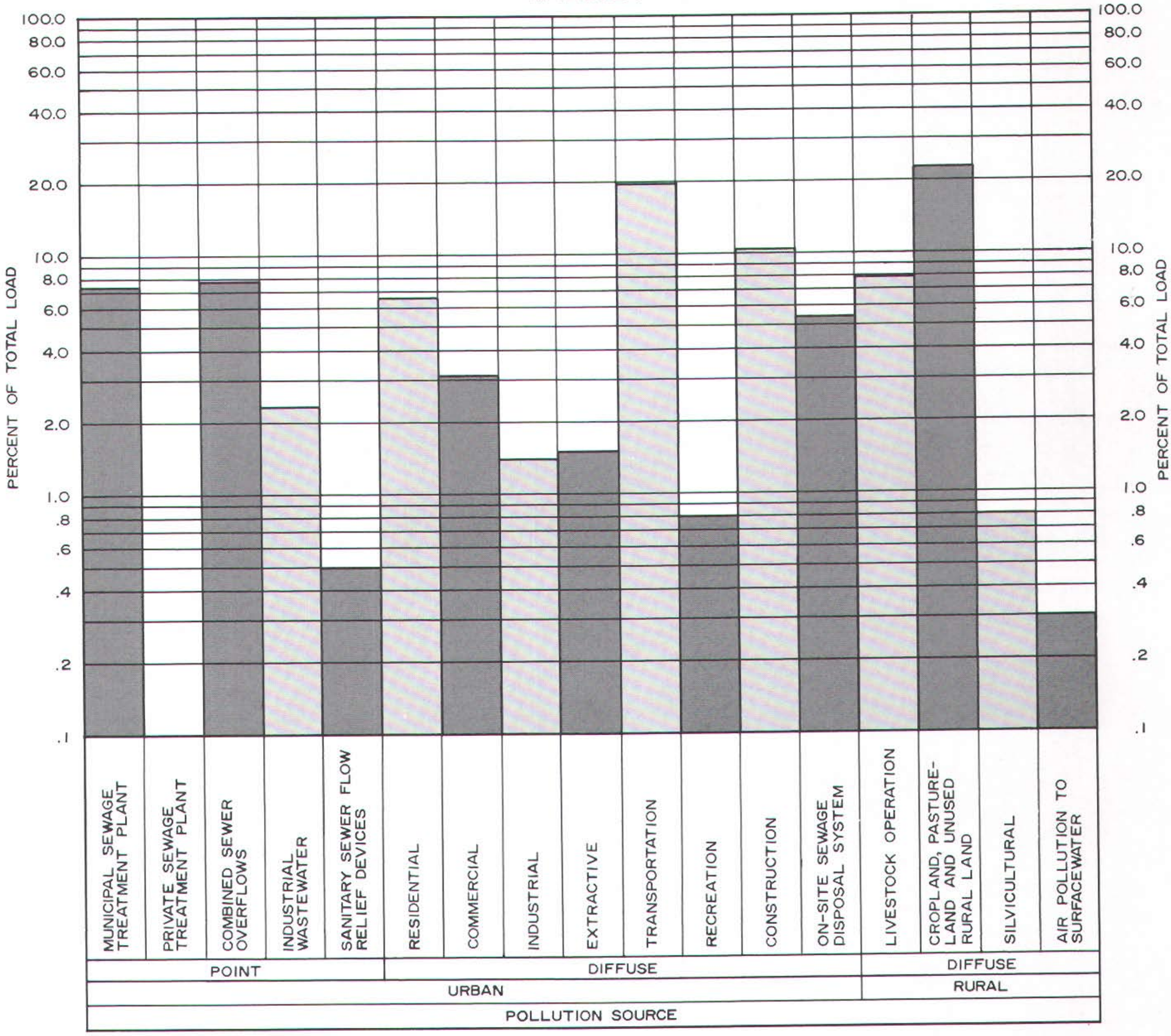


Figure 74 (continued)

PHOSPHOROUS

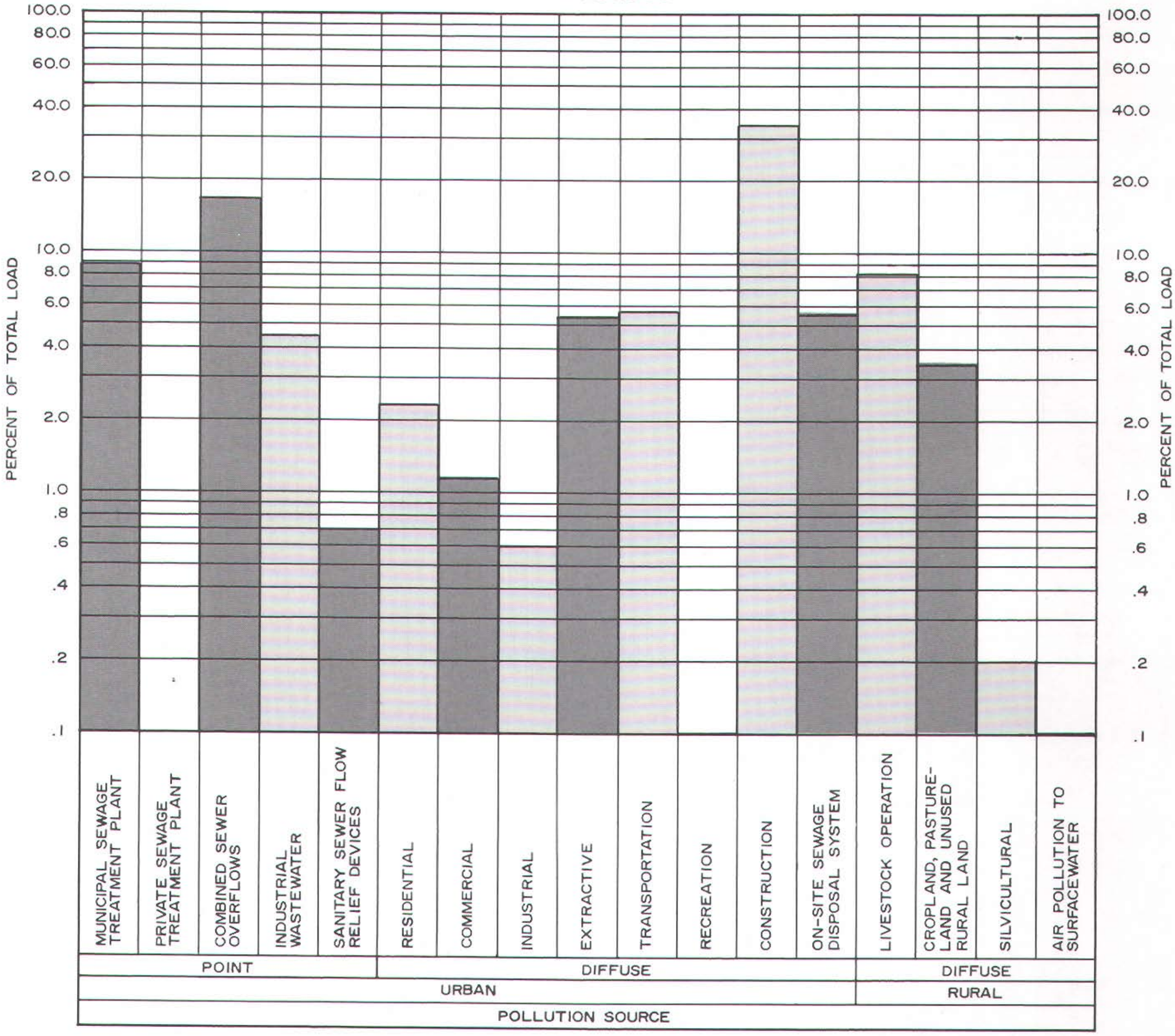


Figure 74 (continued)

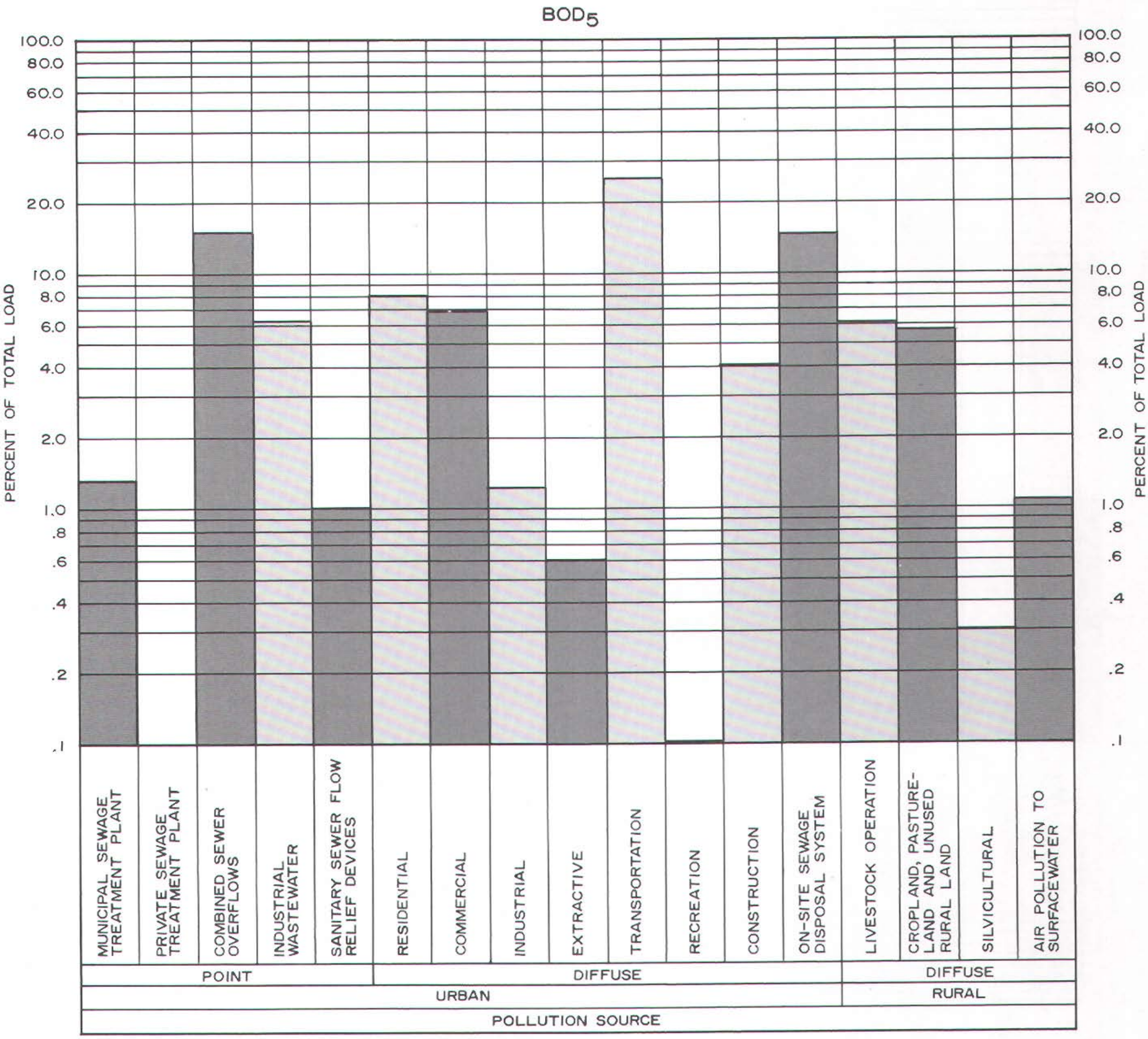


Figure 74 (continued)

FECAL COLIFORM

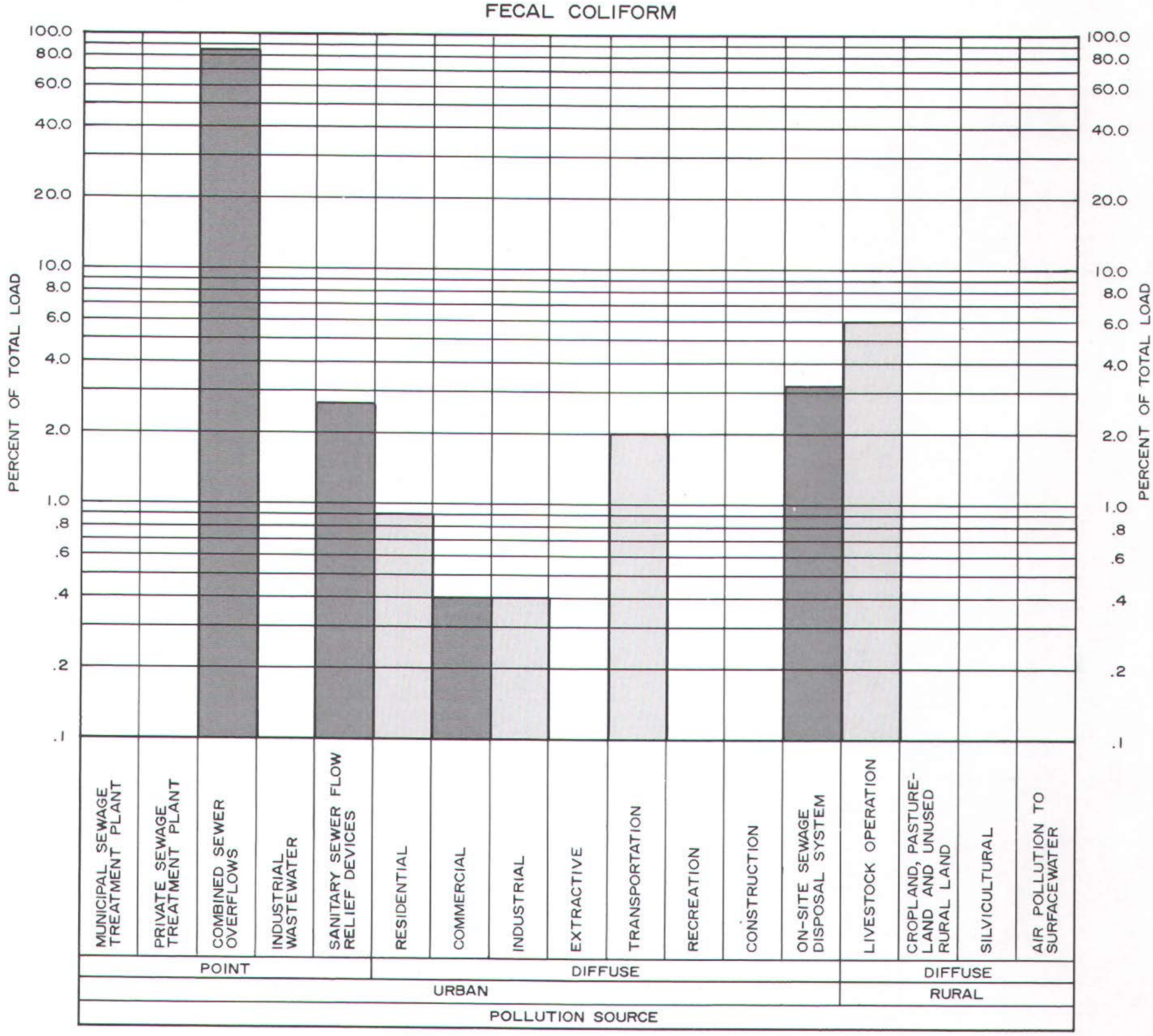
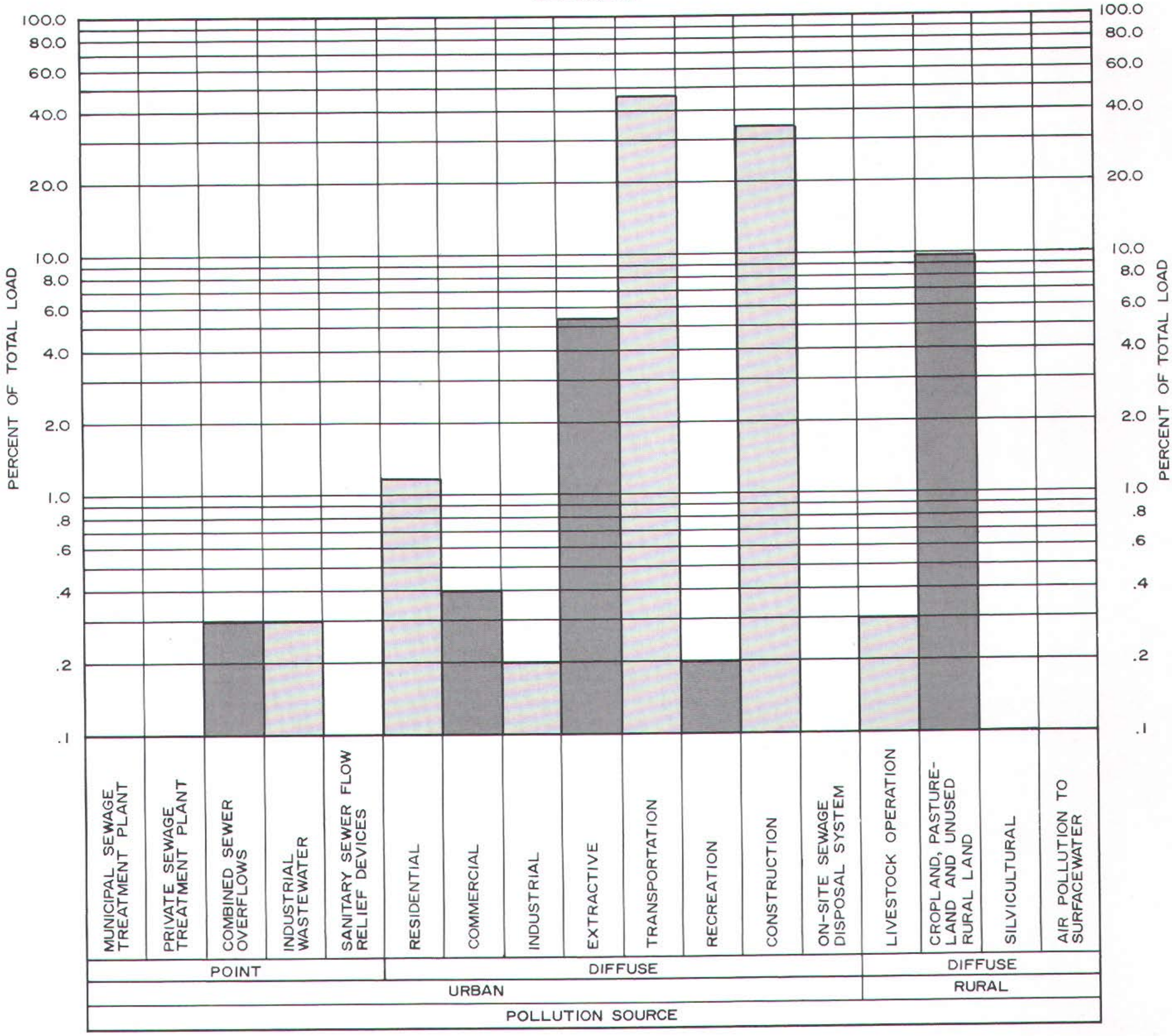


Figure 74 (continued)

SEDIMENT



Source: SEWRPC.

Table 371

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE MENOMONEE RIVER WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	3	Total Nitrogen	104,690.0	7.5	1.000	104,690.0	11.1	1.000	104,690.0	5.6
	3	Total Phosphorus	27,730.0	8.9	1.000	27,730.0	12.9	1.000	27,730.0	6.7
	3	Biochemical Oxygen Demand	98,750.0	1.4	1.000	98,750.0	2.1	1.000	98,750.0	1.0
	3	Fecal Coliform	63,000.0	0.0	1.000	63,000.0	0.0	1.000	63,000.0	0.0
	3	Sediment	80.0	0.0	1.000	80.0	0.0	1.000	80.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	26	Total Nitrogen	109,750.0	7.9	.643	70,570.0	7.5	1.371	150,470.0	8.1
	26	Total Phosphorus	54,880.0	17.6	.643	35,290.0	16.4	1.371	75,240.0	18.3
	26	Biochemical Oxygen Demand	1,097,540.0	15.6	.643	705,720.0	15.0	1.371	1,504,730.0	15.9
	26	Fecal Coliform	350,000,000.0	84.4	.643	225,050,000.0	84.4	1.371	479,850,000.0	84.4
	26	Sediment	1,645.0	0.3	.643	1,060.0	0.3	1.371	2,255.0	0.3
Industrial Discharges	48	Total Nitrogen	32,840.0	2.4	1.000	32,840.0	3.5	1.000	32,840.0	1.8
	48	Total Phosphorus	14,080.0	4.5	1.000	14,080.0	6.5	1.000	14,080.0	3.4
	48	Biochemical Oxygen Demand	434,650.0	6.2	1.000	434,650.0	9.2	1.000	434,650.0	4.6
	48	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	48	Sediment	1,525.0	0.3	1.000	1,525.0	0.5	1.000	1,525.0	0.2
Sanitary Sewer Flow Relief Devices . .	140	Total Nitrogen	6,960.0	0.5	.643	4,480.0	0.5	1.371	9,540.0	0.5
	140	Total Phosphorus	2,320.0	0.7	.643	1,490.0	0.7	1.371	3,180.0	0.8
	140	Biochemical Oxygen Demand	69,560.0	1.0	.643	44,730.0	0.9	1.371	95,370.0	1.0
	140	Fecal Coliform	11,000,000.0	2.7	.643	7,073,000.0	2.7	1.371	15,081,000.0	2.7
	140	Sediment	35.0	0.0	.643	25.0	0.0	1.371	50.0	0.0
Urban Point Source Totals		Total Nitrogen	254,240.0	18.3		212,580.0	22.5		297,540.0	16.0
		Total Phosphorus	99,010.0	31.8		78,590.0	36.5		120,230.0	29.2
		Biochemical Oxygen Demand	1,700,500.0	24.2		1,283,850.0	27.2		2,133,500.0	22.6
		Fecal Coliform	361,063,000.0	87.1		232,186,000.0	87.1		494,994,000.0	87.1
		Sediment	3,285.0	0.6		2,690.0	0.8		3,910.0	0.6
Urban Diffuse Sources										
Residential	23112	Total Nitrogen	92,450.0	6.6	.643	59,450.0	6.3	1.371	126,750.0	6.8
	23112	Total Phosphorus	7,400.0	2.4	.643	4,760.0	2.2	1.371	10,150.0	2.5
	23112	Biochemical Oxygen Demand	561,620.0	8.0	.643	361,120.0	7.7	1.371	769,980.0	8.1
	23112	Fecal Coliform	3,697,920.0	0.9	.643	2,377,762.6	0.9	1.371	5,069,848.3	0.9
	23112	Sediment	6,300.0	1.2	.643	4,050.0	1.2	1.371	8,635.0	1.2
Commercial	4968	Total Nitrogen	44,710.0	3.2	.643	28,750.0	3.0	1.371	61,300.0	3.3
	4968	Total Phosphorus	3,730.0	1.2	.643	2,400.0	1.1	1.371	5,110.0	1.2
	4968	Biochemical Oxygen Demand	484,880.0	6.9	.643	311,780.0	6.6	1.371	664,770.0	7.0
	4968	Fecal Coliform	1,639,440.0	0.4	.643	1,054,159.9	0.4	1.371	2,247,672.2	0.4
	4968	Sediment	1,850.0	0.4	.643	1,190.0	0.4	1.371	2,535.0	0.4
Industrial	2543	Total Nitrogen	21,360.0	1.5	.643	13,730.0	1.5	1.371	29,280.0	1.6
	2543	Total Phosphorus	1,780.0	0.6	.643	1,140.0	0.5	1.371	2,440.0	0.6
	2543	Biochemical Oxygen Demand	93,840.0	1.3	.643	60,340.0	1.3	1.371	128,650.0	1.4
	2543	Fecal Coliform	1,576,660.0	0.4	.643	1,013,792.4	0.4	1.371	2,161,600.9	0.4
	2543	Sediment	1,240.0	0.2	.643	795.0	0.2	1.371	1,700.0	0.2
Extractive	378	Total Nitrogen	22,680.0	1.6	.643	14,580.0	1.5	1.371	31,090.0	1.7
	378	Total Phosphorus	17,010.0	5.5	.643	10,940.0	5.1	1.371	23,320.0	5.7
	378	Biochemical Oxygen Demand	45,360.0	0.6	.643	29,170.0	0.6	1.371	62,190.0	0.7
	378	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	378	Sediment	28,350.0	5.5	.643	18,230.0	5.5	1.371	38,870.0	5.5
Transportation	12855	Total Nitrogen	277,730.0	19.9	.643	178,580.0	18.9	1.371	380,770.0	20.5
	12855	Total Phosphorus	18,190.0	5.8	.643	11,700.0	5.4	1.371	24,940.0	6.1
	12855	Biochemical Oxygen Demand	1,837,990.0	26.1	.643	1,181,830.0	25.1	1.371	2,519,880.0	26.7
	12855	Fecal Coliform	8,300,810.0	2.0	.643	5,337,420.8	2.0	1.371	11,380,410.5	2.0
	12855	Sediment	240,345.0	46.5	.643	154,540.0	46.4	1.371	329,515.0	46.5
Recreation	3951	Total Nitrogen	11,560.0	0.8	.643	7,430.0	0.8	1.371	15,850.0	0.9
	3951	Total Phosphorus	400.0	0.1	.643	260.0	0.1	1.371	550.0	0.1
	3951	Biochemical Oxygen Demand	5,140.0	0.1	.643	3,310.0	0.1	1.371	7,050.0	0.1
	3951	Fecal Coliform	99,864.0	0.0	.643	64,212.6	0.0	1.371	136,913.5	0.0
	3951	Sediment	830.0	0.2	.643	535.0	0.2	1.371	1,140.0	0.2
Construction	2428	Total Nitrogen	145,680.0	10.5	.643	93,670.0	9.9	1.371	199,730.0	10.7
	2428	Total Phosphorus	109,260.0	35.0	.643	70,250.0	32.6	1.371	149,800.0	36.4
	2428	Biochemical Oxygen Demand	291,360.0	4.1	.643	187,340.0	4.0	1.371	399,450.0	4.2
	2428	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	2428	Sediment	182,100.0	35.2	.643	117,090.0	35.2	1.371	249,660.0	35.3
Septic Systems	17760	Total Nitrogen	76,370.0	5.5	.643	49,110.0	5.2	1.371	104,700.0	5.6
	17760	Total Phosphorus	17,580.0	5.6	.643	11,300.0	5.2	1.371	24,100.0	5.8
	17760	Biochemical Oxygen Demand	1,090,460.0	15.5	.643	701,170.0	14.9	1.371	1,495,020.0	15.8
	17760	Fecal Coliform	13,320,000.0	3.2	.643	8,564,760.0	3.2	1.371	18,261,720.0	3.2
	17760	Sediment	185.0	0.0	.643	120.0	0.0	1.371	255.0	0.0

Table 371 (continued)

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	692,540.0	49.7		445,300.0	47.1		949,470.0	51.1
		Total Phosphorus	175,350.0	56.2		112,750.0	52.3		240,410.0	58.3
		Biochemical Oxygen Demand	4,410,650.0	62.7		2,836,060.0	60.1		6,046,990.0	64.0
		Fecal Coliform	28,634,694.0	6.9		18,412,108.3	6.9		39,258,165.4	6.9
		Sediment	461,200.0	89.2		296,550.0	89.1		632,310.0	89.3
Urban Source Totals		Total Nitrogen	946,780.0	68.0		657,880.0	69.6		1,247,010.0	67.1
		Total Phosphorus	274,360.0	88.0		191,340.0	88.8		360,640.0	87.5
		Biochemical Oxygen Demand	6,111,150.0	86.8		4,119,910.0	87.4		8,180,490.0	86.6
		Fecal Coliform	389,697,694.0	94.0		250,598,108.3	94.0		534,252,165.4	94.0
		Sediment	464,485.0	89.9		299,240.0	89.9		636,220.0	89.9
Rural Diffuse Sources										
Livestock Operation	3870	Total Nitrogen	109,910.0	7.9	.643	70,670.0	7.5	1.371	150,690.0	8.1
	3870	Total Phosphorus	25,540.0	8.2	.643	16,420.0	7.6	1.371	35,020.0	8.5
	3870	Biochemical Oxygen Demand	430,340.0	6.1	.643	276,710.0	5.9	1.371	590,000.0	6.2
	3870	Fecal Coliform	24,768,000.0	6.0	.643	15,925,824.0	6.0	1.371	33,956,928.0	6.0
	3870	Sediment	1,355.0	0.3	.643	870.0	0.3	1.371	1,860.0	0.3
Cropland, Pasture and Unused Rural Land	29240	Total Nitrogen	321,080.0	23.1	.643	206,450.0	21.9	1.371	440,200.0	23.7
	29240	Total Phosphorus	11,050.0	3.5	.643	7,110.0	3.3	1.371	15,150.0	3.7
	29240	Biochemical Oxygen Demand	397,930.0	5.7	.643	255,870.0	5.4	1.371	545,560.0	5.8
	29240	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	29240	Sediment	50,285.0	9.7	.643	32,335.0	9.7	1.371	68,940.0	9.7
Silvicultural	4660	Total Nitrogen	10,720.0	0.8	.643	6,890.0	0.7	1.371	14,700.0	0.8
	4660	Total Phosphorus	650.0	0.2	.643	420.0	0.2	1.371	890.0	0.2
	4660	Biochemical Oxygen Demand	21,440.0	0.3	.643	13,790.0	0.3	1.371	29,390.0	0.3
	4660	Fecal Coliform	30,756.0	0.0	.643	19,776.1	0.0	1.371	42,166.5	0.0
	4660	Sediment	585.0	0.1	.643	375.0	0.1	1.371	800.0	0.1
Air Pollution to Surface Water	469	Total Nitrogen	4,170.0	0.3	.643	2,680.0	0.3	1.371	5,720.0	0.3
	469	Total Phosphorus	230.0	0.1	.643	150.0	0.1	1.371	320.0	0.1
	469	Biochemical Oxygen Demand	75,980.0	1.1	.643	48,860.0	1.0	1.371	104,170.0	1.1
	469	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	469	Sediment	155.0	0.0	.643	100.0	0.0	1.371	215.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	445,880.0	32.0		286,690.0	30.4		611,310.0	32.9
		Total Phosphorus	37,470.0	12.0		24,100.0	11.2		51,380.0	12.5
		Biochemical Oxygen Demand	925,690.0	13.2		595,230.0	12.6		1,269,120.0	13.4
		Fecal Coliform	24,798,756.0	6.0		15,945,600.1	6.0		33,999,094.5	6.0
		Sediment	52,380.0	10.1		33,680.0	10.1		71,815.0	10.1
Diffuse Source Totals		Total Nitrogen	1,138,420.0	81.7		731,990.0	77.5		1,560,780.0	84.0
		Total Phosphorus	212,820.0	68.2		136,850.0	63.5		291,790.0	70.8
		Biochemical Oxygen Demand	5,336,340.0	75.8		3,431,290.0	72.8		7,316,110.0	77.4
		Fecal Coliform	53,433,450.0	12.9		34,357,708.4	12.9		73,257,259.9	12.9
		Sediment	513,580.0	99.4		330,230.0	99.2		704,125.0	99.4
Total Sources		Total Nitrogen	1,392,660.0	100.0		944,570.0	100.0		1,858,320.0	100.0
		Total Phosphorus	311,830.0	100.0		215,440.0	100.0		412,020.0	100.0
		Biochemical Oxygen Demand	7,036,840.0	100.0		4,715,140.0	100.0		9,449,610.0	100.0
		Fecal Coliform	414,496,450.0	100.0		266,543,708.4	100.0		568,251,259.9	100.0
		Sediment	516,865.0	100.0		332,920.0	100.0		708,035.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

demand, 100 percent of the fecal coliform, and 3 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 75 percent of the nitrogen, 32 percent of the phosphorus, 53 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 97 percent of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 74 presents the relative pollution loadings discussed above within the Menomonee River watershed.

The dry year and wet year analyses, as shown in Table 371, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. The effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and municipal and private sewage treatment plant discharges of these pollutants are unaffected. The proportion of phosphorus contributed by point sources ranges from 28 percent during a wet year to 36 percent during a dry year. Of the total nitrogen load, point sources contribute from 15 percent of the total load during a wet year to 22 percent during a dry year. Biochemical oxygen demand contributions from point sources similarly range from 20 to 25 percent of the total load. Point sources of sediment contribute less than one percent of the total load during a wet or dry year. Point sources of fecal coliform contribute 85 percent of the total load during a wet or dry year.

The quantity of pollutants transported in the Menomonee River at 70th Street in Wauwatosa was estimated by a transport analysis based on streamflow and pollutant concentration measurements. These data were available from the International Joint Commission, Menomonee River Pilot Watershed Study. However, no biochemical oxygen demand data were available. In the Menomonee River, at 70th Street, Wauwatosa, it is estimated from these in-stream measurements that about 320,000 pounds of nitrogen, 60,000 pounds of phosphorus, and 23,193,000 pounds of sediment are transported annually. Table 372 presents a comparison of pollutant transport loads, based on streamflow samples, to pollutant channel loads as estimated from regional data and general studies. As noted above, the transport loads, as computed from in-stream measurements, are, as expected, significantly less than the channel loads because of the physical, chemical, and biological processes occurring on the land surface and wihtin the stream itself which serve to effectively remove the pollutants temporarily or permanently.

Table 372

COMPARISON OF ESTIMATED TRANSPORT LOADS TO ESTIMATED POLLUTANT CHANNEL LOADS IN THE MENOMONEE RIVER

Pollutant	Channel Load (Thousands of Pounds/Year)	Transport Analysis Load (Thousands of Pounds/Year): Annual Load	Variance[a]
Nitrogen	1,393	320	± 56
Phosphorus	312	60	± 2.5
Sediment	1,033,700	23,193	± 2,425

[a] *Variance significant at a 95% confidence level.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

MILWAUKEE RIVER WATERSHED

A summary of the loadings to the Milwaukee River is presented in Table 373 and depicted in Figure 75. Urban sources of pollution are estimated to contribute 21 percent of the nitrogen, 46 percent of the phosphorus, 31 percent of the biochemical oxygen demand, 62 percent of the fecal coliform, and 47 percent of the sediment which occur as water pollutants to the Milwaukee River and its tributaries. Of the urban contribution, the point sources of pollution contribute 50 percent of the nitrogen, 30 percent of the phosphorus, 33 percent of the biochemical oxygen demand, 96 percent of the fecal coliform, and less than 1 percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 50 percent of the nitrogen, 70 percent of the phosphorus, 67 percent of the biochemical oxygen demand, 4 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 79 percent of the nitrogen, 54 percent of the phosphorus, 69 percent of the biochemical oxygen demand, 38 percent of the fecal coliform, and 53 percent of the sediments from all sources within the watershed. There are no rural point sources of pollution since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 35 percent of the nitrogen, 78 percent of the phosphorus, 59 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 4 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 65 percent of the nitrogen, 22 percent of the phosphorus, 41 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 96 percent of the sediment, is contributed by other rural diffuse sources, namely storm water

Figure 75

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE MILWAUKEE RIVER WATERSHED

NITROGEN

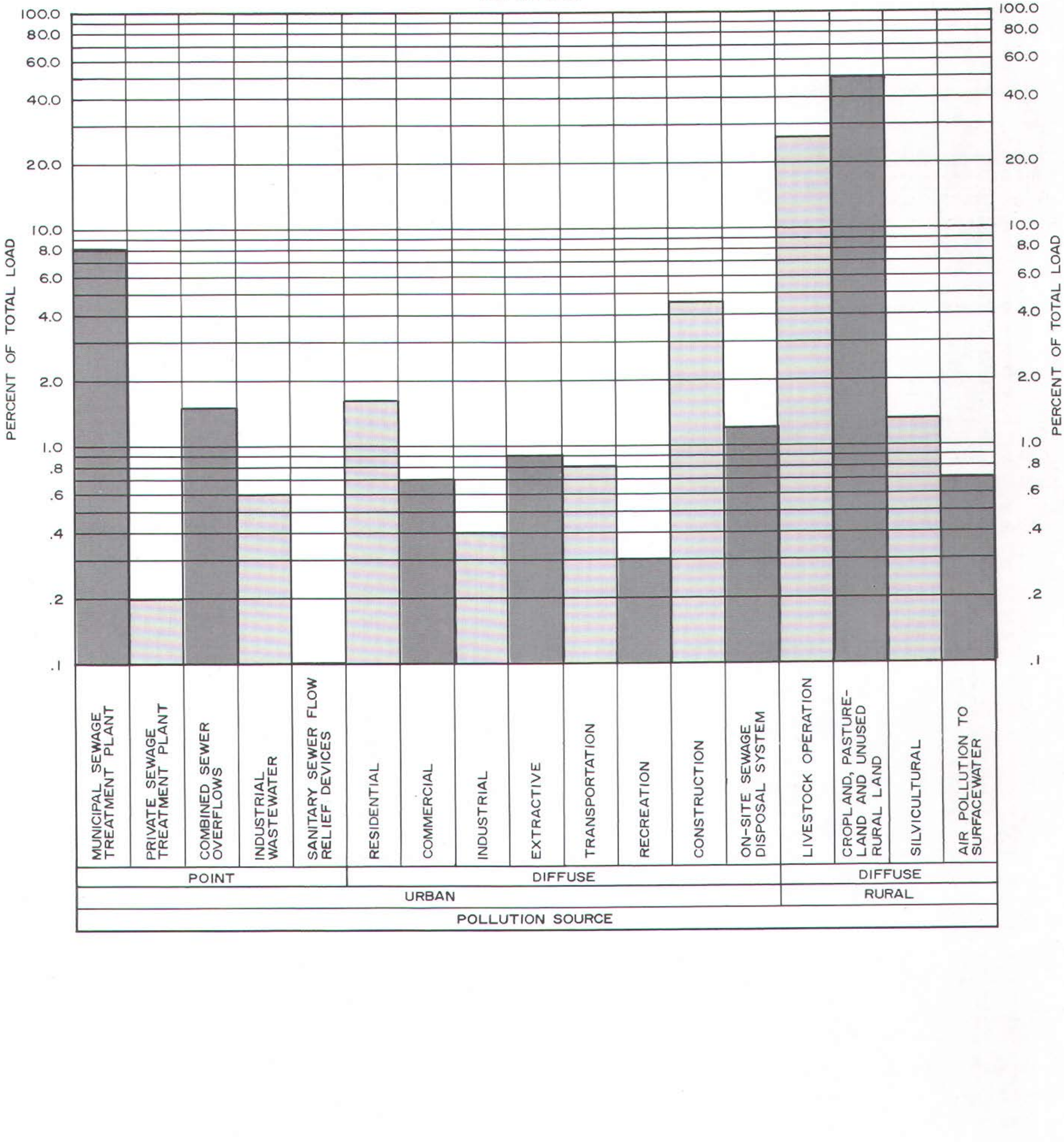


Figure 75 (continued)

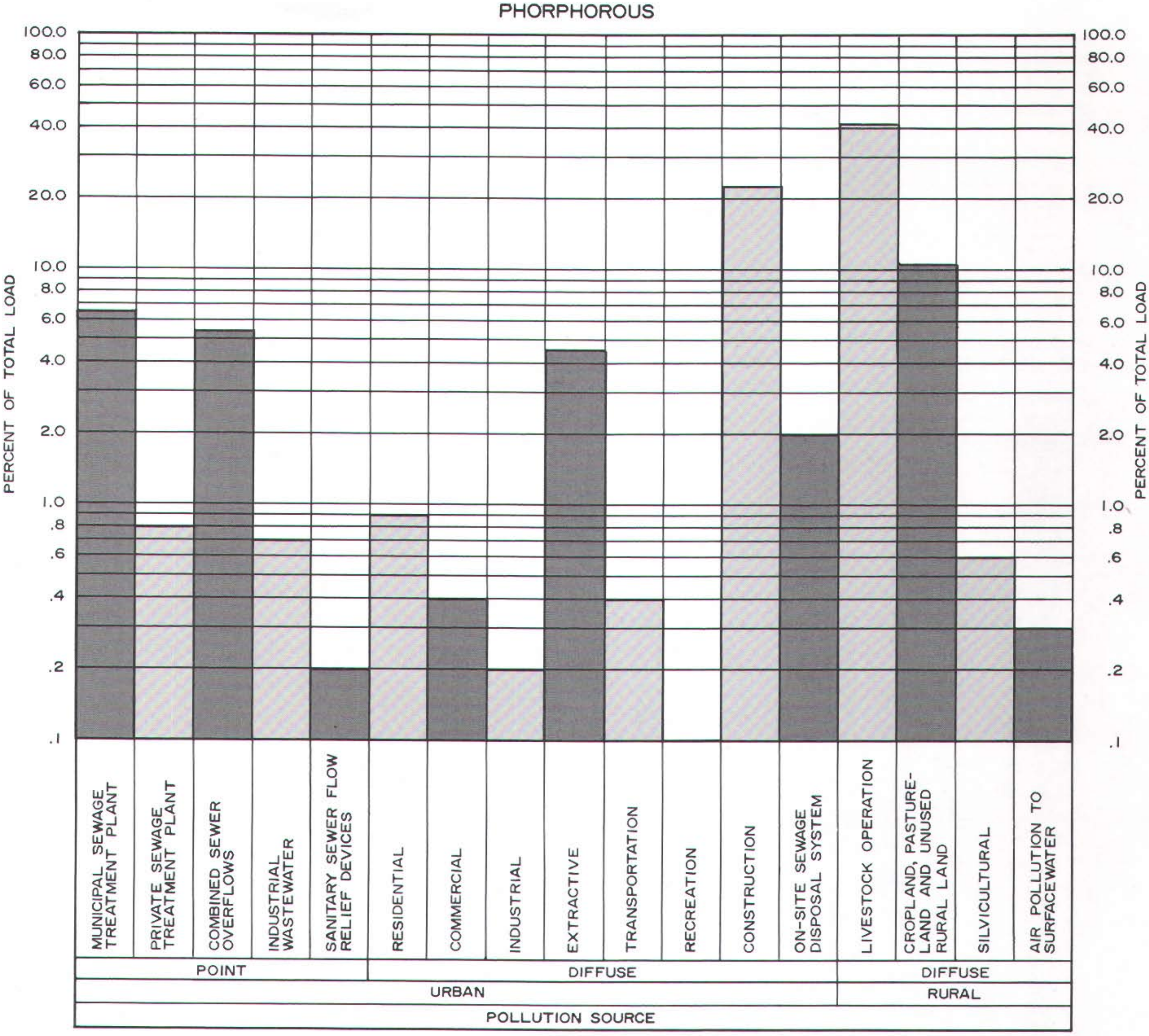


Figure 75 (continued)

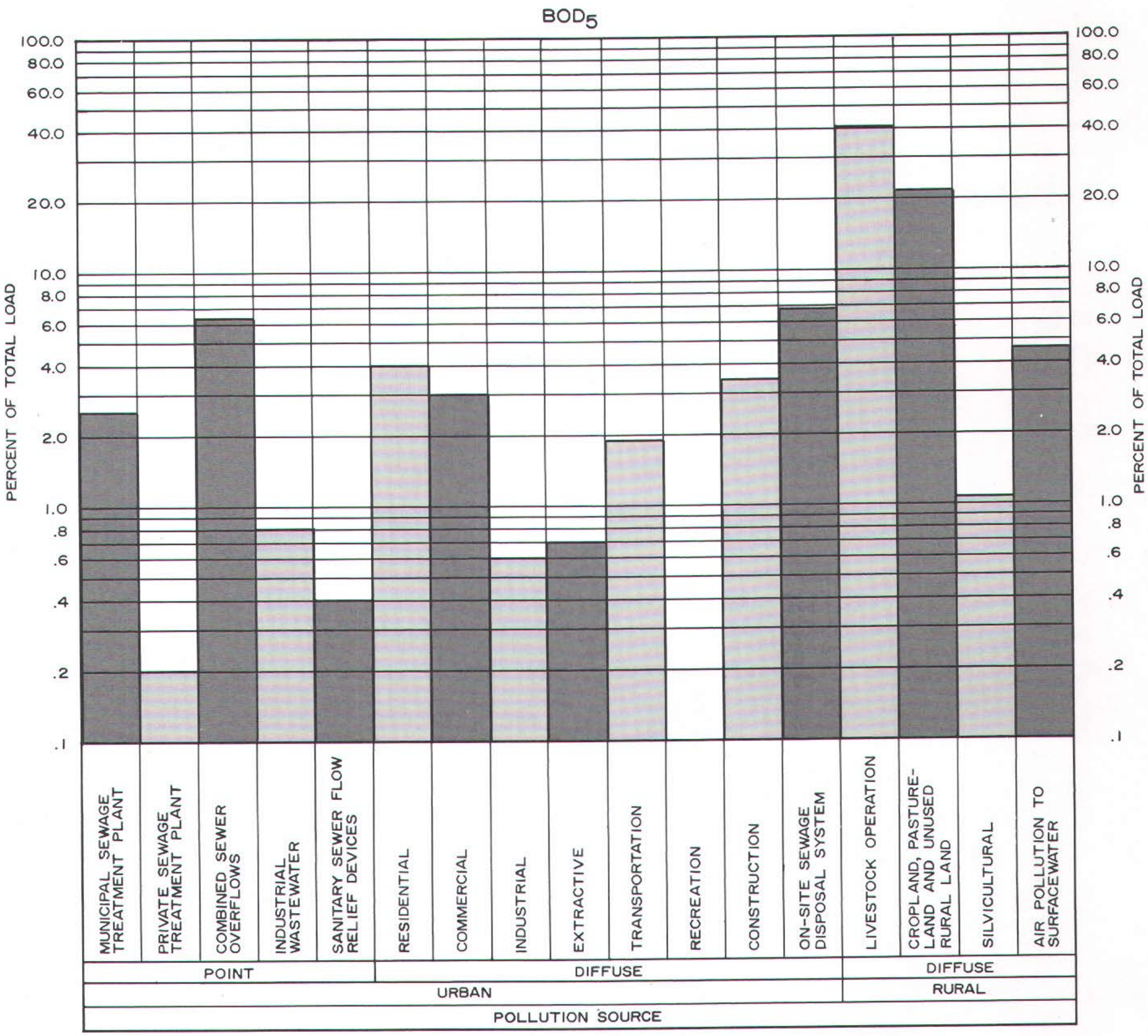


Figure 75 (continued)

FECAL COLIFORM

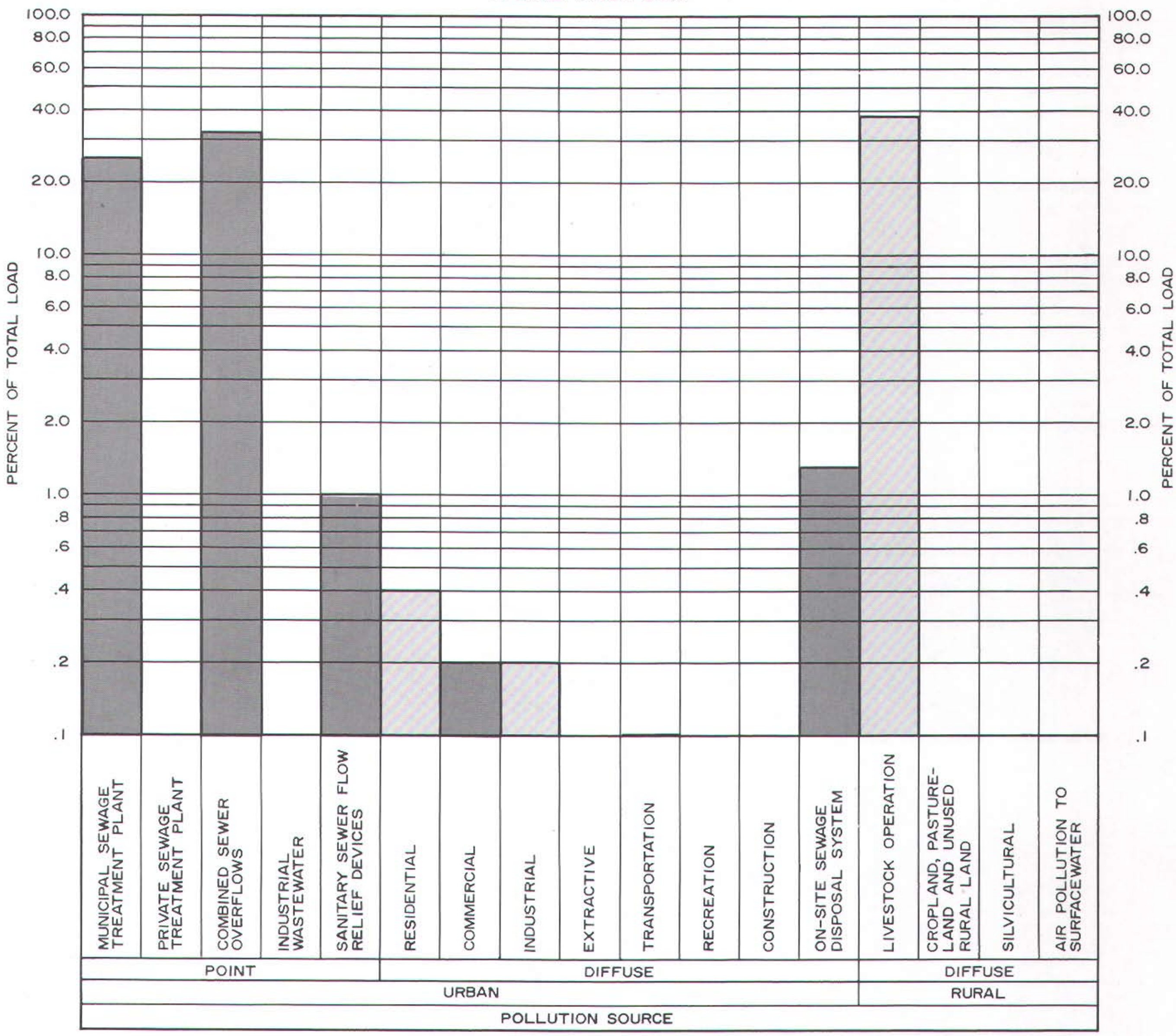
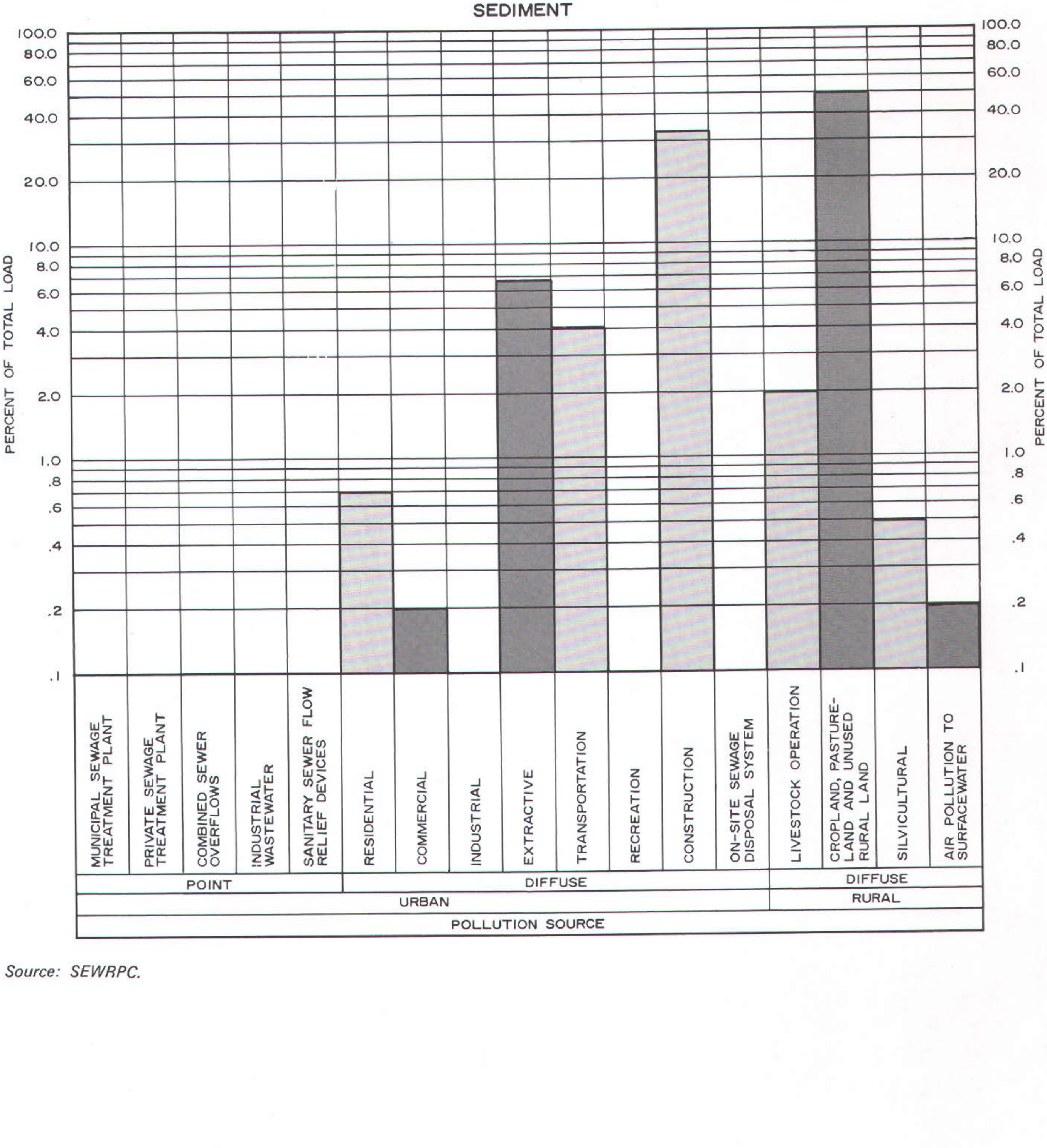


Figure 75 (continued)

SEDIMENT



Source: SEWRPC.

Table 373

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE MILWAUKEE RIVER WATERSHED IN 1975

Source	Extent[b]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Point Sources										
Municipal Sewage Treatment Plants . .	9	Total Nitrogen	536,820.0	8.1	1.000	536,820.0	11.9	1.000	536,820.0	6.0
	9	Total Phosphorus	65,830.0	6.6	1.000	65,830.0	9.9	1.000	65,830.0	5.0
	9	Biochemical Oxygen Demand	460,450.0	2.6	1.000	460,450.0	4.0	1.000	460,450.0	1.9
	9	Fecal Coliform	280,000,000.0	26.1	1.000	280,000,000.0	35.4	1.000	280,000,000.0	20.4
	9	Sediment	310.0	0.0	1.000	310.0	0.0	1.000	310.0	0.0
Private Sewage Treatment Plants	1	Total Nitrogen	10,210.0	0.2	1.000	10,210.0	0.2	1.000	10,210.0	0.1
	1	Total Phosphorus	8,380.0	0.8	1.000	8,380.0	1.3	1.000	8,380.0	0.6
	1	Biochemical Oxygen Demand	27,070.0	0.2	1.000	27,070.0	0.2	1.000	27,070.0	0.1
	1	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Sediment	15.0	0.0	1.000	15.0	0.0	1.000	15.0	0.0
Combined Sewer Overflows	61	Total Nitrogen	109,340.0	1.6	.643	70,310.0	1.6	1.371	149,910.0	1.7
	61	Total Phosphorus	54,670.0	5.5	.643	35,150.0	5.3	1.371	74,950.0	5.6
	61	Biochemical Oxygen Demand	1,093,370.0	6.3	.643	703,040.0	6.1	1.371	1,499,010.0	6.3
	61	Fecal Coliform	350,000,000.0	32.6	.643	225,050,000.0	28.5	1.371	479,850,000.0	35.0
	61	Sediment	1,640.0	0.1	.643	1,055.0	0.1	1.371	2,250.0	0.1
Industrial Discharges	68	Total Nitrogen	37,530.0	0.6	1.000	37,350.0	0.8	1.000	37,530.0	0.4
	68	Total Phosphorus	6,720.0	0.7	1.000	6,720.0	1.0	1.000	6,720.0	0.5
	68	Biochemical Oxygen Demand	131,470.0	0.8	1.000	131,470.0	1.1	1.000	131,470.0	0.6
	68	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	68	Sediment	170.0	0.0	1.000	170.0	0.0	1.000	170.0	0.0
Sanitary Sewer Flow Relief Devices . .	127	Total Nitrogen	7,380.0	0.1	.643	4,750.0	0.1	1.371	10,120.0	0.1
	127	Total Phosphorus	2,460.0	0.2	.643	1,580.0	0.2	1.371	3,370.0	0.3
	127	Biochemical Oxygen Demand	73,800.0	0.4	.643	47,450.0	0.4	1.371	101,180.0	0.4
	127	Fecal Coliform	11,000,000.0	1.0	.643	7,073,000.0	0.9	1.371	15,081,000.0	1.1
	127	Sediment	35.0	0.0	.643	25.0	0.0	1.371	50.0	0.0
Urban Point Source Totals		Total Nitrogen	701,280.0	10.5		659,620.0	14.7		744,590.0	8.3
		Total Phosphorus	138,060.0	13.9		117,660.0	17.7		159,250.0	12.0
		Biochemical Oxygen Demand	1,786,160.0	10.2		1,369,480.0	11.9		2,219,180.0	9.4
		Fecal Coliform	641,000,000.0	59.7		512,123,000.0	64.8		774,931,000.0	56.6
		Sediment	2,170.0	0.2		1,575.0	0.2		2,795.0	0.2
Urban Diffuse Sources										
Residential	29129	Total Nitorgen	116,520.0	1.7	.643	74,920.0	1.7	1.371	159,750.0	1.8
	29129	Total Phosphorus	9,320.0	0.9	.643	5,990.0	0.9	1.371	12,780.0	1.0
	29129	Biochemical Oxygen Demand	707,830.0	4.0	.643	455,130.0	4.0	1.371	970,430.0	4.1
	29129	Fecal Coliform	4,660,640.0	0.4	.643	2,996,791.5	0.4	1.371	6,389,737.4	0.5
	29129	Sediment	7,940.0	0.7	.643	5,105.0	0.7	1.371	10,885.0	0.7
Commercial	5454	Total Nitrogen	49,090.0	0.7	.643	31,560.0	0.7	1.371	67,300.0	0.8
	5454	Total Phosphorus	4,090.0	0.4	.643	2,630.0	0.4	1.371	5,610.0	0.4
	5454	Biochemical Oxygen Demand	532,310.0	3.0	.643	342,280.0	3.0	1.371	729,800.0	3.1
	5454	Fecal Coliform	1,799,820.0	0.2	.643	1,157,284.3	0.1	1.371	2,467,553.2	0.2
	5454	Sediment	2,030.0	0.2	.643	1,305.0	0.2	1.371	2,785.0	0.2
Industrial	3014	Total Nitrogen	25,320.0	0.4	.643	16,280.0	0.4	1.371	34,710.0	0.4
	3014	Total Phosphorus	2,110.0	0.2	.643	1,360.0	0.2	1.371	2,890.0	0.2
	3014	Biochemical Oxygen Demand	111,220.0	0.6	.643	71,510.0	0.6	1.371	152,480.0	0.6
	3014	Fecal Coliform	1,868,680.0	0.2	.643	1,201,561.2	0.2	1.371	2,561,960.3	0.2
	3014	Sediment	1,470.0	0.1	.643	945.0	0.1	1.371	2,015.0	0.1
Extractive	1017	Total Nitrogen	61,020.0	0.9	.643	39,240.0	0.9	1.371	83,660.0	0.9
	1017	Total Phosphorus	45,770.0	4.6	.643	29,430.0	4.4	1.371	62,750.0	4.7
	1017	Biochemical Oxygen Demand	122,040.0	0.7	.643	78,470.0	0.7	1.371	167,320.0	0.7
	1017	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1017	Sediment	76,275.0	6.9	.643	49,045.0	6.9	1.371	104,575.0	6.9
Transportation	2431	Total Nitrogen	52,630.0	0.8	.643	33,840.0	0.8	1.371	72,160.0	0.8
	2431	Total Phosphorus	3,710.0	0.4	.643	2,390.0	0.4	1.371	5,090.0	0.4
	2431	Biochemical Oxygen Demand	339,480.0	1.9	.643	218,290.0	1.9	1.371	465,430.0	2.0
	2431	Fecal Coliform	1,453,420.0	0.1	.643	934,549.1	0.1	1.371	1,992,638.8	0.1
	2431	Sediment	44,885.0	4.1	.643	28,860.0	4.1	1.371	61,535.0	4.1
Recreation	5858	Total Nitrogen	18,180.0	0.3	.643	11,690.0	0.3	1.371	24,920.0	0.3
	5858	Total Phosphorus	670.0	0.1	.643	430.0	0.1	1.371	920.0	0.1
	5858	Biochemical Oxygen Demand	7,620.0	0.0	.643	4,900.0	0.0	1.371	10,450.0	0.0
	5858	Fecal Coliform	130,176.0	0.0	.643	83,703.2	0.0	1.371	178,471.3	0.0
	5858	Sediment	1,230.0	0.1	.643	790.0	0.1	1.371	1,685.0	0.1
Construction	5096	Total Nitrogen	305,760.0	4.6	.643	196,600.0	4.4	1.371	419,200.0	4.7
	5096	Total Phosphorus	229,320.0	23.2	.643	147,450.0	22.2	1.371	314,400.0	23.7
	5096	Biochemical Oxygen Demand	611,520.0	3.5	.643	393,210.0	3.4	1.371	838,390.0	3.5
	5096	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	5096	Sediment	382,200.0	34.5	.643	245,755.0	34.5	1.371	523,995.0	34.5
Septic Systems	38780	Total Nitrogen	86,330.0	1.3	.643	55,510.0	1.2	1.371	118,360.0	1.3
	38780	Total Phosphorus	19,650.0	2.0	.643	12,640.0	1.9	1.371	26,940.0	2.0
	38780	Biochemical Oxygen Demand	1,214,580.0	6.9	.643	780,970.0	6.8	1.371	1,665,190.0	7.0
	38780	Fecal Coliform	14,884,500.0	1.4	.643	9,570,733.5	1.2	1.371	20,406,649.5	1.5
	38780	Sediment	210.0	0.0	.643	135.0	0.0	1.371	290.0	0.0

Table 373 (continued)

Source	Extent[b]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	714,850.0	10.7		459,640.0	10.2		980,060.0	11.0
		Total Phosphorus	314,640.0	31.8		202,320.0	30.4		431,380.0	32.5
		Biochemical Oxygen Demand	3,646,600.0	20.9		2,344,760.0	20.5		4,999,490.0	21.1
		Fecal Coliform	24,797,236.0	2.3		15,944,622.8	2.0		33,997,010.5	2.5
		Sediment	516,240.0	46.6		331,940.0	46.6		707,765.0	46.6
Urban Source Totals		Total Nitrogen	1,416,130.0	21.2		1,119,260.0	24.9		1,724,650.0	19.3
		Total Phosphorus	452,700.0	45.7		319,980.0	48.1		590,630.0	44.5
		Biochemical Oxygen Demand	5,432,760.0	31.1		3,714,240.0	32.4		7,218,670.0	30.4
		Fecal Coliform	665,797,236.0	62.0		528,067,622.8	66.8		808,928,010.5	59.1
		Sediment	518,410.0	46.8		333,515.0	46.8		710,560.0	46.8
Rural Diffuse Sources										
Livestock Operations	63830	Total Nitrogen	1,812,770.0	27.2	.643	1,165,610.0	25.9	1.371	2,485,310.0	27.9
	63830	Total Phosphorus	421,280.0	42.5	.643	270,880.0	40.7	1.371	577,570.0	43.5
	63830	Biochemical Oxygen Demand	7,097,900.0	40.6	.643	4,563,950.0	39.8	1.371	9,731,220.0	41.0
	63830	Fecal Coliform	408,512,000.0	38.0	.643	262,673,216.0	33.2	1.371	560,069,952.0	40.9
	63830	Sediment	22,340.0	2.0	.643	14,365.0	2.0	1.371	30,630.0	2.0
Cropland, Pasture, and Unused Rural Land	312380	Total Nitrogen	3,299,730.0	49.5	.643	2,121,730.0	47.2	1.371	4,523,930.0	50.7
	312380	Total Phosphorus	107,960.0	10.9	.643	69,420.0	10.4	1.371	148,010.0	11.2
	312380	Biochemical Oxygen Demand	3,936,460.0	22.5	.643	2,531,140.0	22.1	1.371	5,396,890.0	22.7
	312380	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	312380	Sediment	560,110.0	50.6	.643	360,150.0	50.6	1.371	767,910.0	50.6
Silvicultural	40000	Total Nitrogen	92,000.0	1.4	.643	59,160.0	1.3	1.371	126,130.0	1.4
	40000	Total Phosphorus	5,600.0	0.6	.643	3,600.0	0.5	1.371	7,680.0	0.6
	40000	Biochemical Oxygen Demand	184,000.0	1.1	.643	118,310.0	1.0	1.371	252,260.0	1.1
	40000	Fecal Coliform	264,000.0	0.0	.643	169,752.0	0.0	1.371	361,944.0	0.0
	40000	Sediment	5,020.0	0.5	.643	3,230.0	0.5	1.371	6,880.0	0.5
Air Pollution to Surface Water	5112	Total Nitrogen	45,500.0	0.7	.643	29,260.0	0.7	1.371	62,380.0	0.7
	5112	Total Phosphorus	2,560.0	0.3	.643	1,650.0	0.2	1.371	3,510.0	0.3
	5112	Biochemical Oxygen Demand	828,140.0	4.7	.643	532,490.0	4.6	1.371	1,135,380.0	4.8
	5112	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	5112	Sediment	1,700.0	0.2	.643	1,095.0	0.2	1.371	2,330.0	0.2
Rural Diffuse Source Totals		Total Nitrogen	5,250,000.0	78.8		3,375,760.0	75.1		7,197,750.0	80.7
		Total Phosphorus	537,400.0	54.3		345,550.0	51.9		736,770.0	55.5
		Biochemical Oxygen Demand	12,046,500.0	68.9		7,745,890.0	67.6		16,515,750.0	69.6
		Fecal Coliform	408,776,000.0	38.0		262,842,968.0	33.2		560,431,896.0	40.9
		Sediment	589,170.0	53.2		378,840.0	53.2		807,750.0	53.2
Diffuse Source Totals		Total Nitrogen	5,964,850.0	85.5		3,835,400.0	85.3		8,177,810.0	91.7
		Total Phosphorus	852,040.0	86.1		547,870.0	82.3		1,168,150.0	88.0
		Biochemical Oxygen Demand	15,693,100.0	89.8		10,090,650.0	88.1		21,515,240.0	90.6
		Fecal Coliform	433,573,236.0	40.3		278,787,590.8	35.2		594,428,906.5	43.4
		Sediment	1,105,410.0	99.8		710,780.0	99.8		1,515,515.0	99.8
Total Sources		Total Nitrogen	6,666,130.0	100.0		4,495,020.0	100.0		8,922,400.0	100.0
		Total Phosphorus	990,100.0	100.0		665,530.0	100.0		1,327,400.0	100.0
		Biochemical Oxygen Demand	17,479,260.0	100.0		11,460,130.0	100.0		23,734,420.0	100.0
		Fecal Coliform	1,074,573,236.0	100.0		790,910,590.8	100.0		1,369,359,906.5	100.0
		Sediment	1,107,580.0	100.0		712,355.0	100.0		1,518,310.0	100.0

[a] *Includes pollution loadings from the approximately 264 square miles of the Milwaukee River watershed located outside of the Region.*

[b] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

runoff from rural land uses and atmospheric loadings to surface waters. Figure 75 presents the relative pollution loadings discussed above within the Milwaukee River watershed.

The dry year and wet year analyses, as shown in Table 373, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. The effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and public and private wastewater treatment plant discharges of these pollutants are unaffected. The proportion of phosphorus contributed by point sources ranges from 12 percent during a wet year to 18 percent during a dry year. Of the total nitrogen load, point sources contribute from 8 percent of the total load during a wet year to 15 percent during a dry year. Biochemical oxygen demand and fecal coliform contributions from point sources similarly range from 9 to

12 percent and from 57 to 65 percent of the total loads, respectively. Point sources of sediment contribute two-tenths of one percent of the total load during a dry year or wet year.

The quantity of pollutants transported in the Milwaukee River at Estabrook Park, Milwaukee, were estimated by a transport analysis based on streamflow and pollutant concentration measurements. Streamflow data were available for the Milwaukee River at Estabrook Park, Milwaukee, from the U.S. Geological Survey for the years 1914 to 1975 as part of its routine sampling program. Total phosphorus and total nitrogen concentrations measurements were available from SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975, and total nitrogen, total phosphorus and biochemical oxygen demand measurements were available from the Commission's index site sampling program. Suspended solids, nitrogen, and phosphorus concentration data were available from the USGS Water Quality Monitoring Program. In the Milwaukee River, at Estabrook Park, Milwaukee, it is estimated from these in-stream measurements that about 3,614,000 pounds of nitrogen, 327,000 pounds of phosphorus, 3,645,000 pounds of biochemical oxygen demand, and 53,596,000 pounds of sediment are transported annually. Table 374 presents a comparison of pollutant transport loads based on streamflow samples, to pollutant channel loads as estimated from regional data and general studies. As noted above, the downstream transport loads, as computed from in-stream measurements, are, as expected, significantly less than the channel loads because of the physical, chemical, and biological processes occurring on the land surface and within the stream itself which serve to effectively remove the pollutants temporarily or permanently.

Table 374

COMPARISON OF ESTIMATED TRANSPORT LOADS TO ESTIMATED POLLUTANT CHANNEL LOADS IN THE MILWAUKEE RIVER

Pollutant	Channel Load (Thousands of Pounds/Year)	Transport Analysis Load (Thousands of Pounds/Year): Annual Load		Variance[a]
Nitrogen	6,666	3,614	±	418
Phosphorus . . .	990	327	±	115
BOD_5	17,479	3,645	±	8,908
Sediment	2,215,200	53,596	±	25,680

[a] *Variance significant level.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

WATERSHED OF MINOR STREAMS DIRECTLY TRIBUTARY TO LAKE MICHIGAN

The minor streams tributary to Lake Michigan—Barnes Creek, Pike Creek, and Sucker Creek—are discussed individually with regard to sources of water pollution. Another area directly tributary to Lake Michigan is the drainage area outside the major watersheds. This shoreland is relatively small in area and therefore not treated as a watershed in this analysis. Similarly, it was not deemed appropriate to compare the runoff from this area to the point sources which contribute pollutants to the near-shore areas of Lake Michigan, since these are the receiving waters for the majority of the sewage treatment plant effluents discharged in the Region. The analysis of pollutant loads is also complicated by the fact that the near-shore areas also receive the pollutants transported by some of the major inland river systems discussed in this report, but only after the pollutant loads in the rivers pass through the small estuaries at the river mouths, where the pollutant loads are affected by complex hydraulic phenomena.

BARNES CREEK SUBWATERSHED

A summary of the loadings to Barnes Creek is presented in Table 375 and depicted in Figure 76. Urban sources of pollution are estimated to contribute 59 percent of the nitrogen, 96 percent of the phosphorus, 89 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 89 percent of the sediment which occur as water pollutants to Barnes Creek. There are no significant point sources of pollution in the Barnes Creek subwatershed, hence all urban pollutants are contributed from diffuse sources, including septic systems.

Of the total pollutant loads, rural pollution sources contribute an estimated 41 percent of the nitrogen, 4 percent of the phosphorus, 11 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and 11 percent of the sediment from sources within the subwatershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—inclusive of the disposal of manure on croplands—contribute 1 percent of the nitrogen, 8 percent of the phosphorus, 4 percent of the biochemical oxygen demand, 98 percent of the fecal coliform, and one-tenth of one percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 99 percent of the nitrogen, 92 percent of the phosphorus, 96 percent of the biochemical oxygen demand, 2 percent of the fecal coliform, and virtually all of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses. Figure 76 presents the relative pollution loadings discussed above within the Barnes Creek subwatershed.

Figure 76

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE BARNES CREEK SUBWATERSHED

NITROGEN

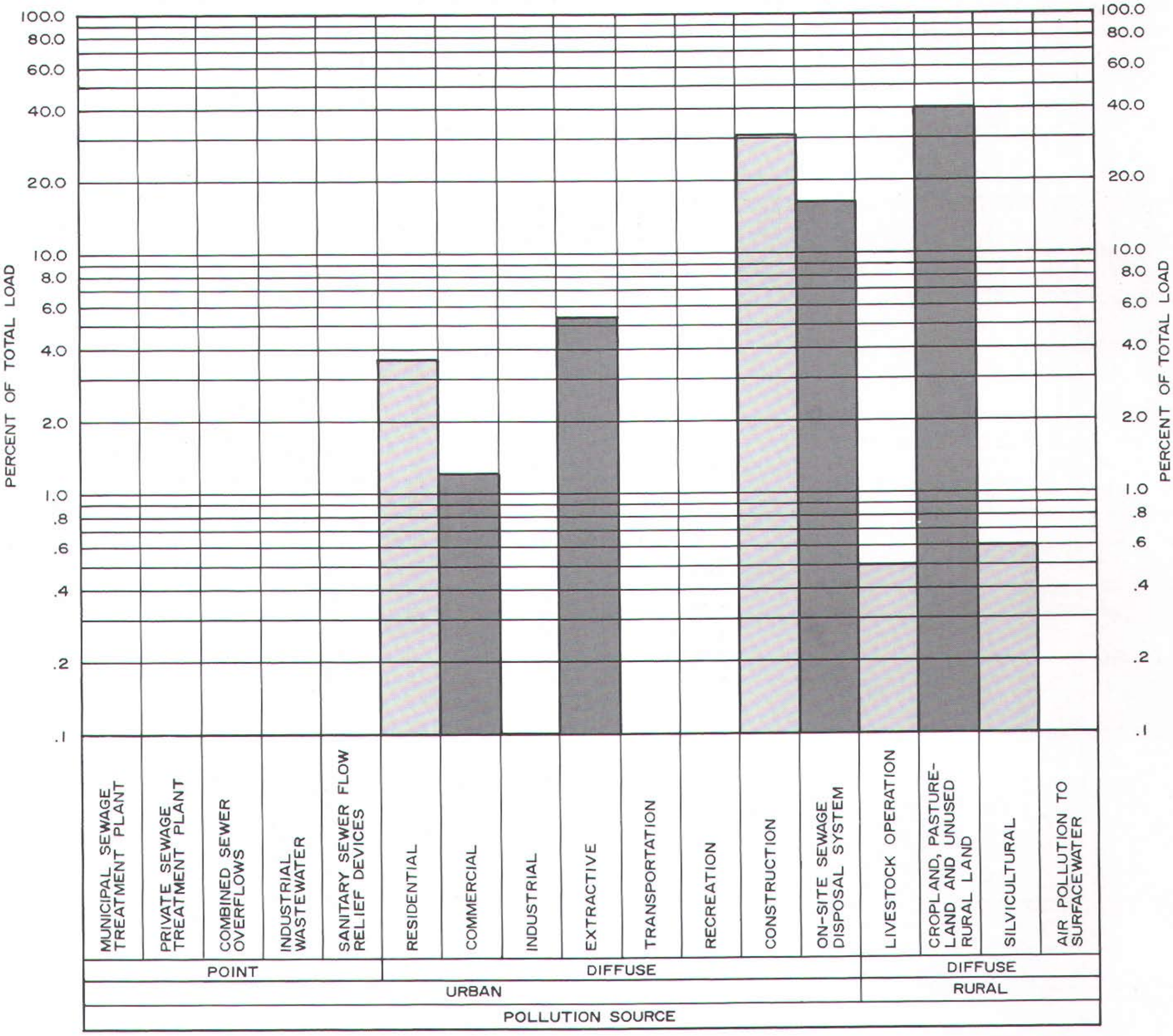


Figure 76 (continued)

PHOSPHOROUS

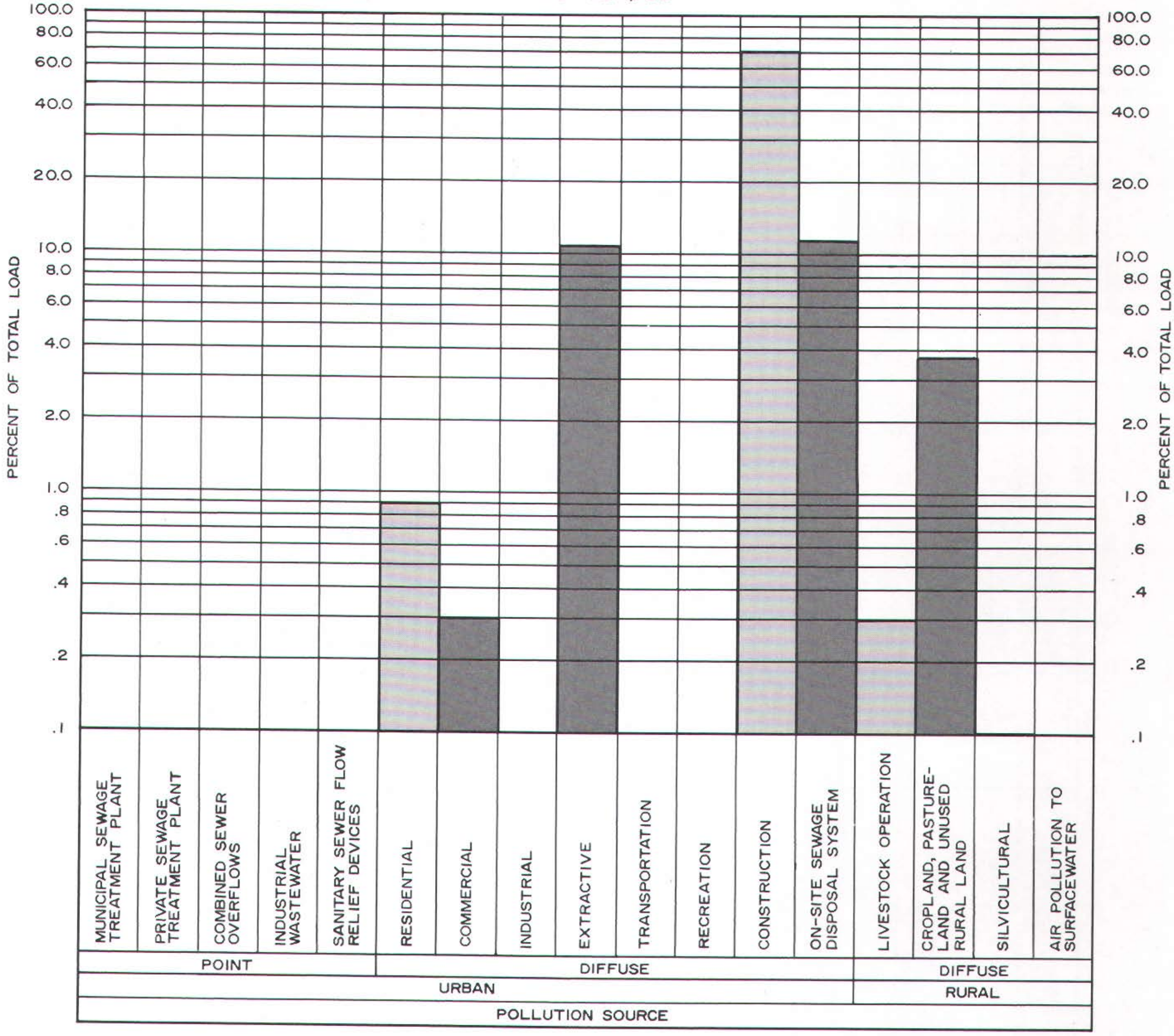


Figure 76 (continued)

BOD_5

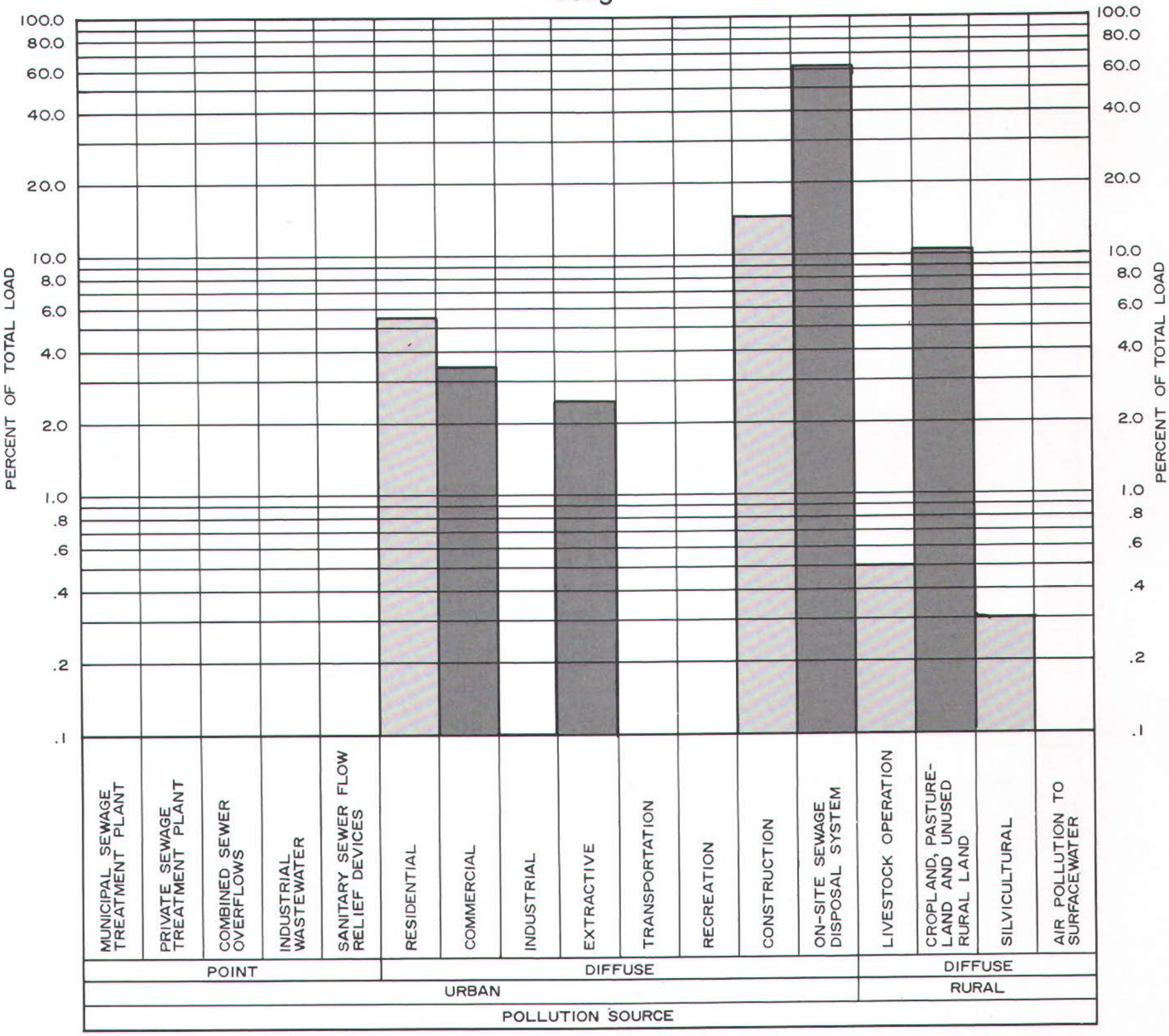


Figure 76 (continued)

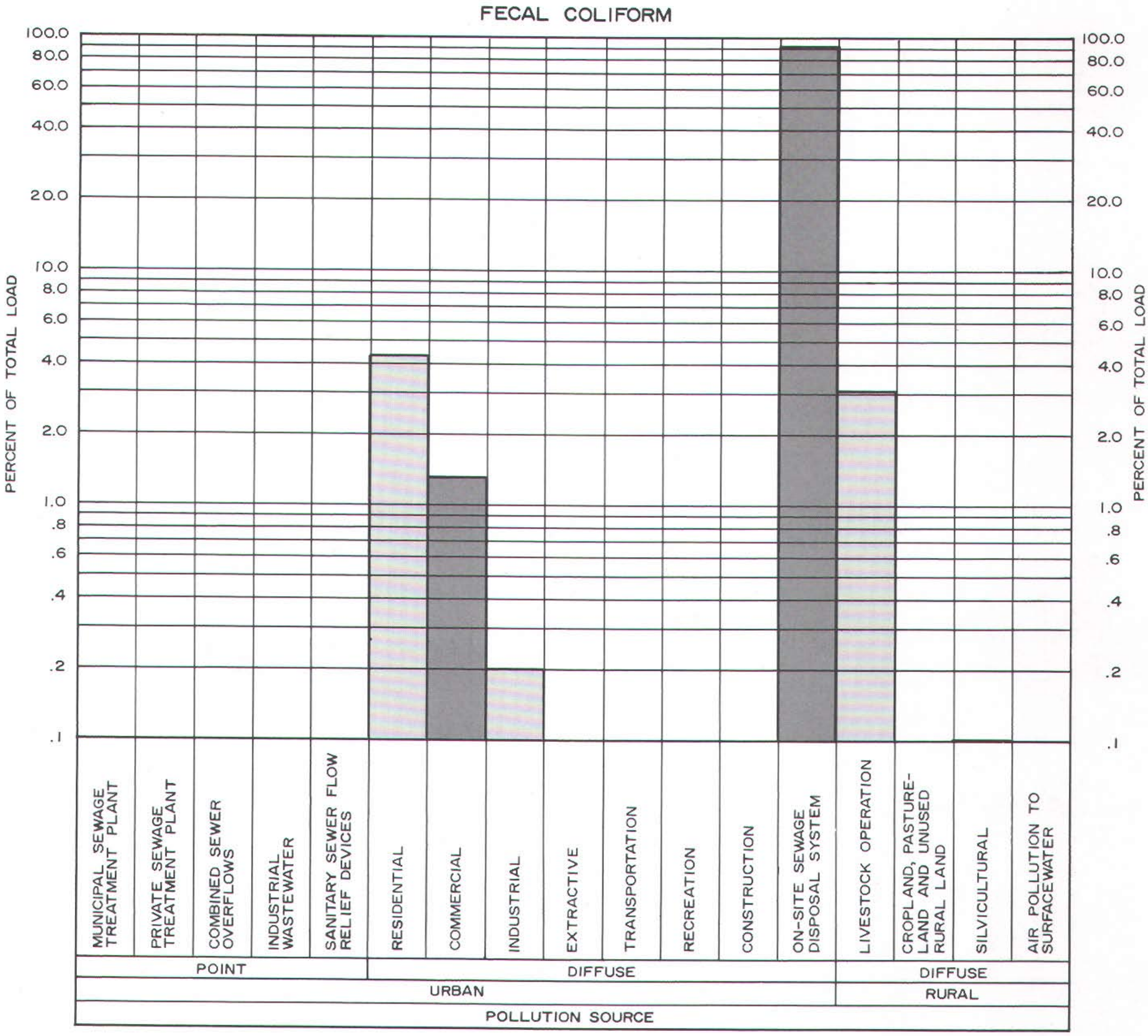
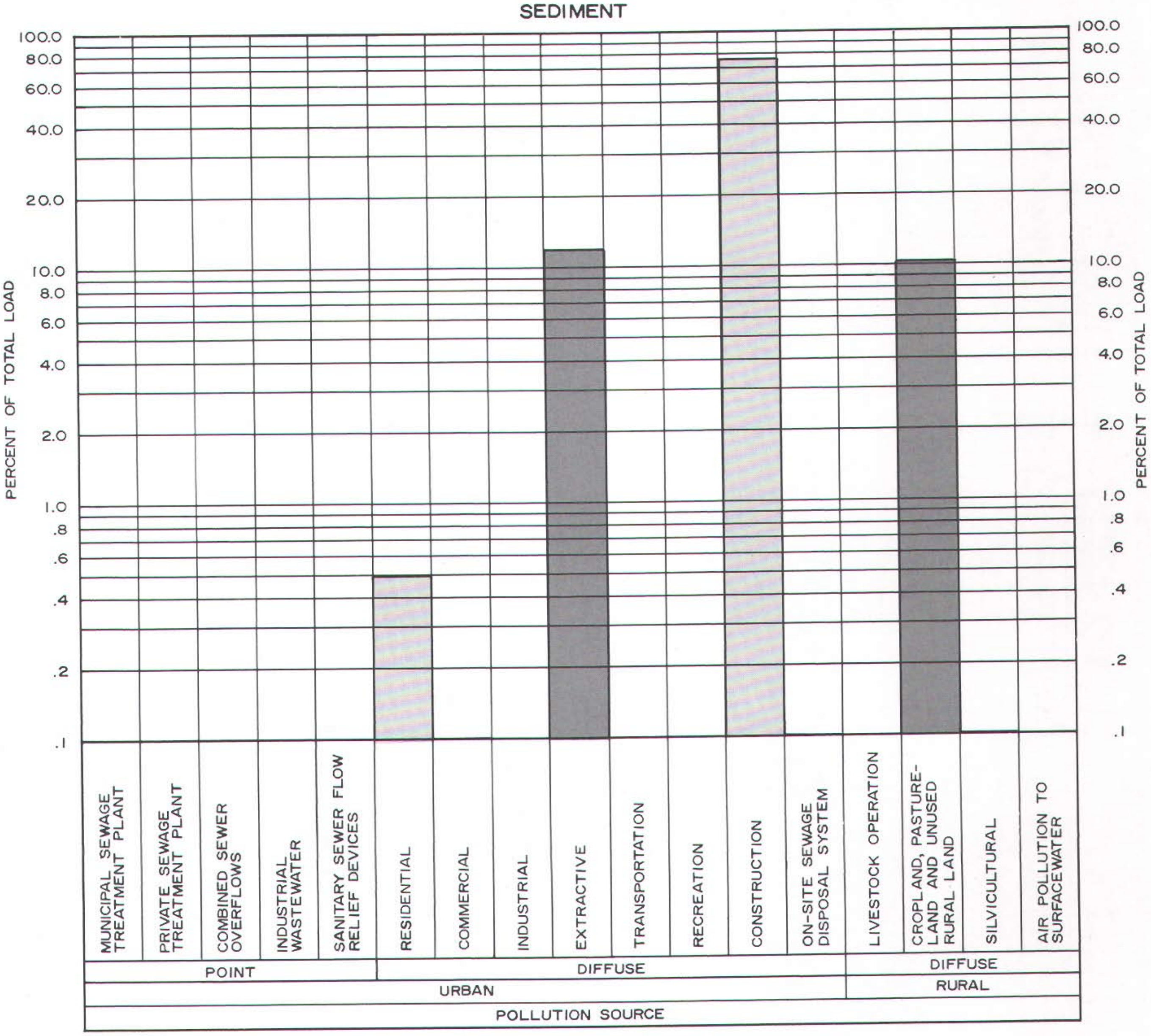


Figure 76 (continued)

SEDIMENT



Source: SEWRPC.

Table 375

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE BARNES CREEK SUBWATERSHED IN 1975

Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Sanitary Sewer Flow Relief Devices . .	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	0.0	0.0		0.0	0.0		0.0	0.0
		Total Phosphorus	0.0	0.0		0.0	0.0		0.0	0.0
		Biochemical Oxygen Demand	0.0	0.0		0.0	0.0		0.0	0.0
		Fecal Coliform	0.0	0.0		0.0	0.0		0.0	0.0
		Sediment	0.0	0.0		0.0	0.0		0.0	0.0
Urban Diffuse Sources										
Residential	567	Total Nitrogen	2,270.0	3.7	.643	1,460.0	3.7	1.371	3,110.0	3.7
	567	Total Phosphorus	180.0	0.9	.643	120.0	0.9	1.371	250.0	0.9
	567	Biochemical Oxygen Demand	13,780.0	5.6	.643	8,860.0	5.6	1.371	18,890.0	5.6
	567	Fecal Coliform	90,720.0	4.4	.643	58,333.0	4.4	1.371	124,377.1	4.4
	567	Sediment	155.0	0.5	.643	100.0	0.5	1.371	215.0	0.5
Commercial	89	Total Nitrogen	800.0	1.3	.643	510.0	1.3	1.371	1,100.0	1.3
	89	Total Phosphorus	70.0	0.3	.643	50.0	0.4	1.371	100.0	0.4
	89	Biochemical Oxygen Demand	8,690.0	3.5	.643	5,590.0	3.5	1.371	11,910.0	3.5
	89	Fecal Coliform	29,370.0	1.4	.643	18,884.9	1.4	1.371	40,266.3	1.4
	89	Sediment	35.0	0.1	.643	25.0	0.1	1.371	50.0	0.1
Industrial	5	Total Nitrogen	40.0	0.1	.643	30.0	0.1	1.371	50.0	0.1
	5	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	5	Biochemical Oxygen Demand	180.0	0.1	.643	120.0	0.1	1.371	250.0	0.1
	5	Fecal Coliform	3,100.0	0.2	.643	1,993.3	0.2	1.371	4,250.1	0.2
	5	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Extractive	54	Total Nitrogen	3,240.0	5.3	.643	2,080.0	5.3	1.371	4,440.0	5.3
	54	Total Phosphorus	2,430.0	11.9	.643	1,560.0	11.9	1.371	3,330.0	11.9
	54	Biochemical Oxygen Demand	6,480.0	2.6	.643	4,170.0	2.6	1.371	8,880.0	2.6
	54	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	54	Sediment	4,050.0	12.8	.643	2,605.0	12.8	1.371	5,555.0	12.8
Transportation	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Recreation	13	Total Nitrogen	30.0	0.0	.643	20.0	0.1	1.371	40.0	0.0
	13	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	13	Biochemical Oxygen Demand	20.0	0.0	.643	10.0	0.0	1.371	30.0	0.0
	13	Fecal Coliform	871.0	0.0	.643	560.1	0.0	1.371	1,194.1	0.0
	13	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Construction	319	Total Nitrogen	19,140.0	31.1	.643	12,310.0	31.1	1.371	26,240.0	31.1
	319	Total Phosphorus	14,360.0	70.5	.643	9,230.0	70.5	1.371	19,690.0	70.5
	319	Biochemical Oxygen Demand	38,280.0	15.6	.643	24,610.0	15.6	1.371	52,480.0	15.6
	319	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	319	Sediment	23,925.0	75.7	.643	15,385.0	75.7	1.371	32,800.0	75.7
Septic Systems	1860	Total Nitrogen	10,600.0	17.2	.643	6,820.0	17.2	1.371	14,530.0	17.2
	1860	Total Phosphorus	2,460.0	12.1	.643	1,580.0	12.1	1.371	3,370.0	12.1
	1860	Biochemical Oxygen Demand	151,780.0	61.7	.643	97,590.0	61.7	1.371	208,090.0	61.7
	1860	Fecal Coliform	1,860,000.0	90.8	.643	1,195,980.0	90.8	1.371	2,550,060.0	90.8
	1860	Sediment	25.0	0.1	.643	15.0	0.1	1.371	35.0	0.1

Table 375 (continued)

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Diffuse Source Totals		Total Nitrogen	36,120.0	58.7		23,230.0	58.7		49,510.0	58.7
		Total Phosphorus	19,500.0	95.7		12,540.0	95.7		26,740.0	95.7
		Biochemical Oxygen Demand	219,210.0	89.1		140,950.0	89.1		300,530.0	89.1
		Fecal Coliform	1,984,061.0	96.8		1,275,751.3	96.8		2,720,147.6	96.8
		Sediment	28,195.0	89.3		18,135.0	89.2		38,660.0	89.3
Urban Source Totals		Total Nitrogen	36,120.0	58.7		23,230.0	58.7		49,510.0	58.7
		Total Phosphorus	19,500.0	95.7		12,540.0	95.7		26,740.0	95.7
		Biochemical Oxygen Demand	219,210.0	89.1		140,950.0	89.1		300,530.0	89.1
		Fecal Coliform	1,984,061.0	96.8		1,275,751.3	96.8		2,720,147.6	96.8
		Sediment	28,195.0	89.3		18,135.0	89.2		38,660.0	89.3
Rural Diffuse Sources										
Livestock Operations	10	Total Nitrogen	280.0	0.5	.643	180.0	0.5	1.371	380.0	0.5
	10	Total Phosphorus	70.0	0.3	.643	50.0	0.4	1.371	100.0	0.4
	10	Biochemical Oxygen Demand	1,110.0	0.5	.643	710.0	0.4	1.371	1,520.0	0.5
	10	Fecal Coliform	64,000.0	3.1	.643	41,152.0	3.1	1.371	87,744.0	3.1
	10	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Cropland, Pasture, and Unused Rural Land	1635	Total Nitrogen	24,720.0	40.2	.643	15,900.0	40.2	1.371	33,890.0	40.2
	1635	Total Phosphorus	780.0	3.8	.643	500.0	3.8	1.371	1,070.0	3.8
	1635	Biochemical Oxygen Demand	25,030.0	10.2	.643	16,090.0	10.2	1.371	34,320.0	10.2
	1635	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1635	Sediment	3,365.0	10.7	.643	2,165.0	10.7	1.371	4,615.0	10.7
Silvicultural	164	Total Nitrogen	380.0	0.6	.643	240.0	0.6	1.371	520.0	0.6
	164	Total Phosphorus	20.0	0.1	.643	10.0	0.1	1.371	30.0	0.1
	164	Biochemical Oxygen Demand	750.0	0.3	.643	480.0	0.3	1.371	1,030.0	0.3
	164	Fecal Coliform	1,082.4	0.1	.643	696.0	0.1	1.371	1,484.0	0.1
	164	Sediment	20.0	0.1	.643	15.0	0.1	1.371	25.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	25,380.0	41.3		16,320.0	41.3		34,790.0	41.3
		Total Phosphorus	870.0	4.3		560.0	4.3		1,200.0	4.3
		Biochemical Oxygen Demand	26,890.0	10.9		17,280.0	10.9		36,870.0	10.9
		Fecal Coliform	65,082.4	3.2		41,848.0	3.2		89,228.0	3.2
		Sediment	3,390.0	10.7		2,185.0	10.8		4,645.0	10.7
Diffuse Source Totals		Total Nitrogen	61,500.0	100.0		39,550.0	100.0		84,300.0	100.0
		Total Phosphorus	20,370.0	100.0		13,100.0	100.0		27,940.0	100.0
		Biochemical Oxygen Demand	246,100.0	100.0		158,230.0	100.0		337,400.0	100.0
		Fecal Coliform	2,049,143.4	100.0		1,317,599.3	100.0		2,809,375.6	100.0
		Sediment	31,585.0	100.0		20,320.0	100.0		43,305.0	100.0
Total Sources		Total Nitrogen	61,500.0	100.0		39,550.0	100.0		84,300.0	100.0
		Total Phosphorus	20,370.0	100.0		13,100.0	100.0		27,940.0	100.0
		Biochemical Oxygen Demand	246,100.0	100.0		158,230.0	100.0		337,400.0	100.0
		Fecal Coliform	2,049,143.4	100.0		1,317,599.3	100.0		2,809,375.6	100.0
		Sediment	31,585.0	100.0		20,320.0	100.0		43,305.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

The dry year and wet year analyses, as shown in Table 375, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since point sources of pollution are insignificant in the Barnes Creek subwatershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors.

Data were not available to prepare a transport analysis of stream pollutant concentrations and flow measurements for Barnes Creek.

PIKE CREEK SUBWATERSHED

A summary of the loadings to Pike Creek is presented in Table 376 and depicted in Figure 77. Urban sources of pollution are estimated to contribute 68 percent of the nitrogen, 96 percent of the phosphorus, 92 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 89 percent of the sediment which occur as water pollutants to Pike Creek. Of the urban contribution, the point sources of pollution contribute 7 percent of the nitrogen, 6 percent of the phosphorus, 12 percent of the biochemical oxygen demand, 24 percent of the fecal coliform, and two-tenths of one percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 93 percent of the nitrogen, 94 percent of the phosphorus, 88 percent of the biochemical oxygen demand, 92 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 32 percent of the nitrogen, 4 percent of the phosphorus, 8 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 11 percent of the sediments from all sources within the subwatershed. Of the rural pollution sources, no livestock operations exist in the subwatershed and the estimated rural pollution loads are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 77 presents the relative pollution loadings discussed above within the Pike Creek subwatershed.

The dry year and wet year analyses, as shown in Table 376, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. The effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and public and private wastewater treatment plant discharges of these pollutants are unaffected. The proportion of the total phosphorus load contributed by point sources ranges from 4 percent during a wet year to 8 percent during a dry year. Of the total nitrogen, load, point sources contribute from 4 percent of the total load during a wet year to 7 percent during a dry year. Point source contributions of biochemical oxygen demand, and sediment similarly range from 9 to 16 percent, and from 0.1 to 0.2 percent of the total loads, respectively. Point source contributions of fecal coliform are estimated to account for about 24 percent of the total load during a wet year or a dry year since essentially all point source fecal coliform contributions are from sewage flow relief devices.

Data were not available to prepare a transport analysis of in-stream pollutant concentration and flow measurement for Pike Creek.

SUCKER CREEK SUBWATERSHED

A summary of the loadings to Sucker Creek is presented in Table 377 and depicted in Figure 78. Urban sources of pollution are estimated to contribute 11 percent of the nitrogen, 35 percent of the phosphorus, 16 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and 55 percent of the sediment which occur as water pollutants to Sucker Creek. There are no significant point sources of pollution in the Sucker Creek subwatershed, hence all urban pollutants are contributed from diffuse sources, including septic systems.

Of the total pollutant loads, rural pollution sources contribute an estimated 89 percent of the nitrogen, 65 percent of the phosphorus, 84 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 45 percent of the sediment from sources within the subwatershed. There are no rural point sources of pollution, since none of the livestock operations in the subwatershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contributes 53 percent of the nitrogen, 90 percent of the phosphorus, 77 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 6 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 47 percent of the nitrogen, 10 percent of the phosphorus, 23 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 94 percent of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses. Figure 78 presents the relative pollution loadings discussed above within the Sucker Creek subwatershed.

The dry year and wet year analyses, as shown in Table 377, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since point sources of pollution and fecal coliform are insignificant in the Sucker Creek subwatershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors.

Data were not available to prepare a transport analysis of in-stream pollutant concentration and flow measurements for Sucker Creek.

Figure 77

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE PIKE CREEK SUBWATERSHED

NITROGEN

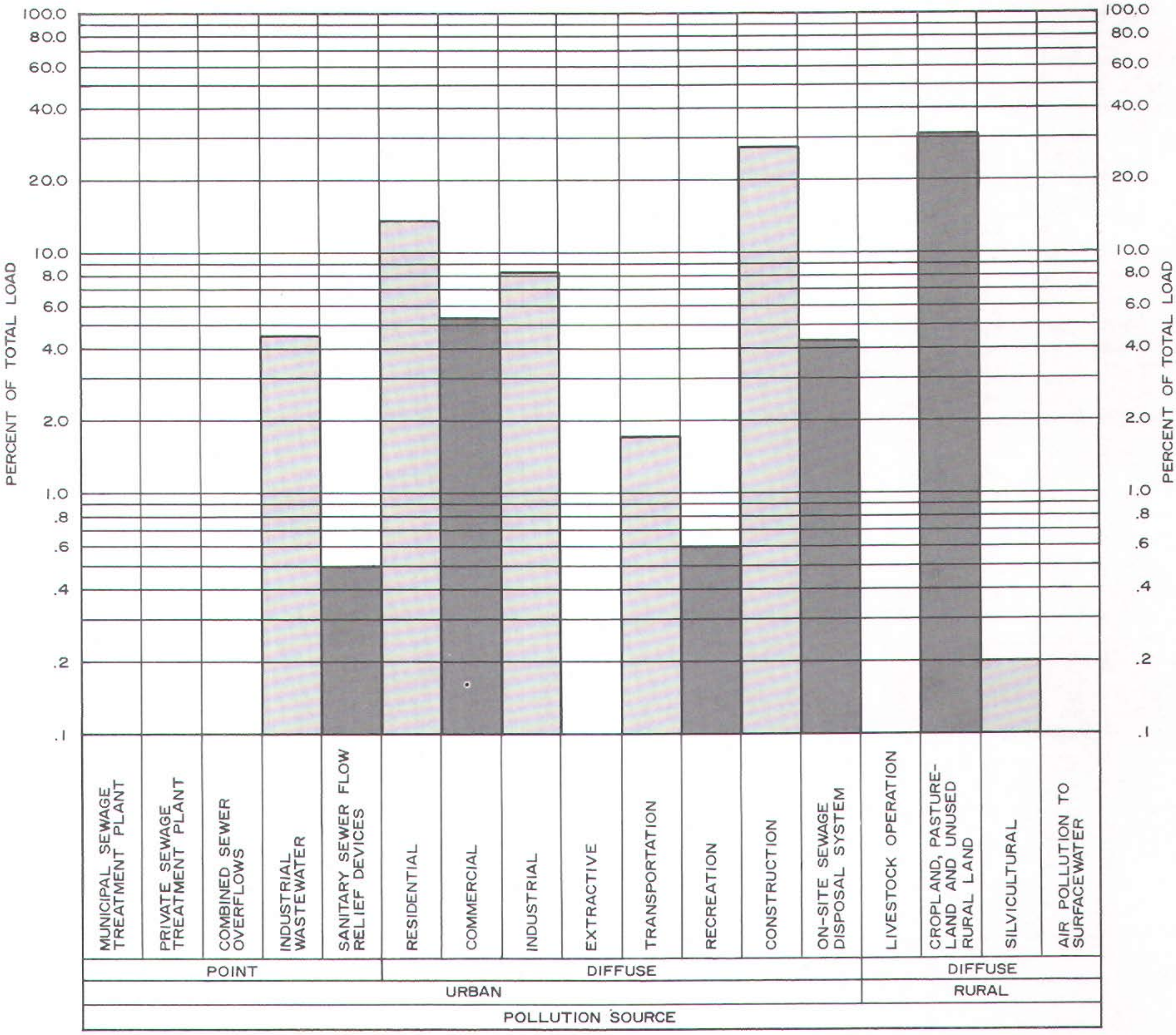


Figure 77 (continued)

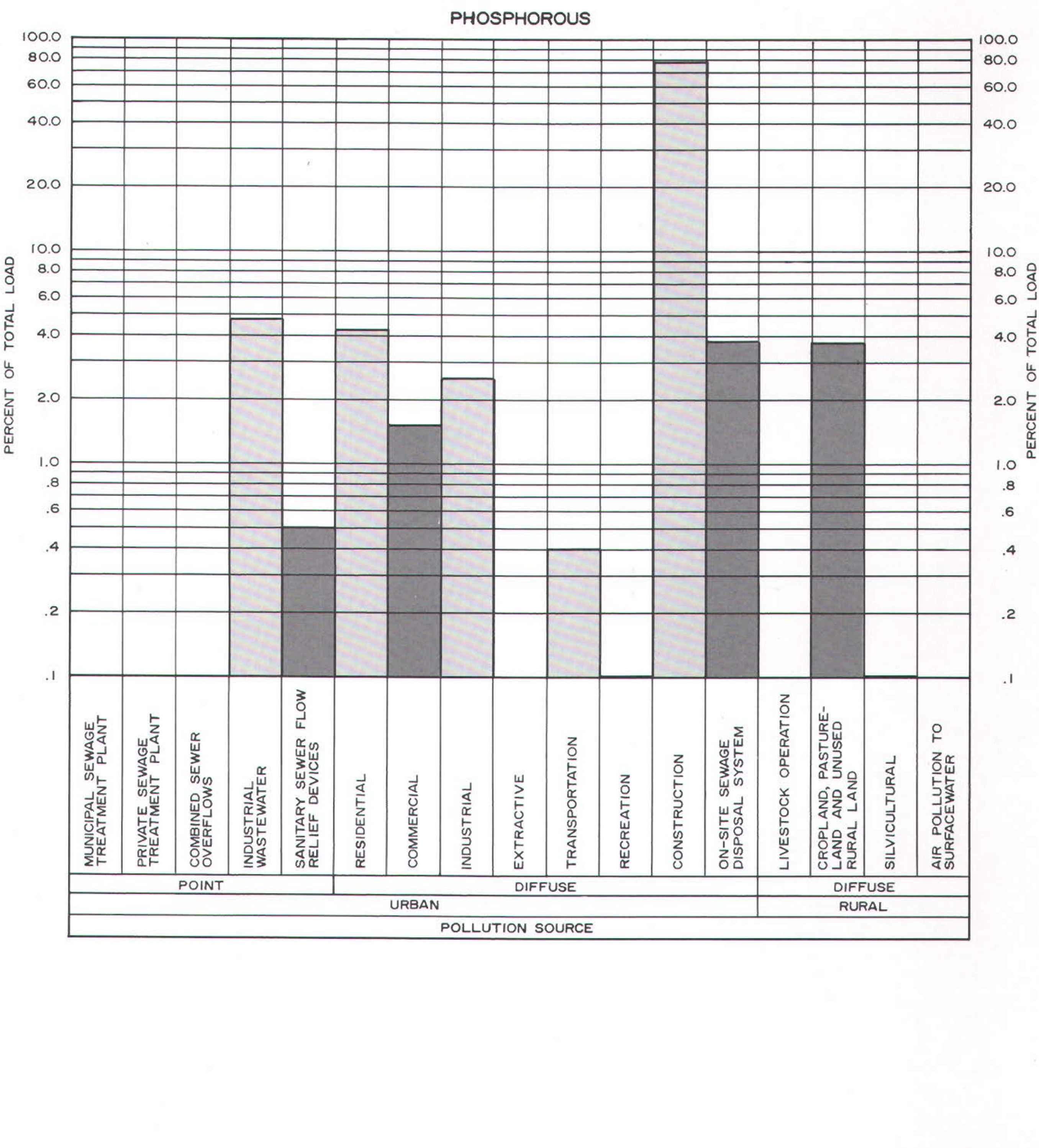


Figure 77 (continued)

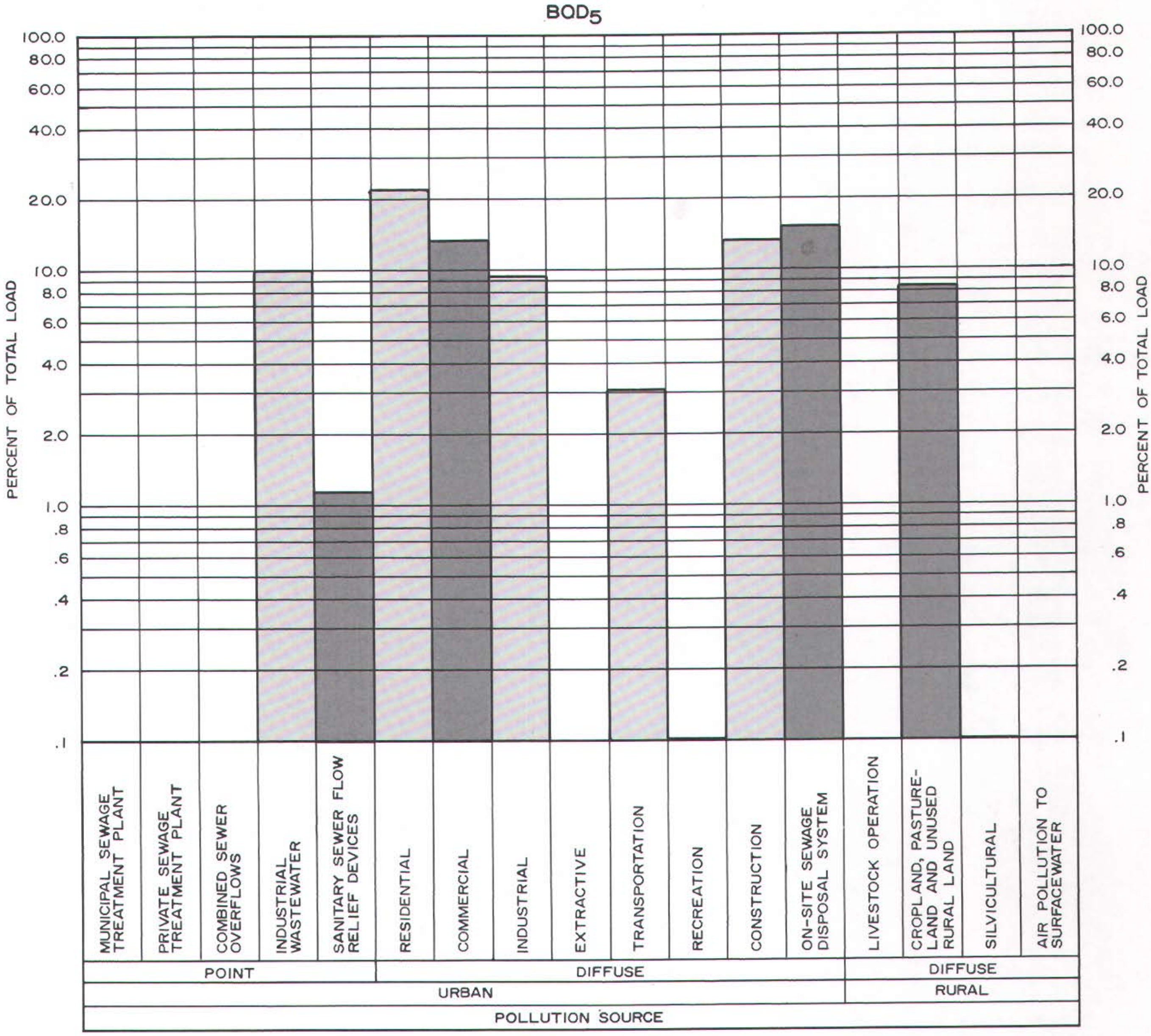


Figure 77 (continued)

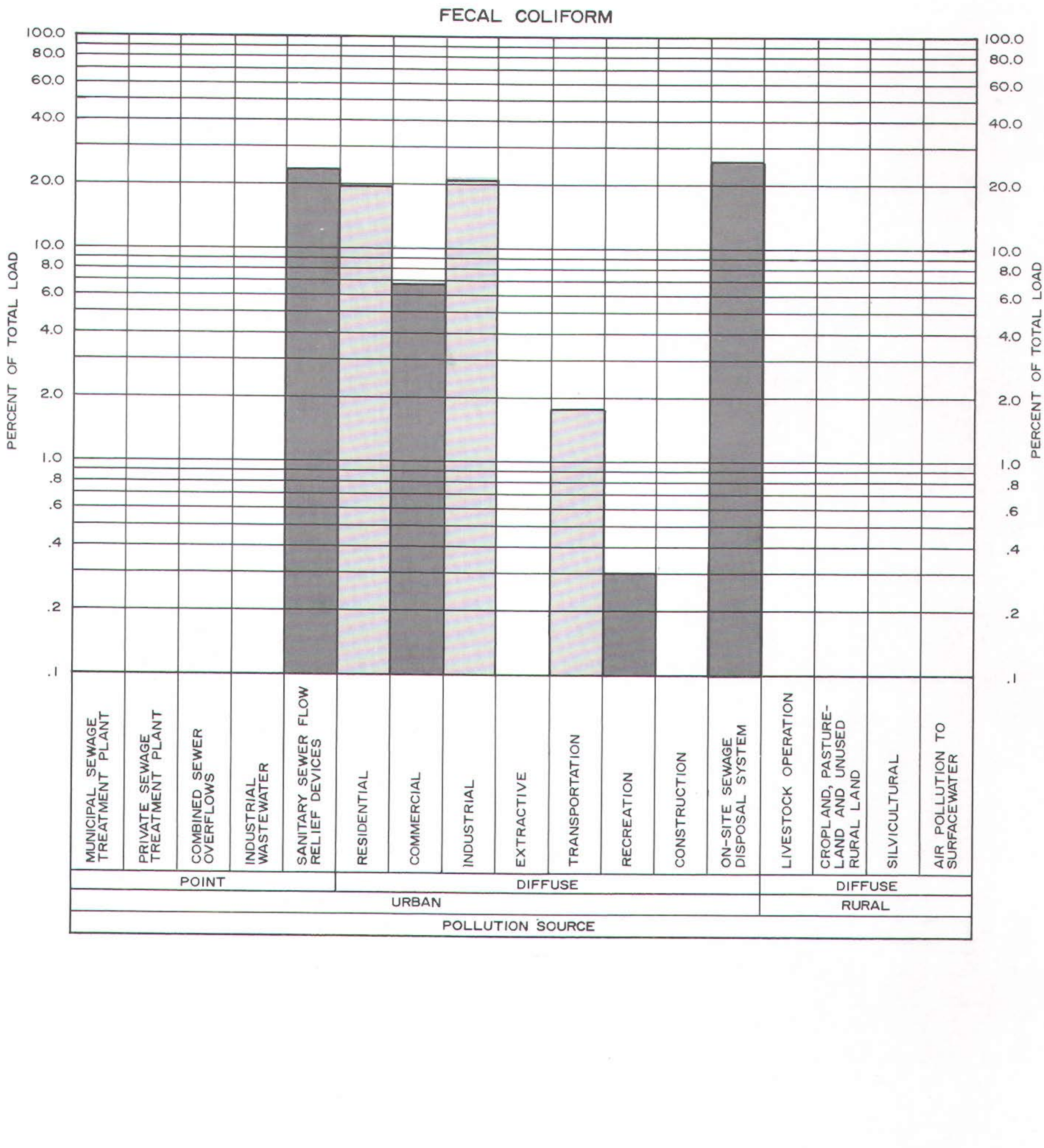
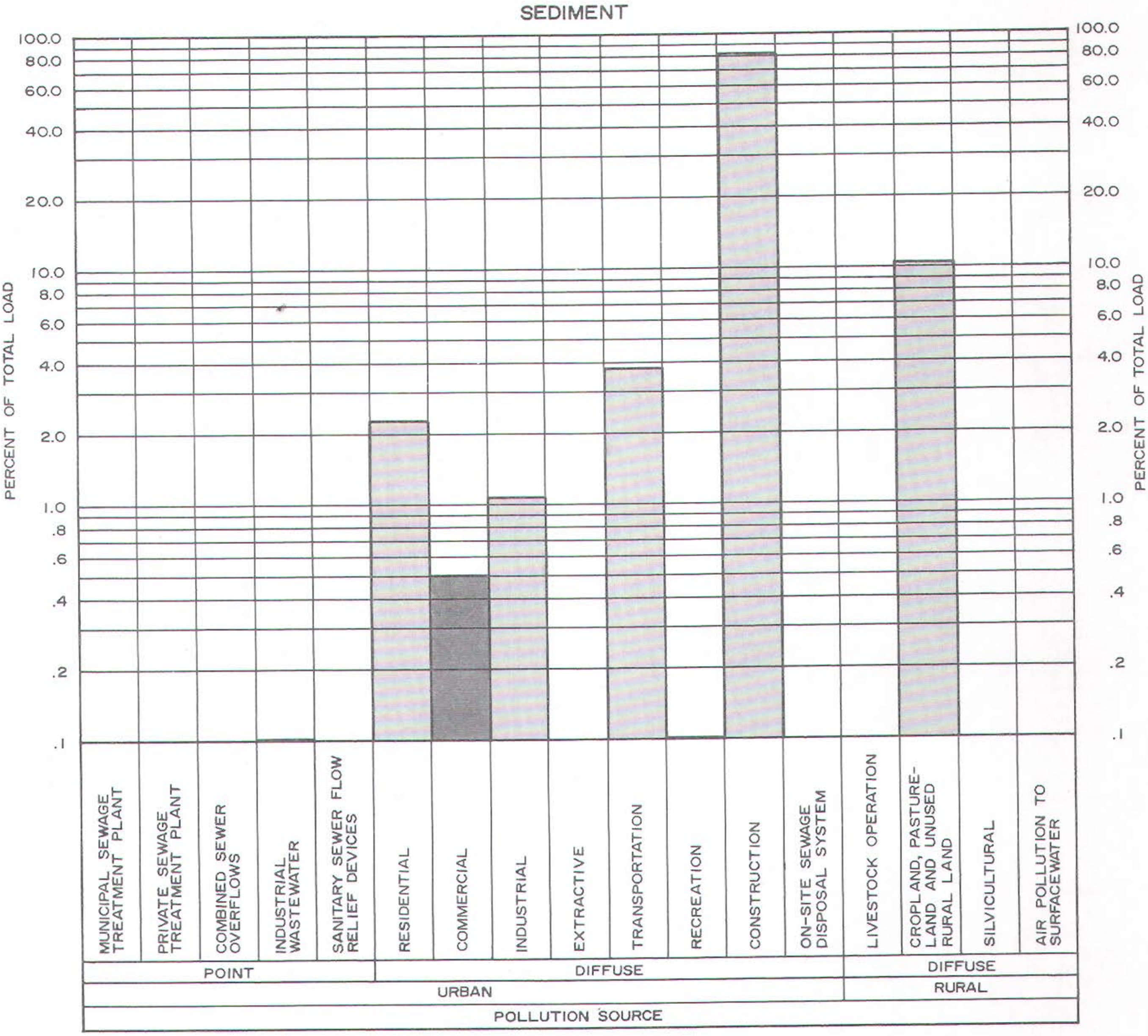


Figure 77 (continued)



Source: SEWRPC.

Table 376

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE PIKE CREEK SUBWATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	1	Total Nitrogen	2,490.0	4.6	1.000	2,490.0	6.9	1.000	2,490.0	3.4
	1	Total Phosphorus	710.0	4.8	1.000	710.0	7.3	1.000	710.0	3.6
	1	Biochemical Oxygen Demand	21,320.0	10.0	1.000	21,320.0	14.8	1.000	21,320.0	7.5
	1	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Sediment	35.0	0.1	1.000	35.0	0.2	1.000	35.0	0.1
Sanitary Sewer Flow Relief Devices	5	Total Nitrogen	250.0	0.5	.643	160.0	0.4	1.371	340.0	0.5
	5	Total Phosphorus	80.0	0.5	.643	50.0	0.5	1.371	110.0	0.6
	5	Biochemical Oxygen Demand	2,500.0	1.2	.643	1,610.0	1.1	1.371	3,430.0	1.2
	5	Fecal Coliform	380,000.0	23.8	.643	244,340.0	23.8	1.371	520,980.0	23.8
	5	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	2,740.0	5.0		2,650.0	7.4		2,830.0	3.8
		Total Phosphorus	790.0	5.4		760.0	7.9		820.0	4.1
		Biochemical Oxygen Demand	23,820.0	11.2		22,930.0	15.9		24,750.0	8.7
		Fecal Coliform	380,000.0	23.8		244,340.0	23.8		520,980.0	23.8
		Sediment	35.0	0.1		35.0	0.2		35.0	0.1
Urban Diffuse Sources										
Residential	1957	Total Nitrogen	7,830.0	14.4	.643	5,030.0	14.0	1.371	10,730.0	14.6
	1957	Total Phosphorus	630.0	4.3	.643	410.0	4.2	1.371	860.0	4.3
	1957	Biochemical Oxygen Demand	47,560.0	22.3	.643	30,580.0	21.1	1.371	65,200.0	23.0
	1957	Fecal Coliform	313,120.0	19.6	.643	201,336.2	19.6	1.371	429,287.5	19.6
	1957	Sediment	535.0	2.3	.643	345.0	2.3	1.371	735.0	2.3
Commercial	323	Total Nitrogen	2,910.0	5.4	.643	1,870.0	5.2	1.371	3,990.0	5.4
	323	Total Phosphorus	240.0	1.6	.643	150.0	1.5	1.371	330.0	1.7
	323	Biochemical Oxygen Demand	31,520.0	14.8	.643	20,270.0	14.0	1.371	43,210.0	15.2
	323	Fecal Coliform	106,590.0	6.7	.643	68,537.4	6.7	1.371	146,134.9	6.7
	323	Sediment	120.0	0.5	.643	75.0	0.5	1.371	165.0	0.5
Industrial	546	Total Nitrogen	4,590.0	8.4	.643	2,950.0	8.2	1.371	6,290.0	8.5
	546	Total Phosphorus	380.0	2.6	.643	240.0	2.5	1.371	520.0	2.6
	546	Biochemical Oxygen Demand	20,150.0	9.5	.643	12,960.0	9.0	1.371	27,630.0	9.7
	546	Fecal Coliform	338,520.0	21.2	.643	217,668.4	21.2	1.371	464,110.9	21.2
	546	Sediment	265.0	1.1	.643	170.0	1.1	1.371	365.0	1.1
Extractive	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Transportation	42	Total Nitrogen	980.0	1.8	.643	630.0	1.8	1.371	1,340.0	1.8
	42	Total Phosphorus	60.0	0.4	.643	40.0	0.4	1.371	80.0	0.4
	42	Biochemical Oxygen Demand	6,680.0	3.1	.643	4,300.0	3.0	1.371	9,160.0	3.2
	42	Fecal Coliform	28,140.0	1.8	.643	18,094.0	1.8	1.371	38,579.9	1.8
	42	Sediment	895.0	3.8	.643	575.0	3.8	1.371	1,225.0	3.8
Recreation	141	Total Nitrogen	320.0	0.6	.643	210.0	0.6	1.371	440.0	0.6
	141	Total Phosphorus	10.0	0.1	.643	10.0	0.1	1.371	10.0	0.1
	141	Biochemical Oxygen Demand	180.0	0.1	.643	120.0	0.1	1.371	250.0	0.1
	141	Fecal Coliform	5,076.0	0.3	.643	3,263.9	0.3	1.371	6,959.2	0.3
	141	Sediment	30.0	0.1	.643	20.0	0.1	1.371	40.0	0.1
Construction	254	Total Nitrogen	15,240.0	28.0	.643	9,800.0	27.3	1.371	20,890.0	28.4
	254	Total Phsophorus	11,430.0	78.0	.643	7,350.0	75.9	1.371	15,670.0	79.1
	254	Biochemical Oxygen Demand	30,480.0	14.3	.643	19,600.0	13.6	1.371	41,790.0	14.7
	254	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	254	Sediment	19,050.0	81.3	.643	12,250.0	81.2	1.371	26,120.0	81.4
Septic Systems	425	Total Nitrogen	2,420.0	4.4	.643	1,560.0	4.3	1.371	3,320.0	4.5
	425	Total Phosphorus	560.0	3.8	.643	360.0	3.7	1.371	770.0	3.9
	425	Biochemical Oxygen Demand	34,680.0	16.3	.643	22,300.0	15.4	1.371	47,550.0	16.7
	425	Fecal Coliform	425,000.0	26.6	.643	273,275.0	26.6	1.371	582,675.0	26.6
	425	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0

Table 376 (continued)

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	34,290.0	63.0		22,050.0	61.5		47,000.0	63.8
		Total Phosphorus	13,310.0	90.9		8,560.0	88.4		18,240.0	92.1
		Biochemical Oxygen Demand	171,250.0	80.4		110,130.0	76.2		234,790.0	82.7
		Fecal Coliform	1,216,446.0	76.2		782,174.9	76.2		1,667,747.4	76.2
		Sediment	20,900.0	89.2		13,440.0	89.1		28,655.0	89.3
Urban Source Totals		Total Nitrogen	37,030.0	68.1		24,700.0	68.9		49,830.0	67.7
		Total Phosphorus	14,100.0	96.2		9,320.0	96.3		19,060.0	96.2
		Biochemical Oxygen Demand	195,070.0	91.6		133,060.0	92.1		259,540.0	91.4
		Fecal Coliform	1,596,446.0	100.0		1,026,514.9	100.0		2,188,727.4	100.0
		Sediment	20,935.0	89.4		13,475.0	89.4		28,690.0	89.4
Rural Diffuse Sources										
Livestock Operations	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Cropland, Pasture, and Unused Rural Land	1164	Total Nitrogen	17,240.0	31.7	.643	11,090.0	30.9	1.371	23,640.0	32.1
	1164	Total Phosphorus	540.0	3.7	.643	350.0	3.6	1.371	740.0	3.7
	1164	Biochemical Oxygen Demand	17,620.0	8.3	.643	11,330.0	7.8	1.371	24,160.0	8.5
	1164	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1164	Sediment	2,485.0	10.6	.643	1,600.0	10.6	1.371	3,405.0	10.6
Silvicultural	51	Total Nitrogen	120.0	0.2	.643	80.0	0.2	1.371	160.0	0.2
	51	Total Phosphorus	10.0	0.1	.643	10.0	0.1	1.371	10.0	0.1
	51	Biochemical Oxygen Demand	230.0	0.1	.643	150.0	0.1	1.371	320.0	0.1
	51	Fecal Coliform	336.6	0.0	.643	216.4	0.0	1.371	461.5	0.0
	51	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	17,360.0	31.9		11,170.0	31.1		23,800.0	32.3
		Total Phosphorus	550.0	3.8		360.0	3.7		750.0	3.8
		Biochemical Oxygen Demand	17,850.0	8.4		11,480.0	7.9		24,480.0	8.6
		Fecal Coliform	336.6	0.0		216.4	0.0		461.5	0.0
		Sediment	2,490.0	10.6		1,605.0	10.6		3,410.0	10.6
Diffuse Source Totals		Total Nitrogen	51,650.0	95.0		33,220.0	92.6		70,800.0	96.2
		Total Phosphorus	13,860.0	94.6		8,920.0	92.1		18,990.0	95.9
		Biochemical Oxygen Demand	189,100.0	88.8		121,610.0	84.1		259,270.0	91.3
		Fecal Coliform	1,216,782.6	76.2		782,391.3	76.2		1,668,208.9	76.2
		Sediment	23,390.0	99.9		15,045.0	99.8		32,065.0	99.9
Total Sources		Total Nitrogen	54,390.0	100.0		35,870.0	100.0		73,630.0	100.0
		Total Phosphorus	14,650.0	100.0		9,680.0	100.0		19,810.0	100.0
		Biochemical Oxygen Demand	212,920.0	100.0		144,540.0	100.0		284,020.0	100.0
		Fecal Coliform	1,596,782.6	100.0		1,026,731.3	100.0		2,189,188.9	100.0
		Sediment	23,425.0	100.0		15,080.0	100.0		32,100.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

Table 377

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE SUCKER CREEK SUBWATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Sanitary Sewer Flow Relief Devices	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	0.0	0.0		0.0	0.0		0.0	0.0
		Total Phosphorus	0.0	0.0		0.0	0.0		0.0	0.0
		Biochemical Oxygen Demand	0.0	0.0		0.0	0.0		0.0	0.0
		Fecal Coliform	0.0	0.0		0.0	0.0		0.0	0.0
		Sediment	0.0	0.0		0.0	0.0		0.0	0.0
Urban Diffuse Sources										
Residential	61	Total Nitrogen	240.0	0.1	.643	150.0	0.1	1.371	330.0	0.1
	61	Total Phosphorus	20.0	0.1	.643	10.0	0.0	1.371	30.0	0.1
	61	Biochemical Oxygen Demand	1,480.0	0.3	.643	950.0	0.3	1.371	2,030.0	0.3
	61	Fecal Coliform	9,760.0	0.0	.643	6,275.7	0.0	1.371	13,381.0	0.0
	61	Sediment	15.0	0.0	.643	10.0	0.0	1.371	20.0	0.0
Commercial	22	Total Nitrogen	200.0	0.1	.643	130.0	0.1	1.371	270.0	0.1
	22	Total Phosphorus	20.0	0.1	.643	10.0	0.0	1.371	30.0	0.1
	22	Biochemical Oxygen Demand	2,150.0	0.4	.643	1,380.0	0.4	1.371	2,950.0	0.4
	22	Fecal Coliform	7,260.0	0.0	.643	4,668.2	0.0	1.371	9,953.5	0.0
	22	Sediment	10.0	0.0	.643	5.0	0.0	1.371	15.0	0.0
Industrial	5	Total Nitrogen	40.0	0.0	.643	30.0	0.0	1.371	50.0	0.0
	5	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	5	Biochemical Oxygen Demand	180.0	0.0	.643	120.0	0.0	1.371	250.0	0.0
	5	Fecal Coliform	3,100.0	0.0	.643	1,993.3	0.0	1.371	4,250.1	0.0
	5	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Extractive	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Transportation	109	Total Nitrogen	2,550.0	1.2	.643	1,640.0	1.2	1.371	3,500.0	1.2
	109	Total Phosphorus	150.0	0.4	.643	100.0	0.4	1.371	210.0	0.4
	109	Biochemical Oxygen Demand	17,330.0	3.0	.643	11,140.0	3.0	1.371	23,760.0	3.0
	109	Fecal Coliform	73,030.0	0.3	.643	46,958.3	0.3	1.371	100,124.1	0.3
	109	Sediment	2,320.0	5.5	.643	1,490.0	5.5	1.371	3,180.0	5.5
Recreation	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Construction	276	Total Nitrogen	16,560.0	8.0	.643	10,650.0	8.0	1.371	22,700.0	8.0
	276	Total Phosphorus	12,420.0	32.3	.643	7,990.0	32.3	1.371	17,030.0	32.3
	276	Biochemical Oxygen Demand	33,120.0	5.7	.643	21,300.0	5.7	1.371	45,410.0	5.7
	276	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	276	Sediment	20,700.0	48.9	.643	13,310.0	48.9	1.371	28,380.0	48.9
Septic Systems	476	Total Nitrogen	2,710.0	1.3	.643	1,740.0	1.3	1.371	3,720.0	1.3
	476	Total Phosphorus	630.0	1.6	.643	410.0	1.7	1.371	860.0	1.6
	476	Biochemical Oxygen Demand	38,840.0	6.6	.643	24,970.0	6.6	1.371	53,250.0	6.6
	476	Fecal Coliform	476,000.0	2.1	.643	306,068.0	2.1	1.371	652,596.0	2.1
	476	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0

Table 377 (continued)

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Diffuse Source Totals		Total Nitrogen	22,300.0	10.8		14,340.0	10.8		30,570.0	10.8
		Total Phosphorus	13,240.0	34.5		8,520.0	34.5		18,160.0	34.5
		Biochemical Oxygen Demand	93,100.0	15.9		59,860.0	15.9		127,650.0	15.9
		Fecal Coliform	569,150.0	2.5		365,963.5	2.5		780.304.7	2.5
		Sediment	23,050.0	54.5		14,820.0	54.5		31,600.0	54.5
Urban Source Totals		Total Nitrogen	22,300.0	10.8		14,340.0	10.8		30,570.0	10.8
		Total Phosphorus	13,240.0	34.5		8,520.0	34.5		18,160.0	34.5
		Biochemical Oxygen Demand	93,100.0	15.9		59,860.0	15.9		127,650.0	15.9
		Fecal Coliform	569,150.0	2.5		365,963.5	2.5		780,304.7	2.5
		Sediment	23,050.0	54.5		14,820.0	54.5		31,600.0	54.5
Rural Diffuse Sources										
Livestock Operations	3420	Total Nitrogen	97,130.0	47.0	.643	62,450.0	47.0	1.371	133,170.0	47.0
	3420	Total Phosphorus	22,570.0	58.8	.643	14,510.0	58.7	1.371	30,940.0	58.8
	3420	Biochemical Oxygen Demand	380,300.0	65.1	.643	244,530.0	65.1	1.371	521,390.0	65.1
	3420	Fecal Coliform	21,888,000.0	97.5	.643	14,073,984.0	97.5	1.371	30,008,448.0	97.5
	3420	Sediment	1,195.0	2.8	.643	770.0	2.8	1.371	1,640.0	2.8
Cropland, Pasture and Unused Rural Land	6270	Total Nitrogen	86,770.0	42.0	.643	55,790.0	42.0	1.371	118,960.0	42.0
	6270	Total Phosphorus	2,550.0	6.6	.643	1,640.0	6.6	1.371	3,500.0	6.6
	6270	Biochemical Oxygen Demand	109,650.0	18.8	.643	70,510.0	18.8	1.371	150,330.0	18.8
	6270	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	6270	Sediment	18,015.0	42.6	.643	11,585.0	42.6	1.371	24,700.0	42.6
Silvicultural	250	Total Nitrogen	580.0	0.3	.643	370.0	0.3	1.371	800.0	0.3
	250	Total Phosphorus	40.0	0.1	.643	30.0	0.1	1.371	50.0	0.1
	250	Biochemical Oxygen Demand	1,150.0	0.2	.643	740.0	0.2	1.371	1,580.0	0.2
	250	Fecal Coliform	1,650.0	0.0	.643	1,061.0	0.0	1.371	2,262.2	0.0
	250	Sediment	30.0	0.1	.643	20.0	0.1	1.371	40.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	184,480.0	89.2		118,610.0	89.2		252,930.0	89.2
		Total Phosphorus	25,160.0	65.5		16,180.0	65.5		34,490.0	65.5
		Biochemical Oxygen Demand	491,100.0	84.1		315,780.0	84.1		673,300.0	84.1
		Fecal Coliform	21,889,650.0	97.5		14,075,045.0	97.5		30,010,710.2	97.5
		Sediment	19,240.0	45.5		12,375.0	45.5		26,380.0	45.5
Diffuse Source Totals		Total Nitrogen	206,780.0	100.0		132,950.0	100.0		283,500.0	100.0
		Total Phosphorus	38,400.0	100.0		24,700.0	100.0		52,650.0	100.0
		Biochemical Oxygen Demand	584,200.0	100.0		375,640.0	100.0		800,950.0	100.0
		Fecal Coliform	22,458,800.0	100.0		14,441,008.5	100.0		30,791,014.9	100.0
		Sediment	42,290.0	100.0		27,195.0	100.0		57,980.0	100.0
Total Sources		Total Nitrogen	206,780.0	100.0		132,950.0	100.0		283,500.0	100.0
		Total Phosphorus	38,400.0	100.0		24,700.0	100.0		52,650.0	100.0
		Biochemical Oxygen Demand	584,200.0	100.0		375,640.0	100.0		800.950.0	100.0
		Fecal Coliform	22,458,800.0	100.0		14,441,008.5	100.0		30,791,014.9	100.0
		Sediment	42,290.0	100.0		27,195.0	100.0		57,980.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

Figure 78

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE SUCKER CREEK SUBWATERSHED

NITROGEN

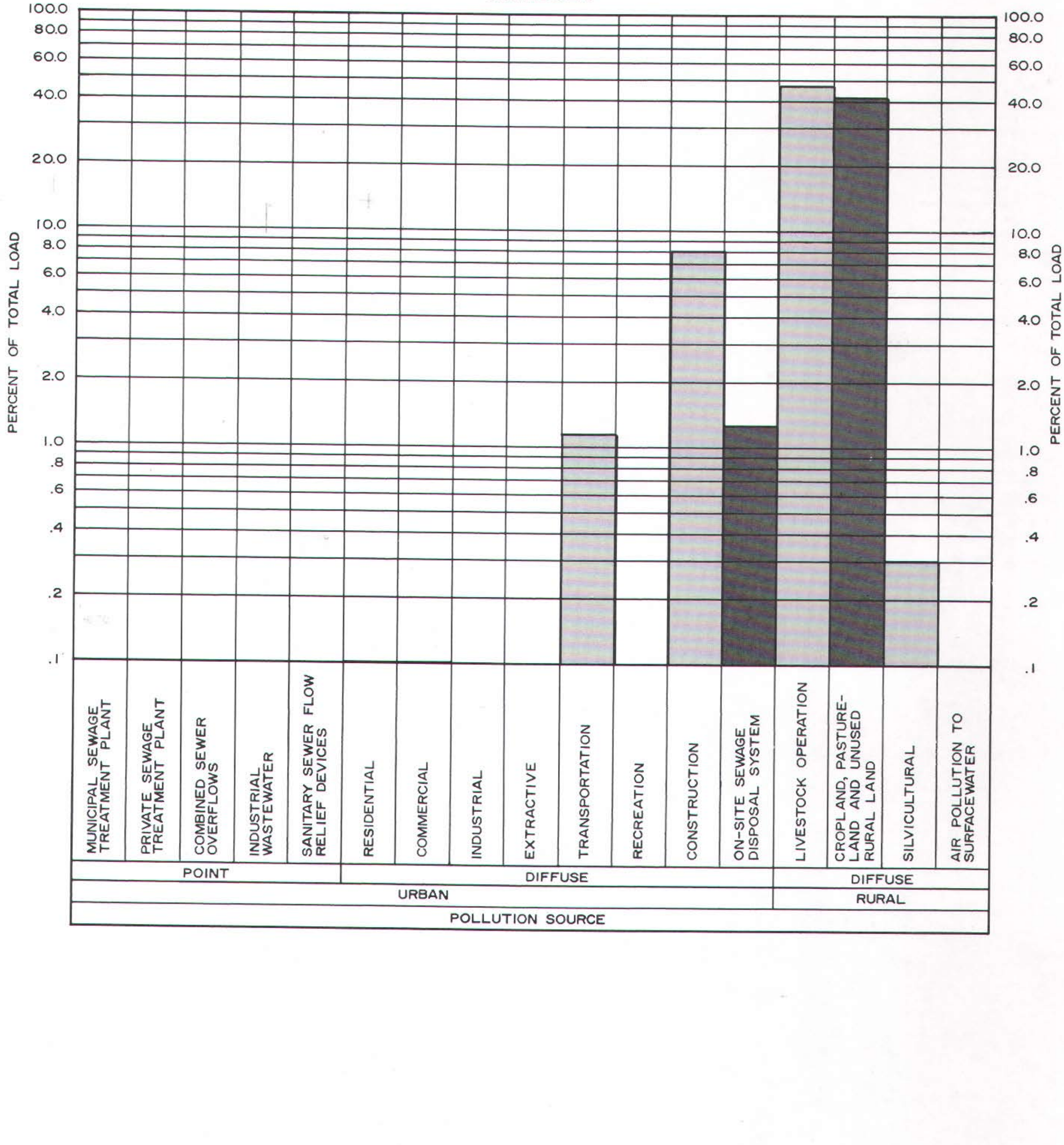


Figure 78 (continued)

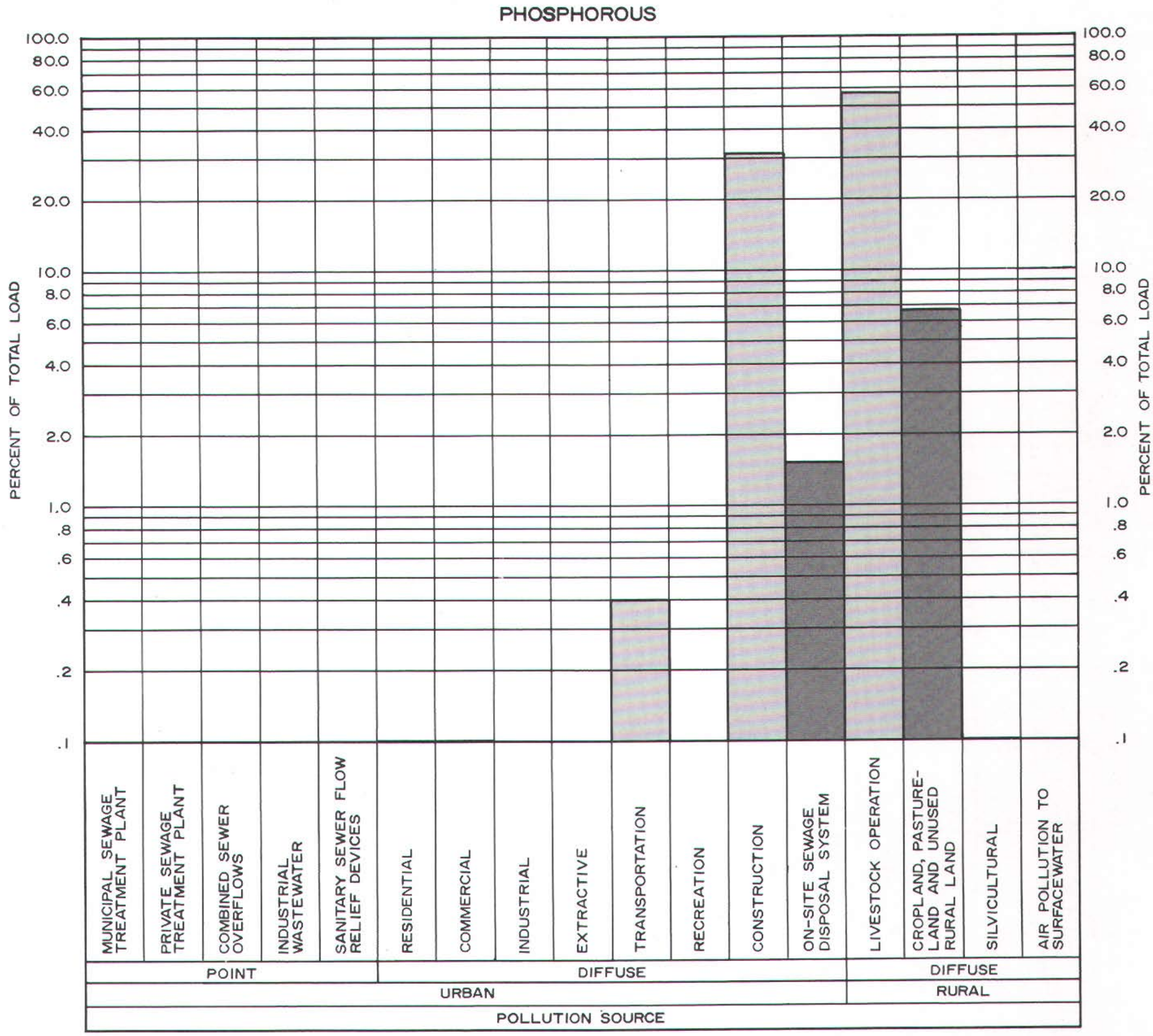


Figure 78 (continued)

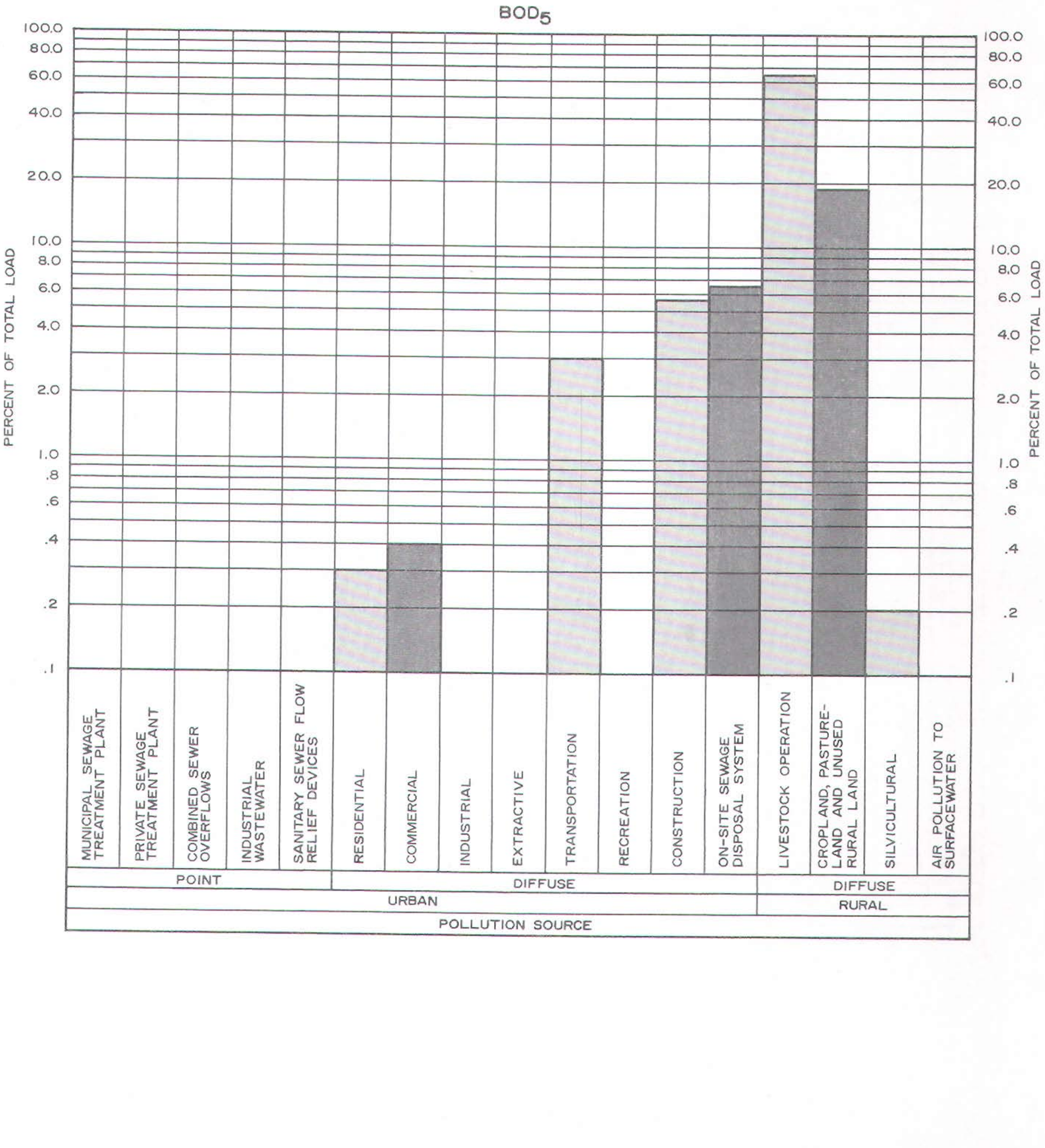


Figure 78 (continued)

FECAL COLIFORM

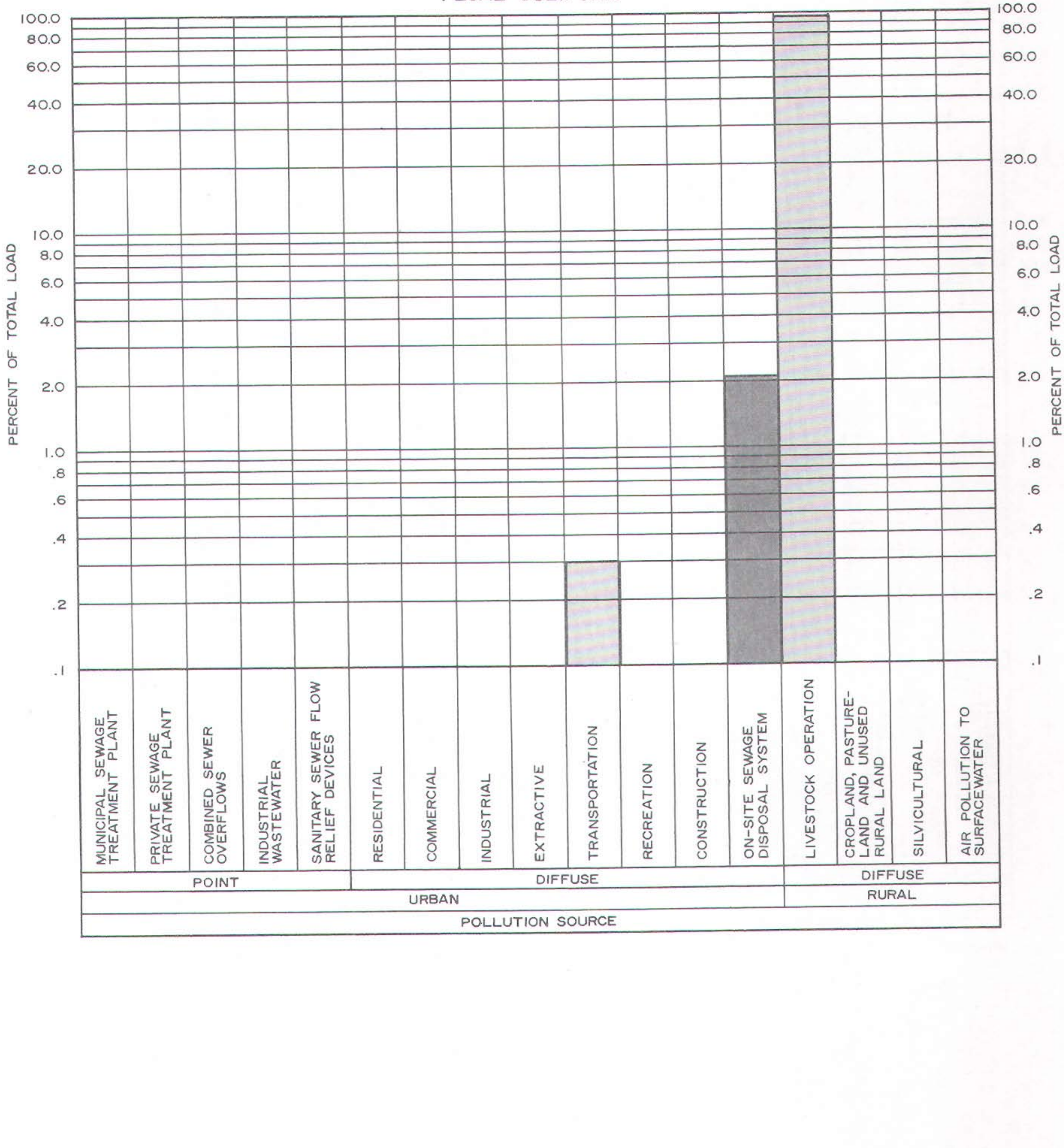
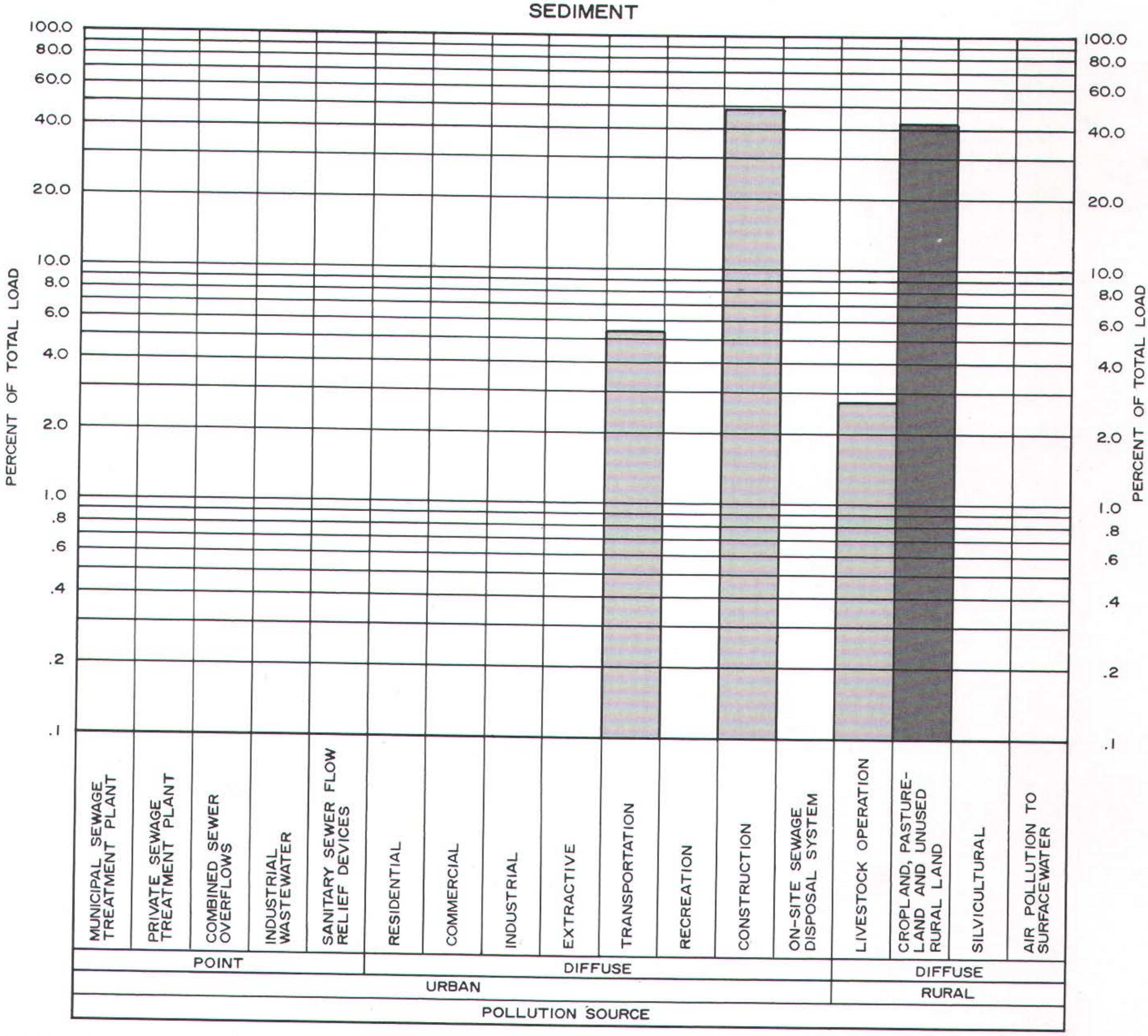


Figure 78 (continued)

SEDIMENT



Source: SEWRPC.

OAK CREEK WATERSHED

A summary of the loadings to Oak Creek is presented in Table 378 and depicted in Figure 79. Urban sources of pollution are estimated to contribute 51 percent of the nitrogen, 90 percent of the phosphorus, 79 percent of the biochemical oxygen demand, 79 percent of the fecal coliform, and 82 percent of the sediment which occur as water pollutants to Oak Creek. Of the urban contribution, the point sources of pollution contribute 5 percent of the nitrogen, 3 percent of the phosphorus, 7 percent of the biochemical oxygen demand, virtually none of the fecal coliform, and one-tenth of one percent of the sediment are estimated to derive from point sources, and all from industrial wastewaters. Of the urban sources of pollution, diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—are estimated to contribute the remaining 95 percent of the nitrogen, 97 percent of the phosphorus, 93 percent of the biochemical oxygen demand and virtually all of the sediment and fecal coliform.

Of the total pollutant loads rural pollution sources contribute an estimated 49 percent of the nitrogen, 10 percent of the phosphorus, 21 percent of the biochemical oxygen demand, 21 percent of the fecal coliform, and 18 percent of the sediment from sources within the watershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 3 percent of the nitrogen, 19 percent of the phosphorus, 9 percent of the biochemical oxygen demand, 99 percent of the fecal coliform, and three-tenths of one percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 97 percent of the nitrogen, 81 percent of the phosphorus, 91 percent of the biochemical oxygen demand, 1 percent of the fecal coliform, and virtually all of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses. Figure 79 presents the relative pollution loadings discussed above within the Oak Creek watershed.

The dry year and wet year analyses, as shown in Table 378, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since point sources of fecal coliform are insignificant in the Oak Creek watershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors. For biochemical oxygen demand, nitrogen, phosphorus and sediments, however, the effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources of these pollutants are unaffected. The proportion of total BOD_5 contributed by point sources ranges from 4 percent during a wet year to 8 percent during a dry year. Of the total sediment load, point sources contribute about 0.1 percent of the total load during a wet or a dry year. The proportion of nitrogen and phosphorus contributed by point sources ranges from 2 percent during a wet year to 3 or 4 percent during a dry year.

The quantity of pollutants transported in Oak Creek near the 15th Avenue bridge was estimated by a transport analysis based on streamflow and pollutant concentration measurements. Streamflow data were available in Oak Creek near the 15th Avenue bridge from the U.S. Geological Survey for the years 1963 to 1975 as part of its routine sampling program. Total phosphorus, total nitrogen, and biochemical oxygen demand concentrations measurements were available from SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975, and from the Commission's index site sampling program. Suspended solids concentration data were available from the Wisconsin Department of Natural Resources monthly sampling program. In Oak Creek, near the 15th Avenue bridge, it is estimated from these in-stream measurements that about 149,000 pounds of nitrogen, 9,000 pounds of phosphorus, 237,000 pounds of biochemical oxygen demand, and 3,256,000 pounds of sediment are transported annually. Table 379 presents a comparison of pollutant transport loads, based on streamflow samples, to pollutant channel loads from diffuse sources as estimated from regional data and general studies. As noted above, the transport loads, as computed from in-stream measurements, are, as expected, significantly less than the channel loads because of the physical, chemical, and biological processes occurring on the land surface and within the stream itself which serve to effectively remove the pollutants temporarily or permanently.

PIKE RIVER WATERSHED

A summary of the loadings to the Pike River is presented in Table 380 and depicted in Figure 80. Urban sources of pollution are estimated to contribute 23 percent of the nitrogen, 74 percent of the phosphorus, 56 percent of the biochemical oxygen demand, 75 percent of the fecal coliform, and 51 percent of the sediment which occur as water pollutants to the Pike River. Of the urban contribution, the point sources of pollution contribute 18 percent of the nitrogen, 9 percent of the phosphorus, 10 percent of the biochemical oxygen demand, 71 percent of the fecal coliform, and one-tenth of one percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 82 percent of the nitrogen, 91 percent of the phosphorus, 90 percent of the biochemical oxygen demand, 29 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Table 378

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE OAK CREEK SUBWATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	8	Total Nitrogen	4,920.0	2.6	1.000	4,920.0	3.9	1.000	4,920.0	1.9
	8	Total Phosphorus	930.0	2.3	1.000	930.0	3.5	1.000	930.0	1.7
	8	Biochemical Oxygen Demand	36,300.0	5.8	1.000	36,300.0	8.7	1.000	36,300.0	4.3
	8	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	8	Sediment	55.0	0.1	1.000	55.0	0.1	1.000	55.0	0.1
Sanitary Sewer Flow Relief Devices	2	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	2	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	2	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	2	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	2	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	4,920.0	2.6		4,920.0	3.9		4,920.0	1.9
		Total Phosphorus	930.0	2.3		930.0	3.5		930.0	1.7
		Biochemical Oxygen Demand	36,300.0	5.8		36,300.0	8.7		36,300.0	4.3
		Fecal Coliform	0.0	0.0		0.0	0.0		0.0	0.0
		Sediment	55.0	0.1		55.0	0.1		55.0	0.1
Urban Diffuse Sources										
Residential	3508	Total Nitrogen	14,030.0	7.3	.643	9,020.0	7.2	1.371	19,240.0	7.4
	3508	Total Phosphorus	1,120.0	2.7	.643	720.0	2.7	1.371	1,540.0	2.7
	3508	Biochemical Oxygen Demand	85,240.0	13.6	.643	54,810.0	13.1	1.371	116,860.0	13.8
	3508	Fecal Coliform	561,280.0	16.5	.643	360,903.0	16.5	1.371	769,514.9	16.5
	3508	Sediment	955.0	1.2	.643	615.0	1.2	1.371	1,310.0	1.2
Commercial	661	Total Nitrogen	5,950.0	3.1	.643	3,830.0	3.1	1.371	8,160.0	3.1
	661	Total Phosphorus	500.0	1.2	.643	320.0	1.2	1.371	690.0	1.2
	661	Biochemical Oxygen Demand	64,510.0	10.3	.643	41,480.0	9.9	1.371	88,440.0	10.4
	661	Fecal Coliform	218,130.0	6.4	.643	140,257.6	6.4	1.371	299,056.2	6.4
	661	Sediment	245.0	0.3	.643	160.0	0.3	1.371	335.0	0.3
Industrial	634	Total Nitrogen	5,330.0	2.8	.643	3,430.0	2.8	1.371	7,310.0	2.8
	634	Total Phosphorus	440.0	1.1	.643	280.0	1.0	1.371	600.0	1.1
	634	Biochemical Oxygen Demand	23,390.0	3.7	.643	15,040.0	3.6	1.371	32,070.0	3.8
	634	Fecal Coliform	393,080.0	11.6	.643	252,750.4	11.6	1.371	538,912.7	11.6
	634	Sediment	310.0	0.4	.643	200.0	0.4	1.371	425.0	0.4
Extractive	55	Total Nitrogen	3,300.0	1.7	.643	2,120.0	1.7	1.371	4,520.0	1.7
	55	Total Phosphorus	2,480.0	6.0	.643	1,590.0	5.9	1.371	3,400.0	6.1
	55	Biochemical Oxygen Demand	6,600.0	1.0	.643	4,240.0	1.0	1.371	9,050.0	1.1
	55	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	55	Sediment	4,125.0	5.3	.643	2,650.0	5.3	1.371	5,655.0	5.3
Transportation	958	Total Nitrogen	17,540.0	9.2	.643	11,280.0	9.0	1.371	24,050.0	9.2
	958	Total Phosphorus	1,930.0	4.7	.643	1,240.0	4.6	1.371	2,650.0	4.7
	958	Biochemical Oxygen Demand	109,920.0	17.5	.643	70,680.0	16.9	1.371	150,700.0	17.8
	958	Fecal Coliform	311,550.0	9.2	.643	200,326.7	9.2	1.371	427,135.1	9.2
	958	Sediment	10,620.0	13.7	.643	6,830.0	13.7	1.371	14,560.0	13.7
Recreation	801	Total Nitrogen	2,050.0	1.1	.643	1,320.0	1.1	1.371	2,810.0	1.1
	801	Total Phosphorus	60.0	0.1	.643	40.0	0.1	1.371	80.0	0.1
	801	Biochemical Oxygen Demand	1,040.0	0.2	.643	670.0	0.2	1.371	1,430.0	0.2
	801	Fecal Coliform	25,308.0	0.7	.643	16,273.0	0.7	1.371	34,697.3	0.7
	801	Sediment	170.0	0.2	.643	110.0	0.2	1.371	235.0	0.2
Construction	626	Total Nitrogen	37,560.0	19.6	.643	24,150.0	19.4	1.371	51,490.0	19.8
	626	Total Phosphorus	28,170.0	68.5	.643	18,110.0	67.7	1.371	38,620.0	68.9
	626	Biochemical Oxygen Demand	75,120.0	11.9	.643	48,300.0	11.6	1.371	102,990.0	12.1
	626	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	626	Sediment	46,950.0	60.8	.643	30,190.0	60.7	1.371	64,370.0	60.8
Septic Systems	1175	Total Nitrogen	6,700.0	3.5	.643	4,310.0	3.5	1.371	9,190.0	3.5
	1175	Total Phosphorus	1,550.0	3.8	.643	1,000.0	3.7	1.371	2,130.0	3.8
	1175	Biochemical Oxygen Demand	95,880.0	15.2	.643	61,650.0	14.8	1.371	131,450.0	15.5
	1175	Fecal Coliform	1,175,000.0	34.6	.643	755,525.0	34.6	1.371	1,610,925.0	34.6
	1175	Sediment	15.0	0.0	.643	10.0	0.0	1.371	20.0	0.0

Table 378 (continued)

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Diffuse Source Totals		Total Nitrogen	92,460.0	48.4		59,460.0	47.7		126,770.0	48.7
		Total Phosphorus	36,250.0	88.2		23,300.0	87.0		49,710.0	88.7
		Biochemical Oxygen Demand	461,700.0	73.4		296,870.0	71.2		632,990.0	74.6
		Fecal Coliform	2,684,348.0	79.1		1,726,035.7	79.1		3,680.241.2	79.1
		Sediment	63,390.0	82.0		40,765.0	82.0		86,910.0	82.0
Urban Source Totals		Total Nitrogen	97,380.0	50.9		64,380.0	51.6		131,690.0	50.6
		Total Phosphorus	37,180.0	90.4		24,230.0	90.5		50,640.0	90.4
		Biochemical Oxygen Demand	498,000.0	79.2		333,170.0	79.9		669,290.0	78.9
		Fecal Coliform	2,684,348.0	79.1		1,726,035.7	79.1		3,680.241.2	79.1
		Sediment	63,445.0	82.1		40,820.0	82.1		86,965.0	82.1
Rural Diffuse Sources										
Livestock Operations	110	Total Nitrogen	3,120.0	1.6	.643	2,010.0	1.6	1.371	4,280.0	1.6
	110	Total Phosphorus	730.0	1.8	.643	470.0	1.8	1.371	1,000.0	1.8
	110	Biochemical Oxygen Demand	12,230.0	1.9	.643	7,860.0	1.9	1.371	16,770.0	2.0
	110	Fecal Coliform	704,000.0	20.7	.643	452,672.0	20.7	1.371	965,184.0	20.7
	110	Sediment	40.0	0.1	.643	25.0	0.1	1.371	55.0	0.1
Cropland, Pasture, and Unused Rural Land	8426	Total Nitrogen	88,960.0	46.5	.643	57,200.0	45.9	1.371	121,960.0	46.9
	8426	Total Phosphorus	3,110.0	7.6	.643	2,000.0	7.5	1.371	4,260.0	7.6
	8426	Biochemical Oxygen Demand	112,320.0	17.9	.643	72,220.0	17.3	1.371	153,990.0	18.1
	8426	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	8426	Sediment	13,705.0	17.7	.643	8,810.0	17.7	1.371	18,790.0	17.7
Silvicultural	676	Total Nitrogen	1,550.0	0.8	.643	1,000.0	0.8	1.371	2,130.0	0.8
	676	Total Phosphorus	90.0	0.2	.643	60.0	0.2	1.371	120.0	0.2
	676	Biochemical Oxygen Demand	3,110.0	0.5	.643	2,000.0	0.5	1.371	4,260.0	0.5
	676	Fecal Coliform	4,461.6	0.1	.643	2,868.8	0.1	1.371	6,116.9	0.1
	676	Sediment	85.0	0.1	.643	55.0	0.1	1.371	115.0	0.1
Air Pollution to Surface Water	19	Total Nitrogen	170.0	0.1	.643	110.0	0.1	1.371	230.0	0.1
	19	Total Phosphorus	10.0	0.0	.643	10.0	0.0	1.371	10.0	0.0
	19	Biochemical Oxygen Demand	3,080.0	0.5	.643	1,980.0	0.5	1.371	4,220.0	0.5
	19	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	19	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	93,800.0	49.1		60,320.0	48.4		128,600.0	49.4
		Total Phosphorus	3,940.0	9.6		2,540.0	9.5		5,390.0	9.6
		Biochemical Oxygen Demand	130,740.0	20.8		84,060.0	20.1		179,240.0	21.1
		Fecal Coliform	708,461.6	20.9		455,540.8	20.9		971,300.9	20.9
		Sediment	13,835.0	17.9		8,895.0	17.9		18,965.0	17.9
Diffuse Source Totals		Total Nitrogen	186,260.0	97.4		119,780.0	96.1		255,370.0	98.1
		Total Phosphorus	40,190.0	97.7		25,840.0	96.5		55,100.0	98.3
		Biochemical Oxygen Demand	592,440.0	94.2		380,930.0	91.3		812,230.0	95.7
		Fecal Coliform	3,392,809.6	100.0		2,181,576.5	100.0		4,651,542.1	100.0
		Sediment	77,225.0	99.9		49,660.0	99.9		105,875.0	99.9
Total Sources		Total Nitrogen	191,180.0	100.0		124,700.0	100.0		260,290.0	100.0
		Total Phosphorus	41,120.0	100.0		26,770.0	100.0		56,030.0	100.0
		Biochemical Oxygen Demand	628,740.0	100.0		417,230.0	100.0		848,530.0	100.0
		Fecal Coliform	3,392,809.6	100.0		2,181,576.5	100.0		4,651,542.1	100.0
		Sediment	77,280.0	100.0		49,715.0	100.0		105,930.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

Figure 79

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE OAK CREEK WATERSHED

NITROGEN

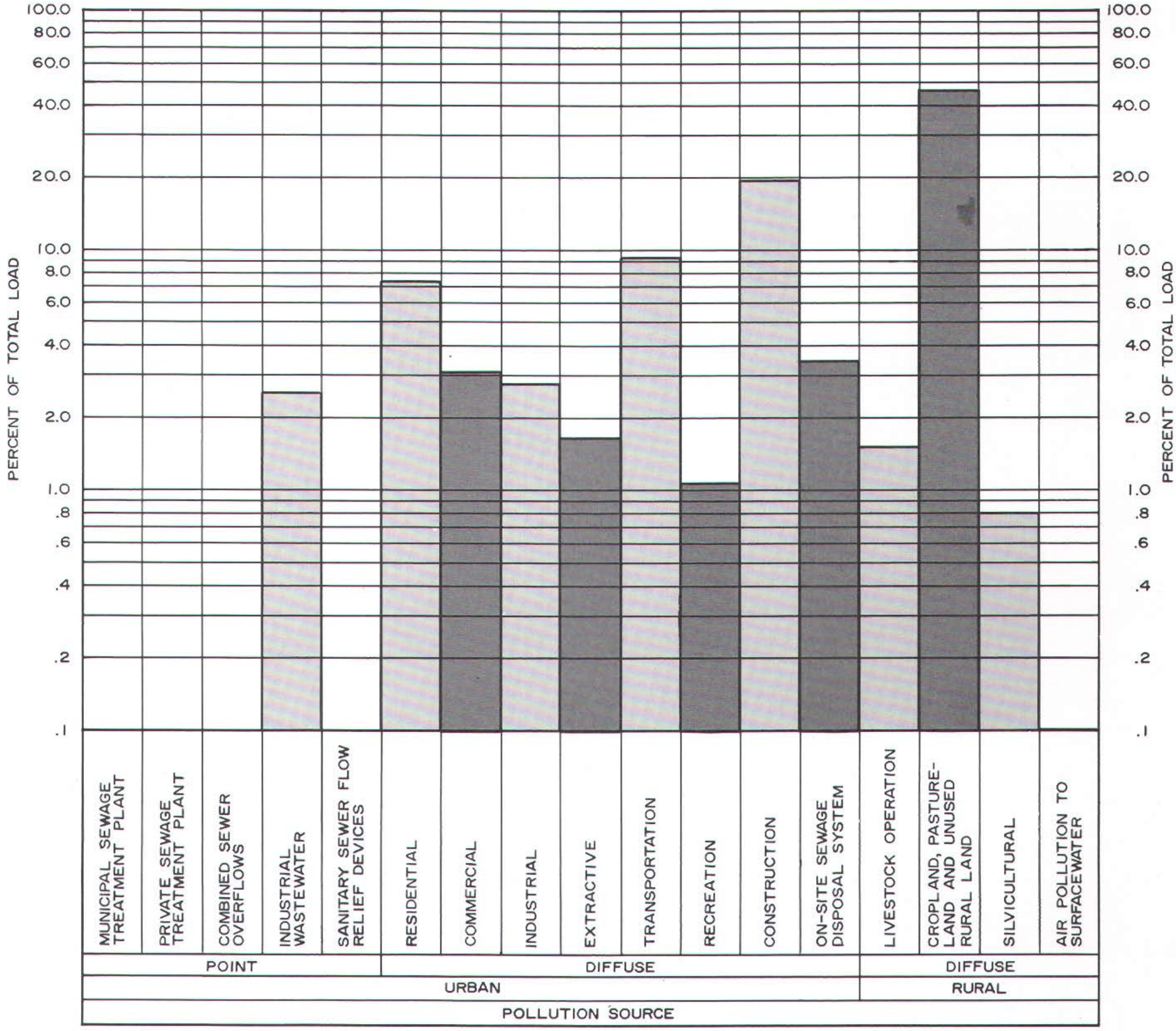


Figure 79 (continued)

PHOSPHOROUS

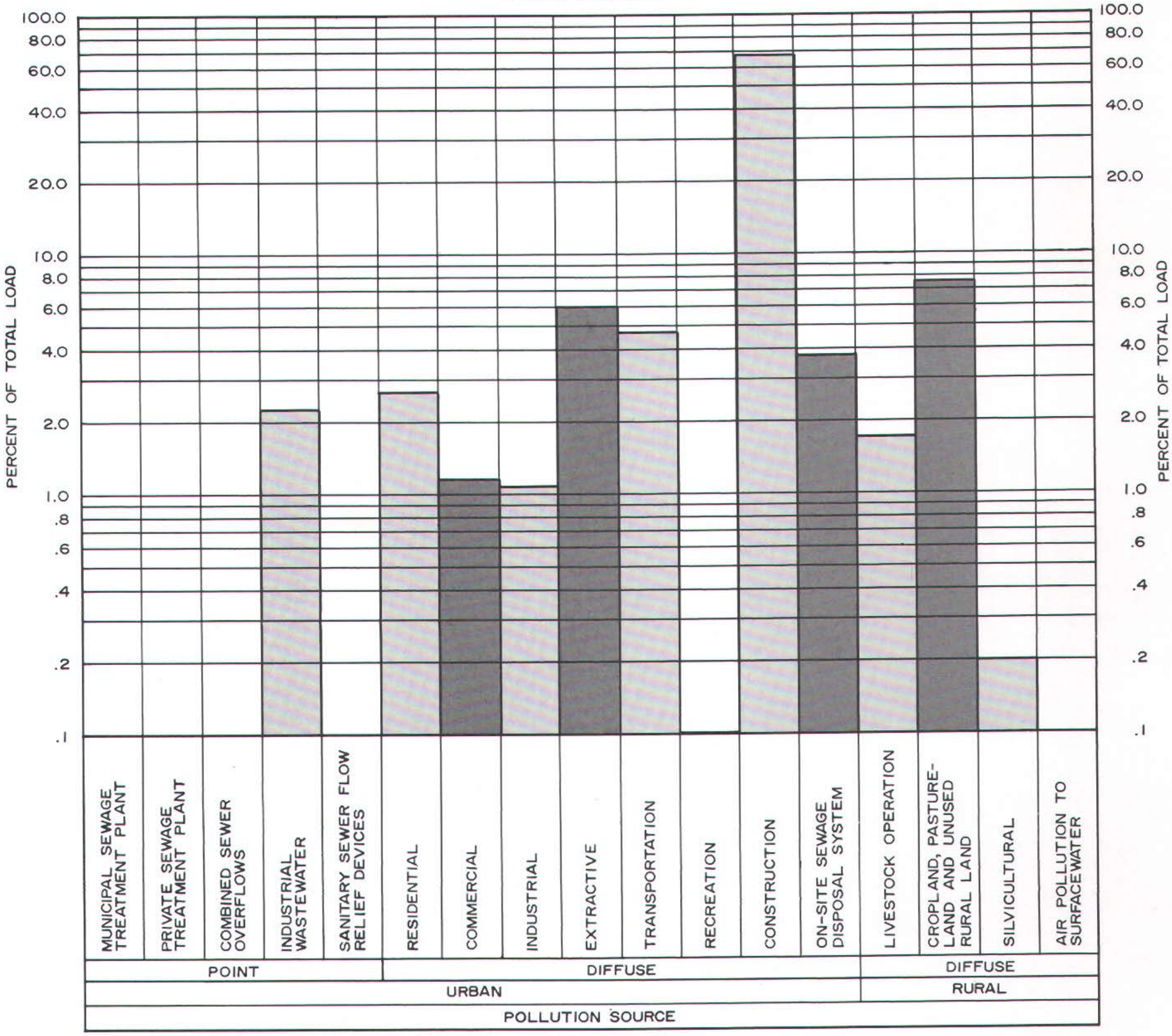


Figure 79 (continued)

FECAL COLIFORM

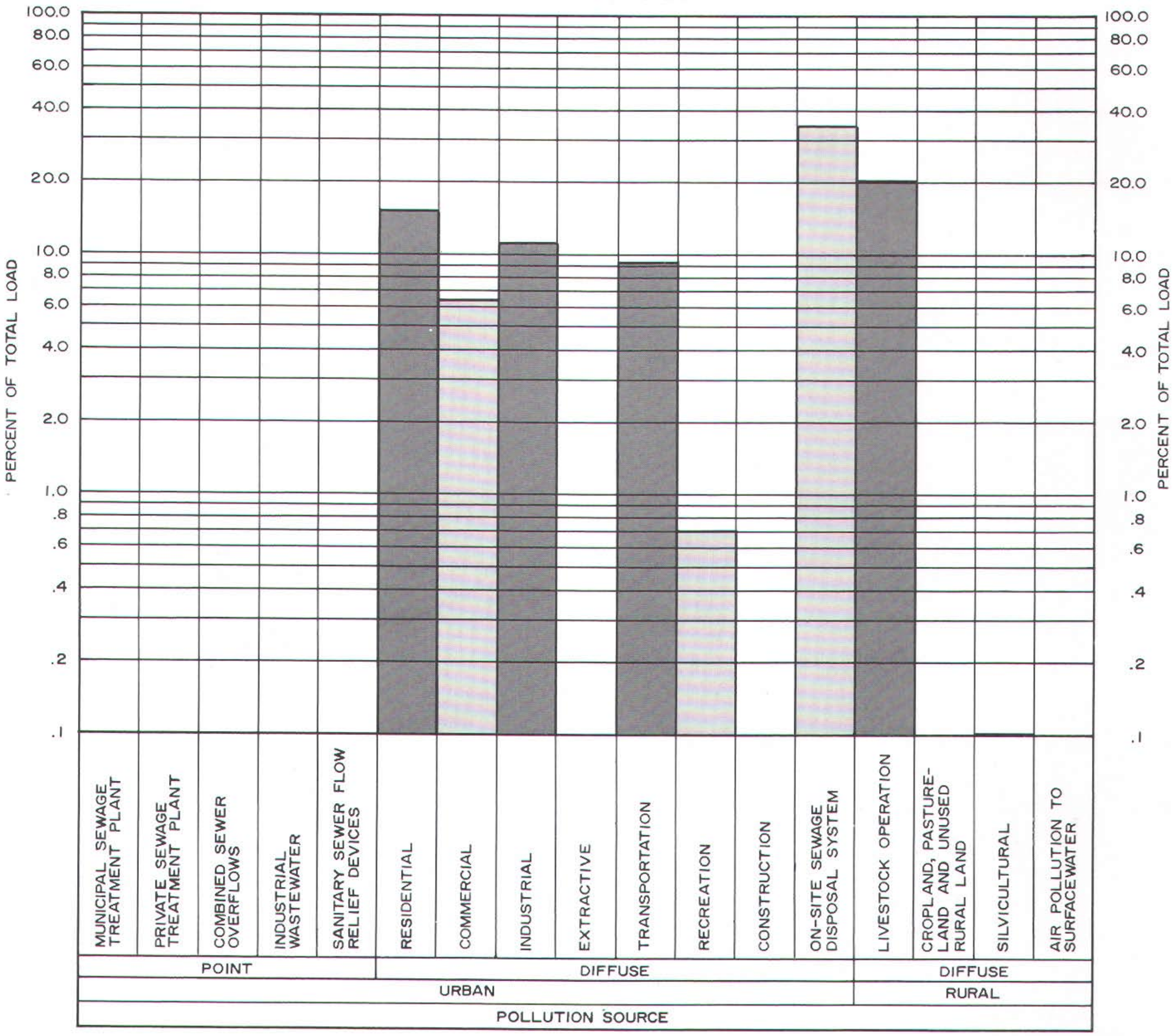


Figure 79 (continued)

BOD_5

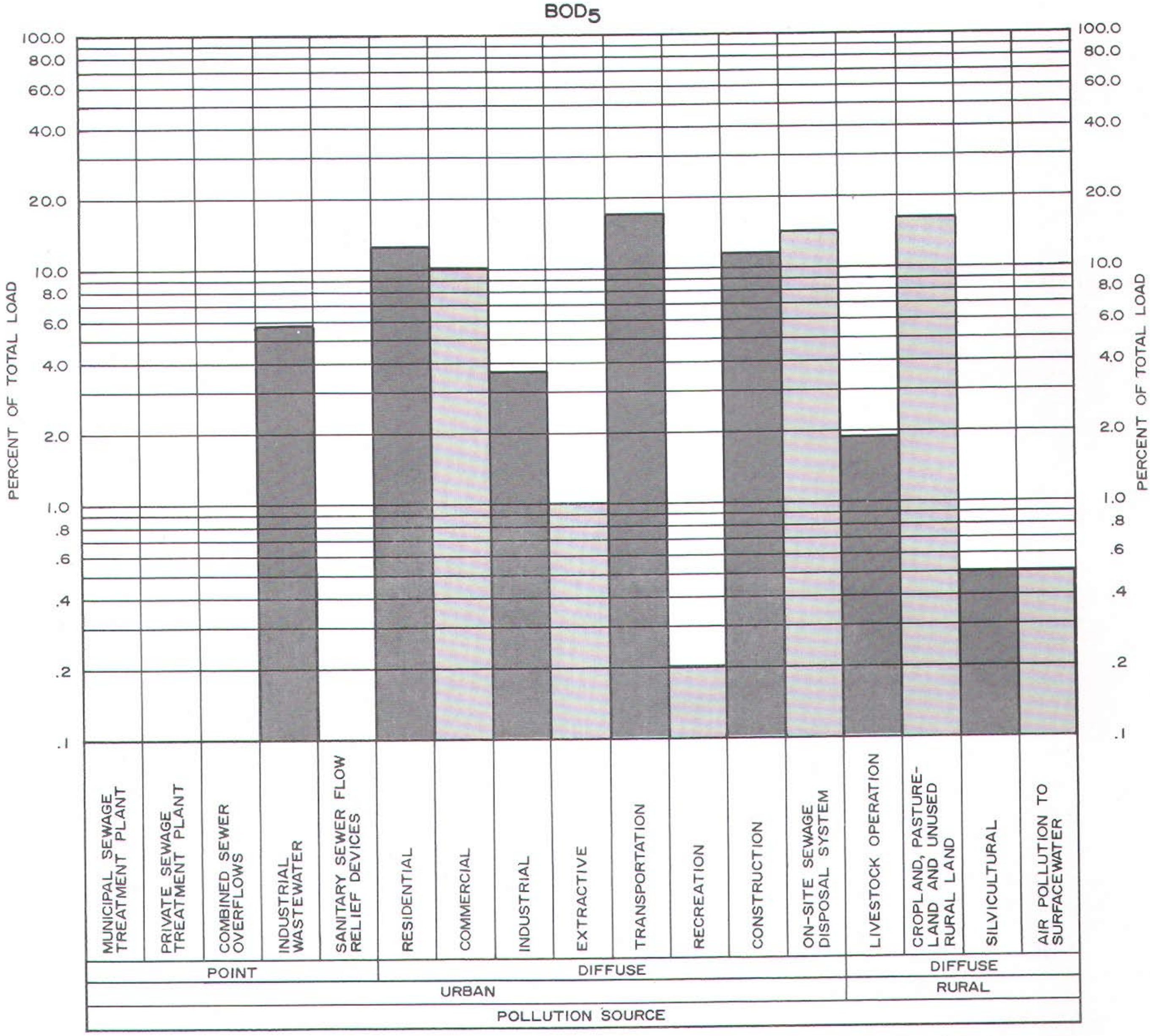
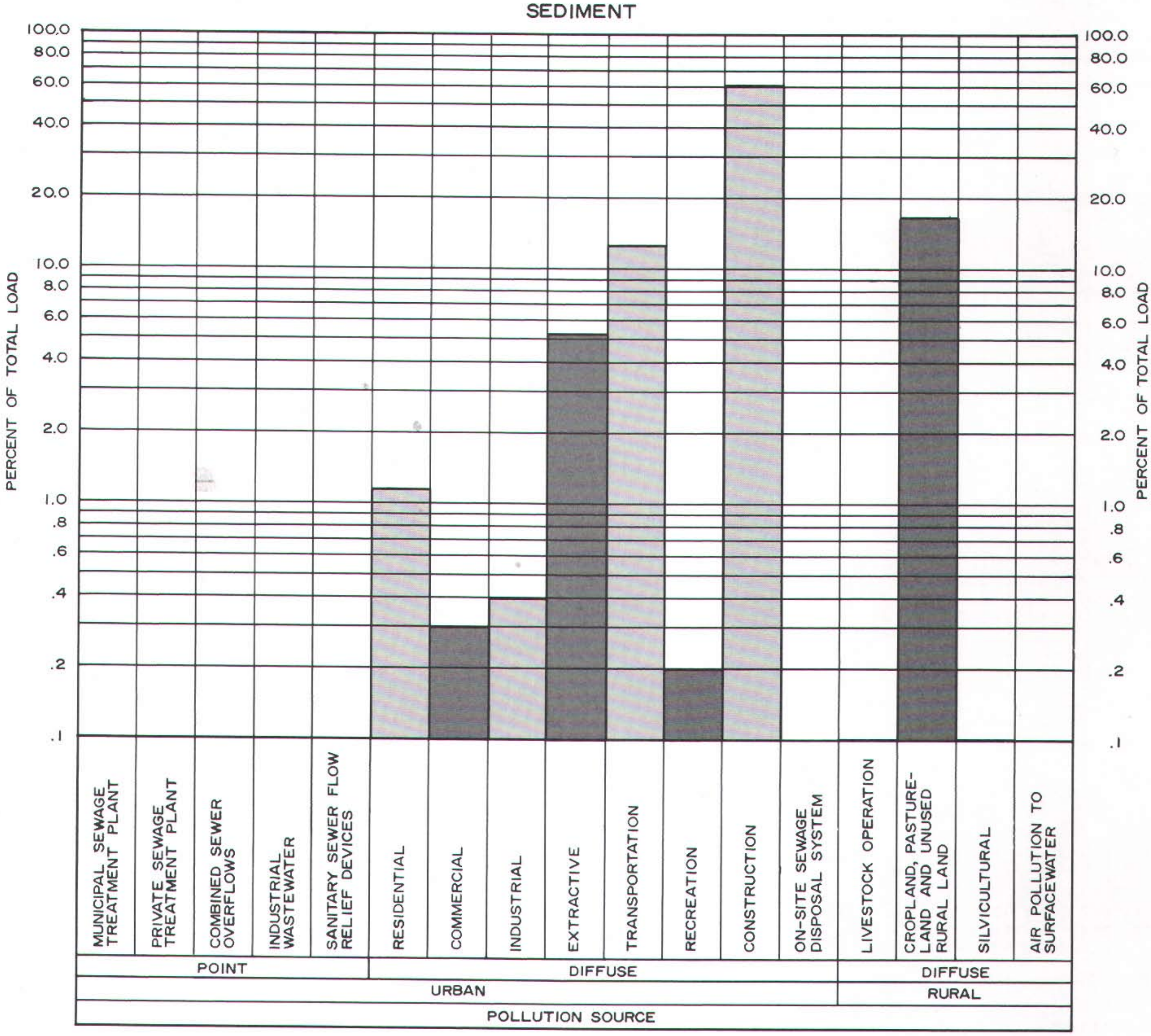


Figure 79 (continued)

SEDIMENT



Source: SEWRPC.

Table 379

COMPARISON OF ESTIMATED TRANSPORT LOADS TO ESTIMATED POLLUTANT CHANNEL LOADS IN OAK CREEK

Pollutant	Channel Load	Transport Analysis Load		
	Thousands of Pounds/Year	Thousands of Pounds/Year		
		Annual Load		Variance[a]
Nitrogen	191	149	±	41
Phosphorus . . .	41	9	±	3
BOD_5	629	237	±	11
Sediment	154,560	3,256	±	937

[a] *Variance significant at a 95% confidence level.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Of the total pollutant loads, rural pollution sources contribute an estimated 77 percent of the nitrogen, 26 percent of the phosphorus, 44 percent of the biochemical oxygen demand, 25 percent of the fecal coliform, and 49 percent of the sediment from all sources within the watershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 6 percent of the nitrogen, 34 percent of the phosphorus, 19 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and one-half of one percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 94 percent of the nitrogen, 66 percent of the phosphorus, 81 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and virtually all of the sediment are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 80 presents the relative pollution loadings discussed above within the Pike River watershed.

The dry year and wet year analyses, as shown in Table 380, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since point sources of sediment are insignificant in the Pike River watershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors. For fecal coliform, biochemical oxygen demand, nitrogen, and phosphorus, however, the effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and municipal and private sewage treatment plant discharges of these pollutants are unaffected. The proportion of phosphorus contributed by point sources ranges from 5 percent during a wet year to 10 percent during a dry year. Of the total fecal coliform load, point sources contribute from 46 percent of the total load during a wet year to 64 percent during a dry year. Nitrogen and biochemical oxygen demand contributions from point sources similarly range from 3 to 6 percent and from 4 to 8 percent of the total loads, respectively.

The quantity of pollutants transported in the Pike River near Racine were estimated by a transport analysis based on streamflow and pollutant concentration measurements. Streamflow data were available for the Pike River near Racine from the U.S. Geological Survey for the years 1971 to 1975 as part of its routine sampling program. Total phosphorus and total nitrogen concentration measurements were available from SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975. Total phosphorus, total nitrogen, and biochemical oxygen demand measurements were available from the Commission's index site sampling program. A suspended solids transport analysis for the Pike River was previously conducted by the U.S. Geological Survey[5], In the Pike River, near Racine, it is estimated from these in-stream measurements that about 349,000 pounds of nitrogen, 27,000 pounds of phosphorus, 255,000 pounds of biochemical oxygen demand, and 6,341,000 pounds of sediment are transported annually. Table 381 presents a comparison of pollutant transport loads, based on streamflow samples, to pollutant channel loads as estimated from regional data and general studies. As noted above, the transport loads, as computed from in-stream measurements, are, as expected, significantly less than the channel loads because of the physical, chemical, and biological processes occurring on the land surface and within the stream itself which serve to effectively remove the pollutants temporarily or permanently.

ROCK RIVER WATERSHED

A summary of the loadings to the Rock River is presented in Table 382 and depicted in Figure 81. Urban sources of pollution are estimated to contribute 12 percent of the nitrogen, 45 percent of the phosphorus, 19 percent of the biochemical oxygen demand, 4 percent of the fecal coliform, and 42 percent of the sediment which occur as water pollutants to the Rock River. Of the urban contribution, the point sources of pollution contribute 32 percent of the nitrogen, 29 percent of the phosphorus, 18 percent of the biochemical oxygen demand, 6 percent of the fecal coliform, and one-tenth of one percent of the sediment. Diffuse sources—including the estimated

---

[5]*S. M. Hindall and R. F. Flint, "Sediment Yields of Wisconsin Streams", Hydrologic Investigations Atlas, HA-376, U.S. Geological Survey, Washington, 1970.*

Table 380

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE PIKE RIVER SUBWATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	2	Total Nitrogen	24,070.0	4.1	1.000	24,070.0	6.3	1.000	24,070.0	3.0
	2	Total Phosphorus	4,620.0	6.5	1.000	4,620.0	9.7	1.000	4,620.0	4.8
	2	Biochemical Oxygen Demand	64,020.0	5.0	1.000	64,020.0	7.6	1.000	64,020.0	3.7
	2	Fecal Coliform	13,000,000.0	51.3	1.000	13,000,000.0	62.1	1.000	13,000,000.0	43.4
	2	Sediment	35.0	0.0	1.000	35.0	0.0	1.000	35.0	0.0
Private Sewage Treatment Plants	2	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	2	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	2	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	2	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	2	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	4	Total Nitrogen	30.0	0.0	1.000	30.0	0.0	1.000	30.0	0.0
	4	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	4	Biochemical Oxygen Demand	920.0	0.1	1.000	920.0	0.1	1.000	920.0	0.1
	4	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	4	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Sanitary Sewer Flow Relief Devices . .	8	Total Nitrogen	380.0	0.1	.643	240.0	0.1	1.371	520.0	0.1
	8	Total Phosphorus	130.0	0.2	.643	80.0	0.2	1.371	180.0	0.2
	8	Biochemical Oxygen Demand	3,750.0	0.3	.643	2,410.0	0.3	1.371	5,140.0	0.3
	8	Fecal Coliform	570,000.0	2.2	.643	366,510.0	1.8	1.371	781,470.0	2.6
	8	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	24,480.0	4.2		24,340.0	6.3		24,620.0	3.1
		Total Phosphorus	4,750.0	6.7		4,700.0	9.9		4,800.0	5.0
		Biochemical Oxygen Demand	68,690.0	5.4		67,350.0	8.0		70,080.0	4.1
		Fecal Coliform	13,570,000.0	53.5		13,366,510.0	63.8		13,781,470.0	46.0
		Sediment	35.0	0.0		35.0	0.0		35.0	0.0
Urban Diffuse Sources										
Residential	3127	Total Nitrogen	12,510.0	2.1	.643	8,040.0	2.1	1.371	17,150.0	2.2
	3127	Total Phosphorus	1,000.0	1.4	.643	640.0	1.3	1.371	1,370.0	1.4
	3127	Biochemical Oxygen Demand	75,990.0	6.0	.643	48,860.0	5.8	1.371	104,180.0	6.0
	3127	Fecal Coliform	500,320.0	2.0	.643	321,705.8	1.5	1.371	685,938.7	2.3
	3127	Sediment	850.0	0.6	.643	545.0	0.6	1.371	1,165.0	0.6
Commercial	690	Total Nitrogen	6,210.0	1.1	.643	3,990.0	1.0	1.371	8,510.0	1.1
	690	Total Phosphorus	520.0	0.7	.643	330.0	0.7	1.371	710.0	0.7
	690	Biochemical Oxygen Demand	67,340.0	5.3	.643	43,300.0	5.1	1.371	92,320.0	5.4
	690	Fecal Coliform	227,700.0	0.9	.643	146,411.1	0.7	1.371	312,176.7	1.0
	690	Sediment	255.0	0.2	.643	165.0	0.2	1.371	350.0	0.2
Industrial	752	Total Nitrogen	6,320.0	1.1	.643	4,060.0	1.1	1.371	8,660.0	1.1
	752	Total Phosphorus	530.0	0.7	.643	340.0	0.7	1.371	730.0	0.8
	752	Biochemical Oxygen Demand	27,750.0	2.2	.643	17,840.0	2.1	1.371	38,050.0	2.2
	752	Fecal Coliform	466,240.0	1.8	.643	299,792.3	1.4	1.371	639,215.0	2.1
	752	Sediment	365.0	0.3	.643	235.0	0.3	1.371	500.0	0.3
Extractive	92	Total Nitrogen	5,520.0	0.9	.643	3,550.0	0.9	1.371	7,570.0	1.0
	92	Total Phosphorus	4,140.0	5.8	.643	2,660.0	5.6	1.371	5,680.0	5.9
	92	Biochemical Oxygen Demand	11,040.0	0.9	.643	7,100.0	0.8	1.371	15,140.0	0.9
	92	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	92	Sediment	6,900.0	5.0	.643	4,435.0	5.0	1.371	9,460.0	5.0
Transportation	319	Total Nitrogen	4,930.0	0.8	.643	3,170.0	0.8	1.371	6,760.0	0.9
	319	Total Phosphorus	650.0	0.9	.643	420.0	0.9	1.371	890.0	0.9
	319	Biochemical Oxygen Demand	21,980.0	1.7	.643	14,130.0	1.7	1.371	30,130.0	1.7
	319	Fecal Coliform	99,740.0	0.4	.643	64,132.8	0.3	1.371	136,743.5	0.5
	319	Sediment	2,630.0	1.9	.643	1,690.0	1.9	1.371	3,605.0	1.9
Recreation	817	Total Nitrogen	3,170.0	0.5	.643	2,040.0	0.5	1.371	4,350.0	0.6
	817	Total Phosphorus	140.0	0.2	.643	90.0	0.2	1.371	190.0	0.2
	817	Biochemical Oxygen Demand	1,060.0	0.1	.643	680.0	0.1	1.371	1,450.0	0.1
	817	Fecal Coliform	7,200.0	0.0	.643	4,629.6	0.0	1.371	9,871.2	0.0
	817	Sediment	170.0	0.1	.643	110.0	0.1	1.371	235.0	0.1
Construction	780	Total Nitrogen	46,800.0	8.0	.643	30,090.0	7.8	1.371	64,160.0	8.1
	780	Total Phosphorus	35,100.0	49.2	.643	22,570.0	47.5	1.371	48,120.0	50.1
	780	Biochemical Oxygen Demand	93,600.0	7.3	.643	60,180.0	7.1	1.371	128,330.0	7.4
	780	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	780	Sediment	58,500.0	42.3	.643	37,615.0	42.3	1.371	80,205.0	42.3
Septic Systems	4200	Total Nitrogen	23,940.0	4.1	.643	15,390.0	4.0	1.371	32,820.0	4.2
	4200	Total Phosphorus	5,540.0	7.8	.643	3,560.0	7.5	1.371	7,600.0	7.9
	4200	Biochemical Oxygen Demand	342,720.0	26.9	.643	220,370.0	26.1	1.371	469,870.0	27.3
	4200	Fecal Coliform	4,200,000.0	16.6	.643	2,700,600.0	12.9	1.371	5,758,200.0	19.2
	4200	Sediment	60.0	0.0	.643	40.0	0.0	1.371	80.0	0.0

Table 380 (continued)

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Diffuse Source Totals		Total Nitrogen	109,400.0	18.8		70,330.0	18.3		149,980.0	19.0
		Total Phosphorus	47,620.0	66.8		30,610.0	64.5		65,290.0	68.0
		Biochemical Oxygen Demand	641,480.0	50.3		412,460.0	48.9		879,470.0	51.0
		Fecal Coliform	5,501,200.0	21.7		3,537,271.6	16.9		7,542,145.1	25.2
		Sediment	69,730.0	50.4		44,835.0	50.4		95,600.0	50.4
Urban Source Totals		Total Nitrogen	133,880.0	23.0		94,670.0	24.7		174,600.0	22.1
		Total Phosphorus	52,370.0	73.5		35,310.0	74.4		70,090.0	73.0
		Biochemical Oxygen Demand	710,170.0	55.7		479,810.0	56.9		949,550.0	55.1
		Fecal Coliform	19,071,200.0	75.2		16,903,781.6	80.7		21,323,615.1	71.2
		Sediment	69,765.0	50.5		44,870.0	50.5		95,635.0	50.5
Rural Diffuse Sources										
Livestock Operations	980	Total Nitrogen	27,830.0	4.8	.643	17,890.0	4.7	1.371	38,150.0	4.8
	980	Total Phosphorus	6,470.0	9.1	.643	4,160.0	8.8	1.371	8,870.0	9.2
	980	Biochemical Oxygen Demand	108,980.0	8.5	.643	70,070.0	8.3	1.371	149,410.0	8.7
	980	Fecal Coliform	6,272,000.0	24.7	.643	4,032,896.0	19.3	1.371	8,598,912.0	28.7
	980	Sediment	345.0	0.2	.643	220.0	0.2	1.371	475.0	0.3
Cropland, Pasture, and Unused Rural Land	23842	Total Nitrogen	417,720.0	71.7	.643	268,590.0	70.1	1.371	572,690.0	72.5
	23842	Total Phosphorus	12,230.0	17.2	.643	7,860.0	16.6	1.371	16,770.0	17.5
	23842	Biochemical Oxygen Demand	436,690.0	34.3	.643	280,790.0	33.3	1.371	598,700.0	34.7
	23842	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	23842	Sediment	67,955.0	49.2	.643	43,695.0	49.2	1.371	93,165.0	49.2
Silvicultural	1213	Total Nitrogen	2,790.0	0.5	.643	1,790.0	0.5	1.371	3,830.0	0.5
	1213	Total Phosphorus	170.0	0.2	.643	110.0	0.2	1.371	230.0	0.2
	1213	Biochemical Oxygen Demand	5,580.0	0.4	.643	3,590.0	0.4	1.371	7,650.0	0.4
	1213	Fecal Coliform	8,005.8	0.0	.643	5,147.7	0.0	1.371	10,976.0	0.0
	1213	Sediment	150.0	0.1	.643	95.0	0.1	1.371	205.0	0.1
Air Pollution to Surface Water	82	Total Nitrogen	730.0	0.1	.643	470.0	0.1	1.371	1,000.0	0.1
	82	Total Phosphorus	40.0	0.1	.643	30.0	0.1	1.371	50.0	0.1
	82	Biochemical Oxygen Demand	13,280.0	1.0	.643	8,540.0	1.0	1.371	18,210.0	1.1
	82	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	82	Sediment	25.0	0.0	.643	15.0	0.0	1.371	35.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	449,070.0	77.0		288,740.0	75.3		615,670.0	77.9
		Total Phosphorus	18,910.0	26.5		12,160.0	25.6		25,920.0	27.0
		Biochemical Oxygen Demand	564,530.0	44.3		362,990.0	43.1		773,970.0	44.9
		Fecal Coliform	6,280,005.8	24.8		4,038,043.7	19.3		8,609,888.0	28.8
		Sediment	68,475.0	49.5		44,025.0	49.5		93,880.0	49.5
Diffuse Source Totals		Total Nitrogen	558,470.0	95.8		359,070.0	93.7		765,650.0	96.9
		Total Phosphorus	66,530.0	93.3		42,770.0	90.1		91,210.0	95.0
		Biochemical Oxygen Demand	1,206,010.0	94.6		775,450.0	92.0		1,653,440.0	95.9
		Fecal Coliform	11,781,205.8	46.5		7,575,315.3	36.2		16,152,033.1	54.0
		Sediment	138,205,0	100.0		88,860.0	100.0		189,480.0	100.0
Total Sources		Total Nitrogen	582,950.0	100.0		383,410.0	100.0		790,270.0	100.0
		Total Phosphorus	71,280.0	100.0		47,470.0	100.0		96,010.0	100.0
		Biochemical Oxygen Demand	1,274,700.0	100.0		842,800.0	100.0		1,723,520.0	100.0
		Fecal Coliform	25,351,205.8	100.0		20,941,825.3	100.0		29,933,503.1	100.0
		Sediment	138,240.0	100.0		88,895.0	100.0		189,515.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

Figure 80

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES
FOR AN AVERAGE YEAR IN THE PIKE RIVER WATERSHED

NITROGEN

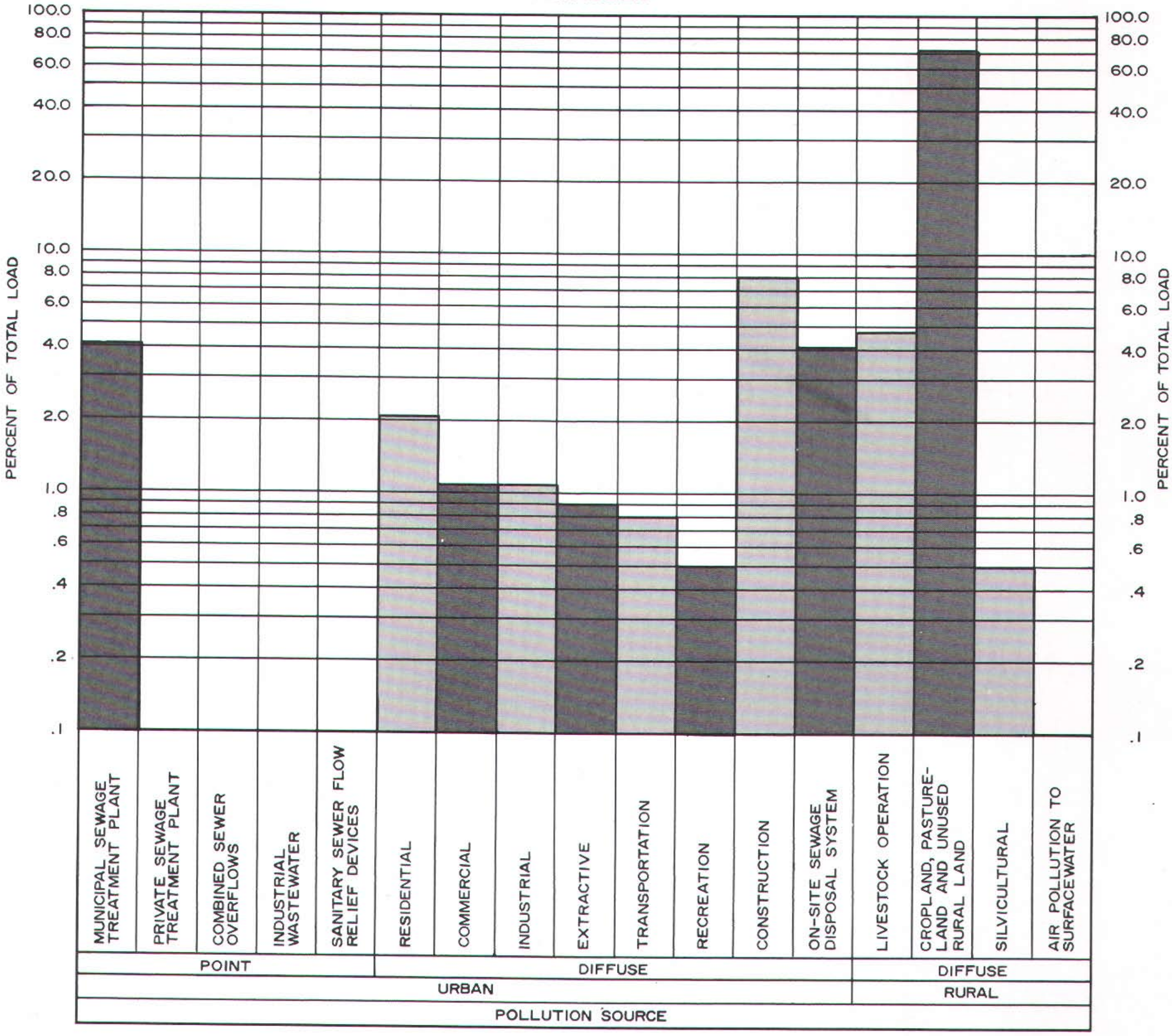


Figure 80 (continued)

PHOSPHOROUS

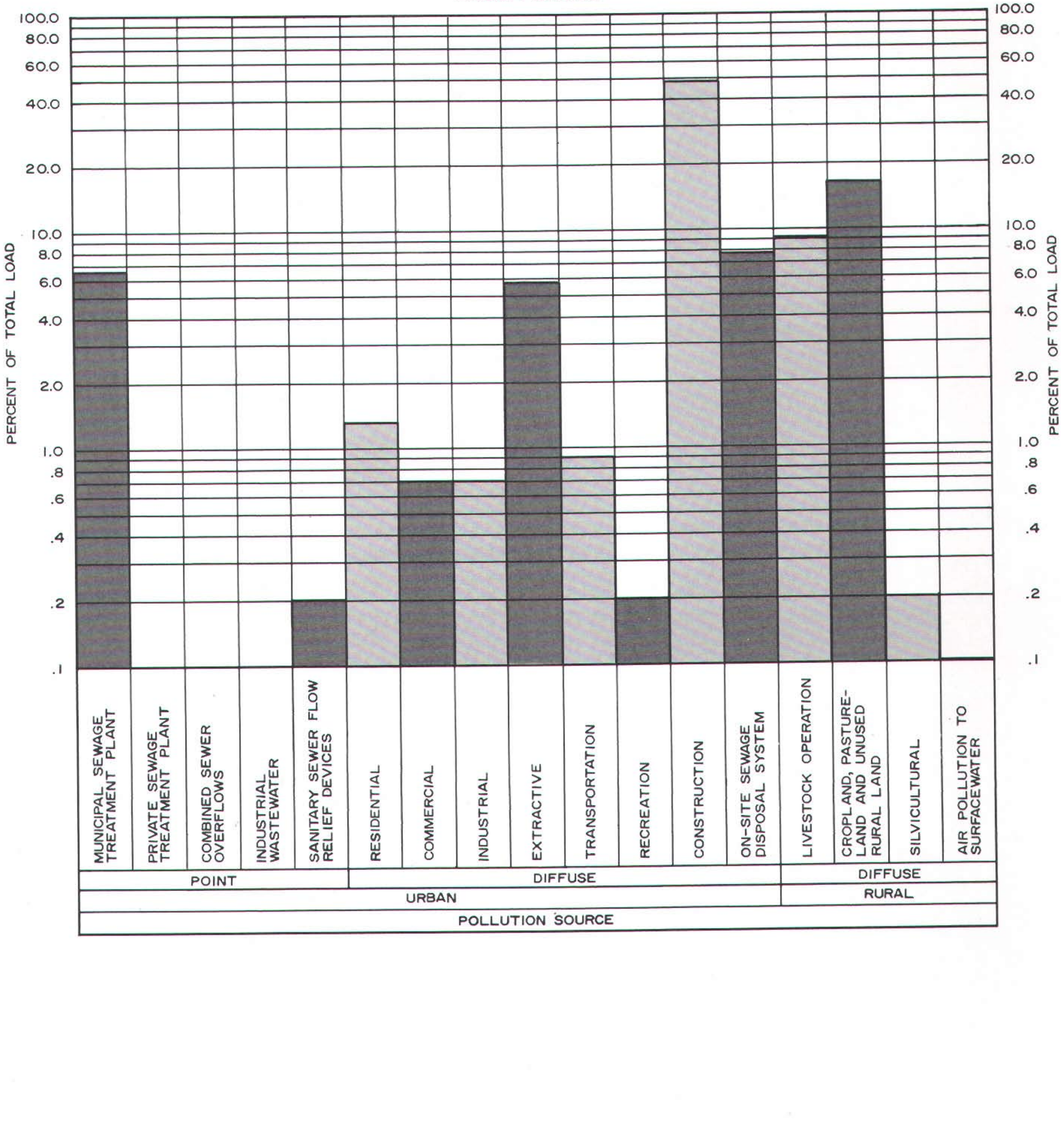


Figure 80 (continued)

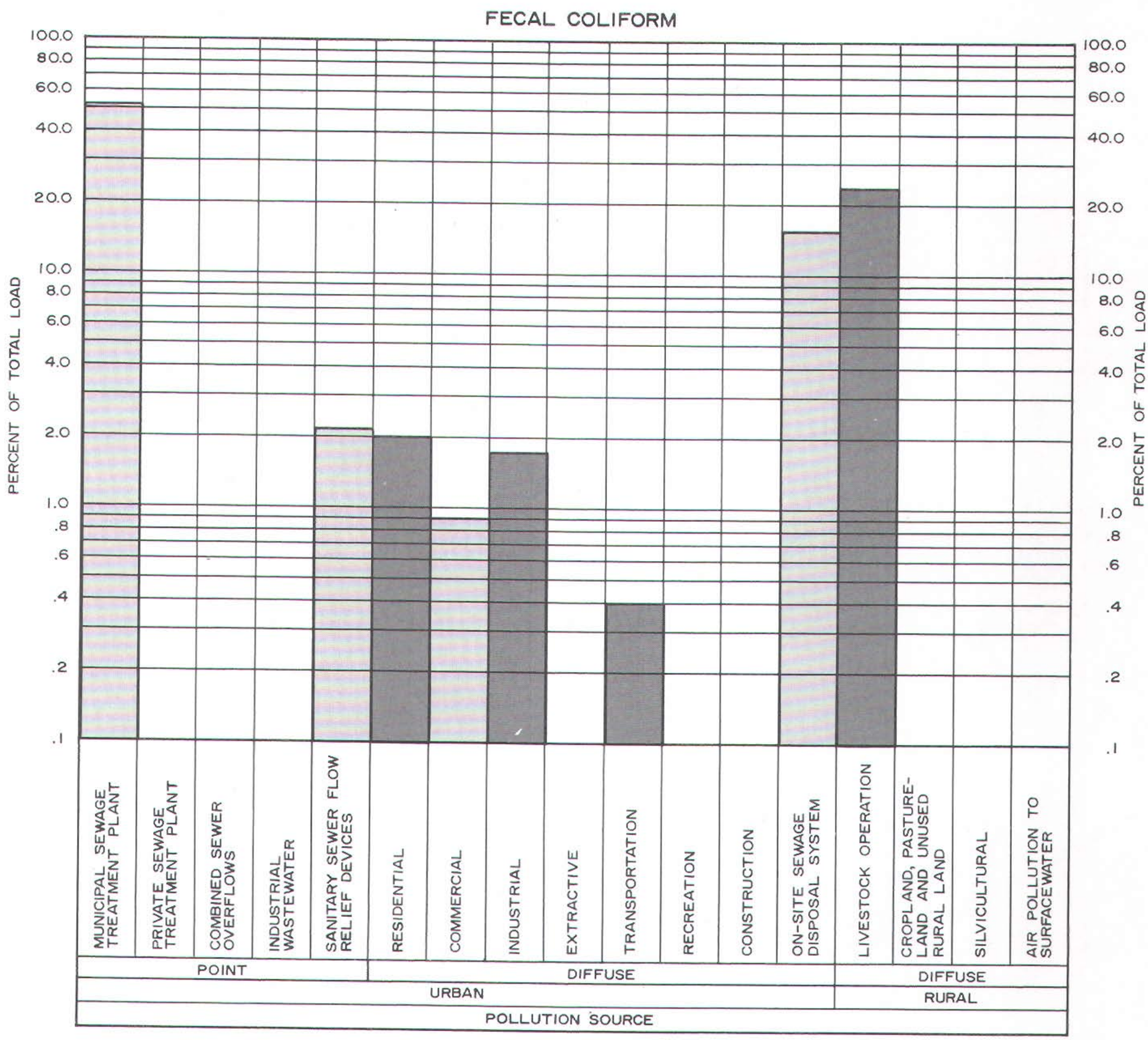


Figure 80 (continued)

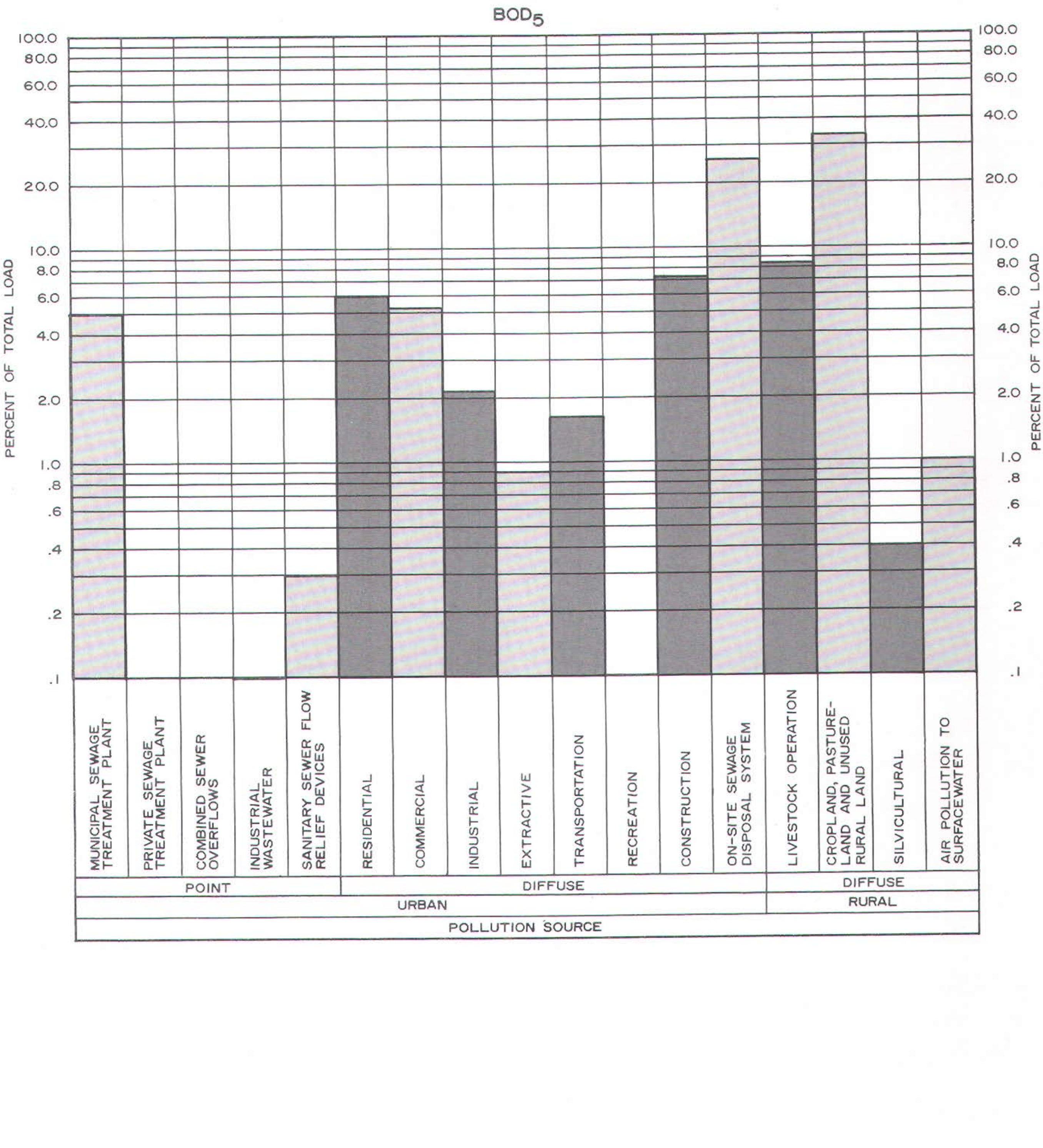
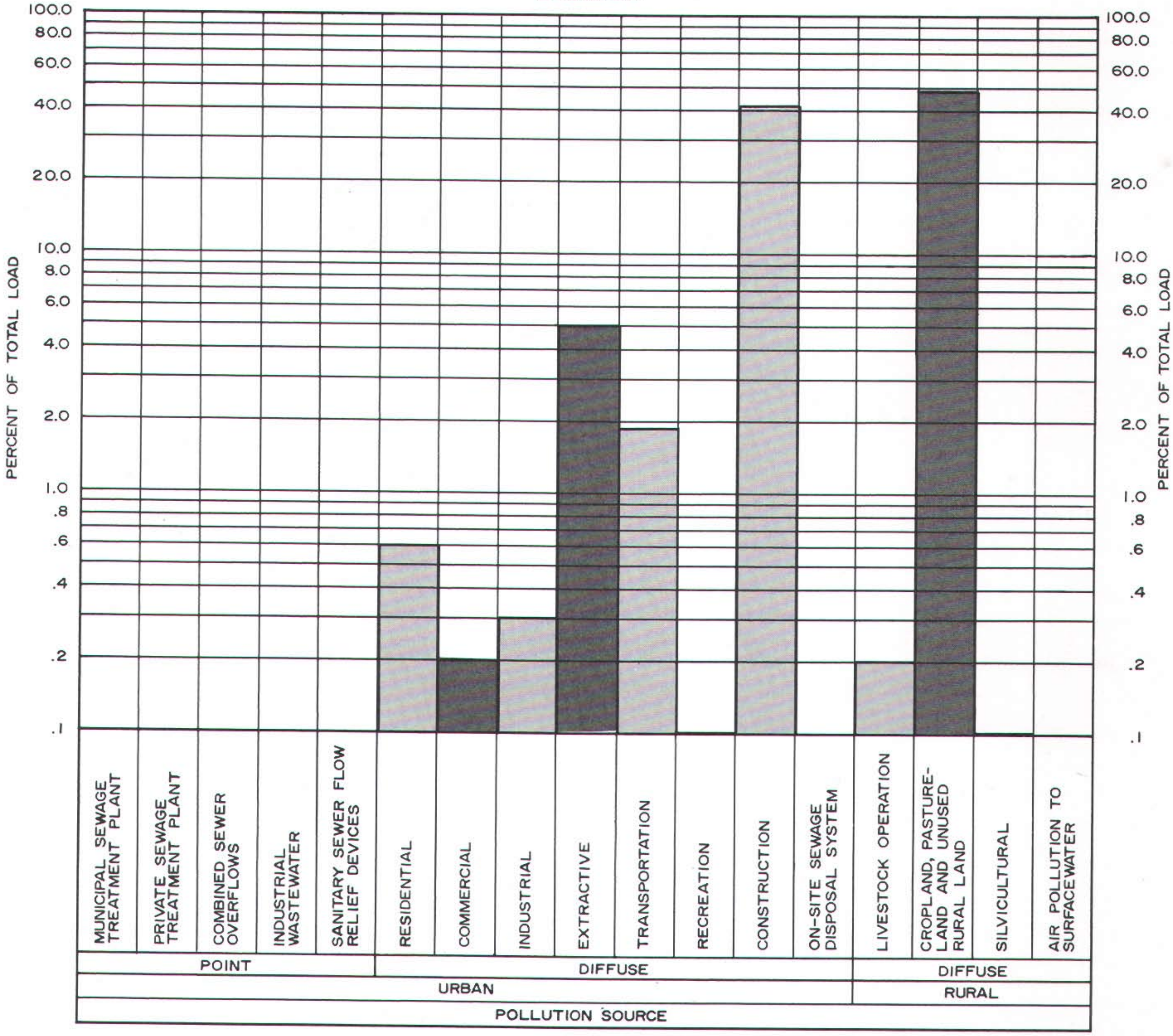


Figure 80 (continued)

SEDIMENT



Source: SEWRPC.

Table 381

COMPARISON OF ESTIMATED TRANSPORT LOADS TO ESTIMATED POLLUTANT CHANNEL LOADS IN THE PIKE RIVER

Pollutant	Channel Load	Transport Analysis Load		
	Thousands of Pounds/Year	Thousands of Pounds/Year		
		Annual Load		Variance[a]
Nitrogen	583	349	±	206
Phosphorus . . .	71	27	±	23
BOD_5	1,275	255	±	8
Sediment	276,480	6,341	±	N/A

NOTE: N/A indicates data not available.

[a] *Variance significant at a 95% confidence level.*

Source: U. S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC.

septic tank and construction-related contributions in the drainage area—account for the remaining 67 percent of the nitrogen, 71 percent of the phosphorus, 81 percent of the biochemical oxygen demand, 94 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Rural pollution sources contribute the remaining estimated 88 percent of the nitrogen, 55 percent of the phosphorus, 81 percent of the biochemical oxygen demand, 96 percent of the fecal coliform, and 58 percent of the sediment from all sources within the watershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 28 percent of the nitrogen, 74 percent of the phosphorus, 50 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 3 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 72 percent of the nitrogen, 26 percent of the phosphorus, 50 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 97 percent of the sediment are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 81 presents the relative pollution loadings discussed above within the Rock River watershed.

The dry year and wet year analyses, as shown in Table 382, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. The effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and municipal and private sewage treatment plant discharges of these pollutants are unaffected. The proportion of phosphorus contributed by point sources ranges from 10 percent during a wet year to 19 percent during a dry year. Of the total nitrogen load, point sources contribute from 3 percent of the total load during a wet year to 6 percent during a dry year. Point source contributions of biochemical oxygen demand range from 3 percent to 5 percent of the total load. Point sources of fecal coliform and sediment account for approximately two or three-tenths of one percent or less and less than one-tenth of one percent, respectively, of the total loads during a wet year or a dry year.

Although a USGS gaging station is located on Turtle Creek at Clinton, sufficient data were not available to enable a transport analysis to be conducted for an adequate portion of the Rock River watershed.

ROOT RIVER WATERSHED

A summary of the loadings to the Root River is presented in Table 383 and depicted in Figure 82. Urban sources of pollution are estimated to contribute 27 percent of the nitrogen, 67 percent of the phosphorus, 60 percent of the biochemical oxygen demand, 58 percent of the fecal coliform, and 53 percent of the sediment which occur as water pollutants to the Root River. Of the urban contribution, the point sources of pollution contribute 24 percent of the nitrogen, 18 percent of the phosphorus, 10 percent of the biochemical oxygen demand, 61 percent of the fecal coliform, and one-tenth of one percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 76 percent of the nitrogen, 82 percent of the phosphorus, 90 percent of the biochemical oxgyen demand, 39 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 73 percent of the nitrogen, 33 percent of the phosphorus, 40 percent of the biochemical oxygen demand, 42 percent of the fecal coliform, and 47 percent of the sediment from all sources within the watershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 16 percent of the nitrogen, 59 percent of the phosphorus, 40 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 1 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 84 percent of the nitrogen, 41 percent of the phosphorus, 60 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 99 percent of the sediment are contributed by other rural diffuse sources, namely storm water runoff from rural land uses and

Table 382

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE ROCK RIVER WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants	12	Total Nitrogen	306,390.0	3.9	1.000	306,390.0	5.9	1.000	306,390.0	2.9
	12	Total Phosphorus	141,430.0	12.9	1.000	141,430.0	18.7	1.000	141,430.0	9.7
	12	Biochemical Oxygen Demand	615,410.0	3.3	1.000	615,410.0	5.1	1.000	615,410.0	2.5
	12	Fecal Coliform	190,000.0	0.0	1.000	190,000.0	0.1	1.000	190,000.0	0.0
	12	Sediment	425.0	0.0	1.000	425.0	0.0	1.000	425.0	0.0
Private Sewage Treatment Plants	5	Total Nitrogen	8,200.0	0.1	1.000	8,200.0	0.2	1.000	8,200.0	0.1
	5	Total Phosphorus	3,830.0	0.3	1.000	3,830.0	0.5	1.000	3,830.0	0.3
	5	Biochemical Oxygen Demand	25,400.0	0.1	1.000	25,400.0	0.2	1.000	25,400.0	0.1
	5	Fecal Coliform	410,000.0	0.1	1.000	410,000.0	0.1	1.000	410,000.0	0.1
	5	Sediment	10.0	0.0	1.000	10.0	0.0	1.000	10.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	17	Total Nitrogen	170.0	0.0	1.000	170.0	0.0	1.000	170.0	0.0
	17	Total Phosphorus	30.0	0.0	1.000	30.0	0.0	1.000	30.0	0.0
	17	Biochemical Oxygen Demand	2,990.0	0.0	1.000	2,990.0	0.0	1.000	2,990.0	0.0
	17	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	17	Sediment	5.0	0.0	1.000	5.0	0.0	1.000	5.0	0.0
Sanitary Sewer Flow Relief Devices	16	Total Nitrogen	400.0	0.0	.643	260.0	0.0	1.371	550.0	0.0
	16	Total Phosphorus	130.0	0.0	.643	80.0	0.0	1.371	180.0	0.0
	16	Biochemical Oxygen Demand	4,000.0	0.0	.643	2,570.0	0.0	1.371	5,480.0	0.0
	16	Fecal Coliform	610,000.0	0.1	.643	392,230.0	0.1	1.371	836,310.0	0.1
	16	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	315,160.0	4.0		315,020.0	6.1		315,310.0	3.0
		Total Phosphorus	145,420.0	13.2		145,370.0	19.2		145,470.0	10.0
		Biochemical Oxygen Demand	647,800.0	3.5		646,370.0	5.4		649,280.0	2.6
		Fecal Coliform	1,210,000.0	0.3		992,230.0	0.3		1,436,310.0	0.2
		Sediment	440.0	0.0		440.0	0.1		440.0	0.0
Urban Diffuse Sources										
Residential	17896	Total Nitrogen	71,580.0	0.9	.643	46,030.0	0.9	1.371	98,140.0	0.9
	17896	Total Phosphorus	5,730.0	0.5	.643	3,680.0	0.5	1.371	7,860.0	0.5
	17896	Biochemical Oxygen Demand	434,870.0	2.4	.643	279,620.0	2.3	1.317	596,210.0	2.4
	17896	Fecal Coliform	2,863,360.0	0.6	.643	1,841,140.5	0.6	1.371	3,925,666.6	0.6
	17896	Sediment	4,875.0	0.4	.643	3,135.0	0.4	1.371	6,685.0	0.4
Commercial	2750	Total Nitrogen	24,750.0	0.3	.643	15,910.0	0.3	1.371	33,930.0	0.3
	2750	Total Phosphorus	2,060.0	0.2	.643	1,320.0	0.2	1.371	2,820.0	0.2
	2750	Biochemical Oxygen Demand	268,400.0	1.5	.643	172,580.0	1.4	1.371	367,980.0	1.5
	2750	Fecal Coliform	907,500.0	0.2	.643	583,522.5	0.2	1.371	1,244,182.5	0.2
	2750	Sediment	1,025.0	0.1	.643	660.0	0.1	1.371	1,405.0	0.1
Industrial	1241	Total Nitrogen	10,420.0	0.1	.643	6,700.0	0.1	1.371	14,290.0	0.1
	1241	Total Phosphorus	870.0	0.1	.643	560.0	0.1	1.371	1,190.0	0.1
	1241	Biochemical Oxygen Demand	45,790.0	0.2	.643	29,440.0	0.2	1.371	62,780.0	0.3
	1241	Fecal Coliform	769,420.0	0.2	.643	494,737.1	0.2	1.371	1,054,874.8	0.2
	1241	Sediment	605.0	0.0	.643	390.0	0.0	1.371	830.0	0.0
Extractive	1595	Total Nitrogen	95,700.0	1.2	.643	61,540.0	1.2	1.371	131,200.0	1.2
	1595	Total Phosphorus	71,780.0	6.5	.643	46,150.0	6.1	1.371	98,410.0	6.8
	1595	Biochemical Oxygen Demand	191,400.0	1.0	.643	123,070.0	1.0	1.371	262,410.0	1.1
	1595	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1595	Sediment	119,625.0	8.8	.643	76,920.0	8.7	1.371	164,005.0	8.8
Transportation	1261	Total Nitrogen	27,630.0	0.4	.643	17,770.0	0.3	1.371	37,880.0	0.4
	1261	Total Phosphorus	1,980.0	0.2	.643	1,270.0	0.2	1.371	2,710.0	0.2
	1261	Biochemical Oxygen Demand	177,170.0	1.0	.643	113,920.0	0.9	1.371	242,900.0	1.0
	1261	Fecal Coliform	734,320.0	0.2	.643	472,167.8	0.2	1.371	1,006,752.7	0.2
	1261	Sediment	23,610.0	1.7	.643	15,180.0	1.7	1.371	32,370.0	1.7
Recreation	4232	Total Nitrogen	13,230.0	0.2	.643	8,510.0	0.2	1.371	18,140.0	0.2
	4232	Total Phosphorus	490.0	0.0	.643	320.0	0.0	1.371	670.0	0.0
	4232	Biochemical Oxygen Demand	5,500.0	0.0	.643	3,540.0	0.0	1.371	7,540.0	0.0
	4232	Fecal Coliform	92,412.0	0.0	.643	59,420.9	0.0	1.371	126,696.9	0.0
	4232	Sediment	890.0	0.1	.643	570.0	0.1	1.371	1,220.0	0.1
Construction	5606	Total Nitrogen	336,360.0	4.3	.643	216,280.0	4.2	1.371	461,150.0	4.3
	5606	Total Phosphorus	252,270.0	23.0	.643	162,210.0	21.4	1.371	345,860.0	23.8
	5606	Biochemical Oxygen Demand	672,720.0	3.7	.643	432,560.0	3.6	1.371	922,300.0	3.7
	5606	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	5606	Sediment	420,450.0	30.8	.643	270,350.0	30.8	1.371	576,435.0	30.8
Septic Systems	50942	Total Nitrogen	71,320.0	0.9	.643	45,860.0	0.9	1.371	97,780.0	0.9
	50942	Total Phosphorus	16,810.0	1.5	.643	10,810.0	1.4	1.371	23,050.0	1.6
	50942	Biochemical Oxygen Demand	1,039,220.0	5.7	.643	668,220.0	5.5	1.371	1,424,770.0	5.7
	50942	Fecal Coliform	12,735,500.0	2.8	.643	8,188,926.5	2.8	1.371	17,460,370.5	2.8
	50942	Sediment	180.0	0.0	.643	115.0	0.0	1.371	245.0	0.0

Table 382 (continued)

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	650,990.0	8.3		418,600.0	8.1		892,510.0	8.4
		Total Phosphorus	351,990.0	32.1		226,320.0	29.9		482,570.0	33.3
		Biochemical Oxygen Demand	2,835,070.0	15.4		1,822,950.0	15.1		3,886,890.0	15.6
		Fecal Coliform	18,102,512.0	4.0		11,639,915.3	4.0		24,818,544.0	4.0
		Sediment	571,260.0	41.8		367,320.0	41.8		783,195.0	41.8
Urban Source Totals		Total Nitrogen	966,150.0	12.3		733,620.0	14.2		1,207,820.0	11.3
		Total Phosphorus	497,410.0	45.3		371,690.0	49.1		628,040.0	43.3
		Biochemical Oxygen Demand	3,482,870.0	19.0		2,469,320.0	20.5		4,536,170.0	18.2
		Fecal Coliform	19,312,512.0	4.3		12,632,143.3	4.4		26,254,854.0	4.3
		Sediment	571,700.0	41.8		367,760.0	41.8		783,635.0	41.8
Rural Diffuse Sources										
Livestock Operations	67300	Total Nitrogen	1,911,320.0	24.3	.643	1,228,980.0	23.7	1.371	2,620,420.0	24.5
	67300	Total Phosphorus	444,180.0	40.5	.643	285,610.0	37.7	1.371	608,970.0	42.0
	67300	Biochemical Oxygen Demand	7,483,760.0	40.7	.643	4,812,060.0	40.0	1.371	10,260,240.0	41.1
	67300	Fecal Coliform	430,720,000.0	95.7	.643	276,952,960.0	95.6	1.371	590,517,120.0	95.7
	67300	Sediment	23,555.0	1.7	.643	15,145.0	1.7	1.371	32,295.0	1.7
Cropland, Pasture, and Unused Rural Land	311886	Total Nitrogen	4,776,180.0	60.6	.643	3,071,080.0	59.3	1.371	6,548,140.0	61.3
	311886	Total Phosphorus	143,080.0	13.0	.643	92,000.0	12.1	1.371	196,160.0	13.5
	311886	Biochemical Oxygen Demand	4,905.240.0	26.7	.643	3,154,070.0	26.2	1.371	6,725,080.0	27.0
	311886	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	311886	Sediment	761,860.0	55.7	.643	489,875.0	55.7	1.371	1,044,510.0	55.7
Silvicultural	41366	Total Nitrogen	95,140.0	1.2	.643	61,180.0	1.2	1.371	130,440.0	1.2
	41366	Total Phosphorus	5,790.0	0.5	.643	3,720.0	0.5	1.371	7,940.0	0.5
	41366	Biochemical Oxygen Demand	190,280.0	1.0	.643	122,350.0	1.0	1.371	260,870.0	1.0
	41366	Fecal Coliform	273,015.6	0.1	.643	175,549.0	0.1	1.371	374,304.4	0.1
	41366	Sediment	5,190.0	0.4	.643	3,335.0	0.4	1.371	7,115.0	0.4
Air Pollution to Surface Water	14256	Total Nitrogen	126,880.0	1.6	.643	81,580.0	1.6	1.371	173,950.0	1.6
	14256	Total Phosphorus	7,130.0	0.6	.643	4,580.0	0.6	1.371	9,780.0	0.7
	14256	Biochemical Oxygen Demand	2,309,470.0	12.6	.643	1,484,990.0	12.3	1.371	3,166,280.0	12.7
	14256	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	14256	Sediment	4,740.0	0.3	.643	3,050.0	0.3	1.371	6,500.0	0.3
Rural Diffuse Soruce Totals		Total Nitrogen	6,909,520.0	87.7		4,442,820.0	85.8		9,472,950.0	88.7
		Total Phosphorus	600,180.0	54.7		385,910.0	50.9		822,850.0	56.7
		Biochemical Oxygen Demand	14,888,750.0	81.0		9,573,470.0	79.5		20,412,470.0	81.8
		Fecal Coliform	430,993,015.6	95.7		277,128,509.0	95.6		590,891,424.4	95.7
		Sediment	795,345.0	58.2		511,405.0	58.2		1,090,420.0	58.2
Diffuse Source Totals		Total Nitrogen	7,560,510.0	96.0		4,861,420.0	93.9		10,365,460.0	97.0
		Total Phosphorus	952,170.0	86.8		612,230.0	80.8		1,305,420.0	90.0
		Biochemical Oxygen Demand	17,723,820.0	96.5		11,396,420.0	94.6		24,299,360.0	97.4
		Fecal Coliform	449,095,527.6	99.7		288,768,424.3	99.7		615,709,968.4	99.8
		Sediment	1,366,605.0	100.0		878,725.0	99.9		1,873,615.0	100.0
Total Sources		Total Nitrogen	7,875,670.0	100.0		5,176,440.0	100.0		10,680,770.0	100.0
		Total Phosphorus	1,097,590.0	100.0		757,600.0	100.0		1,450,890.0	100.0
		Biochemical Oxygen Demand	18,371,620.0	100.0		12,042,790.0	100.0		24,948,640.0	100.0
		Fecal Coliform	450,305,527.6	100.0		289,760,654.3	100.0		617,146,278.4	100.0
		Sediment	1,367,045.0	100.0		879,165.0	100.0		1,874,055.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

Figure 81

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE ROCK RIVER WATERSHED

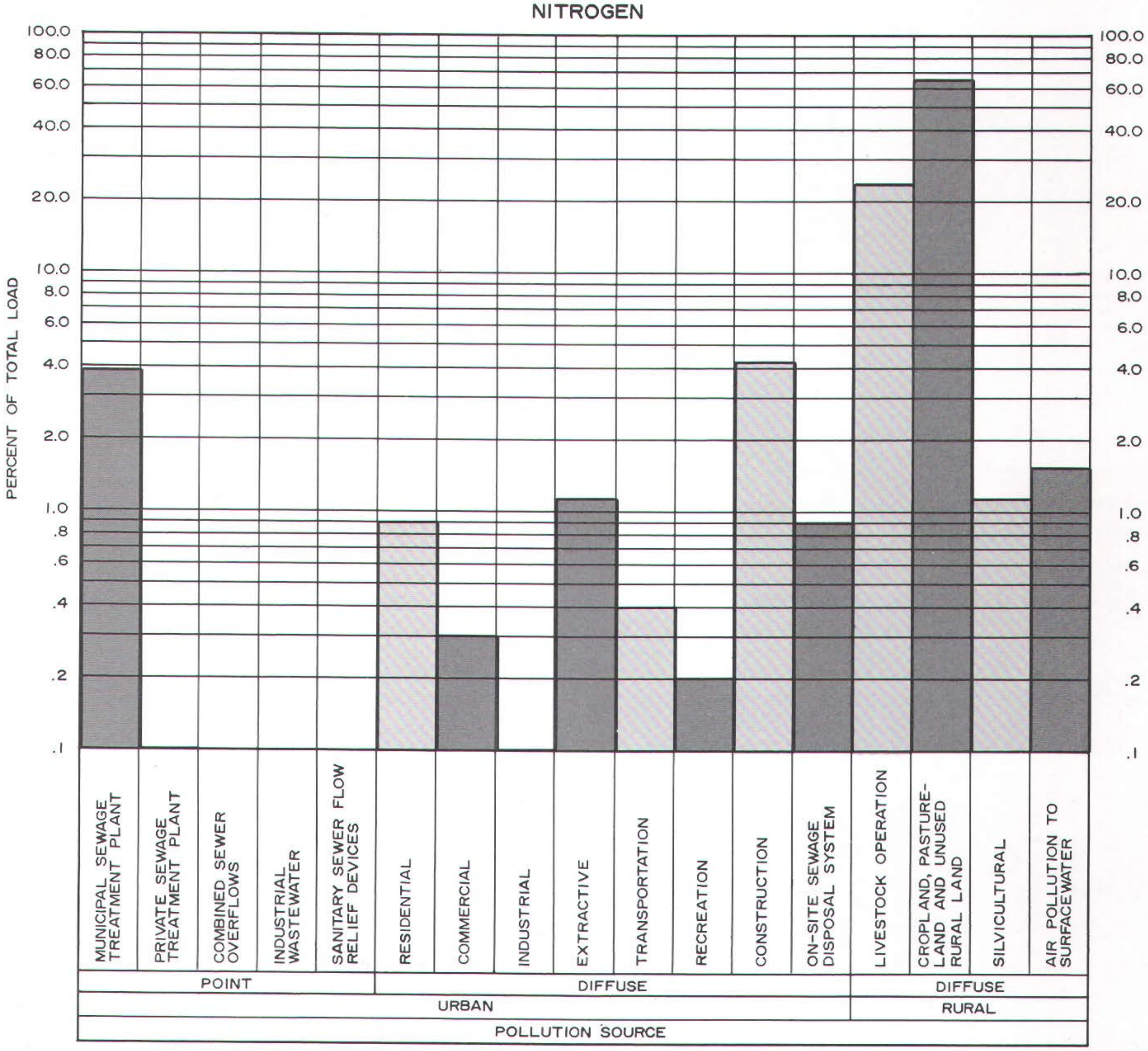


Figure 81 (continued)

PHOSPHOROUS

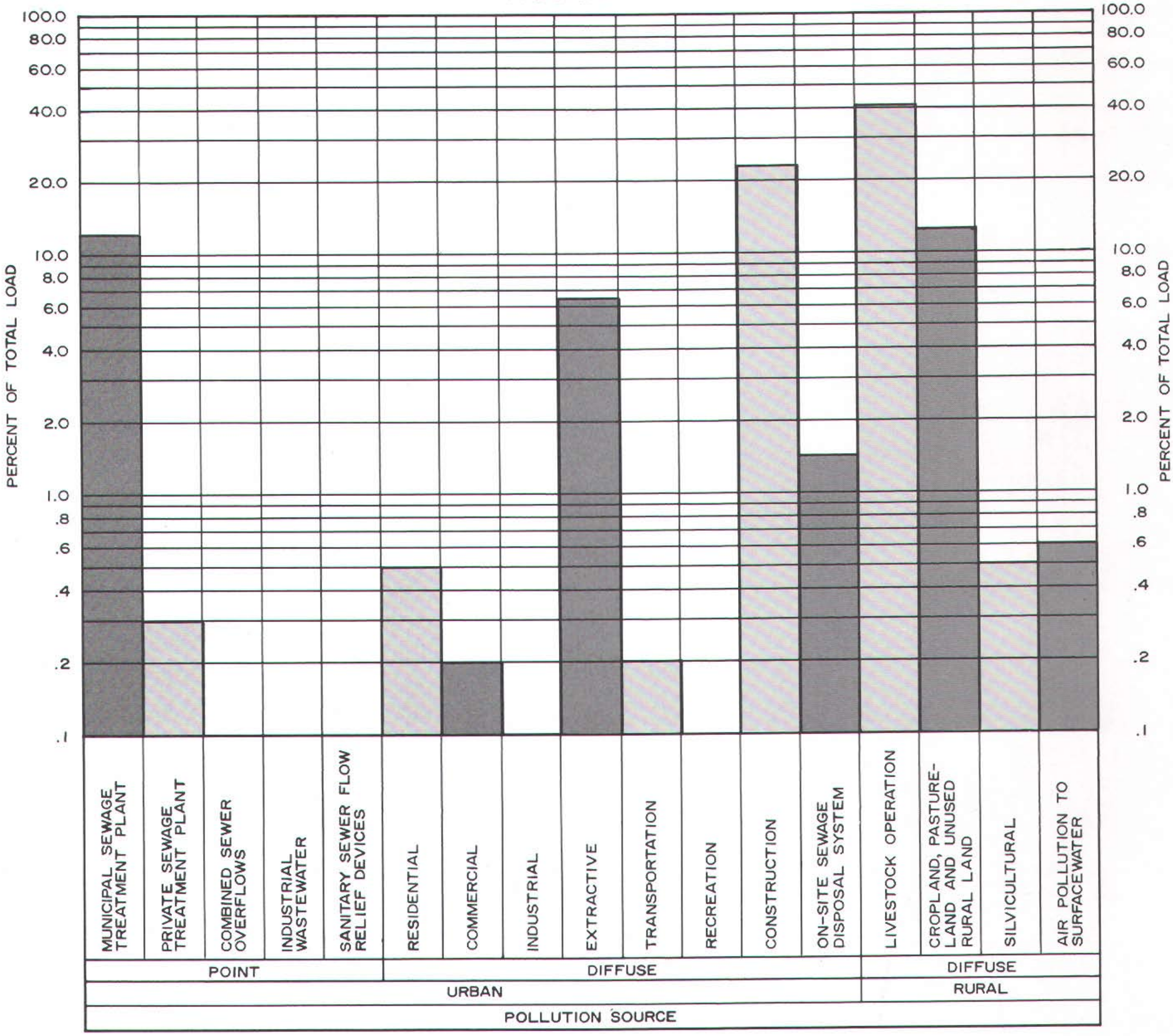


Figure 81 (continued)

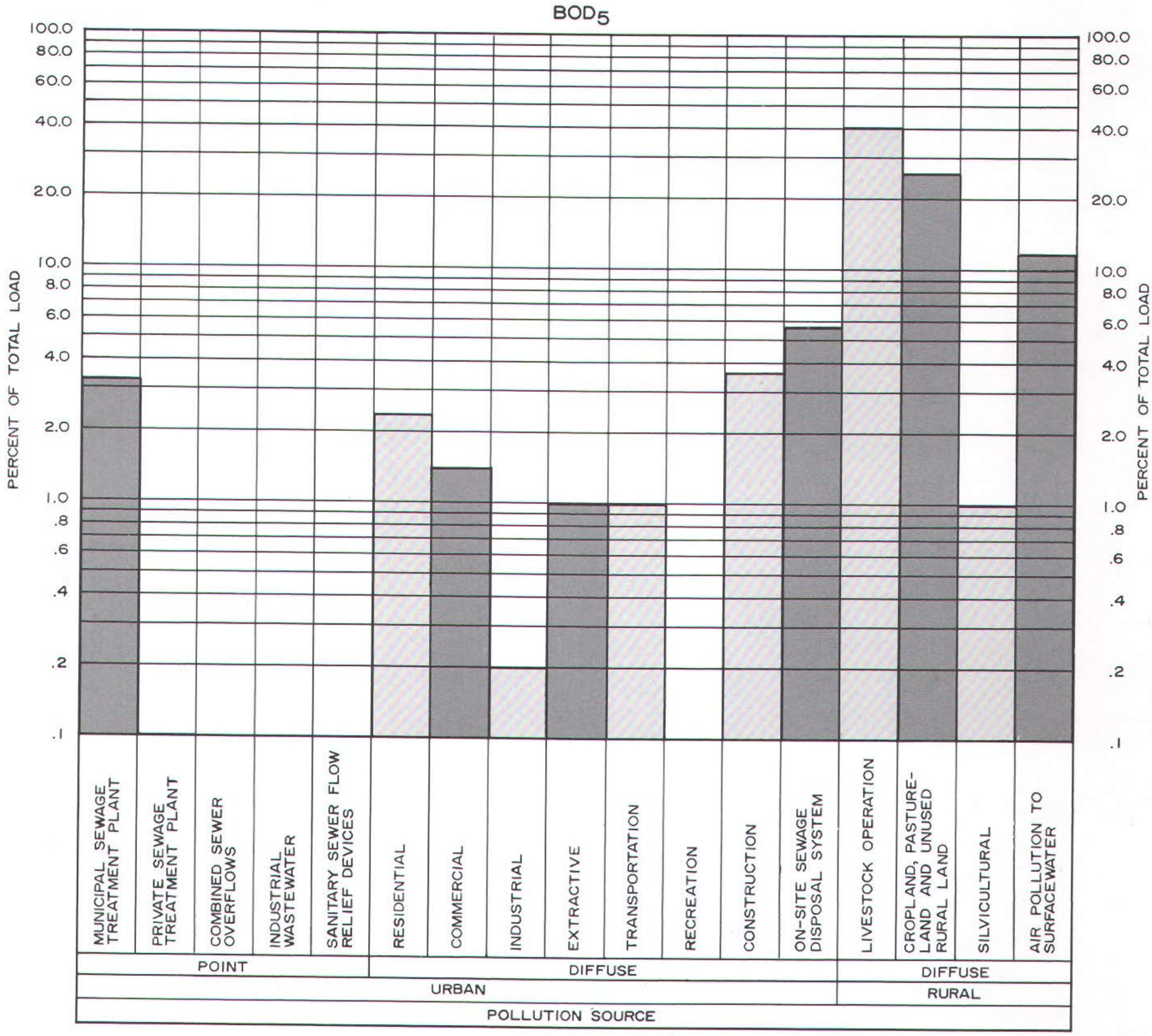


Figure 81 (continued)

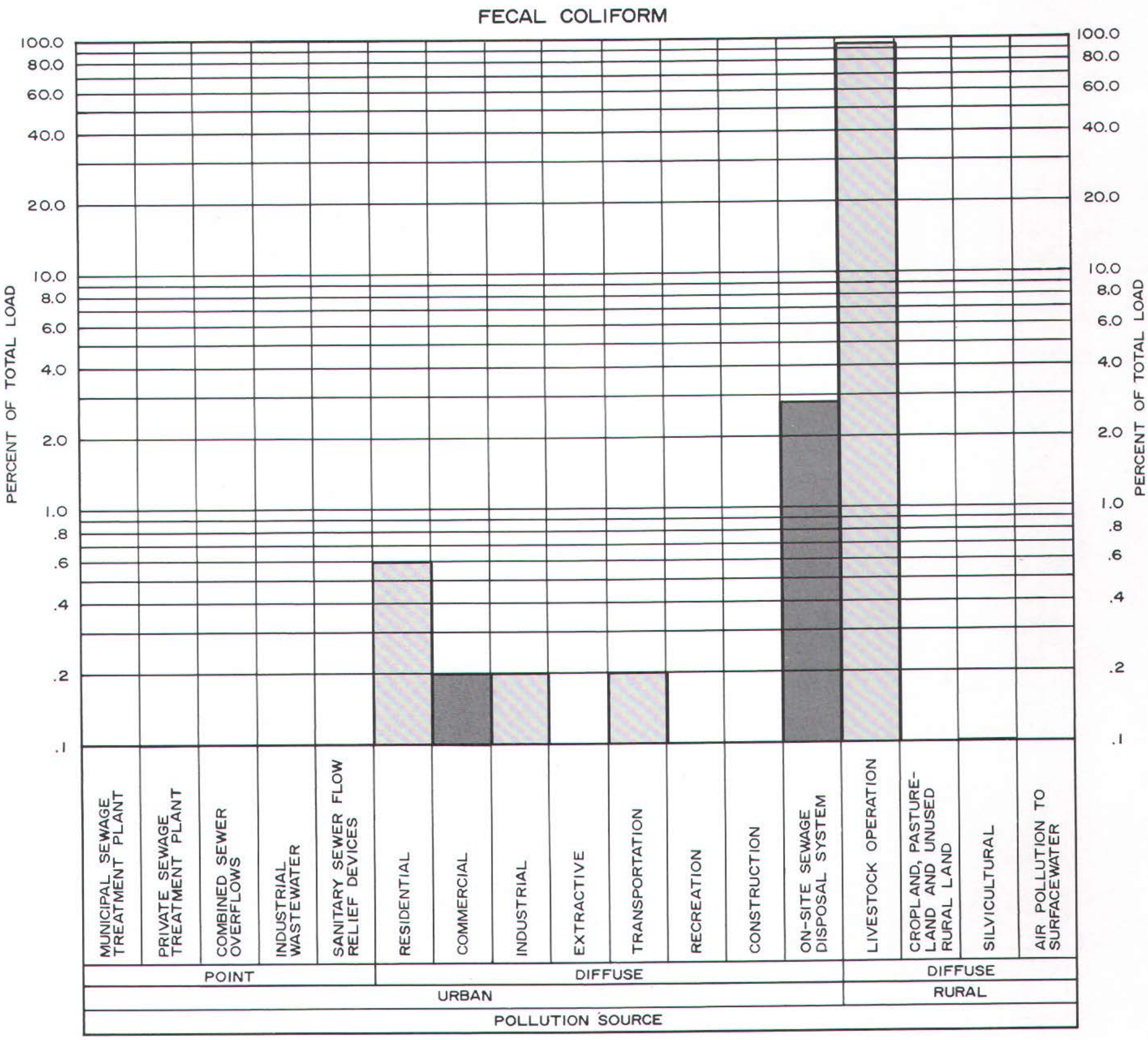
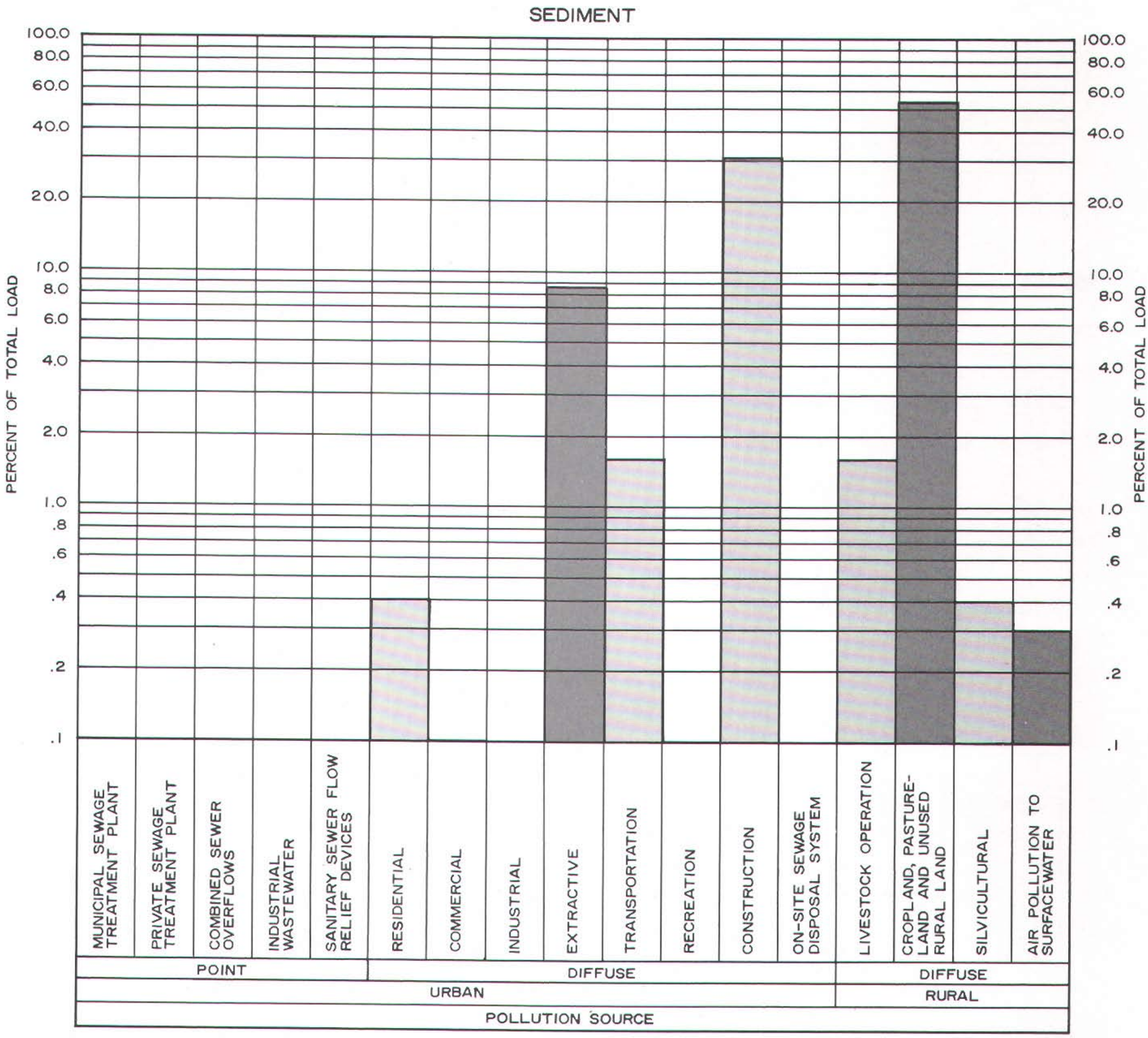


Figure 81 (continued)



Source: SEWRPC.

Figure 82

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE ROOT RIVER WATERSHED

NITROGEN

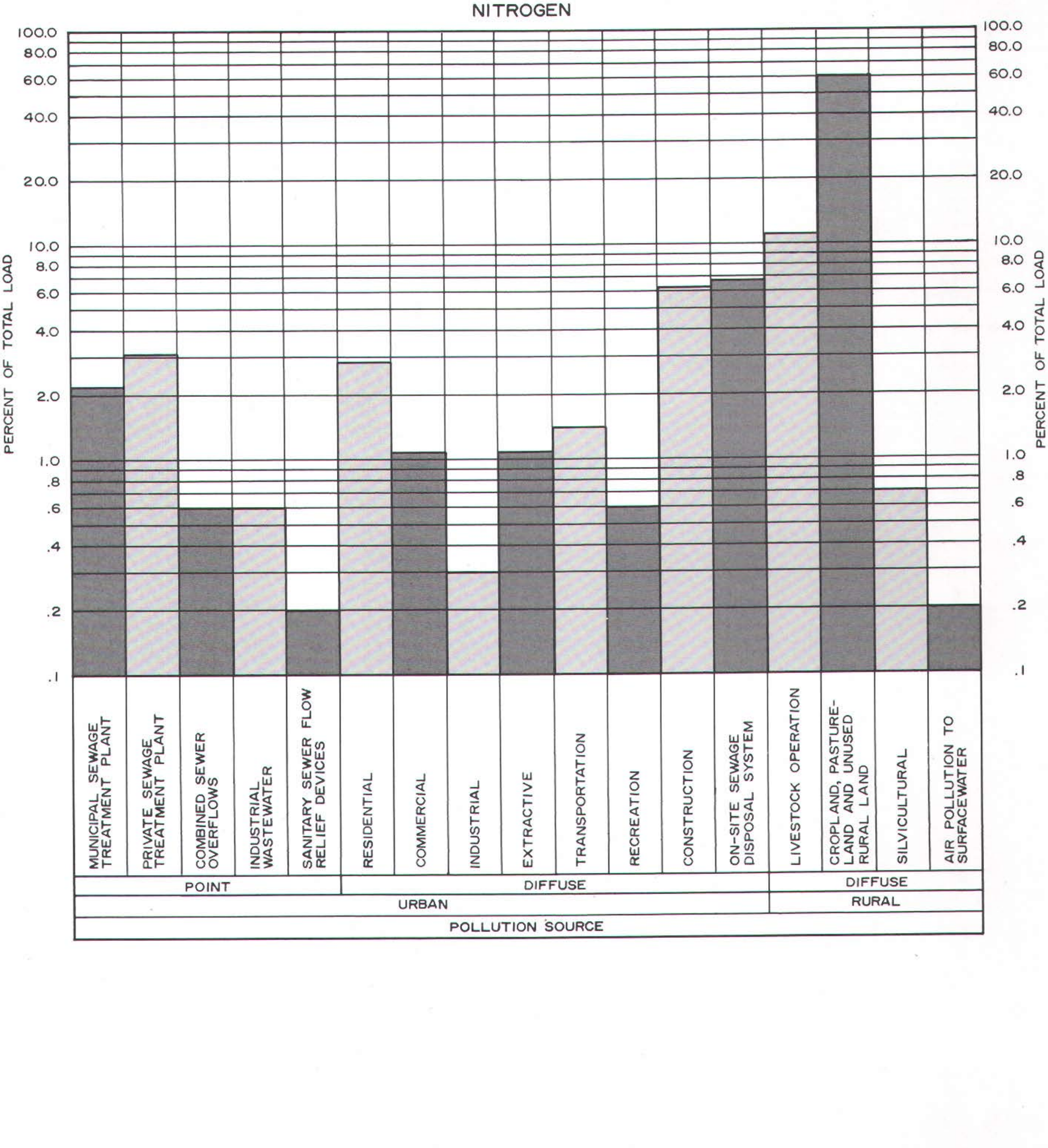


Figure 82 (continued)

PHOSPHOROUS

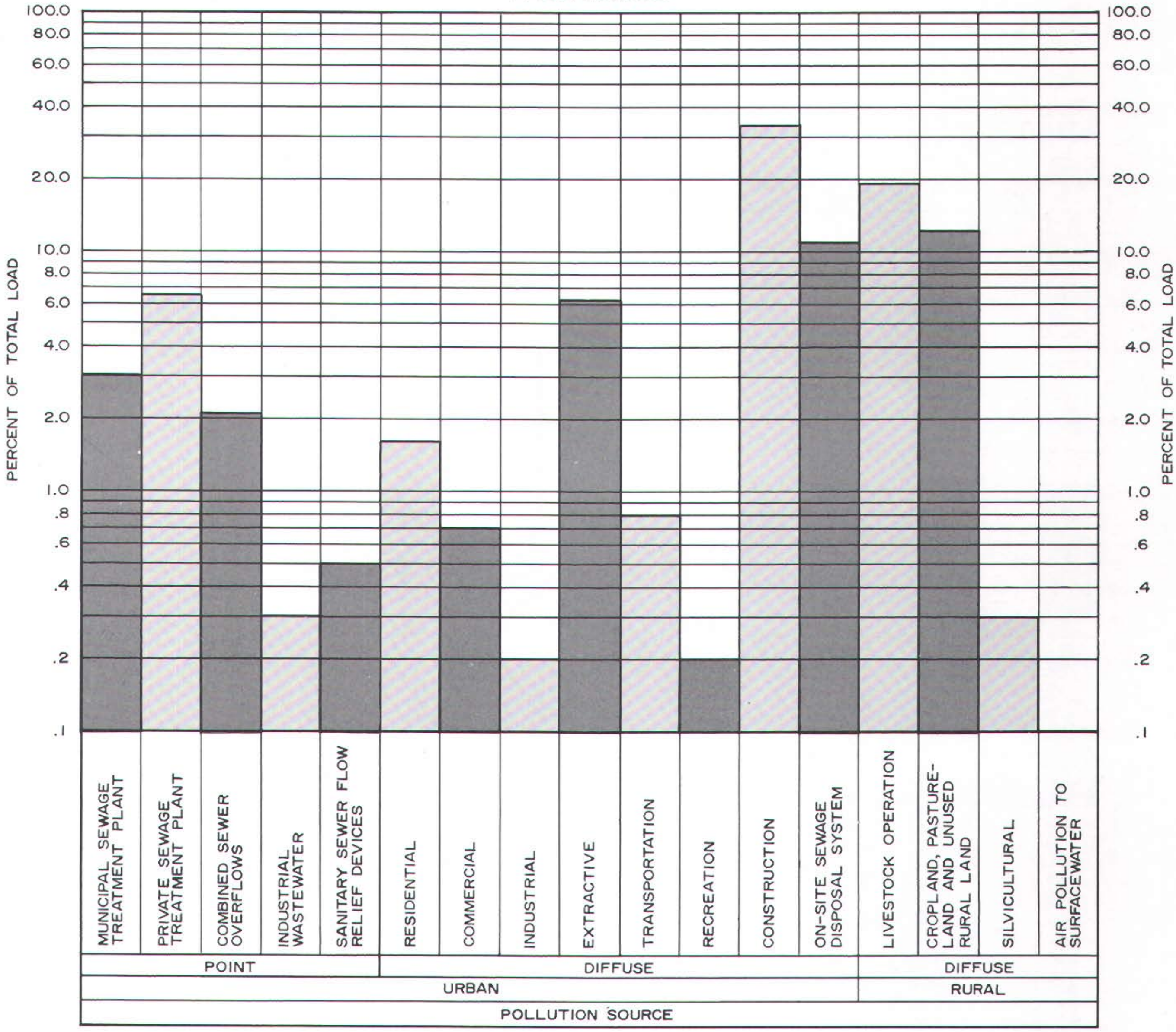
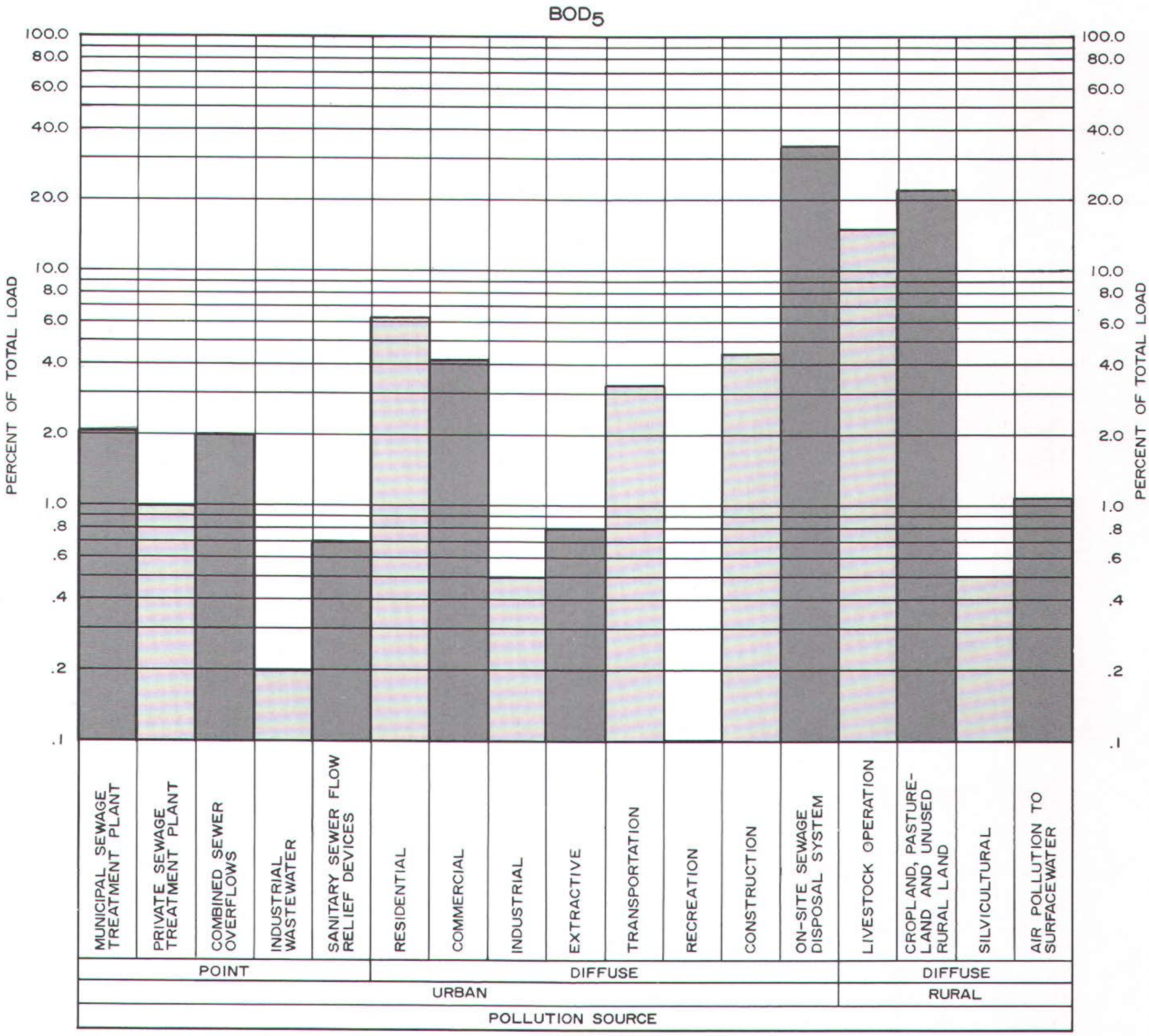
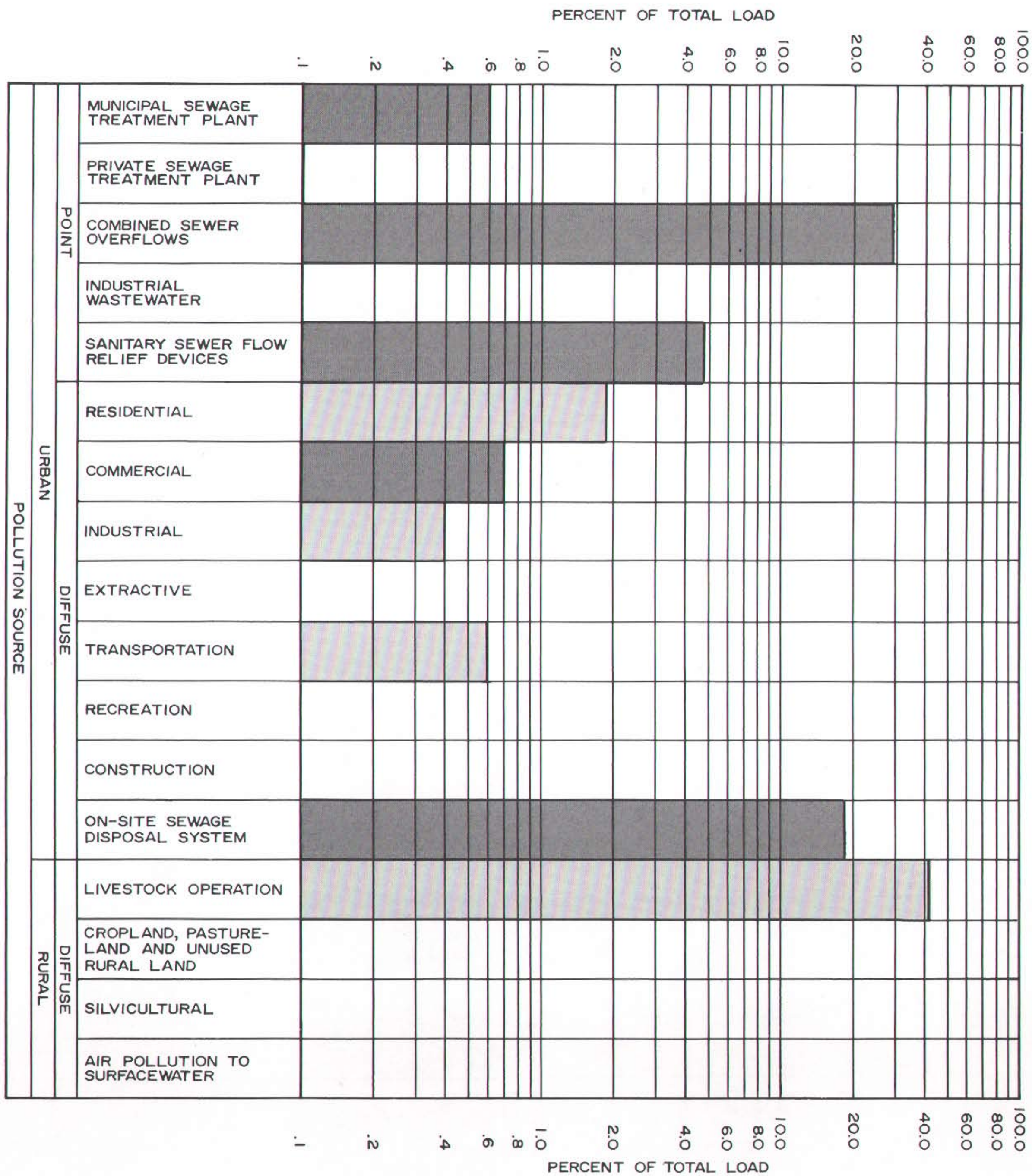


Figure 82 (continued)



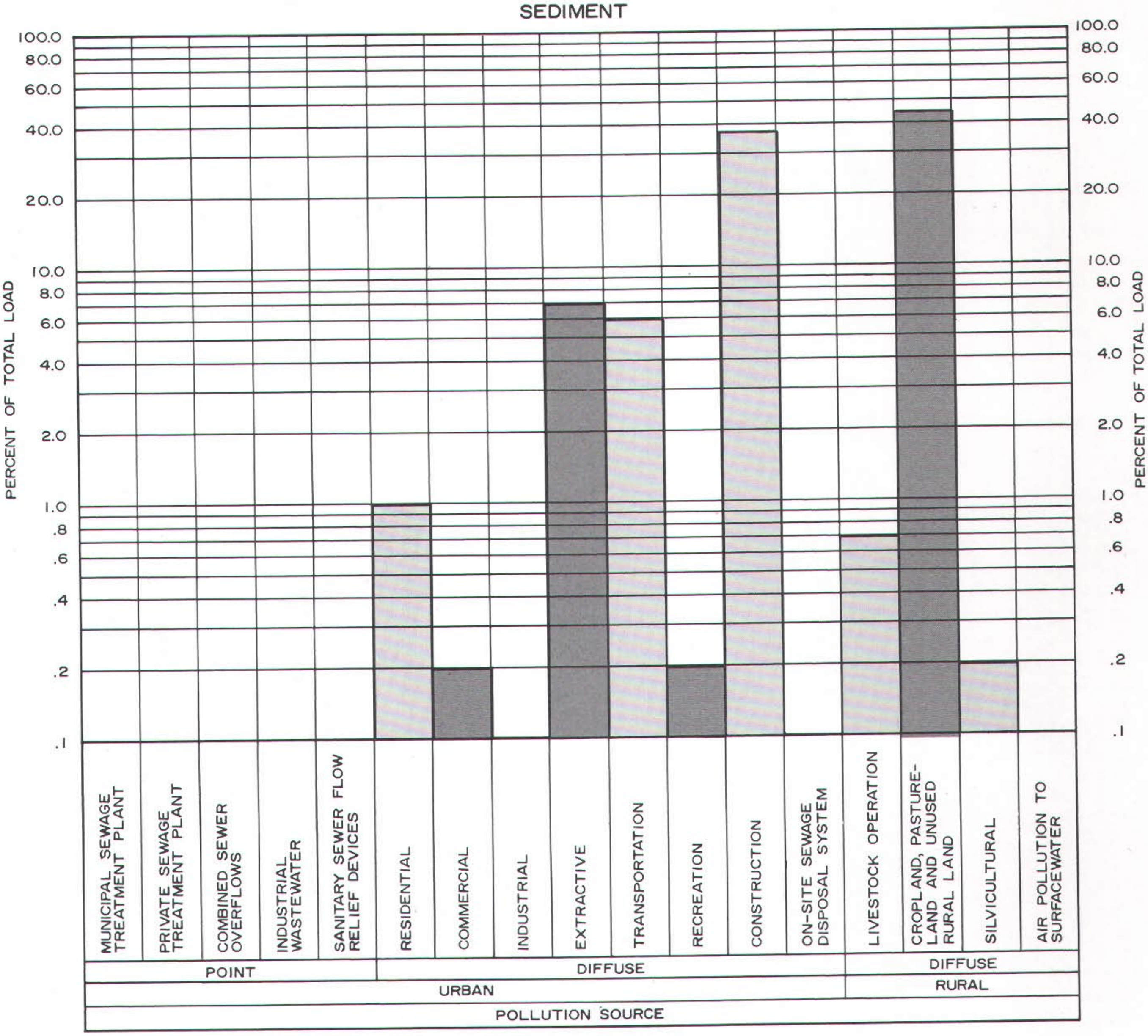


FECAL COLIFORM

Figure 82 (continued)

Figure 82 (continued)

SEDIMENT



Source: SEWRPC.

Table 383

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE ROOT RIVER WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	5	Total Nitrogen	50,870.0	2.2	1.000	50,870.0	3.3	1.000	50,870.0	1.6
	5	Total Phosphorus	9,700.0	3.0	1.000	9,700.0	4.5	1.000	9,700.0	2.3
	5	Biochemical Oxygen Demand	140,000.0	2.1	1.000	140,000.0	3.3	1.000	140,000.0	1.6
	5	Fecal Coliform	850,000.0	0.6	1.000	850,000.0	0.9	1.000	850,000.0	0.4
	5	Sediment	70.0	0.0	1.000	70.0	0.0	1.000	70.0	0.0
Private Sewage Treatment Plants	8	Total Nitrogen	70,790.0	3.1	1.000	70,790.0	4.6	1.000	70,790.0	2.3
	8	Total Phosphorus	20,480.0	6.4	1.000	20,480.0	9.4	1.000	20,480.0	4.8
	8	Biochemical Oxygen Demand	65,520.0	1.0	1.000	65,520.0	1.5	1.000	65,520.0	0.7
	8	Fecal Coliform	170,000.0	0.1	1.000	170,000.0	0.2	1.000	170,000.0	0.1
	8	Sediment	40.0	0.0	1.000	40.0	0.0	1.000	40.0	0.0
Combined Sewer Overflow	8	Total Nitrogen	13,340.0	0.6	.643	8,580.0	0.6	1.371	18,290.0	0.6
	8	Total Phosphorus	6,670.0	2.1	.643	4,290.0	2.0	1.371	9,140.0	2.1
	8	Biochemical Oxygen Demand	133,440.0	2.0	.643	85,800.0	2.0	1.371	182,950.0	2.1
	8	Fecal Coliform	42,000,000.0	29.5	.643	27,006,000.0	29.4	1.371	57,582,000.0	29.5
	8	Sediment	200.0	0.0	.643	130.0	0.0	1.371	275.0	0.0
Industrial Discharges	11	Total Nitrogen	13,560.0	0.6	1.000	13,560.0	0.9	1.000	13,560.0	0.4
	11	Total Phosphorus	1,060.0	0.3	1.000	1,060.0	0.5	1.000	1,060.0	0.2
	11	Biochemical Oxygen Demand	15,670.0	0.2	1.000	15,670.0	0.4	1.000	15,670.0	0.2
	11	Fecal Coliform	33,000.0	0.0	1.000	33,000.0	0.0	1.000	33,000.0	0.0
	11	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Sanitary Sewer Flow Relief Devices . .	53	Total Nitrogen	4,580.0	0.2	.643	2,940.0	0.2	1.371	6,280.0	0.2
	53	Total Phosphorus	1,530.0	0.5	.643	980.0	0.5	1.371	2,100.0	0.5
	53	Biochemical Oxygen Demand	45,790.0	0.7	.643	29,440.0	0.7	1.371	62,780.0	0.7
	53	Fecal Coliform	6,900,000.0	4.8	.643	4,436,700.0	4.8	1.371	9,459,900.0	4.9
	53	Sediment	20.0	0.0	.643	15.0	0.0	1.371	25.0	0.0
Urban Point Source Totals		Total Nitrogen	153,140.0	6.6		146,740.0	9.6		159,790.0	5.1
		Total Phosphorus	39,440.0	12.3		36,510.0	16.8		42,480.0	9.9
		Biochemical Oxygen Demand	400,420.0	6.1		336,430.0	7.9		466,920.0	5.3
		Fecal Coliform	49,953,000.0	35.1		32,495,700.0	35.3		68,094,900.0	34.9
		Sediment	330.0	0.1		255.0	0.1		410.0	0.1
Urban Diffuse Sources										
Residential	16751	Total Nitrogen	67,000.0	2.9	.643	43,080.0	2.8	1.371	91,860.0	2.9
	16751	Total Phosphorus	5,360.0	1.7	.643	3,450.0	1.6	1.371	7,350.0	1.7
	16751	Biochemical Oxygen Demand	407,050.0	6.2	.643	261,730.0	6.1	1.371	558,070.0	6.3
	16751	Fecal Coliform	2,680,160.0	1.9	.643	1,723,342.9	1.9	1.371	3,674,499.4	1.9
	16751	Sediment	4,565.0	1.0	.643	2,935.0	1.0	1.371	6,260.0	1.0
Commercial	2830	Total Nitrogen	25,470.0	1.1	.643	16,380.0	1.1	1.371	34,920.0	1.1
	2830	Total Phosphorus	2,120.0	0.7	.643	1,360.0	0.6	1.371	2,910.0	0.7
	2830	Biochemical Oxygen Demand	276,210.0	4.2	.643	177,600.0	4.2	1.371	378,680.0	4.3
	2830	Fecal Coliform	933,900.0	0.7	.643	600,497.7	0.7	1.371	1,280,376.9	0.7
	2830	Sediment	1,055.0	0.2	.643	680.0	0.2	1.371	1,445.0	0.2
Industrial	851	Total Nitrogen	7,150.0	0.3	.643	4,600.0	0.3	1.371	9,800.0	0.3
	851	Total Phosphorus	600.0	0.2	.643	390.0	0.2	1.371	820.0	0.2
	851	Biochemical Oxygen Demand	31,400.0	0.5	.643	20,190.0	0.5	1.371	43,050.0	0.5
	851	Fecal Coliform	527,620.0	0.4	.643	339,259.7	0.4	1.371	723,367.0	0.4
	851	Sediment	415.0	0.1	.643	265.0	0.1	1.371	570.0	0.1
Extractive	441	Total Nitrogen	26,460.0	1.1	.643	17,010.0	1.1	1.371	36,280.0	1.2
	441	Total Phosphorus	19,850.0	6.2	.643	12,760.0	5.9	1.371	27,210.0	6.4
	441	Biochemical Oxygen Demand	52,920.0	0.8	.643	34,030.0	0.8	1.371	72,550.0	0.8
	441	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	441	Sediment	33,075.0	7.0	.643	21,265.0	7.0	1.371	45,345.0	7.0
Transportation	1547	Total Nitrogen	33,480.0	1.5	.643	21,530.0	1.4	1.371	45,900.0	1.5
	1547	Total Phosphorus	2,470.0	0.8	.643	1,590.0	0.7	1.371	3,390.0	0.8
	1547	Biochemical Oxygen Demand	212,340.0	3.3	.643	136,530.0	3.2	1.371	291,120.0	3.3
	1547	Fecal Coliform	877,650.0	0.6	.643	564,329.0	0.6	1.371	1,203,258.2	0.6
	1547	Sediment	28,260.0	6.0	.643	18,170.0	6.0	1.371	38,745.0	6.0
Recreation	4052	Total Nitrogen	14,410.0	0.6	.643	9,270.0	0.6	1.371	19,760.0	0.6
	4052	Total Phosphorus	580.0	0.2	.643	370.0	0.2	1.371	800.0	0.2
	4052	Biochemical Oxygen Demand	5,270.0	0.1	.643	3,390.0	0.1	1.371	7,230.0	0.1
	4052	Fecal Coliform	58,608.0	0.0	.643	37,684.9	0.0	1.371	80,351.6	0.0
	4052	Sediment	850.0	0.2	.643	545.0	0.2	1.371	1,165.0	0.2
Construction	2419	Total Nitrogen	145,140.0	6.3	.643	93,330.0	6.1	1.371	198,990.0	6.4
	2419	Total Phosphorus	108,860.0	34.0	.643	70,000.0	32.3	1.371	149,250.0	34.9
	2419	Biochemical Oxygen Demand	290,280.0	4.5	.643	186,650.0	4.4	1.371	397,970.0	4.5
	2419	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	2419	Sediment	181,425.0	38.2	.643	116,655.0	38.2	1.371	248,735.0	38.2
Septic Systems	27562	Total Nitrogen	157,100.0	6.8	.643	101,020.0	6.6	1.371	215,380.0	6.9
	27562	Total Phosphorus	36,380.0	11.4	.643	23,390.0	10.8	1.371	49,880.0	11.7
	27562	Biochemical Oxygen Demand	2,249,060.0	34.5	.643	1,446,150.0	33.9	1.371	3,083,460.0	34.8
	27562	Fecal Coliform	27,562,000.0	19.3	.643	17,722,366.0	19.3	1.371	37,787,502.0	19.4
	27562	Sediment	385.0	0.1	.643	250.0	0.1	1.371	530.0	0.1

Table 383 (continued)

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	476,210.0	20.6		306,222.0	20.0		652,890.0	21.0
		Total Phosphorus	176,220.0	55.1		113,310.0	52.2		241,610.0	56.6
		Biochemical Oxygen Demand	3,524,530.0	54.1		2,266,270.0	53.1		4,832,130.0	54.6
		Fecal Coliform	32,639,938.0	22.9		20,987,480.2	22.8		44,749,355.1	23.0
		Sediment	250,030.0	52.7		160,765.0	52.7		342,795.0	52.7
Urban Source Totals		Total Nitrogen	629,350.0	27.3		452,960.0	29.6		812,680.0	26.1
		Total Phosphorus	215,660.0	67.4		149,820.0	69.1		284,090.0	66.5
		Biochemical Oxygen Demand	3,924,950.0	60.2		2,602,700.0	61.0		5,299,050.0	59.9
		Fecal Coliform	82,592,938.0	58.0		53,483,180.2	58.1		112,844,255.1	57.9
		Sediment	250,360.0	52.8		161,020.0	52.8		343,205.0	52.8
Rural Diffuse Sources										
Livestock Operations	9350	Total Nitrogen	265,540.0	11.5	.643	170,740.0	11.1	1.371	364,060.0	11.7
	9350	Total Phosphorus	61,710.0	19.3	.643	39,680.0	18.3	1.371	84,600.0	19.8
	9350	Biochemical Oxygen Demand	1,039,720.0	16.0	.643	668,540.0	15.7	1.371	1,425,460.0	16.1
	9350	Fecal Coliform	59,840,000.0	42.0	.643	38,477,120.0	41.8	1.371	82,040,640.0	42.1
	9350	Sediment	3,275.0	0.7	.643	2,105.0	0.7	1.371	4,490.0	0.7
Cropland, Pasture, and Unused Rural Land	84249	Total Nitrogen	1,393,790.0	60.4	.643	896,210.0	58.5	1.371	1,910,890.0	61.4
	84249	Total Phosphorus	41,550.0	13.0	.643	26,720.0	12.3	1.371	56,970.0	13.3
	84249	Biochemical Oxygen Demand	1,448,050.0	22.2	.643	931,100.0	21.8	1.371	1,985,280.0	22.4
	84249	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	84249	Sediment	219,860.0	46.3	.643	141,370.0	46.3	1.371	301,430.0	46.3
Silvicultural	6607	Total Nitrogen	15,200.0	0.7	.643	9,770.0	0.6	1.371	20,840.0	0.7
	6607	Total Phosphorus	930.0	0.3	.643	600.0	0.3	1.371	1,280.0	0.3
	6607	Biochemical Oxygen Demand	30,390.0	0.5	.643	19,540.0	0.5	1.371	41,660.0	0.5
	6607	Fecal Coliform	43,606.2	0.0	.643	28,038.8	0.0	1.371	59,784.1	0.0
	6607	Sediment	830.0	0.2	.643	535.0	0.2	1.371	1,140.0	0.2
Air Pollution to Surface Water	447	Total Nitrogen	3,980.0	0.2	.643	2,560.0	0.2	1.371	5,460.0	0.2
	447	Total Phosphorus	220.0	0.1	.643	140.0	0.1	1.371	300.0	0.1
	447	Biochemical Oxygen Demand	72,410.0	1.1	.643	46,560.0	1.1	1.371	99,270.0	1.1
	447	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	447	Sediment	150.0	0.0	.643	95.0	0.0	1.371	205.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	1,678,510.0	72.7		1,079,280.0	70.4		2,301,250.0	73.9
		Total Phosphorus	104,410.0	32.6		67,140.0	30.9		143,150.0	33.5
		Biochemical Oxygen Demand	2,590,570.0	39.8		1,665,740.0	39.0		3,551,670.0	40.1
		Fecal Coliform	59,883,606.2	42.0		38,505,158.8	41.9		82,100,424.1	42.1
		Sediment	224,115.0	47.2		144,105.0	47.2		307,265.0	47.2
Diffuse Source Totals		Total Nitrogen	2,154,720.0	93.4		1,385,500.0	90.4		2,954,140.0	94.9
		Total Phosphorus	280,630.0	87.7		180,450.0	83.2		384,760.0	90.1
		Biochemical Oxygen Demand	6,115,100.0	93.9		3,932,010.0	92.1		8,383,800.0	94.7
		Fecal Coliform	92,523,544.2	64.9		59,492,639.0	64.7		126,849,779.2	65.1
		Sediment	474,145.0	99.9		304,870.0	99.9		650,060.0	99.9
Total Sources		Total Nitrogen	2,307,860.0	100.0		1,532,240.0	100.0		3,113,930.0	100.0
		Total Phosphorus	320,070.0	100.0		216,960.0	100.0		427,240.0	100.0
		Biochemical Oxygen Demand	6,515,520.0	100.0		4,268,440.0	100.0		8,850,720.0	100.0
		Fecal Coliform	142,476,544.2	100.0		91,988,339.0	100.0		194,944,679.2	100.0
		Sediment	474,475.0	100.0		305,125.0	100.0		650,470.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

atmospheric loadings to surface waters. Figure 82 presents the relative pollution loadings discussed above within the Root River watershed.

The dry year and wet year analyses, as shown in Table 383, depict the probable range of pollutant loadings as a result of variations in annual precipitation. Since point sources of sediment are relatively insignificant in the Root River watershed, the total load ranges are dependent upon the assumed wet year and dry year factors. For biochemical oxygen demand, nitrogen, phosphorus, and fecal coliform, however, the effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources and municipal and private sewage treatment plant discharges of these pollutants are unaffected. The proportion of fecal coliform contributed by point sources is about 35 percent during a wet year or a dry year because nearly all of the point source fecal coliform are contributed from sewage flow relief devices, which, like diffuse sources, are affected by precipitation variations. Of the total nitrogen load, point sources contribute from 5 percent of the total load during a wet year to 10 percent during a dry year. Biochemical oxygen demand and phosphorus contributions from point sources similarly range from 5 to 7 percent and from 10 to 17 percent of the total loads respectively.

The quantity of pollutants transported in the Root River at Racine were estimated by a transport analysis based on streamflow and pollutant concentration measurements. Streamflow data were available for the Root River at Racine from the U.S. Geological Survey for the years 1963 to 1975 as part of its routine sampling program. Total phosphorus and total nitrogen concentration measurements were available from SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975. Total nitrogen, total phosphorus, and biochemical oxygen demand data were available from the Commission's index site sampling program. Total nitrogen, total phosphorus, biochemical oxygen demand, and suspended solids concentration data were available from the Wisconsin Department of Natural Resources' monthly sampling program. In the Root River, at Racine, it is estimated from these in-stream measurements that about 1,089,000 pounds of nitrogen, 88,000 pounds of phosphorus, 1,892,000 pounds of biochemical oxygen demand, and 76,171,000 pounds of sediment are transported annually. Table 384 presents a comparison of pollutant transport loads, based on streamflow samples, to pollutant channel loads as estimated from regional data and general studies. As noted above, the transport loads, as computed from in-stream measurements, are, as expected, significantly less than the channel loads because of the physical, chemical, and biological processes occurring on the land surface and within the stream itself which serve to effectively remove the pollutants temporarily or permanently.

Table 384

COMPARISON OF ESTIMATED TRANSPORT LOADS TO ESTIMATED POLLUNTANT CHANNEL LOADS IN THE ROOT RIVER

Pollutant	Channel Load	Transport Analysis Load		
	Thousands of Pounds/Year	Thousands of Pounds/Year		
		Annual Load		Variance[a]
Nitrogen	2,308	1,089	±	323
Phosphorus . . .	320	88	±	21
BOD_5	6,516	1,892	±	563
Sediment	948,950	76,171	±	78,870

[a] *Variance significant at a 95% confidence level.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

SAUK CREEK WATERSHED

A summary of the loadings to Sauk Creek is presented in Table 385 and depicted in Figure 83. Urban sources of pollution are estimated to contribute 4 percent of the nitrogen, 7 percent of the phosphorus, 11 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and 13 percent of the sediment which occur as water pollutants to Sauk Creek. Of the urban contribution, the point sources of pollution, which include two flow relief devices and one industrial discharge, contribute 2 percent of the nitrogen, 1 percent of the phosphorus, 1 percent of the biochemical oxygen demand, 7 percent of the fecal coliform, and virtually none of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 98 percent of the nitrogen, 99 percent of the phosphorus and biochemical oxygen demand, 93 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 96 percent of the nitrogen, 93 percent of the phosphorus, 89 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 87 percent of the sediment from sources within the watershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 52 percent of the nitrogen, 89 percent of the phosphorus, 78 percent of the biochemical oxygen demand, 100 percent of

Figure 83

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES
FOR AN AVERAGE YEAR IN THE SAUK CREEK WATERSHED

NITROGEN

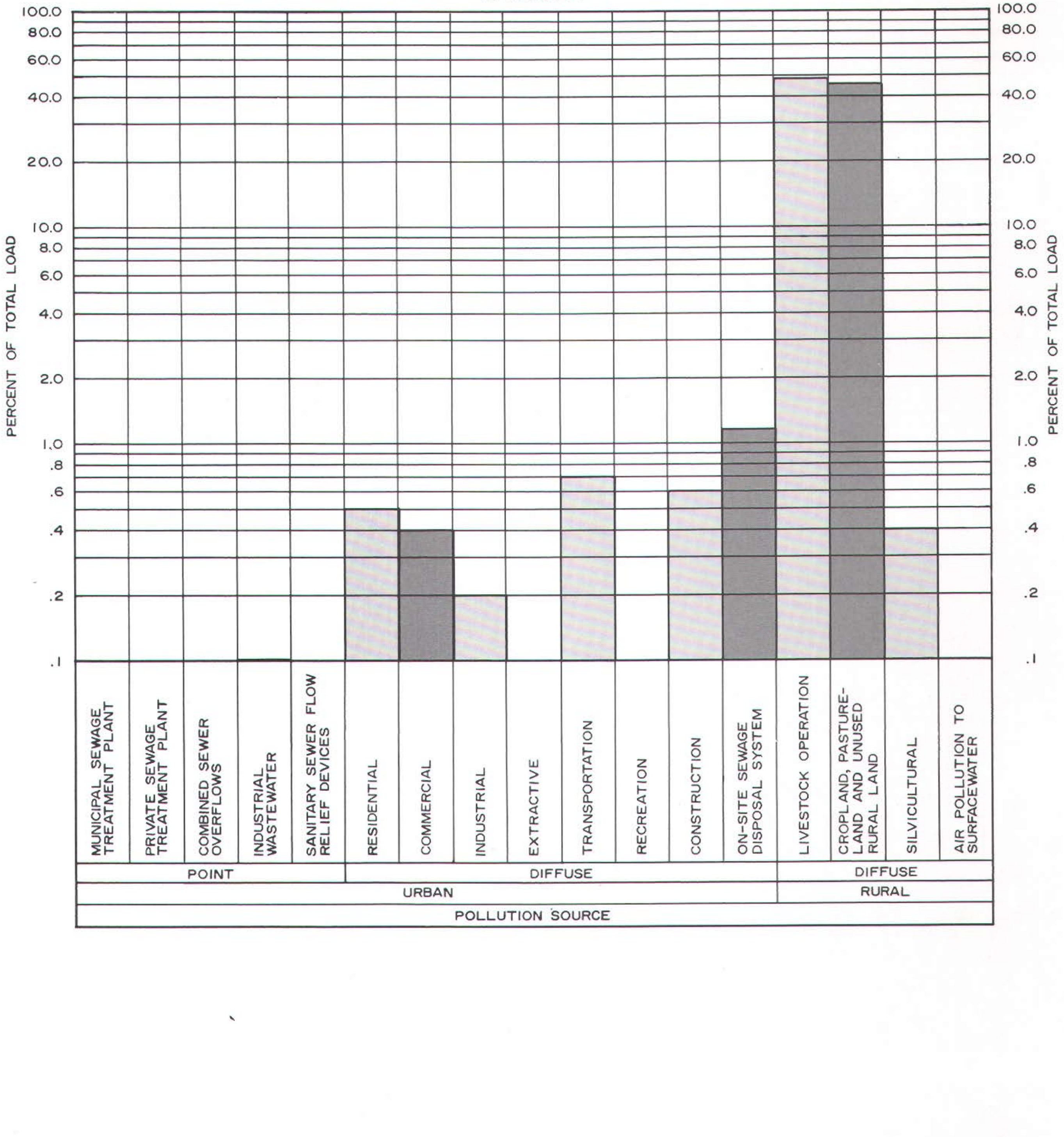


Figure 83 (continued)

PHOSPHOROUS

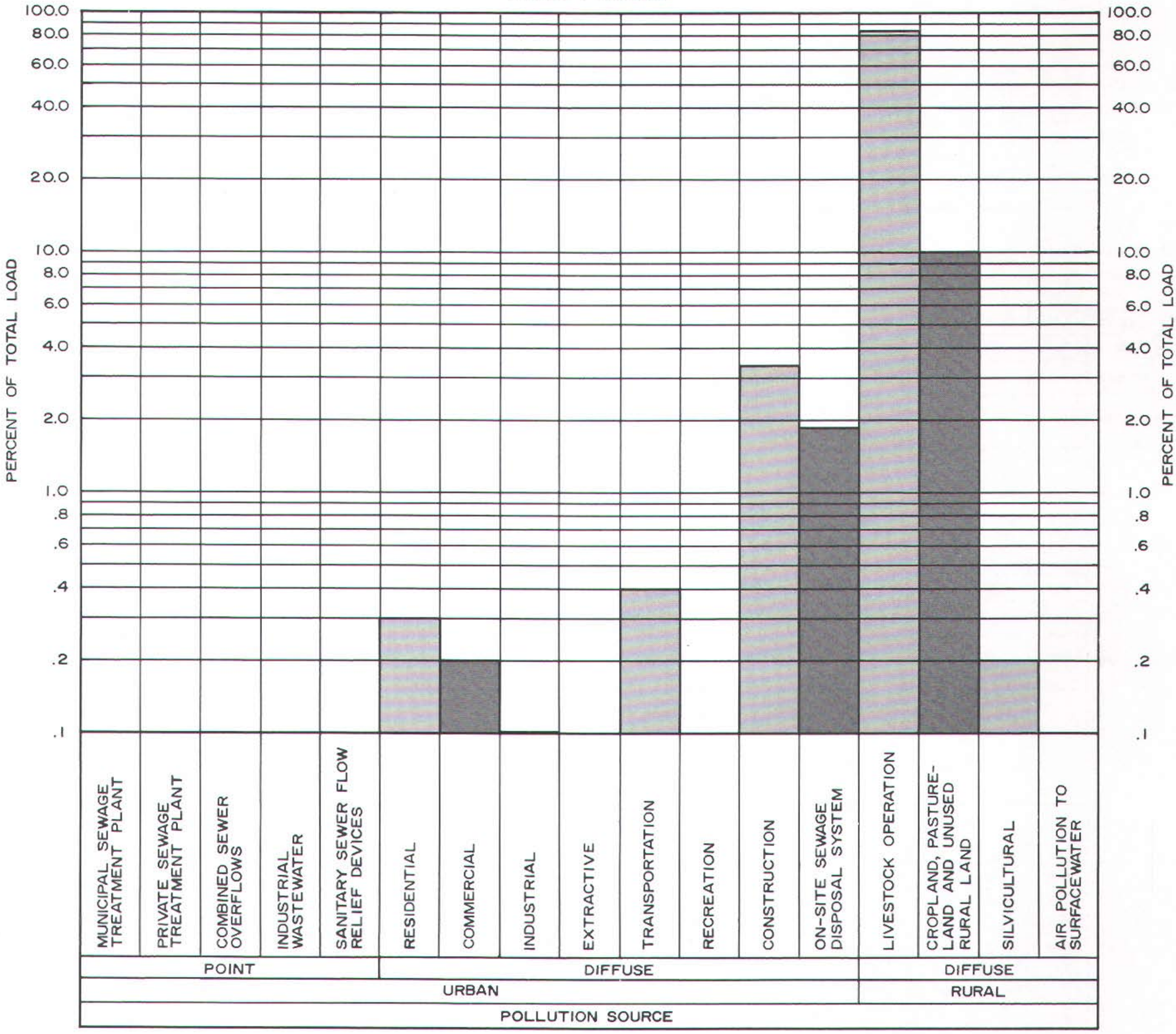


Figure 83 (continued)

BOD5

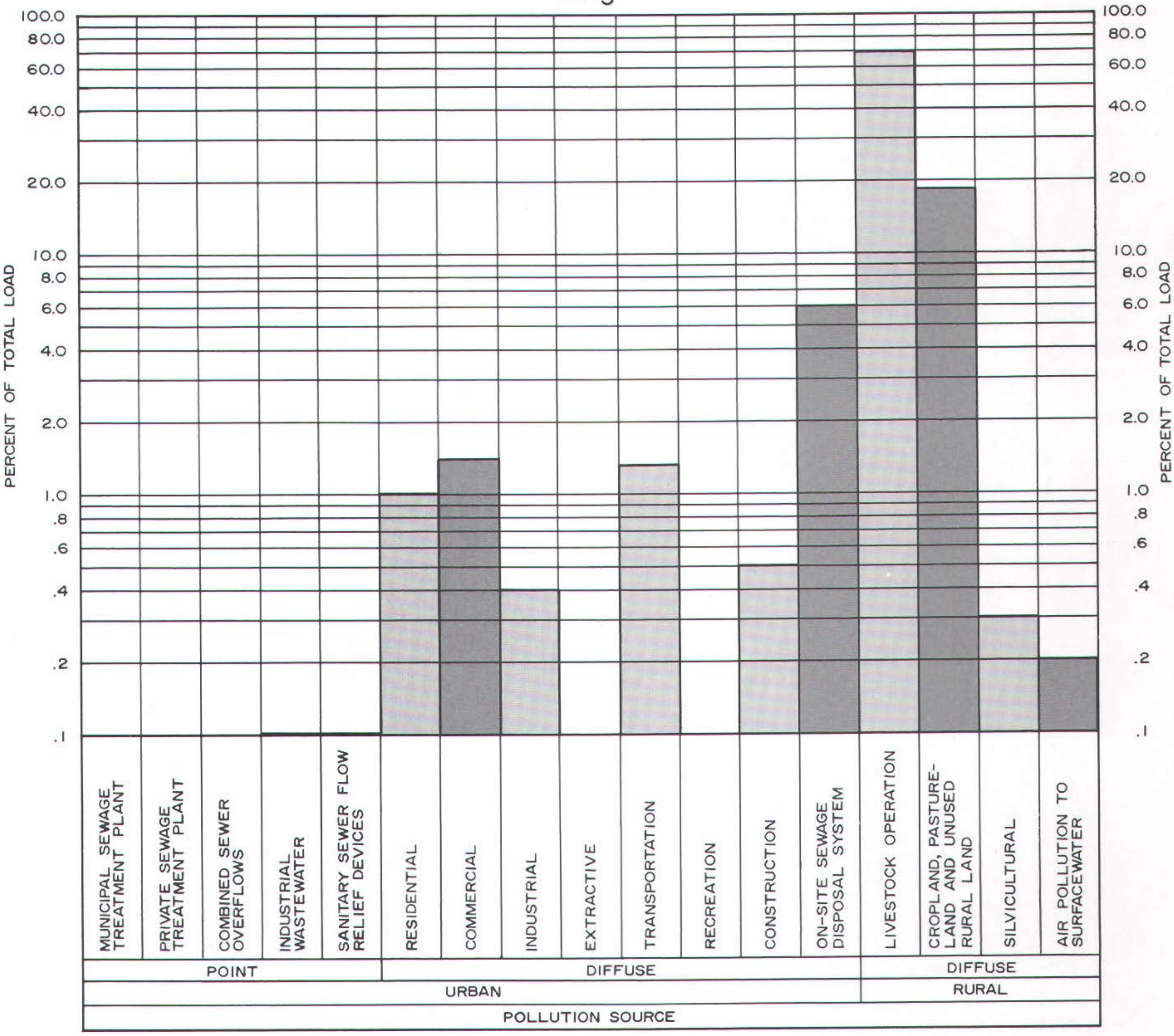


Figure 83 (continued)

FECAL COLIFORM

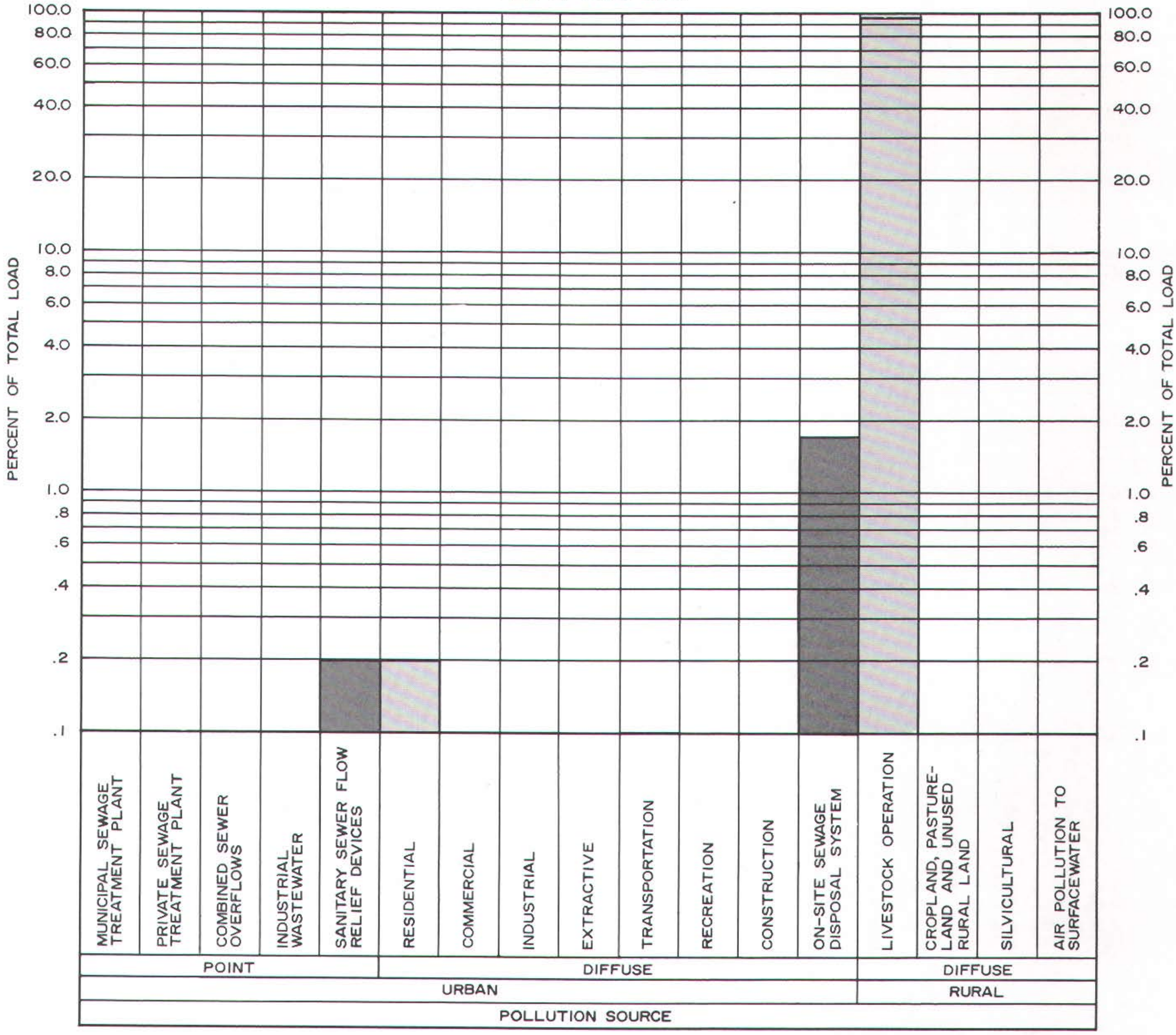
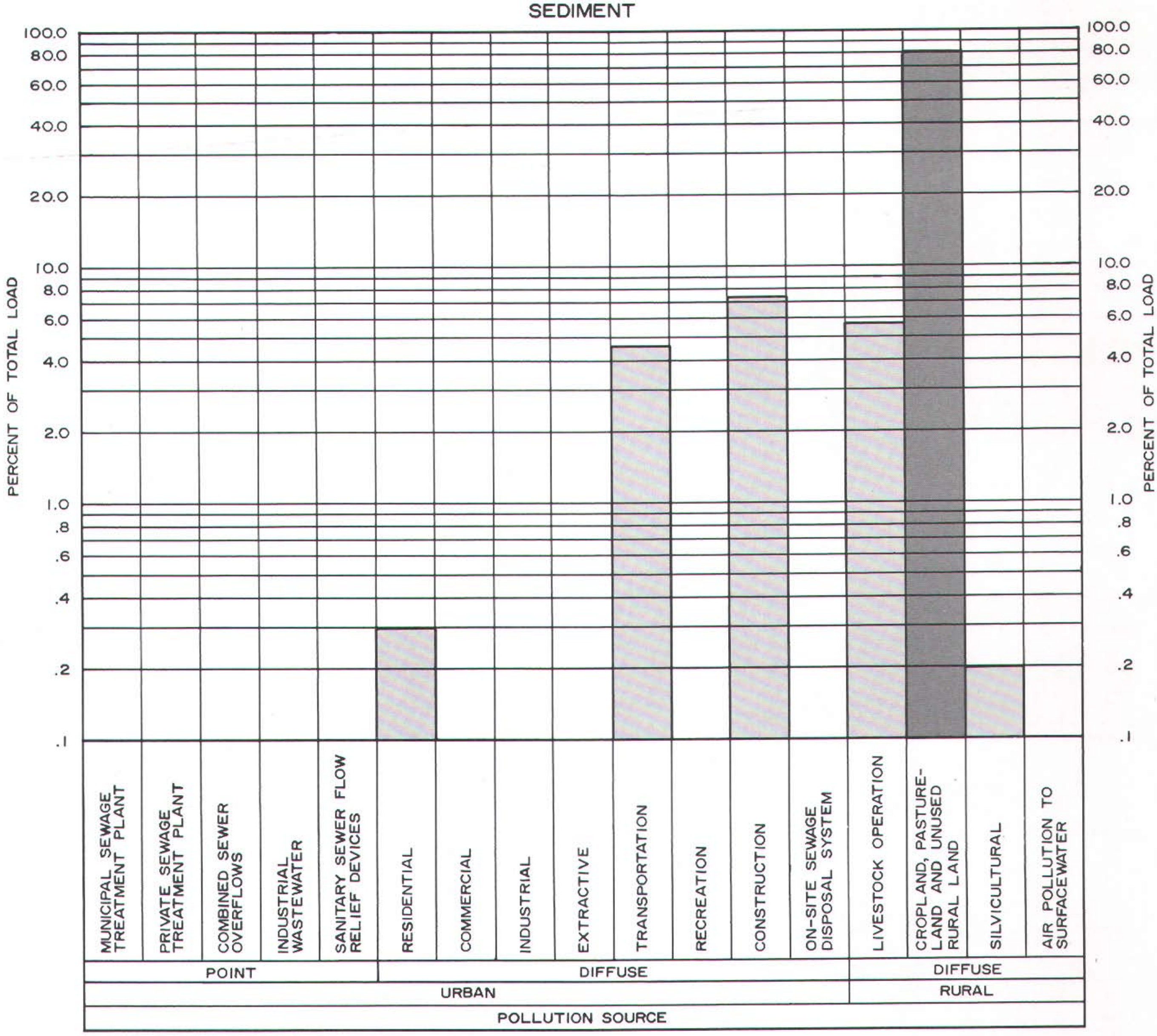


Figure 83 (continued)

SEDIMENT



Source: SEWRPC.

Table 385

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE SAUK CREEK WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Private Sewage Treatment Plants	0	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	0	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	2	Total Nitrogen	290.0	0.1	1.000	290.0	0.1	1.000	290.0	0.0
	2	Total Phosphorus	30.0	0.0	1.000	30.0	0.1	1.000	30.0	0.0
	2	Biochemical Oxygen Demand	1,260.0	0.1	1.000	1,260.0	0.1	1.000	1,260.0	0.1
	2	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	2	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Sanitary Sewer Flow Relief Devices . .	2	Total Nitrogen	80.0	0.0	.643	50.0	0.0	1.371	110.0	0.0
	2	Total Phosphorus	30.0	0.0	.643	20.0	0.0	1.371	40.0	0.0
	2	Biochemical Oxygen Demand	750.0	0.1	.643	480.0	0.1	1.371	1,030.0	0.1
	2	Fecal Coliform	110,000.0	0.2	.643	70,730.0	0.2	1.371	150,810.0	0.2
	2	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	370.0	0.1		340.0	0.1		400.0	0.1
		Total Phosphorus	60.0	0.1		50.0	0.1		70.0	0.1
		Biochemical Oxygen Demand	2,010.0	0.1		1,740.0	0.2		2,290.0	0.1
		Fecal Coliform	110,000.0	0.2		70,730.0	0.2		150,810.0	0.2
		Sediment	0.0	0.0		0.0	0.0		0.0	0.0
Urban Diffuse Sources										
Residential	597	Total Nitrogen	2,390.0	0.5	.643	1,540.0	0.5	1.371	3,280.0	0.5
	597	Total Phosphorus	190.0	0.3	.643	120.0	0.3	1.371	260.0	0.3
	597	Biochemical Oxygen Demand	14,510.0	1.0	.643	9,330.0	1.0	1.371	19,890.0	1.0
	597	Fecal Coliform	95,520.0	0.2	.643	61,419.4	0.2	1.371	130,957.9	0.2
	597	Sediment	165.0	0.3	.643	105.0	0.3	1.371	225.0	0.3
Commercial	218	Total Nitrogen	1,960.0	0.4	.643	1,260.0	0.4	1.371	2,690.0	0.4
	218	Total Phosphorus	160.0	0.2	.643	100.0	0.2	1.371	220.0	0.2
	218	Biochemical Oxygen Demand	21,280.0	1.5	.643	13,680.0	1.5	1.371	29,170.0	1.5
	218	Fecal Coliform	71,940.0	0.1	.643	46,257.4	0.1	1.371	98,629.7	0.1
	218	Sediment	80.0	0.1	.643	50.0	0.1	1.371	110.0	0.1
Industrial	140	Total Nitrogen	1,180.0	0.2	.643	760.0	0.2	1.371	1,620.0	0.2
	140	Total Phosphorus	100.0	0.1	.643	60.0	0.1	1.371	140.0	0.1
	140	Biochemical Oxygen Demand	5,170.0	0.4	.643	3,320.0	0.4	1.371	7,090.0	0.4
	140	Fecal Coliform	86,800.0	0.1	.643	55,812.4	0.1	1.371	119,002.8	0.1
	140	Sediment	70.0	0.1	.643	45.0	0.1	1.371	95.0	0.1
Extractive	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Transportation	175	Total Nitrogen	3,450.0	0.7	.643	2,220.0	0.7	1.371	4,730.0	0.7
	175	Total Phosphorus	320.0	0.4	.643	210.0	0.5	1.371	440.0	0.4
	175	Biochemical Oxygen Demand	19,770.0	1.4	.643	12,710.0	1.4	1.371	27,100.0	1.4
	175	Fecal Coliform	79,060.0	0.1	.643	50,835.6	0.1	1.371	108,391.3	0.1
	175	Sediment	2,605.0	4.7	.643	1,675.0	4.7	1.371	3,570.0	4.7
Recreation	72	Total Nitrogen	170.0	0.0	.643	110.0	0.0	1.371	230.0	0.0
	72	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	72	Biochemical Oxygen Demand	90.0	0.0	.643	60.0	0.0	1.371	120.0	0.0
	72	Fecal Coliform	2,592.0	0.0	.643	1,666.7	0.0	1.371	3,553.6	0.0
	72	Sediment	15.0	0.0	.643	10.0	0.0	1.371	20.0	0.0
Construction	55	Total Nitrogen	3,300.0	0.6	.643	2,120.0	0.6	1.371	4,520.0	0.6
	55	Total Phosphorus	2,480.0	3.4	.643	1,590.0	3.4	1.371	3,400.0	3.4
	55	Biochemical Oxygen Demand	6,600.0	0.5	.643	4,240.0	0.5	1.371	9,050.0	0.5
	55	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	55	Sediment	4,125.0	7.5	.643	2,650.0	7.5	1.371	5,655.0	7.5
Septic Systems	1069	Total Nitrogen	6,090.0	1.2	.643	3,920.0	1.2	1.371	8,350.0	1.2
	1069	Total Phosphorus	1,410.0	1.9	.643	910.0	2.0	1.371	1,930.0	1.9
	1069	Biochemical Oxygen Demand	87,230.0	6.0	.643	56,090.0	6.0	1.371	119,590.0	6.0
	1069	Fecal Coliform	1,069,000.0	1.8	.643	687,367.0	1.8	1.371	1,465,599.0	1.8
	1069	Sediment	15.0	0.0	.643	10.0	0.0	1.371	20.0	0.0

Table 385 (continued)

			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
Source	Extent[a]	Parameter	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	18,540.0	3.6		11,930.0	3.6		25,420.0	3.6
		Total Phosphorus	4,660.0	6.4		2,990.0	6.4		6,390.0	6.4
		Biochemical Oxygen Demand	154,650.0	10.6		99,430.0	10.6		212,010.0	10.6
		Fecal Coliform	1,404,912.0	2.3		903,358.5	2.3		1,926,134.3	2.3
		Sediment	7,075.0	12.9		4,545.0	12.9		9,695.0	12.9
Urban Source Totals		Total Nitrogen	18,910.0	3.6		12,270.0	3.7		25,820.0	3.6
		TotalPhosphorus	4,720.0	6.5		3,040.0	6.5		6,460.0	6.5
		Biochemical Oxygen Demand	156,660.0	10.8		101,170.0	10.8		214,300.0	10.8
		Fecal Coliform	1,514,912.0	2.5		974,088.5	2.5		2,076,944.3	2.5
		Sediment	7,075.0	12.9		4,545.0	12.9		9,695.0	12.9
Rural Diffuse Sources										
Livestock Operations	9120	Total Nitrogen	259,010.0	49.7	.643	166,540.0	49.6	1.371	355,100.0	49.7
	9120	Total Phosphorus	60,190.0	83.2	.643	38,700.0	83.2	1.371	82,520.0	83.2
	9120	Biochemical Oxygen Demand	1,014,140.0	69.8	.643	652,090.0	69.7	1.371	1,390,390.0	69.8
	9120	Fecal Coliform	58,368,000.0	97.5	.643	37,530,624.0	97.5	1.371	80,022,528.0	97.5
	9120	Sediment	3,190.0	5.8	.643	2,050.0	5.8	1.371	4,375.0	5.8
Cropland, Pasture and Unused Rural Land	19287	Total Nitrogen	241,300.0	46.3	.643	155,160.0	46.2	1.371	330,820.0	46.3
	19287	Total Phosphorus	7,260.0	10.0	.643	4,670.0	10.0	1.371	9,950.0	10.0
	19287	Biochemical Oxygen Demand	275,490.0	19.0	.643	177,140.0	18.9	1.371	377,700.0	19.0
	19287	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	19287	Sediment	44,550.0	81.1	.643	28,645.0	81.1	1.371	61,080.0	81.1
Silvicultural	969	Total Nitrogen	2,230.0	0.4	.643	1,430.0	0.4	1.371	3,060.0	0.4
	969	Total Phosphorus	140.0	0.2	.643	90.0	0.2	1.371	190.0	0.2
	969	Biochemical Oxygen Demand	4,460.0	0.3	.643	2,870.0	0.3	1.371	6,110.0	0.3
	969	Fecal Coliform	6,395.4	0.0	.643	4,112.2	0.0	1.371	8,768.1	0.0
	969	Sediment	120.0	0.2	.643	75.0	0.2	1.371	165.0	0.2
Air Pollution to Surface Water	18	Total Nitrogen	160.0	0.0	.643	100.0	0.0	1.371	220.0	0.0
	18	Total Phosphorus	10.0	0.0	.643	10.0	0.0	1.371	10.0	0.0
	18	Biochemical Oxygen Demand	2,920.0	0.2	.643	1,880.0	0.2	1.371	4,000.0	0.2
	18	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	18	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Rural Diffuse Source Totals		Total Nitrogen	502,700.0	96.4		323,230.0	96.3		689,200.0	96.4
		Total Phosphorus	67,600.0	93.5		43,470.0	93.5		92,670.0	93.5
		Biochemical Oxygen Demand	1,297,010.0	89.2		833,980.0	89.2		1,778,200.0	89.2
		Fecal Coliform	58,374,395.4	97.5		37,534,736.2	97.5		80,031,296.1	97.5
		Sediment	47,865.0	87.1		30,775.0	87.1		65,625.0	87.1
Diffuse Source Totals		Total Nitrogen	521,240.0	99.9		335,160.0	99.9		714,620.0	99.9
		Total Phosphorus	72,260.0	99.9		46,460.0	99.9		99,060.0	99.9
		Biochemical Oxygen Demand	1,451,660.0	99.9		933,410.0	99.8		1,990,210.0	99.9
		Fecal Coliform	59,779,307.4	99.8		38,438,094.7	99.8		81,957,430.4	99.8
		Sediment	54,940.0	100.0		35,320.0	100.0		75,320.0	100.0
Total Sources		Total Nitrogen	521,610.0	100.0		335,500.0	100.0		715,020.0	100.0
		Total Phosphorus	72,320.0	100.0		46,510.0	100.0		99,130.0	100.0
		Biochemical Oxygen Demand	1,453,670.0	100.0		935,150.0	100.0		1,992,500.0	100.0
		Fecal Coliform	59,889,307.4	100.0		38,508,824.7	100.0		82,108,240.4	100.0
		Sediment	54,940.0	100.0		35,320.0	100.0		75,320.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

the fecal coliform, and 7 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 48 percent of the nitrogen, 11 percent of the phosphorus, 22 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 93 percent of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 83 presents the relative pollution loadings discussed above within the Sauk Creek watershed.

The dry year and wet year analyses, as shown in Table 385, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since industrial point sources of sediment are relatively insignificant in the Sauk Creek watershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors. For biochemical oxygen demand, nitrogen, and phosphorus, however, the effects of annual precipitation variation on total loads are somewhat buffered because industrial point sources of these pollutants are unaffected. The proportion of total BOD_5 contributed by point sources ranges from 0.1 percent during a wet year to 0.2 percent during a dry year. Of the total fecal coliform load, point sources contribute 0.2 percent during a wet or a dry year and point source nitrogen and phosphorus contributions account for 0.1 percent of the total load during a wet year or a dry year.

Data were not available to enable a transport analysis, based on in-stream pollutant concentrations and flow measurements, to be conducted for Sauk Creek.

SHEBOYGAN RIVER WATERSHED

A summary of the loadings to the Sheboygan River is presented in Table 386, and depicted in Figure 84. Urban sources of pollution are estimated to contribute 5 percent of the nitrogen, 8 percent of the phosphorus, 14 percent of the biochemical oxygen demand, 3 percent of the fecal coliform, and 12 percent of the sediment which occur as water pollutants to the Sheboygan River. Of the urban contribution, point sources of pollution, which include one municipal sewage treatment plant and one industrial discharge, contribute 41 percent of the nitrogen, 18 percent of the phosphorus, 15 percent of the biochemical oxygen demand, virtually none of the fecal coliform, and two-tenths of one percent of the sediment. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 59 percent of the nitrogen, 82 percent of the phosphorus, 85 percent of the biochemical oxygen demand, and nearly all of the fecal coliform and sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 95 percent of the nitrogen, 92 percent of the phosphorus, 86 percent of the biochemical oxygen demand, 97 percent of the fecal coliform, and 88 percent of the sediment from sources within the watershed. There are no rural point sources of pollution, since none of the livestock operations in the watershed is of sufficient size to fall within the definition under EPA guidelines. Other livestock feeding operations—including the disposal of manure on croplands—contribute 30 percent of the nitrogen, 77 percent of the phosphorus, 58 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 3 percent of the sediment attributed to rural sources. The remainder of the estimated rural pollution load, or 70 percent of the nitrogen, 23 percent of the phosphorus, 42 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 97 percent of the sediment, is contributed by other rural diffuse sources, namely storm water runoff from rural land uses and atmospheric loadings to surface waters. Figure 84 presents the relative pollution loadings discussed above within the Sheboygan River watershed.

The dry year and wet year analyses, as shown in Table 386, depict the probable ranges of pollutant loadings as a result of variations in annual precipitation. Since point sources of fecal coliform and sediment are insignificant in the Sheboygan River watershed, the total load ranges are directly dependent upon the assumed wet year and dry year factors. For nitrogen, phosphorus, and biochemical oxygen demand, however, the effects of annual precipitation variation on total loads are somewhat buffered because municipal sewage treatment plant discharges and industrial point sources of these pollutants are unaffected. The proportion of nitrogen and BOD_5 contributed by point sources ranges from 2 percent during a wet year to 3 percent during a dry year. The point source contribution of phosphorus similarly varied from 1 to 2 percent of the total load.

Data were not available to prepare a transport analysis of in-stream pollutant concentrations and flow measurements for the Sheboygan River.

COMPARISON OF WATERSHEDS

Efficiency of Pollutant Delivery

The comparison of pollutant transport loads and pollutant channel loads presented for the seven watersheds for which transport analyses were conducted suggests a theoretical "efficiency" concept. Computations of the percent of pollutant channel loads which were transported downstream were only conducted for those watersheds with adequate data availability. For pollutants other than sediment, factors which affect delivery efficiencies such as biological assimilation and bacterial die-off, would

Figure 84

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN THE SHEBOYGAN RIVER WATERSHED

NITROGEN

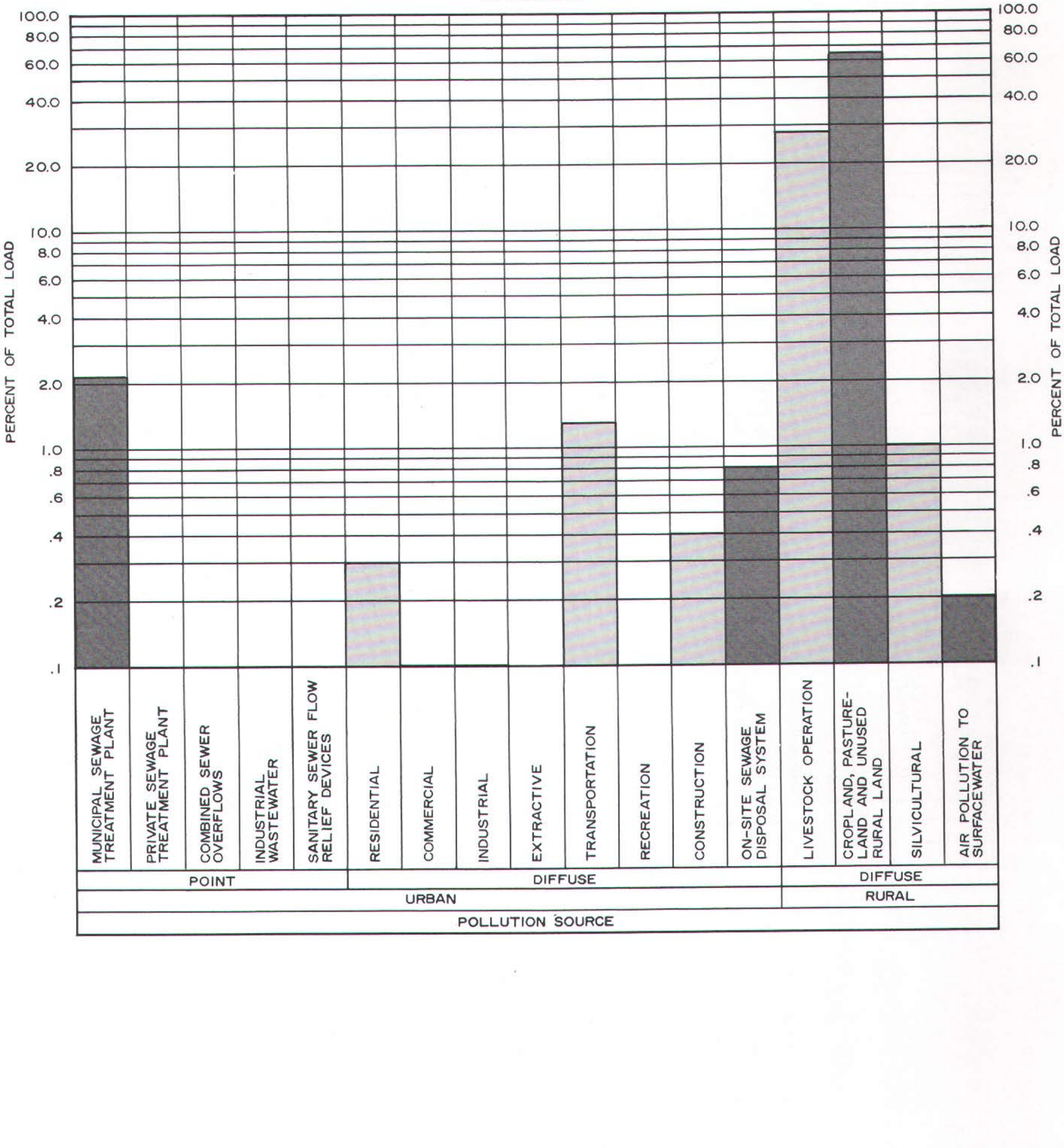


Figure 84 (continued)

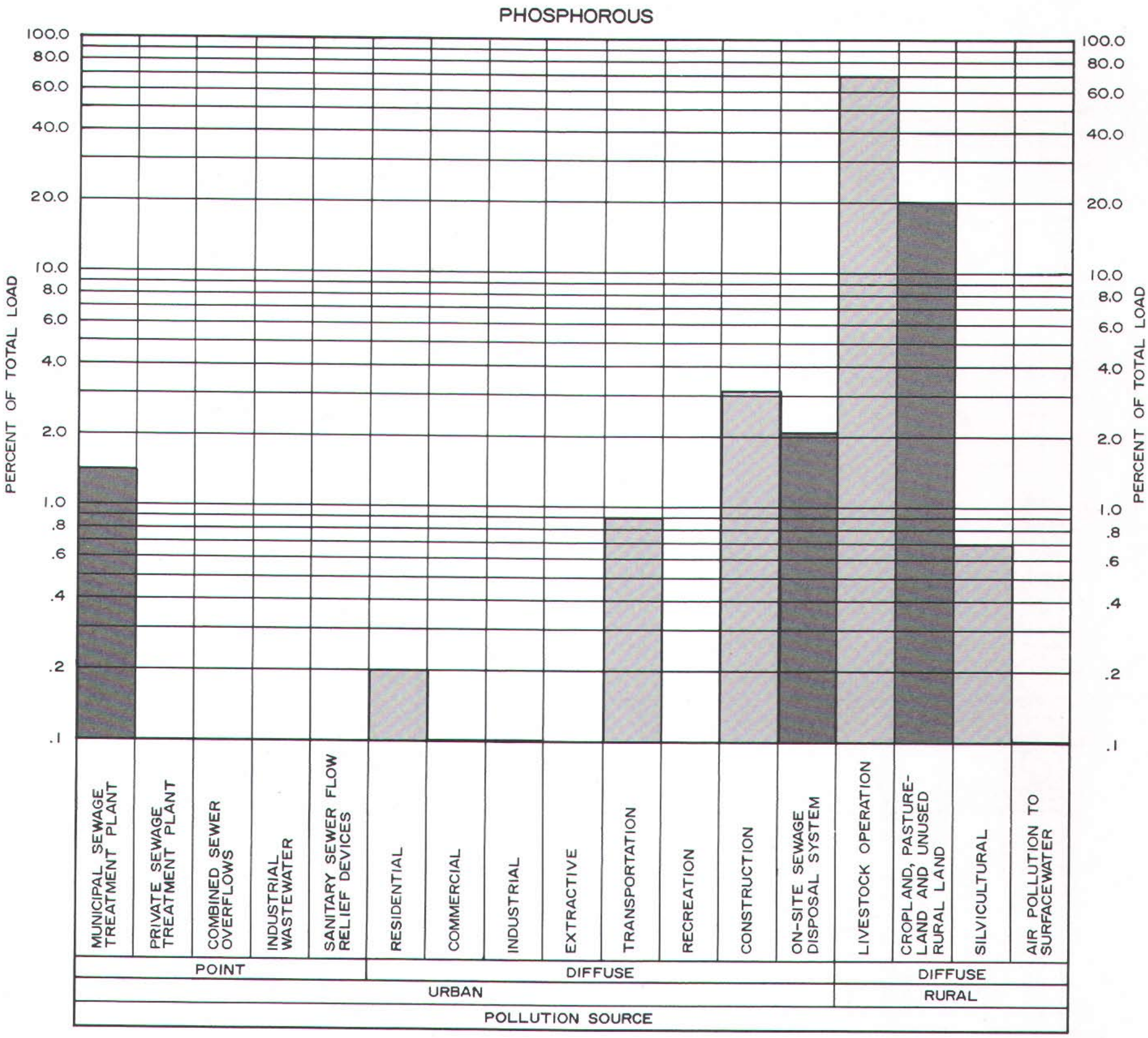


Figure 84 (continued)

BOD5

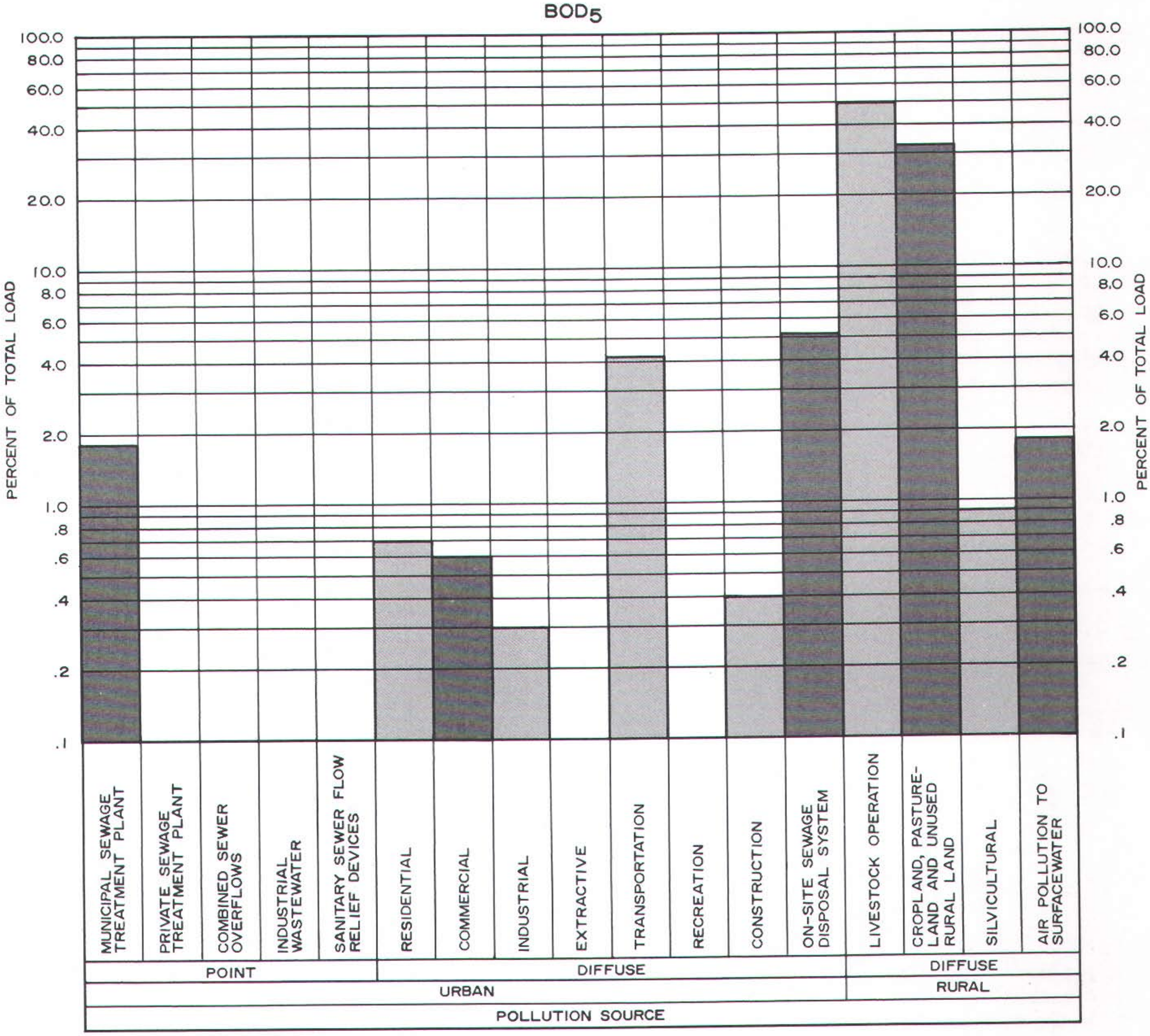


Figure 84 (continued)

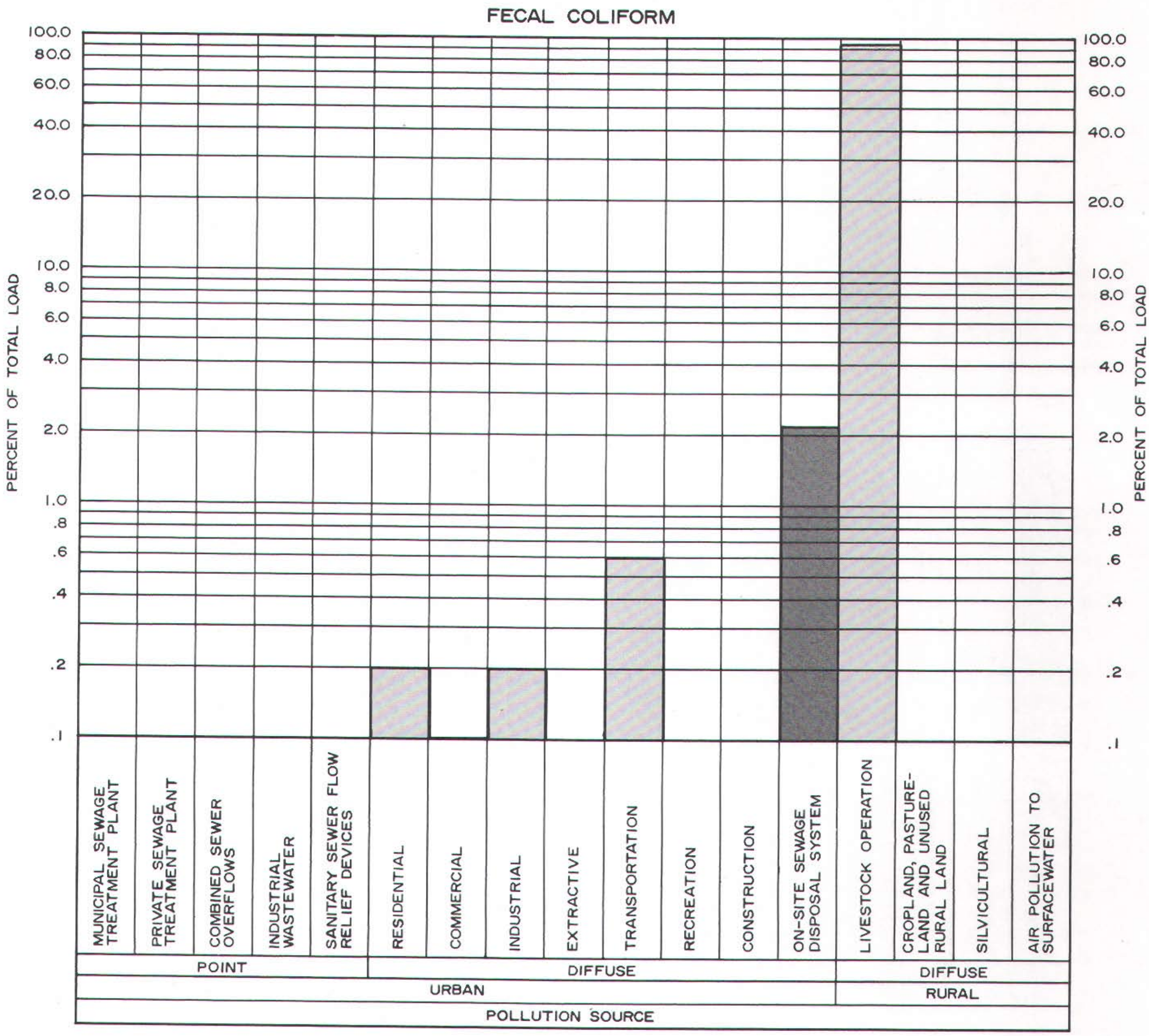
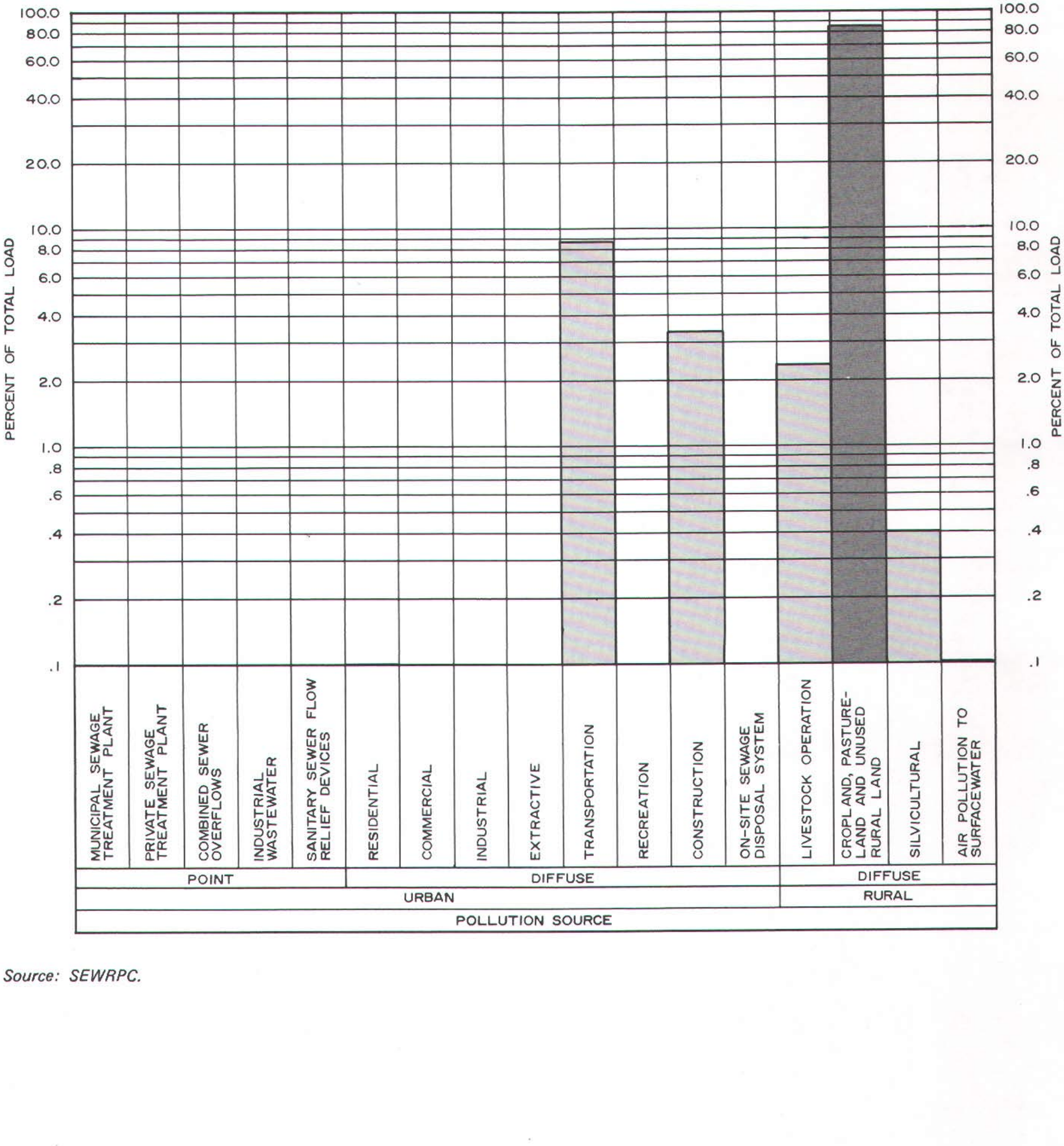


Figure 84 (continued)

SEDIMENT



Source: SEWRPC.

Table 386

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN THE SHEBOYGAN RIVER WATERSHED IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants	1	Total Nitrogen	3,280.0	2.2	1.000	3,280.0	3.3	1.000	3,280.0	1.6
	1	Total Phosphorus	210.0	1.5	1.000	210.0	2.3	1.000	210.0	1.1
	1	Biochemical Oxygen Demand	6,390.0	1.9	1.000	6,390.0	2.9	1.000	6,390.0	1.4
	1	Fecal Coliform	100.0	0.0	1.000	100.0	0.0	1.000	100.0	0.0
	1	Sediment	5.0	0.0	1.000	5.0	0.0	1.000	5.0	0.0
Private Sewage Treatment Plants	1	Total Nitrogen	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Biochemical Oxygen Demand	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Combined Sewer Overflow	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Industrial Discharges	1	Total Nitrogen	20.0	0.0	1.000	20.0	0.0	1.000	20.0	0.0
	1	Total Phosphorus	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Biochemical Oxygen Demand	450.0	0.1	1.000	450.0	0.2	1.000	450.0	0.1
	1	Fecal Coliform	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
	1	Sediment	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.0
Sanitary Sewer Flow Relief Devices	1	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Urban Point Source Totals		Total Nitrogen	3,300.0	2.2		3,300.0	3.4		3,300.0	1.6
		Total Phosphorus	210.0	1.5		210.0	2.3		210.0	1.1
		Biochemical Oxygen Demand	6,840.0	2.0		6,840.0	3.1		6,840.0	1.5
		Fecal Coliform	100.0	0.0		100.0	0.0		100.0	0.0
		Sediment	5.0	0.0		5.0	0.0		5.0	0.0
Urban Diffuse Sources										
Residential	100	Total Nitrogen	400.0	0.3	.643	260.0	0.3	1.371	550.0	0.3
	100	Total Phosphorus	30.0	0.2	.643	20.0	0.2	1.371	40.0	0.2
	100	Biochemical Oxygen Demand	2,430.0	0.7	.643	1,560.0	0.7	1.371	3,330.0	0.7
	100	Fecal Coliform	16,000.0	0.2	.643	10,288.0	0.2	1.371	21,936.0	0.2
	100	Sediment	25.0	0.1	.643	15.0	0.1	1.371	35.0	0.1
Commercial	20	Total Nitrogen	180.0	0.1	.643	120.0	0.1	1.371	250.0	0.1
	20	Total Phosphorus	20.0	0.1	.643	10.0	0.1	1.371	30.0	0.2
	20	Biochemical Oxygen Demand	1,950.0	0.6	.643	1,250.0	0.6	1.371	2,670.0	0.6
	20	Fecal Coliform	6,600.0	0.1	.643	4,243.8	0.1	1.371	9,048.6	0.1
	20	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0
Industrial	25	Total Nitrogen	210.0	0.1	.643	140.0	0.1	1.371	290.0	0.1
	25	Total Phosphorus	20.0	0.1	.643	10.0	0.1	1.371	30.0	0.2
	25	Biochemical Oxygen Demand	920.0	0.3	.643	590.0	0.3	1.371	1,260.0	0.3
	25	Fecal Coliform	15,500.0	0.2	.643	9,966.5	0.2	1.371	21,250.5	0.2
	25	Sediment	10.0	0.0	.643	5.0	0.0	1.371	15.0	0.1
Extractive	0	Total Nitrogen	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Biochemical Oxygen Demand	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	0	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Transportation	90	Total Nitrogen	2,110.0	1.4	.643	1,360.0	1.4	1.371	2,890.0	1.4
	90	Total Phosphorus	130.0	0.9	.643	80.0	0.9	1.371	180.0	0.9
	90	Biochemical Oxygen Demand	14,310.0	4.3	.643	9,200.0	4.2	1.371	19,620.0	4.3
	90	Fecal Coliform	60,300.0	0.6	.643	38,772.9	0.6	1.371	82,671.3	0.6
	90	Sediment	1,915.0	8.8	.643	1,230.0	8.8	1.371	2,625.0	8.8
Recreation	6	Total Nitrogen	10.0	0.0	.643	10.0	0.0	1.371	10.0	0.0
	6	Total Phosphorus	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	6	Biochemical Oxygen Demand	10.0	0.0	.643	10.0	0.0	1.371	10.0	0.0
	6	Fecal Coliform	216.0	0.0	.643	138.9	0.0	1.371	296.1	0.0
	6	Sediment	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
Construction	10	Total Nitrogen	600.0	0.4	.643	390.0	0.4	1.371	820.0	0.4
	10	Total Phosphorus	450.0	3.2	.643	290.0	3.2	1.371	620.0	3.2
	10	Biochemical Oxygen Demand	1,200.0	0.4	.643	770.0	0.4	1.371	1,650.0	0.4
	10	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	10	Sediment	750.0	3.4	.643	480.0	3.4	1.371	1,030.0	3.4
Septic Systems	216	Total Nitrogen	1,230.0	0.8	.643	790.0	0.8	1.371	1,690.0	0.8
	216	Total Phosphorus	290.0	2.1	.643	190.0	2.1	1.371	400.0	2.1
	216	Biochemical Oxygen Demand	17,630.0	5.3	.643	11,340.0	5.2	1.371	24,170.0	5.3
	216	Fecal Coliform	216,000.0	2.2	.643	138,888.0	2.2	1.371	296,136.0	2.2
	216	Sediment	5.0	0.0	.643	5.0	0.0	1.371	5.0	0.0

Table 386 (continued)

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Diffuse Source Totals		Total Nitrogen	4,740.0	3.1		3,070.0	3.1		6,500.0	3.2
		Total Phosphorus	940.0	6.7		600.0	6.6		1,300.0	6.8
		Biochemical Oxygen Demand	38,450.0	11.5		24,720.0	11.4		52,710.0	11.6
		Fecal Coliform	314,616.0	3.2		202,298.1	3.2		431,338.5	3.2
		Sediment	2,710.0	12.4		1,740.0	12.4		3,715.0	12.4
Urban Source Totals		Total Nitrogen	8,040.0	5.3		6,370.0	6.5		9,800.0	4.8
		Total Phosphorus	1,150.0	8.2		810.0	8.9		1,510.0	7.9
		Biochemical Oxygen Demand	45,290.0	13.6		31,560.0	14.5		59,550.0	13.1
		Fecal Coliform	314,716.0	3.2		202,398.1	3.2		431,438.5	3.2
		Sediment	2,715.0	12.4		1,745.0	12.4		3,720.0	12.4
Rural Diffuse Sources										
Livestock Operations	1500	Total Nitrogen	42,600.0	28.2	.643	27,390.0	27.8	1.371	58,400.0	28.4
	1500	Total Phosphorus	9,900.0	70.4	.643	6,370.0	69.9	1.371	13,570.0	70.6
	1500	Biochemical Oxygen Demand	166,800.0	49.9	.643	107,250.0	49.4	1.371	228,680.0	50.2
	1500	Fecal Coliform	9,600,000.0	96.8	.643	6,172,800.0	96.8	1.371	13,161,600.0	96.8
	1500	Sediment	525.0	2.4	.643	340.0	2.4	1.371	720.0	2.4
Cropland, Pasture, and Unused Rural Land	7142	Total Nitrogen	98,540.0	65.2	.643	63,360.0	64.4	1.371	135,100.0	65.6
	7142	Total Phosphorus	2,890.0	20.6	.643	1,860.0	20.4	1.371	3,960.0	20.6
	7142	Biochemical Oxygen Demand	112,460.0	33.7	.643	72,310.0	33.3	1.371	154,180.0	33.8
	7142	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	7142	Sediment	18,510.0	84.7	.643	11,900.0	84.7	1.371	25,375.0	84.7
Silvicultural	685	Total Nitrogen	1,580.0	1.0	.643	1,020.0	1.0	1.371	2,170.0	1.1
	685	Total Phosphorus	100.0	0.7	.643	60.0	0.7	1.371	140.0	0.7
	685	Biochemical Oxygen Demand	3,150.0	0.9	.643	2,030.0	0.9	1.371	4,320.0	0.9
	685	Fecal Coliform	4,521.0	0.0	.643	2,907.0	0.0	1.371	6,198.3	0.0
	685	Sediment	85.0	0.4	.643	55.0	0.4	1.371	115.0	0.4
Air Pollution to Surface Water	40	Total Nitrogen	360.0	0.2	.643	230.0	0.2	1.371	490.0	0.2
	40	Total Phosphorus	20.0	0.1	.643	10.0	0.1	1.371	30.0	0.2
	40	Biochemical Oxygen Demand	6,480.0	1.9	.643	4,170.0	1.9	1.371	8,880.0	1.9
	40	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	40	Sediment	15.0	0.1	.643	10.0	0.1	1.371	20.0	0.1
Rural Diffuse Source Totals		Total Nitrogen	143,080.0	94.7		92,000.0	93.5		196,160.0	95.2
		Total Phosphorus	12,910.0	91.8		8,300.0	91.1		17,700.0	92.1
		Biochemical Oxygen Demand	288,890.0	86.4		185,760.0	85.5		396,060.0	86.9
		Fecal Coliform	9,604,521.0	96.8		6,175,707.0	96.8		13,167,798.3	96.8
		Sediment	19,135.0	87.6		12,305.0	87.6		26,230.0	87.6
Diffuse Source Totals		Total Nitrogen	147,820.0	97.8		95,070.0	96.6		202,660.0	98.4
		Total Phosphorus	13,850.0	98.5		8,900.0	97.7		19,000.0	98.9
		Biochemical Oxygen Demand	327,340.0	98.0		210,480.0	96.9		448,770.0	98.5
		Fecal Coliform	9,919,137.0	100.0		6,378,005.1	100.0		13,599,136.8	100.0
		Sediment	21,845.0	100.0		14,045.0	100.0		29,945.0	100.0
Total Sources		Total Nitrogen	151,120.0	100.0		98,370.0	100.0		205,960.0	100.0
		Total Phosphorus	14,060.0	100.0		9,110.0	100.0		19,210.0	100.0
		Biochemical Oxygen Demand	334,180.0	100.0		217,320.0	100.0		455,610.0	100.0
		Fecal Coliform	9,919,237.0	100.0		6,378,105.1	100.0		13,599,236.8	100.0
		Sediment	21,850.0	100.0		14,050.0	100.0		29,950.0	100.0

[a] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

imply conclusions which may be misleading if firm delivery ratios were computed. In-stream processes affect these pollutants, including nitrogen, phosphorus, fecal coliform, and biochemical oxygen demand, to a generally greater degree than sediment. Hence, an efficiency factor developed for these pollutants is not directly analagous to the delivery ratio concept based on the Universal Soil Loss Equation developed for sediment, which primarily estimates delivery from the gross sheet and rill erosion in the fields, to the stream itself. Moreover, the methods of estimating unit pollutant loading rates from most diffuse sources utilized in the channel loading analysis do not parallel the computation of gross sheet and rill erosion from the Universal Soil Loss Equation, in that loads from some sources were estimated by in-stream small-scale watershed measurements, which account for aspects of the efficiency of pollutant delivery. Also, channel loads include point sources, which are contributed directly to major stream channels, therefore representing an initial efficiency of unity from the source to the major stream channel. Therefore, the theoretical efficiency factors, or the percent of the channel loads estimated to be transported downstream to the mouth of the watersheds, presented in Table 387 should be considered in relative terms—and only in relation to each other—and not be compared to other studies nor used to estimate the amount of channel pollutant contributions which actually are transported downstream from any particular area or pollutant source.

As shown in Table 387, theoretical efficiency factors for nitrogen, phosphorus, and biochemical oxygen demand, average between 24 and 47 percent. The highest factor is suggested, as expected, for nitrogen, since a large proportion of nitrogen is transported in soluble form in runoff and is less affected by physical or sedimentation processes, and since biological and chemical removal processes are generally less efficient at removing gross amounts of pollutants from runoff. Phosphorus has an apparently lower relative efficiency factor, since a significant portion of the phosphorus would be expected to be sorbed on sediment particles and hence be effectively removed by sedimentation processes. The efficiency factor for sediment is, as expected, lower than for the other pollutants. Transport loads for sediment may be underestimated due to the very limited numbers of samples used in the transport analysis and the fact that they were generally representative of dry weather conditions, rather than periods of storm water runoff or snow-melt. This latter possibility is supported by other studies which have found approximately 94 percent, 94 percent and 98 percent of the pollutant transport of nitrogen, phosphorus, and sediment, respectively, to occur during storm events, with "small" events generally transporting at least 70 percent of the pollutants in agricultural areas. [6]

---

[6] *J. Lake, and J. Morrison, Environmental Impact of Land Use on Water Quality, EPA-905/9-76-004, November, 1976, pp. 23.*

Pollutant Unit-Area Loads

A comparison of different watersheds can be made by estimating unit-area loads from the channel loading analyses and from the transport analyses. Figure 85 presents unit-area loads for nitrogen, phosphorus, biochemical oxygen demand, fecal coliform, and sediment for all watersheds in southeastern Wisconsin as quantity of pollutants per square mile of drainage area per year. This data is presented for diffuse source channel loads, total channel loads, and measured transport loads, and addresses nitrogen, phosphorus, biochemical oxygen demand, fecal coliform, and sediment, although fecal coliform transport loads could not be developed from historic data. This analysis does not imply that this amount of pollution actually is contributed by a typical square mile of land surface within that watershed, since point sources are included in the total channel load and the transport load. The analysis is intended to relate the total channel loads to the amount transported on a unit area basis: this enables comparison of pollution loads from different sized watersheds. This analysis suggests which watersheds have the highest existing potential for severe pollution, and which watersheds, based on the limited available water quality measurements, transport the greater relative loads of pollutants.

A visual analysis of the unit-area loading comparison suggests that the more urbanized watersheds have lower unit-area nitrogen channel loads. This is due primarily to lower diffuse source nitrogen loads from urban areas, even though point source contributions generally increase with increasing proportions of urban land use. However, this trend is not evident in the reported transport loads, where unit-area nitrogen transport loads from more urban watersheds appear to approximate unit-area nitrogen transport loads from primarily rural watersheds. This suggests that, while less nitrogen enters drainage channels in more urbanized watersheds than in rural watersheds, a greater percent of the nitrogen channel loads in urban areas eventually reaches the mouth of the stream, due primarily to the impervious areas and resultant increased rates and amounts of precipitation runoff.

A similar urban-rural trend is not evident for phosphorus unit-area loads, but again, point source phosphorus contributions are generally higher for the urban watersheds. The channel loads are more strongly correlated to individual diffuse sources, with Sucker Creek—with a large percentage of agricultural land and a large number of livestock—and Barnes Creek—with a large percentage of urban land under construction—having significantly higher unit-area phosphorus channel loads than the other watersheds. The unit-area phosphorus transport loads are generally consistent for all reported watersheds.

Unit-area diffuse source BOD_5 channel loads generally do not vary as a function of percent urban land use, but high point source BOD_5 contributions

Table 387

THEORETICAL EFFICIENCY FACTOR COMPUTATIONS FOR SELECTED WATERSHEDS IN SOUTHEASTERN WISCONSIN

Watershed	Pollutant	Channel Load	Watershed Transport Load	Theoretical Efficiency Factor
Des Plaines River	Nitrogen	1,666,000	580,000	0.35
	Phosphorus	177,000	50,000	0.28
	BOD_5	3,938,000	600,000	0.15
	Sediment	285,280	3,480	0.012
Fox River	Nitrogen	10,958,000	3,783,000	0.35
	Phosphorus	1,712,000	453,000	0.26
	BOD_5	28,131,000	6,073,000	0.22
	Sediment	2,198,580	27,485	0.013
Menomonee River	Nitrogen	1,393,000	320,000	0.23
	Phosphorus	312,000	60,000	0.19
	Sediment	516,865	11,595	0.022
Milwaukee River	Nitrogen	6,666,000	3,614,000	0.54
	Phosphorus	990,000	327,000	0.33
	BOD_5	17,479,000	3,645,000	0.21
	Sediment	1,107,580	26,800	0.024
Oak Creek	Nitrogen	191,000	149,000	0.78
	Phosphorus	41,000	9,000	0.22
	BOD_5	629,000	237,000	0.38
	Sediment	77,280	1,630	0.021
Pike River	Nitrogen	583,000	349,000	0.60
	Phosphorus	71,000	27,000	0.38
	BOD_5	1,275,000	255,000	0.20
	Sediment	138,240	3,170	0.023
Root River	Nitrogen	2,308,000	1,089,000	0.47
	Phosphorus	320,000	88,000	0.28
	BOD_5	6,516,000	1,892,000	0.29
	Sediment	474,475	38,085	0.080
		Average Efficiency Factor -	Nitrogen	0.47
			Phosphorus	0.28
			BOD_5	0.24
			Sediment	0.03

NOTE: Nitrogen, phosphorus and BOD_5 loads are presented in pounds per year. Sediment loads are presented in tons per year.

Source: SEWRPC.

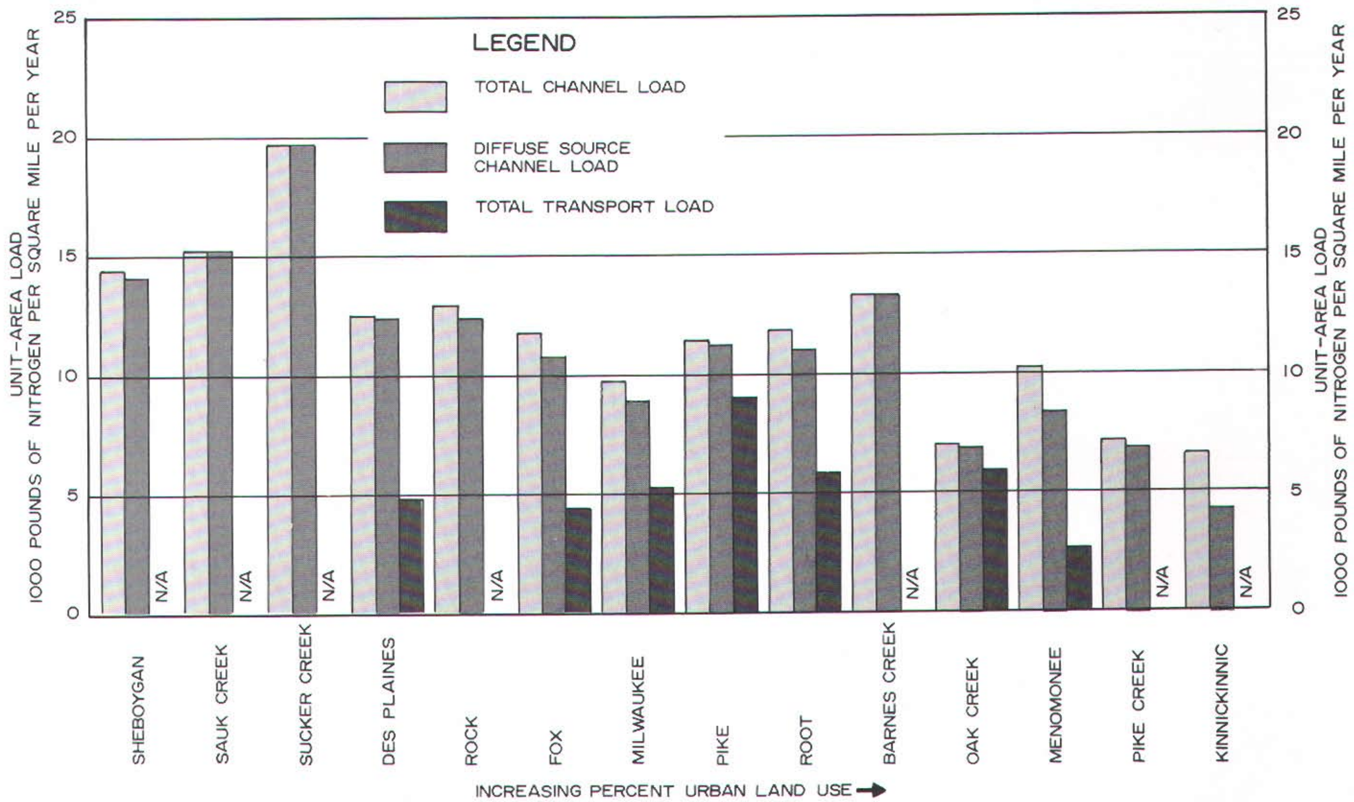
to the Menomonee and Kinnickinnic Rivers result in higher total unit-area channel loads to these streams. BOD_5 unit-area transport loads appear to be slightly higher for more urban watersheds than for more rural watersheds.

Diffuse source unit-area fecal coliform loads decrease significantly with increasing proportions of urban land use, primarily due to the decreasing numbers of livestock present. While septic systems are the major urban diffuse source of fecal coliform, the watersheds with unusually high diffuse source fecal coliform channel loads, such as Sauk Creek and Sucker Creek, did not have unusually high numbers of septic systems. However, high point source contributions of fecal coliform in the pre-

Figure 85

COMPARISON OF POLLUTANT UNIT-AREA LOADINGS FOR INLAND WATERSHEDS IN SOUTHEASTERN WISCONSIN

COMPARISON OF NITROGEN UNIT-AREA LOADINGS FOR WATERSHEDS IN SOUTHEASTERN WISCONSIN



COMPARISON OF PHOSPHORUS UNIT-AREA LOADINGS FOR WATERSHEDS IN SOUTHEASTERN WISCONSIN

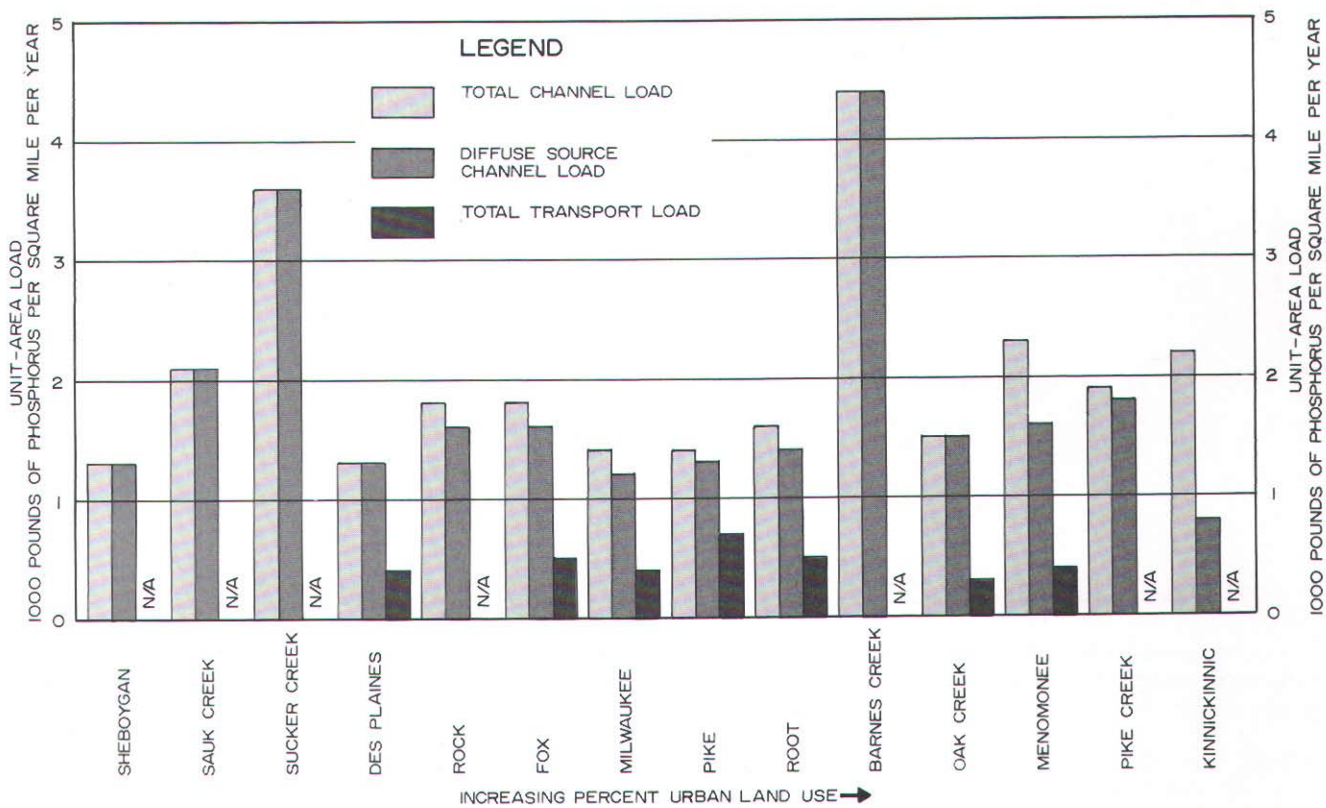
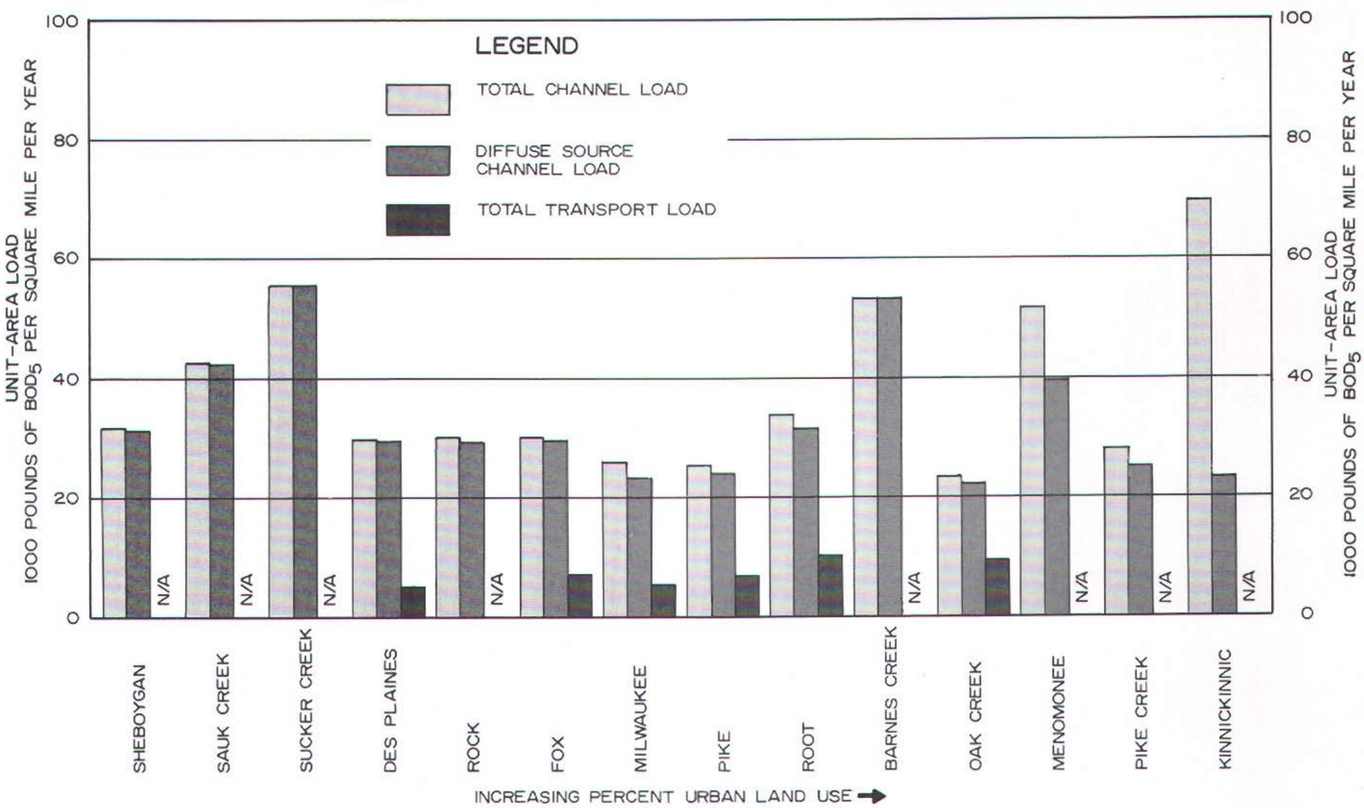
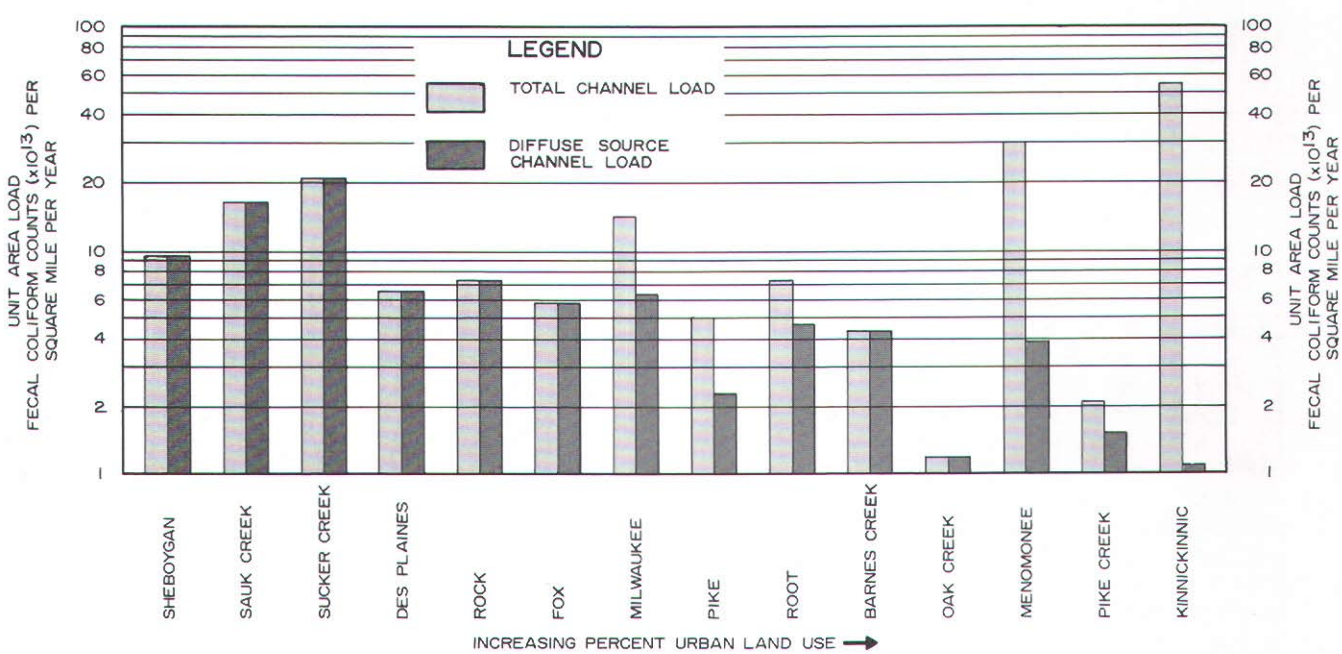


Figure 85 (continued)

COMPARISON OF BOD_5 UNIT-AREA LOADINGS FOR WATERSHEDS IN SOUTHEASTERN WISCONSIN



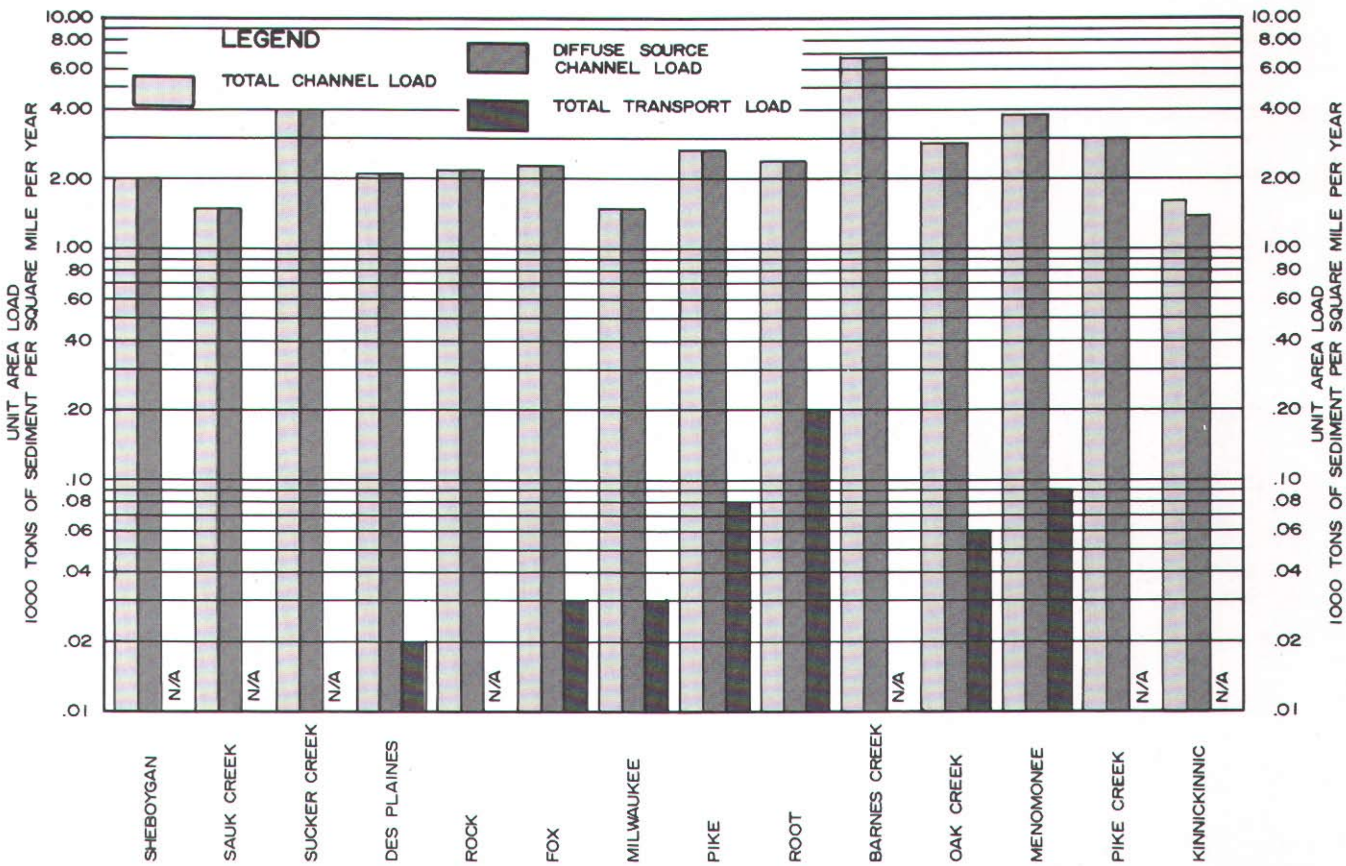
COMPARISON OF FECAL COLIFORM UNIT-AREA LOADINGS FOR WATERSHEDS IN SOUTHEASTERN WISCONSIN



NOTE: TRANSPORT LOADS WERE NOT CALCULATED FOR FECAL COLIFORM

Figure 85 (continued)

COMPARISON OF SEDIMENT UNIT-AREA LOADINGS FOR WATERSHEDS IN SOUTHEASTERN WISCONSIN



Source: SEWRPC.

dominantly urban watersheds such as the Menomonee and Kinnickinnic River watersheds, result in the highest total unit-area fecal coliform loads. No transport analyses were conducted for fecal coliform, since the short-term population dynamics of these organisms are assumed to overshadow the effects of the total numbers actually reaching the streams.

Sediment unit-area loads are not strongly correlated to percent urban land use, although the potential load for the Kinnickinnic River, the most urban watershed, is significantly lower than for the other watersheds. The Menomonee River watershed with an abundance of both agricultural land and urban land under construction, the Sucker Creek subwatershed, with a large percentage of agricultural land, and the Barnes Creek subwatershed, with a large percentage of urban land under construction, have the highest potential unit-area sediment loads. In general, point source contributions of sediment are minimal. The transport sediment loads indicate that a very small percentage of the total sediment load entering a channel is actually transported to the mouth of the rivers. Also, in general, more urban watersheds appear to have higher unit-area sediment transport loads, again because of construction activities and the impervious areas and increased runoff.

In southeastern Wisconsin, Barnes Creek and Sucker Creek have a high potential for nitrogen, phosphorus, biochemical oxygen demand and sediment pollution, based on the unit-area channel loadings. The Kinnickinnic River has a high total load of organic materials and fecal coliform, due primarily to point source contributions. The Menomonee River also has an inordinately high potential for organic, sediment and fecal coliform pollution, and a moderately high potential for nitrogen and phosphorus pollution. The Milwaukee River has a generally lower potential for pollution than most other watersheds, primarily because of the rural proportion devoted to small grains, hay, pasture land, and woodlands. Total channel loads for the Kinnickinnic River, Pike River, Menomonee River, and Milwaukee River will be significantly reduced when point sources are controlled. The transport analysis indicates the Root River has the greatest unit-area pollutant loads for BOD_5 and sediment, whereas the Pike River has the highest unit-area transport load of nitrogen and phosphorus.

Effects of Total Annual Precipitation Differences

Dry year and wet year analyses were made to depict the probable ranges of pollutant channel loadings within the Region as a result of variations in annual precipitation. The effects of annual variations in precipitation on total pollution loads are not directly proportional to the amount of precipitation since industrial point sources and municipal and private sewage treatment plant discharges of these pollutants are substantially unaffected by such variations. The differences in the proportions of pollutants contributed by point sources in the Region—i.e., the differences between the wet year and the dry year point source percentages of the total channel loads—were estimated as 5 percent for nitrogen, 8 percent for phosphorus, 3 percent for biochemical oxygen demand, 5 percent for fecal coliform, and one tenth of one percent for sediment.

Table 388 and Figure 86 present the relative pollution loadings discussed above for the inland lakes and streams of southeastern Wisconsin. It should be noted that a more detailed analysis, relating pollution sources to specific storm events would yield different results, since pollutants from storm water runoff, and sanitary sewage flow relief devices, would constitute a far higher proportion of the pollution sources during storms. Similarily, an analysis of annual contributions as a function of frequency and intensity of storm events might show greater variation between years. The Commission has not performed such an analysis in this report for three reasons. First, the results of the analysis would be biased by the particular storm or storm sequence selected, as regards its intensity and duration and the attendant water quality effects. Second, using currently available analytical tools, the quantification of, and development of controls for pollution from land runoff are more related to the long-term effects on the total load contributed, than to the concentrations or the short-term contribution during a specific storm. Finally, for an evaluation of the likelihood of achieving a specific concentration of a pollutant in a stream or lake—as would be the issue in the case where, for example, large numbers of fecal coliform organisms may be contributed from flow-relief devices—the hydrologic-hydraulic-water quality simulation modeling will be utilized by the Commission, as reported in SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000. The continuous simulation modeling process, applied for a representative time period over a series of wet and dry-weather cycles provides the most valid assessment of existing, and probably alternative future water quality conditions possible under the existing state of the art.

For these reasons, the channel loading analysis presented in this report must be used with caution. Estimated channel loads derived in this report are significantly higher than the estimated loads transported by the flowing streams. This is primarily because the pollutant channel loads are estimated from studies conducted on a small area basis and reported in technical literature. These loads can be made quantitatively precise on a larger watershed basis only by a detailed process of calibration with in-stream measurements. Only by such a calibration, can the physical, chemical, and biological processes occurring on the land surface and within the stream itself be considered with respect to their efficiency for detention or removal of pollutants from the transport system.

Concluding Remarks

In the past, water quality management studies concentrated on the relatively easily identified and controlled point sources—including public and private sewage treatment plants and industrial waste discharges—under the assumption that the most damaging water quality problems occurred during low flow conditions, when point source contributions were at a maximum in relation to other diffuse, or what were commonly referred to as "baseline," pollution contributions. The water management plans developed from the analyses were generally satisfactory in areas subject to high pollutant contributions from point sources due to overloaded or poorly designed or maintained treatment facilities, extensive flow from sewage flow relief devices, or the discharge of untreated wastes. However, as a result of improved treatment system design and effectiveness, increased federal regulation of point pollution sources, the availability of substantial funding for the improvement or replacement of treatment facilities, and a recent significant increase in diffuse source pollution quantification and qualification studies and analyses, an awareness of the magnitude and importance of diffuse source pollution has developed in the government, public, and private sectors alike. As suggested in SEWRPC Technical Report No. 17, Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975, and as documented in this report, point sources of water pollution are not the only major contributors of five commonly cited water pollutants in southeastern Wisconsin, and even complete control of point source pollution will not reduce the loads to most streams in southeastern Wisconsin to enable them to meet applicable water quality standards.

For the inland surface waters of the entire Region, point sources contribute an estimated 7 percent of the nitrogen, 14 percent of the phosphorus, 7 percent

Table 388

SUMMARY OF ESTIMATED LOADINGS FROM POLLUTION SOURCES IN ALL THE INLAND WATERSHEDS OF THE REGION[a] IN 1975

Source	Extent[a]	Parameter	Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
			Average Year		Dry Year			Wet Year		
			Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent	Factor	Total Estimated Loading	Percent
Urban Point Sources										
Municipal Sewage Treatment Plants . .	52	Total Nitrogen	1,917,960.0	5.8	1.000	1,917,960.0	8.8	1.000	1,917,960.0	4.3
	52	Total Phosphorus	459,920.0	9.3	1.000	459,920.0	13.6	1.000	459,920.0	7.0
	52	Biochemical Oxygen Demand	2,122,520.0	2.4	1.000	2,122,520.0	3.7	1.000	2,122,520.0	1.8
	52	Fecal Coliform	294,903,100.0	9.8	1.000	294,903,100.0	14.5	1.000	294,903,100.0	7.4
	52	Sediment	1,620.0	0.0	1.000	1,620.0	0.0	1.000	1,620.0	0.0
Private Sewage Treatment Plants	35	Total Nitrogen	101,360.0	0.3	1.000	101,360.0	0.5	1.000	101,360.0	0.2
	35	Total Phosphorus	38,150.0	0.8	1.000	38,150.0	1.1	1.000	38,150.0	0.6
	35	Biochemical Oxygen Demand	140,160.0	0.2	1.000	140,160.0	0.2	1.000	140,160.0	0.1
	35	Fecal Coliform	618,400.0	0.0	1.000	618,400.0	0.0	1.000	618,400.0	0.0
	35	Sediment	85.0	0.0	1.000	85.0	0.0	1.000	85.0	0.0
Combined Sewer Overflow	118	Total Nitrogen	275,460.0	0.8	.643	177,130.0	0.8	1.371	377,660.0	0.9
	118	Total Phosphorus	137,740.0	2.8	.643	88,570.0	2.6	1.371	188,830.0	2.9
	118	Biochemical Oxygen Demand	2,754,690.0	3.1	.643	1,771,270.0	3.1	1.371	3,776,690.0	3.2
	118	Fecal Coliform	882,000,000.0	29.4	.643	567,126,000.0	27.9	1.371	1,209,222,000.0	30.2
	118	Sediment	4,130.0	0.1	.643	2,660.0	0.1	1.371	5,665.0	0.1
Industrial Discharges	229	Total Nitrogen	116,470.0	0.4	1.000	116,470.0	0.5	1.000	116,470.0	0.3
	229	Total Phosphorus	41,280.0	0.8	1.000	41,280.0	1.2	1.000	41,280.0	0.6
	229	Biochemical Oxygen Demand	1,423,700.0	1.6	1.000	1,423,700.0	2.5	1.000	1,423,700.0	1.2
	229	Fecal Coliform	33,000.0	0.0	1.000	33,000.0	0.0	1.000	33,000.0	0.0
	229	Sediment	6,065.0	0.1	1.000	6,065.0	0.1	1.000	6,065.0	0.1
Sanitary Sewer Flow Relief Devices . .	406	Total Nitrogen	21,590.0	0.1	.643	13,880.0	0.1	1.371	29,610.0	0.1
	406	Total Phosphorus	7,200.0	0.1	.643	4,610.0	0.1	1.371	9,880.0	0.2
	406	Biochemical Oxygen Demand	215,670.0	0.2	.643	138,660.0	0.2	1.371	295,700.0	0.2
	406	Fecal Coliform	32,916,000.0	1.1	.643	21,164,988.0	1.0	1.371	45,127,836.0	1.1
	406	Sediment	100.0	0.0	.643	75.0	0.0	1.371	135.0	0.0
Urban Point Source Totals		Total Nitrogen	2,432,840.0	7.4		2,326,800.0	10.6		2,543,060.0	5.8
		Total Phosphorus	684,290.0	13.8		632,530.0	18.8		738,060.0	11.2
		Biochemical Oxygen Demand	6,656,740.0	7.6		5,596,310.0	9.7		7,758,770.0	6.5
		Fecal Coliform	1,210,470,500.0	40.3		883,845,488.0	43.4		1,549,904,336.0	38.7
		Sediment	12,000.0	0.2		10,505.0	0.3		13,570.0	0.2
Urban Diffuse Sources										
Residential	147652	Total Nitrogen	590,610.0	1.8	.643	379,760.0	1.7	1.371	809,740.0	1.8
	147652	Total Phosphorus	47,250.0	1.0	.643	30,390.0	0.9	1.371	64,800.0	1.0
	147652	Biochemical Oxygen Demand	3,587,940.0	4.1	.643	2,307,030.0	4.0	1.371	4,919,050.0	4.1
	147652	Fecal Coliform	23,624,320.0	0.8	.643	15,190,438.0	0.7	1.371	32,388,942.7	0.8
	147652	Sediment	40,235.0	0.6	.643	25,870.0	0.6	1.371	55,170.0	0.6
Commercial	24568	Total Nitrogen	221,120.0	0.7	.643	142,180.0	0.7	1.371	303,160.0	0.7
	24568	Total Phosphorus	18,440.0	0.4	.643	11,840.0	0.4	1.371	25,300.0	0.4
	24568	Biochemical Oxygen Demand	2,397,840.0	2.7	.643	1,541,810.0	2.7	1.371	3,287,430.0	2.8
	24568	Fecal Coliform	8,107,440.0	0.3	.643	5,213,084.0	0.3	1.371	11,115,300.2	0.3
	24568	Sediment	9,145.0	0.1	.643	5,885.0	0.1	1.371	12,535.0	0.1
Industrial	14997	Total Nitrogen	125,980.0	0.4	.643	81,010.0	0.4	1.371	172,700.0	0.4
	14997	Total Phosphorus	10,500.0	0.2	.643	6,740.0	0.2	1.371	14,390.0	0.2
	14997	Biochemical Oxygen Demand	553,380.0	0.6	.643	355,820.0	0.6	1.371	758,700.0	0.6
	14997	Fecal Coliform	9,298,140.0	0.3	.643	5,978,704.1	0.3	1.371	12,747,749.9	0.3
	14997	Sediment	7,310.0	0.1	.643	4,695.0	0.1	1.371	10,020.0	0.1
Extractive	8029	Total Nitrogen	481,740.0	1.5	.643	309,760.0	1.4	1.371	660,450.0	1.5
	8029	Total Phosphorus	361,330.0	7.3	.643	232,320.0	6.9	1.371	495,380.0	7.5
	8029	Biochemical Oxygen Demand	963,480.0	1.1	.643	619,530.0	1.1	1.371	1,320,940.0	1.1
	8029	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	8029	Sediment	602,175.0	9.4	.643	387,200.0	9.4	1.371	825,585.0	9.4
Transportation	26715	Total Nitrogen	563,880.0	1.7	.643	362,580.0	1.7	1.371	773,090.0	1.7
	26715	Total Phosphorus	41,750.0	0.8	.643	26,850.0	0.8	1.371	57,250.0	0.9
	26715	Biochemical Oxygen Demand	3,637,390.0	4.1	.643	2,338,840.0	4.0	1.371	4,986,850.0	4.2
	26715	Fecal Coliform	15,324,290.0	0.5	.643	9,853,518.7	0.5	1.371	21,009,601.6	0.5
	26715	Sediment	465,885.0	7.3	.643	299,555.0	7.3	1.371	638,725.0	7.3
Recreation	31803	Total Nitrogen	99,880.0	0.3	.643	64,240.0	0.3	1.371	136,930.0	0.3
	31803	Total Phosphorus	3,700.0	0.1	.643	2,390.0	0.1	1.371	5,070.0	0.1
	31803	Biochemical Oxygen Demand	41,350.0	0.0	.643	26,610.0	0.0	1.371	56,700.0	0.0
	31803	Fecal Coliform	686,959.0	0.0	.643	441,714.7	0.0	1.371	941,820.8	0.0
	31803	Sediment	6,680.0	0.1	.643	4,300.0	0.1	1.371	9,160.0	0.1
Construction	30217	Total Nitrogen	1,813,020.0	5.5	.643	1,165,770.0	5.3	1.371	2,485,640.0	5.6
	30217	Total Phosphorus	1,359,790.0	27.5	.643	874,330.0	25.9	1.371	1,864,280.0	28.3
	30217	Biochemical Oxygen Demand	3,626,040.0	4.1	.643	2,331,530.0	4.0	1.371	4,971,310.0	4.2
	30217	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	30217	Sediment	2,266,275.0	35.5	.643	1,457,215.0	35.5	1.371	3,107,065.0	35.5
Septic Systems	251594	Total Nitrogen	782,180.0	2.4	.643	502,960.0	2.3	1.371	1,072,370.0	2.4
	251594	Total Phosphorus	179,860.0	3.6	.643	115,670.0	3.4	1.371	246,600.0	3.7
	251594	Biochemical Oxygen Demand	11,121,980.0	12.6	.643	7,151,430.0	12.4	1.371	15,248,230.0	12.8
	251594	Fecal Coliform	136,255,000.0	4.5	.643	87,611,965.0	4.3	1.371	186,805,605.0	4.7
	251594	Sediment	1,910.0	0.0	.643	1,235.0	0.0	1.371	2,615.0	0.0

Table 388 (continued)

Source	Extent[a]	Parameter	Average Year: Total Estimated Loading	Average Year: Percent	Dry Year: Factor	Dry Year: Total Estimated Loading	Dry Year: Percent	Wet Year: Factor	Wet Year: Total Estimated Loading	Wet Year: Percent
			Loads presented in pounds per year, except for fecal coliform presented in counts x 10^8 per year, and sediment presented in tons per year							
Urban Diffuse Source Totals		Total Nitrogen	4,678,410.0	14.3		3,008,260.0	13.8		6,414,080.0	14.5
		Total Phosphorus	2,022,620.0	40.9		1,300,530.0	38.6		2,773,070.0	42.1
		Biochemical Oxygen Demand	25,929,400.0	29.5		16,672,600.0	28.8		35,549,210.0	29.8
		Fecal Coliform	193,296,149.0	6.4		124,289,424.5	6.1		265,009,020.2	6.6
		Sediment	3,399,615.0	53.3		2,185,955.0	53.2		4,660,875.0	53.3
Urban Source Totals		Total Nitrogen	7,111,250.0	21.7		5,335,060.0	24.4		8,957,140.0	20.3
		Total Phosphorus	2,706,910.0	54.7		1,933,060.0	57.3		3,511,130.0	53.3
		Biochemical Oxygen Demand	32,586,140.0	37.0		22,268,910.0	38.5		43,307,980.0	36.3
		Fecal Coliform	1,403,766,649.0	46.8		1,008,134,912.5	49.6		1,814,913,356.2	45.3
		Sediment	3,411,615.0	53.4		2,196,460.0	53.5		4,674,445.0	53.4
Rural Diffuse Sources										
Livestock Operations	249250	Total Nitrogen	7,078,700.0	21.6	.643	4,551,590.0	20.8	1.371	9,704,900.0	22.0
	249250	Total Phosphorus	1,645,050.0	33.3	.643	1,057,770.0	31.4	1.371	2,255,350.0	34.3
	249250	Biochemical Oxygen Demand	27,716,590.0	31.5	.643	17,821,750.0	30.8	1.371	37,999,460.0	31.9
	249250	Fecal Coliform	1,595,200,000.0	53.2	.643	1,025,713,600.0	50.4	1.371	2,187,019,200.0	54.6
	249250	Sediment	87,240.0	1.4	.643	56,095.0	1.4	1.371	119,615.0	1.4
Agricultural	1258985	Total Nitrogen	17,809,620.0	54.3	.643	11,451,590.0	52.4	1.371	24,416,970.0	55.3
	1258985	Total Phosphorus	548,040.0	11.1	.643	352,400.0	10.4	1.371	751,360.0	11.4
	1258985	Biochemical Oxygen Demand	19,143,390.0	21.8	.643	12,309,200.0	21.3	1.371	26,245,590.0	22.0
	1258985	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	1258985	Sediment	2,847,490.0	44.6	.643	1,830,940.0	44.6	1.371	3,903,915.0	44.6
Silvicultural	164202	Total Nitrogen	377,680.0	1.2	.643	242,840.0	1.1	1.371	517,820.0	1.2
	164202	Total Phosphorus	22,990.0	0.5	.643	14,790.0	0.4	1.371	31,510.0	0.5
	164202	Biochemical Oxygen Demand	755,320.0	0.9	.643	485,680.0	0.8	1.371	1,035,530.0	0.9
	164202	Fecal Coliform	1,083,733.2	0.0	.643	696,840.4	0.0	1.371	1,485,798.5	0.0
	164202	Sediment	20,600.0	0.3	.643	13,250.0	0.3	1.371	28,225.0	0.3
Air Pollution to Surface Water	48101	Total Nitrogen	428,110.0	1.3	.643	275,270.0	1.3	1.371	586,930.0	1.3
	48101	Total Phosphorus	24,050.0	0.5	.643	15,470.0	0.5	1.371	32,980.0	0.5
	48101	Biochemical Oxygen Demand	7,792,350.0	8.9	.643	5,010,490.0	8.7	1.371	10,683,290.0	9.0
	48101	Fecal Coliform	0.0	0.0	.643	0.0	0.0	1.371	0.0	0.0
	48101	Sediment	15,990.0	0.3	.643	10,285.0	0.3	1.371	21,925.0	0.3
Rural Diffuse Source Totals		Total Nitrogen	25,694,110.0	78.3		16,521,290.0	75.6		35,226,620.0	79.7
		Total Phosphorus	2,240,130.0	45.3		1,440,430.0	42.7		3,071,200.0	46.7
		Biochemical Oxygen Demand	55,407,650.0	63.0		35,627,120.0	61.5		75,963,870.0	63.7
		Fecal Coliform	1,596,283,733.2	53.2		1,026,410,440.4	50.4		2,188,504,998.5	54.7
		Sediment	2,971,320.0	46.6		1,910,570.0	46.5		4,073,680.0	46.6
Diffuse Source Totals		Total Nitrogen	30,372,520.0	92.6		19,529,550.0	89.4		41,640,700.0	94.2
		Total Phosphorus	4,262,750.0	86.2		2,740,960.0	81.2		5,844,270.0	88.8
		Biochemical Oxygen Demand	81,337,050.0	92.4		52,299,720.0	90.3		111,513,080.0	93.5
		Fecal Coliform	1,789,579,882.2	59.7		1,150,699,864.9	56.6		2,453,514,018.7	61.3
		Sediment	6,370,935.0	99.8		4,096,525.0	99.7		8,734,555.0	99.8
Total Sources		Total Nitrogen	32,805,360.0	100.0		21,856,350.0	100.0		44,183,760.0	100.0
		Total Phosphorus	4,947,040.0	100.0		3,373,490.0	100.0		6,582,330.0	100.0
		Biochemical Oxygen Demand	87,993,790.0	100.0		57,896,030.0	100.0		119,271,850.0	100.0
		Fecal Coliform	3,000,050,382.2	100.0		2,034,545,352.9	100.0		4,003,418,354.7	100.0
		Sediment	6,382,935.0	100.0		4,107,030.0	100.0		8,748,125.0	100.0

[a] *Includes pollution loadings from the approximately 264 square miles of the Milwaukee River watershed located outside of the Region.*

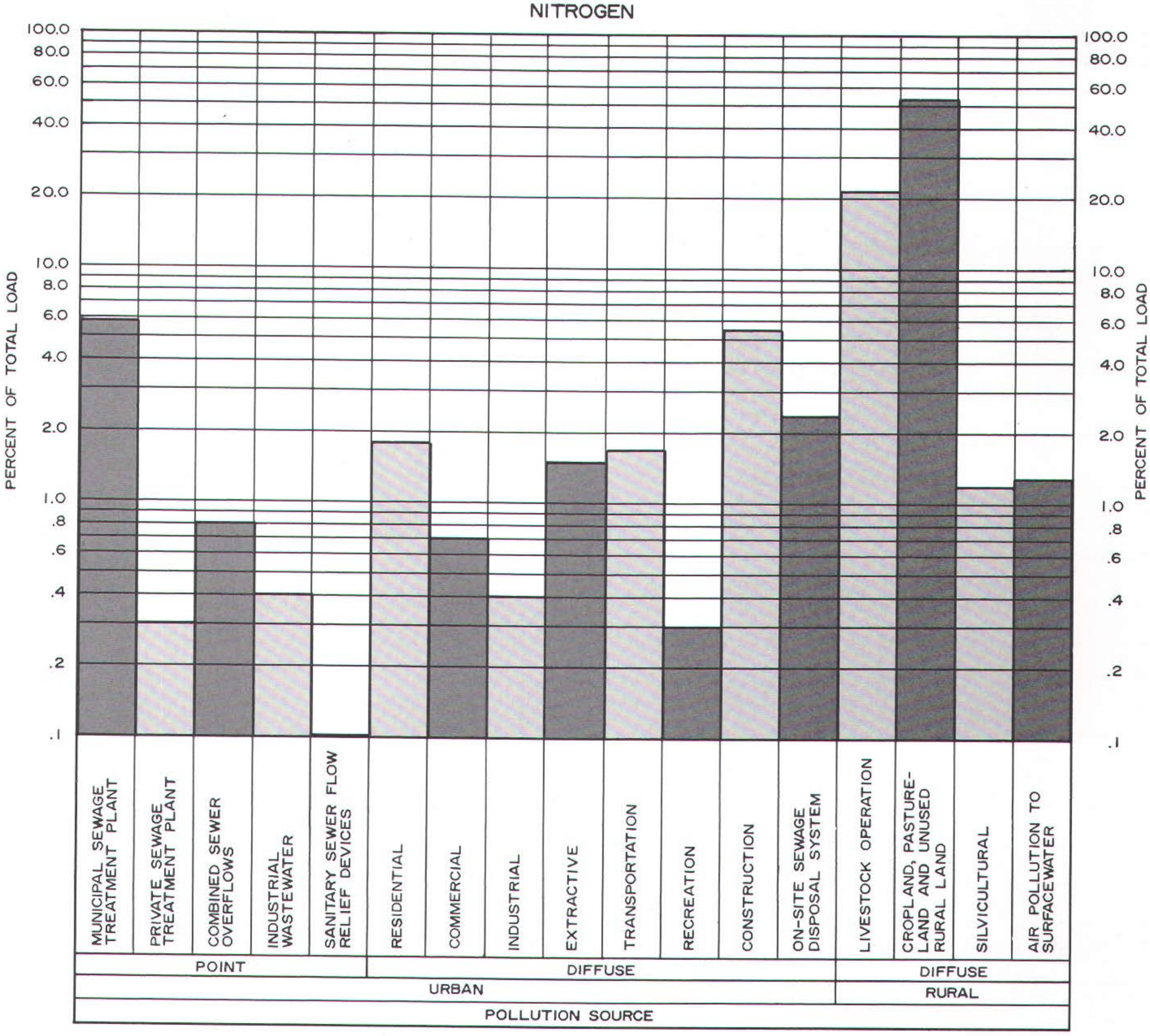
[b] *Urban point sources are expressed in number of plants, other facilities, and points of sewage flow relief; urban diffuse sources are expressed in number of acres except septic systems which are expressed in the number of persons served; and rural diffuse sources are expressed in acres except livestock operations which are expressed in equivalent animal units.*

Source: SEWRPC.

of the biochemical oxygen demand, 40 percent of the fecal coliform, and only 0.2 percent of the sediment annually contributed to the inland surface waters. Some streams, such as the Pike River and Milwaukee River, have high point source loads from old or overloaded treatment facilities, with point sources contributing up to 49 percent of the total fecal coliform load. Other streams, namely the Kinnickinnic River, Menomonee River, Milwaukee River, and Root River, have a large percentage of transported pollutants, especially fecal coliform, originating from combined sewer overflows. However, for the Region as a whole, point sources of pollution do not contribute a majority of the pollutants to the streams in southeastern Wisconsin on an annual basis, and in addition, recently enacted federal regulations and recent court decisions will further reduce point source loadings by 1990 or sooner. It should also be noted that, with regard to the duration of pollutant contributions—and subsequently the proportion of the time that water quality standards may be expected to be violated—point sources are relatively more important, since they represent continuous loadings to surface waters. The relationship of the various

Figure 86

ESTIMATED RELATIVE CONTRIBUTIONS OF POLLUTION SOURCES FOR AN AVERAGE YEAR IN SOUTHEASTERN WISCONSIN



point and diffuse source pollutants to water quality conditions and the degree to which water use objectives and supporting water quality standards are met is addressed in SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000.

As evident in the summary loading tables presented for each watershed previously in this chapter, there are several diffuse sources of water pollution which are significant. The relative significance of a given source varies for each watershed, being dependent upon the relative extent of the source activities for both diffuse and point sources.

SUMMARY

This chapter has presented quantitative estimates of the pollution loadings on the inland lakes and streams of southeastern Wisconsin as well as for the Region as a whole. Overall, within the Region, urban sources of pollution are estimated to contribute 22 percent of the nitrogen, 55 percent of the phosphorus, 37 percent of the biochemical oxygen demand, 47 percent of the fecal coliform, and 53 percent of the sediment

Figure 86 (continued)

PHOSPHOROUS

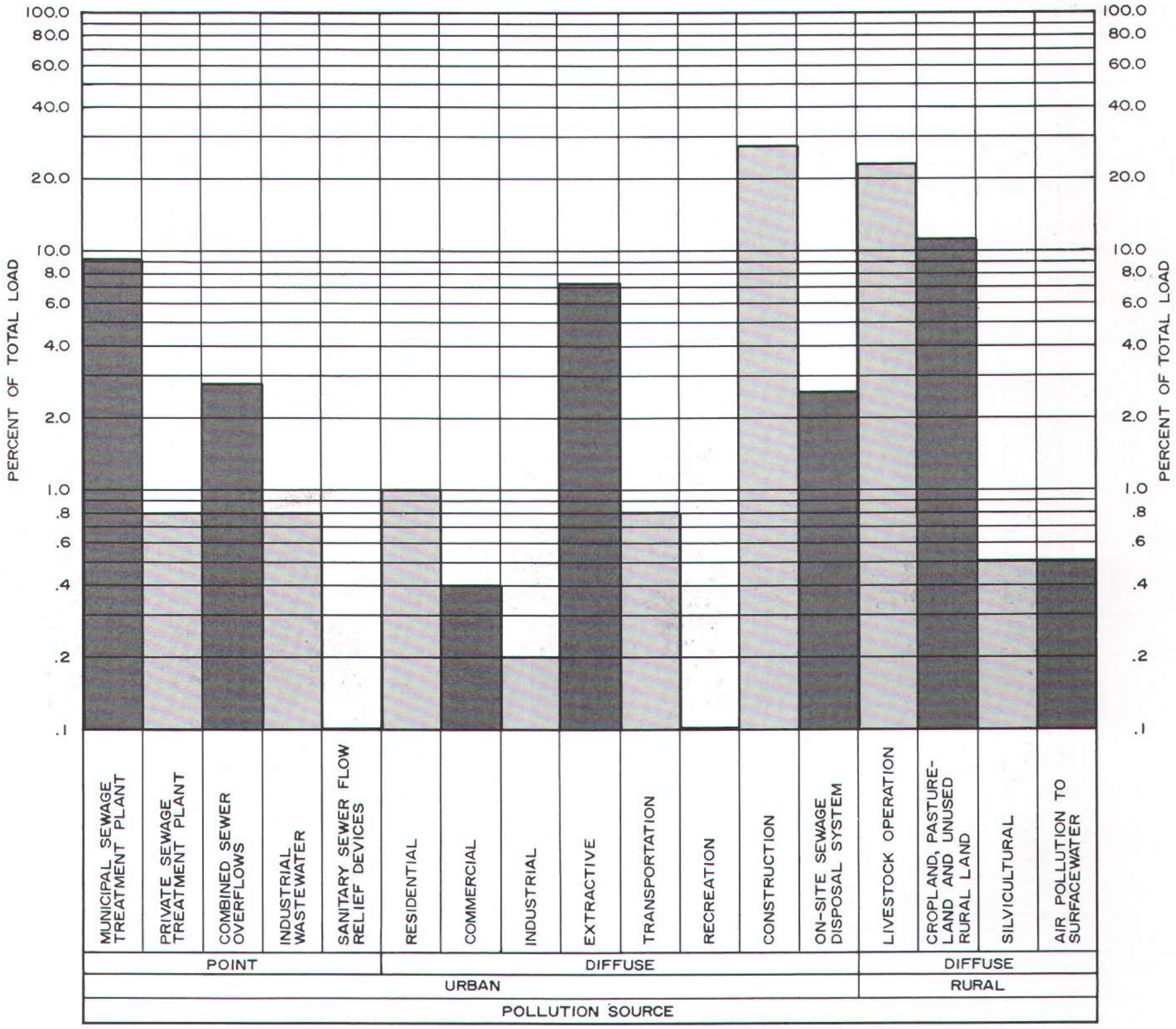


Figure 86 (continued)

BOD_5

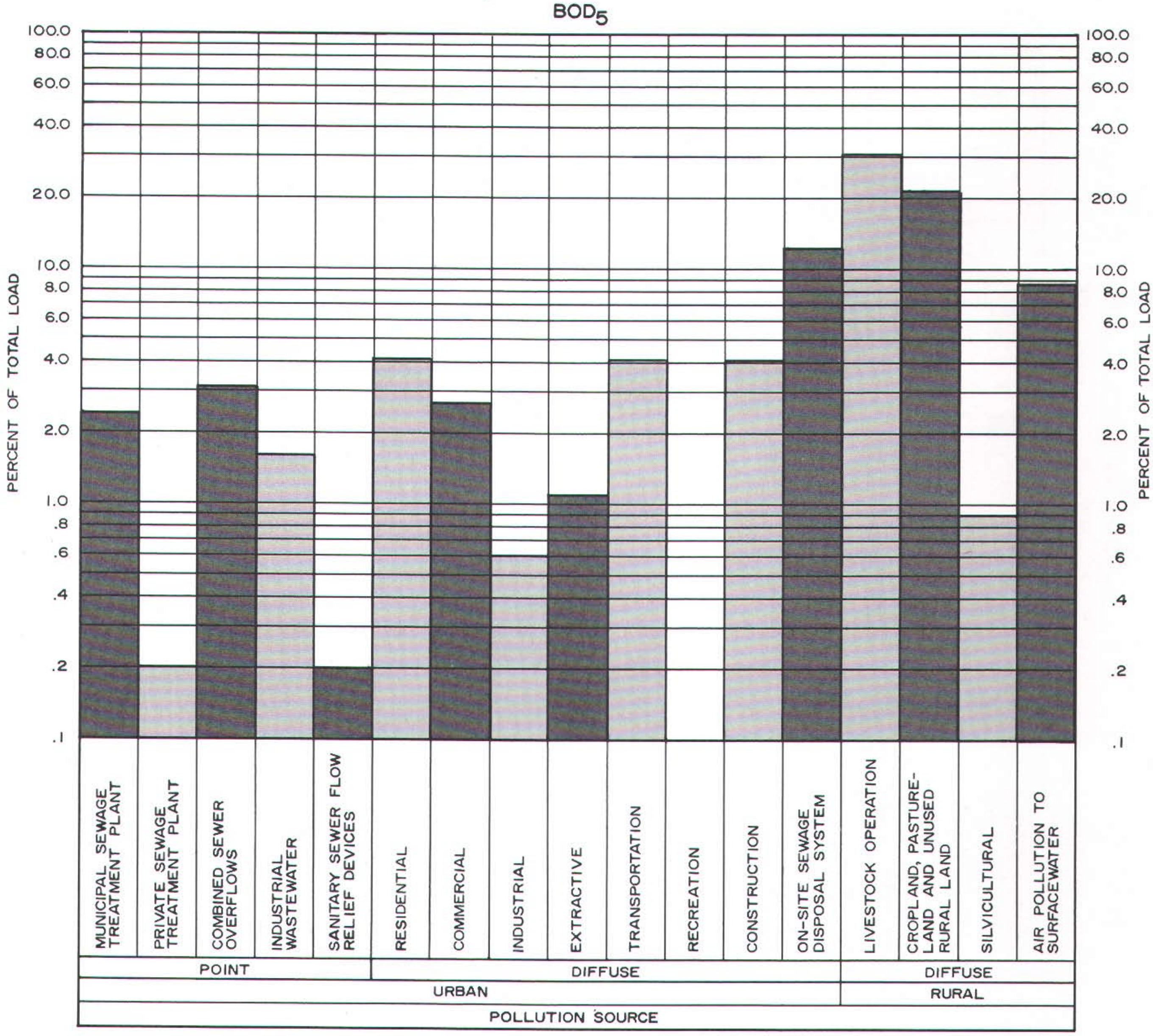


Figure 86 (continued)
FECAL COLIFORM

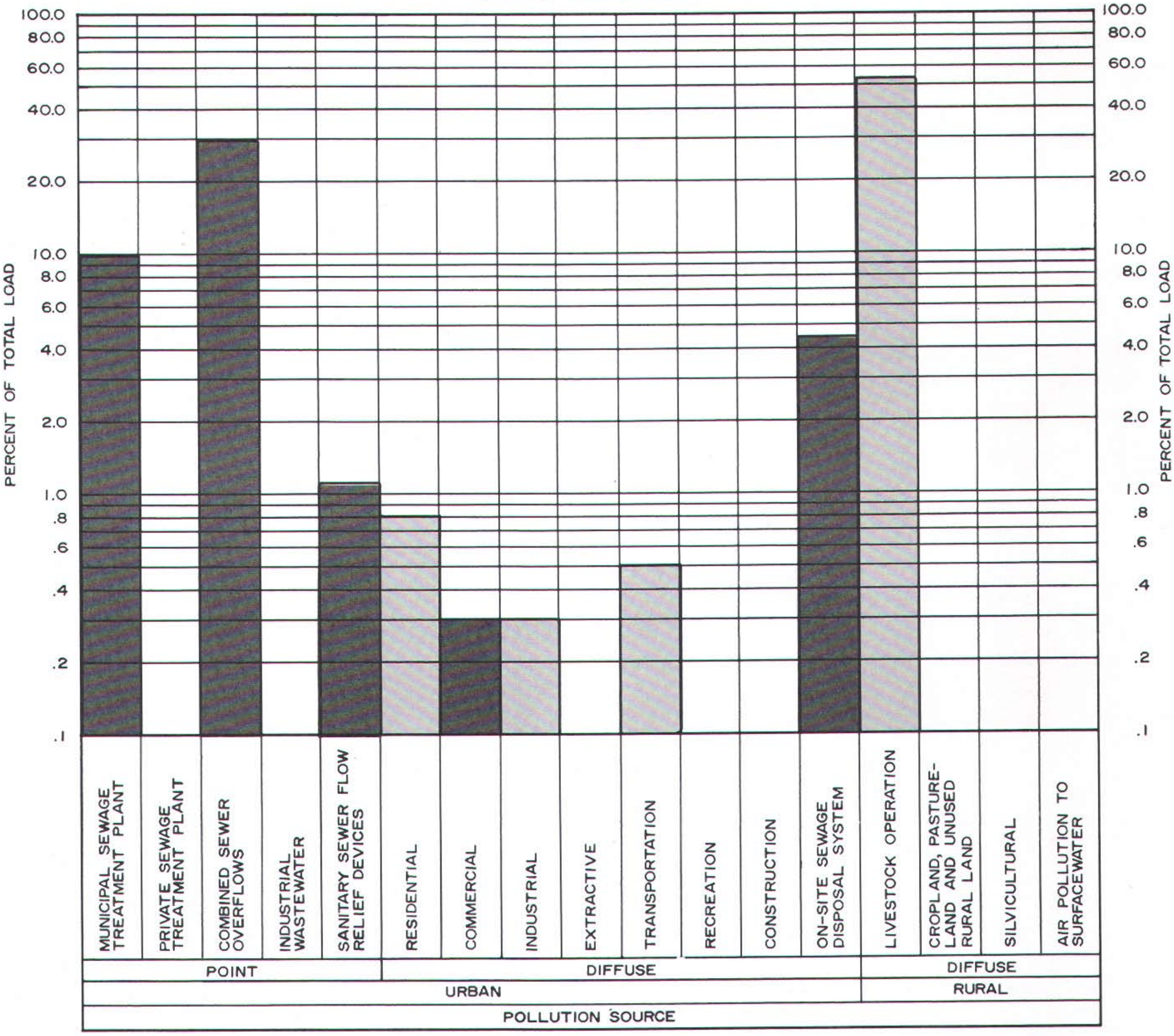
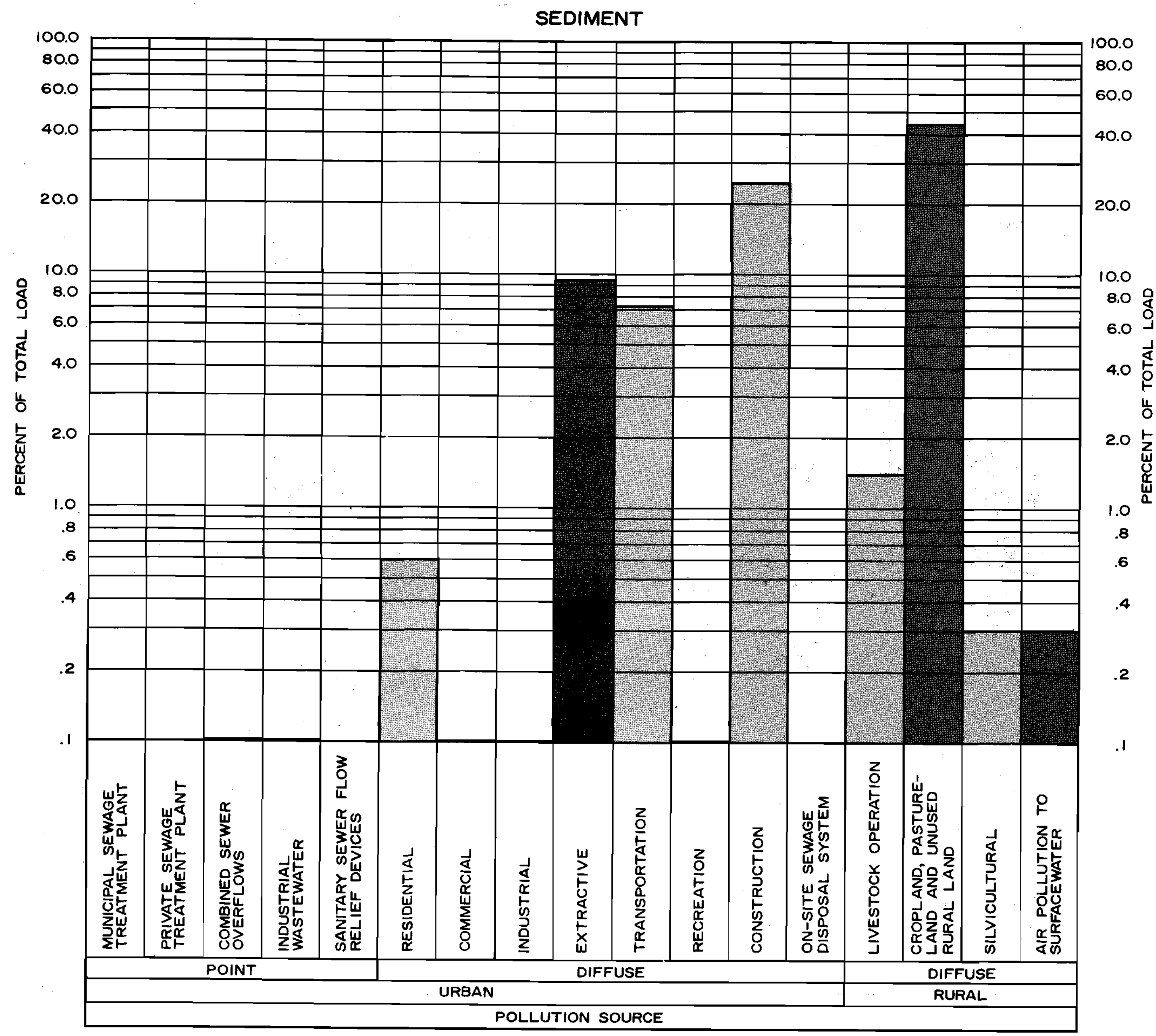


Figure 86 (continued)



Source: SEWRPC.

loadings to the inland surface waters of the Region. Of the total sources of urban loadings, the point sources of pollution consist of 52 municipal sewage treatment plants, which contribute an estimated 27 percent of the nitrogen, 17 percent of the phosphorus, 6 percent of the biochemical oxygen demand, 21 percent of the fecal coliform, and virtually none of the sediment; 35 private sewage treatment plants, which contribute 1 percent of the nitrogen and phosphorus, less than 1 percent of the biochemical oxygen demand, and essentially a negligible amount of the fecal coliform, and sediment; 524 sewage flow relief devices including combined sewer overflows which contribute 4 percent of the nitrogen, 5 percent of the phosphorus, 9 percent of the biochemical oxygen demand, 65 percent of the fecal coliform, and one-tenth of one percent of the sediment; and 229 point sources other than wastewater treatment plants consisting primarily of industrial discharges. These other point sources had a total of 368 outfalls and are estimated to contributed 2 percent of the nitrogen, 2 percent of the phosphorus, 4 percent of the biochemical oxygen demand, virtually none of the fecal coliform and, two-tenths of one percent of the sediment potentially contributed by urban sources as channel loads. Diffuse sources—including the estimated septic tank and construction-related contributions in the drainage area—account for the remaining 66 percent of the nitrogen, 75 percent of the phosphorus, 80 percent of the biochemical oxygen demand, 14 percent of the fecal coliform, and nearly all of the sediment contributed from urban sources.

Of the total pollutant loads, rural pollution sources contribute an estimated 78 percent of the nitrogen, 45 percent of the phosphorus, 63 percent of the biochemical oxygen demand, 53 percent of the fecal coliform, and 47 percent of the sediment from all sources within the Region. There are no rural point sources of pollution, since none of the livestock operations in the Region is of sufficient size to constitute a point source as defined herein. Other livestock feeding operations—inclusive of the disposal of manure on croplands—are estimated to contribute 27 percent of the nitrogen, 73 percent of the phosphorus, 50 percent of the biochemical oxygen demand, 100 percent of the fecal coliform, and 3 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, or 73 percent of the nitrogen, 27 percent of the phosphorus, 50 percent of the biochemical oxygen demand, essentially none of the fecal coliform, and 97 percent of the sediment are contributed by other rural diffuse sources, primarily storm water runoff from rural land uses and atmospheric loadings to surface waters.

The dry year and wet year analyses, conducted to depict the probable ranges of total potential pollutant loadings and the variations in the relative proportion of point source contributions as a result of variations in annual precipitation, indicated that total potential pollutant loads may be expected to deviate about 35 percent from the estimated "average" potential loads. Although point source contributions would, in theory, be reduced in their relative importance during wet years, or increased during dry years, these effects represented shifts of 8 or less percent in the proportion of pollution attributable to point sources.

Efficiency factors, or estimates of the effectiveness of a watershed and a stream system to transport channel pollutants downstream, were estimated for seven of the major watersheds in the Region. Efficiency factors, presented as the portion of the channel load estimated to be transported downstream, averaged 0.47 for nitrogen, 0.28 for phosphorus, 0.24 for biochemical oxygen demand, and 0.03 for sediment. In general, the predominantly urban watersheds were more efficient at transporting channel pollutants than were the rural watersheds.

Unit-area loads were computed from the estimated channel loading analyses and from the transport loading analyses. The unit-area loads, presented as the estimated annual amount of channel pollutant load per square mile of drainage area, enabled the comparison of different watersheds, suggesting which watersheds have the highest potential for severe pollution.

The results of the unit-area loading analysis suggested that nitrogen channel loads decreased with increasing percent urban land use. Since urban areas are more efficient at transporting pollutants, however, the unit-area transport loads from urban watersheds approximated the nitrogen transport loads from rural watersheds. Phosphorus unit-area loads could not be correlated to the proportion of urban land use, but rather were strongly influenced by the magnitude of a few individual diffuse sources, namely land under construction and livestock operations. Unit-area diffuse source channel loads of biochemical oxygen demand did not vary as a function of percent urban land use, but high point source contributions of biochemical oxygen demand in the Menomonee and Kinnickinnic River watersheds resulted in significantly higher total BOD_5 channel loads for these watersheds. Fecal coliform unit-area channel loads were highest for watersheds with high numbers of livestock and significant point source contributions. Unit-area sediment channel loads were highest for watersheds with a large percentage of agricultural land and urban land under construction.

In southeastern Wisconsin, Barnes Creek has the greatest unit-area channel loads of phosphorus and sediment; the Kinnickinnic River has the highest unit-area channel load of biochemical oxygen demand and fecal coliform pollution—primarily due to point sources of pollution; and Sucker Creek has the highest unit-area nitrogen channel load. The Milwaukee River has a generally lower potential for pollution than most other watersheds, primarily because of the rural proportion devoted to small grains, hay, pasture land and woodlands.

This chapter, which analyzes the potential for water pollution in the Region, supports the development of alternative water quality management plans and aids in selecting priorities for pollution control measures through the development and implementation of the areawide water quality management plan.

(This page intentionally left blank)

Chapter VII

SUMMARY

INTRODUCTION

In order to develop a sound and realistic plan for the abatement of water pollution, it is necessary to know the number, type, and location of all significant sources of pollution; the type and amount of pollutants contributed by each source to the surface waters of the planning area; and the conditions under which such contributions occur. This information must be known for all "point" sources contributing pollutants to the streams and lakes of the planning area through clearly identifiable wastewater discharge points—such as sewage treatment plant outfalls, sanitary and combined sewer flow relief points and industrial wastewater outfalls—and for all known "nonpoint," or diffuse, sources contributing pollutants to the streams and inland lakes in the form of overland flow, storm sewer discharges, and groundwater inflow. Accordingly, a comprehensive inventory of the sources of water pollution in southeastern Wisconsin was conducted as a part of the areawide water quality management planning program for the Region. This inventory not only established the number and location or spatial distribution of all known sources, but also the amounts and strengths of the wastewater contributed.

For purposes of this inventory, pollution sources were categorized as urban or rural, and as point or nonpoint. The urban sources were defined as including public sanitary sewerage systems—including separate and combined sewer flow relief devices and sewage treatment plant outfalls; existing privately-owned, onsite sewage disposal systems; and industrial wastewater outfalls. The urban storm sewerage systems which collect and convey rainfall and snowmelt runoff from areas which contribute pollutants—as diffuse sources—were also classified as urban sources. The pollutant contributions from the land cover types associated with various urban land uses were estimated for areas of residential, commercial, industrial and related activities—including solid waste disposal, mining, construction, transportation, dredging and channelization, and recreation activities. Direct air contaminant fallout was implicitly considered in the urban land uses. Because most of the inland surface waters of the Region are located in rural areas, the direct air contaminant fallout to inland lakes, ponds, and streams was included as a rural source. The other rural sources were defined as including livestock raising operations and rainfall and snowmelt runoff which contribute pollutants from croplands, orchards, pastures, woodlands and wetlands, and wildlife areas.

Two other categories of pollution sources are often used in considering the effects of human activities on surface water quality: point sources and nonpoint sources. Point sources of pollution are defined as concentrated discharges of wastewater emanating from a specific, discrete site, such as a pipe or other identifiable conduit. Since they are more easily identifiable, point sources can be more readily eliminated or abated than nonpoint sources. Examples of point sources include sewerage system flow relief devices, sewage treatment plant outfalls, and industrial waste outfalls. Nonpoint sources of pollution are defined as diffuse discharges of wastewater which cannot be identified as a point source. Most commonly, these consist of storm water and snowmelt runoff carrying sediment and chemical substances which act as water pollutants. The distinction between point and nonpoint sources of pollution is, however, somewhat arbitrary, and very difficult to make, since diffuse pollution sources associated with urban and rural runoff can be collected, channelized, and conveyed to an identifiable point of discharge, such as storm sewer outfalls.

The inventory recognizes the significance of diffuse pollution sources to surface water quality and considers such sources—which have not been historically considered as primary pollutant sources—together with the point sources associated with sanitary and industrial sewage discharges traditionally considered the principle sources of pollution by practicing sanitary engineers.

From the multitude of pollutants which can be measured, the inventory concentrated on five which are recognized as major pollutants or which are recognized as indicators of the presence of other specific pollutants. These five are total nitrogen, total phosphorus, five-day biochemical oxygen demand, sediment, and fecal coliform.

SANITARY SEWERAGE SYSTEMS

Of special importance as sources of water pollution are the sanitary and combined storm and sanitary sewerage systems within the Region. In 1975, a total of 95 public sanitary sewerage systems served a total area of about 353 square miles within the Region, or about 13 percent of the total area of the Region, and a total population of about 1.54 million persons, or nearly 86 percent of the total resident population of the Region. Of the total area served by public sanitary sewers in the Region, over

7 percent was served by combined sewer systems where, by design, sanitary sewage and storm water are collected and conveyed in a single sewer system.

Treatment of wastewater generated from the 95 centralized sanitary sewerage systems was provided at 61 municipal sewage treatment plants throughout the Region, indicating that many of the sanitary sewerage systems are actually subsystems of larger systems which provide wastewater treatment on an areawide basis. For example, the three sewage treatment plants of the Milwaukee-Metropolitan Sewerage Commissions provide service to 24 such subsystems. A total of 60 of these 61 sewage treatment plants discharge treated wastes to the surface waters of the Region. Of these 60, one discharges directly to an inland lake, one discharges to both the groundwater reservoir and to an inland lake, and eight discharge directly to Lake Michigan.

As of 1975, all of the 61 municipal sewage treatment plants were equipped to provide at least a secondary level of waste treatment, two were equipped to provide a tertiary level of waste treatment, and 26 were equipped to provide an advanced level of waste treatment. All of the plants except two provided auxiliary waste treatment for effluent disinfection.

The total effluent discharged from the 61 municipal sewage treatment plants in the Region was about 293 mgd. Of this total, over 87 percent was discharged directly to Lake Michigan, and an additional 4 percent was discharged to streams draining directly to Lake Michigan. Less than 1 percent was discharged to the groundwater reservoir, leaving only about 8 percent discharged to streams which drain ultimately to the Mississippi River. Clearly, the waters in the Lake Michigan basin bear the greatest burden of sanitary wastewater assimilation in the Region.

In addition to the 61 municipal sewage treatment plants, there were in 1975 a total of 67 privately-owned wastewater treatment plants serving isolated enclaves of urban land use development, inclusive of 25 facilities for the treatment of wastes predominantly industrial in nature, as opposed to domestic or sanitary. A total of 39 of these 67 private wastewater treatment facilities discharge to the surface waters of the Region and 28 discharge to land application or soil absorption systems. Thus, there were in all, a total of 128 municipal and private wastewater treatment facilities in operation within the Region in 1975, of which all but 29 discharge to the Region's inland surface waters or to Lake Michigan.

Of the 61 municipal sewage treatment plants serving the centralized sanitary sewerage systems in the Region, 17 were found to be operating over their design capacity when comparing annual average loading to the plant hydraulic capacity, indicating that the plant capacity is probably exceeded during both dry weather months and wet weather months or months of high groundwater. These plants accounted for about 40 mgd, or 13 percent of the average daily wastewater flow from public sewage treatment facilities within the Region. It should be noted that in all of these instances, the communities operating the overloaded facilities have acted to either begin construction or engineering studies to provide new or expanded treatment facilities. In addition to the 17 municipal plants which are operating over their design capacity, based on average annual flow, there are 14 plants which exceeded their design flow during at least one monthly reporting period during the year, indicating that the facilities may be experiencing overloading only during periods of high wastewater flows due to wet weather or high groundwater conditions. These plants accounted for about 28.3 mgd, or about 10 percent of the average daily sewage flow within the Region. Clear water infiltration and storm water inflow into separate sanitary sewer systems are one of the major causes of such peak flow waste treatment problems.

The inventory of pollution sources included the identification of the known points of flow relief in the separate sanitary sewerage systems, and the combined storm and sanitary sewerage systems. These included all known points at which untreated wastewater is presently discharged to surface waters in the Region, particularly during periods of wet weather and peak wastewater flows. Of the 61 public sewage treatment facilities serving the Region, 29 had a flow relief device located at the sewage treatment plant, which would allow for direct bypass of untreated or partially treated sewage at times when the plant capacity is exceeded or the plant is rendered inoperable. There were in 1975 an additional 464 known flow relief devices on the sanitary sewerage systems tributary to the wastewater treatment plants within the Region. In addition, there were a total of 126 combined storm and sanitary sewerage system overflow points. Annually, these separate and combined sewer overflow devices and bypasses discharged during wet weather an estimated 5,044 million gallons of raw sewage—a flow equivalent to about 5 percent of total annual municipal sewage treatment plant flows. Of this total about 77 percent is estimated to be from combined sewer overflows.

In addition to the municipal and private sewage treatment plants, all other known point sources of wastewater were identified. These other point sources consisted principally of industrial cooling, process, rinse, and wash wastewater outfalls. A total of 452 such outfalls were known to exist within the Region, emanating from 277 industrial or commercial installations. These outfalls were estimated to discharge a total of about 2,800 mgd of industrial wastewaters to the streams and lakes of the Region. Of this 2,800 mgd, about 97 percent is discharged from power plants to Lake Michigan or to rivers tributary to Lake Michigan.

The inventory indicated that in 1975, total expenditures for the operation, maintenance, and capital improvement—including debt retirement—of the public sanitary sewerage systems in the Region approximated $60 million, or about $40 per capita per year, based on the total resident population served by sanitary sewers. Of this total, about $42.1 million, or $28 per capita was expended for capital improvements.

Of the resident population of the Region, about 246,000 persons, or 14 percent, rely on private, onsite, sewage disposal systems. Of this total, about 113,500 persons, or about 6 percent of the total regional population, reside in concentrated areas of urban development having at least 32 housing units within a U.S. Public Land Survey quarter section. These scattered quarter sections of urban concentrations total about 145 square miles of urban land use, or slightly over five percent of the total area of the Region.

An inventory was also conducted of all local plans and engineering reports relating to the future provisions of sanitary sewerage service in the Region. This inventory indicated that 72 local units of government in the Region have proposed the extension of centralized sanitary sewerage service to a total of 373 additional square miles of land throughout the Region.

URBAN STORM WATER MANAGEMENT SYSTEMS

Engineered urban storm water management systems are important to any inventory of water pollution sources because such systems provide conveyance facilities which deliver the pollutants associated with storm water runoff directly to receiving surface waters. Accordingly, an inventory was made of the location and tributary drainage areas of all urban storm sewer outlets 30 inches or more in diameter, and the frequency, amount, and probable quality of the associated discharges were estimated. A total of 55 engineered urban storm water management systems consisting of a combination of piped and channelized drains and in some cases natural surface drainage channels were identified in the inventory. Storm sewer mapping was available for 48 of these 55 systems. Within these 48 systems, a total of 1,358 outfalls were known to exist. These systems serve a total area of about 190 square miles, or about seven percent of the total area of the Region, in which a total of about 1.50 million persons reside, or nearly 84 percent of the total population of the Region. In addition to natural drainageways, constructed or improved surface channels, and subsurface conduits—inclusive of storm sewers and combined storm and sanitary sewers—these systems also include pumping stations, detention-retention basins, and a few experimental installations for the treatment of combined sewer overflows.

The total runoff discharged from these engineered stormwater drainage systems—excluding the combined sewer systems—in the Region during 1975 was estimated at about 22,900 million gallons (mg). Of this total, 21,400 mg, or nearly 94 percent, were discharged to the Lake Michigan basin.

DIFFUSE SOURCES OF POLLUTION

Urban diffuse sources of pollution include residential, industrial, commercial, mining, construction, transportation and recreational land uses, dredging and channelization, and onsite sewage disposal systems. Rural sources include wetlands, and agricultural and silvicultural land uses—including croplands, pasturelands, woodlands, orchards and nurseries—and air pollution fallout and washout directly to surface waters. Pollutant channel loads from diffuse sources were estimated to determine the relative amounts of pollutants generated from the various sources, using data available from within the Region, or from studies conducted near the Region and under similar conditions to those found in southeastern Wisconsin.

Analysis of the watershed pollutant loadings from nonpoint pollution sources indicates that for the Region as a whole, runoff from cropland and other storm water runoff from rural lands is the largest single nonpoint source contributor of nitrogen and sediment. Livestock operations are estimated to constitute the greatest nonpoint source of phosphorus, biochemical oxygen demand, and fecal coliform organisms. In the predominantly agricultural watersheds—the Fox River, Milwaukee River, Rock River, Des Plaines River, Sauk Creek, Sucker Creek, and Sheboygan River—the major diffuse sources of pollutants are thus cropland runoff and livestock operations.

The urban and urbanizing watersheds have a greater variety of major pollution sources. The Oak Creek and Barnes Creek watersheds remain primarily agricultural with regard to the areal extent of land uses, but construction activities are estimated to be of sufficient magnitude to contribute a potentially larger amount of sediment and phosphorus than cropland or livestock operations. In the Pike Creek subwatershed, construction activities are estimated to contribute the greatest amount of phosphorus and sediment, while septic systems may contribute the largest number of fecal coliform organisms. In the Menomonee River watershed as a whole, the analyses indicate that cropland runoff is the major potential nonpoint contributor only for total nitrogen, while transportation land uses, which serve the urbanized area, contribute the largest amount of sediment. However, it should be recognized that for the predominantly agricultural subwatersheds of the Menomonee River watershed, agricultural activities are identified in the Commission comprehensive plan for the Menomonee River watershed as the largest source of pollutants to the surface waters. Only in the Kinnickinnic River watershed, the most highly urbanized watershed in the Region, are agricultural sources not the major source of one or more pollutants. Estimates indicate that residential land uses contribute the largest nonpoint amount of nitrogen, fecal coliform, and biochemical oxygen demand; construction activities are the largest nonpoint contributor of phosphorus and sediment in this watershed (see Table 389).

SOIL AND WATER CONSERVATION PRACTICES

In order to estimate the extent of the existing soil and water conservation practices within the Region, a review of information from the U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, and Soil Conservation Service, was conducted. As of 1975, and after over 30 years of effort since the first soil and water conservation District in the Region was established in 1944, farm conservation plans had been prepared by the U.S. Soil Conservation Service for only 19 percent of the agricultural land within the Region. Even prior to this time, some educational efforts were begun to encourage farmers to reduce erosion and thereby preserve soil productivity. A total of 5,895 applications of soil and water conservation practices were installed onto about 4 percent of the agricultural land in the Region during the ten-year period ending in 1975. It should be noted that some of these practices can be, and indeed were implemented on lands for which no farm conservation plans were prepared, but nevertheless could be expected to result in reduced nonpoint contributions.

The 1976 replacement costs of conservation practices in place within the Region was estimated to total about $9.7 million, or an equivalent of about $6.57 per acre of the total rural land within the Region. Of the total estimated expenditures on conservation practices, about $4.07 per acre of total rural land, or about 62 percent of the total investment, were related to those practices directly affecting water quality, the remainder being for practices which serve primarily to enhance the productivity of the land surface for crop growth. This represents about 34 percent of the estimated cost per acre of rural land to implement water quality control elements included in conventional SCS farm plans, based on a sample analysis of the implementation costs of 56 farm plans.

TOTAL POLLUTANT LOADINGS REGIONWIDE

By comparing the estimated pollutant loadings from diffuse sources, to contributions from the known point sources of pollution, the Commission was able to estimate the relative potential of diffuse pollution sources compared to point sources for each particular pollutant.

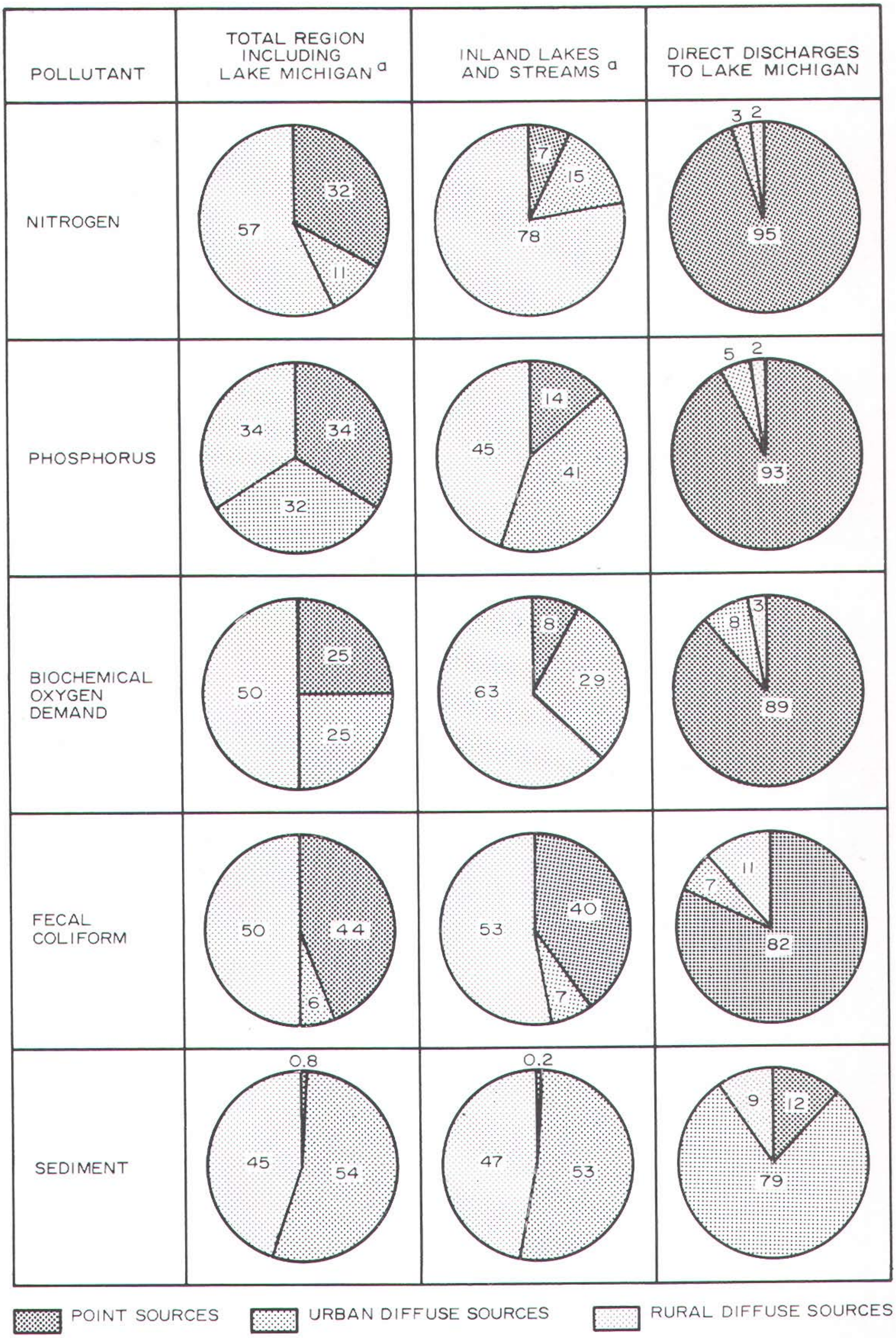
The relative contributions of pollutant loads from various urban and rural diffuse sources and from point sources are presented in summary form in Table 390 and Figure 87 for the inland lakes and streams and for direct discharges to Lake Michigan; for direct discharges to Lake Michigan; and for the Region as a whole. The pollutant loading analysis areas are shown on Map 87. The estimated annual pollutant loads to all surface waters of the Region and the portion of the Milwaukee River watershed located outside of the Region—including the inland lakes and streams, and Lake Michigan, are 45,648,000 pounds of nitrogen, 6,670,000 pounds of phosphorus, 113,104,000 pounds of biochemical oxygen demand, 3.2 x 10^{17} fecal coliform counts, and 6,700,000 tons of sediment. Of this total, 28 percent of the nitrogen, 26 percent of the phosphorus, 22 percent of the biochemical oxygen demand, 6 percent of the fecal coliform, and 5 percent of the sediment are contributed directly to Lake Michigan as point source discharges or runoff from direct tributary areas not including Barnes, Pike, or Sucker Creeks, the small perennial streams which discharge directly to the Great Lake. The remaining 72 percent of the nitrogen, 74 percent of the phosphorus, 78 percent of the biochemical oxygen demand, 94 percent of the fecal coliform, and 95 percent of the sediment are contributed as channel loads to the inland lakes and streams of the Region—some draining ultimately to the Mississippi River, and others draining ultimately to Lake Michigan—and are discussed by watershed in greater detail elsewhere in this report.

The areas directly tributary to Lake Michigan—and not contained within one of the major watersheds previously discussed—include major sewage treatment plants and their outfalls, and other point sources discharges, and also generate diffuse source pollutants, which, due to the magnitude of the pollutant loads and proximity to the Lake, induce a potentially detrimental effect on the quality of the coastal waters. This tributary area is about 62 square miles in size, and based on the 1970 land use and assumed unit-loading values, has an estimated annual diffuse source contribution of about 618,000 pounds of nitrogen, 112,000 pounds of phosphorus, 2,872,000 pounds of biochemical oxygen demand, 4.2 x 10^{15} fecal coliform counts, and 278,000 tons of sediment.

Direct point source pollutant discharges to Lake Michigan from public sewage treatment plants, including the Jones Island, South Shore, and South Milwaukee sewage treatment plants in Milwaukee County; the Kenosha, North Park, Pleasent Park, and Racine sewage treatment plants in Kenosha and Racine Counties; the Port Washington sewage treatment plant in Ozaukee County; five private sewage treatment plant outfalls; eight combined sewer flow relief devices; 87 separate sanitary sewer flow relief devices; and 67 outfalls of industrial and other wastewaters, contributed an estimated 12,225,000 pounds of nitrogen, 1,604,000 pounds of phosphorus, 22,238,000 pounds of biochemical oxygen demand, 1.8 x 10^{16} fecal coliform counts, and 39,100 tons

Figure 87

PERCENTAGE OF DISTRIBUTION OF POLLUTANT LOADS TO SURFACE WATERS IN SOUTHEASTERN WISCONSIN: 1975



[a] INCLUDES POLLUTION LOADINGS FROM APPROXIMATELY 264 SQUARE MILES OF THE MILWAUKEE RIVER WATERSHED LOCATED OUTSIDE OF THE REGION

Source: SEWRPC.

Table 389

SIGNIFICANT SOURCES[a] OF WATER POLLUTION IN THE MAJOR WATERSHEDS OF SOUTHEASTERN WISCONSIN

Watershed	Pollutant									
	Nitrogen		Phosphorus		BOD_5		Fecal Coliform		Sediment	
	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load	Source	Estimated Contribution as Percent of Total Estimated Load
Des Plaines River	Cropland, Pasture and Unused Rural Land Livestock	67 21	Livestock Construction Cropland, Pasture and Unused Rural Land	44 21 18	Livestock Cropland, Pasture and Unused Rural Land Septic Systems	35 30 20	Livestock Septic Systems	88 11	Cropland, Pasture and Unused Rural Land Construction	65 22
Fox River	Cropland, Pasture and Unused Rural Land Livestock	54 20	Livestock Construction Municipal Sew. Treat. Plants Extractive Cropland, Pasture and Unused Rural Land	30 30 12 11 11	Livestock Cropland, Pasture and Unused Rural Land Septic Systems Atmospheric Contributions to Surface Waters	31 22 14 15	Livestock	89	Cropland, Pasture and Unused Rural Land Construction Extractive	41 38 14
Kinnickinnic River	Combined Sewer Overflow Residential Transportation	25 18 17	Combined Sewer Overflow Industrial Discharges Construction	38 24 21	Industrial Discharges Combined Sewer Overflow Residential	43 24 10	Combined Sewer Overflow	97	Construction Transportation	46 31
Menomonee River	Cropland, Pasture and Unused Rural Land Transportation Construction	23 20 11	Construction Combined Sewer Overflow	35 18	Transportation Septic Systems Combined Sewer Overflow	26 16 16	Combined Sewer Overflow	84	Transportation Construction Cropland, Pasture and Unused Land	47 35 10
Milwaukee River	Cropland, Pasture and Unused Rural Land Livestock	50 27	Livestock Construction Cropland, Pasture and Unused Rural Land	43 23 11	Livestock Cropland, Pasture and Unused Rural Land	41 23	Livestock Combined Sewer Overflow Municipal Sew. Treat. Plants	38 33 26	Cropland, Pasture and Unused Rural Land Construction	51 35
Minor Streams Tributary to Lake Michigan Barnes Creek	Cropland, Pasture and Unused Rural Land Construction Septic Systems	40 31 17	Construction Extractive Septic Systems	71 12 12	Septic Systems Construction Cropland, Pasture and Unused Rural Land	62 16 10	Septic Systems	91	Construction Extractive Cropland, Pasture and Unused Rural Land	76 13 11
Pike Creek	Cropland, Pasture and Unused Rural Land Construction Residential	32 28 14	Construction	78	Residential Septic Systems Commercial Construction Industrial Discharges	22 16 15 14 10	Septic Systems Sew. Flow Relief Devices Industrial	27 24 21	Construction Cropland, Pasture and Unused Rural Land	81 11

Table 389 (continued)

Watershed	Nitrogen Source	Nitrogen: Estimated Contribution as Percent of Total Estimated Load	Phosphorus Source	Phosphorus: Estimated Contribution as Percent of Total Estimated Load	BOD_5 Source	BOD_5: Estimated Contribution as Percent of Total Estimated Load	Fecal Coliform Source	Fecal Coliform: Estimated Contribution as Percent of Total Estimated Load	Sediment Source	Sediment: Estimated Contribution as Percent of Total Estimated Load
Minor Streams Tributary to Lake Michigan (cont) Sucker Creek	Livestock Cropland, Pasture and Unused Rural Land	47 42	Livestock Construction[b]	59 32	Livestock Cropland, Pasture and Unused Rural Land	65 19	Livestock	98	Construction[b] Cropland, Pasture and Unused Rural Land	49 43
Oak Creek	Cropland, Pasture and Unused Rural Land Construction	47 20	Construction	69	Cropland, Pasture and Unused Rural Land Transportation Septic Systems Residential	18 18 15 14	Septic Systems Livestock Residential Industrial	35 21 17 12	Construction Cropland, Pasture and Unused Rural Land Transportation	61 18 14
Pike River	Cropland, Pasture and Unused Rural Land	72	Construction Cropland, Pasture and Unused Rural Land	49 17	Cropland, Pasture and Unused Rural Land Septic Systems	34 27	Municipal Sew. Treat. Plants Livestock Septic Systems	51 25 17	Cropland, Pasture and Unused Rural Land Construction	49 42
Rock River	Cropland, Pasture and Unused Rural Land Livestock	61 24	Livestock Construction Municipal Sew. Treat. Plants Cropland, Pasture and Unused Rural Land	41 23 13 13	Livestock Cropland, Pasture and Unused Rural Land Atmospheric Contributions to Surface Water	41 27 13	Livestock	96	Cropland, Pasture and Unused Rural Land Construction	56 31
Root River	Cropland, Pasture and Unused Rural Land Livestock Septic Systems	60 12 10	Construction Livestock Septic Systems Cropland, Pasture and Unused Rural Land	34 19 11 13	Septic Systems Cropland, Pasture and Unused Rural Land Livestock	35 22 16	Livestock Combined Sewer Overflow Septic Systems	42 30 19	Cropland, Pasture and Unused Rural Land Construction	46 38
Sauk Creek	Livestock Cropland, Pasture and Unused Rural Land	50 46	Livestock Cropland, Pasture and Unused Rural Land	83 10	Livestock Cropland, Pasture and Unused Rural Land	70 19	Livestock	98	Cropland, Pasture and Unused Rural Land	81
Sheboygan River	Cropland, Pasture and Unused Rural Land Livestock	65 28	Livestock Cropland, Pasture and Unused Rural Land	70 21	Livestock Cropland, Pasture and Unused Rural Land	50 34	Livestock	97	Cropland, Pasture and Unused Rural Land	85
Region	Cropland, Pasture and Unused Rural Land Livestock	54 22	Livestock Construction Cropland, Pasture and Unused Rural Land	33 28 11	Livestock Cropland, Pasture and Unused Rural Land Septic Systems	32 22 13	Livestock Combined Sewer Overflow Municipal Sew. Treat. Plants	53 29 10	Cropland, Pasture and Unused Rural Land Construction	45 36

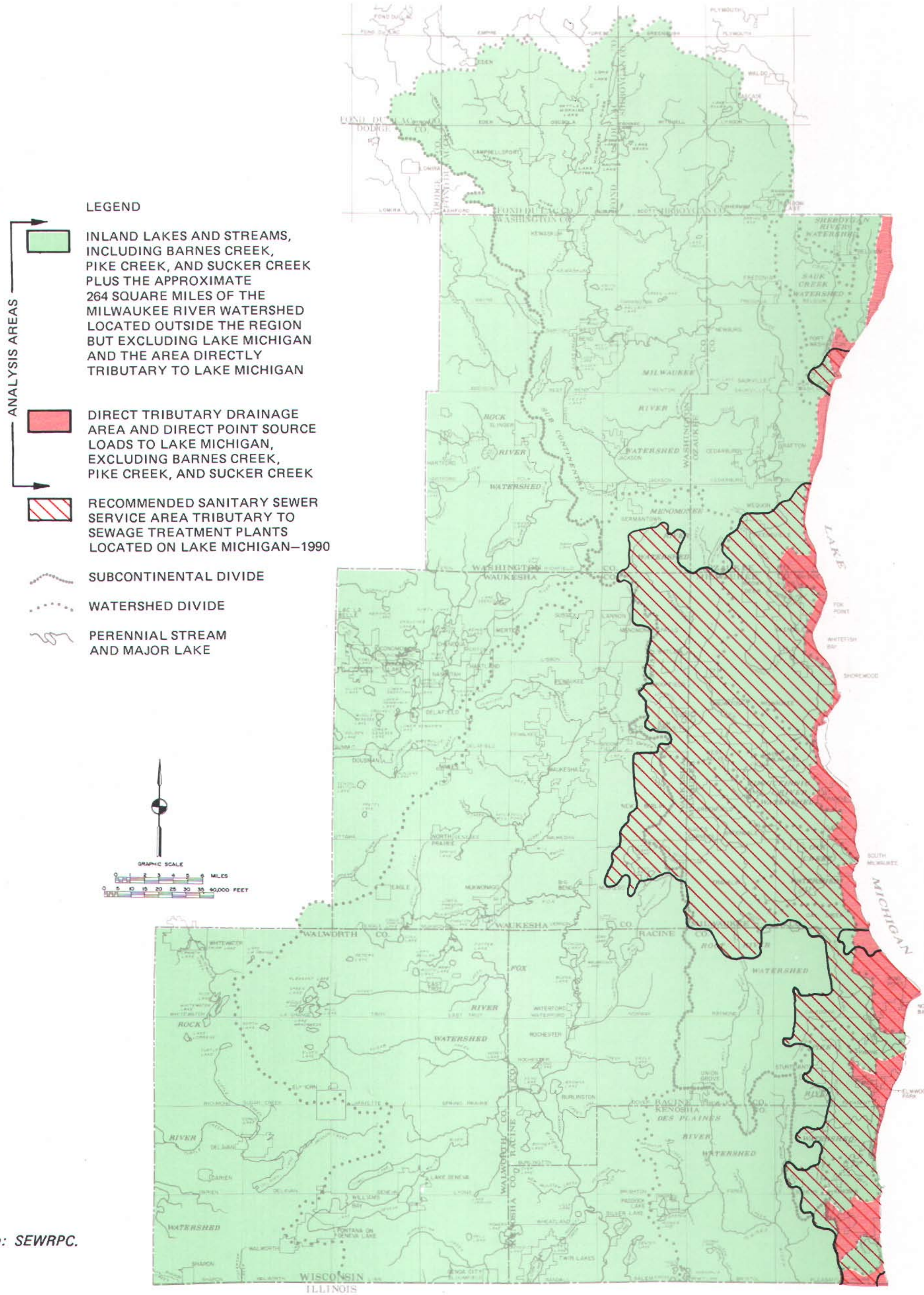
[a] *Defined as those sources contributing 10 percent or more of the potential load of the pollutant.*

[b] *Construction activities are identified as a significant pollution source in the Sucker Creek Watershed because of the construction of Hwy I-43.*

Source: SEWRPC.

Map 87

POLLUTANT LOADING ANALYSIS AREAS FOR SOUTHEASTERN WISCONSIN



Source: SEWRPC.

of sediment to Lake Michigan in 1975. Therefore, the estimated potential total pollution load to Lake Michigan from sources not previously addressed in the inland watershed discussions is 12,843,000 pounds of nitrogen, 1,723,000 pounds of phosphorus, 25,110,000 pounds of biochemical oxygen demand, 2.2 x 10^{16} fecal coliform counts, and 317,200 tons of sediment. These contributions, because of their proximity and direct impacts on Lake Michigan, are important beyond their relative magnitude; and these pollutant contributions to Lake Michigan from this area of approximately 4 percent of the Region, are in fact, a significant proportion when compared to the total potential load to the inland lakes and streams of the Region.

Point sources contribute 32 percent of the nitrogen, 34 percent of the phosphorus, 26 percent of the biochemical oxygen demand, 44 percent of the fecal coliform, and 1 percent of the sediment contributed to all surface waters—including Lake Michigan—in the Region. Urban diffuse sources account for 11 percent of the nitrogen, 32 percent of the phosphorus, 25 percent of the biochemical oxygen demand, 8 percent of the fecal coliform, and 54 percent of the sediment. Rural diffuse sources account for 57 percent of the nitrogen, 34 percent of the phosphorus, 50 percent of the biochemical oxygen demand, 50 percent of the fecal coliform, and 45 percent of the sediment contributed to the Region's surface waters—including Lake Michigan.

Of the pollutants contributed directly to Lake Michigan, without passing through one of the intervening perennial streams in the Region, point source contributions comprise 95 percent of the nitrogen, 93 percent of the phosphorus, 89 percent of the biochemical oxygen demand, 82 percent of the fecal coliform, and 12 percent of the sediment. Urban diffuse sources contribute only 2 percent of the nitrogen, 5 percent of the phosphorus, 8 percent of the biochemical oxygen demand, 7 percent of the fecal coliform, and 78 percent of the sediment directly discharged to Lake Michigan. Rural sources are estimated to contribute only 2 percent of the nitrogen, 2 percent of the phosphorus, 3 percent of the biochemical oxygen demand, 11 percent of the fecal coliform, and about 9 percent of the sediment discharged directly to Lake Michigan.

Because the pollutant loads contributed directly to Lake Michigan do not contribute to the degradation of the inflowing inland lakes and streams—which are the subject of the areawide water quality management planning program—in the Region, and because a pollutant loading analysis of Lake Michigan is beyond the scope of the initial areawide water quality management planning program,[1] these direct pollutant loads are not evaluated in the analyses of the Regional total pollutant loads to inland waters. The estimated loads are reported above in order to assess the relative magnitude of the major pollution sources expected from the Region to Lake Michigan, and to illustrate the relative sizes of the total loads to inland waters and the direct loads to Lake Michigan. It is anticipated that such information may be of use for ongoing studies by the International Joint Commission, and for possible future studies of the Commission through the continuing water quality management planning program.

Based on annual loading estimates to the inland streams and lakes, point sources contribute only 7 percent of the nitrogen, 14 percent of the phosphorus, 8 percent of the biochemical oxygen demand, 40 percent of the fecal coliform, and 0.2 percent of the sediment. Urban diffuse sources produce an estimated 14 percent of the nitrogen, 41 percent of the phosphorus, 30 percent of the biochemical oxygen demand, 16 percent of the fecal coliform, and 53 percent of the sediment contributed to inland lakes and streams. Rural diffuse sources contribute about 78 percent of the nitrogen, 45 percent of the phosphorus, 63 percent of the biochemical oxygen demand, 52 percent of the fecal coliform, and 46 percent of the sediment which enter the Region's inland lakes and streams as channel loads.

TOTAL POLLUTANT LOADINGS TO PERENNIAL STREAMS AND INLAND LAKES

The comparison of significant pollution sources presented in Chapter VI indicates that the proportion of the pollutant channel load attributable to a specific source ranges from about 10 to more than 95 percent in the various inland watersheds of the Region. Significant sources were defined as those which potentially contribute at least 10 percent of a given pollutant within a watershed. These significant pollution sources to inland lakes and streams are summarized by watershed in Table 389.

Municipal and private sewage treatment plants and sewage flow relief devices are estimated to contribute more than 10 percent of the total phosphorus load in the Fox River, Kinnickinnic River, Menomonee River, Milwaukee River, Rock River, and Root River watersheds. In addition, all sanitary sewage-related categories of point sources together contribute more than 10 percent of the total fecal coliform load in the Milwaukee River watershed. In the Menomonee and Kinnickinnic River watersheds, municipal and private sewage treatment plants and flow relief devices account for more than 10 percent

[1] *The International Joint Commission, in cooperation with the Wisconsin Department of Natural Resources, the University of Wisconsin, and SEWRPC, is conducting detailed research on the quantification and analysis of water pollution sources and problems in the Great Lakes drainage area.*

of the total loads of all pollutants except sediment. In the Milwaukee River watershed, the Root River watershed, the Pike Creek drainage area of the watershed of streams directly draining to Lake Michigan, and the Pike River watershed, these sanitary sewage-related point sources in the aggregate, are estimated to contribute more than 10 percent of the fecal coliform load.

Point source industrial discharges account for 10 percent or more of the total phosphorus and biochemical oxygen demand loads only in the Kinnickinnic River watershed. This is in marked contrast to what might be expected in a highly urbanized and industrial region. This good situation in southeastern Wisconsin is in large part attributable to the treatment of industrial wastes in municipal sewage treatment plants, a practice developed by design over many years of wastewater management.

Of the urban diffuse sources, construction-related activities, septic systems, transportation activities, and residential land uses are the primary sources, based on the estimated total pollution loads. Construction-related activities accounted for 10 percent or more of the total phosphorus and sediment load to all watersheds except Sauk Creek and the Sheboygan River watersheds, both predominantly agricultural. Septic systems are estimated to contribute more than 10 percent of the total biochemical oxygen demand load for the Des Plaines River, Fox River, Menomonee River, Barnes Creek, Pike Creek, Oak Creek, Pike River, and Root River watersheds. In addition, the fecal coliform contributions attributed to septic systems contributed more than 10 percent of the total load in the Des Plaines River, Barnes Creek, Pike Creek, Oak Creek, Pike River, and Root River watersheds, and more than 10 percent of the total phosphorus loads in the Barnes Creek, and Root River watersheds. Transportation-related activities are important as sources of the total sediment load in the Kinnickinnic River, Menomonee River, and Oak Creek watersheds, as sources of the total nitrogen load in the Kinnickinnic River and Menomonee River watersheds; and as sources of the total biochemical oxygen demand loads in the Menomonee River and Oak Creek watersheds. Residential land uses are important contributors of total nitrogen and biochemical oxygen demand loads in the Kinnickinnic River and Pike Creek watersheds.

No rural point sources of pollution are known to exist in the Region, since none of the livestock operations in the Region is of sufficient size to constitute a point source as defined herein on the basis of size. As of 1975, the 2,336 known domestic livestock operations in the Region, having more than 25 animals, included a total of 852,330 animals—beef and dairy cattle, hogs, horses, fowl, sheep, mink, and goats—or about 226,000 "animal units," each approximately equivalent to a 1,000 pound dairy cow. Of the total, 1,043 operations, or 45 percent, were located within 500 feet of a stream or lake, and because of their proximity are potentially subject to a field inspection and subsequent determination, by the Department of Natural Resources and Environmental Protection Agency, that they are situated close enough to a watercourse to be considered point sources. Of these, only twelve, or one-half of one percent of the total, were of significant size (greater than 300 animal units) to be considered as highest priority for such potential inspection.

Livestock operations—including the disposal of manure on cropland—contribute more than 10 percent of the total nitrogen, phosphorus, biochemical oxygen demand, and fecal coliform loads for the Des Plaines River, Fox River, Milwaukee River, Sucker Creek, Rock River, Root River, Sauk Creek and Sheboygan River watersheds. In addition, livestock operations are significant sources of fecal coliform in the Oak Creek watershed, and the Pike River watershed. Cropland and other rural storm water runoff is a significant contributor of nitrogen, phosphorus, biochemical oxygen demand, and sediment in the Des Plaines River, Fox River, Milwaukee River, Pike River, Rock River, Root River, Sauk Creek and Sheboygan River watersheds; and of nitrogen, biochemical oxygen demand, and sediment in the Barnes Creek, Sucker Creek, and Oak Creek watersheds.

In summary, the Kinnickinnic River, Menomonee River, Barnes Creek, Pike Creek, and Oak Creek watersheds are affected most by urban sources of pollution; whereas rural pollution sources are dominant in the Des Plaines River, Fox River, Milwaukee River, Sucker Creek, Rock River, Sauk Creek, and Sheboygan River watersheds. The pollution sources to the Pike River and Root River could not be classified as being primarily urban or rural, since both types of land uses are about equally important.

CONCLUSION

The areawide water quality management planning program for southeastern Wisconsin has identified all significant sources of water pollution within the Region and has estimated the relative potential pollutant loads to each major inland stream system from these sources. The inventory findings indicate the compelling significance of diffuse source water pollution from urban and rural storm runoff and support the need to develop and implement water quality management plans for the major watersheds of the Region. The significant sources of pollutants considered in the inventory are presented in Table 390.

The following conclusions may be drawn about the existing sources of water pollution in southeastern Wisconsin:

Table 390

ESTIMATED TOTAL OF AVERAGE ANNUAL LOADS OF POLLUTANTS TO RECEIVING WATERS (INCLUDING LAKE MICHIGAN) OF SOUTHEASTERN WISCONSIN[a]: 1975

Source	Parameter	Total Region Including Lake Michigan		Total Inland Lakes and Streams		Lake Michigan - Direct Drainage and Direct Point Source Contributions	
		Load	Percent of Total	Load	Percent of Total	Load	Percent of Total
Urban Point Sources							
Municipal Sewage Treatment Plants	Total Nitrogen (pounds/year)	13,897,660	30.4	1,917,960	5.8	11,979,700	93.1
	Total Phosphorus (pounds/year)	2,028,760	30.4	459,920	9.3	1,568,840	91.0
	Biochemical Oxygen Demand (pounds/year)	23,321,140	20.6	2,122,520	2.4	21,198,620	84.4
	Fecal Coliform (counts/year)	2.95×10^{16}	9.2	2.9×10^{16}	9.8	9.0×10^{14}	4.1
	Sediment (tons/year)	23,065	0.3	1,620	0.0	21,445	6.8
Private Sewage Treatment Plants	Total Nitrogen (pounds/year)	114,510	0.3	101,360	0.3	13,150	0.1
	Total Phosphorus (pounds/year)	38,770	0.6	38,150	0.8	620	0.0
	Biochemical Oxygen Demand (pounds/year)	384,540	0.3	140,160	0.2	244,380	1.0
	Fecal Coliform (counts/year)	6.2×10^{13}	0.0	6.2×10^{13}	0.0	–	0
	Sediment (tons/year)	215	0.0	85	0.0	130	0.0
Combined Sewer Overflow	Total Nitrogen (pounds/year)	324,670	0.7	275,460	0.8	49,210	0.4
	Total Phosphorus (pounds/year)	162,350	2.4	137,740	2.8	24,610	1.4
	Biochemical Oxygen Demand (pounds/year)	3,246,750	2.9	2,754,690	3.1	492,060	2.0
	Fecal Coliform (counts/year)	1.04×10^{17}	32.5	8.8×10^{16}	29.4	1.6×10^{16}	72.7
	Sediment (tons/year)	4,870	0.1	4,130	0.1	740	0.2
Industrial Discharges	Total Nitrogen (pounds/year)	291,720	0.6	116,470	0.4	175,250	1.4
	Total Phosphorus (pounds/year)	48,810	0.7	41,280	0.8	7,530	0.4
	Biochemical Oxygen Demand (pounds/year)	1,654,430	1.4	1,423,700	1.6	230,730	0.9
	Fecal Coliform (counts/year)	3.3×10^{12}	0.0	3.3×10^{12}	0.0	–	0
	Sediment (tons/year)	22,845	0.3	6,065	0.1	16,780	5.3
Sanitary Sewer Flow Relief Devices	Total Nitrogen (pounds/year)	28,820	0.1	21,590	0.1	7,230	0.1
	Total Phosphorus (pounds/year)	9,610	0.1	7,200	0.1	2,410	0.1
	Biochemical Oxygen Demand (pounds/year)	287,980	0.2	215,670	0.2	72,310	0.3
	Fecal Coliform (counts/year)	5.0×10^{15}	1.6	3.3×10^{15}	1.1	1.1×10^{15}	5.0
	Sediment (tons/year)	135	0.0	100	0.0	35	0.0
Point Source Total	Total Nitrogen (pounds/year)	14,657,380	32.1	2,432,840	7.4	12,224,540	95.0
	Total Phosphorus (pounds/year)	2,288,300	34.2	684,290	13.8	1,604,010	93.1
	Biochemical Oxygen Demand (pounds/year)	28,894,840	25.5	6,656,740	7.6	22,238,100	88.6
	Fecal Coliform (counts/year)	1.4×10^{17}	43.7	1.2×10^{17}	40.3	1.8×10^{16}	81.8
	Sediment (tons/year)	51,130	0.8	12,000	0.2	39,130	12.3
Urban Diffuse Sources							
Residential	Total Nitrogen (pounds/year)	635,430	1.4	590,610	1.8	44,820	0.4
	Total Phosphorus (pounds/year)	50,840	0.8	47,250	1.0	3590	0.2
	Biochemical Oxygen Demand (pounds/year)	3,860,220	3.4	3,587,940	4.1	272,280	1.1
	Fecal Coliform (counts/year)	2.6×10^{15}	0.8	2.4×10^{15}	0.8	1.8×10^{14}	0.8
	Sediment (tons/year)	43,290	0.6	40,235	0.6	3,055	1.0
Commercial	Total Nitrogen (pounds/year)	235,220	0.5	221,120	0.7	14,100	0.1
	Total Phosphorus (pounds/year)	19,610	0.3	18,440	0.4	1,170	0.1
	Biochemical Oxygen Demand (pounds/year)	2,550,720	2.3	2,397,840	2.7	152,880	0.6
	Fecal Coliform (counts/year)	8.5×10^{14}	0.3	8.1×10^{14}	0.3	4.0×10^{13}	0.2
	Sediment (tons/year)	9,730	0.1	9,145	0.1	585	0.2
Industrial	Total Nitrogen (pounds/year)	138,620	0.3	125,980	0.4	12,640	0.1
	Total Phosphorus (pounds/year)	11,550	0.2	10,500	0.2	1050	0.1
	Biochemical Oxygen Demand (pounds/year)	608,900	0.5	553,380	0.6	55520	0.2
	Fecal Coliform (counts/year)	1.0×10^{15}	0.3	9.3×10^{14}	0.3	7.0×10^{13}	0.3
	Sediment (tons/year)	8,045	0.1	7,310	0.1	735	0.2
Extractive	Total Nitrogen (pounds/year)	481,740	1.0	481,740	1.5	0	0.0
	Total Phosphorus (pounds /year)	361,330	5.4	361,330	7.3	0	0.0
	Biochemical Oxygen Demand (pounds/year)	963,480	0.8	963,480	1.1	0	0.0
	Fecal Coliform (counts/year)	0	0.0	0	0.0	0	0.0
	Sediment (tons/year)	602,175	9.0	602,175	9.4	0	0.0
Transportation	Total Nitrogen (pounds/year)	710,650	1.6	563,880	1.7	146,770	1.0
	Total Phosphorus (pounds/year)	50,530	0.8	41,750	0.8	8780	0.5
	Biochemical Oxygen Demand (pounds/year)	4,634,650	4.1	3,637,390	4.1	997260	4.0
	Fecal Coliform (counts/year)	1.9×10^{15}	0.6	1.5×10^{15}	0.5	4.2×10^{14}	1.8
	Sediment (tons/year)	599,480	8.9	465,885	7.3	133595	42.1

Table 390 (continued)

Source	Parameter	Total Region Including Lake Michigan		Total Inland Lakes and Streams		Lake Michigan - Direct Drainage and Direct Point Source Contributions	
		Load	Percent of Total	Load	Percent of Total	Load	Percent of Total
Recreation	Total Nitrogen (pounds/year)	104,300	0.2	99,880	0.3	4,420	0.0
	Total Phosphorus (pounds/year)	3,820	0.1	3,700	0.1	120	0.0
	Biochemical Oxygen Demand (pounds/year)	43,850	0.0	41,350	0.0	2,500	0.0
	Fecal Coliform (counts/year)	7.5×10^{13}	0.0	6.9×10^{13}	0.0	6.2×10^{12}	0.0
	Sediment (tons/year)	7,085	0.1	6,680	0.1	405	0.1
Construction	Total Nitrogen (pounds/year)	1,901,100	4.2	1,813,020	5.5	88,080	0.7
	Total Phosphorus (pounds/year)	1,425,850	21.4	1,359,790	27.5	66,060	3.8
	Biochemical Oxygen Demand (pounds/year)	3802200	3.4	3,626,040	4.1	176,160	0.7
	Fecal Coliform (counts/year)	0	0.0	0	0.0	0	0.0
	Sediment (tons/year)	2376375	35.5	2,266,275	35.5	110,100	34.7
Septic Systems	Total Nitrogen (pounds/year)	812,190	1.7	782,180	2.4	30,010	0.2
	Total Phosphorus (pounds/year)	186,950	2.8	179,860	3.6	7,090	0.4
	Biochemical Oxygen Demand (pounds/year)	11,549,280	10.2	11,121,980	12.6	427,300	1.7
	Fecal Coliform (counts/year)	1.4×10^{16}	4.4	1.3×10^{16}	4.5	1.0×10^{15}	4.5
	Sediment (tons/year)	1,985	0.0	1,910	0.0	75	0.0
Urban Diffuse Source Totals	Total Nitrogen (pounds/year)	4,989,240	10.9	4,678,410	14.3	310,830	2.4
	Total Phosphorus (pounds/year)	2,110,480	31.6	2,022,620	40.9	87,860	5.1
	Biochemical Oxygen Demand (pounds/year)	28,013,300	24.8	25,929,400	29.5	2,083,900	8.3
	Fecal Coliform (counts/year)	2.0×10^{16}	6.4	1.9×10^{16}	6.4	1.7×10^{15}	7.3
	Sediment (tons/year)	3,648,085	54.4	3,399,615	53.3	248,470	78.3
Urban Sources Total	Total Nitrogen (pounds/year)	19,646,620	43.0	7,111,250	21.7	12,535,370	97.6
	Total Phosphorus (pounds/year)	4,398,780	65.9	2,706,910	54.7	1,691,870	98.2
	Biochemical Oxygen Demand (pounds/year)	56,908,140	50.3	32,586,140	37.0	24,322,000	96.9
	Fecal Coliform (counts/year)	1.7×10^{17}	50.1	1.4×10^{17}	46.8	2.0×10^{16}	90.9
	Sediment (tons/year)	3,699,295	55.2	3,411,615	53.4	287,680	90.7
Rural Diffuse Sources Livestock Operations	Total Nitrogen (pounds/year)	7,188,180	15.7	7,078,700	21.6	109,480	0.9
	Total Phosphorus (pounds/year)	1,670,400	25.0	1,645,050	33.3	25,440	1.5
	Biochemical Oxygen Demand (pounds/year)	28,145,270	24.9	27,716,590	31.5	428,860	1.7
	Fecal Coliform (counts/year)	1.6×10^{17}	49.9	1.6×10^{17}	53.2	2.5×10^{15}	11.4
	Sediment (tons/year)	88,590	1.3	87,240	1.4	1,350	0.4
Crop Land & Pasture Land + Unused Rural Land	Total Nitrogen (pounds/year)	17,954,340	39.3	17,809,620	54.3	144,720	1.1
	Total Phosphorus (pounds/year)	552,420	8.3	548,040	11.1	4,380	0.3
	Biochemical Oxygen Demand (pounds/year)	19,314,620	17.1	19,143,390	21.8	171,230	0.7
	Fecal Coliform (counts/year)	0	0.0	0	0.0	0	0.0
	Sediment (tons/year)	2,874,330	42.9	2,847,490	44.6	26,840	8.5
Silvicultural	Total Nitrogen (pounds/year)	392,670	0.9	377,680	1.2	14,990	0.1
	Total Phosphorus (pounds/year)	23,990	0.4	22,990	0.5	1,000	0.1
	Biochemical Oxygen Demand (pounds/year)	790,290	0.7	755,320	0.9	34,970	0.1
	Fecal Coliform (counts/year)	1.1×10^{14}	0.0	1.1×10^{14}	0.0	1.6×10^{12}	0.0
	Sediment (tons/year)	21,600	0.3	20,600	0.3	1,000	0.3
Air Pollution to Surface Water	Total Nitrogen (pounds/year)	466,420	1.0	428,110	1.3	38,310	0.3
	Total Phosphorus (pounds/year)	24,520	0.4	24,050	0.5	470	0.0
	Biochemical Oxygen Demand (pounds/year)	7,945,600	7.0	7,792,350	8.9	153,250	0.6
	Fecal Coliform (pounds/year)	0	0.0	0	0.0	0	0.0
	Sediment (tons/year)	16,300	0.2	15,990	0.3	310	0.1
Rural Diffuse Source Total	Total Nitrogen (pounds/year)	26,001,610	57.0	25,694,110	78.3	307,500	2.4
	Total Phosphorus (pounds/year)	2,271,430	34.1	2,240,130	45.3	31,300	1.8
	Biochemical Oxygen Demand (pounds/year)	56,195,780	49.7	55,407,650	63.0	788,130	3.1
	Fecal Coliform (pounds/year)	1.6×10^{17}	49.9	1.6×10^{17}	53.2	2.5×10^{15}	11.4
	Sediment (tons/year)	3,000,820	44.8	2,971,320	46.6	29,500	9.3
Total Diffuse Source	Total Nitrogen (pounds/year)	30,990,850	67.8	30,372,520	92.6	618,330	4.8
	Total Phosphorus (pounds/year)	4,374,820	65.5	4,262,750	86.2	112,070	6.5
	Biochemical Oxygen Demand (pounds/year)	84,209,050	74.5	81,337,050	92.4	2,872,000	11.4
	Fecal Coliform (pounds/year)	1.7×10^{17}	56.3	1.7×10^{17}	59.7	4.2×10^{15}	19.1
	Sediment (tons/year)	6,648,905	99.2	6,370,935	99.8	277,970	87.6
Total Sources	Total Nitrogen (pounds/year)	45,648,230	100.0	32,805,360	100.0	12,842,870	100.0
	Total Phosphorus (pounds/year)	6,670,200	100.0	4,947,040	100.0	1,723,160	100.0
	Biochemical Oxygen Demand (pounds/year)	113,103,920	100.0	87,993,790	100.0	25,110,130	100.0
	Fecal Coliform (pounds/year)	3.2×10^{17}	100.0	3.0×10^{17}	100.0	2.2×10^{16}	100.0
	Sediment (tons/year)	6,700,115	100.0	6,382,935	100.0	317,180	100.0

[a] *Includes pollution loadings from the approximate 264 square miles of the Milwaukee River watershed located outside of the Region.*

Source: SEWRPC.

1. Of the total estimated pollutants to the surface waters of southeastern Wisconsin and the portion of the Milwaukee River watershed lying outside the Region, about 28 percent of the nitrogen, 26 percent of the phosphorus, 22 percent of the biochemical oxygen demand, 7 percent of the fecal coliform, and 5 percent of the sediment are contributed directly to Lake Michigan. The remaining 72 percent of the nitrogen, 74 percent of the phosphorus, 78 percent of the biochemical oxygen demand, 93 percent of the fecal coliform, and 95 percent of the sediment are contributed to the inland watersheds. The majority of the pollutants to the inland waters are nonpoint in nature, and the majority of the direct pollutants to Lake Michigan are point sources, although both types of water pollution control are required in both areas.

2. Based on annual loading estimates, point sources of pollution do not comprise the dominant pollution source in most inland watersheds of the Region. Moreover, point source contributions can be expected in the future to be further reduced in their magnitude as a result of local, state, and federal requirements; increased expenditures; and improved wastewater treatment technologies. It should also be noted, that point sources of pollutants are relatively more important with regard to the duration of pollutant contributions—and subsequently the proportion of the time that water of quality standards may be violated—since such sources constitute continuous rather than intermittant loadings to surface waters.

3. Of the point sources of pollution, the domestic, commercial, and sanitary wastewaters, discharged from municipal and private sewage treatment plants and from sanitary and combined sewage flow relief devices, together constitute the most important sources of pollution. On a regional basis, industrial wastewater discharges are only minor sources of water pollution and only contribute from less than 0.1 percent to about 1.4 percent of the total for the five basic pollutants discussed in this report, but can constitute important sources of such "exotic" substances as poisonous metals and dangerous chemicals. For the major watersheds, industrial sources are of minor significance, except with regard to biochemical oxygen demand and phosphorus in the Kinnickinnic River watershed. For more localized stream reaches, selected industrial waste discharges can be expected to be important.

4. Storm water runoff from croplands, pasture, and unused rural lands, is the largest single contributor of nitrogen and sediment to the inland lakes and streams, and is a significant source of phosphorus and BOD_5. Livestock operations are the largest single source of phosphorus, BOD_5, and fecal coliform organisms.

5. Runoff to inland lakes and streams from urban and suburban construction activities is the second largest single contributor of phosphorus—the most recognized direct cause of eutrophic waters—and is the largest urban source of sediment.

6. Livestock operations and septic systems are major diffuse source contributors of fecal coliform, and together account for an estimated 58 percent of the fecal coliform organisms potentially reaching the surface waters. Improperly installed or malfunctioning septic systems are important urban sources of surface water pollution, even in rural subdivisions, and especially in the poorly suited soils which predominate in the eastern half of the Southeastern Wisconsin Region. In addition, flow relief devices, which contribute 30 percent of the total fecal coliform load, to inland lakes and streams, and municipal sewage treatment plants, which contribute 10 percent of the total fecal coliform load, account for nearly all of the remaining fecal coliform loads in the Region.

7. For the eleven major watersheds lying wholly or partially within the Region, the major pollution sources cited in this report should be considered first for the development of the most cost-effective measures for control of the pollutants addressed herein. For subwatershed areas, such as urban areas drained by small streams, more localized and refined pollution source analyses must be conducted in the areawide water quality management planning program. For pollutants such as industrial chemicals or pesticides, data concerning the sources and in-stream water quality or sediment conditions are not currently available to identify the specific problems and control measures needed.

IMPLICATIONS FOR PLANNING

A fortuitous aspect of the inventory findings is that the major potential sources of water pollution—construction activities, cropland runoff, livestock operations, and onsite sewage disposal systems—are relatively cost-effective to control and understood in the development of pollution control measures. The state of the art of control and management of construction sediment, cropland soil erosion, livestock waste, and septic system effluent are better developed and accepted than are the techniques for control of urban storm water runoff. By contrast, it is unfortunate that the nonpoint pollution sources identified here as being very important are probably not generally recognized as such by the citizens of the Region. This is particularly true during a period of major public discussion of the interstate water pollution issues pertaining to point source discharges to Lake Michigan. The information presented in this report on the significant pollution sources within the Region, together with the information on the existing surface water quality conditions within the Region presented in SEWRPC Technical Report No. 17, provide the basis for developing an areawide water quality management plan for southeastern Wisconsin. That plan, and the alternatives developed from the analyzed relationship of pollution sources to instream water quality, will be presented in SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000.

APPENDICES

(This page intentionally left blank)

Appendix A

SELECTED SANITARY SEWERAGE SYSTEM DATA SUMMARIZED BY COUNTY

Table A-1

SELECTED PUBLIC SANITARY SEWERAGE SYSTEMS: 1975

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Area Served (square miles)	Selected Wastewater Treatment Facility Characteristics: Estimated Total Population Served	Selected Wastewater Treatment Facility Characteristics: Annual Average Hydraulic Loading (mgd)	Selected Wastewater Treatment Facility Characteristics: Average Hydraulic Design Capacity (mgd)	Selected Wastewater Treatment Facility Characteristics: Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Flow Relief Devices: Sewer System	Flow Relief Devices: Total Estimated Average Annual Wastewater Discharge (mg)
Kenosha County												
City of Kenosha	9,939	15.53	83,400	Operates a Facility	17.38	89,500	18.40	18.00	Lake Michigan	1 Bypass	2 Relief Pumping Stations 19 Crossovers 4 Combined Sewer Outfalls	300 (C50 = 260, Others = 40)
Village of Paddock Lake	504	0.79	1,900	Operates a Facility	0.79	1,900	0.17	0.32	Marsh Drained by Brighton Creek	1 Bypass	None	< 1.0
Village of Silver Lake	298	0.47	1,300	Operates a Facility	0.47	1,300	0.15	0.30	Fox River	1 Bypass	None	21.0
Village of Twin Lakes	1,478	2.31	3,400	Operates a Facility	2.31	3,400	0.41	0.82	Bassett Creek	None	None	None
Town of Bristol												
Utility District No. 1	459	0.72	800	Operates a Facility	0.72	800	0.07	0.16	Tributary of the Des Plaines River	1 Bypass	None	<1.0
Town of Pleasant Prairie												
Sewer Utility District No. 1	274	0.43	1,600							None	None	None
Sewer Utility District No. 2	183	0.29	600							None	None	None
Sewer Utility District A	111	0.17	400	Contracts with the City of Kenosha	See City of Kenosha Above					None	None	None
Sewer Utility District B	47	0.07	1,100							None	None	None
Sewer Utility District C	14	0.02	700							None	None	None
Sewer Utility District E	22	0.03	200							None	None	None
Sewer Utility Disctict D	436	0.68	1,000	Operates a Facility	0.68	1,000	0.10	0.13	Des Plaines River	None	None	None
Sanitary District No. 73-1	55	0.09	100	Operates a Facility	0.09	100	0.03	0.40	Des Plaines River via Drainage Ditch	None	None	None
Town of Somers												
Sanitary District No. 1	535	0.84	1,500	Contracts with the City of Kenosha	See City of Kenosha Above					1 Bypass	None	2.0
Utility District No. 1	184	0.29	700	Operates a Facility	0.29	700	0.06	0.03	Tributary of the Pike River	None 1 Bypass	None None	None 2.0
Town of Salem												
Sewer Utility District No. 1	240	0.37	1,000	Operates a Facility	0.37	1,000	0.06	0.30	Salem Branch of Brighton Creek	None	None	None
Pleasant Park Sewer Utility	127	0.19	800	Operates a Facility	0.19	800	0.04	0.06	Lake Michigan via Drainage Ditch	None	None	None
Total	14,906	23.29	100,500	–	–	–	–	–	–	6 Bypasses	25	304.0

Table A-1 (continued)

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Area Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge (mg)
Milwaukee County												
Milwaukee-Metropolitan Sewerage Commissions	–	–	–	Jones Island Plant South Shore Plant Hales Corners Plant	207.98 2.99	1,018,900 8,800	137.10 73.70 0.52	200.0 120.0 0.9	Lake Michigan Lake Michigan Root River	None	23 Bypasses 14 Crossovers 10 Relief Pumping Stations 2 Combined Sewer Outfalls Portable Pumping Stations	143
City of Cudahy	3,036	4.74	21,700	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	22 Crossovers	44.0
City of Franklin	3,814	5.96	8,800	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of Glendale	3,821	5.97	13,500	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	1 Crossover 1 Portable Pumping Station	4.0
City of Greenfield	5,542	8.66	29,900	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of Milwaukee	57,152	89.30	670,100	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	107 Crossovers 110 Combined Sewer Outfalls	3,476.0
City of Oak Creek	7,738	12.09	14,400	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of South Milwaukee	3,110	4.86	23,400	Operates a Facility	4.86	23,400	2.67	6 0	Lake Michigan	1 Bypass	3 Bypasses	4.0
City of St. Francis	1,638	2.56	9,900	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of Wauwatosa	8,499	13.28	55,700	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	31 Crossovers 19 Relief Pumping Stations	42.0
City of West Allis	7,284	11.38	69,000	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	12 Crossovers 35 Portable Pumping Stations	40.0
Village of Bayside	1,536	2.40	4,400	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	2 Crossovers 2 Bypasses 1 Relief Pumping Station 2 Portable Pumping Stations	9.0
Village of Brown Deer	2,788	4.36	13,600	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	2 Bypasses 5 Portable Pumping Stations	37.0
Village of Fox Point	1,844	2.88	7,900	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	8 Crossovers 2 Bypasses 2 Relief Pumping Stations 5 Portable Pumping Stations	36.0
Village of Greendale	3,200	5.00	16,800	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Hales Corners	1,914	2.99	8,800	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of River Hills	3,405	5.32	1,500	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	1 Crossover	5.0
Village of Shorewood	1,085	1.70	14,300	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	8 Crossovers	16.0
Village of West Milwaukee	710	1.10	3,800	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Whitefish Bay	1,362	2.13	16,200	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	24 Crossovers	48.0
Rawson Homes Sewer and Water Trust	102	0.16	600	Operates a Temporary Facility	0.16	600	N/A	0.04	Minor Tributary of the Root River	None	None	None
Total	119,580	186.85	1,004,300	–	–	–	–	–	–	1	454	.3,904

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Area Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge (mg)
Ozaukee County												
City of Cedarburg	1,652	2.58	10,400	Operates a Facility	2.58	10,400	1.41	3.00	Cedar Creek	None	2 Bypasses	<1.0
City of Mequon	5,901	9.22	9,500	Contracts with Milwaukee-Metropolitan Sewerage Commissions	_[c]	_[c]	_[c]	_[c]	_[c]	None	2 Bypasses 5 Portable Pumping Stations	12.0
City of Port Washington	1,579	2.47	9,500	Operates a Facility	2.47	9,500	1.70	1.25	Lake Michigan	1 Bypass	5 Bypasses	21.0
Village of Belgium	229	0.36	900	Operates a Facility	0.36	900	0.07	0.07	Tributary of the Onion River	1 Bypass	None	<1.0
Village of Fredonia	422	0.66	1,500	Operates a Facility	0.66	1,500	0.28	0.12	Milwaukee River	1 Bypass	None	2.0
Village of Grafton	1,377	2.15	8,800	Operates a Facility	2.15	8,800	0.88	1.00	Milwaukee River	None	None	None
Village of Saukville	275	0.43	2,300	Operates a Facility	0.43	2,300	0.29	0.28	Milwaukee River	None	1 Relief Pumping Station	<1.0
Village of Thiensville	742	1.16	4,200	Operates a Temporary Facility	1.16	4,200	0.57	0.24	Milwaukee River	None	1 Bypass 1 Relief Pumping Station	4.0
Total	12,177	19.03	47,100	–	–	–	–	–	–	3	17	39.0

Table A-1 (continued)

Name of Public Sanitary Sewerage System	Existing Estimated Service Area		Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics					Flow Relief Devices		
	Acres	Square Miles			Estimated Total Area Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge (mg)
Racine County												
City of Burlington	1,451	2.77	8,900	Operates a Facility	2.27	10,800	1.48	2.50	Fox River	None	None	None
City of Racine	8,499	13.28	96,700	Operates a Facility	25.76	116,500	19.69	23.0	Lake Michigan	None	17 Crossovers 14 Bypasses 10 Combined Sewer Outfalls	567 (C50 = 290, Others = 277)
Village of Elmwood Park	415	0.65	400	Contracts with the City of Racine	See City of Racine Above					None	None	None
Village of North Bay	69	0.11	1,300	Contracts with the City of Racine	See City of Racine Above					None	1 Bypass	<1.0
Village of Rochester	120	0.19	800	Part of Western Racine County Sewerage District	See Western Racine County Sewerage District Below					None	None	None
Village of Sturtevant	531	0.83	4,400	Operates a Facility	0.83	4,400	0.53	0.30	Tributary of the Pike River	1 Bypass	None	1.0
Village of Union Grove	619	0.97	3,200	Operates a Facility	0.97	3,200	0.43	0.30	West Branch of Root River Canal	1 Bypass	None	2.0
Village of Waterford	369	0.58	2,300	Part of Western Racine County Sewerage District	See Western Racine County Sewerage District Below					None	None	None
Town of Mt. Pleasant Sewer Utility District No. 1	4,731	7.39	13,800	Contracts with the City of Racine	See City of Racine Above					None	3 Bypasses	9.0
Town of Rochester Sewer Utility District No. 1	110	0.17	300	Part of Western Racine County Sewerage District	See Western Racine County Sewerage District Below					None	None	None
Browns Lake Sanitary District	505	0.79	1,900	Contracts with the City of Burlington	See City of Burlington Above					None	None	None
Caddy Vista Sanitary District	186	0.29	1,000	Operates a Temporary Facility	0.29	1,000	0.09	0.25	Root River	1 Bypass	None	2.0
Caledonia Sewer Utility District No. 1	2,769	4.33	4,300	Contracts with the City of Racine	See City of Racine Above					None	3 Bypasses	<1.0
Crestview Sanitary District	423	0.66	2,500	Contracts with North Park Sanitary District	See North Park Sanitary District Below					None	None	None
North Park Sanitary District	2,741	4.28	6,800	Operates a Facility	4.94	9,300	1.13	2.00	Lake Michigan	None	None	None
Western Racine County Sewerage District	–[d]	–[d]	–[d]	Operates a Facility	0.94	3,400	0.24	0.50	Fox River	None	None	None
Total	23,538	36.78	148,600	–	–	–	–	–	–	3	48	581

Name of Public Sanitary Sewerage System	Existing Estimated Service Area		Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics					Flow Relief Devices		
	Acres	Square Miles			Estimated Total Area Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge (mg)
Walworth County												
City of Delavan	1,285	2.01	5,800	Operates a Facility	2.01	5,800	0.59	1.00	Turtle Creek	1 Bypass	None	2.0
City of Elkhorn	1,551	2.42	4,400	Operates a Facility	2.42	4,400	0.69	0.50	Jackson Creek	1 Bypass	None	<1.0
City of Lake Geneva	1,252	1.96	5,700	Operates a Facility	1.96	5,700	0.74	1.10	White River	1 Bypass	None	4.0
City of Whitewater	1,524	2.38	11,000	Operates a Facility	2.38	11,000	1.14	2.50	Whitewater Creek	1 Bypass	4 Bypasses	4.0
Village of Darien	303	0.47	1,000	Operates a Facility	0.47	1,000	0.14	0.15	Turtle Creek	1 Bypass	None	1.0
Village of East Troy	523	0.82	2,200	Operates a Facility	0.82	2,200	0.25	0.32	Honey Creek	1 Bypass	None	<1.0
Village of Genoa City	174	0.27	1,100	Operates a Facility	0.27	1,100	0.07	0.12	Nippersink Creek	1 Bypass	None	1.0
Village of Fontana	909	1.42	1,800	Operates a Facility	1.42	1,800	0.52	0.90	Soil Absorption and Lake Geneva	None	None	None
Village of Sharon	340	0.53	1,400	Operates a Facility	0.53	1,400	0.08	0.15	Turtle Creek	1 Bypass	None	<1.0
Village of Walworth	303	0.47	1,700	Operates a Facility	0.47	1,700	N/A	0.15	Picasaw Creek	1 Bypass	None	<1.0
Village of Willams Bay	771	1.21	1,700	Operates a Facility	1.21	1,700	0.55	0.80	Seepage Lagoon	None	None	None
Total	8,935	13.96	37,800	–	–	–	–	–	–	9	4	15.0

Name of Public Sanitary Sewerage System	Existing Estimated Service Area		Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics					Flow Relief Devices		
	Acres	Square Miles			Estimated Total Area Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge (mg)
Washington County												
City of Hartford	1,230	1.92	7,600	Operates a Facility	1.92	7,600	1.37	2.00	Rubicon River	None	None	None
City of West Bend	4,021	6.28	21,000	Operates a Facility	6.28	21,000	3.70	2.50	Milwaukee River	1 Bypass	None	<1.0
Village of Germantown	1,203	1.88	4,600	Operates a Temporary Facility	1.88	4,600	0.80	1.0	Menomonee River	None	None	None
Village of Jackson	275	0.43	2,000	Operates a Facility	0.43	2,000	0.26	0.03	Cedar Creek	None	2 Bypasses	4.0
Village of Kewaskum	415	0.65	2,000	Operates a Facility	0.65	2,000	0.32	0.50	Milwaukee River	None	None	None
Village of Newburg	119	0.19	600	Operates a Facility	0.19	600	0.07	0.05	Milwaukee River	1 Bypass	None	<1.0
Village of Slinger	289	0.45	1,300	Operates a Facility	0.45	1,300	0.15	0.15	Marshland Drained by the Rubicon River	None	None	None
Allenton Sanitary District	120	0.19	800	Operates a Facility	0.19	800	0.08	0.10	East Branch of the Rock River	None	None	None
Total	7,672	11.99	39,900	–	–	–	–	–	–	2	2	4.0

Table A-1 (continued)

Name of Public Sanitary Sewerage System	Estisting Estimated Service Area: Acres	Estisting Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Area Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge (mg)
Waukesha County												
City of Brookfield—Area Connected to Milwaukee Metropolitan System	6,950	10.86	16,300	Contracts with Milwaukee-Metropolitan Sewerage Commissions	—[c]	—[c]	—[c]	—[c]	—[c]	None	3 Portable Pumping Stations	8.0
City of Brookfield-Fox River Watershed System	5,443	8.50	16,200	Operates a Facility	8.50	16,200	2.49	5.00	Fox River	None	2 Portable Pumping Stations	4.0
City of Muskego	3,040	4.75	10,200	Operates Temporary Facilities	2.15 Big Muskego	4,200	0.58	0.70	Big Muskego Lake	1 Bypass	None	<1.0
					2.60 Northeast Plant	6,000	0.34	0.50	Tess Corners Creek			
City of New Berlin—Area connected to Milwaukee-Metropolitan System	3,219	5.03	12,500	Contracts with Milwaukee-Metropolitan Sewerage Commissions	—[c]	—[c]	—[c]	—[c]	—[c]	None	None	None
City of Oconomowoc	1,752	2.74	11,100	Operates a Facility	2.74	11,100	1.90	1.50	Oconomowoc River	1 Bypass	3 Bypasses	6.0
City of Waukesha	8,695	13.59	51,300	Operates a Facility	13.59	51,300	9.90	8.50	Fox River	1 Bypass	7 Bypasses 2 Portable Pumping Stations	26.0
Village of Butler	499	0.78	2,100	Contracts with Milwaukee-Metropolitan Sewerage Commissions	—[c]	—[c]	—[c]	—[c]	—[c]	None	2 Bypasses	116
Village of Dousman	288	0.45	1,000	Operates a Facility	0.45	1,000	0.11	0.12	Bark River	1 Bypass	None	<1.0
Village of Elm Grove												
Sanitary District 1	1,139	1.78	4,100	Contracts with Milwaukee-Metropolitan Sewerage Commissions	—[c]	—[c]	—[c]	—[c]	—[c]	None	None	None
Sanitary District 2	941	1.47	2,900									
Village of Hartland	799	0.45	4,400	Operates a Facility	1.25	4,400	0.42	0.36	Bark River	1 Bypass	None	<1.0
Village of Menomonee Falls	3,949	6.17	20,400	Operates Temporary Facilities and Contracts with the Milwaukee-Metropolitan Sewerage Commissions	—[c]	—[c]	—[c]	—[c]	—[c]	None	5 Crossovers 4 Bypasses 11 Portable Pumping Stations	35.0
Village of Mukwonago	804	1.26	3,400	Operates a Facility	1.26	3,400	0.44	0.22	Mukwonago River	None	None	None
Village of Pewaukee	835	1.31	4,800	Operates a Temporary Facility	1.31	4,800	0.48	0.80	Pewaukee River	None	None	None
Village of Sussex	679	1.06	4,000	Operates a Temporary Facility	1.06	4,000	0.47	0.30	Sussex Creek	None	1 Portable Pumping Station	2.0
Total	39,376	61.54	165,800	—	—	—	—	—	—	5	40	197.0
Region Total	226,240	353.45	1,544,000							29	590	5044

NOTE: N/A indicates data not available.

[a] *Based upon an approximation of the existing sewer service area by U.S. Public Land Survey quarter section.*

[b] *Rawson Homes wastewater treatment facility was abandoned in 1977 and the sewerage system was connected to the City of Franklin, which is part of the Milwaukee Metropolitan Sewerage District.*

[c] *See the Milwaukee-Metropolitan Sewerage Commission in Milwaukee County for treatment facility characteristics.*

[d] *Service area and population included in the service area of the Villages of Rochester and Waterford and Town of Rochester Sewer Utility District 1.*

[e] *Includes 141 acres (0.22 square mile) in Jefferson County.*

Source: SEWRPC.

Table A-2

SELECTED CHARACTERISTICS OF PRIVATE SEWAGE TREATMENT FACILITIES: 1975

Treatment Plant	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Average Hydraulic Design Capacity (gallons per day)	Disposal of Effluent
Kenosha County				
Kenosha-Racine Subregional Area				
American Motors Kenosha	Process	2,000	2,000	Pike River
Des Plaines River Subregional Area				
Brightondale County Park	Sanitary	9,700 May through September	10,000	Soil Absorption
George Connolly Development (not yet in operation)	Sanitary	--	34,000	Tributary of the Des Plaines River
Howard Johnson Motor Lodge and Restaurant	Sanitary	49,000	18,300	Des Plaines River
Kenosha Packing Company	Process, Cooling, and Sanitary	23,200	N/A	Soil Absorption
Paramski Mobile Home Park	Sanitary	11,500	40,000	Marsh Tributary to Mud Lake
Wheatland Mobile Home Park	Sanitary	31,000	39,000	Fox River
Wisconsin Department of Transportation Tourist Information Center	Sanitary	4,000	9,250	Tributary of the Des Plaines River
Milwaukee County				
Milwaukee Metropolitan Subregional Area				
Highway 100 Drive-In Theatre	Sanitary	N/A	6,000	Soil Absorption
Union Oil Truck Stop	Sanitary	N/A	10,000	Root River
Wisconsin Electrical Power Company—Oak Creek Plant	Sanitary	30,000	40,000	Lake Michigan
Ozaukee County				
Milwaukee Metropolitan Subregional Area				
Chalet on the Lake Restaurant	Sanitary	N/A	50,000	Lake Michigan
Federal Foods Company	Process	N/A	N/A	Soil Absorption
Sisters of Notre Dame Academy	Sanitary	20,000	40,000	Lake Michigan
Upper Milwaukee River Subregional Area				
Justro Food Company (not in operation)	Process	N/A	N/A	Soil Absorption
S & R Cheese Corporation	Process	1,800	N/A	Soil Absorption
Sauk Creek Subregional Area				
Cedar Valley Cheese Factory	Process and Cooling	N/A	N/A	Soil Absorption
Krier Preserving Company				
Outfall No. 1	Process	Intermittent	N/A	Onion River via Drainage Ditch
Outfall No. 3	Process	550,000	N/A	Soil Absorption
Port Country Club	Sanitary	N/A	N/A	Soil Absorption
Racine County				
Kenosha-Racine Subregional Area				
J. I. Case Company	Process and Cooling	1,259,400	N/A	Lake Michigan
St. Boneventure Seminary	Sanitary	8,000	15,000	Waxdale Creek
Siendale Noterhouse	Sanitary	2,000	4,000	Bartlett Creek
Frank's Pure Food Company	Process	70,000	N/A	Hands Creek via Drainage Tile
Root River Canal Subregional Area				
C & D Foods, Inc.	Process and Sanitary	269,900	N/A	West Branch Root River Canal
Fonk's Mobile Home Park No. 1	Sanitary	13,000	15,000	East Branch Root River Canal
Grove Duck Farm, Inc.	Process and Sanitary	25,000	N/A	West Branch Root River Canal
Meeter Brothers Company	Process and Cooling	66,500	N/A	Tributary of the Des Plaines River via Storm Sewer
Pekin Duck Farm	Process	6,000	50,000	Soil Absorption
Racine County Highway and Park Commission	Sanitary	N/A	10,000	Hoods Creek
Southern Colony Training School and Treatment Facility	Sanitary	180,000	445,000	West Branch Root River Canal
Fonk's Mobile Home Park No. 2	Sanitary	2,500	15,000	Tributary of the Des Plaines River
Lower Fox River Subregional Area				
Downey Duck Company, Inc.	Process and Sanitary	45,000	200,000	Soil Absorption
Holy Redeemer College	Sanitary	8,000	15,000	Tributary of the Wind Lake Canal
Packaging Corporation of America	Process and Sanitary	7,500	10,000	Tributary of the Fox River

Table A-2 (Continued)

Treatment Plant	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Average Hydraulic Design Capacity (gallons per day)	Disposal of Effluent
Walworth County				
Lower Fox River Subregional Area				
Alpine Valley Resort, Inc.	Sanitary	N/A	40,000	Soil Absorption
County Estates Mobile Home Park	Sanitary	15,000	N/A	White River
Interlaken Resort Village	Sanitary	27,000	125,000	Soil Absorption
Pairser Produce (not in operation)	Process	N/A	N/A	Soil Absorption
Playboy Club Hotel	Sanitary	120,000	500,000	White River
Slovok Sokol Camp	Sanitary	20,000	N/A	Potter Lake
Wisconsin Dairies Cooporative	Process	6,200	N/A	Nippersink Creek
Wisconsin Department of Transportation—East Troy Rest Area	Sanitary	N/A	18,000	Tributary of the Sugar Creek
Lower Rock River Subregional Area				
Kikkoman Foods, Inc.	Process and Sanitary	240,000	N/A	Soil Absorption
Lakeland Nursing Home (Walworth County Institution)	Sanitary	80,000	230,000	Jackson Creek
Lake Lawn Lodge	Sanitary	69,000	100,000	Delavan Lake
Libby McNeil and Libby, Inc.				
Outfall - 1	Process	1,100,000	N/A	Soil Absorption
Outfall - 2	Sanitary	10,000	N/A	Soil Absorption
Walworth County Correctional Center (not in operation)	Sanitary	—	N/A	Tributary of the Jackson Creek
Washington County				
Upper Milwaukee River Subregional Area				
Cedar Lake Rest Home	Sanitary	N/A	N/A	Soil Absorption
Level Valley Dairy	Process and Cooling	172,000	N/A	Cedar Creek
Libby, McNeil Inc, and Libby—Jackson	Process and Cooling	144,000	N/A	Soil Absorption
Upper Rock River Subregional Area				
Libby, McNeil and Libby, Inc.	Process	458,000	N/A	Hartford Sewage Treatment Plant
National Farmers Organization—Slinger Transfer Station	Washwater	N/A	N/A	Soil Absorption
Pike Lake State Park	Sanitary	N/A	N/A	Soil Absorption
Waukesha County				
Milwaukee Metropolitan Subregional Area				
Brookfield Central High School	Sanitary	N/A	N/A	Soil Absorption
Cleveland Heights Elementary School	Sanitary	5,000	N/A	Tributary of the Poplar Creek
Highway 24 Outdoor Theater	Sanitary	N/A	Intermittent	Soil Absorption
Muskego Rendering Company, Inc.	Process	N/A	N/A	Soil Absorption
New Berlin Memorial Hospital	Sanitary	26,000	19,000	Root River via Drainage Ditch
Upper Fox River Subregional Area				
Mammoth Springs Canning Corporation	Process	200,000	N/A	Soil Absorption
New Berlin West High School	Sanitary	18,000	24,000	Tributary of the Poplar Creek
Oakton Manor—Tumblebrook Golf Course	Sanitary	800	36,000	Pewaukee Lake
Steeplechase Inn	Sanitary	N/A	25,000	Soil Absorption
Willow Springs Mobile Home Park	Sanitary	N/A	N/A	Soil Absorption
Lower Fox River Subregional Area				
Rainbow Springs Resort (not in operation)	Sanitary	N/A	160,000	Tributary of the Mukwonago River
Middle Rock River Subregional Area				
Ethan Allen School	Sanitary	59,000	165,000	Soil Absorption
Gigas Hillside Apartments	Sanitary	N/A	20,000	Soil Absorption
St. John's Military Academy	Sanitary	30,000	75,000	Bark River

NOTE: N/A indicates data not available.

Source: SEWRPC

Table A-3

KNOWN POINT SOURCES OTHER THAN SEWAGE TREATMENT PLANTS: 1975

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Kenosha County			
Kenosha-Racine Subregional Area			
American Motors Corporation—Main Plant	Cooling	2,335,000	Pike Creek
Anaconda American Brass Company	Cooling and Rinse	185,500	Lake Michigan via Storm Sewer
Eaton Corporation—Industrial Drives Division	Cooling	15,700	Lake Michigan via Storm Sewer
Des Plaines River Subregional Area			
Ladish Company—Tri-Clover Division	Process and Cooling	94,800	Tributary of the Des Plaines River
Town of Bristol Water Utility	Filter Backwash	Intermittent	Tributary of the Des Plaines River
Lower Fox River Subregional Area			
White Construction Company	Groundwater Seepage	Intermittent	Tributary of the Fox River
Milwaukee County			
Milwaukee Metropolitan Subregional Area			
Advance Roller and Tank Company	Hydrostatic Test Water	40	Lake Michigan
A.F. Gallun & Sons Corporation	Cooling	5,400	Milwaukee River via Storm Sewer
Allied Smelting Corporation	Process and Cooling	121,000	Kinnickinnic River via Storm Sewer
Allis Chalmers Corporation	Process	70,000	Menomonee River via Storm Sewer
Allis Chalmers Corporation	Process and Cooling	9,700	Lake Michigan via Storm Sewer
American Can Company	Cooling	30,000	Lincoln Creek via Storm Sewer
American Motors Corporation—Body Plant	Cooling	530,100	Milwaukee River via Storm Sewer
American Motors Corporation—Services and Distribution Division	Cooling	75,000	Lake Michigan via Storm Sewers
AMF, Incorporated—Harley Davidson Motor Company	Process and Cooling	40,000	Tributary of Menomonee River
A.O. Smith Corporation—Automotive Division	Cooling	1,685,900	Lincoln Creek via Storm Sewer
Appleton Electric Company—Foundry Division	Cooling	66,000	Oak Creek
Appleton Electric Company—Lighting Products Division	Process	34,100	Oak Creek via Storm Sewer
Aqua Chem, Incorporated—			
North Plant No. 1	Process and Cooling	11,600	Lincoln Creek via Storm Sewer
North Plant No. 2	Process, Cooling and Boiler Blowdown	37,500	Lincoln Creek via Storm Sewer
Babcock and Wilcox—Tubular Products Division	Cooling	825,000	Menomonee River via Storm Sewer
Badger Die Casting Corporation	Cooling	43,500	Kinnickinnic River via Storm Sewer
Badger Meter, Inc.	Cooling	7,000	Beaver Creek and Drainage Ditch
Beatrice Foods Company	Cooling	51,000	Milwaukee River via Storm Sewer
Briggs & Stratton Corporation	Cooling	5,000	Brown Deer Park Creek
Briggs & Stratton Corporation	Cooling	1,478,000	Kinnickinnic River via Storm Sewer
Briggs & Stratton Corporation	Cooling	25,000	Menomonee River via Storm Sewer
Bucyrus Erie Company	Cooling	17,300	Lake Michigan via Drainage Ditch and Storm Sewer
Bucyrus Erie Company	Process and Cooling	764,200	Oak Creek
Butler Lime and Cement Company	Process	1,700	Menomonee River via Storm Sewer
Caterpiller Tractor Company	Process and Cooling	7,800	Kinnickinnic River via Storm Sewer
Center Fuel Company	Runoff	Intermittant	Little Menomonee River via Storm Sewer
Chicago, Milwaukee, St. Paul & Pacific Railroad Company	Process	319,800	Menomonee River via Drainage Ditch
Chicago & North Western Railway	Process	300	Menomonee River via Drainage Ditch
Chris Hansen's Laboratory, Inc.	Cooling	50,000	Honey Creek via Storm Sewer
Continental Can Company	Cooling	340,000	Milwaukee River via Storm Sewer
Continental Equipment	Cooling	N/A	Lincoln Creek via Storm Sewer and Drainage Ditch
Cutler-Hammer, Inc.—Industrial System Division	Cooling	145,000	Lincoln Creek via Storm Sewer
Eaton Corporation	Process, Cooling, and Boiler Blowdown	131,600	Kinnickinnic River via Storm Sewer and Drainage Ditch
EZ Paintr Corporation	Cooling	49,000	Lake Michigan via Drainage Ditch
Falk Corporation—Research and Development	Process and Cooling	55,000	Menomonee River
Falk Corporation—			
Plant No. 1	Process and Cooling	428,000	Menomonee River
Plant No. 2	Cooling	25,000	Tributary of Menomonee River
Federal Malleable Company	Cooling and Boiler Blowdown	36,100	Honey Creek via Storm Sewer
First Wisconsin Development Corporation	Cooling	660,000	Milwaukee River
Florence Eiseman, Inc.	Cooling and Boiler Blowdown	100	Milwaukee River
Fred Usinger, Inc.	Cooling	45,000	Milwaukee River

Table A-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Milwaukee County (cont.)			
Froedtert Malt Corporation	Cooling	19,900	Kinnickinnic River via Storm Sewer
Fruehauf Corporation	Process and Cooling	3,200	Root River via Storm Sewer and Drainage Ditch
General Electric Company—Dishwasher and Disposal Products Department	Cooling	109,000	Kinnickinnic River via Storm Sewer and Drainage Ditch
General Electric Company—Medical Systems Divisions	Cooling and Cooling Tower Blowdown	475,700	43rd Street Ditch
General Electric Company—West Edgerton	Cooling	300	Holmes Avenue Creek
Gimbels Midwest, Inc.	Process and Cooling	1,519,200	Milwaukee River
Gimbels Midwest, Inc.—Warehouse	Boiler Blowdown	100	Milwaukee River
Globe Union, Inc.—			
Administration and Research Park	Cooling	7,100	Lincoln Creek via Storm Sewer
Central Lab Division	Cooling	120,000	Lincoln Creek via Storm Sewer
Grede Foundries, Incorporated—Liberty Foundry	Cooling	60,000	Menomonee River via Storm Sewer
Grey Iron Foundry, Incorporated	Process and Cooling	474,000	Honey Creek
Harley Davidson Motor Company	Cooling	4,400	North Branch Oak Creek via Storm Sewer
Harnischfeger Corporation	Process and Cooling	380,000	Menomonee River via Storm Sewer
Heil Company—			
Bulk Trailer Division (Tank)	Test and Cooling	10,800	Kinnickinnic River via Storm Sewer
Solid Waste Systems and Truck Equipment Division	Cooling	82,400	Kinnickinnic River
Hentzen Chemical Coatings, Inc.	Cooling	54,000	Little Menomonee River via Storm Sewer
Hoerner Waldorf Corporation	Cooling and Boiler Blowdown	1,200	Milwaukee River via Storm Sewer
Howmet Turbine Components Corporation	Process and Cooling	636,800	Kinnickinnic River
Industrial Fuel, Inc.	Process	600	North Branch Oak Creek via Storm Sewer
Inland Ryerson Construction Products Company	Cooling	1,100	Lincoln Creek via Storm Sewer
Inryco, Inc.	Cooling	211,000	Menomonee River via Storm Sewer
Interstate Drop Forge Company	Cooling	60,000	Lincoln Creek via Storm Sewer
James Manufacturing Incorporated— Froemming Cast Products Division	Process and Cooling	36,300	Lake Michigan via Storm Sewer
Joseph Schlitz Brewing Company	Cooling	10,915,300	Milwaukee River via Storm Sewer
Kearney & Trecker Corporation	Cooling	121,900	Underwood Creek via Storm Sewer
Kurth Malting Corporation—			
Plant No. 1	Cooling	150,000	43rd Street Ditch
Plant No. 2	Cooling	46,783,300	Milwaukee River
Ladish Company—Cudahy	Cooling	708,000	Lake Michigan via Storm Sewer
Ladish Company	Cooling	756,000	Oak Creek via Storm Sewer
Ladish Company	Cooling	465,500	Wilson Park Creek via Storm Sewer
Longview Fibre Company—Downing Box Division	Cooling	4,800	Milwaukee River via Storm Sewer
Marquette University	Cooling and Steam Condensate	56,000	North Menomonee Canal via Storm Sewer
Maynard Steel Casting Company	Process and Cooling	110,400	Kinnickinnic River
Miller Brewing Company	Cooling and Drainage	1,676,900	Menomonee River via Storm Sewer
Milprint, Inc.	Cooling	288,700	Milwaukee River via Storm Sewer
Milwaukee Country Club	Cooling	17,700	Milwaukee River via Storm Sewer
Milwaukee County Institutions Power Plant	Process and Cooling	67,000	Menomonee River via Drainage Ditch
Milwaukee County Park Commission—Carver Park	Swimming Pool Overflow and Drainage	Intermittent	Milwaukee River via Storm Sewer
Milwaukee County Park Commission—Gordon Park	Swimming Pool Overflow and Drainage	Intermittent	Milwaukee River via Storm Sewer
Milwaukee County Park Commission—Greenfield Park	Swimming Pool Overflow and Drainage	Intermittent	South Branch Underwood Creek via Storm Sewer
Milwaukee County Park Commission—Hales Corners Park	Swimming Pool Overflow and Drainage	Intermittent	Root River via Storm Sewer
Milwaukee County Park Commission—Holler Park	Swimming Pool Overflow and Emptying	Intermittent	Holmes Avenue Creek
Milwaukee County Park Commission—Hoyt Park	Swimming Pool Overflow and Drainage	Intermittent	Menomonee River via Storm Sewer
Milwaukee County Park Commission—Jackson Park	Swimming Pool Overflow	Intermittent	Kinnickinnic River via Storm Sewer
Milwaukee County Park Commission—Kosciuszko Park	Swimming Pool Overflow	Intermittent	Kinnickinnic River via Storm Sewer

Table A-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Milwaukee County (cont.)			
Milwaukee County Park Commission—Lincoln Park	Swimming Pool Overflow and Drainage	Intermittent	Milwaukee River via Storm Sewer
Milwaukee County Park Commission—Madison Park	Swimming Pool Overflow and Drainage	Intermittent	Menomonee River via Storm Sewer
Milwaukee County Park Commission—McCarty Park	Swimming Pool Overflow and Drainage	Intermittent	Honey Creek via Storm Sewer
Milwaukee County Park Commission—McGovern Park	Swimming Pool Overflow and Drainage	Intermittent	Lincoln Creek via Storm Sewer
Milwaukee County Park Commission—Oak Creek Park	Swimming Pool Overflow	Intermittent	Oak Creek via Storm Sewer
Milwaukee County Park Commission—Swimming Pool, Sheridan Park	Swimming Pool Overflow and Drainage	Intermittent	Lake Michigan via Storm Sewer
Milwaukee County Park Commission—Washington Park	Swimming Pool Overflow and Drainage	Intermittent	Menomonee River via Storm Sewer
Milwaukee County Park Commission—Wilson Park	Swimming Pool Overflow	Intermittent	Wilson Park Creek via Storm Sewer
Milwaukee Die Casting Company	Cooling	11,000	Milwaukee River via Storm Sewer
Milwaukee Marble Company	Process	5,500	Menomonee Canal via Storm Sewer
Milwaukee Oceanic Terminal, Division of Optics for Industry	Cooling	Intermittent	Lake Michigan
Milwaukee Solvay Coke Company	Process, Cooling, and Boiler Blowdown	4,820,800	Kinnickinnic River
Milwaukee Spring Company	Cooling	78,000	Wilson Park Creek via Storm Sewer
Milwaukee Water Works—Linwood Avenue Plant	Filter Backwash	1,013,300	Lake Michigan
Milwaukee Water Works	Filter Backwash	415,800	Kinnickinnic River
Mobile Oil Corporation—			
Lubrication Plant	Cooling	4,600	Menomonee River via Storm Sewer
Milwaukee Terminal	Runoff	4,600	Lake Michigan
Motor Casting Plant No. 1	Cooling	220,000	Woods Creek via Storm Sewer
Motor Casting Plant No. 2	Cooling	18,000	Honey Creek via Storm Sewer
Murphy Diesel Company	Cooling	40,220	43rd Street Ditch via Storm Sewer
North Milwaukee Lime & Cement Company	Process	2,000	Lincoln Creek via Storm Sewer
Oak Creek Water Filtration Plant	Filter Backwash	611,600	Lake Michigan via Storm Sewer
Oil Gear Company	Cooling	1,960	Kinnickinnic River via Storm Sewer
Oster Corporation	Cooling	41,000	Milwaukee River via Storm Sewer
Outboard Marine Company—Evinrude Foundry	Cooling	1,093,500	Lincoln Creek via Storm Sewer
Plant No. 1 Research Annex	Cooling	262,200	Lincoln Creek via Storm Sewer
Patrick Cudahy, Inc.	Cooling	72,000	Lake Michigan via Storm Sewer
Pelton Casteel, Inc.	Process and Cooling	79,800	Kinnickinnic River via Drainage Ditch
Perfex, Inc.	Test and Cooling	130,000	Kinnickinnic River via Storm Sewer
Perlick Company, Inc.	Cooling	1,000	Little Menomonee River via Storm Sewer
Peter Cooper Company—United States Glue and Gelatin Division	Process and Cooling	3,204,600	Lake Michigan via Storm Sewer
Phillips Petroleum Company	Runoff	Intermittent	Lake Michigan
P.P.G. Industries, Inc.	Cooling Tower Blowdown; Cooling Boiler	4,000	Root River via Drainage Ditch
Rexnord, Inc.—			
Nordberg Machinery Group	Process and Cooling; Boiler Blowdown	448,800	Kinnickinnic River via Storm Sewer
West Milwaukee Facility	Process and Cooling	475,600	Woods Creek via Storm Sewer
Robert A. Johnston Company	Cooling	511,600	Menomonee River via Storm Sewer
Safeway Wash-A-Car, Inc.	Process	1,000	Honey Creek via Storm Sewer
Seven-Up Milwaukee Inc.	Process Washwater	7,000	South Branch of Underwood Creek
Shell Oil Company	Runoff	1,200	Lake Michigan
Square D Company	Cooling	128,200	Milwaukee River via Storm Sewer
Stainless Foundry and Engineering Company	Cooling	130,000	Lincoln Creek via Storm Sewer
Teledyne Wisconsin Motor	Process and Cooling	36,000	43rd Street Ditch via Storm Sewer
Texaco, Inc.	Runoff	Intermittent	Lake Michigan
Treat All Metals, Inc.	Cooling	200,000	Milwaukee River via Storm Sewer
Union Oil of California—			
N. 107th Street	Runoff	Intermittent	Little Menomonee River via Drainage Ditch
General Mitchell Field	Contaminated Storm Water	Intermittent	Wilson Park Creek via Storm Sewer
Union Oil Milwaukee Truck Stop	Runoff	Intermittent	Tributary of the Root River
Union Oil Truck Stop	Runoff	Intermittent	Oak Creek

Table A-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Milwaukee County (cont.)			
UWM Physical Plant	Cooling	9,000,000	Lake Michigan
Vulcan Materials Company	Runoff	32,100	Root River
Wehr Steel Company	Process and Cooling	253,000	43rd Street Ditch via Storm Water
Western Electric Company, Inc.—Wisconsin Service Center	Cooling	1,000	Milwaukee River via Storm Sewer
Western Metal Specialty—Division of Western Industries, Inc.	Cooling	10,000 to 50,000	Menomonee River via Storm Sewer
West Shore Pipe Line Company	Process	4,000	Menomonee River
W. H. Brady Company—Florist Avenue Plant	Cooling	29,000	Milwaukee River via Storm Sewer
Wire and Metal Specialties Company	Cooling	111,566,500	Lake Michigan via Storm Sewer
Wisconsin Bridge and Iron Company	Cooling and Drainage	5,600	Lincoln Creek via Storm Sewer
Wisconsin Cuneo Press	Process and Cooling	135,000	Lincoln Creek via Storm Sewer
Wisconsin Electric Power Company—			
Commerce Street	Process, Cooling, and Boiler Blowdown	46,721,200	Milwaukee River
Heating Steam System	Steam Condensate and Groundwater	83,300	Milwaukee River
Heating System	Steam Condensate and Seepage	62,000	Menomonee River
Lakeside Power Plant	Cooling and Boiler Blowdown, Drainage, Boiler Cleaning, De-icing Line	1,654,489,800	Lake Michigan via Storm Sewer
Oak Creek Plant	Process, Cooling, Boiler Blowdown, Drainage, and De-icing Line	2,028,976,400	Lake Michigan via Storm Sewer
Valley Plant	Cooling, Boiler Blow-down, Drainage Ditch and Steam Condensate	142,798,500	South Menomonee Canal
Wells Street	Cooling, Boiler Blow-down, Drainage, and Tank Overflow	1,024,510	Milwaukee River
Wright Metal Processors, Inc.	Cooling	3,000	Lincoln Creek via Storm Sewer
Ozaukee County			
Milwaukee Metropolitan Subregional Area			
Ataco Steel Products Company	Cooling	20,000	Milwaukee River via Storm Sewer
Brunswick Corporation—			
Mercury Marine Division Plant No. 1	Process and Cooling	43,000	Cedar Creek via Storm Sewer
Mercury Marine Division Plant No. 2	Cooling	5,000	Cedar Creek via Storm Sewer
Dayton Malleable—Meta-Mold Division	Process and Cooling	21,000	Cedar Creek via Storm Sewer and Drainage Ditch
Doerr Electric Corporation	Process and Cooling	1,000	Cedar Creek via Storm Sewer, Soil Absorption
EST Company, Inc.	Cooling	8,100	Milwaukee River via Storm Sewer and Drainage Ditch
Freeman Chemical Corporation	Cooling	344,200	Milwaukee River
Johnson Brass and Machine Foundry, Inc.	Cooling	7,000	Milwaukee River via Storm Sewer
KMC Stampings Division	Cooling	125	Milwaukee River via Drainage Ditch
Leeson Electric Corporation	Cooling	5,000	Milwaukee River via Storm Sewer
MSD Plastics, Inc.	Cooling	25,000	Cedar Creek via Storm Sewer
Russel T. Gilman, Inc.	Cooling	700	Milwaukee River via Storm Sewer
Sauk Creek Subregional Area			
Allis Chalmers, Inc.—Simplicity Manufacturing Company	Cooling	47,000	Tributary of the Sauk Creek via Storm Sewer
Fromm Laboratories, Inc.	Cooling	200	Lake Michigan via Storm Sewer and Drainage Ditch
Murphy Oil Corporation	Storm Water Runoff from Petroleum Terminal	76,500	Tributary of Sauk Creek
Krier Preserving Company	Cooling	29,600	Tributary of The Onion River via Drainage Ditch
Port Washington Filtration Plant	Process	14,700	Lake Michigan
Wisconsin Electric Power Company—Port Washington Power Plant	Process and Cooling	513,500,000	Lake Michigan

Table A-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Racine County			
Kenosha-Racine Subregional Area			
Ametek-Lamb Electric	Cooling	3,000	Sorenson Creek
Emerson Electric Company—Insinkerator Division	Cooling	40,600	Root River via Storm Sewer
Frank's Pure Food Company	Cooling	12,800	Hoods Creek via Drainage Tile
Harris Metals, Inc.	Process and Cooling	N/A	Birch Creek via Storm Sewer and Drainage Ditch
J.I. Case Company—Clausen Plant	Process and Cooling	1,486,100	Lake Michigan
J.I. Case Company—Transmission Plant	Cooling	70,000	Pike River
Madison Fuel Company—Baumann Oil Branch	Runoff	Intermittent	Lake Michigan
Printing Developments, Inc.	Cooling	120,000	Lake Michigan via Storm Sewer
Racine Stamping Corporation	Cooling	17,500	Root River via Storm Sewer
Rexnord, Inc.—Hydraulic Component Division	Cooling	130,000	Pike River
S. C. Johnson and Son, Inc.	Cooling	1,635,400	Tributary of the Pike River
S. C. Johnson and Son, Inc.	Cooling	1,092,900	Lake Michigan via Storm Sewer
TEK Products, Inc.	Cooling	26,000	Lake Michigan via Storm Sewer
Twin Disc, Inc.—Racine Street Plant	Cooling	57,000	Root River via Storm Sewer
Twin Disc, Inc.—21st Street Plant	Cooling	124,000	Root River via Storm Sewer
Vulcan Materials Company—Construction Materials Division	Process	421,000	Tributary of Lake Michigan via Storm Sewer
Western Publishing Company	Cooling	358,300	Root River
Young Radiator Company	Process, Cooling, and Boiler Blowdown	40,000	Lake Michigan via Drainage Ditch
Root River Canal Subregional Area			
Bardon Rubber Products Company Inc.	Cooling	64,700	Des Plaines River via Storm Sewer
Culligan Water Conditioning Company	Filter Backwash	1,100	Des Plaines River via Storm Sewer
Fohr's Meat Service	Process and Sanitary	N/A	Soil Absorption
Harry Hansen Meat Service	Process	1,400	Soil Absorption
Plastic Parts, Inc.	Cooling	192,000	Des Plaines River via Storm Sewer
Wisconsin Rubber Products Company	Cooling	130,000	Des Plaines River via Storm Sewer
Lower Fox River Subregional Area			
Burlington Brass Works	Process and Sanitary	1,700	Fox River via Storm Sewer
Continental Can Company, Inc.	Process	N/A	Soil Absorption
Culligan Soft Water Service	Process	1,100	Fox River via Storm Sewer
Foster-Forbes Glass Company	Cooling	581,000	Fox River
Lavelle Industries, Inc.	Process and Cooling	55,000	Fox River via Storm Sewer
Murphy Products Company, Inc.	Cooling	3,000	Fox River via Storm Sewer
The Nestle Company	Cooling	12,000	Fox River via Storm Sewer
Walworth County			
Lower Fox River Subregional Area			
Coca-Cola Bottling Company, Inc.	Washwater	7,000	White River via Drainage Ditch
Crucible, Inc.—Trent Tube Division Plant No. 1	Process and Cooling	480,000	Honey Creek
Crucible, Inc.—Trent Tube Division Plants No. 2 and 3	Process and Cooling	64,000	Honey Creek
Genoa City Water Treatment Plant	Filter Backwash	Intermittent	North Branch Nippersink Creek
Lake Geneva Packing, Inc.	Process	N/A	Soil Absorption
Wisconsin Dairies Cooperative	Cooling	3,600	Nippersink Creek
Lower Rock River Subregional Area			
A and K Rubber Products Company, Inc.	Cooling	1,600	Jackson Creek via Storm Sewer
Allied Music Corporation	Process	3,600	Soil Absorption
Alpha Cast, Inc.	Cooling	125,000	Whitewater Creek
Buncker Ramo Corporation	Cooling	4,400	Swan Creek via Storm Sewer
Darien Waterworks	Filter Backwash	Intermittent	Turtle Creek via Storm Sewer
Elkhorn Light & Water Commission	Process, Filter Backwash	50,000	Jackson Creek via Storm Sewer
Frank Holton and Company	Process	15,000	Soil Absorption
Getzen Company, Inc.	Process	N/A	Soil Absorption
Hawthorn Melody Farms Dairy	Cooling	1,280,000	Whitewater Creek
J. W. Reichel & Sons, Inc.	Cooling	3,500	Jackson Creek via Storm Sewer
Sharon Foundry, Inc.	Cooling	750	Little Turtle Creek
U. S. Gypsum Company	Boiler Blowdown	35,000	Soil Absorption
Whitewater Water Utility	Backwash	92,000	Whitewater Creek via Storm Sewer
Washington County			
Milwaukee Metropolitan Subregional Area			
Gehl Guernsey Farms, Inc.	Cooling	190,000	Menomonee River via Storm Sewer
Upper Milwaukee River Subregional Area			
Amity Leather Products Company	Cooling and Boiler Blowdown	N/A	Milwaukee River via Storm Sewer

Table A-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Washington County (cont.)			
Bermico Company	Process and Cooling	228,800	Milwaukee River
Culligan Water Conditioning, Inc.	Filter Backwash	2,900	Milwaukee River via Storm Sewer
Fairmount Foods Company	Cooling	8,000	Milwaukee River via Storm Sewer
Gehl Company	Cooling	253,000	Milwaukee River via Storm Sewer
Kewaskum Frozen Foods	Cooling	10,000-60,000	Milwaukee River via Storm Sewer
Pick Automotive Corporation	Cooling	N/A	Milwaukee River via Storm Sewer
Regal Ware, Inc.	Cooling	124,300	Milwaukee River
The West Bend Company	Cooling	143,000	Milwaukee River
Upper Rock River Subregional Area			
International Stamping Company, Inc.	Cooling	154,000	Rubicon River
Oak Cheese Factory	Washwater	N/A	Soil Absorption
W. B. Place and Company, Inc.	Process	200	Rubicon River
Wissota Sand and Gravel Company, Inc.	Washwater	50,000	Bark River
Waukesha County			
Milwaukee Metropolitan Subregional Area			
Best Block Company	Process	9,200	Soil Absorption
Carnation Company—Can Division	Cooling	48,300	Menomonee River via Storm Sewer
General Electric Company—Medical System Division	Cooling	2,400	Deer Creek via Storm Sewer
Huber Supreme Metal Treating Company	Cooling	N/A	Deer Creek
Menomonee Falls Water Utility	Filter Backwash	162,900	Menomonee River
Molded Rubber and Plastics Corporation	Cooling	33-100	Menomonee River via Storm Sewer
SEFO, Inc.—D/B/A Safer Cleaning Center	Cooling	1,000-1,500	Menomonee River via Storm Sewer
State Sand and Gravel Company	Process	N/A	Muskego Lake
W. A. Krueger Company, Inc.	Cooling	10,000	Underwood Creek
Western States Envelope	Cooling	15,000	Menomonee River via Storm Sewer
Upper Fox River Subregional Area			
Alby Products Corporation			
Outfall 1	Process and Cooling	68,000	Soil Absorption
American Telephone and Telegraph Company—Long Lines Division	Cooling Tower Blowdown and Groundwater Seepage	28,000	Fox River
Amron Corporation	Process and Cooling	75,000	Fox River via Storm Sewer
Elmbrook Memorial Hospital	Cooling	8,000	Fox River
General Casting Corporation	Cooling	449,000	Fox River via Storm Sewer
Grede Foundries, Inc.—Spring City Foundry	Cooling	228,000	Fox River via Storm Sewer
Halquist Stone Company	Washwater	1,035,000	Sussex Creek
Howard B. Stark Company	Cooling	55,000	Pewaukee River
International Harvester Company	Cooling	338,900	Tributary of the Fox River
Mammoth Springs Canning Company	Cooling	46,000	Sussex Creek and Soil Absorption
Payne & Dolan of Wisconsin, Inc.	Washwater	1,017,000	Fox River
Port Shell Molding, Inc.	Cooling	2,700	Pewaukee River
Quality Aluminum Casting Company	Cooling	2,300	Fox River via Storm Sewer
R.T.E. Corporation	Cooling	106,000	Fox River via Storm Sewer
Vulcan Materials Company	Groundwater	498,000	Fox River via Drainage Ditch
Waukesha Engine—Division of Dresser Industries, Inc.	Cooling	418,000	Marsh Adjacent to the Fox River
Waukesha Foundry	Cooling	272,000	Fox River via Drainage Ditch
Waukesha Lime & Stone Company, Inc.	Groundwater	120,000	Fox River
Western Bituminous Company, Inc.	Process	1,500	Fox River
Wisconsin Centrifugal, Inc.	Cooling	96,000	Fox River via Storm Sewer
Middle Rock River Subregional Area			
Carnation Company—Can Division	Cooling	18,200	Oconomowoc River via Storm Sewer
Carnation Company—Instant Products Division	Cooling and Boiler Blowdown	1,234,000	Oconomowoc River via Storm Sewer
Essential Chemicals Corporation	Cooling	500	Bark Creek via Storm Sewer
Hartland Plastics, Inc.	Cooling	3,000	Soil Absorption
La Belle Industries, Inc.	Cooling	17,500	Oconomowoc River via Storm Sewer
State Sand and Gravel	Washwater	670,000	Little Oconomowoc River
U. S. Gypsum Company—Fiberesin Plastics Division	Cooling and Boiler Blowdown	3,500	Soil Absorption

NOTE: N/A indicates data not available.

Source: SEWRPC

Table A-4

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS: 1975

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
Kenosha County	Kenosha-Racine Subregional Area (see Map 10)		
1	Tobin	300	321
2	Carol Beach	1,400	1,052
3	City of Kenosha-South	300	327
4	City of Kenosha-West	300	322
5	Town of Pleasant Prairie-Section 5	100	163
6	Town of Somers-Section 29	200	159
7	City of Kenosha-North	500	323
8	Parkside	100	162
9	Town of Somers-Section 1	100	166
10	Town of Somers-Section 3	100	161
	Des Plaines River Subregional Area (see Map 14)		
2	Town of Brighton-Section 12	200	162
3	Mud Lake	200	161
4	Town of Pleasant Prairie-Sections 26 and 27	300	326
5	Town of Pleasant Prairie-Section 15	100	163
6	Town of Pleasant Prairie-Section 6	200	150
7	Town of Somers-Section 6	400	133
	Lower Fox River Subregional Area (see Map 18)		
1	Town of Wheatland-Section 25	500	160
2	Silver Lake-Northwest	600	656
3	Silver Lake, Camp Lake, Trevor	2,400	2,096
4	Cross Lake, Voit and Benet Lakes	1,300	643
5	Wilmot	300	167
6	Lily Lake	300	489
7	New Munster	100	165
8	Powers & Benedict Lakes	1,100	1,919
29	Pell Lake	1,300	1,116
30	Genoa City	100	163
31	Town of Bloomfield-Section 7	100	157
32	Town of Linn-Sections 11 and 14, 9 and 10	100	318
33	Town of Linn-Sections 15 and 16	500	972
34	Zenda	100	162
Milwaukee County	Milwaukee Metropolitan Subregional Area (see Map 4)		
1	City of Franklin-Sections 20 and 21	1,500	475
2	City of Oak Creek-Section 26	200	159
3	City of Oak Creek-Section 19	200	163
4	City of Franklin-Section 13	300	162
5	Cities of Franklin and Oak Creek-Sections 12 and 17	300	311
6	City of Greenfield-West	1,300	1,052
7	City of Milwaukee-Section 17 (0821)	200	167
8	City of Mequon-Section 17	100	159
9	City of Mequon-Sections 15 and 21	1,300	644
10	City of Mequon-Section 30	200	171
11	City of Mequon-Section 31	200	165

Table A-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
Ozaukee County	Upper Milwaukee Subregional Area (see Map 6)		
1	Waubeka	400	317
2	Village of Saukville	100	160
3	Town of Port Washington-Section 30	200	160
4	Deckers Corner	100	161
5	Town of Grafton-Section 7	100	165
6	Town of Grafton-Section 18	200	163
7	Town of Cedarburg-Sections 14 and 15	600	482
8	Town of Cedarburg-Section 22	200	160
9	Town of Cedarburg-Sections 28 and 33	400	483
10	Town of Cedarburg-Sections 35 and 36	300	317
11	Town of Grafton-Section 31	200	163
12	Town of Grafton-Section 29	100	160
	Sauk Creek Subregional Area (see Map 8)		
1	Nellsville	100	160
Racine County	Kenosha-Racine Subregional Area (see Map 10)		
11	Town of Mt. Pleasant-Section 17	100	162
12	Town of Mt. Pleasant-Sections 4, 8, and 9	400	488
13	City of Racine-North	200	163
14	Town of Caledonia-Section 6	100	159
15	Town of Caledonia-Section 7	300	307
	Root River Canal Subregional Area (see Map 12)		
1	Town of Raymond-Section 6	100	159
2	Town of Raymond-Section 13	200	160
3	Ives Grove	200	157
4	Town of Yorkville-Section 27	500	320
	Des Plaines River Subregional Area (see Map 14)		
1	Town of Dover-Section 36	300	164
	Lower Fox Subregional Area (see Map 18)		
9	Eagle Lake Manor	800	955
10	City of Burlington	200	157
11	Bohner Lake	700	1,116
12	Tichigan Lake	1,600	1,749
13	Wind Lake	2,700	2,356

Table A-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
Walworth County	Lower Fox River Subregional Area (see Map 18)		
14	Lake Beulah-Potter Lake	100	1,925
15	Booth Lake	100	320
16	Troy Center	100	161
17	Town of Troy-Section 3	100	142
18	Pleasant Lake	0	162
19	Mill Lake	300	1,136
20	North Lake	200	323
21	Lake Wandawega and Silver Lake	600	635
22	Vienna-Honey Lake	300	319
23	Town of Lyons-Section 1	100	160
24	Lyons	500	323
25	Springfield	500	472
26	Lake Como	1,600	1,775
27	City of Lake Geneva	500	478
28	Lake Ivanhoe	100	162
	Lower Rock River Subregional Area (see Map 24)		
1	Whitewater Lake	500	806
2	Lake Loraine	300	321
3	Turtle Lake	300	488
4	Town of Delavan-Section 2	200	158
5	Town of Geneva-Section 8	300	164
6	Town of Darien-Section 23	300	162
7	Delavan Lake	2,500	2,886
8	Town of Delavan-Section 36	100	157
9	Village of Williams Bay	300	860
10	Allens Grove	100	187
Washington County	Milwaukee Metropolitan Subregional Area (see Map 4)		
12	Village of Germantown-Section 7	100	157
13	Theinsville-Rockfield	100	159
14	Village of Germantown-Section 13	100	163
15	Village of Germantown-Section 24	200	164
16	Village of Germantown-Sections 19 and 20	600	477
17	Willow Creek	300	314
	Upper Milwaukee River Subregional Area (see Map 6)		
13	Town of Richfield-Section 12	400	330
14	Town of Jackson-Section 36	300	163
15	Town of Polk-Section 36	100	161
16	Town of Jackson-Section 22	300	160
17	Big Cedar Lake	1,800	2,351
18	Silver Lake	100	159
19	City of West Bend-West	100	164
20	City of West Bend-East	400	462
21	Green Lake	100	166
22	Village of Kewaskum	500	162

Table A-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
	Upper Rock River Subregional Area (see Map 20)		
1	Town of Barton-Section 7	100	159
2	Town of Addison St. Lawrence	300	164
3	Village of Slinger Area Mud Lake	400	156
4	Pike Lake Area	400	323
5	City of Hartford Area	100	161
6	Town of Richfield-Section 10	100	165
7	Town of Richfield-Sections 13, 14, 22, and 23	2,200	1,274
8	Amy Bell Lake	400	318
9	Bark Lake	400	315
10	Town of Richfield-Section 34	200	161
11	Town of Richfield-Section 33	200	156
12	Town of Erin-Section 27	100	159
13	Friess Lake	600	631
Waukesha County	Milwaukee Metropolitan Subregional Area (see Map 4)		
18	Village of Menomonee Falls-Section 5	500	162
19	Village of Menomonee Falls-Section 1	100	165
20	Village of Menomonee Falls-East	4,200	1,962
21	Village of Menomonee Falls-South	5,600	2,137
22	City of New Berlin-North	5,500	1,464
23	City of New Berlin-Section 22	500	159
24	City of New Berlin-Southwest	2,500	1,438
25	City of New Berlin-Southeast	3,900	1,290
26	Bass Bay	500	479
27	City of Muskego-Section 13	100	163
	Upper Fox River Subregional Area (see Map 16)		
1	Lannon	2,700	1,449
2	Willow Springs	700	160
3	Village of Sussex-North	300	161
4	Town of Lisbon-Section 15	100	160
5	Town of Lisbon-Section 20	100	160
6	Town of Lisbon-Sections 28 and 29	400	488
7	Village of Sussex-Southeast	900	643
8	Oakwood Park	700	495
9	Village of Menomonee Falls-Sections 28, 32, and 33	1,100	490
10	Town of Lisbon-Section 32	100	160
11	Town of Lisbon-Section 31	300	153
12	Town of Pewaukee-Section 1	100	155
13	Duplainville	300	167
14	Pewaukee Lake	4,300	2,986
15	Town of Delafield-Section 27	100	157
16	City of Waukesha-North	300	161
17	City of Brookfield-Section 20	300	165
18	Goerkes Corners-South	3,100	1,605
19	City of New Berlin-Sections 16 and 17	600	314
20	City of Waukesha-Southeast	1,000	665

Table A-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
21	Town of Waukesha-Section 24 City of New Berlin-Section 19	400	497
22	City of Waukesha-Southwest	600	500
23	Town of Genesee-Section 10, 11	400	325
24	Genesee Depot	200	156
25	Genesee	200	161
26	Town of Genesee-Section 35	100	162
27	Town of Waukesha-Section 26	100	163
28	Town of Waukesha-Section 35	100	163
29	City of New Berlin-Section 31	700	173
	Lower Fox River Subregional Area (see Map 18)		
35	North Prairie	800	328
36	Town of Mukwonago-Section 7	200	163
37	Town of Vernon-Section 12	200	159
38	Big Bend	1,800	968
39	Town of Vernon-Section 19	200	142
40	Town of Mukwonago-Sections 15 and 21	200	319
41	Eagle	800	478
42	Eagle Spring Lake	400	485
43	Phantom Lakes	400	483
44	Lake Denoon	200	165
	Middle Rock River Subregional Area (see Map 22)		
1	Town of Lisbon-Section 4	200	349
2	Town of Lisbon-Section 20	100	158
3	Lake Keesus	600	794
4	Village of Merton	600	479
5	Beaver Lake	100	162
6	Town of Merton-Sections 16, 22, and 27	500	638
7	North Lake	100	159
8	Stonebank-Chenequa	500	465
9	Ashippun Lake	200	169
10	Okauchee Lake-Mud Lake	3,700	3,073
11	Lac La Belle (Lake)	1,000	960
12	Town of Summit-Silver Lake	300	482
13	Nashotah	1,200	1,312
14	Town of Delafield-Sections 17, 18, 19, and 20	1,800	1,447
15	Nemahbin Lakes (Town of Summit)	800	1,101
16	Town of Delafield-Section 28	100	319
17	Golden Lake	200	311
18	Utica Lake	200	177
19	Hunters Lake	100	157
20	Village of Wales	900	483
21	Pretty Lake	200	319

[a] Urban development is defined in this context as concentrations of urban land uses within any given U.S. Public Land Survey Quarter Section that has at least 32 housing units, or an average of one housing unit per five acres, and is not served by public sanitary sewers.

Appendix B

SELECTED SANITARY SEWERAGE SYSTEM DATA SUMMARIZED BY WATERSHED

Table B-1

SELECTED PUBLIC SANITARY SEWERAGE SYSTEMS: 1975

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Des Plaines River Watershed												
City of Kenosha	90	0.14	<100	Operates a Facility	17.38	89,500	18.40	18.00	Lake Michigan	None	None	None
Village of Paddock Lake	504	0.79	1,900	Operates a Facility	0.79	1,900	0.17	0.32	Marsh Drained by Brighton Creek	1 Bypass	None	<1.0
Village of Union Grove	427	0.67	1,500	Operates a Facility	0.97	3,200	0.43	0.30	West Branch of Root River Canal	None	None	None
Town of Bristol Utility District No. 1	459	0.72	800	Operates a Facility	0.72	800	0.07	0.16	Tributary of the Des Plaines River	1 Bypass	None	<1.0
Town of Pleasant Prairie Sanitary District No. 73-1	55	0.09	100	Operates a Facility	0.09	100	0.03	0.40	Des Plaines River via Drainage Ditch	None	None	None
Sewer Utility A	39	0.06	400	Contracts with the City of Kenosha	See City of Kenosha Above					None	None	None
Sewer Utility District D	398	0.62	700	Operates a Facility	0.68	1,000	0.10	0.13	Des Plaines River	1 Bypass	None	2.0
Sewer Utility District No. 1	70	0.11	<100							None	None	None
Town of Salem Sewer Utility District No. 1	202	0.31	900	Operates a Facility	0.37	1,000	0.06	0.30	Salem Branch of Brighton Creek	None	None	None
Total	2,244	3.51	6,300							3	None	2

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Fox River Watershed												
City of Brookfield-Fox River Watershed System	5,443	8.50	16,200	Operates a Facility	8.50	16,200	2.49	5.00	Fox River	None	2 Portable Pumping Stations	4.0
City of Burlington	1,451	2.77	8,900	Operates a Facility	2.27	10,800	1.48	2.50	Fox River	None	None	None
City of Elkhorn	750	1.17	2,700	Operates a Facility	2.42	4,400	0.69	0.50	Jackson Creek	None	None	None
City of Lake Geneva	1,252	1.96	5,700	Operates a Facility	1.96	5,700	0.74	1.10	White River	1 Bypass	None	4.0
City of Muskego	1,728	2.70	6,200	Operates Temporary Facilities	Big Muskego Plant 2.15	4,200	0.58	0.70	Big Muskego Lake	1 Bypass	None	<1.0
					Northeast Plant 2.60	6,000	0.34	0.50	Tess Corners Creek			
City of New Berlin—Area Connected to Milwaukee Metropolitan System	1,849	2.89		Contracts with Milwaukee-Metropolitan Sewerage Commissions	_[b]	_[b]	_[b]	_[b]	_[b]	None	None	None
Regal Manors Subdivision	344	0.54	1,100	Operates a Temporary Facility	0.54	1,100	0.12	0.30	Deer Creek	None	None	None
City of Waukesha	8,695	13.59	51,300	Operates a Facility	13.59	51,300	9.90	8.50	Fox River	1 Bypass	1 Bypass 2 Portable Pumping Stations	26.0
Village of East Rroy	523	0.82	2,200	Operates a Facility	0.82	2,700	0.25	0.32	Honey Creek	1 Bypass	None	<1.0
Village of Fontana	832	1.30	1,600	Operates a Facility	1.42	1,800	0.52	0.90	Soil Absorption and Lake Geneva	None	None	None
Village of Genoa City	174	0.27	1,100	Operates a Facility	0.27	1,100	0.07	0.12	Nippersink Creek	1 Bypass	None	1.0
Village of Mukwonago	804	1.26	3,400	Operates a Facility	1.26	3,400	0.44	0.22	Mukwonago River	None	None	None
Village of Pewaukee	835	1.31	4,800	Operates a Temporary Facility	1.31	4,800	0.48	0.80	Pewaukee River	None	None	None
Village of Rochester	120	0.19	800	Part of Western Racine County Sewerage District	See Western Racine County Sewerage District Below					None	None	None
Village of Silver Lake	298	0.47	1,300	Operates a Facility	0.47	1,300	0.15	0.30	Fox River	1 Bypass	None	<1.0
Village of Sussex	679	1.06	4,000	Operates a Temporary Facility	1.06	4,000	0.47	0.30	Sussex Creek	None	1 Portable Pumping Station	2.0
Village of Twin Lakes	1,478	2.31	3,400	Operates a Facility	2.81	3,400	0.41	0.82	Bassett Creek	None	None	None
Village of Waterford	369	0.58	2,300	Part of Western Racine County Sewerage District	See Western Racine County Sewerage District Below					None	None	None
Village of Williams Bay	765	1.20	1,700	Operates a Facility	1.21	1,700	0.55	0.80	Seepage Lagoon	None	None	None
Town of Rochester Sewer Utility District No. 1	110	0.17	300	Part of Western Racine County Sewerage District	See Western Racine County Sewerage District Below					None	None	None
Town of Salem Sewer Utility District No. 1	38	0.06	100	Operates a Facility	0.37	1,000	0.06	0.30	Salem Branch at Brighton Creek	None	None	None
Browns Lake Sanitary District	505	0.79	1,900	Contracts with City of Burlington	See City of Burlington Above					None	None	None
Western Racine County Sewerage District	_[c]	_[c]	_[c]	Operates a Facility	0.94	3,400	0.24	0.50	Fox River	None	None	None
Total	29,048	45.41	127,500							6 Bypasses	12 Other	37

Table B-1 (continued)

Name of Public Sanitary Sewerage System	Existing Estimated Service Area		Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics					Flow Relief Devices		
	Acres	Square Miles			Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Kinnickinnic River Watershed												
Milwaukee-Metropolitan Sewerage Commissions	–[h]	–[h]	–	Jones Island Plant	207.98	1,018,900	137.10	200.00	Lake Michigan	None	4 Bypasses	6
				South Shore Plant			73.70	120.00	Lake Michigan		2 Relief Pump Stations	
				Hales Corners Plant	2.99	8,800	0.52	0.90	Root River			
City of Cudahy	961	1.50	5,000	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee Metropolitan Above					None	None	None
City of Greenfield	1,715	2.68	11,300	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee Metropolitan Above					None	None	None
City of Milwaukee	12,378	19.34	125,200	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee Metropolitan Above					None	17 Crossovers 23 CSO	531 (CSO=516, Others = 15)
City of St. Francis	64	0.10	100	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee Metropolitan Above					None	None	None
City of West Allis	1,018	1.59	22,600	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee Metropolitan Above					None	2 Crossovers 4 Portable Pumping Stations	2
Village of West Milwaukee	301	0.47	1,000	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee Metropolitan Above					None	None	None
Total	16,437	25.68	165,100							None	52	539

Name of Public Sanitary Sewerage System	Existing Estimated Service Area		Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics					Flow Relief Devices		
	Acres	Square Miles			Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Lake Michigan Watershed												
Milwaukee-Metropolitan Sewerage Commissions	–	–	–	Jones Island Plant	207.98	1,018,900	137.10	200.00	Lake Michigan	None	1 Bypass	6.0
				South Shore Plant			73.70	120.00	Lake Michigan		2 Crossovers	
				Hales Corners	2.99	8,800	0.52	0.90	Root River			
City of Cudahy	1,934	3.02	16,600	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions					None	22 Crossovers	44.0
City of Kenosha	7,878	12.31	75,400	Operates a Facility	17.38	89,500	18.40	18.00	Lake Michigan	1 Bypass	2 Relief Pump Stations 14 Crossovers 4 Combined Sewer Outfalls	290 (CSO = 260, Other = 30)
City of Mequon	1,478	2.31	2,700	Contracts with Milwaukee-Metropolitan Sewerage Commissions	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of Milwaukee	2,886	4.51	27,900	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	1 Bypass 2 CSO's	202 (CSO = 200, Other = 2)
City of Oak Creek	870	7.36	1,000	Part of Milwaukee Metropolitan District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of Port Washington	672	1.05	3,200	Operates a Facility	2.47	9,500	1.70	1.25	Lake Michigan	1 Bypass	3 Bypasses	18
City of Racine	4,269	6.67	52,400	Operates a Facility	25.76	116,500	19.69	23.00	Lake Michigan	None	6 Crossovers 2 CSO's	130 CSO + 127 Other = 257 Total
City of South Milwaukee	1,043	1.63	7,100	Operates a Facility	4.86	23,400	2.67	6.00	Lake Michigan	1 Bypass	1 Bypass	4.0
City of St. Francis	1,574	2.46	9,900	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Bayside	1,158	1.81	4,000	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	2 Crossovers 2 Bypasses 1 Relief and 2 Portable Pumping Stations	9.0
Village of Elmwood Park	415	0.65	400	Contracts with Racine	See City of Racine Above					None	None	None
Village of Fox Point	1,121	1.75	2,300	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	7 Crossovers	17
Village of North Bay	69	0.11	1,300	Contracts with the City of Racine	See City of Racine Above					None	1 Bypass	<1.0
Village of River Hills	768	1.20	300	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Shorewood	83	0.13	500	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Whitefish Bay	1,189	1.86	8,200	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	21 Crossovers	42
Town of Mt. Pleasant Sewer Utility District No. 1	832	1.30	4,000	Contracts with the City of Racine	See City of Racine Above					None	1 Bypass	<1.0
Pleasant Park Sewer Utility	127	0.19	800	Operates a Facility	0.19	800	0.04	0.06	Lake Michigan via Drainage Ditch	None	None	None
Town of Pleasant Prairie												
Sewer Utility District No. 1	204	0.32	1,600	City of Kenosha	See City of Kenosha Above					None	None	None
Sewer Utility District No. 2	183	0.29	600		See City of Kenosha Above					None	None	None
Sewer Utility District A	72	0.11	–		See City of Kenosha Above					None	None	None
Sewer Utility District B	27	0.04	1,100		See City of Kenosha Above					None	None	None
Sewer Utility District C	14	0.02	700		See City of Kenosha Above					None	None	None
Sewer Utility District E	22	0.03	200		See City of Kenosha Above					None	None	None
Town of Sommers Sanitary District No. 1	340	0.53	400	Contracts with the City of Kenosha	See City of Kenosha Above							
Crestview Sanitary District	423	0.66	2,500	Contracts with North Park Sanitary District	See North Park Sanitary District Below					None	None	None
North Park Sanitary District[d]	2,741	4.28	6,800	Operates a Facility	4.94	9,300	1.13	2.00	Lake Michigan	None	None	None
Caledonia Sewer Utility District No. 1	768	1.20	300	Contracts with the City of Racine	See City of Racine Above							
Total	33,160	51.80	232,200	–	–	–	–	–	–	3 Bypasses	97	889

Table B-1 (continued)

Name of Public Sanitary Sewerage System	Existing Estimated Service Area		Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics					Flow Relief Devices		
	Acres	Square Miles			Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Menomonee River Watershed Milwaukee-Metropolitan Sewerage Commissions	–	–	–	Jones Island Plant South Shore Plant Hales Corners Plant	207.98 2.99	1,018,900 8,800	137.10 73.70 0.52	200.00 120.00 0.90	Lake Michigan Lake Michigan Root River	None	5 Bypasses 4 Crossovers 5 Relief Pump Stations	16
City of Brookfield–Area Connected to Milwaukee Metropolitan System	6,950	10.86	16,300	Contracts with Milwaukee-Metropolitan Sewerage Commissions	See Milwaukee-Metropolitan Sewerage Commissions Above					None	3 Portable Pumping Stations	8.0
City of Greenfield	1,843	2.88	8,000	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of Milwaukee	15,878	24.81	166,600	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	30 Crossovers 26 CSO's	1,357 (CSO = 1,316, Others = 41)
City of New Berlin	429	0.67	1,200	Contracts with the Milwaukee-Metropolitan Sewerage Commissions	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
City of Wauwatosa	8,499	13.28	55,700	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	3 Crossovers 19 Relief Pumps	42
City of West Allis	4,461	6.97	33,900	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	3 Crossovers 20 Portable Pumping Stations	20
Village of Butler	499	0.78	2,100	Contracts with Milwaukee-Metropolitan Sewerage Commissions	See Milwaukee-Metropolitan Sewerage Commissions Above					None	2 Bypasses	116
Village of Elm Grove Sanitary District 1 Sanitary District 2	 1,139 941	 1.78 1.47	 4,100 2,900	Contracts with Milwaukee-Metropolitan Sewerage Commissions	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Germantown	1,203	1.88	4,600	Operates a Temporary Facility	1.88	4,600	0.80	1.0	Menomonee River	None	None	None
Village of Greendale	83	0.13	500	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Menomonee Falls	3,949	6.17	20,400	Operates Temporary Facilities and Contracts with the Milwaukee-Metropolitan Sewerage Commissions	See Milwaukee-Metropolitan Sewerage Commissions Above					None	5 Crossovers 4 Relief Pumps 11 Portable Pumping Stations	35
Village of West Milwaukee	409	0.64	2,800	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Total	46,283	72.32	319,100	–	–	–	–	–	–	None	168[e]	1,594

Name of Public Sanitary Sewerage System	Existing Estimated Service Area		Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics					Flow Relief Devices		
	Acres	Square Miles			Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Milwaukee River Watershed Milwaukee-Metropolitan Sewerage Commissions	–	–	–	Jones Island Plant South Shore Plant Hales Corners Plant	207.98 2.99	1,018,900 8,800	137.10 73.70 0.52	200.00 120.00 0.90	Lake Michigan Lake Michigan Root River	None	13 Bypasses 8 Crossovers 3 Relief Pump Stations 2 Combined Sewer Outfalls	115
City of Cedarburg	1,652	2.58	10,400	Operates a Facility	2.58	10,400	1.41	3.00	Cedar Creek	None	2 Bypasses	<1.0
City of Glendale	3,821	5.97	13,500	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	1 Crossover 1 Portable Pumping Station	4.0
City of Mequon	4,423	6.91	6,800	Contracts with the Milwaukee-Metropolitan Sewerage Commissions	See Milwaukee-Metropolitan Sewerage Commissions Above					None	2 Bypasses 5 Portable Pumping Stations	12.0
City of Milwaukee	23,882	37.32	357,700	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	55 Crossovers 59 CSO	1,382
City of West Bend	4,021	6.28	21,000	Operates a Facility	6.28	21,000	3.70	2.50	Milwaukee River	1 Bypass	None	<1.0
Village of Bayside	378	0.59	400	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	None	None
Village of Brown Deer	2,788	4.36	13,600	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	2 Bypasses 5 Portable Pumping Stations	37.0
Village of Fox Point	723	1.13	5,600	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	1 Crossover 2 Relief Pumps 2 Bypasses 5 Portable Pumping Stations	19.0
Village of Fredonia	371	0.58	1,500	Operates a Facility	0.66	1,500	0.28	0.12	Milwaukee River	1 Bypass	None	2.0
Village of Grafton	1,377	2.15	8,800	Operates a Facility	2.15	8,800	0.88	1.00	Milwaukee River	None	None	None
Village of Jackson	275	0.43	2,000	Operates a Facility	0.43	2,000	0.26	0.03	Cedar Creek	None	2 Bypasses	4.0
Village of Kewaskum	415	0.65	2,000	Operates a Facility	0.65	2,000	0.32	0.50	Milwaukee River	None	None	None
Village of Newburg	119	0.19	600	Operates a Facility	0.19	600	0.07	0.05	Milwaukee River	1 Bypass	None	<1.0
Village of River Hills	2,637	4.12	1,200	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	1 Crossover	5.0
Village of Saukville	275	0.43	2,300	Operates a Facility	0.43	2,300	0.29	0.28	Milwaukee River	None	1 Pumping Station	<1.0
Village of Shorewood	1,002	1.57	13,800	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	8 Crossovers	16
Village of Thiensville	742	1.16	4,200	Operates a Temporary Facility	1.16	4,200	0.57	0.24	Milwaukee River	None	1 Bypass 1 Pumping Station	4.0
Village of Whitefish Bay	173	0.27	8,000	Part of Milwaukee Metropolitan Sewerage District	See Milwaukee-Metropolitan Sewerage Commissions Above					None	3 Crossovers	6.0
Total	49,074	76.69	453,400	–	–	–	–	–	–	3 Bypasses	185	1,606

Table B-1 (continued)

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Oak Creek Watershed												
City of Cudahy	141	0.22	100	Part of Milwaukee Metropolitan Sewerage District	—[b]	—[b]	—[b]	—[b]	—[b]	None	None	None
City of Franklin	742	1.16	1,900	Part of Milwaukee Metropolitan Sewerage District	—[b]	—[b]	—[b]	—[b]	—[b]	None	None	None
City of Greenfield	147	0.23	1,600	Part of Milwaukee Metropolitan Sewerage District	—[b]	—[b]	—[b]	—[b]	—[b]	None	None	None
City of Milwaukee	1,818	2.84	7,300	Part of Milwaukee Metropolitan Sewerage District	—[b]	—[b]	—[b]	—[b]	—[b]	None	None	None
City of Oak Creek	6,010	9.39	11,100	Part of Milwaukee Metropolitan Sewerage District	—[b]	—[b]	—[b]	—[b]	—[b]	None	None	None
City of South Milwaukee	2,067	3.23	16,300	Operates a Facility	4.86	23,400	2.67	6.00	Lake Michigan	None	2 Bypasses	<1.0
Total	10,925	17.07	38,300	—	—	—	—	—	—	None	2 Bypasses	<1.0
Pike River Watershed												
City of Kenosha	1,971	3.08	8,000	Operates a Facility	17.38	89,500	18.40	18.00	Lake Michigan	None	5 Crossovers	10.0
City of Racine	205	0.32	100	Operates a Facility	25.76	116,500	19.69	23.00	Lake Michigan	None	None	None
Village of Sturtevant	531	0.83	4,400	Operates a Facility	0.83	4,400	0.53	0.30	Tributary of the Pike River	1 Bypass	None	1.0
Town of Mt. Pleasant Utility District No. 1	3,002	4.69	9,000	Contracts with City of Racine	See City of Racine Above					None	1 Bypass	2.0
Town of Pleasant Prairie Sewer Utility District D	38	0.06	300	Operates a Facility	0.68	1,000	0.10	0.13	Des Plaines River	None	None	None
Town of Somers Sanitary District No. 1	198	0.31	1,100	Contracts with City of Kenosha	See City of Kenosha Above					None	None	None
Utility District No. 1	184	0.29	700	Operates a Facility	0.29	700	0.06	0.03	Tributary of the Pike River	1 Bypass	None	2.0
Total	6,128	9.58	23,600	—	—	—	—	—	—	2 Bypasses	6	15.0

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Rock River Watershed												
City of Delavan	1,285	2.01	5,800	Operates a Facility	2.01	5,800	0.59	1.00	Turtle Creek	1 Bypass	None	2.0
City of Elkhorn	801	1.25	1,700	Operates a Facility	2.42	4,400	0.69	0.50	Jackson Creek	1 Bypass	None	<1.0
City of Hartford	1,230	1.92	7,600	Operates a Facility	1.92	7,600	1.37	2.00	Rubicon River	None	None	None
City of Oconomowoc	1,752	2.74	11,100	Operates a Facility	2.74	11,100	1.90	1.50	Oconomowoc River	1 Bypass	3 Bypasses	6.0
City of Whitewater	1,524[f]	2.38	11,000	Operates a Facility	2.38	11,000	1.14	2.50	Whitewater Creek	1 Bypass	4 Bypasses	7.0
Village of Darien	303	0.47	1,000	Operates a Facility	0.47	1,000	0.14	0.15	Turtle Creek	1 Bypass	None	1.0
Village of Dousman	288	0.45	1,000	Operates a Facility	0.45	1,000	0.11	0.12	Bark River	1 Bypass	None	—[b]
Village of Fontana	77	0.12	200	Operates a Facility	1.42	1,800	0.52	0.90	Soil Absorption and Lake Geneva	None	None	None
Village of Hartland	799	1.25	4,400	Operates a Facility	1.25	4,400	0.42	0.36	Bark River	1 Bypass	None	—[b]
Village of Sharon	340	0.53	1,400	Operates a Facility	0.53	1,400	0.08	0.15	Turtle Creek	1 Bypass	None	<1.0
Village of Slinger	289	0.45	1,300	Operates a Facility	0.45	1,300	0.15	0.15	Marshland Drained by the Rubicon River	None	None	None
Village of Walworth	303	0.47	1,700	Operates a Facility	0.47	1,700	N/A	0.15	Picasaw Creek	1 Bypass	None	<1.0
Village of Williams Bay	6	0.01		Operates a Facility	1.21	1,700	0.55	0.80	Seepage Lagoon	None	None	None
Allenton Sanitary District	120	0.19	800	Operates a Facility	0.19	800	0.08	0.10	East Branch of the Rock River	None	None	None
Total	9,117	14.24	46,400	—	—	—	—	—	—	9 Bypasses	7	16.0

Table B-1 (continued)

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Root River Watershed												
City of Franklin	3,072	4.80	6,900	Part of Milwaukee Metropolitan Sewerage District	–[b]	–[b]	–[b]	–[b]	–[b]	None	None	None
City of Greenfield	1,837	2.87	9,000	Part of Milwaukee Metropolitan Sewerage District	–[b]	–[b]	–[b]	–[b]	–[b]	None	None	None
City of Milwaukee	307	0.48	6,400	Part of Milwaukee Metropolitan Sewerage District	–[b]	–[b]	–[b]	–[b]	–[b]	None	4	4.0
City of Muskego	1,312	2.05	7,000	Operates Temporary Facility	Big Muskego Plant 2.15 Northeast Plant 2.60	4,200 6,000	0.58 0.34	0.70 0.50	Big Muskego Lake Tess Corners Creek	None	None	None
City of New Berlin	941	1.47	4,800	Contracts with Milwaukee-Metropolitan Sewerage Commissions	–[b]	–[b]	–[b]	–[b]	–[b]	None	None	None
City of Oak Creek	858	1.34	2,300	Part of Milwaukee Metropolitan Sewerage District	–[b]	–[b]	–[b]	–[b]	–[b]	None	None	None
City of Racine	4,026	6.29	44,000	Operates a Facility	25.76	116,500	19.69	23.00	Lake Michigan	None	11 Crossovers 14 Bypasses 8 CSO's	310 (CSO = 160, Other = 150)
City of West Allis	1,805	2.82	12,500	Part of Milwaukee Metropolitan Sewerage District	–[b]	–[b]	–[b]	–[b]	–[b]	None	7 Crossovers 11 Portable Pumps	18.0
Village of Greendale	3,117	4.87	16,300	Part of Milwaukee Metropolitan Sewerage District	–[b]	–[b]	–[b]	–[b]	–[b]	None	None	None
Village of Hales Corners	1,914	2.99	8,800	Part of Milwaukee Metropolitan Sewerage District	–[b]	–[b]	–[b]	–[b]	–[b]	None	None	None
Village of Union Grove	192	0.30	1,700	Operates a Facility	0.97	3,200	0.43	0.30	West Branch Root River Canal	1 Bypass	None	2.0
Caddy Vista Sanitary District	186	0.29	1,000	Operates a Temporary Facility	0.29	1,000	0.09	0.25	Root River	1 Bypass	None	2.0
Town of Caledonia Sewer Utility District No. 1	2,001	3.13	4,000	Contracts with City of Racine	See City of Racine Above					None	3 Bypasses	<1.0
Town of Mt. Pleasant Utility District No. 1	897	1.40	2,600	Contracts with City of Racine	See City of Racine Above					None	1 Bypass	7.0
Town of Pleasant Prairie Sewer Utility District B	20	0.03	<100	Contracts with City of Kenosha	–[h]	–[h]	–[h]	–[h]	–[h]	None	None	None
Rawson Homes Sewer & Water Trust	102	0.16	600	Operates a Temporary Facility[g]	0.16	600	N/A	0.04	Minor Tributary of the Root River	None	None	None
Total	22,587	35.29	124,900	–	–	–	–	–	–	2 Bypasses	59	343.0

Name of Public Sanitary Sewerage System	Existing Estimated Service Area: Acres	Existing Estimated Service Area: Square Miles	Population[a] Served	Arrangement for Treatment of Sewage	Selected Wastewater Treatment Facility Characteristics: Estimated Total Served (square miles)	Estimated Total Population Served	Annual Average Hydraulic Loading (mgd)	Average Hydraulic Design Capacity (mgd)	Disposal of Effluent	Flow Relief Devices: Wastewater Treatment Plant	Sewer System	Total Estimated Average Annual Wastewater Discharge
Sauk Creek Watershed												
City of Port Washington	907	1.42	6,300	Operates a Facility	2.47	9,500	1.70	1.25	Lake Michigan	None	2 Bypasses	3.0
Village of Belgium	19	0.03	<100	Operates a Facility	0.36	900	0.07	0.07	Tributary of the Onion River	None	None	None
Village of Fredonia	51	0.08	<100	Operates a Facility	0.66	1,500	0.28	0.12	Milwaukee River	None	None	None
Total	977	1.53	6,300							None	2 Bypasses	3.0
Sheboygan River Watershed												
Village of Belgium	210	0.33	900	Operates a Facility	0.36	900	0.07	0.07	Tributary of the Onion River	1 Bypass	None	<1.0
Total	210	0.33	900	–	–	–	–	–	–	1 Bypass	None	<1.0
Region Total	226,184	353.45	1,544,000	–	–	–	–	–	–	29	590	5,044

NOTE: N/A indicates data not available.

[a] *Based upon an approximation of the existing sewer service area by the U.S. Public Land Survey quarter section.*

[b] *See Milwaukee-Metropolitan Sewerage Commission (under Kinnickinnic River, Lake Michigan, Menomonee River, and Milwaukee River watersheds in this table) for treatment facility characteristics.*

[c] *Service area and population included in the service areas of Village of Rochester and Waterford and Town of Rochester Sewer Utility District No. 1.*

[d] *Includes Village of Wind Point.*

[e] *Includes two portable pumping stations from the Fox River watershed.*

[f] *Includes 141 acres (0.22 square mile) in Jefferson County.*

[g] *Rawson Homes Wastewater Treatment facility was abandoned in 1977 and the sewerage system was connected to the City of Franklin, which is part of the Milwaukee Metropolitan Sewerage District.*

[h] *See City of Kenosha (under Des Plaines River, Lake Michigan, and Pike River watersheds) for treatment plant characteristics.*

Table B-2

SELECTED CHARACTERISTICS OF PRIVATE SEWAGE TREATMENT FACILITIES: 1975

Treatment Plant	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Average Hydraulic Design Capacity (gallons per day)	Disposal of Effluent
Des Plaines River Watershed				
Root River Canal Subregional Area				
Fonk's Mobile Home Park No. 2	Sanitary	2,500	15,000	Tributary of the Des Plaines River
Des Plaines River Subregional Area				
Brightondale County Park	Sanitary	9,700 May through September	10,000	Soil Absorption
George Connolly Development (not yet in operation)	Sanitary	--	34,000	Tributary of the Des Plaines River
Howard Johnson Motor Lodge and Restaurant	Sanitary	49,000	18,300	Des Plaines River
Kenosha Packing Company	Process, Cooling, and Sanitary	23,200	N/A	Soil Absorption
Paramski Mobile Home Park	Sanitary	11,500	40,000	Marsh Tributary of Mud Lake
Wisconsin Department of Transportation—Tourist Information Center	Sanitary	4,500	9,250	Tributary of the Des Plaines River
Fox River Watershed				
Milwaukee Metropolitan Subregional Area				
Brookfield Central High School	Sanitary	N/A	N/A	Soil Absorption
Cleveland Heights Elementary School	Sanitary	5,000	N/A	Tributary of the Poplar Creek
Muskego Rendering Company Inc.	Process	N/A	N/A	Soil Absorption
Des Plaines River Subregional Area				
Wheatland Mobile Homes Park				
Upper Fox River Subregional Area				
Mammoth Springs Canning Corporation	Process	200,000	N/A	Soil Absorption
New Berlin West High School	Sanitary	18,000	24,000	Tributary of the Poplar Creek
Oakton Manor—Tumblebrook Golf Course	Sanitary	800	36,000	Pewaukee Lake
Steeplechase Inn	Sanitary	N/A	25,000	Soil Absorption
Willow Springs Mobile Home Park	Sanitary	N/A	N/A	Soil Absorption
Lower Fox River Subregional Area				
Alpine Valley Resort, Inc.	Sanitary	N/A	40,000	Soil Absorption
County Estates Mobile Home Park	Sanitary	15,000	N/A	White River
Downe Duck Company, Inc.	Process and Sanitary	45,000	200,000	Soil Absorption
Holy Redeemer College	Sanitary	8,000	15,000	Tributary of the Wind Lake Canal
Packaging Corporation of America	Process and Sanitary	7,500	10,000	Tributary of Fox River
Playboy Club Hotel	Sanitary	120,000	500,000	White River
Paiser Produce (not in operation)	Process	N/A	N/A	Soil Absorption
Rainbow Springs Resort (not in operation)	Sanitary	N/A	160,000	Tributary of the Mukwonago River
Slovak Sokol Camp	Sanitary	20,000	N/A	Potter Lake
Wisconsin Dairies Cooperative	Process	6,200	N/A	Nippersink Creek
Wisconsin Department of Transportation—East Troy Rest Area	Sanitary	N/A	18,000	Tributary of the Sugar Creek
Lower Rock River Subregional Area				
Lake Geneva Interlaken Resort Village	Sanitary	27,000	125,000	Soil Absorption
Lake Michigan Watershed				
Milwaukee Metropolitan Subregional Area				
Chalet on the Lake Restaurant	Sanitary	N/A	50,000	Lake Michigan
Sisters of Notre Dame Academy	Sanitary	20,000	40,000	Lake Michigan
Wisconsin Electric Power Company Plant—Oak Creek	Sanitary	30,000	40,000	Lake Michigan
Sauk Creek Subregional Area				
Port Country Club	Sanitary	N/A	N/A	Soil Absorption
Kenosha-Racine Subregional Area				
J. I. Case Company	Process and Cooling	1,259,400	N/A	Lake Michigan
Siendale Noterhouse	Sanitary	2,000	4,000	Bartlett Creek

Table B-2 (continued)

Treatment Plant	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Average Hydraulic Design Capacity (gallons per day)	Disposal of Effluent
Milwaukee River Watershed				
Milwaukee Metropolitan Subregional Area				
Federal Foods Company	Process	N/A	N/A	Soil Absorption
Upper Milwaukee River Subregional Area				
Cedar Lake Rest Home	Sanitary	N/A	N/A	Soil Absorption
Justro Food Company (not in operation)	Process	N/A	N/A	Soil Absorption
Level Valley Dairy	Process and Cooling	172,000	N/A	Cedar Creek
Libby McNeill and Libby Jackson	Process and Cooling	144,000	N/A	Soil Absorption
S & R Cheese Corporation	Process	1,800	N/A	Soil Absorption
Pike River Watershed				
Kenosha-Racine Subregional Area				
American Motors-Kenosha	Process	2,000	2,000	Pike River
St. Bonaventure Seminary	Sanitary	8,000	15,000	Waxdale Creek
Rock River Watershed				
Upper Rock River Subregional Area				
Libby, McNeill and Libby, Inc.	Process	458,000	N/A	Hartford Sewage Treatment Plant
National Farmers Organization— Slinger Transfer Station	Washwater	N/A	N/A	Soil Absorption
Pike Lake State Park	Sanitary	N/A	N/A	Soil Absorption
Middle Rock River Subregional Area				
Ethan Allen School	Sanitary	59,000	165,000	Soil Absorption
Gigas Hillside Apartments	Sanitary	N/A	20,000	Soil Absorption
St. John's Military Academy	Sanitary	30,000	75,000	Bark River
Lower Rock River Subregional Area				
Kikkoman Foods, Inc.	Process and Sanitary	240,000	N/A	Soil Absorption
Lakeland Nursing Home				
Walworth County Institutions	Sanitary	80,000	230,000	Jackson Creek
Lake Lawn Lodge	Sanitary	69,000	100,000	Delavan Lake
Libby, McNeill and Libby, Inc.				
Outfall - 1	Process	1,100,000	N/A	Soil Absorption
Outfall - 2	Sanitary	10,000	N/A	Soil Absorption
Walworth County Correctional Center (not in operation)	Sanitary	—	N/A	Tributary of the Jackson Creek
Root River Watershed				
Milwaukee Metropolitan Subregional Area				
Highway 100 Drive-In Theatre	Sanitary	N/A	6,000	Soil Absorption
Highway 24 Outdoor Theatre	Sanitary	N/A	Intermittent	Soil Absorption
New Berlin Memorial Hospital	Sanitary	26,000	19,000	Root River via Drainage Ditch
Union Oil Truck Stop	Sanitary	N/A	10,000	Root River
Kenosha-Racine Subretional Area				
Frank's Pure Food Company	Process	70,000	N/A	Hoods Creek via Drainage Tile
Root River Canal Subregional Area				
C & D Foods, Inc.	Process and Sanitary	269,900	N/A	West Branch Root River Canal
Fonk's Mobile Home Park No. 1	Sanitary	13,000	15,000	East Branch Root River Canal
Grove Duck Farm, Inc	Process and Sanitary	25,000	N/A	West Branch Root River Canal
Meeter Brothers Company	Process and Cooling	66,500	N/A	Tributary of the Des Plaines River via Storm Sewer
Pekin Duck Farm	Process	6,000	50,000	Soil Absorption
Racine County Highway and Park Commission	Sanitary	N/A	10,000	Hoods Creek
Southern Colony Training School and Treatment Facility	Sanitary	180,000	445,000	West Branch Root River Canal
Sauk Creek Watershed				
Sauk Creek Subregional Area				
Cedar Valley Cheese Factory	Process and Cooling	N/A	N/A	Soil Absorption
Sheboygan River Watershed				
Sauk Creek Subregional Area				
Krier Preserving Company				
Outfall No. 1	Process	Intermittent	N/A	Onion River via Drainage Ditch
Outfall No. 3	Process	550,000	N/A	Soil Absorption

NOTE: N/A indicates data not available.

Source: SEWRPC.

Table B-3

KNOWN POINT SOURCES OTHER THAN SEWAGE TREATMENT PLANTS: 1975

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Des Plaines River Watershed			
Des Plaines River Subregional Area			
Bristol Water Utility	Filter Backwash	Intermittent	Tributary of the Des Plaines River
Ladish Company—Tri-Clover Division	Cooling and Process	94,800	Tributary of the Des Plaines River
Fox River Watershed			
Milwaukee Metropolitan Subregional Area			
General Electric Company—Medical System Division	Cooling	2,400	Deer Creek via Storm Sewer
Huber Supreme—Metal Treating Company	Cooling	N/A	Deer Creek
State Sand and Gravel Company	Process	N/A	Muskego Lake
Upper Fox River Subregional Area			
Alloy Products Corporation	Process and Cooling	68,000	Soil Absorption
American Telephone and Telegraph Company—Long Lines Division	Cooling Tower Blow-down and Ground-water Seepage	28,000	Fox River
Amron Corporation			
Outfall - 1	Process and Cooling	75,000	Fox River via Storm Sewer
Elmbrook Memorial Hospital	Cooling	8,000	Fox River
General Casting Corporation	Cooling	449,000	Fox River via Storm Sewer
Grede Foundries, Inc.—Spring City Foundry	Cooling	228,000	Fox River via Storm Sewer
Halquist Stone Company	Washwater	1,035,000	Sussex Creek
Howard B. Stark Company	Cooling	55,000	Pewaukee River
International Harvester Company	Cooling	338,900	Tributary of Fox River
Mammoth Springs Canning Corporation	Cooling	46,000	Sussex Creek and Soil Absorption
Paynel Dalar of Wisconsin, Inc.	Washwater	1,017,000	Fox River
Port Shell Molding, Inc.	Cooling	2,700	Pewaukee River
Quality Aluminum Casting Company	Cooling	2,300	Fox River via Storm Sewer
RTE Corporation	Cooling	106,000	Fox River via Storm Sewer
Vulcan Materials Company	Groundwater	498,000	Fox River via Drainage Ditch
Waukesha Engine—Division of Dresser Industries, Inc.	Cooling	418,000	Marsh Adjacent to the Fox River
Waukesha Foundry	Cooling	272,000	Fox River via Drainage Ditch
Waukesha Lime & Stone Company, Inc.	Groundwater	120,000	Fox River
Western Bituminous Company, Inc.	Process	1,500	Fox River
Wisconsin Centrifugal, Inc.	Cooling	96,000	Fox River via Storm Sewer
Lower Fox River Subregional Area			
Burlington Brass Works	Process and Sanitary	1,700	Fox River via Storm Sewer
Coca-Cola Bottling Company, Inc.	Washwater	7,000	White River via Drainage Ditch
Continental Can Company, Inc.	Process	N/A	Soil Absorption
Crucible, Inc.—Trent Tube Division Plant No. 1	Process and Cooling	480,000	Honey Creek
Crucible, Inc.—Trent Tube Division Plants No. 2 and 3	Process and Cooling	64,000	Honey Creek
Culligan Soft Water Service	Process	1,100	Fox River via Storm Sewer
Foster-Forbes Glass Company	Cooling	581,000	Fox River
Genoa City Water Treatment Plant	Filter Backwash	Intermittent	North Branch, Nippersink Creek
Lake Geneva Packing, Inc.	Process	N/A	Soil Absorption
Lavelle Industries, Inc.	Process and Cooling	55,000	Fox River via Storm Sewer
Murphy Products Company, Inc.	Cooling	3,000	Fox River via Storm Sewer
The Nestle Company, Inc.	Cooling	12,000	Fox River via Storm Sewer
White Construction Company	Groundwater Seepage	Intermittent	Tributary of the Fox River
Wisconsin Dairies Cooperative	Cooling	3,600	Nippersink Creek
Kinnickinnic River Watershed			
Milwaukee Metropolitan Subregional Area			
Allied Smelting Corporation	Process and Cooling	121,000	Kinnickinnic River via Storm Sewer
Badger Die Casting Corporation	Cooling	43,500	Kinnickinnic River via Storm Sewer
Briggs & Stratton Corporation	Cooling	1,478,000	Kinnickinnic River via Storm Sewer
Caterpiller Tractor Company	Process and Cooling	7,800	Kinnickinniv River via Storm Sewer
Eaton Corporation	Process, Cooling, and Boiler Blowdown	131,600	Kinnickinnic River via Storm Sewer and Drainage Ditch
Froedtert Malt Corporation	Cooling	19,900	Kinnickinnic River via Storm Sewer
General Electric Company—Dishwasher & Disposal Products Department	Cooling	109,000	Kinnickinnic River via Storm Sewer and Drainage Ditch
General Electric Company—Medical Systems Division	Cooling and Cooling Tower Blowdown	475,700	43rd Street Ditch
General Electric Company—West Edgerton	Cooling	300	Holmes Avenue Creek
Heil Company—Bulk Trailer Division (Tank)	Test and Cooling	10,800	Kinnickinnic River via Storm Sewer

Table B-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Kinnickinnic River Watershed (continued)			
Milwaukee Metropolitan Subregional Area (continued)			
Heil Company—Solid Waste Systems and Truck Equipment Division	Cooling	82,400	Kinnickinnic River
Howmet Turbine Components Corporation	Process and Cooling	636,800	Kinnickinnic River
Kurth Malting Corporation—Plant No. 1	Cooling	150,000	43rd Street Ditch
Ladish Company	Cooling	465,500	Wilson Park Creek via Storm Sewer
Maynard Steel Casting Company	Process and Cooling	110,400	Kinnickinnic River
Milwaukee County Park Commission—Holler Park	Swimming Pool Overflow and Emptying	Intermittent	Holmes Avenue Creek
Milwaukee County Park Commission—Jackson Park	Swimming Pool Overflow	Intermittent	Kinnickinnic River via Storm Sewer
Milwaukee County Park Commission—Kosciuszko Park	Swimming Pool Overflow	Intermittent	Kinnickinnic River via Storm Sewer
Milwaukee County Park Commission—Wilson Park	Swimming Pool Overflow	Intermittent	Wilson Park Creek via Storm Sewer
Milwaukee Solvay Coke Company	Process, Cooling, and Boiler Blowdown	4,820,800	Kinnickinnic River
Milwaukee Spring Company	Cooling	78,000	Wilson Park Creek via Storm Sewer
Milwaukee Waterworks	Filter Backwash	415,800	Kinnickinnic River
Murphy Diesel Company	Cooling	40,220	43rd Street Ditch via Storm Sewer
Oil Gear Company	Cooling	1,960	Kinnickinnic River via Storm Sewer
Pelton Casteel, Inc.	Process and Cooling	79,800	Kinnickinnic River via Drainage Ditch
Perfex, Inc.	Cooling and Test	130,000	Kinnickinnic River via Storm Sewer
Rexnord, Inc.—Nordberg Machinery Group	Process and Cooling Boiler Blowdown	448,800	Kinnickinnic River via Storm Sewer
Teledyne Wisconsin Motor	Process and Cooling	36,000	43rd Street Ditch via Storm Sewer
Union Oil of California—General Mitchell Field	Contaminated Storm Water	Intermittent	Wilson Park Creek via Storm Sewer
Wehr Steel Company	Process and Cooling	253,000	43rd Street Ditch via Storm Sewer
Lake Michigan Watershed			
Milwaukee Metropolitan Subregional Area			
Advance Boiler and Tank Company	Hydrostatic Test Water	40	Lake Michigan
Allis Chalmers Corporation	Process and Cooling	9,700	Lake Michigan via Storm Sewer
American Motors Corporation—Services and Distribution Division	Cooling	75,000	Lake Michigan via Storm Sewers
Bucyrus Erie Company	Cooling	17,300	Lake Michigan via Drainage Ditch and Storm Sewer
EZ Paintr Corporation	Cooling	49,000	Lake Michigan via Drainage Ditch and Storm Sewer
James Manufacturing, Inc.—Froemming Cast Products Division	Process and Cooling	36,300	Lake Michigan via Storm Sewer
Ladish Company—Cudahy	Cooling	708,000	Lake Michigan via Storm Sewer
Milwaukee County Park Commission—Swimming Pool, Sheridan Park	Swimming Pool Overflow and Drainage	Intermittent	Lake Michigan via Storm Sewer
Milwaukee Oceanic Terminal, Division of Optics for Industry	Cooling	Intermittent	Lake Michigan
Milwaukee Water Works—Linwood Avenue Plant	Filter Backwash	1,013,300	Lake Michigan
Mobile Oil Corporation—Milwaukee Terminal	Runoff	4,600	Lake Michigan
Oak Creek Water Filtration Plant	Filter Backwash	611,600	Lake Michigan via Storm Sewer
Patrick Cudahy, Inc.	Cooling	72,000	Lake Michigan via Storm Sewer
Peter Cooper Corporation—United States Glue and Gelation Division	Process and Cooling	3,204,600	Lake Michigan via Storm Sewer
Phillips Petroleum Company	Runoff	Intermittent	Lake Michigan
Shell Oil Company	Runoff	1,200	Lake Michigan
Texaco, Inc.	Runoff	Intermittent	Lake Michigan
UWM Physical Plant	Cooling	9,000,000	Lake Michigan
Wire and Metal Specialties Company	Cooling	111,566,500	Lake Michigan via Storm Sewer
Wisconsin Electric Power Company—Lakeside Power Plant	Cooling, Boiler Blow-down, Drainage, Boiler Cleaning, Deicing Line	1,654,489,800	Lake Michigan via Storm Sewer
Wisconsin Electric Power Company—Oak Creek Plant	Process, Cooling, Boiler Blowdown, Drainage, and Deicing Line	2,028,976,400	Lake Michigan via Storm Sewer

Table B-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Lake Michigan Watershed (continued)			
Sauk Creek Subregional Area			
Fromm Laboratories, Inc.	Cooling	200	Lake Michigan via Storm Sewer and Drainage Ditch
Port Washington Filtration Plant	Process	14,700	Lake Michigan
Wisconsin Electric Power Company—Port Washington Power Plant	Process and Cooling	513,500,000	Lake Michigan
Kenosha-Racine Subregional Area			
Anaconda American Brass Company	Cooling and Rinse	185,500	Lake Michigan via Storm Sewer
Eaton Corporation—Industrial Drives Division	Cooling	15,700	Lake Michigan via Storm Sewer
Harris Metals, Inc.	Process and Cooling	N/A	Birch Creek via Storm Sewer and Drainage Ditch
J.I. Case Company—Clausen Plant	Process and Cooling	1,486,100	Lake Michigan
Madison Fuel Company—Baumann Oil Branch	Runoff	Intermittent	Lake Michigan
Printing Developments, Inc.	Cooling	120,000	Lake Michigan via Storm Sewer
S. C. Johnson and Son, Inc.	Cooling	1,092,900	Lake Michigan via Storm Sewer
TEK Products, Inc.	Cooling	26,000	Lake Michigan via Storm Sewer
Vulcan Materials Company—Construction Materials Division	Process	421,000	Tributary of Lake Michigan via Storm Ditch
Young Radiator Company	Process, Cooling, and Boiler Blowdown	40,000	Lake Michigan via Drainage Ditch
Menomonee River Watershed			
Milwaukee Metropolitan Subregional Area			
Allis Chalmers Corporation	Process	70,000	Menomonee River via Storm Sewer
AMF, Inc.—Harley Davidsen Motor Company	Process and Cooling	40,000	Tributary of the Menomonee River
Babcock and Wilcox—Tubular Products Division	Cooling	825,000	Menomonee River via Storm Sewer
Best Block Company	Process	9,200	Soil Absorption
Briggs & Stratton Corporation	Cooling	25,000	Menomonee River via Storm Sewer
Butler Lime & Cement Company	Process	1,700	Menomonee River via Storm Sewer
Carnation Company—Can Division	Cooling	48,300	Menomonee River via Storm Sewer
Center Fuel Company	Runoff	Intermittent	Little Menomonee River via Storm Sewer
Chicago, Milwaukee, St. Paul & Pacific Railroad Company	Process	319,800	Menomonee River via Drainage Ditch
Chicago & North Western Railway	Process	300	Menomonee River via Drainage Ditch
Chris Hanson's Laboratory, Inc.	Cooling	50,000	Honey Creek via Storm Sewer
Falk Corporation—Plant No. 1	Process and Cooling	428,100	Menomonee River
Falk Corporation—Plant No. 2	Cooling	25,000	Tributary of the Menomonee River
Falk Corporation—Research and Development	Process and Cooling	55,000	Menomonee River
Federal Malleable Company	Cooling and Boiler Blowdown	36,100	Honey Creek via Storm Sewer
Gehl Guernsey Farms, Inc.	Cooling	190,000	Menomonee River via Storm Sewer
Grede Foundries, Inc.—Liberty Foundry	Cooling	60,000	Menomonee River via Storm Sewer
Grey Iron Foundry, Inc.	Process and Cooling	474,000	Honey Creek
Harnischfeger Corporation	Process and Cooling	380,000	Menomonee River via Storm Sewer
Hentzen Chemical Coatings, Inc.	Cooling	54,000	Little Menomonee River via Storm Sewer
Inryco, Inc.	Cooling	211,000	Menomonee River via Storm Sewer
Kearney & Trecker Corporation	Cooling	121,900	Underwood Creek via Storm Sewer
Marquette University	Cooling and Steam Condensate	56,000	North Menomonee Canal via Storm Sewer
Menomonee Falls Water Utility	Filter Backwash	162,900	Menomonee River
Miller Brewing Company	Cooling and Drainage	1,676,900	Menomonee River via Storm Sewer
Milwaukee County Institutions—Power Plant	Process and Cooling	67,000	Menomonee River via Drainage Ditch
Milwaukee County Park Commission—Greenfield Park	Swimming Pool Overflow and Drainage	Intermittent	South Branch of Underwood Creek via Storm Sewer
Milwaukee County Park Commission—Hoyt Park	Swimming Pool Overflow and Drainage	Intermittent	Menomonee River via Storm Sewer

Table B-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Menomonee River Watershed (continued)			
Milwaukee Metropolitan Subregional Area (continued)			
Milwaukee County Park Commission—Madison Park	Swimming Pool Overflow and Drainage	Intermittent	Menomonee River via Storm Sewer
Milwaukee County Park Commission—McCarty Park	Swimming Pool Overflow and Drainage	Intermittent	Honey Creek via Storm Sewer
Milwaukee County Park Commission—Washington Park	Swimming Pool Overflow and Drainage	Intermittent	Menomonee River via Storm Sewer
Milwaukee Marble Company	Process	5,500	Menomonee Canal via Storm Sewer
Mobile Oil Corporation—Lubrication Plant	Cooling	4,600	Menomonee River via Storm Sewer
Molded Rubber and Plastics Corporation	Cooling	33,100	Menomonee River via Storm Sewer
Motor Casting Plant No. 1	Cooling	220,000	Woods Creek via Storm Sewer
Motor Casting Plant No. 2	Cooling	18,000	Honey Creek via Storm Sewer
Perlick Company, Inc.	Cooling	1,000	Little Menomonee River via Storm Sewer
Rexnord, Inc.—West Milwaukee Facility	Process and Cooling	475,600	Woods Creek via Storm Sewer
Robert A. Johnston Company	Cooling	511,600	Menomonee River via Storm Sewer
Safeway Wash-A-Car, Inc.	Process	1,000	Honey Creek via Storm Sewer
SEFO, Inc.—D/B/A Safer Cleaning Center	Cooling	1,000-1,500	Menomonee River via Storm Sewer
Seven-Up Milwaukee Inc.	Process Washwater	7,000	South Branch of Underwood Creek
Union Oil of California, N. 107th Street	Runoff	Intermittent	Little Menomonee River via Drainage Ditch
W. A. Krueger Company, Inc.	Cooling	10,000	Underwood Creek
Western Metal Speciality—Division of Western Industries, Inc.	Cooling	10,000 to 50,000	Menomonee River via Storm Sewer
Western States Envelope	Cooling	15,000	Menomonee River via Storm Sewer
West Shore Pipe Line Company	Process	4,000	Menomonee River
Wisconsin Electric Power Company—Heating System	Steam Condensate and Seepage	62,000	Menomonee River
Wisconsin Electric Power Company—Valley Plant	Cooling, Boiler Blow-down and Drainage Ditch	142,798,500	South Menomonee Canal
Milwaukee River Watershed			
Milwaukee Metropolitan Subregional Area			
A. F. Gallun & Sons Corporation	Cooling	5,400	Milwaukee River via Storm Sewer
American Can Company	Cooling	30,000	Lincoln Creek via Storm Sewer
American Motors Corporation—Body Plant	Cooling	530,100	Milwaukee River via Storm Sewer
A. O. Smith Corporation—Automotive Division	Cooling	1,685,900	Lincoln Creek via Storm Sewer
Aqua Chem, Inc.—North Plant No. 1	Process and Cooling	11,600	Lincoln Creek via Storm Sewer
Aqua Chem Inc.—North Plant No. 2	Process Cooling and Boiler Blowdown	37,500	Lincoln Creek via Storm Sewer
Ataco Steel Products Company	Cooling	20,000	Milwaukee River via Storm Sewer
Badger Meter, Inc.	Cooling	7,000	Beaver Creek and Drainage Ditch
Beatrice Foods Company	Cooling	51,000	Milwaukee River via Storm Sewer
Briggs & Stratton Corporation	Cooling	5,000	Brown Deer Park Creek
Brunswick Corporation—Mercury Marine Division Plant No. 1	Process and Cooling	43,000	Cedar Creek via Storm Sewer
Brunswick Corporation—Mercury Marine Division Plant No. 2	Cooling	5,000	Cedar Creek via Storm Sewer
Continental Can Company	Cooling	340,000	Milwaukee River via Storm Sewer
Continental Equipment	Cooling	N/A	Lincoln Creek via Storm Sewer and Drainage Ditch
Cutler-Hammer Inc.—Industrial System Division	Cooling	145,000	Lincoln Creek via Storm Sewer
Dayton Malleable—Meta-Mold Division	Process and Cooling	21,000	Cedar Creek via Storm Sewer and Drainage Ditch
Doerr Electric Corporation	Process and Cooling	1,000	Cedar Creek via Storm Sewer Soil Absorption
EST Company, Inc.	Cooling	8,100	Milwaukee River via Storm Sewer and Drainage Ditch
First Wisconsin Development Corporation	Cooling	660,000	Milwaukee River
Florence Eiseman, Inc.	Cooling and Boiler Blowdown	100	Milwaukee River
Fred Usinger, Inc.	Cooling	45,000	Milwaukee River

Table B-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Milwaukee River Watershed (continued)			
Milwaukee Metropolitan Subregional Area (continued)			
Freeman Chemical Corporation	Cooling	344,200	Milwaukee River
Gimbels Midwest, Inc.	Process and Cooling	1,519,200	Milwaukee River
Gimbels Midwest, Inc.—Warehouse	Boiler Blowdown	100	Milwaukee River
Globe Union, Inc.—Administration and Research	Cooling	7,100	Lincoln Creek via Storm Sewer
Globe Union, Inc.—Central Lab Division	Cooling	120,000	Lincoln Creek via Storm Sewer
Hoernor Waldorf Corporation	Cooling and Boiler Blowdown	1,200	Milwaukee River via Storm Sewer
Inland Ryerson Construction Products Company	Cooling	1,100	Lincoln Creek via Storm Sewer
Interstate Drop Forge Company	Cooling	60,000	Lincoln Creek via Storm Sewer
Johnson Brass and Machine Foundry, Inc.	Cooling	7,000	Milwaukee River via Storm Sewer
Joseph Schlitz Brewing Company	Cooling	10,915,300	Milwaukee River via Storm Sewer
KMC Stampings Division	Cooling	125	Milwaukee River via Drainage Ditch
Kurth Malting Corporation—Plant No. 2	Cooling	46,783,300	Milwaukee River
Leeson Electric Corporation	Cooling	5,000	Milwaukee River via Storm Sewer
Longview Fibre Company—Downing Box Division	Cooling	4,800	Milwaukee River via Storm Sewer
Milprint, Inc.	Cooling	288,700	Milwaukee River via Storm Sewer
Milwaukee County Club	Cooling	17,700	Milwaukee River via Storm Sewer
Milwaukee County Park Commission—Carver Park	Swimming Pool Overflow and Drainage	Intermittent	Milwaukee River via Storm Sewer
Milwaukee County Park Commission—Gordon Park	Swimming Pool Overflow and Drainage	Intermittent	Milwaukee River via Storm Sewer
Milwaukee County Park Commission—Lincoln Park	Swimming Pool Overflow and Drainage	Intermittent	Milwaukee River via Storm Sewer
Milwaukee County Park Commission—McGovern Park	Swimming Pool Overflow and Drainage	Intermittent	Lincoln Creek via Storm Sewer
Milwaukee Die Casting Company	Cooling	11,000	Milwaukee River via Storm Sewer
MSD Plastics, Inc.	Cooling	25,000	Cedar Creek via Storm Sewer
North Milwaukee Lime and Cement Company	Process	2,000	Lincoln Creek via Storm Sewer
Oster Corporation	Cooling	41,000	Milwaukee River via Storm Sewer
Outboard Marine Corporation—Evinrude Foundry	Cooling	1,093,500	Lincoln Creek via Storm Sewer
Outboard Marine Corporation—Plant No. 1, Research Annex	Cooling	262,200	Lincoln Creek via Storm Sewer
Russel T. Gilman, Inc.	Cooling	100	Milwaukee River via Storm Sewer
Square D Company	Cooling	128,200	Milwaukee River via Storm Sewer
Stainless Foundry and Engineering Company	Cooling	130,000	Lincoln Creek via Storm Sewer
Treat All Metals, Inc.	Cooling	200,000	Milwaukee River via Storm Sewer
Western Electric Company, Inc.—Wisconsin Service Center	Cooling	1,000	Milwaukee River via Storm Sewer
W. H. Brady Company—Florist Avenue Plant	Cooling	29,000	Milwaukee River via Storm Sewer
Wisconsin Bridge and Iron Company	Cooling and Drainage	5,600	Lincoln Creek via Storm Sewer
Wisconsin Cuneo Press	Process and Cooling	135,000	Lincoln Creek via Storm Sewer
Wisconsin Electric Power Company—Commerce Street	Process, Cooling, and Boiler Blowdown	46,721,200	Milwaukee River
Wisconsin Electric Power Company—Wells Street	Boiler Blowdown, Drainage, Tank Over-flow, Cooling	1,024,510	Milwaukee River
Wisconsin Electric Power Company—Heating Steam System	Steam Condensate and Groundwater	83,300	Milwaukee River
Wright Metal Processors, Inc.	Cooling	3,000	Lincoln Creek via Storm Sewer

Table B-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Milwaukee River Watershed (continued)			
Upper Milwaukee River Subregional Area			
Amity Leather Products Company	Cooling and Boiler Blowdown	N/A	Milwaukee River via Storm Sewer
Bermico Company	Process and Cooling	228,800	Milwaukee River
Culligan Water Conditioning, Inc.	Filter Backwash	2,900	Milwaukee River via Storm Sewer
Fairmount Foods Company	Cooling	8,000	Milwaukee River via Storm Sewer
Gehl Company	Cooling	253,000	Milwaukee River via Storm Sewer
Kewaskum Frozen Foods	Cooling	10,000-60,000	Milwaukee River via Storm Sewer
Pick Automotive Corporation	Cooling	1,000	Milwaukee River via Storm Sewer
Regal Ware Inc.	Cooling	124,300	Milwaukee River
The West Bend Company	Cooling	143,000	Milwaukee River
Oak Creek Watershed			
Milwaukee Metropolitan Subregional Area			
Appleton Electric Company—Foundry Division	Cooling	66,000	Oak Creek
Appleton Electric Company—Lighting Products Division	Process	34,100	Oak Creek via Storm Sewer
Bucyrus Erie Company	Process and Cooling	764,200	Oak Creek
Harley Davidson Motor Company	Cooling	4,400	North Branch Oak Creek via Storm Sewer
Industrial Fuel, Inc.	Process	600	North Branch Oak Creek via Storm Sewer
Ladish Company	Cooling	756,000	Oak Creek via Storm Sewer
Milwaukee County Park Commission—Oak Creek Park	Swimming Pool Overflow	Intermittent	Oak Creek via Storm Sewer
Union Oil Truck Stop	Runoff	Intermittent	Oak Creek
Pike Creek Watershed			
Kenosha-Racine Subregional Area			
American Motors Corporation—Main Plant	Cooling	2,335,000	Pike Creek
Pike River Watershed			
Kenosha-Racine Subregional Area			
Ametek Lamb Electric	Cooling	3,000	Sorenson Creek
J. I. Case Company—Transmission Plant	Cooling	70,000	Pike River
Rexnord, Inc.—Hydraulic Component Division	Cooling	130,000	Pike River
S. C. Johnson and Son, Inc.	Cooling	1,635,400	Tributary of the Pike River
Rock River Watershed			
Upper Rock River Subregional Area			
International Stamping Company, Inc.	Cooling	154,000	Rubicon River
Oak Cheese Factory	Washwater	N/A	Soil Absorption
W. B. Place and Company, Inc.	Process	200	Rubicon River
Wissota Sand and Gravel Company, Inc.	Washwater	50,000	Bark River
Middle Rock River Subregional Area			
Carnation Company—Can Division	Cooling	18,200	Oconomowoc River via Storm Sewer
Carnation Company—Instant Products Division	Cooling and Boiler Blowdown	1,234,000	Oconomowoc River via Storm Sewer
Essential Chemicals Corporation	Cooling	500	Bark Creek via Storm Sewer
Hartland Plastics, Inc.	Cooling	3,000	Soil Absorption
La Belle Industries, Inc.	Cooling	17,500	Oconomowoc River via Storm Sewers
State Sand and Gravel	Washwater	670,000	Little Oconomowoc River
U. S. Gypsum Company—Fiberesin Plastics Division	Cooling and Boiler Blowdown	3,500	Soil Absorption
Lower Rock River Subregional Area			
A. K. Rubber Products Company	Cooling	1,600	Jackson Creek via Storm Sewer
Allied Music Corporation	Process	3,000	Soil Absorption
Alpha Cast, Inc.	Cooling	125,000	Whitewater Creek
Buncker Ramp Corporation	Cooling	4,400	Swan Creek via Storm Sewer
Darien Waterworks	Filter Backwash	Intermittent	Turtle Creek via Storm Sewer
Elkhorn Light & Water Commission	Process, Filter Backwash	50,000	Jackson Creek via Storm Sewer
Frank Holton and Company	Process	15,000	Soil Absorption
Getzen Company, Inc.	Process	N/A	Soil Absorption
Hawthorn Melody Farms Dairy	Cooling	1,280,000	Whitewater Creek
L. W. Reichel & Sons, Inc.	Cooling	3,500	Jackson Creek via Storm Sewer
Sharon Foundry, Inc.	Cooling	750	Little Turtle Creek
U. S. Gypsum Company	Boiler Blowdown	35,000	Soil Absorption
Whitewater Water Utility	Backwash	92,000	Whitewater Creek via Storm Sewer

Table B-3 (continued)

Point Source	Type of Wastewater	Reported Average Annual Hydraulic Discharge Rate (gallons per day)	Disposal of Effluent
Root River Watershed			
Milwaukee Metropolitan Subregional Area			
Fruehauf Corporation	Process and Cooling	3,200	Root River via Storm Sewer and Drainage Ditch
Milwaukee County Park Commission—Hales Corners Park	Swimming Pool Overflow and Drainage	Intermittent	Root River via Storm Sewer
P. P. G. Industries, Inc.	Cooling Tower, Blowdown, Cooling Boiler	4,000	Root River via Drainage Ditch
Union Oil Milwaukee Truck Stop	Runoff	Intermittent	Tributary of the Root River
Vulcan Materials Company	Runoff	321,000	Root River
Kenosha-Racine Subregional Area			
Emerson Electric Company—Insinkerator Division	Cooling	40,600	Root River via Storm Sewer
Frank's Pure Food Company	Cooling	12,800	Hoods Creek via Drainage Tile
Racine Stamping Corporation	Cooling	17,500	Root River via Storm Sewer
Twin Disc, Inc.—Racine Street Plant	Cooling	57,000	Root River via Storm Sewer
Twin Disc, Inc.—21st Street Plant	Cooling	124,000	Root River via Storm Sewer
Western Publishing Company	Cooling	358,300	Root River
Root River Canal Subregional Area			
Bardon Rubber Products Company, Inc.	Cooling	64,700	Des Plaines River via Storm Sewer
Culligan Water Conditioning Company	Filter Backwash	1,100	Des Plaines River via Storm Sewer
Fohr's Meat Service	Process and Sanitary	N/A	Soil Absorption
Harry Hansen Meat Service	Process	1,400	Soil Absorption
Plastic Parts Inc.	Cooling	192,000	Des Plaines River via Storm Sewer
Wisconsin Rubber Products Company	Cooling	130,000	Des Plaines River via Storm Sewer
Sauk Creek Watershed			
Sauk Creek Subregional Area			
Allis Chalmers, Inc.—Simplicity Manufacturing Company	Cooling	47,000	Tributary of the Sauk Creek via Storm Sewer
Murphy Oil Corporation	Stormwater Runoff from Petroleum Terminal	76,500	Tributary of the Sauk Creek
Sheboygan River Watershed			
Sauk Creek Subregional Area			
Krier Preserving Company	Cooling	29,600	Tributary of the Onion River via Drainage Ditch

NOTE: N/A indicates data not available.

Source: SEWRPC.

Table B-4

EXISTING URBAN DEVELOPMENT NOT SERVED BY PUBLIC SANITARY SEWERS: 1975

Major Urban Concentration[a] Number	Major Urban Concentration[a] Name	Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Des Plaines River Watershed	Kenosha-Racine Subregional Area (see Map 10)		
5	Town of Pleasant Prairie-Section 5	100	163
	Root River Canal Subregional Area (see Map 12)		
1	Town of Raymond-Section 6	100	159
	Des Plaines River Subregional Area (see Map 14)		
1	Town of Dover-Section 36	300	164
2	Town of Brighton-Section 12	200	162
3	Mud Lake	200	161
4	Town of Pleasant Prairie-Sections 26 and 27	300	326
5	Town of Pleasant Prairie-Section 15	100	163
6	Town of Pleasant Prairie-Section 6	200	150
7	Town of Somers-Section 6	400	133
Fox River Watershed	Milwaukee Metropolitan Subregional Area (see Map 4)		
23	City of New Berlin-Section 22	500	159
24	City of New Berlin-Southwest	2,500	1,430
26	Bass Bay	500	479
27	City of Muskego-Section 13	100	163
	Upper Fox River Subregional Area (see Map 16)		
1	Lannon	2,700	1,449
2	Willow Springs	700	160
3	Village of Sussex-North	300	161
4	Town of Lisbon-Section 15	100	160
5	Town of Lisbon-Section 20	100	160
6	Town of Lisbon-Sections 28 and 29	400	488
7	Village of Sussex-Southeast	900	643
8	Oakwood Park	700	495
9	Village of Menomonee Falls-Sections 28, 32, 33	1,100	490
10	Town of Lisbon-Section 32	100	160
11	Town of Lisbon-Section 31	300	153
12	Town of Pewaukee-Section 1	100	155
13	Duplainville	300	167
14	Pewaukee Lake	4,300	2,986
15	Town of Delafield-Section 27	100	157
16	City of Waukesha-North	300	161
17	City of Brookfield-Section 20	300	165
18	Goerkes Corners-South	3,100	1,605
19	City of New Berlin-Sections 16 and 17	600	314
20	City of Waukesha-Southeast	1,000	665
21	Town of Waukesha-Section 24 City of New Berlin-Section 19	400	497
22	City of Waukesha-Southwest	600	500
23	Town of Genesee-Section 10, 11	400	325
24	Genesee Depot	200	156

Table B-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
Fox River Watershed	Upper Fox River Subregional Area (continued) (see Map 16)		
25	Genesee	200	161
26	Town of Genesee-Section 36	100	162
27	Town of Waukesha-Section 26	100	163
28	Town of Waukesha-Section 35	100	163
29	City of New Berlin-Section 31	700	173
	Lower Fox River Subregional Area (see Map 18)		
1	Town of Wheatland-Section 25	500	160
2	Silver Lake-Northwest	600	656
3	Silver Lake, Camp Lake, Trevor	2,400	2,096
4	Cross Lake, Voitz and Benet Lakes	1,300	643
5	Wilmot	300	167
6	Lily Lake	300	489
7	New Munster	100	176
8	Powers and Benedict Lakes	1,100	1,919
9	Eagle Lake Manor	800	955
10	City of Burlington	200	157
11	Bohner Lake	700	1,116
12	Tichigan Lake	1,600	1,749
13	Wind Lake	2,700	2,356
14	Lake Beulah-Potter Lake	100	1,925
15	Booth Lake	100	320
16	Troy Center	100	161
17	Town of Troy-Section 3	100	142
18	Pleasant Lake	0	162
19	Mill Lake	300	1,136
20	North Lake	200	323
21	Lake Wandawega and Silver Lake	600	635
22	Vienna-Honey Lake	300	319
23	Town of Lyons-Section 1	100	160
24	Lyons	500	323
25	Springfield	500	472
26	Lake Como	1,600	1,775
27	City of Lake Geneva	500	478
28	Lake Ivanhoe	100	162
29	Pell Lake	1,300	1,116
30	Genoa City	100	163
31	Town of Bloomfield-Section 7	100	157
32	Town of Linn-Sections 11 and 14, 9 and 10	100	318
33	Town of Linn-Sections 15 and 16	500	972
34	Zenda	100	162
35	North Prairie	800	328
36	Town of Mukwonago-Section 7	200	163
37	Town of Vernon-Section 12	200	159
38	Big Bend	1,800	968
39	Town of Vernon-Section 19	200	142
40	Town of Mukwonago-Sections 15 and 21	200	319
41	Eagle	800	478
42	Eagle Spring Lake	400	485
43	Phantom Lakes	400	483
44	Lake Denoon	200	165

Table B-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
	Lower Rock River Subregional Area (see Map 24)		
8	Town of Delavan-Section 36	100	157
9	Village of Williams Bay	300	860
Lake Michigan Watershed	Milwaukee Metropolitan Subregional Area (see Map 47)		
5	City of Mequon-Section 31	200	165
	Kenosha-Racine Subregional Area (see Map 10)		
1	Tobin	300	321
2	Carol Beach	1,400	1,052
3	City of Kenosha-South	300	327
4	City of Kenosha-West	300	322
7	City of Kenosha-North	500	323
14	Town of Caledonia-Section 6	100	159
Menomonee River Watershed	Milwaukee Metropolitan Subregional Area (see Map 4)		
1	City of Franklin-Sections 20 and 21	1,500	475
4	City of Franklin-Section 13	300	162
6	City of Greenfield-West	1,300	1,052
7	City of Milwaukee-Section 17 (0821)	200	167
8	City of Mequon-Section 17	100	159
10	City of Mequon-Section 30	200	171
12	Village of Germantown-Section 7	100	157
13	Theinsville-Rockfield	100	159
14	Village of Germantown-Section 13	100	163
15	Village of Germantown-Section 24	200	164
16	Village of Germantown-Sections 19 and 20	600	477
17	Willow Creek	300	314
18	Village of Menomonee Falls-Section 5	500	162
19	Village of Menomonee Falls-Section 1	100	165
20	Village of Menomonee Falls, East	4,200	1,962
21	Village of Menomonee Falls-South	5,600	2,137
22	City of New Berlin-North	5,500	1,464
25	City of New Berlin-Southeast	3,900	1,290
Milwaukee River Watershed	Milwaukee Metropolitan Subregional Area (see Map 4)		
9	City of Mequon-Sections 15 and 21	1,300	644
	Upper Milwaukee River Subregional Area (see Map 6)		
1	Waubeka	400	317
2	Village of Saukville	100	160
3	Town of Port Washington-Section 30	200	160
4	Deckers Corner	100	161
5	Town of Grafton-Section 7	100	165
6	Town of Grafton-Section 18	600	163
7	Town of Cedarburg-Sections 14 and 15	600	482
8	Town of Cedarburg-Section 22	200	160
9	Town of Cedarburg-Sections 28 and 33	400	483

Table B-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
	Upper Milwaukee River Subregional Area (continued) (see Map 6)		
10	Town of Cedarburg-Sections 35 and 36	300	317
11	Town of Grafton-Section 31	200	163
12	Town of Grafton-Section 29	100	160
13	Town of Richfield-Section 12	400	330
14	Town of Jackson-Section 36	300	163
15	Town of Polk-Section 36	100	161
16	Town of Jackson-Section 22	300	160
17	Big Cedar Lake	1,800	2,351
18	Silver Lake	100	159
19	City of West Bend-West	100	164
20	City of West Bend-East	400	462
21	Green Lake	100	166
22	Village of Kewaskum	500	162
Oak Creek Watershed	Milwaukee Metropolitan Subregional Area (see Map 4)		
2	City of Oak Creek-Section 26	200	159
3	City of Oak Creek-Section 19	200	163
5	Cities of Franklin and Oak Creek-Sections 12 and 7	300	311
Pike River Watershed	Kenosha-Racine Subregional Area (see Map 10)		
6	Town of Somers-Section 29	200	159
8	Parkside	100	162
9	Town of Somers-Section 1	100	166
10	Town of Somers-Section 3	100	161
Rock River Watershed	Lower Rock River Subregional Area (see Map 24)		
1	Whitewater Lake	500	806
2	Lake Loraine	300	321
3	Turtle Lake	300	488
4	Town of Delavan-Section 2	200	158
5	Town of Geneva-Section 8	300	164
6	Town of Darien-Section 23	300	162
7	Delavan Lake	2,500	2,886
10	Allens Grove	100	187
	Middle Rock River Subregional Area (see Map 22)		
1	Town of Lisbon-Section 4	200	349
2	Town of Lisbon-Section 20	100	158
3	Lake Kessus	600	794
4	Village of Merton	600	479
5	Beaver Lake	100	162
6	Town of Merton-Sections 16, 22 and 27	500	638
7	North Lake	100	159
8	Stonebank-Chenequa	500	465

Table B-4 (continued)

Major Urban Concentration[a]		Estimated Resident Population	Developed Urban Quarter Section Area (acres)
Number	Name		
Rock River Watershed (continued)			
9	Ashippun Lake	200	169
10	Okauchee Lake-Mud Lake	3,700	3,073
11	Lac La Belle (Lake)	1,000	960
12	Town of Summit-Silver Lake	300	482
13	Nashotah	1,200	1,312
14	Town of Delafield-Section 17, 18, 19, and 20	1,800	1,447
15	Nemahbin Lakes (Town of Summit)	800	1,101
16	Town of Delafield-Section 28	100	319
17	Golden Lake	200	311
18	Utica Lake	200	177
19	Hunters Lake	100	157
20	Village of Wales	900	483
21	Pretty Lake	200	319
	Upper Rock River Subregional Area (see Map 20)		
1	Town of Barton-Section 7	100	159
2	Town of Addison St. Lawrence	300	164
3	Village of Slinger Area Mudlake	400	156
4	Pike Lake Area	400	323
5	City of Hartford Area	100	161
6	Town of Richfield-Section 10	100	165
7	Town of Richfield-Sections 13, 14, 22, and 23	2,200	1,274
8	Amy Bell Lake	400	318
9	Bark Lake	400	315
10	Town of Richfield-Section 34	200	161
11	Town of Richfield-Section 33	200	156
12	Town of Erin-Section 27	100	159
13	Friess Lake	600	631
Root River Watershed	Kenosha-Racine Subregional Area (see Map 10)		
11	Town of Mt. Pleasant-Section 17	100	162
12	Town of Mt. Pleasant-Sections 4, 8 and 9	400	488
13	City of Racine-North	200	163
15	Town of Caledonia-Section 7	300	307
	Root River Canal Subregional Area (see Map 12)		
2	Town of Raymond-Section 13	200	160
3	Ives Grove	200	157
4	Town of Yorkville-Section 27	500	320
Sauk Creek Watershed	Sauk Creek Subregional Area (see Map 8)		
1	Nellsville	100	160

[a] *Urban development is defined in this context as concentrations of urban land uses within any given U. S. Public Land Survey quarter section that has at least 32 housing units, or an average of one housing unit per five acres, and it is not served by public sanitary sewers.*

Source: SEWRPC.

Table B-5

KNOWN CROSSOVERS IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
KINNICKINNIC RIVER WATERSHED		
City of Milwaukee		
1. 36th Street at W. Lakefield Drive	Kinnickinnic River	12
2. W. Ruskin Street at S. 38th Street	Kinnickinnic River	12
3. E. Armour Avenue, 69 feet west of S. Austin Street	Wilson Creek	15
4. S. Austin Street at W. Dakota Street	Kinnickinnic River	12
5. E. Ohio Street and S. Quincy Avenue	Kinnickinnic River	15
6. S. 43rd Street and W. Morgan Avenue	Cherokee Park Creek	12
7. S. 46th Street at W. Cleveland Avenue	Kinnickinnic River	N/A
8. Midblock W. Lincoln Avenue between S. 36th Street and S. 37th Street	S. 43rd Street Ditch	N/A
9. 3253 S. 57th Street	Lyons Creek	N/A
10. 54th Street at W. Midland Drive	Lyons Creek	N/A
11. S. Howell Avenue at E. Edgerton Avenue	Wilson Creek	N/A
12. S. Burrell Street at E. Van Norman Avenue	Wilson Creek	N/A
13. S. 1st Place and W. Boliva Avenue (south side)	Wilson Creek	N/A
14. S. Pine Avenue and E. Cudahy Avenue	Wilson Creek	N/A
15. E. Lincoln Avenue and S. Burrell Street	Kinnickinnic River	36
16. E. Lincoln Avenue, 150 feet west of South Greeley Street	Kinnickinnic River	24
17. E. Lincoln Avenue, 450 feet west of South Greeley Street	Kinnickinnic River	24
City of West Allis		
18. S. 70th Street and W. Burnham Street (north side)	Kinnickinnic River	N/A
19. S. 73rd Street and W. Burnham Street (north side)	Kinnickinnic River	N/A
LAKE MICHIGAN WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
20. S. Kinnickinnic Avenue at E. St. Francis Avenue	Lake Michigan	N/A
21. Easement 500 feet south of Milwaukee-Ozaukee County Line and 200 feet west of Waverly Raod	Fish Creek	N/A
City of Milwaukee		
22. E. Newport Court 415 feet east of Lake Drive	Lake Michigan	N/A
City of Cudahy		
23. E. Hammond Avenue between S. Packard Avenue and S. Kirkwood Avenue overflow	Lake Michigan	N/A
24. S. Hately Avenue and E. Allerton Avenue overflow	Lake Michigan	N/A
25. S. Hately Avenue and E. Van Norman Avenue overflow	Lake Michigan	N/A
26. S. Hately Avenue and E. Somers Avenue overflow	Lake Michigan	N/A
27. S. Kirkwood Avenue and E. Armour Avenue overflow	Lake Michigan	N/A
28. S. Kirkwood Avenue and E. Barnard Avenue overflow	Lake Michigan	N/A
29. S. Kirkwood Avenue and E. Hammond Avenue overflow	Lake Michigan	N/A
30. S. Kirkwood Avenue and E. Holmes Avenue overflow	Lake Michigan	N/A
31. S. Kirkwood Avenue and E. Morris Avenue overflow	Lake Michigan	N/A
32. S. Lake Drive and E. Allerton Avenue overflow	Lake Michigan	N/A
33. S. Lake Drive and E. Hammond Avenue overflow	Lake Michigan	N/A
34. S. Lake Drive and E. Martin Avenue overflow	Lake Michigan	N/A
35. S. Lake Drive and E. Pulaski Avenue overflow	Lake Michigan	N/A
36. S. Lake Drive and E. Somers Avenue overflow	Lake Michigan	N/A
37. S. Lake Drive and E. Squire Avenue overflow	Lake Michigan	N/A
38. S. Packard and East Armour Avenue overflow	Lake Michigan	N/A
39. S. Packard and East Layton Avenue overflow	Lake Michigan	N/A
40. S. Sheridan Drive and E. Allerton Avenue overflow	Lake Michigan	N/A
41. S. Swift Avenue and E. Carpenter Avenue overflow	Lake Michigan	N/A
42. S. Swift Avenue and E. Lunham Avenue overflow	Lake Michigan	N/A
43. S. Swift Avenue and E. Munkwitz Avenue overflow	Lake Michigan	N/A
44. S. Swift Avenue and E. Squire Avenue overflow	Lake Michigan	N/A
Village of Bayside		
45. Laramie and 500 feet west of Ironwood	Lake Michigan	N/A
46. Sleepy Hollow and 600 feet north of Laramie	Lake Michigan	N/A
Village of Fox Point		
47. North Barnett Lane and E. View Place	Lake Michigan	15
48. 7870 N. Club Circle	Lake Michigan	12
49. N. Lake Drive and Bradley Road	Lake Michigan	12
50. Goodrich Lane and W. Bridge	Lake Michigan	12
51. Lake Drive and Fox Lane	Lake Michigan	18
52. Lake Drive and Daphne Road	Lake Michigan	15
53. East Apple and N. Lake Drive	Lake Michigan	N/A
Village of Whitefish Bay		
54. Bay Ridge and Devan	Lake Michigan	N/A
55. Bay Ridge and Monrovia	Lake Michigan	N/A
56. Bay Ridge and Montclaire	Lake Michigan	N/A
57. Chateau and Newhall	Lake Michigan	N/A
58. Circle Drive and Easement	Lake Michigan	N/A
59. Fairmont and Larkin	Lake Michigan	N/A
60. Fairmont and Newhall	Lake Michigan	N/A
61. Glendale and Cramer	Lake Michigan	N/A
62. Lake Drive and Lake View	Lake Michigan	N/A
63. Lake Drive and Monrovia	Lake Michigan	N/A
64. Lake Drive and Montclaire	Lake Michigan	N/A
65. Monrovia and Santa Monica	Lake Michigan	N/A
66. Montclaire and Berkeley	Lake Michigan	N/A
67. Montclaire and Kent	Lake Michigan	N/A
LAKE MICHIGAN WATERSHED (continued)		
68. Montclaire and Santa Monica	Lake Michigan	N/A
69. Wilshire and Cumberland	Lake Michigan	N/A
70. 6135 Bay Ridge Avenue	Lake Michigan	N/A
71. 6237 North Bay Ridge Avenue	Lake Michigan	N/A
72. 6069 North Berkeley Boulevard	Lake Michigan	N/A
73. 6111 North Berkeley Boulevard	Lake Michigan	N/A
74. 6151 North Berkley Boulevard	Lake Michigan	N/A
MENOMONEE RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
75. N. Martha Washington Drive, 450 feet south of W. Vliet Street	Menomonee River	N/A
76. N. 62nd Street, 258 feet south of W. Martin Drive	Menomonee River	N/A
77. N. 62nd Street and W. Martin Drive	Menomonee River	N/A
78. 13th Street north of W. Clybourn Street	Menomonee River	N/A
City of Milwaukee		
79. N. 68th Street and W. Center Street	Menomonee River	8
80. W. Center Street at N. 86th Street	Menomonee River	12
81. W. Center Street at N. 88th Street	Menomonee River	12
82. N. 89th Street at W. Townsend Street	Menomonee River	12
83. N. 90th Street at W. Townsend Street	Menomonee River	12
84. W. Dickinson Street and S. 62nd Street	Menomonee River	15
85. W. Stevenson Street and N. 71st Street	Menomonee River	12
86. W. Mt. Vernon Avenue and N. 69th Street	Menomonee River	12
87. W. Morgan Avenue at S. 57th Street	Honey Creek	12
88. W. Mt. Vernon Avenue at 75 feet east of N. 91st Street	Menomonee River	12
89. N. 94th Street and W. Townsend Street	Menomonee River	12
90. N. 95th Street and W. Metcalf Place	Menomonee River	12
91. N. 89th Street and W. Center Street	Menomonee River	12
92. N. 87th Street and W. Center Street	Menomonee River	12
93. N. 96th Street at W. Auer Avenue	Menomonee River	N/A
94. N. 99th Street at W. Concordia Avenue	Menomonee River	N/A
95. S. 72nd Street at W. Honey Creek Parkway	Menomonee River	N/A
96. S. 77th Street at W. Oklahoma Avenue	Menomonee River	N/A
97. W. Monrovia Avenue at W. Crossfield Avenue	Menomonee River	N/A
98. 89th Street and W. Center Street (southerly)	Menomonee River	N/A
99. N. 92nd Street and W. Hawthorne Avenue	Honey Creek	N/A
100. N. 92nd Street and W. Park Hill Avenue	Honey Creek	15
101. W. Riverbend Drive and S. Honey Creek Parkway	Honey Creek	N/A
102. S. 86th Street and W. Ohio Avenue	Honey Creek	N/A
103. N. 106th Street and W. Lawn Avenue	Menomonee River	N/A
104. N. 107th Street and W. Silver Spring Drive	Menomonee River	N/A
105. N. 37th Street, 145 feet north of W. Mt. Vernon Avenue	Menomonee River	12
106. N. 38th Street and W. Mt. Vernon Avenue	Menomonee River	15
107. N. 46th Street and W. State Street	Menomonee River	21
108. W. Hilda Place and S. 38th Street	Menomonee River	12
City of West Allis		
109. S. 77th Street and Walker Street (deleted 1976)	Honey Creek	N/A
110. S. 78th Street and W. Arthur Avenue	HOney Creek	N/A
111. S. 78th Street extended and W. Madison Street extended	Honey Creek	N/A
Village of Menomonee Falls		
112. Donald Court and May Avenue	Menomonee River	10
113. Arthur Avenue and Menomonee River gravity	Menomonee River	14
114. Pilgrim Road and Menomonee River overflow (north) gravity	Menomonee River	12
115. Pilgrim Road and Menomonee River (south) gravity overflow	Menomonee River	12
116. Main Street and Pilgrim Road gravity overflow	Menomonee River	10
City of Wauwatosa		
117. Ridge Boulevard and N. Harding Boulevard overflow	Menomonee River	N/A
118. W. North Avenue and Menomonee River Parkway overflow	Menomonee River	N/A
119. Jackson Park Boulevard and Swan Boulevard overflow	Menomonee River	N/A
120. Jackson Park Boulevard and N. 90th Street overflow	Menomonee River	N/A
121. Jackson Park Boulevard and N. 85th Street overflow	Menomonee River	N/A
122. W. North Avenue and N. 82nd Street	Menomonee River	N/A
123. Milwaukee Avenue and N. 72nd Street overflow	Menomonee River	N/A
124. Martin Drive and N. 62nd Street overflow	Menomonee River	N/A
125. N. 62nd Avenue south of Martin Drive overflow	Menomonee River	N/A
126. East End of Hillside Lane overflow	Menomonee River	N/A
127. Glenview Avenue and Currie Avenue	Menomonee River	N/A
128. Ravenswood Circle and N. 89th Street overflow	Honey Creek	N/A
129. Glenview Avenue and Hawthorne Avenue overflow	Honey Creek	N/A
130. Honey Creek Parkway and W. Wisconsin Avenue overflow	Honey Creek	N/A
131. N. 65th Street and W. Wisconsin Avenue overflow	Menomonee River	N/A
132. N. 68th Street and W. Wisconsin Avenue overflow	Menomonee River	N/A
133. N. 70th Street and W. Center Street overflow	Menomonee River	N/A
134. N. 105th Street and W. Ruby Avenue overflow	Menomonee River	N/A
135. W. Concordia Avenue and N. Menomonee River Parkway overflow	Menomonee River	N/A

Table B-5 (continued)

Location[a]	Receiving Water	Pipe Size (inches)
MENOMONEE RIVER WATERSHED (continued)		
City of Wauwatosa		
136. N. 106th Street and W. Fisher Parkway overflow	Menomonee River	N/A
137. N. 67th Street and W. Wells Street overflow	Menomonee River	N/A
138. Glencoe Place and Ravenswood Circle overflow	Honey Creek	N/A
139. N. 85th Street between Hill Street and Ravenswood Circle overflow	Honey Creek	N/A
140. W. Meinecke Avenue from N. 83rd Street to N. 86th Street overflow	Menomonee River	N/A
141. W. Meinecke Avenue and N. 83rd Street overflow	Menomonee River	N/A
142. Stickney Avenue and North 85th Street overflow	Menomonee River	N/A
143. Stickney Avenue and North 90th Street overflow	Menomonee River	N/A
144. Swan Boulevard Menomonee River Parkway overflow	Menomonee River	N/A
145. N. 90th Street and Menomonee River Parkway overflow	Menomonee River	N/A
146. Ludington Avenue and Hoyt Park overflow	Menomonee River	N/A
147. Hillcrest Drive and N. 85th Street overflow	Menomonee River	N/A
MILWAUKEE RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
148. Hampton Avenue and N. Green Bay Road, West	Milwaukee River	N/A
149. Hampton Avenue and N. Green Bay Road, East	Milwaukee River	N/A
150. Roosevelt Drive and W. Seranton Place	Lincoln Creek	N/A
151. Lydell Avenue and W. Lancaster Avenue	Milwaukee River	N/A
152. Lydell Avenue at W. Montclair Avenue	Milwaukee River	N/A
153. Richards Street at E. Congress Street, extended	Milwaukee River	N/A
154. N. 27th Street at W. Silver Spring Drive	Lincoln Creek	N/A
155. 31st Street and W. Fairmount Avenue	Lincoln Creek	N/A
City of Glendale		
156. East side of Milwaukee River from Mill to Bradley (through manhole covers)	Milwaukee River	N/A
City of Milwaukee		
157. N. 20th Street at W. Fairmount Avenue	Milwaukee River	12
158. W. Capitol Drive (north side) and N. 31 Street	Lincoln Creek	12
159. W. Capitol Drive (south side) and N. 31st Street	Lincoln Creek	15
160. N. Sherman Boulevard and W. Fond du Lac Avenue	Lincoln Creek	15
161. N. 36th Street between W. Carmen Avenue and W. Florist Avenue	Lincoln Creek	12
162. N. 35th Street, 40 feet north of W. Oriole Drive	Lincoln Creek	12
163. W. Silver Spring Drive at N. 38th Street	Lincoln Creek	12
164. W. Silver Spring Drive at N. 37th Street	Lincoln Creek	12
165. W. Silver Spring Drive at N. 36th Street	Lincoln Creek	12
166. W. Silver Spring Drive at N. 35th Street	Lincoln Creek	12
167. W. Hope Avenue at N. 47th Street	Lincoln Creek	12
168. W. Silver Spring Drive and N. 39th Street	Lincoln Creek	12
169. W. Silver Spring Drive and N. 41st Street	Lincoln Creek	12
170. N. 41st Street and Congress Street	Lincoln Creek	18
171. N. 66th Street 1/2 Block between W. Congress Street and W. Ruby Avenue	Lincoln Creek	12
172. N. 44th Street, 285 feet south of W. Burleigh Street	Lincoln Creek	12
173. N. 53rd Street at W. Glendale Avenue	Lincoln Creek	12
174. N. 53rd Street at W. Courtland Avenue, extended	Lincoln Creek	12
175. N. 27th Street, 404 feet north of W. Hope Road	Lincoln Creek	12
176. W. Lawn Avenue and N. Milwaukee River Parkway	Milwaukee River	12
177. W. Fairmount Avenue and N. 19th Place	Milwaukee River	12
178. W. Fairmount Avenue and N. Green Bay Raod	Milwaukee River	12
179. N. 20th Street at W. Hampton Avenue (north side)	Milwaukee River	N/A
180. N. 20th Street at W. Hampton Avenue (south side)	Milwaukee River	N/A
181. N. 19th Place at W. Fairmount Avenue	Lincoln Creek	12
182. N. 49th Street at W. Luscher Avenue	Lincoln Creek	N/A
183. N. 60th Street at W. Custer Avenue	Lincoln Creek	N/A
184. 5384 N. 60th Street	Lincoln Creek	N/A
185. N. 61st Street at W. Lawn Avenue	Lincoln Creek	N/A
186. 5373 N. 60th Street	Lincoln Creek	N/A
187. 5344 N. 60th Street	Lincoln Creek	N/A
188. N. 63rd at W. Fairmount Avenue	Lincoln Creek	18
MILWAUKEE RIVER WATERSHED (continued)		
189. N. 64th Street at W. Stark Street	Lincoln Creek	N/A
190. 5030 N. 55th Street	Lincoln Creek	N/A
191. N. 66th Street at W. Ruby Avenue	Lincoln Creek	N/A
192. N. Milwaukee River Parkway at W. Lawn Avenue	Milwaukee River	N/A
193. N. Milwaukee River Parkway north of W. Lawn	Milwaukee River	N/A
194. N. 58th Street at W. Sheridan Avenue	Lincoln Creek	N/A
195. W. Olive Street 435 feet southeast of W. Roosevelt Drive	Lincoln Creek	N/A
196. N. 37th Street and W. Kiley Avenue	Milwaukee River	N/A
197. N. 43rd Street (west side) and W. Douglas Avenue	Lincoln Creek	N/A
198. N. 53rd Street and W. Sheridan Avenue	Lincoln Creek	N/A
199. N. 57th Street and W. Silver Spring Drive	Lincoln Creek	N/A
200. N. 60th Street (west side) and W. Thurston Avenue	Lincoln Creek	N/A
201. N. 72nd Street and W. Fairmount Avenue	Lincoln Creek	N/A
202. N. 72nd Street and W. Hope Avenue	Lincoln Creek	N/A
203. N. 72nd Street and W. Capitol Drive	Lincoln Creek	N/A
204. N. 74th Street and W. Potomac	Lincoln Creek	N/A
205. N. 30th Street and W. Hope Avenue	Lincoln Creek	N/A
206. N. 31st Street extended and W. Hope Avenue extended	Lincoln Creek	N/A
207. N. 31st Street and W. Villard Avenue	Lincoln Creek	N/A
208. N. 41st Street and W. Congress Street	Lincoln Creek	N/A
209. E. Meinecke Avenue and N. Gordon Place	Milwaukee River	12
210. N. Sherman Boulevard at W. Burleigh Street	Lincoln Creek	18
211. N. 26th Street and W. Vienna Avenue	Lincoln Creek	12
Village of Fox Point		
212. Cherokee Circle and Spooner Road	Indian Creek	N/A
Village of River Hills		
213. Indian Creek easement from Milwaukee River to River Road	Indian Creek	N/A
Village of Shorewood		
214. E. Edgewood Avenue and N. Cambridge overflow	Milwaukee River	N/A
215. E. Edgewood Avenue and N. Cambridge (interceptor) overflow	Milwaukee River	N/A
216. E. Edgewood Avenue and N. Oakland Avenue overflow	Milwaukee River	N/A
217. E. Glendale Avenue and N. Morris Boulevard overflow	Milwaukee River	N/A
218. E. Glendale Avenue and N. Larkin Street overflow	Milwaukee River	N/A
219. E. Olive Street and N. Wilson Drive overflow	Milwaukee River	N/A
220. N. Morris Boulevard and E. Lake Bluff Boulevard overflow	Milwaukee River	N/A
221. N. Woodburn Street and E. Olive Street overflow	Milwaukee River	N/A
Village of Whitefish Bay		
222. Hampton and Idlewild	Milwaukee River	N/A
223. Hampton and Sheffield	Milwaukee River	N/A
224. Lancaster and Diversey	Milwaukee River	N/A
ROOT RIVER WATERSHED		
City of Milwaukee		
225. W. Green Avenue, midblock between W. Iona Terrace and S. 31st Street	East Branch Root River	N/A
226. W. Parnell Avenue and S. Honey Creek Drive	East Branch Root River	N/A
227. 92nd Street at W. Howard Avenue	Root River	12
228. S. 94th Street at West Howard Avenue	Root River	15
City of West Allis		
229. Root River Parkway and W. Mariana Avenue	Root River	N/A
230. Root River Parkway, West Rust Court	Root River	N/A
231. S. 99th Street and W. Arthur Avenue	Root River	N/A
232. S. 102nd Street and W. Cleveland Avenue	Root River	N/A
233. S. 110th Street and W. Morgan Avenue	Root River	N/A
234. S. 112th Street and W. Cleveland Avenue	Root River	N/A
235. S. 112th Street and W. Oklahoma Avenue	Root River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed crossover location corresponds to a code number on Map 3.*

Table B-6

KNOWN BYPASSES IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
FOX RIVER WATERSHED		
City of Muskego		
1. At wastewater treatment plant	Big Muskego Lake	N/A
KINNICKINNIC RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commission		
2. W. Layton Avenue at S. 1st Street	Wilson Creek	N/A
3. S. 1st Street at the Kinnickinnic River	Kinnickinnic River	48
4. W. Lincoln Avenue at 565 feet west of S. 43rd Street	S. 43rd Street Ditch	21
5. S. 60th Street on south side of the Kinnickinnic River	Kinnickinnic River	N/A
LAKE MICHIGAN WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
6. N. Lake Drive at E. Fairmount	Lake Michigan	N/A
City of South Milwaukee		
7. Lake Drive lift station	Lake Michigan	N/A
8. Southeast lift station	Lake Michigan	N/A
Village of Bayside		
9. E. Hermitage	Lake Michigan	N/A
10. N. Lake Drive	Lake Michigan	N/A
MENOMONEE RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
11. W. Canal Street at S. 8th Street	Menomonee River	N/A
12. Honey Creek Parkway, W. Portland Avenue	Honey Creek	N/A
13. Menomonee River Parkway, 300 feet east of W. 68th Street	Menomonee River	N/A
14. W. Oklahoma Avenue, 100 feet W. of S. 74th Street	Honey Creek	N/A
15. S. 79th Street extended at W. Dickinson Street extended	Honey Creek	N/A
Village of Butler		
16. 100 feet S. of W. Custer Avenue and N. 124th Street	Menomonee River	N/A
17. W. Villard Avenue and N. 124th Street	Menomonee River	N/A
MILWAUKEE RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
18. E. Erie Street and Milwaukee River east line	Milwaukee River	24
19. E. Erie Street and Milwaukee River west line	Milwaukee River	30
20. W. Hampton Avenue at N. Lydell Avenue	Milwaukee River	N/A
21. W. Hampton Avenue at N. 32nd Street	Lincoln Creek	N/A
22. W. Roosevelt Drive at N. 35th Street	Lincoln Creek	N/A
23. W. Vliet Street extended east of N. 3rd Street	Milwaukee River	N/A
24. N. Marshall Street and the Milwaukee River	Milwaukee River	N/A
25. N. Van Buren Street and E. Brady Street	Milwaukee River	N/A
26. N. 31st Street extended north side of Lincoln Creek	Lincoln Creek	N/A
27. N. 35th Street and W. Congress Street	Lincoln Creek	60
28. S. Water Street and E. Bruce Street	Milwaukee River (harbor)	N/A
29. In S. Water Street at E. Bruce Street	Milwaukee River (harbor)	N/A
30. 3506 N. Manor Lane (in Fox Point)	Indian Creek	N/A
City of Mequon		
31. W. Parkview pump station 5000 Parkview Drive	Milwaukee River	N/A
32. N. River Road pump station 11101 N. River Road	Milwaukee River	N/A
Village of Brown Deer		
33. River Lane	Milwaukee River	N/A
34. Brown Deer Road and N. 51st Street	Beaver Creek	N/A
Village of Fox Point		
35. Manor Road booster station	Indian Creek	18
36. Santa Monica lift station	Indian Creek	N/A
Village of Thiensville		
37. Riverview Road and Luista Road	Milwaukee River	N/A
Caddy Vista Sanitary District		
38. At wastewater treatment plant	Root River	N/A
OAK CREEK WATERSHED		
City of South Milwaukee		
39. N. Chicago Avenue	Oak Creek	N/A
40. Ravine lift station	Oak Creek	N/A

NOTE: N/A indicates data not available.

[a] The number beside each listed bypass location corresponds to a code number on Map 3.

Table B-7

KNOWN RELIEF PUMPING STATIONS IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pump Capacity (gpm)
KINNICKINNIC RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
1. S. Howell Avenue at W. Grange Avenue	Wilson Creek	N/A
2. S. 35th Street at W. Manitoba Street	Kinnickinnic River	N/A
LAKE MICHIGAN WATERSHED		
Village of Bayside		
3. Pelham and Manor	Lake Michigan	N/A
MENOMONEE RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
4. Honey Creek Parkway at W. Wisconsin Avenue	Honey Creek	N/A
5. Menomonee River Parkway at W. Center Street	Menomonee River	N/A
6. Menomonee River Parkway at 600 feet south of W. North Avenue	Menomonee River	N/A
7. W. Fisher Parkway at N. 106th Street	Underwood Creek	N/A
8. S. 84th Street at W. Adler Street extended	Honey Creek	N/A
City of Wauwatosa		
9. East end of Hillside Lane (pump)	Menomonee River	N/A
10. Menomonee River Parkway and N. 90th Street (pump)	Menomonee River	N/A
11. Ravenswood Circle and Glencoe Circle (pump)	Honey Creek	N/A
12. Ravenswood Circle and N. 85th Street (pump)	Honey Creek	N/A
13. W. Argonne Drive and W. Concordia Avenue (pump)	Menomonee River	N/A
14. W. Concordia Avenue and N. Menomonee River Parkway—east of river (pump)	Menomonee River	N/A
15. W. Concordia Avenue and N. Menomonee River—west of river (pump)	Menomonee River	N/A
16. W. Keefe Avenue and N. Menomonee River Parkway (pump)	Menomonee River	N/A
17. W. Wisconsin Avenue and Honey Creek Parkway (pump)	Honey Creek	N/A
18. N. 65th Street and W. Wisconsin Avenue (pump)	Menomonee River	N/A
19. N. 71st Street and W. State Street (pump)	Menomonee River	N/A
20. N. 104th Street and W. Fisher Parkway (pump)	Underwood Creek	N/A
21. N. 104th Street and W. Wisconsin Avenue (pump)	Underwood Creek	N/A
22. N. 106th Street and W. Fisher Parkway (pump)	Underwood Creek	N/A
23. N. 106th Street and W. Ruby Avenue (pump)	Menomonee River	N/A
24. N. 115th Street south of Watertown Plank Road (pump)	Underwood Creek	N/A
25. N. 116th Street and Diane Drive (pump)	Underwood Creek	N/A
26. N. 118th Street and Watertown Plank Road (pump)	Underwood Creek	N/A
27. N. 121st Street and W. Underwood Parkway (pump)	Underwood Creek	N/A
Village of Menomonee Falls		
28. Grand Avenue and Roger Avenue	Menomonee River	350
29. Grand Avenue and Woodlawn Avenue	Menomonee River	300
30. Parkview pumping facility	Menomonee River	600
31. Shady Lane	Menomonee River	2 at 700
MILWAUKEE RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
32. N. Range Line Road at north side of the Milwaukee River	Milwaukee River	N/A
33. W. Villard Avenue at N. 27th Street	Lincoln Creek	N/A
34. W. Hampton Avenue at N. 63rd Street extended	Lincoln Creek	N/A
Village of Fox Point		
35. Crossway Road and Mall Road	Indian Creek	N/A
36. Willow Road and Santa Monica Boulevard	Indian Creek	N/A
Village of Thiensville		
37. STH 57 south of Friestadt Road	Pigeon Creek	N/A

[a] The number beside each relief pumping station location corresponds to a code number on Map 3.

Table B-8

KNOWN PORTABLE RELIEF PUMPS IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pump Capacity (gpm)
FOX RIVER WATERSHED		
Village of Menomonee Falls		
1. Buhe Street and Princeway	Fox River	N/A
2. Queensway and Klingers	Fox River	N/A
KINNICKINNIC RIVER WATERSHED		
City of West Allis		
3. 61st Street and Mobile	Kinnickinnic River	1,600
4. 61st Street and Mobile	Kinnickinnic River	550
5. 69-70th Street and Burnham (south side)	Kinnickinnic River	1,600
6. 69th Street and Burnham (north side)	Kinnickinnic River	1,600
LAKE MICHIGAN WATERSHED		
Village of Bayside		
7. Fairy Chasm and Bayside Drive	Lake Michigan	N/A
8. Pelham and Manor	Lake Michigan	N/A
MENOMONEE RIVER WATERSHED		
City of Brookfield		
9. Princeton Road and Pinewood Road	Butler Ditch	N/A
10. Rosedale Drive and Bluemound	Underwood Creek	N/A
11. S. 124th Street near Robinwood Street	Underwood Creek	N/A
City of West Allis		
12. Beloit and Osage	Honey Creek	550
13. Stratton and Dakota	Honey Creek	550
14. Stuth and Osage	Honey Creek	550
15. 74th Street and Bennet	Honey Creek	1,600
16. 77th Street and Dakota	Honey Creek	550
17. 79th Street and Hayes	Honey Creek	550
18. 79th Street and Lincoln	Honey Creek	550
19. 82nd Street and Arthur	Honey Creek	1,600
20. 85th Street and Becher	Honey Creek	1,000
21. 85th Street and Montana	Honey Creek	550
22. 86th Street and Montana	Honey Creek	1,600
23. 88th Street and Becher	Honey Creek	1,600
24. 88th Street and Montana	Honey Creek	1,600
25. 90th Street and Lapham	Honey Creek	550
26. 93rd Street and Hayes	Honey Creek	550
27. 107th Street and Madison	Underwood Creek	550
28. 116th Street and Greenfield	Underwood Creek	1,600
29. 116th Street and Madison	Underwood Creek	1,600
30. 122nd Street and Schlinger	Underwood Creek	1,600
31. 123rd Street and Schlinger	Underwood Creek	1,600
Village of Menomonee Falls		
32. Ann Avenue and Sheridan Drive	Menomonee River	337 and 200
33. Hillcrest Drive and Sheridan Drive	Menomonee River	360
34. Hope Lane and Shepherd Drive	Menomonee River	670
35. Joss Place and Sheridan Drive	Menomonee River	385
36. Menomonee Avenue and Norman Drive	Menomonee River	337
37. Roosevelt Avenue and Caroline Street	Menomonee River	325
38. Roosevelt Avenue and St. Francis Drive	Menomonee River	670
39. Water Street and Cherokee Drive	Menomonee River	325
40. Water Street and railroad tracks	Menomonee River	600
MILWAUKEE RIVER WATERSHED		
City of Glendale		
41. Fransee Lane and East W/R 141	Indian Creek	N/A
City of Mequon		
42. Riverside and S. County Line	Milwaukee River	350
43. LeGrande Boulevard	Milwaukee River	260
44. CTH W and STH 167	Milwaukee River	260
45. Oriole and Ranch	Milwaukee River	1,150
46. Highland and Friestadt	Milwaukee River	260
Village of Brown Deer		
47. N. 52nd Street and W. Wahner Avenue	Beaver Creek	600
48. Fairy Chasm Lane and Fairy Chasm	Beaver Creek	600
49. 4300 W. River Lane	Beaver Creek	600
50. N. 59th Street and W. Range Road	Beaver Creek	500
51. N. 51st Street and W. Fairy Chasm Road	Beaver Creek	1,600
Village of Fox Point		
52. E. Dean Road and N. Regent Road	Indian Creek	20,000
53. Indian Creek between E. Dean Road and E. Spooner	Indian Creek	40,000
54. Indian Creek Parkway and N. Seneca Road	Indian Creek	60,000
55. E. Spooner Road and N. Greenvale Road	Indian Creek	20,000
56. Nokomis Creek and Indian Creek	Indian Creek	N/A
ROOT RIVER WATERSHED		
City of West Allis		
57. Montana and Root River Parkway	Root River	550
58. Montana and Root River Parkway	Root River	550
59. Montana and Root River Parkway	Root River	1,600
60. Rust Court	Root River	550
61. 99th Street and Arthur	Root River	550
62. 99th Street and Dakota	Root River	1,600
63. 99th Street and Dakota	Root River	1,600
64. 102nd Street and National	Root River	1,600
65. 108th Street and Lincoln	Root River	1,600
66. 109th Street and Arthur	Root River	550
67. 109th Street and Becher	Root River	550

NOTE: N/A indicates data not available.

[a] The numbers beside each listed portable relief pump location corresponds to a code number on Map 3.

Table B-9

KNOWN COMBINED SEWER OUTFALLS IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
KINNICKINNIC RIVER WATERSHED		
City of Milwaukee		
1. E. National Avenue	Kinnickinnic River	48
2. E. Walker Street	Kinnickinnic River	6'-0" x 4'-6"
3. South of E. Walker Street	Kinnickinnic River	(2) 6'-6" x 5'-0"
4. South of E. Washington Street	Kinnickinnic River	36
5. W. Becher Street	Kinnickinnic River	Box 12' x 96"
6. W. Becher Street	Kinnickinnic River	Box 12' x 96"
7. W. Cleveland Avenue	Kinnickinnic River	84
8. W. Cleveland Avenue	Kinnickinnic River	72
9. W. Lincoln Avenue	Kinnickinnic River	30
10. E. Lincoln Avenue	Kinnickinnic River	48
11. W. Rogers Street	Kinnickinnic River	72
12. S. Chase Avenue North	Kinnickinnic River	18
13. S. Chase Avenue South	Kinnickinnic River	Box 10' x 15'
14. S. Kinnickinnic Avenue	Kinnickinnic River	30
15. S. Kinnickinnic Avenue	Kinnickinnic River	60
16. S. 1st Street North	Kinnickinnic River	42
17. S. 1st Street South	Kinnickinnic River	42
18 S. 2nd Street	Kinnickinnic River	78
19. S. 8th Street	Kinnickinnic River	Box 9' x 6'
20. S. 14th Street	Kinnickinnic River	Box 10' x 5'
21. S. 27th Street	Kinnickinnic River	72
22. E. Greenfield Avenue	Kinnickinnic River	Box 3'-0" x 5'-6"
23. E. Lincoln Avenue	Kinnickinnic River	54
LAKE MICHIGAN WATERSHED		
City of Milwaukee		
24. E. Bay Street (2)	Lake Michigan	7'-6" x 6'-6"
25. E. Russell Avenue	Lake Michigan	10'
MENOMONEE RIVER WATERSHED		
City of Milwaukee		
26. N. 15th Street	Menomonee River	Double Box (2) 7' x 4'
27. N. 15th Street	Menomonee River	Box 7' x 4'
28. N. 17th Street	Menomonee River	Box 5'-9"
29. N. 25th Street	Menomonee River	Double Box (2) 7'-0" x 7'-0"
30. N. 26th Street	Menomonee River	Triple Box (3) 7'-0" x 6'-0"
31. N. 43rd Street	Menomonee River	Box 120' x 6'
32. N. 45th Street	Menomonee River	42
33. N. Muskego Avenue	Menomonee River	
34. N. Muskego Avenue	Menomonee River	30
35. S. Muskego Avenue	Burnham's Canal Branch.	54
36. S. Stadium Access	Menomonee River	54
Road 150 feet east of S. 44th Street	Menomonee River	Triple Box (3) 4'-0" x 4'4"
37. S. 2nd Street	Menomonee River	Double Box (2) 78
	Menomonee River	54
38. S. 4th Street	S. Menomonee Canal branch of Menomonee River	48
39. N. 9th Street extended	Menomonee River	96
40. S. 6th Street	S. Menomonee Canal branch of Menomonee River	30
41. S. 9th Street	Burnham's Canal-Branch of Menomonee River	54
42. S. 9th Street	Burnham's Canal-branch of Menomonee River	78
43. S. 11th Street	Burnham's Canal-Branch of Menomonee River	36
44. S. 13th Street	Burnham's Canal Branch of Menomonee River	Box 6'-9" x 36"
45. S. 13th Street	Burnham's Canal Branch of Menomonee River	36
46. S. 27th Street	Menomonee River	48
47. S. 27th Street	Menomonee River	Box 4'-0" x 4'-0"
48. S. 35th Street	Menomonee River	60
49. W. Wisconsin Avenue East	Menomonee River	24
50. W. Wisconsin Avenue West	Menomonee River	24
51. N. Hawley Road	Menomonee River	Box 8'-6" x 5'-0"
MILWAUKEE RIVER WATERSHED		
Milwaukee-Metropolitan Sewerage Commissions		
52. Point 350 feet west of N. Humboldt Avenue	Milwaukee River	78
53. Point 800 feet west of N. Cambridge	Milwaukee River	96
City of Milwaukee		
54. E. Auer Avenue	Milwaukee River	84
55. E. Boylston Street	Milwaukee River	72
56. E. Bradford	Milwaukee River	72
57. E. Brady Street	Milwaukee River	30
58. E. Bruce Street	Milwaukee River	24
59. E. Buffalo Street	Milwaukee River	42
60. E. Burleigh Street	Milwaukee River	(2) 9'-6" x 4'-3"

Table B-9 (continued)

Location[a]	Receiving Water	Pipe Size (inches)
MILWAUKEE RIVER WATERSHED (continued)		
City of Milwaukee		
61. E. Capitol Drive	Milwaukee River	72
62. E. Chambers Street	Milwaukee River	21
63. E. Chicago Street	Milwaukee River	Box 4' x 6'
64. E. Clybourn Street	Milwaukee River	(2) 48
65. W. Clybourn Street	Milwaukee River	48
66. N. of West Clybourn	Milwaukee River	24 x 26
67. E. Edgewood Avenue	Milwaukee River	72
68. E. Florida Street	Milwaukee River	60
69. E. Hampshire Street	Milwaukee River	24
70. E. Highland Avenue	Milwaukee River	36
71. W. Highland Avenue	Milwaukee River	Box 9'-3" x 4'-6"
72. E. Juneau Avenue	Milwaukee River	42
73. W. Juneau Avenue	Milwaukee River	42
74. E. Keefe Avenue	Milwaukee River	54
75. E. Kilbourn Avenue	Milwaukee River	54
76. W. Kilbourn Avenue	Milwaukee River	Box 4'-6" x 6'-0"
77. E. Locust Street	Milwaukee River	78
78. E. Lyon Street	Milwaukee River	18
79. E. Lyon Street	Milwaukee River	36
80. E. Michigan Street	Milwaukee River	42
81. W. Michigan Street	Milwaukee River	54
82. E. Ogden Avenue	Milwaukee River	Box 3'-0" x 6'-0"
83. South of E. Oregon Street	Milwaukee River	30
84. E. Park Place	Milwaukee River	60
85. E. Pittsburgh Avenue	Milwaukee River	24
86. E. Pleasant Street	Milwaukee River	Box 7'-3" x 3'-0"
87. E. Polk Street	Milwaukee River	54
88. E. Saint Paul Avenue	Milwaukee River	Box 8'-6" x 4'-0"
89. W. Saint Paul Avenue	Milwaukee River	Box 2'-6" x 6'-3"
90. North of Saint Paul Avenue	Milwaukee River	30
91. E. State Street	Milwaukee River	60
92. W. State Street	Milwaukee River	46
93. E. Tunnel Place	Milwaukee River	12
94. E. Walnut Street	Milwaukee River	42
95. North of E. Walnut Street	Milwaukee River	96
96. E. Wells Street	Milwaukee River	34
97. E. Wells Street	Milwaukee River	48
98. N. of West Wells	Milwaukee River	30
99. E. Wisconsin Avenue	Milwaukee River	30
100. W. Wisconsin Avenue	Milwaukee River	24
101. North of W. Wisconsin Avenue	Milwaukee River	24
102. W. Cherry Street	Milwaukee River	90
103. W. Congress Street east of North 35th Street	Lincoln Creek	Double Box (2) 10'-0" x 7'-6"
104. W. McKinley Avenue	Milwaukee River	60
105. N. Broadway	Milwaukee River	30
106. N. Holton Street	Milwaukee River	Box 4' x 7'
107. N. Humboldt Avenue	Milwaukee River	72
108. N. Marshall Street	Milwaukee River	24
109. N. Pulaski Street	Milwaukee River	72
110. S. Water Street	Milwaukee River	24
111. S. 1st Street	Milwaukee River	36
112. North of Cherry Street	Milwaukee River	Box 4'-5" x 5'-0"

[a] *The number beside each listed combined sewer outfall location corresponds to a code number on Map 3.*

Table B-10

KNOWN BYPASSES IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
MILWAUKEE RIVER WATERSHED		
City of Cedarburg		
1. Riveredge Lift Station	Cedar Creek	6
2. Columbia Avenue east of Highland Drive	Cedar Creek	8
City of West Bend		
3. Manhole near wastewater treatment plant	Milwaukee River	N/A
Village of Fredonia		
4. At wastewater treatment plant	Milwaukee River	N/A
Village of Jackson		
5. Lift Station No. 1	Cedar Creek	N/A
6. Lift Station No. 2	Cedar Creek	N/A
Village of Newburg		
7. At wastewater treatment plant	Milwaukee River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass location corresponds to a code number in Map 5.*

Table B-11

KNOWN RELIEF PUMPING STATIONS IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pump Capacity (gpm)
MILWAUKEE RIVER WATERSHED		
Village of Saukville		
8. Access from wastewater treatment plant	Milwaukee River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed relief pumping station location corresponds to a code number on Map 5. There is one known relief pumping station in the Upper Milwaukee River subregional area. The above number corresponds to that in Map 5.*

Table B-12

KNOWN BYPASSES IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
LAKE MICHIGAN WATERSHED		
City of Port Washington		
1. At wastewater treatment plant	Lake Michigan	24
2. Grand Avenue and Franklin Street	Lake Michigan	36
3. Lake Street and Jackson Avenue	Lake Michigan	8
4. Wisconsin Street, 130 feet north of Chestnut Street	Lake Michigan	24
SAUK CREEK WATERSHED		
City of Port Washington		
5. Grand Avenue and Webster Street	Sauk Creek	24
6. North of River Street pump station	Sauk Creek	N/A
SHEBOYGAN RIVER WATERSHED		
Village of Belgium		
7. At wastewater treatment plant	Onion River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass location corresponds to a code number on Map 7.*

Table B-13

KNOWN CROSSOVERS IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
PIKE RIVER WATERSHED		
City of Kenosha		
1. Alford Drive and 18th Street	Pike River	N/A
2. N. Pershing Boulevard and 19th Avenue	Pike River	N/A
3. 20th Place and 22nd Avenue	Pike River	N/A
4. 31st Street and 14th Avenue, 200 feet east of 14th Avenue	Pike River	N/A
5. 33rd Street and 14th Avenue, 200 feet east of 14th Avenue	Pike River	N/A
PIKE CREEK WATERSHED		
City of Kenosha		
6. Sheridan Road and 51st Place	Pike Creek	N/A
7. 33rd Street and 25th Avenue	Pike Creek	N/A
8. 50th Street and 10th Avenue	Pike Creek	N/A
LAKE MICHIGAN WATERSHED		
City of Kenosha		
9. Pershing Boulevard and Taft Road	Lake Michigan	N/A
10. Roosevelt Road and 64th Street	Lake Michigan	N/A
11. Sheridan Road and 76th Street	Lake Michigan	N/A
12. 63rd Street and 12th Avenue	Lake Michigan	N/A
13. 65th Street and 22nd Avenue, 100 feet west of 22nd Avenue	Lake Michigan	N/A
14. 75th Street and 20th Avenue	Lake Michigan	N/A
15. 78th Street and 20th Avenue	Lake Michigan	N/A
16. 79th Street and 24th Avenue	Lake Michigan	N/A
17. 79th Street and Johnson Road	Lake Michigan	N/A
18. 79th Street and Lincoln Road	Lake Michigan	N/A
19. 78th Street and 43rd Avenue	Lake Michigan	N/A
City of Racine		
20. La Salle Street and Carlton Drive	Lake Michigan	N/A
21. 10th Avenue and Shoreland Drive	Lake Michigan	N/A
22. 3rd Street and Lake Street	Lake Michigan	N/A
23. 11th Street and Lake Street	Lake Michigan	N/A
24. 14th Street and Main Street	Lake Michigan	N/A
25. 16th Street and College Street	Lake Michigan	N/A
ROOT RIVERWATERSHED		
City of Racine		
26. 9th Street and CMSTP&P Railroad	Root River	N/A
27. 11th Street and CMSTP&P Railroad	Root River	N/A
28. 12th Street and Schiller Street	Root River	N/A
29. 13th Street and Schiller Street	Root River	N/A
30. 13th Street and Schiller Street	Root River	N/A
31. Liberty Street and Forest Street	Root River	N/A
32. Kinzie Avenue and Blaine Avenue	Root River	N/A
33. Washington Avenue and Grove	Root River	N/A
34. 21st Street and Grove	Root River	N/A
35. Lift Station No. 1	Root River	N/A
36. Lift Station No. 2	Root River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed crossover location corresponds to a code number on Map 9.*

Table B-14

KNOWN BYPASSES IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
ROOT RIVER WATERSHED		
Town of Caledonia		
1. Frankville Lift Station, CTH K and Kraut Road	Hoods Creek	N/A
2. Hoods Creek Lift Station, South Lane and Gifford Road	Hoods Creek	N/A
3. Lift Station No. C31, 500 feet of Birch Drive	Root River	N/A
Town of Mt. Pleasant		
4. Lift Station MP 11, STH 38—Holiday Inn	Root River	N/A
City of Racine		
5. Lift Station No. 8	Root River	N/A
6. Lift Station No. 9	Root River	N/A
7. 4th Street and Water Street	Root River	N/A
8. Water Street and Park Avenue	Root River	N/A
9. Water Street and Grand Avenue	Root River	N/A
10. 2nd Street and Main Street	Root River	N/A
11. 2nd Street and Lake Avenue	Root River	N/A
12. Standard Street and River	Root River	N/A
13. Howe Street and River	Root River	N/A
14. N. Memorial Drive and Riverview Terrace	Root River	N/A
15. Harrison Street and River	Root River	N/A
16. W. 6th Street and Kinzie Avenue	Root River	N/A
17. E. 6th Street and River	Root River	30
18. 4th Street and Ontario	Root River	30
LAKE MICHIGAN WATERSHED		
City of Kenosha		
19. At wastewater treatment plant	Lake Michigan	N/A
Village of North Bay		
20. Lighthouse Drive and Vincennes Circle	Lake Michigan	N/A
Town of Mt. Pleasant		
21. Lift Station MP-18	Lake Michigan	N/A
PIKE RIVER WATERSHED		
Village of Sturtevant		
22. At wastewater treatment plant	Pike River	N/A
Town of Mt. Pleasant		
23. Creziger lift station	Pike River	N/A
Town of Somers Utility District No. 1		
24. At wastewater treatment plant	Pike Creek (tributary of Pike River)	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass location corresponds to a code number on Map 9.*

Table B-15

KNOWN RELIEF PUMPING STATIONS IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pump Capacity (gpm)
PIKE CREEK WATERSHED		
City of Kenosha		
1. Wilson Raod between Pershing Boulevard and 46th Avenue	Pike Creek	N/A
2. 24th Street between 24th Avenue and 25th Avenue	Pike Creek	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed relief pumping station location corresponds to a code number in Map 9.*

Table B-16

KNOWN COMBINED SEWER OUTFALLS IN THE KENOSHA -RACINE SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
LAKE MICHIGAN WATERSHED		
City of Kenosha		
1. 57th Street and 3rd Avenue	Lake Michigan	N/A
2. 59th Street and 3rd Avenue	Lake Michigan	N/A
3. 68th Street and 3rd Avenue, 150 feet north of 68th Street	Lake Michigan	N/A
4. 75th Street and 3rd Avenue	Lake Michigan	N/A
City of Racine		
5. Augusta Street and Michigan Boulevard	Lake Michigan	66
6. 21st Street and Roosevelt Park Drive	Lake Michigan	66
ROOT RIVER WATERSHED		
City of Racine		
7. Envirex Unit No. 1	Root River	N/A
8. Envirex Unit No. 2	Root River	N/A
9. Domanik Drive and Luedtke	Root River	N/A
10. Marquette Street and Liberty	Root River	N/A
11. State Street and Ontario Street	Root River	42
12. 4th Street and Ontario Street	Root River	30
13. Bank Street and Mound Avenue	Root River	12
14. W. 6th Street and Parkview Drive	Root River	12

NOTE: N/A indicates data not available.

[a] *The number beside each listed combined sewer outfall corresponds to a code number on Map 9.*

Table B-17

KNOWN BYPASSES IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
ROOT RIVER WATERSHED		
Village of Union Grove		
1. At wastewater treatment plant	West branch Root River Canal	N/A

NOTE: N/A indicates data not available.

[a] *The number beside the listed bypass location corresponds to a code number on Map 11.*

Table B-18

KNOWN BYPASSES IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
DES PLAINES WATERSHED		
Village of Paddock Lake		
1. At wastewater treatment plant	Brighton Creek	N/A
Town of Bristol Sanitary Utility District 1		
2. At wastewater treatment plant	Des Plaines River	N/A
Town of Pleasant Prairie Sewer Utility District D		
3. At wastewater treatment plant	Des Plaines River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass location corresponds to a code number on Map 13.*

Table D-19

KNOWN BYPASSES IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
FOX RIVER WATERSHED		
City of Waukesha		
1. At wastewater treatment plant	Fox River	N/A
2. Burr Oak Boulevard lift station	Fox River	N/A
3. Gray Terrace lift station	Fox River	N/A
4. Greenmeadow Drive lift station	Fox River	N/A
5. Pearl Street lift station	Fox River	N/A
6. Pebble Valley lift station	Fox River	N/A
7. Peters Subdivision lift station	Fox River	N/A
8. Sunset Drive lift station	Fox River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass location corresponds to a code number on Map 15.*

Table B-20

KNOWN PORTABLE PUMPING STATIONS IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pump Capacity (gpm)
FOX RIVER WATERSHED		
City of Brookfield		
9. Deer Park Drive and east of Betty Lane	Deer Creek	N/A
10. N. Brookfield Road and Beverly Hills Drive	Fox River	N/A
City of Waukesha		
11. Fox River interceptor manhole	Fox River	N/A
12. Pine Street sanitary manhole	Fox River	N/A
Village of Sussex		
13. Manhole near wastewater treatment plant	Sussex Creek	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed portable pumping station location corresponds to a code number on Map 15. There are five known portable pumping stations in the Upper Fox subregional area. The above numbering corresponds to that of Map 15.*

Table B-21

KNOWN BYPASSES IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
LOWER FOX WATERSHED		
City of Lake Geneva		
1. At wastewater treatment plant	White River	N/A
Village of East Troy		
2. At wastewater treatment plant	Honey Creek	N/A
Village of Genoa City		
3. At wastewater treatment plant	Nippersink Creek	N/A
Village of Silver Lake		
4. At wastewater treatment plant	Silver Lake Outlet	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass location corresponds to a code number on Map 17.*

Table B-22

KNOWN BYPASSES IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
ROCK RIVER WATERSHED		
City of Oconomowoc		
1. Two manholes ahead of wastewater treatment plant	Oconomowoc River	N/A
2. N. Main Street lift station	Lac La Belle	N/A
3. N. Main Street Siphon	Lac La Belle	N/A
4. North End of Walnut Street	Fowlers Lake	18
Village of Dousman		
5. At wastewater treatment plant	Bark River	N/A
Village of Hartland		
6. At wastewater treatment plant	Bark River	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass lcoation corresponds to a code number on Map 21.*

Table B-23

KNOWN BYPASSES IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Location[a]	Receiving Water	Pipe Size (inches)
ROCK RIVER WATERSHED		
City of Delavan		
1. At wastewater treatment plant	Turtle Creek	N/A
City of Elkhorn		
2. At wastewater treatment plant	Jackson Creek	N/A
City of Whitewater		
3. At wastewater treatment plant	Whitewater Creek	N/A
4. Main Bridge over Whitewater Creek	Whitewater Creek	18
5. Ann Street	Whitewater Creek	N/A
6. North Street	Whitewater Creek	N/A
7. Starin Road	Whitewater Creek	N/A
Village of Darien		
8. At wastewater treatment plant	Turtle Creek	N/A
Village of Sharon		
9. At wastewater treatment plant	Little Turtle Creek	N/A
Village of Walworth		
10. At wastewater treatment plant	Piscasaw Creek	N/A

NOTE: N/A indicates data not available.

[a] *The number beside each listed bypass location corresponds to a code number on Map 23.*

Appendix C

GLOSSARY OF TERMS USED IN THE SEWRPC REGIONAL WATER QUALITY MANAGEMENT PLANNING PROGRAM

Activated Sludge Process—A biological waste treatment process in which a mixture of sewage and activated sludge is agitated and aerated in a tank to oxidize organic matter in the sewage. The activated sludge, which consists of a growth of zoogleal organisms, is subsequently separated from the treated sewage by sedimentation and wasted or returned to the process as needed.

Aeration, Extended—A modification of the activated sludge process which provides for aerobic sludge digestion within the aeration system.

Aeration, Step—A procedure for adding increments of settled sewage along the line of flow in the aeration tanks of an activated sludge sewage treatment plant.

Appurtenances—Appliances or auxiliary structures comprising an integral part of a sewerage system, such as manholes, manhole covers, ladders, frames, and screens to provide for ventilation, inspection, or maintenance of the sewerage system, or the specialized structures, such as depressed siphons and junctions, for conveying sewage.

Best Available Technology (BAT)—The best available technology economically achievable, and the most advanced levels of waste treatment that have been or are capable of being achieved economically. The phrase is sometimes abbreviated as BATEA, and is established in federal law and regulations as the wastewater treatment methods required to be achieved by industrial point sources of wastewater by no later than July 1, 1983. The technology represents the treatment processes defined by the U.S. Environmental Protection Agency for different categories of industrial point source—generally on the basis of Standard Industrial Classification (S.I.C.) codes. (See Section 301(b)(2)(A) of Public Law 92-500.) The analogous requirement for municipal sewage treatment plants is termed "Best Practicable Waste Treatment Technology" (BPWTT) and is defined case by case under the terms of Section 201(b) of Public Law 92-500.)

Best Management Practices—The land management techniques or practices determined to be the most effective and practicable means of preventing or reducing diffuse source pollutants.

Best Practicable Control Technology (BPCT), or Best Practicable Technology (BPT)—For industry, a minimum level of wastewater treatment required nationally. The treatment level is defined by the U.S. Environmental Protection Agency, generally on the basis of Standard Industrial Classification (S.I.C.) Codes. For municipal sewage treatment plants, secondary treatment—as defined by the U.S. Environmental Protection Agency—represents the corresponding treatment level. (See Sections 301(b)(1)(A) and 301(b)(1)(B) of Public Law 92-500.)

BOD_5—Five-day biochemical oxygen demand

Bypass—A flow relief device by which sanitary sewers entering a lift station, pumping station, or sewage treatment plant can discharge a portion or all of their flow, by gravity, directly into a receiving body of surface water to alleviate sewer surcharge; also, a flow relief device by which intercepting or main sewers can discharge a portion or all of their flow, by gravity, into a receiving body of surface water to alleviate surcharging of intercepting or main sewers.

CFS—Cubic feet per second, a measure of rates of flow commonly applied to rates of stream flow in natural drainage channels.

Chlorination—The application of elemental chlorine gas to sewage effluent, generally for purposes of disinfection.

Clarification—Any process or combination of processes of which the primary purpose is to reduce the concentration of suspended matter in a liquid.

Clarifier—A unit such as a sedimentation tank or basin of which the primary purpose is to secure clarification of wastewater.

COD—Chemical oxygen demand

Contact Stabilization Process—A modification of the activated sludge process in which raw sewage is aerated with a high concentration of activated sludge for a relatively short period of time to obtain removal of oxygen-demanding substances by absorption, the solids being subsequently removed by sedimentation and transferred to a stabilization tank, where aeration is continued to further oxidize and condition the sludge before reintroduction to the raw sewage flow.

Continuous or Perennial Stream—A watercourse with a defined stream channel and a natural seven-day, one-in-ten-year-recurrence interval low flow of greater than 0.1 cubic foot per second and exhibiting the characteristics of a perpetually wet environment.

Crossover—A flow relief device by which sanitary sewers discharge a portion of their flow, by gravity, into storm sewers during periods of sanitary sewer surcharge or by which combined sewers discharge a portion of their flow, by gravity, into storm sewers to alleviate sanitary or combined sewer surcharge.

Designated Management Agency—The responsible agency or unit of government identified as being responsible for a specified set of water quality management tasks, including but not limited to monitoring, surveillance, plan implementation, construction, operation, maintenance, enforcement and technical assistance.

Design Capacity, Average Hydraulic—The average influent sewage flow at which a sewage treatment plant will operate at design pollutant removal efficiencies.

Design Capacity, Average Organic—The average biochemical oxygen demand of the influent sewage, expressed as pounds of $CBOD_5$ per day, which the sewage treatment plant is designed to treat.

Design Capacity, Peak Hydraulic—The maximum influent sewage flow for which the plant is designed to operate without flooding; pollutant removal is still performed under this flow condition but at a much lower efficiency than the design efficiency.

Diffused Surface Waters—Any water from rain, intermittent springs, or melting snow which flows on the land surface, or through ravines which are usually dry except at times of storm water runoff, but not including waters on the land surface in the immediate vicinity of agricultural or wastewater irrigation systems.

Digestion, Aerobic—The decompositon of organic matter in the presence of elemental oxygen.

Digestion, Anaerobic—The decomposition of organic matter resulting in gasification, liquefaction, and mineralization through the action of microorganisms in the absence of elemental oxygen.

D.O.—Dissolved Oxygen.

Effluent Channels—Discharge conveyances constructed for the transport of wastewaters from a treatment facility to a point of discharge to the natural drainage course, but not including drainage ditches constructed primarily for the purpose of relieving excess waters on agricultural lands, or modifications made to natural watercourses for the purpose of increasing or enhancing the natural flow characteristics of a stream.

Effluent Limited Segment—A stream segment for which the applicable water quality standards are achievable through the implementation of the effluent limitations for "best practicable treatment" and "secondary treatment."

Eutrophication—A natural aging process by which lakes become progressively more fertile and evolve into bogs, marshes, or wetlands, ultimately assuming completely terrestrial characteristics as a result of the contribution of nutritive compounds—especially nitrogen and phosphorus—encouraging the growth of algae and other aquatic plant life. The process of eutrophication occurs as a result of natural evolutionary ecological processes, but may be accelerated by human activity.

F.C.—Fecal coliform.

Feedlot—A relatively small—generally less than five acres—confined land area such as a fenced barnyard or pasture for raising livestock primarily through the use of imported feed rather than natural pasturing processes, and relying on the transport of manure and bedding materials from the feeding, resting, or loafing areas. Feedlots are generally denuded of vegetative cover and, therefore, subject to high rates of erosion and washoff of manure.

Filtration—The process of passing a liquid through a filtering medium consisting of granular material, such as sand, magnetite, anthracite, garnet, activated carbon, or diatomaceous earth, finely woven cloth, unglazed porcelain, or specially prepared paper, to remove suspended or colloidal matter.

Flash Mixer—A device for quickly dispersing chemicals uniformly throughout a liquid.

Force Main—A pipeline joining the discharge of a pumping station with a point of gravity flow and designed to transmit sewage under pressure flow throughout its length.

Grit Chamber—A detention chamber designed to reduce the velocity of the influent sewage to permit the removal of coarse minerals from organic solids by differential sedimentation.

Groundwater—The supply of fresh water under the land surface and present either in the "saturated" zone below the water table level or above it in the "unsaturated" zone.

Heavy Metals—Metallic elements of high atomic weights, generally including iron, mercury, manganese, copper, chromium, cadmium, lead, and vanadium. These elements are generally found in trace amounts in natural waters, may be toxic to plant or animal life at relatively low concentrations, and may exhibit properties of biological accumulation.

Holding Tank—An onsite storage tank for short-term storage of sewage as part of a sewage disposal process whereby the wastes are periodically removed from the tank and transported by tank truck to a suitable treatment and discharge facility. The systems are generally only utilized where centralized sanitary sewerage service is unavailable and soils are not suitable for septic system installation and use.

Incinerator—A mechanical device for controlled combustion. Special design may be used to incinerate or to maximize energy recovery or volume reduction, or destruction of toxic or hazardous materials.

Infiltration—The water entering a sanitary sewerage system from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, or manhole walls. Infiltration does not include, and is distinguished from, inflow.

Inflow—The water discharged into a sanitary sewerage system from such sources as, but not limited to, roof leaders; cellar, yard, and area drains; foundation drains; cooling water discharges; drains from springs and swampy areas; manhole covers; cross connections from storm sewers and combined sewers; and catch basins. Inflow consists of storm water runoff, street wash waters, and other forms of surface drainage and does not include, and is distinguished from, infiltration.

Intercepting Structure—A structure designed to intercept all dryweather sanitary sewage flow in a combined sewer and a proportionate amount of the mixed storm water and sanitary sewage flow during periods of rainfall or snowmelt and discharge such flows to an intercepting sewer.

Interflow—The component of subsurface (groundwater) flow which passes from surface infiltration during precipitation to groundwater discharge to a stream at a later time.

Intermittent Stream—A watercourse with a defined stream channel, but a natural seven-day, one-in-ten-year-recurrence interval flow of less than one-tenth of a cubic foot per second, and characterized by groundwater infiltration rather than groundwater discharge during dry periods.

Lake or Flowage—Bodies of standing water which lack a unidirectional current, or in which the current is generally very slow.

Leachate—Contaminated groundwater in the saturated or unsaturated zones resulting from the percolation of storm waters through soils and other materials which contain pollutants and are thereby transported to groundwater or surface waters through the discharge of the leachate.

Loading, Average Hydraulic—The arithmetic average of the total metered daily flow at a sewage treatment plant for any selected year.

Loading, Average Organic—The arithmetic average of the total daily loading of $CBOD_5$ at a sewage treatment plant for any selected year.

Loading, Maximum Monthly Hydraulic—The arithmetic average of the total metered daily flow at a sewage treatment plant for any month during any selected year.

Loading, Peak Hydraulic—The greatest total daily sewage flow received by a treatment plant in any selected year.

MGD—Million gallons per day, a unit of measurement of flow commonly applied to rates of wastewater flow in engineered wastewater conveyance and treatment systems.

μ g/l—Micrograms per liter, a measure of the mass per unit volume of a substance in an aqueous solution, and commonly utilized for the measurement of pollutant concentrations in wastewaters or in natural surface waters or groundwaters.

Mg/l—Milligrams per liter, a measure of the mass per unit volume of a substance in an aqueous solution, and commonly utilized for the measurement of pollutant concentrations in wastewaters or natural surface waters or groundwaters. The term is frequently interchanged with the expression "parts per million," since at the specific density of water, a liter of water weighs one kilogram.

Microstrainer—An extremely fine rotating screen for the removal of small suspended solids in sewage.

Multimedia Filter—A treatment utilized to process wastewater by passing the liquid through a sequence of three media—usually combinations of sand, anthracite, activated carbon, weighted spherical resin beds, and garnet—for the removal of suspended or colloidal matter.

NH_3-N—Ammonia-nitrogen.

Nonpoint Source—One of many pollution sources not able to be ascribed to a discrete location but which collectively result in the generalized or diffuse discharge of water pollutants to a body of water. Thus, the term refers to any source of pollution which is not able to be identified as a "point source." It should be noted that piped storm sewer outfalls through which pollutants of diffuse origin are discharged are regarded within this report as diffuse sources despite the point source nature of the actual discharge site, as in the case of runoff carried in pipes or other closed or open conduits, roadside ditches, drainage swales, or watercourses.

NO_3-N—Nitrate-nitrogen.

NO_2-N—Nitrite-nitrogen.

NPDES—National Pollutant Discharge Elimination System, the system of permit issuance established under Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972, whereby the regulation of effluent discharge characteristics and pollution abatement schedules is specified in surface water discharge permits issued under the authority of the U.S. Environmental Protection Agency.

OP or PO-P_4—Orthophosphate phosphorus, or phosphate-phosphorus, or soluble phosphorus, or inorganic phosphorus.

Package Plant—A relatively small, usually prefabricated, sewage treatment plant.

PCB's—Polychlorinated biphenyls, a group of organic compounds which are used in the manufacture of plastics or electrical equipment, have low rates of degradation resulting in their persistence in the environment, and are biologically accumulative in the food chain resulting in a potential to be highly toxic for aquatic life and humans.

Point Source—A discrete site at which collected wastewater is discharged into a body of water, thereby rendering the wastewater amenable to treatment, elimination, or other control of the related water pollution. Point sources consist of any discernible confined and discrete conveyances including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft from which pollutants are or may be discharged directly or indirectly to surface waters or groundwaters. Point sources also include outfalls from sanitary sewerage system flow relief devices, sewage treatment plants, and industrial waste discharges. It should be noted however, that because the pollutants associated with storm water runoff are directly related to the tributary land uses and associated land management practices, urban storm sewer systems have been included within this report as nonpoint sources of pollution.

Polishing Lagoon—An unaerated lagoon designed and intended to upgrade or stabilize secondary, tertiary, or advanced wastewater treatment process effluent by natural oxidation of organic matter and settling.

Pollutant Channel Loadings—The pollutant loads which enter continuous or intermittent drainage channels, drainage swales, streams, or lakes. On a short-term basis, many of the pollutant loads entering a drainage channel may be stored in the channel and not transported any great distance downstream.

Pollutants—Substances which did not originate from natural sources and are present in such quantities as to adversely affect certain beneficial water uses.

Population Equivalent—The existing or design organic loading to a sewage treatment plant expressed in population and based on an average normal domestic sewage strength and flow.[1]

Potential Pollutant Runoff—The pollutant loads which are generated directly as a result of specified natural processes and human activities and which may be available for transport by storm water runoff. These pollutants may be transported only short distances and may not necessarily reach drainage channels, streams, or lakes. Examples include the exposed soil of a construction site and the entire amount of manure generated by a herd of livestock.

Pretreatment—The conditioning of a waste at its source before discharge to remove or neutralize substances injurious to sewers and treatment processes or to effect a partial reduction in load on the treatment process. The term generally applies to the conditioning of industrial wastes before discharge to municipal sewerage systems.

Private Sanitary Sewerage System—A waste water disposal system providing conveyance, treatment, and final disposal for wastes from users who have agreed-upon rights to the benefits of the facility which is owned and operated by an individual owner, either a private business or a public institution.

Public Law 92-500 (PL 92-500)—The Federal Water Pollution Control Act Amendments of 1972, as established in Section 1251 of the 33rd Volume of the United States Code of Federal Statutory Enactments (33 USC 1251 et. seq.)

Public Sanitary Sewerage System—A waste water disposal system providing conveyance, treatment, and final disposal for wastes from users who all have equal rights to the benefits of the utility which is owned and operated by a legally established governmental body.

Q—A symbol frequently used for a rate of flow of wastewater or of streamflow.

Screening—The removal of floating and suspended solids in sewage by straining through racks or screens.

Sedimentation—The process of subsidence and deposition of the suspended matter in sewage by gravity, usually accomplished by reducing the velocity of the sewage below the point at which it can carry suspended matter. Primary sedimentation occurs in a complete sewage treatment process before biological or chemical treatment; secondary sedimentation occurs after such treatment.

Septic System (Mound Type)—A septic system which incorporates as a drain field, granular material placed on a mound above the existing grade and receiving a dosed application of pumped septic tank effluent for discharge to the inside of the mounded bed through tile lines. The granular material allows the liquid to be lifted to the surface by capillary action to evaporate or be used by vegetation atop the mound, or allows the liquid to infiltrate the underlying soil after undergoing some filtration within the mound.

Septic Tank—A settling tank in which organic solids are settled and decomposed by anaerobic bacterial action, with the settled sludge being in immediate contact with sewage flowing through the tank. The treated sewage is then discharged to the groundwater reservoirs by underground tile lines.

Sewage—The spent water of a community consisting of a combination of liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, or storm water which may be unintentionally present.

Sewage Lagoon—A shallow body of water containing partially treated sewage in which aerobic stabilization occurs.

Sewage Treatment Plant—An arrangement of devices and structures for treating sewage in order to remove or alter its objectionable constituents and thus render it less offensive or dangerous.

Sewage Treatment Plant Efficiency—The ratio of the amount of pollutant removed by the sewage treatment plant to the amount of pollutant in the influent sewage expressed in percent.

Sewer—A pipe or conduit, generally closed but not normally flowing under pressure, for carrying sewage.

Sewer, Branch—A common sewer receiving sewage from two or more lateral sewers serving relatively small tributary drainage areas.

Sewer, Building—A private sewer conveying sewage from a single building to a common sewer; also called housing connection.

Sewer, Combined—A common sewer intended to carry sanitary sewage, with component domestic, commercial, and industrial wastes, at all times, and which, during periods of rainfall or snowmelt, is intended to also carry storm water runoff from streets and other sources.

Sewer, Common—A sewer in which all abutters have equal rights; also called public sewer.

Sewer, Intercepting—A common sewer that receives dry weather sanitary sewage flows from a combined sewer system and predetermined proportionate amounts of mixed storm water and sanitary sewage flows during periods of rainfall or snowmelt and conducts these flows to a point of treatment or disposal.

Sewer, Lateral—A common sewer discharging into a branch or other common sewer and having no other common sewer tributary to it.

Sewer, Main—A common sewer which receives flows from many lateral and branch sewers serving relatively large tributary drainage areas for conveyance to a treatment plant; also called trunk sewer.

Sewer, Outfall—A sewer that receives flows from a collection system or treatment plant and conveys the untreated or treated waste flows to a point of discharge into a receiving body of surface water.

Sewer, Relief—A common sewer built to carry the flows in excess of the capacity of an existing sewer, thus relieving surcharging of the latter.

Sewer, Sanitary—A common sewer which carries sewage from residences, commercial buildings, and institutions, and certain types of liquid wastes from industrial plants, together with minor amounts of storm, surface, and ground waters that are not intentionally admitted.

Sewer, Storm—A common sewer which carries surface water and storm water runoff from open areas, rooftops, streets, and other sources, including street wash and other wash waters, but from which sanitary sewage and industrial wastes are specifically excluded.

Sewerage System—A system of piping treatment facilities and appurtenances for collecting, conveying, and treating wastewater.

Sludge—An aqueous suspension of residual solids generated through the treatment of a municipal or industrial wastewater, and of such a nature and concentration as to require special consideration for disposal. Industrial residuals having economic value without significant processing are not included under this definition.

Station, Lift—A relatively small sewage pumping installation designed to lift sewage from a gravity flow sewer to a higher elevation when the continuance of the gravity flow sewer would involve excessive depths of trench, or designed to lift sewage from areas too low to drain into available sewers. Lift stations normally discharge through relatively short force mains to gravity flow points located at or very near the lift station.

Station, Portable Pumping—A point of flow relief at which flows from surcharged sanitary sewers are discharged into storm sewers or directly into a receiving body of surface water through the use of portable pumping units.

Station, Pumping—A relatively large sewage pumping installation designed not only to lift sewage to a higher elevation but to convey it through force mains to gravity flow points located relatively long distances from the pumping station.

Station, Relief Pumping—A flow relief device by which flows from surcharged main sewers are discharged into storm sewers or directly into a receiving body of surface water through the use of permanent lift or pumping stations.

Stream Reach—A drainageway having a specified location and course of direction, identified by defined terminus points.

Stream Segment—See "stream reach."

Storm Water Management System—A system of conveyance and storage facilities—including but not limited to subsurface pipes and conduits, surface ditches and channels, and appurtenant inlet, outlet, storage, pumping, and treatment facilities—located in urbanized areas and constructed—or improved—and operated for purposes of collecting storm water runoff from tributary developed areas and conveying such runoff to natural watercourses for disposal.

Subbasin—A relatively small surface drainage unit, generally encompassing no more than 10 square miles, defined by its common drainage to a single, identifiable, downstream point of storm water discharge.

Subwatershed—A surface drainage unit larger than a subbasin but smaller than a watershed, and comprised of the area tributary to a named, generally recognized, continuously flowing stream or lake.

TKN—Total Kjeldahl nitrogen.

TN—Total nitrogen.

Treatment, Advanced—Additional biological, or physical, and chemical treatment to provide removal of additional constituents, particularly phosphorus and nitrogen compounds, by such means as chemical coagulation, sedimentation, charcoal filtration, and aeration. Although advanced treatment is traditionally conceived of as following secondary treatment or as combined with tertiary treatment, it can be performed following primary treatment or as an integral part of secondary treatment. Advanced treatment may remove 90 percent or more of the raw influent phosphorus and up to 90 percent of the raw influent nitrogen, or effect up to 95 percent reduction in the oxygen demand of ammonia in the sewage treatment plant influent by converting the ammonia compounds to nitrates.

Treatment, Auxiliary—A treatment measure which is used in combination with all other treatment methods, and which includes, for example, effluent aeration and disinfection by chlorination.

Treatment, Primary—The physical treatment of raw sewage in which the coarser floating and settleable solids are removed by screening and sedimentation. Primary treatment normally provides 50 to 60 percent reduction of the influent suspended matter and 25 to 35 percent reduction of the influent carbonaceous biochemical oxygen-demanding organic matter ($CBOD_{ult}$). It removes little or no colloidal and dissolved matter.

Treatment, Secondary—The biological treatment of the effluent from primary treatment in which additional oxygen-demanding organic matter is removed by trickling filters or activated sludge tanks and additional sedimentation. Secondary treatment normally provides up to 90 percent removal of the raw influent suspended matter and 75 to 95 percent removal of the raw influent $CBOD_{ult}$. Secondary treatment facilities can be designed and operated to also remove 30 to 50 percent of the raw influent nitrogenous biochemical oxygen demand ($NBOD_{ult}$) and 30 to 40 percent of the raw influent phosphorus content of the influent sewage. In addition to this definition used by the SEWRPC, it should be noted that a definition has been set forth by the U.S. Environmental Protection Agency for the "secondary treatment" requirements to be achieved by all publicly owned treatment works (municipal sewage treatment plants) by 1977; or by July 1, 1983 if sufficient construction time or timely federal financial assistance is not available, providing that a request for extension is submitted by the municipality. That federal definition calls for treatment which is either adequate to achieve an effluent quality of 30 mg/l of biochemical oxygen demand and 30 mg/l of suspended solids, or is adequate to achieve a reduction of at least 85 percent in the concentrations of biochemical oxygen demand and of suspended solids.

Treatment, Tertiary—The physical and biological treatment of the effluent from secondary treatment in which additional oxygen-demanding matter is removed by use of shallow detention ponds to provide additional biochemical treatment and settling of solids or filtration using sand or other media filters or mechanical screening or filtration. Tertiary treatment normally provides up to 99 percent removal of the raw influent suspended matter and 95 to 97 percent of the raw influent $CBOD_{ult}$.

Trickling Filter Process—A biological waste treatment process in which sewage is applied in spray form from nozzles or other distribution devices over a filter consisting of an artificial bed of coarse material, such as broken stone, through which the sewage trickles to underdrains, giving opportunity for the formation of zoogleal slimes which clarify and oxidize the sewage.

TS—Total solids.

TSS—Total suspended solids.

Un-ionized ammonia—The fraction of ammonia present in surface waters, which is toxic to fish and other aquatic life. At higher temperatures and higher pH, the proportion of ammonia which is un-ionized is greater than at low temperature and low pH.

Vacuum filter—A filter consisting of a cylindrical metal drum covered with cloth or other media revolving on a horizontal axis with partial submergence in liquid sludge. A vacuum is maintained under the media to extract moisture from the sludge which adheres to the cloth or media and which is scraped off continuously for disposal.

Water Pollution—The condition in which substances which do not originate from natural sources are present in such quantities as to adversely affect certain beneficial water uses. The principal forms of pollution are: organic, nutrient, inorganic, pathogenic, thermal, aesthetic and radiological.

Water Quality Limited Segment—A stream segment which would not meet the applicable water quality standard except by the application of wastewater treatment technology more advanced than "best practicable treatment" or "secondary treatment."

Water Quality Standards—Statements of the characteristics of water which must be maintained in order to make it suitable for specific uses, and commonly expressed in terms of specific water quality indicators, relating the maximum or minimum concentrations of desirable and undesirable chemical substances in waters, or relating to other physical characteristics of the waters. Such standards are generally specified as ambient stream or lake water quality conditions, but the term is sometimes applied to criteria for the quality of discharged wastewater effluents.

Watershed—A relatively large, geographic area of overland drainage contributing surface runoff to the flow of a particular watercourse at a particular point, and having within the area natural and man-made features so interrelated and mutually interdependent as to create a significant community of interest among its residents. The term is applied by the Commission in its major planning programs with the reference to 11 major drainage units lying wholly or partially within the Southeastern Wisconsin Region. These include the Des Plaines River watershed; Fox River watershed; Kinnickinnic River watershed; Menomonee River watershed; Milwaukee River watershed; Oak Creek watershed; Pike River watershed; Rock River watershed; Root River watershed; Sauk Creek watershed; and Sheboygan River watershed. In addition, Commission work programs include collectively as a 12th major drainage unit the watersheds of the minor streams directly tributary to Lake Michigan, including but not limited to the areas tributary to Barnes Creek, Pike Creek, and sucker Creek. It should be noted that the Southeastern Wisconsin Region is divided by a subcontinental divide which separates these 12 watersheds into those tributary to Lake Michigan, and those which drain ultimately to the Mississippi River.

Watershed Pollutant Transport—The pollutant loads transported, and modified by processes occurring during transport, by a surface water system from all of the upstream sources and channels past a given point on a stream network. The quantity of such loads would generally be measured near the downstream end of a watershed, and reported on either an annual or a storm event basis.

WPDES—Wisconsin Pollutant Discharge Elimination System, a system of permit issuance established under Chapter 147 of the Wisconsin Statutes whereby the regulation of effluent discharge characteristics and pollution abatement schedules is specified in surface water and groundwater discharge permits issued under the authority of the Wisconsin Department of Natural Resources, as that authority was explicitly delegated to the State of Wisconsin Department of Natural Resources by the U.S. Environmental Protection Agency, and in accordance with state authority established under Chapter 147 of Wisconsin Statutes.

---

[1]*In the areawide water quality planning program, the average sewage strength is assumed to be 200 mg/l of $CBOD_5$, and the average domestic sewage flow is assumed to be 125 gallons per capita per day. This concentration and daily per capita flow are equivalent to 0.21 pound of $CBOD_5$/capita/day. The population equivalent is computed for either the existing or design loading by dividing the daily $CBOD_5$ loading in pounds by 0.21 pound of $CBOD_5$/capita/day. The computation of equivalent population can also be based on suspended solids by dividing the daily suspended solids loading in pounds by 0.21 pound suspended solids/capita/day.*

Appendix D

SELECTED DEMOGRAPHIC, WATER CONSUMPTION, AND WASTEWATER FLOW RELATIONSHIPS BY SUBREGIONAL AREA

To assist in the formulation of sanitary wastewater flow system design criteria, including particularly the determination of per capita flows, inventories were conducted of water consumption and analyses were made of the relationship of such consumption to wastewater flows at selected communities within the Region. The results of these inventories and analyses are presented in the following tables. These tables set forth those data utilized as a basis for the analyses and assumptions discussed in Chapter III of this report.

Table D-1

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
Milwaukee—Metropolitan Wastewater Commission[h] (South Shore and Jones Island Plants)	179.632[i]	61.965	117.667	1,018,900	176	115	210.800	84.35[k]	126.45	1,018,900	207	124	0.85	0.92
City of Muskego (Two Plants)	N/A	N/A	N/A	5,100[l]	140[l]	90[l]	0.918	N/A	N/A	10,200	90	N/A	1.56	N/A
City of South Milwaukee	4.10	1.940	2.16	23,400	175	92	2.67	1.06	1.61	23,400	114	69	1.54	1.33
Village of Germantown	0.241	0.105	0.136	2800	86	49	0.801	0.105[j]	0.696	4,600	174	151	0.49	0.32
Village of Hales Corners	N/A	N/A	N/A	N/A	90[l]	90[l]	0.518	—	0.518	8,800	59	59	1.53	1.53
Village of Menomonee Falls (Two Plants)	2.181	0.810[j]	1.371	18,800	116	90[l]	2.177	0.688[j]	1.489	20,400	107	73	1.08	1.00
Village of Thiensville	N/A	N/A	N/A	N/A	140[l]	—	0.571	0.210	0.361	4,200	136	86	1.03	1.05
Caddy Vista Sanitary District	0.052	—	0.052	1,000[l]	52	52	0.09	—	0.09	1,000	90	90	0.58	0.58
Rawson Homes Subdivision	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	600	N/A	N/A	N/A	N/A
Regal Manors Subdivision	0.302	—	0.302	1,100[l]	275	275	0.123	—	0.123	1,100	112	112	2.46	2.46
Subtotal	187		122	1,071,100	1,250	926	218.7		131.3	1,093,200	1089	764	11.12	9.19
Subregional Area Average[m]					139	103					121	96	1.15	1.07
Weighted Average[n]					175	114					200	120	0.88	0.95

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *The Milwaukee Metropolitan Wastewater District includes the cities of Cudahy, Franklin, Glendale, Greenfield, Mequon, Milwaukee, Oak Creek, St. Francis, Wauwatosa, and West Allis and portions of the cities of Brookfield and New Berlin, and the Villages of Bayside, Brown Deer, Butler, Elm Grove, Fox Point, Greendale, River Hills, Shorewood, West Milwaukee, and Whitefish Bay.*

[i] *Consumption based upon an average of the per capita consumption for communities with available data.*

[j] *Data obtained from J.C. Zimmerman, Infiltration/Inflow Analysis—Metropolitan Wastewater District of the County of Milwaukee, Intercepting Sewer Project No. 813, 1975.*

[k] *Data obtained from Milwaukee Metropolitan Wastewater District, Facilities Plan, November 1976.*

[l] *Flow from Bayside, Elm Grove, River Hills, Brookfield, Mequon, and Franklin derived using 90 gpcd average pumpage and Milwaukee—Metropolitan Wastewater Commissions sewered population.*

[m] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[n] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by that aggregate population for the subregion or region.*

Source: SEWRPC.

Table D-2

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Cedarburg	1.186	0.359	0.827	10,400	114	80	1.41	0.25	1.16	10,400	136	112	0.84	0.71
City of West Bend	3.344	1.197	2.147	19,800	169	108	3.70	1.00	2.70	21,000	176	129	0.96	0.84
Village of Fredonia	0.124	N/A	0.124	1,300	95	95	0.28	–	0.28	1,500	186	186	0.51	0.51
Village of Grafton	0.94[h]	0.53[h]	0.41[h]	8,800	107	47	0.88	0.23[h]	0.55	8,800	100	63	1.07	0.75
Village of Jackson	0.211	0.102	0.109	2,000	106	55	0.26	0.025	0.235	2,000	130	118	0.82	0.47
Village of Kewaskum	0.408	N/A	0.216[i]	2,400	170	90[i]	0.32	0.19	0.13	2,000	160	65	1.06	1.38
Village of Newburg	N/A	N/A	N/A	–	90	90[i]	0.072	–	0.072	600	120	120	0.75	0.75
Village of Saukville	0.696	0.378	0.318	2,400	290	133	0.287	0.05	0.237	2,300	125	103	2.32	1.29
Subtotal	6.91	4.15	–	47,100	1141	–	7.21	–	5.36	48,600	1,133	896	–	–
Subregional Area Average[j]	–	–	–	–	143	87	–	–	–	–	142	112	1.01	.78
Weighted Average[k]	–	–	–	–	147	88	–	–	–	–	148	110	0.99	0.80

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Data obtained from Donahue & Associates, Inc., Sanitary Sewer System Infiltration/Inflow Analysis, Grafton, 1976*

[i] *Consumption based upon an average of the per capita consumption for communities with available data.*

[j] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[k] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-3

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Port Washington	1.045	0.205	0.840	9,500	110	88	1.698	0.082	1.616	9,500	179	170	0.61	0.52
Village of Belgium	0.142	N/A	0.0810[h]	900	158	90[h]	0.070	–	0.070	900	78	78	2.03	1.15
Subtotal	1.19		0.92	10,400			1.77		1.69	10,400	257	248	2.64	1.67
Subregional Area Average[i]					134	89					128	124	1.05	0.72
Weighted Average[j]					114	88					170	163	0.67	0.54

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Consumption based upon an average of the per capita consumption for communities with available data.*

[i] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[j] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-4

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE KENOSHA–RACINE SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Kenosha[h]	15.659	7.154	8.505	89,500	175	95	18.400	4.623[i]	13.777	89,500	206	154	0.85	0.62
City of Racine[j]	20.962	9.303	11.659	116,500	180	100	19.690	6.40[k]	13.29	116,500	169	114	1.07	0.88
Village of Sturtevant	0.362	0.009	0.353	4,400	82	80	.530	0.009	0.521	4,400	120	118	0.68	0.68
Town of Somer's . . . . Utility District No. 1	N/A	N/A	N/A	N/A	N/A	N/A	.061	—	0.061	700	87	87	1.03	1.03
North Park Sanitary District . .	0.832	0.169	0.663	9,700	86	68	1.130	0.169[i]	0.961	9,700	116	99	0.74	0.69
Pleasant Park Utility . . . . Company Inc.	N/A	N/A	N/A	800	N/A	N/A	N/A	N/A	N/A	800	N/A	N/A	N/A	N/A
Subtotal	37.82		21.18	220,900			39.81		28.61	221,600	698	572	4.37	3.9
Subregional Area Average[l]					131	86					140	114	0.94	0.75
Weighted Average[m]					171.8	96.2					180.3	129.6	0.95	0.74

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *The City of Kenosha includes the following: Town of Pleasant Prairie Sewer Utility Districts A, B, C, and D; Town of Pleasant Prairie Sewer Utility District Nos. 1 and 2, and Town of Somers Sanitary District No. 1.*

[i] *Metered industrial water pumpage less known industrial discharges to storm sewers or watercourses.*

[j] *The City of Racine includes the following: Village of Elmwood Park, Village of Worth Bay, Town of Mt. Pleasant Sewer Utility No. 1, Town of Caledonia Sewer Utility District No. 1, and South Lawn Sanitary District.*

[k] *Data obtained from Donahue & Associates, Inc., Sewer System Evaluation—Phase I Infiltration/Inflow Analysis, Racine Wastewater Service Area, January 1975.*

[l] *Average is calculated as the mean valve of the individual community treatment plant or water system per capita values.*

[m] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the population for the subregion.*

Source: SEWRPC.

Table D-5

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE ROOT RIVER SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
Village of Union Grove	0.574	0.291	0.283	3,000	191	94	0.428	0.0006	0.427	3,200	134	133	1.43	0.71
Subtotal	.574		0.283	3,000			0.428		0.427	3,200				
Subregional Area Average[h]					191	94					134	133	1.43	0.71
Weighted Average[i]					191	94					134	133	1.43	0.71

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[i] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-6

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
Village of Paddock Lake	0.099	N/A	0.099	1,100	90	90	0.170	--	0.170	1,900	89	89	1.01	1.01
Town of Bristol	0.039	N/A	.039	500	78	78	0.071	--	0.071	800	89	89	0.88	0.88
Town of Pleasant Prairie (Sanitary District No. 73-1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	N/A	N/A	N/A	N/A
Town of Pleasant Prairie (Sewer Utility District D)	0.045[h]	N/A	0.45[h]	500	90[h]	90[h]	0.102	--	0.102	1,000	102	102	0.88	0.88
Town of Salem (Sewer Utility District No. 1)	N/A	N/A	N/A	N/A	90[h]	90[h]	0.079	--	0.079	1,000	79	79	1.14	1.14
Subtotal	.18		.18	2,100			.42		.42	4,800	359	359	3.91	3.91
Subregional Area Average[i]					87	87					90	90	.97	.97
Weighted Average[j]					86	86					88	88	.98	.98

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Consumption based upon an average of the per capita consumption for communities with available data.*

[i] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[j] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-7

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Brookfield	1.296[h]	N/A	1.296[h]	14,400	90[h]	90[h]	2.487	--	2.487	16,900	147	147	0.61	0.61
City of Waukesha	9.141	4.370	4.771	49,000	187	97	9.902	2.317	7.585	51,300	193	148	0.99	0.68
Village of Pewaukee	0.520	0.161	0.359	4,400	118	82	0.304	0.106	0.198	4,800	63	41	1.87 0.97	2.00 0.66
Village of Sussex	0.37 [h]	--	0.37 [h]	4,100	90[h]	90[h]	0.472	--	0.472	4,000	118	118	0.76	0.76
Subtotal	11.33		6.796	71,900			13.17		10.74	77,000	521	454	4.21	4.03
Subregional Area Average[i]					121	90					130	114	0.93 1.05	0.79 1.01
Weighted Average[j]					158	95					171	139	0.92	0.68

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Consumption based upon an average of the per capita consumption for communities with available data.*

[i] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[j] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-8

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Burlington	1.286	N/A	0.792[j]	8,800	146	90	1.480	0.147	1.333	10,800	137	123	1.07	0.73
City of Lake Geneva	1.044	N/A	.504[j]	5,600	186	90[j]	0.737	–	0.737	5,700	129	129	1.44	0.70
Village of East Troy	0.607	N/A	0.198[j]	2,200	276	90	0.247	0.028	0.219	2,200	112	100	2.46	0.90
Village of Genoa City	0.085	N/A	0.085[j]	1,100	77	77[j]	0.071	–	0.071	1,100	65	65	1.85	1.18
Village of Mukwonago	0.286	0.005	0.287	3,400	84	83	0.440	0.005[h]	0.435	3,400	129	128	0.65	0.65
Village of Silver Lake	–	–	–	–	90[j]	90[j]	0.150	–	0.150	1,300	115	115	0.78	0.78
Village of Twin Lakes	–	–	–	–	90[j]	90[j]	0.410	–	0.410	3,400	121	121	0.74	0.74
Western Racine County Wastewater District	0.178	–	0.178	2,300[i]	77	77	0.240	–	0.240	3,400	71	71	1.08	1.08
Subtotal	3.49		2.04	23,400			3.775		3.595	31,300	879	852	9.9	6.76
Subregional Area Average[k]				9	124	86					108	105	1.15	0.82
Weighted Average[l]					149	87					121	115	1.23	0.76

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Data obtained from Ruekert & Mielke, Inc., Study for Mukwonago, September 1976, p. 26.*

[i] *Data obtained from Donahue & Associates, Inc., Western Racine County Wastewater District. Infiltration/Inflow Analysis, September 1976.*

[j] *Consumption based upon an average of the per capita consumption for communities with available data.*

[k] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[l] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-9

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Water Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Hartford	0.731	N/A	0.68[h]	7,600	96	90[h]	1.370	0.500	0.870	7,600	180	114	0.53	0.79
Village of Slinger	0.197	0.104	0.093	1,300	152	72	0.153	0.030[i]	0.123	1,300	118	95	1.29	0.76
Allenton (Sanitary District No. 1)	0.130	N/A	.072[h]	800	163	90[h]	0.079	0.050	0.029	800	99	36	1.65	2.50
Subtotal	1.06		0.81	9,700			1.60		1.02	9,700	397	245	3.47	4.05
Subregional Area Average[j]					137	84					132	82	1.04	1.02
Weighted Average[k]					109	83					165	105	0.66	0.79

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Consumption based upon an average of the per capita consumption for communities with available data.*

[i] *Data obtained from Ruekert & Mielke, Inc., Infiltration/Inflow Analysis for the Village of Slinger, January 1977, p. 34.*

[j] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[k] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-10

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Oconomowoc	1.306	0.112	1.194	11,000	119	109	1.903	0.139	1.764	11,100	171	159	0.70	0.69
Village of Dousman	0.065	N/A	0.065	800	81	81	0.113	—	0.113	1,000	113	113	0.72	0.72
Village of Hartland	1.308	N/A	0.39[h]	4,300	304	90[h]	0.425	N/A	N/A	4,400	97	N/A	3.13	N/A
Subtotal	2.68		1.63	16,100			2.44		2.25	16,500	381	272	4.55	1.41
Subregional Area Average[i]					168	93					127	136	1.51	0.71
Weighted Average[j]					166	101					148	136	1.12	0.74

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Consumption based upon an average of the per capita consumption for communities with available data.*

[i] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[j] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Table D-11

WATER CONSUMPTION AND WASTEWATER FLOW RELATIONSHIPS IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Wastewater Treatment Plant Service Community	Water Consumption						Wastewater Flow						Ratio of Water Delivered to Wastewater Received (Based on Per Capita Relationship)	
	Water Delivered[a]			Estimated Service Area Population[c]	Per Capita Relationships		Wastewater Received			Estimated Service Area Population[g]	Per Capita Relationship			
	Total (mgd)	Metered Industrial (mgd)	Domestic[b] (mgd)		Total Water Delivered (gpcd)	Domestic Water Delivered (gpcd)	Total[d] (mgd)	Estimated Industrial[e] (mgd)	Domestic[f] (mgd)		Total Wastewater Received (gpcd)	Domestic Wastewater Received (gpcd)	Total Flow	Domestic Flow
City of Delevan	0.799	N/A	.522[i]	5,800	138	90[i]	0.590	0.115	0.475	5,800	126	106	1.10	0.85
City of Elkhorn	0.530	N/A	.387[i]	4,300	123	90[i]	0.690	0.037[h]	0.653	4,400	157	148	0.78	0.61
City of Whitewater	1.492	0.542	0.950	11,000	136	86	1.138	0.284	0.854	11,000	103	78	1.32	1.10
Village of Darien	0.074	N/A	0.074	1,000	74	74	0.137	0.004	0.133	1,000	137	133	0.54	0.56
Village of Fontana	0.334	N/A	0.162[i]	1,800	186	90[i]	0.520	N/A	N/A	1,800	289	N/A	0.64	N/A
Village of Sharon	N/A	N/A	0.117[i]	1,300	90	90[i]	0.082	—	0.082	1,400	59	59	1.53	1.53
Village of Walworth	0.243	0.084	0.159	1,700	143	94	0.200	N/A	N/A	1,700	118	N/A	1.21	N/A
Village of Willam's Bay	0.235	N/A	.153[i]	1,700	138	90[i]	0.196	N/A	N/A	1,700	115	N/A	1.20	N/A
Subtotal	3.70		2.52	28,600			3.55		2.20	28,800	1.104	524	8.32	4.65
Subregional Area Average[j]					128	88					138	105	0.93	.93
Weighted Average[k]					129	88					123	93.2	1.05	0.94

Note: N/A indicates data not available.

[a] *Unless otherwise noted, data obtained from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[b] *Includes residential, commercial, and public authority water users.*

[c] *1975 Wisconsin Department of Administration estimate adjusted to reflect civil division quarter sections not served by public water supply.*

[d] *Unless otherwise noted, from 1975 monthly reports submitted by the plant operating authorities to the Wisconsin Department of Natural Resources.*

[e] *Unless otherwise noted, data obtained from facilities plans or wastewater treatment plant operator's estimate.*

[f] *Unless otherwise noted, total wastewater received less industrial wastewater received.*

[g] *Estimated population based on 1975 approximations of existing service area by U.S. public land survey quarter sections.*

[h] *Data obtained from Donahue & Associates, Inc., Infiltration/Inflow Analysis for the City of Elkhorn, June 1976.*

[i] *Consumption based upon an average of the per capita consumption for communities with available data.*

[j] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

[k] *Average is calculated as the total daily water consumption or wastewater flow for the subregion divided by the corresponding population for the subregion.*

Source: SEWRPC.

Appendix E

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW BY SUBREGIONAL AREA: 1975

To assist in the formulation of sanitary wastewater flow system design criteria, including particularly the determination of per capita flows, inventories were conducted of industrial and commercial contribution to wastewater flow. The results of these inventories are presented in the following tables. These tables set forth those data utilized as a basis for the analysis and assumptions discussed in Chapter III of this report.

Table E-1

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
Milwaukee-Metropolitan Sewerage Commissions (Jones Island and South Shore plants)	84.35	21.69	1,018,900[d]	83	21
City of Muskego (Big Muskego and Northeast District plants)	N/A	N/A	10,200	N/A	N/A
City of South Milwaukee	N/A	0.08	23,400	N/A	3
Village of Germantown	0.10	0.02[e]	4,600	23	3
Village of Hales Corners	N/A	N/A	8,800	N/A	N/A
Village of Menomonee Falls (Pilgrim Road and Lilly Road plants)	0.69	0.26[e]	20,400	34	13
Village of Thiensville	N/A	N/A	4,200	N/A	N/A
Caddy Vista Sanitary District	–	–	1,000	–	–
Rawson Homes	N/A	N/A	600	N/A	N/A
Regal Manor	–	–	1,100	–	–
Total	85.14	22.05	1,093,200	140	40
Average[f]	–	–	–	28	7

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimates, unless otherwise noted.*

[b] *Commercial wastewater was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter section.*

[d] *From data provided in reports filed under Section NR101 of Wisconsin Administrative Code.*

[e] *Data obtained from Infiltration/Inflow Analysis, Metropolitan Sewerage District of the County of Milwaukee, Intercepting Sewer Project No. 813, J. C. Zimmerman, 1975.*

[f] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-2

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Cedarburg	0.25	0.13[d]	10,400	24	12
City of West Bend	1.00	0.37	21,000	48	18
Village of Fredonia	N/A	N/A	1,500	N/A	N/A
Village of Grafton	0.23[e]	N/A	8,800	26	N/A
Village of Jackson	0.02	0.02	2,000	10	10
Village of Kewaskum	0.19[f]	N/A	2,000	95	N/A
Village of Newburg	–[f]	N/A	600	–	N/A
Village of Saukville	0.05	0.01	2,300	22	4
Total	1.74	0.53	48,600	225	44
Average[g]	–	–	–	32	11

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimates, unless otherwise noted.*

[b] *Commercial wastewater was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *Data obtained from Infiltration/Inflow Analysis for the City of Cedarburg, R. W. Nicholson, 1975.*

[e] *Data obtained from Sanitary Infiltration/Inflow Analysis, Grafton, Wisconsin, Donohue & Associates, Inc., 1976.*

[f] *From data provided in reports filed under Section NR101 of Wisconsin Administration Code.*

[g] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-3

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Port Washington	0.08	0.17	9,500	9	18
Village of Belgium	–	N/A	900	–	N/A
Total	0.08	0.17	10,400	9	18
Average[d]	–	–	–	5	18

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimates, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-4

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Kenosha[d]	4.62	1.59	89,500	52	18
City of Racine[e]	6.40f	2.57	116,500	55	22
Village of Sturtevant	0.01	0.07	4,400	2	16
Town of Sommers (Utility District No. 2)	–	N/A	700	–	N/A
North Park Sanitary District	0.17	0.01	9,700	17	1
Pleasant Park Utility Company, Inc.	N/A	N/A	800	N/A	N/A
Total	11.20	4.24	221,600	126	57
Average[g]	–	–	–	25	14

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimate, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water comsumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *Kenosha includes Town of Pleasant Prairie, Town of Sommers, and Sommers Sanitary District No. 1.*

[e] *Racine includes North Bay, Village of Elmwood Park, Town of Mt. Pleasant, and South Lawn.*

[f] *Data obtained from Sewer System Evaluation, Phase I, Infiltration/Inflow Analysis, Racine Sewer Service Area, Donohue & Associates, Inc., January 1975.*

[g] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-5

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
Village of Union Grove	–[d]	0.06	3,200	–	20
Total	–	0.06	3,200	–	20
Average[e]	–	–	–	–	20

[a] *Wastewater Treatment plant operator's estimate, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Population estimates based on 1975 sewered quarter sections.*

[d] *From data provided in reports filed under Section NR101 of the Wisconsin Administrative Code.*

[e] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-6

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
Village of Paddock Lake	–	N/A	1,900	–	N/A
Town of Bristol	–	N/A	800	–	N/A
Town of Pleasant Prairie (Sewer Utility District 73-1)	N/A	N/A	100	N/A	N/A
Town of Pleasant Prairie (Sewer Utility District D)	–	N/A	1,000	–	N/A
Town of Salem	–	N/A	1,000	–	N/A
Total	–	N/A	4,800	–	N/A
Average[d]	–	–	–	–	N/A

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimates, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annaul reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Population estimates based on sewered quarter sections.*

[d] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

SOURCE: SEWRPC.

Table E-7

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Brookfield	–	N/A	16,900	–	N/A
City of Waukesha	2.32	0.91	51,300	45	18
Village of Pewaukee	0.11	0.11	4,800	22	23
Village of Sussex	–	N/A	4,000	–	N/A
Total	2.43	1.02	77,000	67	41
Average[d]	–	–	–	17	21

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimates, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-8

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Burlington	0.14[d]	N/A	10,800	13	N/A
City of Lake Geneva	–	N/A	5,700	–	N/A
Village of East Troy	–	N/A	2,200	–	N/A
Village of Genoa City	–	N/A	1,100	–	N/A
Village of Mukwonago	0.01[e]	N/A	3,400	3	N/A
Village of Silver Lake	–	N/A	1,300	–	N/A
Village of Twin Lakes	–	N/A	3,400	–	N/A
Western Racine County Sewerage District	–	0.03[f]	3,400	–	10
Total	0.15	0.03	31,300	16	10
Average[g]	–	–	–	2	10

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimate, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *From data provided in reports filed under Section NR101 of the Wisconsin Administrative Code.*

[e] *Data obtained from Infiltration/Inflow Analysis for the Village of Mukwonago, Ruekert and Mielke, Inc., September 1976.*

[f] *Western Racine County Sanitary Commission Infiltration/Inflow Analysis, Donohue & Associates, Inc., September 1976.*

[g] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-9

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Hartford	0.50	N/A	7,600	66	N/A
Village of Slinger	0.03[d]	0.02	1,300	23	18
Allenton (Sanitary District No. 1)	0.05	N/A	800	63	N/A
Total	0.58	0.02	9,700	152	18
Average[e]	–	–	–	51	18

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimate, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *Data obtained from Infiltration/Inflow Analysis for the Village of Slinger, Ruekert and Mielke, Inc., January 1977.*

[e] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table E-10

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Oconomowoc	0.14[d]	0.40	11,100	13	36
Village of Dousman	–	0.01[e]	1,000	–	9
Village of Hartland	N/A	N/A	4,400	N/A	N/A
Total	0.14	0.41	16,500	13	45
Average[f]	–	–	–	7	23

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimate, unless otherwise noted.*

[b] *Comercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *From data provided in reports filed under Section NR101 of the Wisconsin Administrative Code.*

[e] *Data obtained from Infiltration/Inflow Analysis of the Village of Dousman, Ruekert and Mielke, Inc., July 1977.*

[f] *Average is calculated as the mean value of the individual community treatment plant or water system values.*

Source: SEWRPC.

Table E-11

INDUSTRIAL AND COMMERCIAL CONTRIBUTION TO WASTEWATER FLOW IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Community	Estimated Wastewater Flow (million gallons/day)		Estimated Service Area Population[c]	Average Wastewater Flow Rate (gallons/capita/day)	
	Industrial[a]	Commercial[b]		Industrial	Commercial
City of Delavan	0.11[d]	0.09[e]	5,800	20	15
City of Elkhorn	0.04[f]	0.07[g]	4,400	8	17
City of Whitewater	0.28[d]	0.25	11,000	26	22
Village of Darien	0.01	N/A	1,000	4	N/A
Village of Fontana	N/A	N/A	1,800	N/A	N/A
Village of Sharon	–	N/A	1,400	–	N/A
Village of Walworth	N/A	0.03[h]	1,700	N/A	18
Village of William's Bay	N/A	0.06	1,700	N/A	34
Total	0.44	0.50	28,800	58	106
Average[i]	–	–	–	12	21

NOTE: N/A indicates data not available.

[a] *Wastewater treatment plant operator's estimate, unless otherwise noted.*

[b] *Commercial wastewater flow was assumed equal to metered commercial water consumption as determined from 1975 annual reports submitted by the water utilities to the Wisconsin Public Service Commission.*

[c] *Estimated population based on 1975 sewered quarter sections.*

[d] *From data provided in reports filed under Section NR101 of the Wisconsin Administrative Code.*

[e] *Data obtained from Infiltration/Inflow Analysis for the City of Delavan, Jensen & Johnson, Inc., June 1976.*

[f] *Data obtained from Infiltration/Inflow Analysis for the City of Elkhorn, Jensen & Johnson, Inc., June 1976.*

[g] *Data obtained from City of Elkhorn, Project No. 75-114, Infiltration/Inflow Analysis, Jensen & Johnson, Inc., June 1976.*

[h] *Data obtained from Infiltration/Inflow Analysis for the Village of Walworth, Jensen & Johnson, Inc., p. 17, September 1976.*

[i] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Appendix F

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW BY SUBREGIONAL AREA: 1975

To assist in the formulation of sanitary wastewater flow system design criteria, including particularly the determination of per capita flows, inventories were conducted of the groundwater infiltration contribution to wastewater flow. The results of these inventories are presented in the following tables. These tables set forth those data utilized as a basis for the analyses and assumptions discussed in Chapter III of this report.

Table F-1

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
Jones Island and South Shore Plants	57.000[c]	1,018,900	56
City of Muskego (Two Plants)	N/A	10,200	N/A
City of South Milwaukee	0.469	23,400	20
Village of Germantown	0.567	4,600	123
Village of Hales Corners	0.426[c]	8,800	48
Village of Menomonee Falls (Two Plants)	1.048	20,400	51
Village of Thiensville	0.581[c]	4,200	138
Caddy Vista Sanitary District	0.010	1,000	10
Rawson Homes	N/A	600	N/A
Regal Manors	N/A	1,100	N/A
Total	60.101	1,093,200	446
Average[d]	–	–	64

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Milwaukee Metropolitan Sewerage District of the County of Milwaukee, Facilities Plan—Pollution Abatement Facilities in the Service of the Metropolitan Sewerage District, November 1976.*

[d] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Table F-2

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Cedarburg	1.189[c]	10,400	114
City of West Bend	2.97 [d]	21,000	141
Village of Fredonia	N/A	1,500	N/A
Village of Grafton	0.850[e]	8,800	97
Village of Jackson	0.191[f]	2,000	96
Village of Kewaskum	0.141	2,000	71
Village of Newburg	N/A	600	N/A
Village of Saukville	0.131[g]	2,300	57
Total	5.472	48,600	576
Average[h]	–	–	96

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Infiltration/Inflow Analysis for City of Cedarburg, Wisconsin, R. W. Nicholson, 1975, p. 20.*

[d] *Data obtained from Donohue & Associates, Inc., Sanitary Sewer System Infiltration/Inflow Analysis, West Bend, Wisconsin, 1974, p. 23.*

[e] *Data obtained from Donohue & Associates, Inc., Sanitary Sewer System Infiltration/Inflow Analysis—Grafton, Wisconsin, 1976.*

[f] *Data obtained from Valentine & Associates, Inc., Engineer's Report on Infiltration/Inflow Analysis—Jackson, Wisconsin, 1976.*

[g] *Data obtained from Ruekert & Mielke Inc., Infiltration/Inflow Analysis for the Village of Saukville, Wisconsin, 1974.*

[h] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table F-3

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Port Washington	2.261[c]	9,500	239[c]
Village of Belgium	N/A	900	N/A
Total	2.261	10,400	239
Average[d]	–	–	239

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Donohue & Associates, Inc., Infiltration/Inflow Analysis for the City of Port Washington, October 1974, p. 43.*

[d] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table F-4

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Kenosha[c]	5.100[d]	89,500	57
City of Racine[e]	9.050[f]	116,500	78
Village of Sturtevant	0.668[f]	4,400	152
Town of Somers (Utility District No. 2)	N/A	700	N/A
Worth Park (Sanitary District)	N/A	9,700	N/A
Pleasant Park Utility County, Inc.	N/A	800	N/A
Total	14.818	221,600	287
Average[g]	–	–	96

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *The City of Kenosha includes the Town of Pleasant Prairie, Town of Somers, Utility District No. 1 and Town of Somers Sanitary District No. 1.*

[d] *Data obtained from American Consulting Services, Infiltration/Inflow Analysis for Kenosha, 1975, p. 38.*

[e] *The City of Racine includes the Village of North Bay, Village of Elmwood Park, Town of Mt. Pleasant, South Lawn Sanitary District, and Caledonia Sewer Utility District No. 1.*

[f] *Data obtained from Jensen & Johnson, Inc., Wastewater Conveyance Facilities Plan for the Village of Sturtevant, 1976, p. 28.*

[g] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table F-5

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
Village of Union Grove	0.300[c]	3,200	94
Total	0.300	3,200	94
Average[d]	–	–	94

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Robers & Boyd, Inc., Village of Union Grove Infiltration/Inflow Analysis, 1975, p. 7.*

[d] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table F-6

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
Village of Paddock Lake	0.1887	1,900	99
Town of Bristol	N/A	800	N/A
Town of Pleasant Prairie (Sewer Utility District 73-1)	N/A	100	N/A
Town of Pleasant Prairie (Sewer Utility District D)	N/A	1,000	N/A
Town of Salem (Sewer Utility District No. 1)	N/A	1,000	N/A
Total	0.1887	4,800	99
Average[c]	–	–	99

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Average is calculated as the mean value of the individual community treatment plant or water systerm per capita values.*

Source: SEWRPC.

Table F-7

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Brookfield	N/A	16,900	N/A
City of Waukesha	1.52 [c]	51,300	30
Village of Pewaukee	N/A	4,800	N/A
Village of Sussex	0.950[d]	4,000	238
Total	2.47	77,000	268
Average[e]	–	–	134

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Graef-Anhalt-Schloemer & Associates, Inc., Infiltration/Inflow Analysis and Report, Village of Sussex, January 1974, p. 3 of Supplement.*

[d] *Data obtained from Graef-Anhalt-Schloemer & Associates, Inc., Environmental Assessment for Additions to Water Pollution Control Facilities and Wastewater Collection System, May 1974.*

[e] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table F-8

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Burlington	0.4352	10,800[c]	40
City of Lake Geneva	0.180 [d]	5,700	32
Village of East Troy	N/A	2,200	N/A
Village of Genoa City	0.0238	1,100	22
Village of Mukwonago	0.2467[c]	3,400	73
Village of Silver Lake	N/A	1,300	N/A
Village of Twin Lakes	N/A	3,400	N/A
Western Racine County Sewerage District	0.0767[e]	3,400	23
Total	0.962	31,300	190
Average[f]	–	–	38

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Includes Browns Lake Sanitary District.*

[d] *Data obtained from Donohue & Associates, Inc., City of Lake Geneva Infiltration/Inflow Analysis, June 1976, p. 19.*

[e] *Data obtained from Donohue & Associates, Inc., Western Racine County Sanitary Commission Infiltration/Inflow Analysis, September 1976, p. 30.*

[f] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table F-9

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Hartford	1.0658	7,600	140
Village of Slinger	0.300 [c]	1,300	231
Allenton (Sanitary District No. 1)	N/A	800	N/A
Total	1.366	9,700	371
Average[d]	–	–	186

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Ruekert & Mielke, Inc., Infiltration/Inflow Analysis for the Village of Slinger, January 1977, p. 33.*

[d] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Table F-10

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Oconomowoc	N/A	11,100	N/A
Village of Dousman	0.050[c]	1,000	50
Village of Hartland	N/A	4,400	N/A
Total	0.05	16,500	50
Average[d]	–	–	50

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Ruekert & Mielke, Inc., Infiltration/Inflow Analysis for the Village of Dousman, July 1977, p. 27.*

[d] *Average is calculated as the mean value of the individual treatment plant or water system per capita values.*

Soruce: SEWRPC.

Table F-11

GROUNDWATER INFILTRATION CONTRIBUTION TO WASTEWATER FLOW IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Community	Infiltration Flow Rate (mgd)[a]	Estimated Service Area Population[b]	Estimated Per Capita Infiltration Rate (gpcd)
City of Delevan	0.0890[c]	5,800	15[c]
City of Elkhorn	0.185 [d]	4,400	45[d]
City of Whitewater	0.165 [e]	11,000	15
Village of Darien	N/A	1,000	N/A
Village of Fontana	N/A	1,800	N/A
Village of Sharon	N/A	1,400	N/A
Village of Walworth	–	1,700	–
Village of William's Bay	N/A	1,700	N/A
Total	0.439	28,800	75
Average[f]	–	–	19

NOTE: N/A indicates data not available.

[a] *May 1975 wastewater flow - theoretical May base wastewater flow; the May wastewater flow was selected based on a review of meteorologic records which indicated that May was the minimum rainfall month in 1975 in which groundwater levels would be expected to be high. The theoretical base wastewater flow was computed using the May water pumpage less industrial waters which are discharged to storm sewers, and then reduced by a factor of 0.10 to account for losses in the distribution system, internal uses (hydrant flushing), and water service areas not served by sanitary sewers, unless otherwise noted.*

[b] *Estimated population based on 1975 sewered quarter sections.*

[c] *Data obtained from Jenson & Johnson, Inc., Infiltration/Inflow Analysis for the City of Delevan, June 1976, p. 26.*

[d] *Data obtained from Jenson & Johnson, Inc., Infiltration/Inflow Analysis for the City of Elkhorn, June 1976, p. 18.*

[e] *Data obtained from Robinson & Associates, Infiltration/Inflow Analysis of the City of Whitewater, June 1976.*

[f] *Average is calculated as the mean value of the individual community treatment plant or water system per capita values.*

Source: SEWRPC.

Appendix G

INFLOW CONTRIBUTION TO WASTEWATER FLOW BY SUBREGIONAL AREA: 1975

To assist in the formulation of sanitary wastewater flow system design criteria, including particularly the determination of per capita flows, inventories were conducted of the inflow contribution to wastewater flow. The results of these inventories are presented in the following tables. These tables set forth those data utilized as a basis for the analyses and assumptions discussed in Chapter III of this report.

Table G-1

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE MILWAUKEE METROPOLITAN SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
Milwaukee-Metropolitan Sewerage Commissions (Jones Island and South Shore Plants)	410.00[b]	1,018,900	402
City of Muskego (Big Muskego and Northeast District Plants)	N/A	10,200	N/A
City of South Milwaukee	N/A	23,400	N/A
Village of Germantown	0.57[c]	4,600	123
Village of Hales Corners	N/A	8,800	N/A
Village of Menomonee Falls (Pilgrim Road and Lilly Road Plants)	5.71[c]	20,400	280
Village of Thiensville	N/A	4,200	41
Caddy Vista Sanitary District	0.04	1,000	N/A
Rawson Homes	N/A	600	N/A
Regal Manor	0.04	1,100	40
Total	416.36	1,093,200	886
Average[d]	–	–	177

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from Metropolitan Sewerage District of the County of Milwaukee, Facilities Plan, Pollution Abatement Facilities in The Service Area of The Metropolitan Sewerage District, November 1976.*

[c] *Data obtained from Metropolitan Sewerage District report, Intercepting Sewer Project No. 813 Infiltration and Inflow Analysis, by J. C. Zimmerman Engineering Corporation, December 1975.*

[d] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-2

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER MILWAUKEE RIVER SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Cedarburg	3.22[b]	10,400	310
City of West Bend	0.50[c]	21,000	24
Village of Fredonia	0.14	1,500	95
Village of Grafton	1.13	8,800	128
Village of Jackson	0.01[d]	2,000	6
Village of Kewaskum	0.01	2,000	6
Village of Newburg	N/A	600	N/A
Village of Saukville	less than 0.01[e]	2,300	–
Total	5.00	48,600	569
Average[f]	–	–	81

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from City of Cedarburg report, Infiltration/Inflow Analyses for the City of Cedarburg, Wisconsin, R. W. Nicholson Consulting Engineer, 1975.*

[c] *Data obtained from City of West Bend report, Sanitary Sewer System Infiltration/Inflow Analysis, West Bend, Wisconsin, Donohue & Associates, Inc., 1974.*

[d] *Data obtained from Village of Jackson report, Engineers Report on Infiltration/Inflow Analyses, Jackson, Wisconsin, Valentine and Associates, Inc., 1976.*

[e] *Data based upon generalized calculation as noted in footnote a, subsequent local facilities planning has indicated that excessive infiltration and inflow exists.*

[f] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-3

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE SAUK CREEK SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Port Washington	2.46[b]	9,500	259
Village of Belgium	N/A	900	N/A
Total	2.46	10,400	259
Average[c]	–	–	259

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from City of Port Washington report, Infiltration/Inflow Analysis, Port Washington, Wisconsin, Donohue & Associates, Inc. 1974.*

[c] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-4

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE KENOSHA-RACINE SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Kenosha	26.90[b]	89,500	301
City of Racine	44.40[c]	116,500	381
Village of Sturtevant	1.35[c]	4,400	307
Town of Somers Sewer Utility District No. 2	N/A	700	N/A
North Park Sanitary District	N/A	9,300	N/A
Pleasant Park Utility Company, Inc.	N/A	800	N/A
Total	72.65	221,600	989
Average[d]	–	–	330

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from City of Kenosha report, Infiltration/Inflow Analysis, Kenosha, Wisconsin, American Consulting Services, 1975.*

[c] *Data obtained from Village of Sturtevant report, Wastewater Conveyance Facilities Plan for the Village of Sturtevant, Jensen & Johnson, Inc. 1976.*

[d] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-5

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE ROOT RIVER CANAL SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
Village of Union Grove	0.63[b]	3,200	198
Total	0.63	3,200	198
Average[c]	–	–	198

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from Village of Union Grove report, Infiltration/Inflow Analyses, Robers & Boyd, Inc., 1975.*

[c] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-6

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE DES PLAINES RIVER SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
Village of Paddock Lake	0.17	1,900	89
Town of Bristol	N/A	800	N/A
Town of Pleasant Prairie Sewer Utility District No. 73-1	N/A	100	N/A
Town of Pleasant Prairie Sewer Utility District D	N/A	1,000	N/A
Town of Salem Sewer Utility District No. 1	N/A	1,000	N/A
Total	0.17	4,800	89
Average[b]	–	–	89

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-7

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER FOX RIVER SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Brookfield	N/A	16,200	N/A
City of Waukesha	0.08[b]	51,300	2
Village of Pewaukee	0.05	4,800	10
Village of Sussex	0.25[c]	4,000	63
Total	0.38	76,300	75
Average[d]	-	-	25

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from City of Waukesha report, Environmental Assessment Report for Additions to the Sewerage Treatment Plant, Waukesha, Wisconsin, ?????????? Burdick and Howson, 1975.*

[c] *Data obtained from Village of Sussex report, Infiltration/Inflow Analysis and Report, Graef Anhalt-Schloener & Associates, Inc., January 1974.*

[d] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC

Table G-8

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE LOWER FOX RIVER SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Burlington	0.37	10,800	34
City of Lake Geneva	1.18 [b]	5,700	207
Village of East Troy	N/A	2,200	N/A
Village of Genoa City	0.003	1,100	3
Village of Mukwonago	0.38 [c]	3,400	112
Village of Silver Lake	N/A	1,300	N/A
Village of Twin Lakes	N/A	3,400	N/A
Western Racine County Sewerage District	0.08 [d]	3,400	24
Total	1.633	31,300	380
Average[e]	-	-	76

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from City of Lake Geneva report, Infiltration and Inflow Analyses, Donohue & Associates, June 1976.*

[c] *Data obtained from Village of Mukwonago report, Infiltration/Inflow Analysis for the Village of Mukwonago, Ruekert and Mielke Inc., September 1976.*

[d] *Data obtained from Western Racine County Sewerage District report, Infiltration/Inflow Analysis, Donohue & Associates, Inc., September 1976.*

[e] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-9

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE UPPER ROCK RIVER SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Hartford	1.31	7,600	172
Village of Slinger	0.05[b]	1,300	38
Allenton Sanitary District No. 1	N/A	800	N/A
Total	1.36	9,700	210
Average[c]	-	-	105

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from Village of Slinger report, Infiltration/Inflow Analysis, Ruekert and Mielke, Inc., January 1977.*

[c] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-10

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE MIDDLE ROCK RIVER SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Oconomowoc	N/A	11,100	N/A
Village of Dousman	0.05[b]	1,000	47
Village of Hartland	N/A	4,400	N/A
Total	0.05	16,500	47
Average[c]	-	-	47

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from Village of Dousman report, Infiltration-Inflow Analysis, Ruekert and Mielke, Inc., July 1977.*

[c] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Table G-11

STORM WATER INFLOW CONTRIBUTION TO WASTEWATER FLOW IN THE LOWER ROCK RIVER SUBREGIONAL AREA: 1975

Community	Storm Water Inflow Flow Rate (mgd)[a]	Estimated Sewer Service Area Population	Estimated Per Capita Inflow Rate (gpcd)
City of Delevan	0.16[b]	5,800	27
City of Elkhorn	0.25[c]	4,400	62
City of Whitewater	1.01[d]	11,000	92
Village of Darien	N/A	1,000	N/A
Village of Fontana	N/A	1,800	N/A
Village of Sharon	N/A	1,400	N/A
Village of Walworth	N/A	1,700	N/A
Village of William's Bay	N/A	1,700	N/A
Total	1.42	28,800	181
Average[e]	–	–	45

NOTE: N/A indicates data not available.

[a] *Unless specific data are available from local studies, this value is estimated as the peak daily wastewater flow rate during August 1975 less the theoretical base wastewater flow for August 1975. The month of August was selected based upon a review of meteorologic records which indicated that August was the maximum precipitation month in 1975, and because the water table is generally low in the late summer-early fall months and, therefore, groundwater infiltration during the month of August was assumed to be a relatively small portion of total flow. The theoretical base wastewater flow was computed using the August 1975 water pumpage less industrial waters which are discharged to storm sewers and less a 10 percent factor to account for losses in the water distribution system, internal uses, and water service areas not served by sanitary sewers.*

[b] *Data obtained from City of Delevan report, Infiltration/Inflow Analysis for the City of Delevan, Jensen & Johnson, Inc., June 1976.*

[c] *Data obtained from City of Elkhorn report, Infiltration/Inflow Analysis for the City of Elkhorn, Jenson & Johnson , Inc., June 1976.*

[d] *Data obtained from City of Whitewater report, Infiltration/Inflow Analysis for the City of Whitewater, Robenson & Associate, Inc., June 1976.*

[e] *Average is calculated as the mean value of the individual community per capita values.*

Source: SEWRPC.

Appendix H

WASTEWATER STRENGTH PARAMETERS BY SUBREGIONAL AREA

Table H-1

WASTEWATER STRENGTH PARAMETERS: MILWAUKEE METROPOLITAN SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]												
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen		
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
Milwaukee-Metropolitan Sewerage Commissions												
Jones Island Plant	209	231	426	0.743	377	0.658	6.5[b]	N/A	–	–	–	–
South Shore Plant	209	267	308	0.537	437	0.762	–	N/A	–	–	–	–
City of Muskego												
Big Muskego Plant	127	137	110	0.083	122	0.092	24.7[d]	0.019	–	–	–	–
Northeast Plant	53	133	153	0.115	136	0.102	8.7[c]	0.007	–	–	–	–
City of South Milwaukee	114	151	161	0.153	166	0.158	5.6[e]	0.005	10.5[e]	0.010	15.0[e]	0.014
Village of Germantown	174	231	29	0.042	28	0.041	12.9[f]	0.019	10.9[f]	0.016	12.4[f]	0.018
Village of Hales Corners	59	78	174	0.085	174	0.085	7.1[g]	0.003	8.1[g]	0.004	15.0[g]	0.007
Village of Menomonee Falls[k]												
Lilly Road Plant	106	139	99	0.088	247	0.219	5.5[e]	0.005	6.9[e]	0.006	11.0[e]	0.009
Pilgrim Road Plant	107	137	71	0.063	146	0.130	4.9[e]		3.4[e]	0.003	10.0[e]	
Village of Thiensville	136	243	70	0.079	82	0.093	4.8[h]	0.005	10.1[i]	0.011	10.3[i]	0.012
Caddy Vista Sanitary District	86	122	215	0.154	163	0.117	–	–	–	–	–	–
Rawson Homes	–	–	–	–	–	–	–	–	–	–	–	–
Regal Manors	112	116	209	0.195	160	0.149	–	–	–	–	–	–
Total	1,492	1,985	2,025	2.337	2,238	2.606	80.7		49.9	0.050	73.7	0.060
Average[l]	124	165	169	0.195	186	0.217	9.0	0.010	8.3	0.008	12.3	0.012

NOTE: N/A indicates data not available.

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1976 24-hour survey by the Wisconsin Department of Natural Resources*

[c] *Data obtained from a 1973 survey by the Wisconsin Department of Natural Resources.*

[d] *Data obtained from a 1975 two-month average.*

[e] *Data obtained from a 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[f] *Data obtained from a September 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[g] *Data obtained from a 1976 three-hour survey by the Wisconsin Department of Natural Resources.*

[h] *Data obtained from a 1973 eight-month average.*

[i] *Data obtained from a 1974 24-hour survey by the Wisconsin Department of Natural Resources.*

[j] *The estimation of the population served by the Jones Island plant and the South Shore plant is proportioned on the basis of the average annual flow into each plant.*

[k] *The estimation of the population served by the Pilgrim Road plant and the Lilly Road plant is proportional on the basis of the average annual flow into each plant.*

[l] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-2

WASTEWATER STRENGTH PARAMETERS: UPPER MILWAUKEE RIVER SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Cedarburg	136	202	121	0.137	154	0.174	4.0[b]	0.005	7.6[b]	0.009	7.4[b]	0.008
City of West Bend	176	200	106	0.156	259	0.381	12.8[e]	0.019	11.0[c]	0.016	10.0[e]	0.015
Village of Fredonia	183	245	132	0.202	141	0.216	9.0[d]	0.014	12.9[d]	0.020	–	–
Village of Grafton	100	119	138	0.115	258	0.216	15.6[b]	0.013	9.8[b]	0.008	16.7[b]	0.014
Village of Jackson	130	140	–	–	–	–	–	–	–	–	–	–
Village of Kewaskum	159	236	362	0.480	454	0.602	20.7[b]	0.027	19.0[b]	0.025	17.0[b]	0.023
Village of Newburg	120	–	246	0.246	372	0.372	7.6[b]	0.008	4.8[b]	0.005	24.4[b]	0.024
Village of Saukville	125	185	129	0.134	139	0.145	5.7[e]	0.006	5.4[e]	0.006	15.0[e]	0.016
Total	1,129	1,327	1,234	1.470	1,777	2.106	75.4	0.092	70.5	0.089	90.5	0.100
Average[f]	141	190	176	0.210	254	0.301	10.8	0.013	10.1	0.013	15.1	0.017

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1974 24-hour survey by the Wisconsin Department of Natural Resources.*

[c] *Data obtained from a September 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[d] *Data obtained from a 1971 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from a 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[f] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-3

WASTEWATER STRENGTH PARAMETERS: SAUK CREEK SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Port Washington	179	222	123	0.183	170	0.253	6.9[b]	0.010	11.2[c]	0.017	12.6[c]	0.019
Village of Belgium	78	116	209	0.136	205	0.133	11.5[d]	0.007	5.5[d]	0.004	20.0[d]	0.013
Total	257	338	332	0.319	375	0.386	18.4	0.017	16.7	0.021	32.6	0.032
Average[e]	128	169	166	0.160	188	0.193	9.2	0.009	8.4	0.010	16.3	0.016

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1973 three-month average.*

[c] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[d] *Data obtained from a 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-4

WASTEWATER STRENGTH PARAMETERS: KENOSHA-RACINE SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Kenosha[e]	206	232	117	0.201	203	0.348	6.1[b]	0.010	1.0[b]	0.002	9.8[b]	0.017
City of Racine[f]	169	212	99	0.140	121	0.171	6.8[b]	0.010	9.4[b]	0.013	13.0[b]	0.018
Village of Sturtevant	120	188	139	0.140	146	0.147	6.2[c]	0.006	11.6[d]	0.012	31.6[d]	0.032
Town of Somers												
Utility District No. 2	87	134	209	0.152	164	0.119	--	--	--	--	--	--
North Park Sewer Utility	116	134	97	0.094	179	0.174	7.0	0.007	14.9	0.014	18.0	0.017
Pleasant Park Sewer Utility	--	--	--	--	--	--	--	--	--	--	--	--
Total	698	900	661	0.727	813	0.959	26.1	0.033	36.9	0.041	72.4	0.084
Average[g]	140	180	132	0.145	163	0.192	6.5	0.008	9.2	0.010	18.1	0.021

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1976 24-hour survey by the Wisconsin Department of Natural Resources.*

[c] *Data obtained from a 1974 two-month average.*

[d] *Data obtained from a 1966 24-hour survey by the Wisconsin Department of Natural Resources.*

[e] *Kenosha includes: Town of Somers Utility District No. 1; Town of Somers Sanitary District No. 1.*

[f] *Racine includes: Village of North Bay, Village of Elmwood Park, Town of Mt. Pleasant, Southlawn, and Town of Caledonia Sewer Utility District No. 1.*

[g] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-5

WASTEWATER STRENGTH PARAMETERS: ROOT RIVER CANAL SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
Village of Union Grove	134	184	212	0.236	203	0.226	6.1[b]	0.007	12.0[b]	0.013	12.0[b]	0.013

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1976 24-hour survey by the Wisconsin Department of Natural Resources.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-6

WASTEWATER STRENGTH PARAMETERS: DES PLAINES RIVER SUBREGIONAL AREA

	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
Public Treatment Facility	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
Village of Paddock Lake	89	189	97	0.072	201	0.150	–	–	–	–	–	–
Town of Bristol	89	144	148	0.110	123	0.091	–	–	–	–	–	–
Town of Pleasant Prairie Sewer Utility District 73-1	–	–	–	–	–	–	–	–	–	–	–	–
Town of Pleasant Prairie Sewer Utility District D	102	169	124	0.105	–	–	–	–	–	–	–	–
Town of Salem Sewer Utility District No. 1	79	129	118	0.078	157	0.103	–	–	–	–	–	–
Total	359	631	487	0.365	481	0.344	–	–	–	–	–	–
Average[b]	90	158	122	0.091	160	0.115	–	–	–	–	–	–

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-7

WASTEWATER STRENGTH PARAMETERS: UPPER FOX RIVER SUBREGIONAL AREA

	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
Public Treatment Facility	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Brookfield	147	231	110	0.135	195	0.239	6.4[b]	0.008	1.3[b]	0.002	1.5[b]	0.002
City of Waukesha	193	234	162	0.261	153	0.246	7.7[c]	0.012	6.5[c]	0.010	9.3[c]	0.015
Village of Pewaukee	63	94	203	0.107	276	0.146	13.1[c]	0.007	14.8[c]	0.008	17.5[c]	0.009
Village of Sussex	118	155	142	0.140	191	0.188	9.9[c]	0.010	11.1[c]	0.011	22.5[c]	0.022
Total	521	714	617	0.643	815	0.819	37.1	0.037	33.7	0.031	50.8	0.048
Average[d]	130	178	154	0.161	204	0.205	9.3	0.009	8.4	0.008	12.7	0.012

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1976 24-hour survey by the Wisconsin Department of Natural Resources.*

[c] *Data obtained from a 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[d] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-8

WASTEWATER STRENGTH PARAMETERS: LOWER FOX RIVER SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Burlington	137	162	213	0.243	142	0.162	8.2[b]	0.009	11.5[b]	0.013	12.5[b]	0.014
City of Lake Geneva	129	153	127	0.137	149	0.161	10.3[e]	0.011	–	–	–	–
Village of East Troy	112	124	105	0.098	64	0.060	12.0[d]	0.011	–	–	–	–
Village of Genoa City	65	86	132	0.071	110	0.059	–	–	–	–	–	–
Village of Mukwonago	128	163	121	0.129	127	0.136	6.4[e]	0.007	9.8[e]	0.010	15.0[e]	0.016
Village of Silver Lake	115	138	47	0.045	74	0.071	17.8[f]	0.017	9.0[f]	0.009	39.0[f]	0.038
Village of Twin Lakes	121	144	137	0.138	293	0.295	8.9[g]	0.009	9.0[g]	0.009	18.0[g]	0.018
Western Racine County Sewerage District[i]	72	91	162	0.097	198	0.119	5.6[h]	0.003	13.0[h]	0.008	14.0[h]	0.008
Total	879	1,061	1,044	0.958	1,157	1.063	69.2	0.067	52.3	0.049	98.5	0.094
Average[j]	110	133	131	0.121	145	0.133	9.9	0.010	10.5	0.010	19.7	0.019

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1976 24-hour survey by the Wisconsin Department of Natural Resources.*

[c] *Data obtained from a 1970 24-hour survey by the Wisconsin Department of Natural Resources.*

[d] *Data obtained from a 1976 survey by the Wisconsin Department of Natural Resources.*

[e] *Data obtained from a 1975 survey by the Wisconsin Department of Natural Resources.*

[f] *Data obtained from a 1975 three-hour survey by the Wisconsin Department of Natural Resources.*

[g] *Data obtained from a 1975 24-hour survey by the Wisconsin Department of Natural Resources.*

[h] *Data obtained from a 1976 24-hour survey by the Wisconsin Department of Natural Resources.*

[i] *Includes Village of Waterford, Village of Rochester, and Town of Rochester Sewer Utility District No. 1.*

[j] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-9

WASTEWATER STRENGTH PARAMETERS: UPPER ROCK RIVER SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Hartford	180	237	190	0.286	246	0.370	–	–	–	–	–	–
Village of Slinger	118	226	127	0.125	169	0.166	12.5[b]	0.012	–	–	–	–
Allenton Sanitary District No. 1	99	138	424	0.349	479	0.394	–	–	–	–	–	–
Total	397	601	741	0.760	894	0.930	12.5	0.012	–	–	–	–
Average[c]	132	200	247	0.253	298	0.310	12.5	0.012	–	–	–	–

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[c] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-10

WASTEWATER STRENGTH PARAMETERS: MIDDLE ROCK RIVER SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Oconomowoc	171	210	232	0.332	180	0.257	6.0[b]	0.009	–	–	–	–
Village of Dousman	113	129	94	0.089	135	0.127	29.6[c]	0.028	15.8[c]	0.015	8.7[c]	0.008
Village of Hartland	97	113	95	0.077	157	0.126	8.7[d]	0.007	9.0[d]	0.007	24.0[d]	0.019
Total	381	452	421	0.498	472	0.510	44.3	0.044	24.8	0.022	32.7	0.027
Average[e]	127	151	140	0.166	157	0.170	14.8	0.015	12.4	0.011	16.4	0.013

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[c] *Data obtained from a 1973 three-hour survey by the Wisconsin Department of Natural Resources.*

[d] *Data obtained from a 1977 three-hour survey by the Wisconsin Department of Natural Resources*

[e] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table H-11

WASTEWATER STRENGTH PARAMETERS: LOWER ROCK RIVER SUBREGIONAL AREA

Public Treatment Facility	Average Wastewater Strength in Influent Wastewater[a]											
	Average Hydraulic Loading		BOD_5		Suspended Solids		Total Phosphorus		Organic Nitrogen		Ammonia-Nitrogen	
	Average Annual (gpcd)	Maximum Monthly (gpcd)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)	Average Annual (mg/l)	Average Annual (pounds/capita/day)
City of Delavan	102	157	101	0.086	160	0.137	–	–	–	–	–	–
City of Elkhorn	157	311	139	0.182	104	0.136	–	–	–	–	–	–
City of Whitewater	103	134	461	0.398	281	0.242	21.5[b]	0.019	31.7[b]	0.027	32.0[b]	0.028
Village of Darien	137	185	122	0.139	119	0.136	–	–	–	–	–	–
Village of Fontana	289	–	11	0.027	10	0.024	–	–	–	–	–	–
Village of Sharon	59	91	73	0.036	54	0.026	–	–	–	–	–	–
Village of Walworth	118	–	159	0.156	151	0.148	13.5[c]	0.013	7.8[c]	0.008	8.0[c]	0.008
Village of William's Bay	115	118	32	0.031	5	0.005	–	–	–	–	–	–
Total	1,080	996	1,098	1.055	884	0.854	35.0	0.032	39.5	0.035	40.0	0.036
Average[d]	135	166	137	0.130	110	0.106	17.5	0.016	19.8	0.018	20.0	0.018

[a] *Average and maximum monthly values reported to the Wisconsin Department of Natural Resources during 1975 are indicated unless otherwise noted.*

[b] *Data obtained from a 1972 24-hour survey by the Wisconsin Department of Natural Resources.*

[c] *Data obtained from a 1969 24-hour survey by the Wisconsin Department of Natural Resources.*

[d] *Average is calculated as the mean value of the individual treatment plant values.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Appendix I

SELECTED STORM WATER DRAINAGE SYSTEM DATA BY COUNTY: 1975

Table I-1

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN KENOSHA COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Kenosha	9,754	15.24	34	1,530	4,050	6,587
Village of Twin Lakes	395	0.62	10	39	246	325
County Total	10,149	15.86	44	1,569	4,296	6,912

Table I-2

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN MILWAUKEE COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Cudahy	1,921	3.00	6	519	1,209	1,619
City of Franklin	492	1.24	8	132	301	397
City of Glendale	4,436	6.93	59	776	1,937	2,619
City of Greenfield	2,908	4.54	44	604	2,075	2,763
City of Milwaukee	30,462	47.60	293	7,736	18,727	25,200
City of Oak Creek	4,305	6.73	50	809	2,015	2,718
City of St. Francis	1,483	2.32	12	511	1,524	1,851
City of South Milwaukee	2,961	4.63	38	545	1,688	2,323
City of Wauwatosa	5,942	9.28	70	1,227	4,646	6,189
City of West Allis	6,529	10.20	67	1,613	5,391	7,206
Village of Brown Deer	839	1.31	19	192	524	707
Village of Fox Point	1,494	2.33	25	126	767	1,118
Village of Greendale	2,126	3.32	32	357	1,482	1,977
Village of Shorewood	427	0.67	6	143	378	502
Village of West Milwaukee	1,308	2.04	13	439	1,217	1,966
Village of Whitefish Bay	1,086	1.70	6	362	858	1,159
County Total	69,019	107.84	748	16,091	44,739	60,314

Table I-3

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN OZAUKEE COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Cedarburg	839	1.31	11	64	568	759
City of Port Washington	1,315	2.05	28	88	837	1,069
Village of Belgium	95	0.15	2	4	40	54
Village of Grafton	1,274	1.99	23	138	470	672
Village of Saukville	64	0.10	1	8	31	42
Village of Thiensville	357	0.56	4	39	212	277
County Total	3,944	6.16	69	341	2,158	2,873

Table I-4

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN RACINE COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Burlington	1,247	1.95	39	87	642	831
City of Racine	8,548	13.36	51	2,118	4,197	5,757
Village of Rochester	24	0.04	1	1	14	18
Village of Sturtevant	440	0.69	3	49	170	231
Village of Union Grove	337	0.53	5	114	213	288
Village of Waterford	435	0.68	24	59	261	352
County Total	11,031	17.24	123	2,428	5,497	7,477

Table I-5

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN WALWORTH COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Delavan	1,050	1.64	15	56	396	524
City of Elkhorn	813	1.27	10	77	388	512
City of Whitewater	963	1.50	19	75	513	688
County Total	2,826	4.42	44	208	1,297	1,724

Table I-6

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN WASHINGTON COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Hartford	752	1.18	23	80	508	671
City of West Bend	2,764	4.32	63	227	1,510	2,030
Village of Jackson	171	0.27	5	53	67	91
Village of Slinger	370	0.58	4	23	241	317
County Total	4,057	6.34	95	383	2,326	3,109

Table I-7

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN WAUKESHA COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
City of Brookfield	2,776	4.34	44	403	1,758	2,345
City of New Berlin	658	1.03	22	129	448	604
City of Waukesha	6,617	10.34	52	510	2,963	3,983
Village of Butler	331	0.52	2	68	241	331
Village of Elm Grove	1,075	1.68	11	135	634	843
Village of Menomonee Falls	3,676	5.74	56	506	2,167	2,899
Village of Mukwonago	177	0.28	5	13	96	127
Village of Pewaukee	454	0.71	26	39	293	392
Village of Sussex	574	0.90	17	33	305	411
Village of Wales	39	0.06	–	–	–	–
County Total	16,377	25.59	235	1,836	8,905	11,935

Table I-8

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE REGION BY COUNTY: 1975

Civil Division	Estimated Tributary Area		Number of Storm Water Outfalls in Civil Division Discharging to Surface Waters	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
	Acres	Square Miles			2-Year Recurrence Interval Event (cubic feet per second)	5-Year Recurrence Interval Event (cubic feet per second)
Kenosha	10,149	15.86	44	1,569	4,296	6,912
Milwaukee	69,019	107.84	748	16,091	44,739	80,314
Ozaukee	3,944	6.16	69	341	2,158	2,873
Racine	11,031	17.24	123	2,428	5,497	7,477
Walworth	2,826	4.42	44	208	1,297	1,724
Washington	4,067	6.34	95	383	2,326	3,109
Waukesha	16,377	25.59	235	1,836	8,905	11,935
Region Total	117,403	183.44	1,358	22,856	69,218	94,344

Appendix J

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEM FOR THE REGION BY WATERSHED: 1975

Table J-1

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE DES PLAINES RIVER WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
					Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
Village of Union Grove	1	129	36	43	83	111
	2	55	24	19	41	55
Subtotal	2	184	–	62	124	166
Total	2	184	–	62	124	166

Table J-2

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE FOX RIVER WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
					Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Brookfield	1	12	18	2	11	14
	2	16	18	2	8	11
	3	–	36			
	4	30	N/A	4	14	19
	5	64	36	13	37	52
	6	28	21	6	25	34
	7	25	18	2	21	27
	8	150	Open Ditch	31	89	119
	9	153	36	32	86	116
	10	243	Open Ditch	19	131	175
	11	85	N/A	18	101	127
	12	12	N/A	2	12	16
	13	42	42	9	32	38
	14	37	30	8	28	38
	15	441	Open Ditch	56	189	247
Subtotal	15	1,338	–	204	784	1,033
City of Burlington	1	40	10	3	24	32
	2	–	10			
	3	–	15			
	4	–	36			
	5	6	10	–	3	4
	6	184	10	14	83	110
	7		10			
	8		12			
	9		12			
	10		12			
	11		48			
	12	55	36	4	38	50
	13	15	36	1	11	14
	14	37	36	3	22	30
	15	25	12	2	18	24
	16		24			
	17		24			
	18	58	24	4	36	49
	19	119	42	9	64	90
	20	340	48	26	214	255
	21	184	72	8	35	47
	22	119	8	9	61	84
	23		8			
	24		10			
	25		10			
	26		10			
	27		12			
	28		12			
	29		15			
	30		30			
	31	12	10	1	9	11
	32		12			
	33	16	10	1	7	9
	34		12			
	35	25	18	1	10	13

Table J-2 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
					Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Burlington (continued) . .	36	12	10	1	7	9
	37		12			
	38		12			
	39		15			
Subtotal	39	1,247	–	87	642	831
City of Elkhorn	1	165	30	13	58	76
	2	119	12	9	71	93
	3	156	42	7	35	45
	4	3	12		2	3
Subtotal	4	443		29	166	217
City of Lake Geneva	No System Mapping Available					
City of Muskego	No System Mapping Available					
City of New Berlin	1	37	36	5	19	26
	2		27			
	3	25	N/A	5	21	29
	4		N/A			
	5		N/A			
	6	6	N/A	1	6	8
	7	28	48	6	23	30
	8	21	18	3	13	17
	9	28	15	6	24	32
	10	119	48	25	75	102
	11	101	12	21	70	93
	12		12			
	13		21			
	14		48			
	15	30	36	6	23	31
	16	18	30	4	15	19
Subtotal	16	413	–	82	289	387
City of Waukesha	1	85	36	11	39	51
	2	28	Open Ditch	3	20	26
	3	21	24	2	15	20
	4	294	54	22	141	185
	5	83	42	4	55	74
	6	202	54	15	91	127
	7	168	42	13	106	147
	8	37	30	3	31	41
	9	46	66	4	29	39
	10	43	24	3	28	39
	11	113	15	9	75	98
	12		19			
	13		36			
	14	76	48	6	46	62
	15	46	21	4	32	43
	16	1,138	48	87	311	430
	17	303	27	23	127	165
	18	119	30	40	155	206
	19		30			
	20	138	24	6	35	55
	21		42			
	22	119	36	5	55	73
	23	51	15	2	28	38
	24	349	60	27	167	230
	25	83	30	6	52	72
	26	33	24	3	25	34
	27	367	54	28	143	187
	28	3	15	1	6	8
	29	85	24	7	51	69
	30		24			
	31	285	30 x 42	22	128	171
	32	24	24	2	16	21
	33	61	24	5	38	53
	34	95	42	7	48	65
	35	64	24	5	39	52
	36	119	27	9	68	90
	37	862	24	66	303	396
	38		78			
	39	119	42	5	55	75
	40	18	24	1	9	12
	41	58	42	2	23	32
	42	156	48	7	56	75
	43	129	N/A	6	46	59
	44	58	18	4	38	50
	45		18			
	46	184	60	8	50	69
	47	55	36	4	30	40
	48	61	15	5	40	53
	49		18			
	50		36			
	51	110	42	8	54	71
	52	129	48	10	59	80
Subtotal	52	6,617	–	510	2,963	3,983

Table J-2 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
Village of East Troy	No System Mapping Available					
Village of Menomonee Falls	1	230	Open Ditch	29	98	132
Subtotal	1	230		29	98	132
Village of Mukwonago	1	40	36	3	24	32
	2	6	18		4	6
	3	21	21	2	14	18
	4		27			
	5	110	48	8	54	71
Subtotal	5	177	–	13	96	127
Village of Pewaukee	1	9	15	1	9	12
	2	51	15	6	29	39
	3		15			
	4		15			
	5		15			
	6		15			
	7	16	24	2	9	12
	8	9	N/A	1	8	10
	9	3	N/A		2	3
	10	21	N/A	2	17	23
	11		N/A			
	12	28	18	2	22	30
	13		18			
	14		N/A			
	15	18	24	1	14	18
	16	51	32	4	31	42
	17	70	24	5	50	67
	18	95	27	7	60	80
	19		36			
	20		N/A			
	21	18	N/A	1	14	18
	22	28	N/A	2	22	30
	23		N/A			
	24		N/A			
	25		N/A			
	26	37	Open Ditch	5	6	8
Subtotal	26	454	–	39	293	392
Village of Rochester	1	24	24	1	14	18
Subtotal	1	24	–	1	14	18
Village of Sussex	1	138	48	6	47	63
	2	18	Open Ditch	1	8	10
	3	64	12 x 44	3	25	33
	4	18	27	1	10	14
	5	18	36	1	13	18
	6	34	21 x 45	3	25	33
	7	16	Open Ditch	1	10	14
	8	21	Open Ditch	2	13	18
	9	6	12		5	6
	10	6	18		5	6
	11	6	18		5	6
	12	55	12	4	36	48
	13	9	12		4	6
	14	43	42	3	27	35
	15	40	36	2	19	29
	16	64	45 x 29	5	40	54
	17	18	N/A	1	13	18
Subtotal	17	574	–	33	305	411
Village of Twin Lakes	1	147	Open Ditch	19	39	53
	2	18	12	1	13	17
	3	21	N/A	2	18	24
	4	67	30	5	60	80
	5	15	18	1	12	16
	6	9	N/A	1	8	10
	7	15	21	1	13	16
	8	21	18	2	18	24
	9	9	18	1	8	10
	10	73	30	6	57	75
Subtotal	10	395	–	39	246	325
Village of Wales		39				
Village of Waterford	1	15	18	1	13	17
	2	9	12		5	7
	3	101	12	8	74	102
	4		18			
	5		18			
	6		18			
	7		21			
	8		24			
	9		24			
	10	73	12	9	46	61
	11		12			
	12		15			
	13		15			
	14		15			
	15		18			
	16		18			
	17		27			
	18		72 x 44			
	19	3	12		2	3
	20	6	24	1	5	6
	21	188	24	39	91	123
	22	3	18 x 11		3	4
	23	28	24	1	16	21
	24	9	12		6	8
Subtotal	24	435	–	59	261	352
Total	210	12,386	–	1,125	6,157	8,208

NOTE: N/A indicates data not available.

Table J-3

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE KINNICKINNIC RIVER WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Cudahy	1	40	72	8	31	42
	2	597	Open Ditch	123	295	414
	3	340	36	70	191	247
Subtotal	3	977	–	201	517	703
City of Greenfield	1	12	15	4	15	20
	2	49	42	10	23	29
	3	3	15	2	5	6
	4	40	30	26	42	56
	5	15	15	3	12	16
	6	18	24	6	20	26
	7	83	60	28	89	118
	8	211	72	43	112	153
	9	28	36	9	35	46
	10	83	42	28	93	126
Subtotal	10	542	–	159	446	596
City of Milwaukee	1	211	N/A	71	248	323
	2		30			
	3		60			
	4	46	36	9	35	45
	5		27			
	6	156	N/A	32	103	139
	7		48			
	8	119	18	15	49	65
	9		30			
	10		18			
	11		27			
	12		18			
	13		18			
	14		24			
	15		18			
	16	386	42	130	393	531
	17		18			
	18		12			
	19		36			
	20		60 x 38			
	21		18			
	22	101	54	34	98	134
	23	46	24	15	76	101
	24	165	48	56	152	211
	25	38	27	8	29	39
	26	46	N/A	9	35	47
	27	110	36	23	76	102
	28		24			
	29	248	60	51	131	172
	30	349	78	44	89	119
	31	83	60	28	80	110
	32	18	36	2	7	9
	33	37	21	12	45	60
	34		36			
	35	165	54	56	152	202
	36	119	78	40	97	128
	37	18	24	6	19	25
	38	477	84	160	341	463
	39	349	60	117	214	285
	40	670	96	225	376	513
	41	248	142 x 89	83	190	266
	42	18	12	4	12	16
	43		12			
	44		12			
	45		12			
	46	6	12	1	2	3
	47	615	84	126	284	365
	48	496	78	62	198	273
	49	230	42	153	266	364
	50	147	78	19	45	60
	51	83	60	17	49	65
	52	64	36	13	40	53
	53	55	60	28	91	119
	54	28	N/A	3	12	16
	55	9	27	5	17	21
	56	73	54	15	56	75
	57	37	30	8	30	40
	58	46	36	9	29	38
	59	73	36	15	46	61
	60	72	78	36	44	59
	61	231	2 x 3	47	18	23
	62		3 x 3			
	63		3 x 4			
	64	1,120	36	141	14	18
	65		N/A			
	66		29 x 18			
	67		22 x 7			
	68		18			
Subtotal	68	7,608	–	1,928	4,288	5,758
City of St. Francis	1	42	30	1	28	38
Subtotal	1	42	–	1	28	38
City of West Allis	1	257	60	86	223	303
	2	166	42	55	266	355
	3	46	36	15	66	88
	4		24			
Subtotal	4	469	–	156	555	746

Table J-3 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
Village of West Milwaukee	1	55	30	19	86	116
	2		48			
	3	9	18	3	17	22
	4	18	Open Ditch	6	30	40
	5	42	24	14	52	69
	6	92	54	31	144	187
	7	74	72	25	46	65
	8	670	78	225	499	997
Subtotal	8	960	–	323	874	1,496
Total	94	10,598	–	2,768	6,708	9,337

NOTE: N/A indicates data not available.

Table J-4

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE LAKE MICHIGAN WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Cudahy	1	201	60	68	144	196
	2	422	66	142	302	409
	3	321	72	108	246	311
Subtotal	3	944	–	318	692	916
City of Kenosha	1	11	36	71	140	194
	2		60			
	3	40	30	13	40	75
	4	532	72	109	211	281
	5	119	82 x 128	40	97	128
	6	193	72	3	92	119
	7	119	18	2	64	84
	8		36			
	9		24			
	10	73	24	1	35	47
	11	2,965	90	374	460	643
	12	129	60	10	31	41
	13		18			
	14	679	84	140	309	404
	15	588	72	121	264	352
	16	33	54	7	23	31
	17	15	18	3	10	14
	18	76	30	16	43	57
	19	24	15	5	18	24
	20	432	60	89	194	259
	21	15	21	2	11	14
	22	46	48	4	24	32
	23	55	30	4	32	43
	24	257	60	20	124	166
	25	1,643	84	338	986	2,465
	26	101	78	34	117	151
Subtotal	26	8,145	–	1,406	3,325	5,624
City of Oak Creek	1	230	78	77	253	333
Subtotal	1	230		77	253	333
City of Port Washington	1	85	36	4	28	38
	2	46	36	4	25	34
	3	28	36	2	16	22
	4	24	18	2	15	19
	5	18	24	1	11	15
	6	9	15	1	6	9
	7	58	24	4	30	39
	8	18	12	1	13	18
	9	33	18	3	21	26
	10	3	12	–	2	3
	11	6	24	1	5	6
	12	18	24	4	15	19
	13	39	24	1	27	35
	14	9	12	1	7	9
Subtotal	14	394	–	29	221	292
City of Racine	1	468	72	96	219	287
	2	1,221	54	410	791	1,074
	3	496	60	167	309	412
	4	21	15	11	40	52
	5		24			
	6	37	24	8	35	48
	7	110	54	23	99	132

Table J-4 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Racine (continued)	8	3	15	1	2	3
	9	395	54	133	302	403
	10		54			
	11	1,744	66	359	466	673
	12		72			
	13		96			
	14	30	29 x 18	6	23	30
	15	18	36	9	34	45
Subtotal	15	4,543	–	1,223	2,320	3,159
City of St. Francis	1	707	24	238	685	793
	2		126			
	3	275	12	139	416	496
	4		102			
	5	40	21	13	52	71
	6	18	15	4	16	21
	7	42	24	9	32	42
	8	51	36	11	37	49
	9	33	24	11	42	56
	10	55	42	11	36	49
	11	220	42	74	180	236
Subtotal	11	1,441	–	510	1,496	1,813
City of South Milwaukee	1	257	24	4	17	22
	2	15	21	3	13	17
	3	15	18	3	12	16
	4	9	12	2	8	10
	5	312	43 x 68	105	239	334
	6	73	24	9	82	112
	7	33	15	3	21	28
	8	349	24	72	196	265
	9		48			
Subtotal	9	1,063	–	201	588	804
Village of Fox Point	1	83	Open Ditch	6	51	67
	2		Open Ditch			
	3	15	Open Ditch	1	10	13
	4	340	66	26	143	183
	5	12	18	2	10	14
	6	76	42	6	50	66
	7	239	18	18	97	66
	8		48			
	9	9	12	1	6	8
	10	67	Open Ditch	14	38	50
Subtotal	10	841	–	74	405	530
Village of Shorewood	1	55	24 x 48	19	48	65
Subtotal	1	55	–	19	48	65
Village of Whitefish Bay	1	220	48	74	194	259
	2	21	10	4	27	32
	3	294	60	99	202	274
	4	220	54	74	176	238
Subtotal	4	755	–	251	599	803
Total	94	18,411	–	4,108	9,947	14,339

Table J-5

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE MENOMONEE RIVER WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Brookfield	1	12	42	2	9	12
	2	129	42	16	81	112
	3	64	42	13	63	84
	4	101	42	13	67	88
	5	164	48	21	103	138
	6	25	Open Ditch	3	17	23
	7	156	48	20	103	150
	8	97	Open Ditch	10	15	20
	9	76	60	10	46	62
	10	67	36	8	42	58
	11	165	Open Ditch	21	109	144
	12		Open Ditch			
	13		Open Ditch			
	14		N/A			
	15		N/A			
	16	28	24	3	22	30

Table J-5 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
					Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
	17	37	36	3	24	31
	18	5	15		4	5
	19	3	15		2	3
	20	37	N/A	5	26	35
	21	83	48	17	95	124
	22	129	15	26	99	132
	23		15			
	24		24			
	25		24			
	26		27			
	27		36			
	28	30	36	4	23	30
	29	30	18	4	24	31
Subtotal	29	1,438	–	199	974	1,312
City of Greenfield	1	18	24	4	25	32
	2		12			
	3	275	66	57	241	317
	4	28	36	6	30	41
	5	79	30	16	69	94
	6	92	84	12	55	74
	7	101	48	13	55	73
	8	28	36	6	34	44
	9		24			
	10	92	42	19	56	76
	11	64	36	13	49	66
	12	18	24	2	13	18
	13	202	66	43	136	181
	14	12	21	2	10	13
	15	42	24	9	50	68
Subtotal	15	1,051	–	202	823	1,097
City of Milwaukee	1	165	108 x 72	56	139	185
	2	64	42	22	86	112
	3	64	30	22	82	108
	4		36			
	5	46	30	15	56	77
	6	55	36	19	77	102
	7	15	36	3	18	25
	8	28	36	9	35	46
	9	37	36	12	43	58
	10	23	24	8	31	40
	11	55	30	19	70	93
	12		30			
	13	64	42	22	86	112
	14	26	N/A	9	42	56
	15	64	Open Ditch	5	27	36
	16	193	N/A	15	69	93
	17	37	18	2	17	22
	18	37	42	1	13	17
	19	147	68 x 98	11	84	85
	20	147	60	19	73	96
	21	129	60	10	39	51
	22	37	81 x 59	3	17	22
	23	376	78	29	98	128
	24		78			
	25	73	60	6	28	37
	26	18	30	1	10	13
	27	129	24	10	49	67
	28		36			
	29	138	42	11	50	66
	30		54			
	31	37	N/A	3	18	24
	32	64	24	13	61	79
	33		21			
	34	73	48	15	65	86
	35	9	21	2	10	13
	36	28	24	6	28	37
	37		27			
	38	46	42	9	44	60
	39	55	24	11	51	69
	40		36			
	41		24			
	42	64	66	13	46	62
	43	119	36	25	97	129
	44		36			
	45		48			
	46	28	30	6	28	37
	47	64	27	13	51	68
	48	46	30	9	30	40
	49	73	21	15	48	64
	50		18			
	51		24			
	52	9	21	2	6	8
	53	147	30	30	101	130
	54		68 x 43			
	55	248	72 x 44	51	156	208
	56	138	48	11	50	65
	57	156	48	32	122	165
	58	64	36	13	59	80
	59		Open Ditch			
	60	9	N/A	19	79	107
	61	37	21	8	36	47
	62	3	12	1	4	5
	63	37	66	8	34	46
	64	37	42	8	41	54
	65	37	30	8	41	54
	66	46	30	8	43	60
	67	9	21	2	10	14
	68	28	36	6	28	37
	69	64	N/A	13	59	80

Table J-5 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
					Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Milwaukee (continued) . .	70	92	18	19	101	135
	71	487	96 x 54	100	515	671
	72	83	42	17	80	106
	73	73	Open Ditch	15	64	85
	74	37	72	8	32	42
	75	55	N/A	11	52	72
	76	64	24	13	71	95
	77		27			
	78	55	24	19	61	80
	79	28	27	6	25	33
	80	6	36	1	21	28
	81	55	36	11	58	79
	82	147	54	30	115	155
	83	110	48	23	86	117
	84	184	36	38	152	203
	85	64	48	13	58	75
	86	46	48	9	42	53
	87	46	36	9	40	55
	88	46	12	9	49	63
	89		24			
	90	744	108	250	474	647
	91	193	60	65	201	268
	92	73	30	25	94	124
	93		36			
	94	37	24	12	45	62
	95	101	36	34	111	146
	96	92	42	31	101	138
	97	28	36	9	42	54
	98	37	24	12	50	66
	99	110	N/A	37	128	173
	100	28	48	9	32	43
	101	441	54	148	332	460
	102	1,028	120	211	567	792
	103	422	84 x 52	87	279	432
	104	28	27	9	39	53
	105	21	36	7	28	38
	106	58	24	3	8	10
	107	56	42	12	26	34
	108	18	21	4	15	20
Subtotal	108	9,135	–	2,016	6,979	9,382
City of New Berlin	1	21	18	4	16	22
Subtotal	1	21	–	4	16	22
City of Wauwatosa	1	51	24	11	52	69
	2		24			
	3	275	78	57	266	355
	4	101	42	21	88	121
	5	9	24	2	10	12
	6	46	21	9	49	63
	7		18			
	8	64	30	8	39	52
	9	211	84	27	127	171
	10	61	N/A	8	38	51
	11	129	54	26	102	135
	12	83	N/A	17	84	113
	13	211	66	43	133	181
	14	33	36	7	37	49
	15	321	42	66	174	246
	16	413	72	85	260	353
	17	413	66	32	116	141
	18	24	42	2	10	13
	19	110	42	23	76	106
	20	6	18	1	6	8
	21	12	15	2	13	17
	22	21	21	4	23	31
	23	15	18	3	10	22
	24	49	30	10	36	49
	25	119	48	25	88	121
	26	70	36	5	25	33
	27	73	30	6	26	35
	28	37	27	8	41	54
	29	18	24	4	20	27
	30	33	27	7	44	58
	31	33	24	7	35	46
	32	30	24	6	32	42
	33	15	18	3	17	22
	34	156	18	32	165	223
	35		18			
	36		27			
	37		21			
	38	46	30	9	42	55
	39	119	24	40	132	173
	40		36			
	41	129	36	43	134	179
	42		36			
	43	46	36	15	56	77
	44	174	24	59	152	212
	45		48			
	46	24	12	8	29	40
	47	18	21	6	26	34
	48	376	66	127	306	415
	49	37	30	5	26	35
	50	119	42	15	227	90
	51	30	15	4	19	26
	52	58	24	7	40	54
	53	24	15	3	19	25
	54	184	48	23	94	128
	55	156	54	20	70	94
	56	33	30	4	25	33
	57	46	30	9	44	61

Table J-5 (continued)

Civil Division	Outfall Number	Estimated Tributary Area (Acres)	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Wauwatosa (continued) . .	58	30	36	6	33	44
	59	165	54	34	122	160
	60	42	120 x 62	9	59	78
	61	63	78	13	55	69
	62	55	27	11	61	81
	63	15	15	3	16	22
	64	46	21	9	47	61
	65		15			
	66	184	48	62	170	234
	67	156	54	52	145	344
	68	239	60	49	187	253
	69	46	30	9	40	55
	70	28	24	6	28	38
Subtotal	70	5,942	–	1,227	4,646	6,189
City of West Allis	1	18	21	4	19	25
	2	569	9 x 7	117	359	487
	3	33	27	7	39	52
	4	33	30	7	36	48
	5	30	60	6	31	42
	6	92	54	7	67	91
	7	661	96	136	568	767
	8	9	18	2	11	15
	9	37	27	8	30	41
	10	532	Triple Box 90 x 54	109	288	383
	11	376	84	77	242	329
	12	55	24	19	65	86
	13	41	42	14	51	67
	14	12	15	4	18	24
	15	184	72	62	170	224
	16	101	60	34	111	146
	17	21	42	7	30	39
	18	101	48	34	100	135
	19		48			
	20	21	24	7	31	40
	21	65	36	22	71	93
	22	239	72	80	253	318
	23	9	24	3	13	17
	24	73	42	25	77	102
	25	30	30	10	47	63
	26	46	30	15	56	75
	27		24			
	28	39	36	13	37	48
	29	30	36	10	39	53
	30	28	24	9	35	46
	31		36			
	32	46	18	15	61	83
	33	28	48	9	37	49
	34	33	15	11	43	56
	35	18	30	6	26	34
	36	40	36	13	51	66
	37	37	24	12	51	68
	38	9	24	2	10	13
	39	46	42	9	38	51
	40	119	48	25	98	128
	41		54			
	42	92	78	19	66	87
	43	64	51 x 31	22	82	108
	44	36	36	12	52	71
	45	12	48	4	18	24
	46	187	78	22	112	153
	47	184	60	62	170	224
	48	156	42	52	145	190
Subtotal	48	4,592	–	1,143	3,954	5,261
Village of Butler	1	101	36 x 60	21	86	114
	2	230	36	47	155	217
Subtotal	2	331	–	68	241	331
Village of Elm Grove	1	232	Open Ditch	29	105	139
	2	92	30	12	66	88
	3	25	30	3	63	83
	4	285	78	36	137	188
	5	135	60	17	77	101
	6	28	30	3	19	25
	7	12	27	2	11	12
	8	30	27	4	22	29
	9	9	24	1	7	9
	10	25	42	3	18	24
	11	202	48	25	109	145
Subtotal	11	1,075	–	135	634	843
Village of Menomonee Falls . . .	1	37	N/A	5	25	33
	2		N/A			
	3		N/A			
	4	220	N/A	45	162	213
	5	3	N/A	1	3	5
	6	6	N/A	1	7	9
	7	193	N/A	40	124	169
	8	184	N/A	38	107	149
	9	9	N/A	2	11	15
	10	24	N/A	5	28	36
	11	28	N/A	6	30	41
	12	15	N/A	3	16	22
	13	85	N/A	18	79	106
	14	1,028	Open Ditch	79	317	430
	15	27	N/A	6	29	39
	16	28	N/A	6	30	40
	17	103	N/A	21	115	153
	18		N/A			
	19		N/A			
	20	12	N/A	2	14	18
	21	119	N/A	25	104	137
Village of Menomonee Falls (continued)	22	147	N/A	11	59	79
	23	6	N/A	1	6	8
	24	12	N/A	2	15	20
	25	12	N/A	2	15	20
	26		N/A			
	27		N/A			
	28	24	N/A	5	28	37
	29		N/A			
	30		N/A			
	31		N/A			
	32	42	N/A	9	51	66
	33	9	N/A	2	12	15
	34	40	N/A	8	44	58
	35	321	N/A	40	171	234
	36		N/A			
	37	73	N/A	15	78	101
	38	9	N/A	2	12	16
	39	12	N/A	2	15	20
	40		N/A			
	41		N/A			
	42	24	N/A	3	19	24
	43		N/A			
	44	51	N/A	6	37	49
	45		N/A			
	46	49	N/A	6	29	39
	47	95	Open Ditch	12	45	62
	48	24	N/A	3	17	22
	49	3	N/A		2	3
	50	21	N/A	3	15	19
	51	28	N/A	3	22	29
	52	18	N/A	2	14	18
	53*	51	Open Ditch	6	29	40
	54	24	N/A	2	16	21
	55	230	Open Ditch	29	117	152
Subtotal	55	3,446	–	477	2,069	2,767
Village of West Milwaukee	1	266	66	89	247	340
	2	9	18	3	14	19
	3		N/A			
	4	61	30	20	70	95
	5	12	24	4	12	16
Subtotal	5	348	–	116	343	470
Total	344	27,379	–	5,587	20,679	27,674

NOTE: N/A indicates data not available.

Table J-6

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE MILWAUKEE RIVER WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area (Acres)	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Cedarburg	1	15	12	1	12	15
	2	6	12	–	5	6
	3	64	Open Ditch	3	46	62
	4		N/A			
	5		N/A			
	6		N/A			
	7	340	27	26	245	326
	8	168	27	13	116	151
	9	198	42	15	107	149
	10	24	24	3	20	26
	11	24	27	3	17	24
Subtotal	11	839	–	64	568	759
City of Glendale	1	24	24	5	19	25
	2	46	42	9	33	44
	3	6	18	1	4	6
	4	49	21	10	35	47
	5		12			
	6	55	27	11	40	53
	7		12			
	8	257	54	53	139	185
	9	184	Open Ditch	23	112	153
	10	211	60	27	128	169
	11	3	15	–	1	2
	12	28	15	2	7	15
	13		36			

Table J-6 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
					Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Glendale (continued) . . .	14	70	60 x 38	5	20	26
	15	97	Open Ditch	12	54	71
	16	211	78	16	11	15
	17	83	48	6	19	25
	18	9	Open Ditch	1	7	9
	19	18	N/A	2	13	18
	20	184	18	38	88	118
	21	129	54	26	70	95
	22	6	24	1	2	3
	23	9	18	1	4	5
	24	6	12	1	2	3
	25	24	24	3	13	17
	26		24			
	27	138	54	17	35	46
	28	15	36	2	9	11
	29		18			
	30	52	40	26	87	113
	31	49	30	10	33	45
	32	129	66	16	32	43
	33		15			
	34	51	30	26	67	89
	35		42			
	36	42	36	9	27	37
	37	79	48	40	97	131
	38	138	68 x 43	46	110	152
	39	46	36	15	57	76
	40	40	36	5	13	18
	41	12	15	2	4	6
	42	1	18			
	43	156	60	20	37	50
	44	28	36	9	48	63
	45	49	36	16	64	87
	46	110	36	37	144	198
	47	32	48	7	25	33
	48		N/A			
	49	1,479	Open Ditch	186	145	207
	50	21	30	3	8	10
	51	61	42	31	74	100
Subtotal	51	4,436	–	776	1,937	2,619
City of Milwaukee	1	37	Open Ditch	12	14	18
	2	835	Open Ditch	105	79	111
	3	165	Open Ditch	56	50	66
	4	55	Open Ditch	19	18	24
	5	257	108 x 60	53	123	162
	6	294	120 x 60	37	58	74
	7	138	48	17	41	54
	8	46	48	15	11	15
	9	12	36	2	5	7
	10	83	36	17	52	69
	11	9	30	3	3	4
	12	101	60	13	24	33
	13	184	66	23	37	51
	14	9	48	19	52	72
	15	12	18	2	3	4
	16	165	72	56	44	81
	17	73	48	25	22	29
	18	211	18 x 96	43	95	127
	19	12	48	2	9	12
	20	46	24	9	33	44
	21	55	48	11	36	50
	22	15	24	5	25	32
	23	18	60	9	32	42
	24	15	30	7	23	31
	25	129	42	26	192	259
	26		42			
	27	404	120 x 72	51	79	107
	28	202	54	68	58	78
	29	37	27	5	12	17
	30	28	12	6	19	28
	31	1,350	96	454	810	1,080
	32	101	54	34	111	146
	33	46	36	6	33	43
	34		18			
	35	24	24	5	19	24
	36		21			
	37		26			
	38	30	42	6	25	34
	39	73	42	15	48	64
	40	340	104	114	127	179
	41	110	42	23	69	91
	42	55	42	11	35	45
	43	46	36	9	30	40
	44	101	54	21	56	75
	45		12			
	46	119	66	25	67	93
	47		36			
	48	220	48	74	191	258
	49	28	40	9	28	37
	50	248	48 x 96	83	179	238
	51	46	21	9	33	44
	52	28	30	6	21	27
	53	37	30	8	27	36
	54		18			
	55	28	27	6	21	27
	56		15			
	57	37	24	8	26	35
	58	18	10	4	14	18
	59	220	66	45	102	137
	60	73	96 x 60	15	43	57
	61	174	48	59	122	166
	62	9	18	3	12	17

Table J-6 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates	
					Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Milwaukee (continued) . .	63		15			
	64	46	36	15	53	69
	65	266	72	89	200	266
	66	1,129	132 x 72	380	565	734
	67	55	30	19	63	85
	68		21			
	69	46	42	15	46	62
	70		16			
	71	28	24	9	33	44
	72	551	120 x 72	185	331	468
	73	21	15	7	25	34
	74		42			
	75	15	15	5	18	24
	76		15			
	77		18			
	78	46	15	15	60	80
	79		15			
	80		15			
	81		15			
	82		15			
	83	9	18	3	11	15
	84	9		3	12	16
	85	18	21	6	20	27
	86	588	72	197	294	411
	87	92	60	31	83	115
	88	1,487	90 x 105	500	595	818
	89	496	120 x 90	167	297	397
	90	28		9	36	47
	91	266	72	89	276	386
	92	28		9	44	59
	93	15	13	5	18	24
	94	3			1	1
	95	12	30	2	10	14
	96	28	27	9	12	15
	97	73	42	25	73	99
	98	51	36	10	27	36
	99		12			
	100	9	18	1	7	9
	101	44	48	9	34	45
	102	28	54	3	16	19
Subtotal	102	12,695	–	3,585	6,758	9,132
City of West Bend	1	92	24	7	6	9
	2	18	18	1	13	18
	3	42	24	3	24	33
	4	9	18		5	6
	5	55	27	1	26	35
	6	42	18	3	29	38
	7	12	18	2	11	17
	8	15	15	1	12	17
	9	162	15	12	68	92
	10		15			
	11	28	15	3	26	35
	12		24			
	13	6	18		2	3
	14	15	18			
	15			1	11	15
	16	64	58 x 36	8	35	47
	17	51	15	6	30	40
	18		30			
	19	6	15	1	5	6
	20	24	24	3	28	37
	21		N/A			
	22	49	24	10	56	75
	23		24			
	24		N/A			
	25		N/A			
	26	79	18	6	52	69
	27	40	30	3	24	32
	28		24			
	29	51	42	2	26	35
	30	147	Open Ditch	11	62	83
	31	37	24	1	15	21
	32	79	42	3	41	57
	33	33	18	3	21	28
	34	37	36	1	13	18
	35	37	36	3	28	41
	36	18	12	4	23	31
	37	28	30	6	39	50
	38		N/A			
	39	6	15	1	5	6
	40	12	12	2	11	14
	41		18			
	42		18			
	43	28	15	2	15	22
	44		24			
	45	92	21	12	55	74
	46		18			
	47	3	12		2	3
	48	76	15	10	43	59
	49		15			
	50		N/A			
	51		N/A			
	52	88	32	7	48	64
	53	6	24	1	10	14
	54	294	48 x 36	22	144	195
	55	12	18	1	10	14
	56	538	48	41	210	274
	57	18	18	1	15	21
	58	40	36	3	30	40
	59	3	12	–	2	2
	60	28	30	1	13	17

Table J-6 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of West Bend (continued) . .	61	24	58 x 36	1	12	15
	62	220	30	17	154	208
	63		58 x 36			
Subtotal	63	2,764	–	227	1,510	2,030
Village of Brown Deer	1	30	53 x 34	2	23	30
	2	168	Twin 60	35	114	154
	3	28	24	6	24	34
	4	6	18	1	3	4
	5	92	48	31	46	62
	6	101	48	34	42	56
	7		24			
	8	33	24	7	30	41
	9		24			
	10	33	12	7	29	39
	11		12			
	12		15			
	13		12			
	14	21	18	7	10	13
	15	18	30	4	17	22
	16	67	30	8	33	45
	17		42			
	18	202	60	42	137	185
	19	40	48	8	16	22
Subtotal	19	839	–	192	524	707
Village of Fox Point	1	88	Open Ditch	7	58	77
	2		Open Ditch			
	3		15			
	4	18	42	1	15	20
	5	28	18	2	22	29
	6		12			
	7		12			
	8		12			
	9	18	36	1	14	19
	10	24	24	2	19	26
	11	40	42	3	25	33
	12	340	12	26	143	296
	13		72			
	14	76	N/A	6	48	64
	15	21	42	4	18	24
Subtotal	15	653	–	52	362	588
Village of Grafton	1	3	15	1	1	2
	2	46	21	6	16	21
	3	239	48	18	100	172
	4	106	48	8	57	76
	5		48			
	6	46	24	4	28	37
	7	266	Open Ditch	11	52	69
	8	12	15	1	4	5
	9		15			
	10	28	30	2	9	12
	11	349	54	72	89	125
	12	33	18	3	22	30
	13	73	15	6	53	71
	14		15			
	15		12			
	16		12			
	17		12			
	18		12			
	19	9	12	1	7	10
	20	18	24	1	14	19
	21	28	Open Ditch	3	7	8
	22	18	12	1	11	15
	23		12			
Subtotal	23	1,274	–	138	470	672
Village of Jackson	1	21	18	7	9	12
	2	113	21	38	33	43
	3	6	15	1	2	3
	4	28	18	6	22	31
	5	3	12	1	1	2
Subtotal	5	171	–	53	67	91
Village of Kewaskum	No Mapping Available					
Village of Saukville	1	64	36	8	31	42
Subtotal	1	64	–	8	31	42
Village of Shorewood	1	257	72	86	206	270
	2	18	18	6	21	28
	3	21	24	7	25	34
	4	30	30	10	31	42
	5	46	36	15	47	63
Subtotal	5	372	–	124	330	437
Village of Thiensville	1	12	18	1	9	12
	2	97	36	7	58	70
	3	202	Open Ditch	25	116	155
	4	46	24	6	29	40
Subtotal	4	357	–	39	212	277
Village of Whitefish Bay	1	331	24	111	259	356
	2		N/A			
Subtotal	2	331	–	111	259	356
Total	309	24,795	–	5,369	13,028	17,710

NOTE: N/A indicates data not available.

Table J-7

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE OAK CREEK WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Franklin	1	34	N/A	3	16	22
Subtotal	1	34	–	3	16	22
City of Milwaukee	1	174	60	36	94	126
	2	49	30	10	37	48
	3	101	42	21	70	93
	4	12	24	2	11	14
	5	18	48	4	15	19
	6	37	42	8	25	35
	7	12	15	2	10	14
Subtotal	7	403	–	83	262	349
City of Oak Creek	1	156	66	32	88	113
	2	28	21	6	21	28
	3	70	48	14	48	65
	4	2,139	Open Ditch	269	481	642
	5	110	48	23	87	116
	6	21	42	3	11	15
	7	18	27	2	9	12
	8	15	24	2	7	10
	9	37	48	25	41	54
	10	21	N/A	4	15	20
	11	9	N/A	2	7	10
	12	6	N/A	1	4	6
	13	6	N/A	1	5	6
	14	30	Open Ditch	6	19	35
	15	70	Open Ditch	14	44	80
	16	193	Open Ditch	40	98	133
	17	12	21	2	9	13
	18	46	48	9	17	22
	19	129	Open Ditch	26	59	81
	20	3	48	2	5	6
	21	12	24	8	17	23
	22	6	27	4	8	11
	23	9	27	6	14	18
	24	12	24	8	17	23
	25	12	36	8	18	24
	26	12	48	8	17	23
	27	18	Open Ditch	4	13	18
	28	9	N/A	2	7	9
	29	28	N/A	18	39	52
	30	12	N/A	8	19	25
	31	42	N/A	9	29	39
	32	12	N/A	9	9	13
	33	73	N/A	15	48	65
	34	76	Open Ditch	16	53	70
	35	110	Open Ditch	23	87	116
	36	67	54	14	17	22
	37	21	42	11	37	50
	38	30	36	6	16	21
	39	15	15	3	14	18
	40	12	27	2	15	20
	41	9	15	6	29	38
	42	33	54	4	9	12
	43	30	12	6	15	21
	44	6	N/A	4	28	38
	45	9	N/A	6	27	36
	46	9	N/A	6	28	37
	47	21	N/A	3	9	12
	48	21	Open Ditch	3	7	9
Subtotal	48	3,845	–	703	1,721	2,330
City of South Milwaukee	1	15	21	2	12	17
	2	184	54	38	73	127
	3	285	36	58	178	235
	4		N/A			
	5		42			
	6		12			
	7		18			
	8	21	N/A	3	16	22
	9	28	18	6	23	30
	10	119	36	25	83	114
	11		18			
	12	18	21	4	14	19
	13	624	54	126	288	391
	14	64	24	13	51	68
	15		21			
	16	18	12	4	15	19
	17	21	15	3	16	21
	18	18	21	2	14	19
	19	257	36	32	132	189
	20	21	18	3	17	22
	21	9	12	1	7	10
	22	40	18	5	34	46
	23	21	12	2	19	25
	24	6	12		5	6
	25	21	15	3	16	22
	26	21	12	3	18	24
	27	30	24	4	23	31
	28	33	24	4	25	34
	29	24	24	3	21	28
Subtotal	29	1,898	–	344	1,100	1,519
Total	85	6,180	–	1,133	3,099	4,220

NOTE: N/A indicates data not available.

Table J-8

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE PIKE RIVER WATERSHED: 1975

					Estimated Maximum Storm Water Discharge Rates	
Civil Division	Outfall *Number*	Estimated Tributary Area *Acres*	Size Range of Outfalls in System *(diameter in inches)*	Total Estimated Annual Discharge Volume *(million gallons)*	Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Kenosha	1	349	90	27	94	126
	2	1,120	48	86	571	739
	3	49	54	4	20	27
	4	9	18	1	3	3
	5	6	18	–	2	3
	6	76	18	6	35	65
	7		15			
	8		27			
Subtotal	8	1,609	–	124	725	963
City of Racine	1	230	43 x 68	47	38	53
	2	129	72 x 113	26	76	102
Subtotal	2	*359*	–	73	114	155
Village of Sturtevant	1	15	N/A	1	10	14
	2	104	30	8	50	68
	3	321	60	40	110	149
Subtotal	3	440		49	170	231
Total	13	2,408	–	246	1,009	1,349

NOTE: N/A indicates data not available.

Table J-9

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE ROCK RIVER WATERSHED: 1975

					Estimated Maximum Storm Water Discharge Rates	
Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Delavan	1	6	12	–	5	6
	2	202	Open Ditch	15	109	139
	3	9	15	1	8	10
	4	12	18	1	8	11
	5	3	12	–	2	3
	6	6	N/A	–	5	6
	7	643	78	28	153	208
	8	18	18	1	13	18
	9	21	15	2	15	20
	10	15	12	1	11	15
	11	21	24	2	17	22
	12	9	12	1	8	10
	13	21	21	1	9	12
	14	46	27	2	18	24
	15	18	12	1	15	20
Subtotal	15	1,050	–	56	396	524
City of Elkhorn	1	156	24	20	84	112
	2	156	24	20	103	136
	3		30			
	4		36			
	5	46	12	6	26	36
	6	12	12	2	9	11
Subtotal	6	370	–	48	222	295
City of Hartford	1	15	24	1	12	16
	2	9	28 x 24	1	7	10
	3	21	15	2	15	20
	4	42	24	3	32	42
	5	46	15	4	32	41
	6		18			
	7	3	15		3	3
	8	37	18	3	24	32
	9	6	12	1	5	6
	10		15			
	11	6	12	1	5	6
	12		12			
	13	73	24	9	39	52
	14		26			
	15	30	N/A	4	23	31
	16	40	48	5	24	31
	17		48			

Table J-9 (continued)

					Estimated Maximum Storm Water Discharge Rates	
Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Hartford (continued) . . .	18	281	18	35	195	260
	19	3	15	–	2	3
	20	9	18	1	8	11
	21	110	24 x 24	8	66	86
	22	12	12	1	9	12
	23	9	15	1	7	9
Subtotal	23	752	–	80	508	671
City of Oconomowoc	No System Mapping Available					
City of Whitewater	1	46	60	2	13	17
	2	239	30	18	107	143
	3	9	12	1	8	11
	4	18	15	1	10	14
	5	55	12	4	40	53
	6		15			
	7	18	12	2	14	18
	8	18	15	2	14	18
	9	9	18	1	7	9
	10	64	24	5	35	46
	11	9	15	3	17	23
	12	28	24	2	18	24
	13	211	18	16	101	139
	14	18	15	1	14	19
	15	28	15	3	11	15
	16	37	N/A	5	15	20
	17	92	21	7	58	77
	18	9	15	–	5	7
	19	55	Open Ditch	2	26	35
Subtotal	19	963	–	75	513	688
Village of Hartland	No System Mapping Available					
Village of Slinger	1	101	54	4	40	53
	2	239	36	18	186	244
	3		48			
	4	30	48	1	15	20
Subtotal	4	370	–	23	241	317
Total	67	3,505	–	282	1,880	2,495

NOTE: N/A indicates data not available.

Table J-10

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE ROOT RIVER WATERSHED: 1975

					Estimated Maximum Storm Water Discharge Rates	
Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
City of Franklin	1	67	N/A	3	23	35
	2	104	N/A	13	61	80
	3	83	N/A	10	41	56
	4	15	N/A	2	9	12
	5	257	N/A	53	42	51
	6	30	N/A	6	24	32
	7	202	Open Ditch	42	85	109
Subtotal	7	758	–	129	285	375
City of Greenfield	1	92	96 x 75	19	60	79
	2	129	60	26	65	86
	3	92	60	19	38	51
	4	21	36	4	13	17
	5	51	30	11	40	54
	6	9	12	1	5	7
	7	12	12	2	11	15
	8	184	84 x 72	38	145	194
	9	3	10	1	6	8
	10	6	24	3	11	14
	11	24	30	3	14	19
	12	15	54	3	12	16
	13	6	30	1	4	5
	14	22	27	5	19	25
	15	67	48	8	19	26
	16	285	96	58	141	188
	17	3	18	1	6	8
	18	28	36	6	24	32
	19	266	72 x 44	34	173	226
Subtotal	19	1,315	–	243	806	1,070

Table J-10 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Milwaukee	1	101	36	21	70	94
	2	92	68 x 43	19	61	80
	3	37	27	8	25	33
	4	55	27	7	15	20
	5	55	36	11	40	48
	6	165	66	34	144	190
	7	15	30	3	10	14
	8	101	91 x 58	21	75	100
Subtotal	8	621	–	124	440	579
City of Muskego	No System Mapping Available					
City of New Berlin	1	21	21	4	18	25
	2	16	10	3	14	19
	3	141	60	29	80	110
	4	9	N/A	2	8	11
	5	37	24	5	23	30
Subtotal	5	224	–	43	143	195
City of Oak Creek	1	230	Open Ditch	29	41	55
Subtotal	1	230	–	29	41	55
City of Racine	1	18	15	4	16	21
	2	83	21	17	55	71
	3	40	36	8	25	33
	4	138	18	46	155	209
	5		36			
	6	138	54	28	70	95
	7	6	15	1	5	7
	8	12	21	2	10	15
	9	12	15	2	10	15
	10	6	15	1	5	7
	11	76	48	10	42	63
	12	37	24	5	17	23
	13	3	18	1	4	5
	14	24	18	8	31	40
	15	6	12	1	5	6
	16	83	36	28	81	109
	17	107	30	36	120	179
	18		48			
	19	12	21	4	16	21
	20	49	15	16	55	72
	21		30			
	22	9	12	3	12	16
	23		22 x 13			
	24	138	60	11	115	155
	25	6	18	3	10	14
	26	21	48	7	23	30
	27	138	66	46	108	148
	28	12	27	4	14	19
	29	12	N/A	1	12	16
	30	1,597	72	328	474	685
	31		84			
	32		96			
	33	725	48	155	158	214
	34	138	60	46	115	155
Subtotal	34	3,646	–	822	1,763	2,443
City of West Allis	1	46	27	9	36	49
	2	248	48 x 96	83	211	285
	3	138	Open Ditch	17	62	83
	4	9	21	2	8	11
	5	101	53 x 83	13	48	66
	6	12	21	2	10	13
	7	28	36	6	18	25
	8	28	48	6	18	25
	9	9	21	2	8	10
	10	156	60	32	88	119
	11	487	84	100	241	337
	12	55	42	11	40	53
	13	15	27	3	12	16
	14	110	30	23	62	84
	15	26	21	5	20	23
Subtotal	15	1,468	–	314	882	1,199
Village of Greendale	1	21	24	3	19	26
	2	21	15	3	18	24
	3	83	24	10	69	93
	4		36			
	5	110	24	14	85	116
	6	211	42	27	148	200
	7	95	36	19	63	83
	8	49	36	6	39	53
	9	6	48	1	4	6
	10	477	72	60	254	327
	11	129	42	26	123	167
	12	58	36	12	57	78
	13	64	24	13	69	90
	14		36			
	15	49	24	10	53	68
	16		24			
	17		24			
	18	21	18	4	19	26
	19	12	36	2	14	18
	20	30	24	6	33	44
	21	138	42	28	87	116
	22	76	42	16	48	66
	23	9	18	2	7	10
	24	101	76 x 48	21	58	76

Table J-10 (continued)

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
Village of Greendale (continued)	25	122	48	25	73	99
	26	55	66 x 40	11	36	48
	27	156	66	32	84	112
	28	12	42	2	8	11
	29	3	24	1	2	3
	30	12	24	2	8	11
	31	6	21	1	4	6
	32		24			
Subtotal	32	2,126	–	357	1,482	1,977
Village of Hales Corners	No System Mapping Available					
Village of Union Grove	1	55	21	19	35	46
	2	92	42	31	48	68
	3	6	12	2	6	8
Subtotal	3	153	–	52	89	122
Total	124	10,541	–	2,113	5,931	8,015

NOTE: N/A indicates data not available.

Table J-11

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE SAUK CREEK WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
City of Port Washington	1	58	36	4	33	45
	2	55	36	4	35	46
	3	55	36	4	30	41
	4	9	15	1	7	9
	5	6	12		5	6
	6	95	60	4	46	60
	7	404	42	31	327	400
	8	28	12	2	19	25
	9	101	30	4	57	70
	10	6	15	–	3	4
	11	3	12	–	2	2
	12	15	24	1	8	11
	13	49	72	2	24	31
	14	37	48	2	20	27
Subtotal	14	921	–	59	616	777
Total	14	921	–	59	616	777

Table J-12

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE SHEBOYGAN RIVER WATERSHED: 1975

Civil Division	Outfall Number	Estimated Tributary Area Acres	Size Range of Outfalls in System (diameter in inches)	Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rates: Two-Year Recurrence Interval Event (cubic feet per second)	Estimated Maximum Storm Water Discharge Rates: Five-Year Recurrence Interval Event (cubic feet per second)
Village of Belgium	1	95	15	4	40	54
	2		24			
Subtotal	2	95	–	4	40	54
Total	2	95	–	4	40	54

Table J-13

AREA SERVED AND SELECTED CHARACTERISTICS OF EXISTING STORM WATER DRAINAGE SYSTEMS IN THE REGION BY WATERSHED: 1975

Watershed	Estimated Tributary Area		Number of Storm Water Outfalls Discharging to Surface Waters	Size Range of Outfalls (diameter in inches)	Summation of Drainage Systems		
					Total Estimated Annual Discharge Volume (million gallons)	Estimated Maximum Storm Water Discharge Rate	
	Acres	Square Miles				Two-Year Recurrence Interval Event (cubic feet per second)	Five-Year Recurrence Interval Event (cubic feet per second)
Des Plaines River	184	0.29	2	24-36	62	124	166
Fox River	12,386	19.35	210	8-78	1,125	6,157	8,208
Kinnickinnic River	10,598	16.56	94	12-142 x 89	2,768	6,708	9,337
Lake Michigan—Minor Streams	18,411	28.77	94	12-82 x 128	4,108	9,947	14,339
Menomonee River	27,379	42.78	344	12-Triple 90 x 54	5,587	20,679	27,674
Milwaukee River	24,795	38.74	309	12-144 x 60	5,369	13,028	17,710
Oak Creek	6,180	9.66	85	12-78	1,133	3,099	4,220
Pike River	2,408	3.76	13	15-72 x 113	246	1,009	1,349
Rock River	3,505	5.48	67	12-78	282	1,880	2,495
Root River	10,541	16.47	124	12-96	2,113	5,931	8,015
Sauk Creek	921	1.44	14	12-72	59	616	777
Sheboygan River	95	0.15	2	15-24	4	40	54
Region Total	117,403	183.44	1,358	–	22,856	69,218	94,344

Appendix K

SELECTED DATA ON STREET AND HIGHWAY SWEEPING PRACTICES AND ICE AND SNOW CONTROL PRACTICES WITHIN THE REGION

Because storm water runoff from streets and highways may constitute an important source of water pollution in some areas of the Region, information on street cleaning and snow and ice control procedures was gathered under a special inventory conducted as part of the areawide water quality management planning program. A survey questionnaire was sent to selected local units of government and to the two district offices of the Wisconsin Department of Transportation. This survey instrument is reprinted below. The completed survey forms are on file at the Commission offices.

____

(Agency or Community completing questionnaire)

STREET AND HIGHWAY MAINTENANCE PRACTICES QUESTIONNAIRE
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
ENVIRONMENTAL PLANNING DIVISION

Answer only the questions that pertain to your operation. If one of the following operations, in whole or part, is performed by someone else, please specify this in your answer. Please feel free to make any additional comments or suggestions you feel are appropriate, on additional sheets of paper, indicating the category number and question number corresponding to the comment. For your convenience we have enclosed a copy of the official Wisconsin State Highway Commission Plat Map(s) for your jurisdiction (current to January 1, 1975), should you find it desirable to map parts of the information requested below.

This questionnaire should be returned to:

Southeastern Wisconsin Regional Planning Commission
916 N. East Avenue
Waukesha, Wisconsin 53186

Should you have any questions, please contact Mr. Jeffrey D. Cowee of the Commission staff at 547-6721, Extension 255.

A. STREET SWEEPING AND CLEANING OPERATIONS

1. Of the total system of streets and highways in your corporate limits, what percentage is built to urban sections with curb and gutter and what percentage is built to rural sections with shoulders and ditches?______% urban ______%rural.

   Please complete the appropriate following table(s) and if possible, attach a copy of your street sweeping route map with the frequencies of sweeping designated on the map.

2. a. Size and frequency of street sweeping operations on streets and highways built to urban sections with curb and gutter:

	Total No. of Curb Miles within your corporate limits	Approximate frequency of sweeping operations (please indicate units-per day, per week, per month—as appropriate)				
		Central Business District	Other Commercial Districts	Industrial Districts	Residential Districts	Other
Freeways and Expressways						
U.S. and S.T. Highways other than Freeways & Expressways						
C. T. Highways						
Local Arterials						
Local Collector Streets						
Local Land Access Streets						
Other-alleys, park drives, pedestrian malls, parking lots						
Totals						

2. b. Size and frequency of street sweeping operations on streets and highways built to rural sections with shoulders and ditches:

	Total No. of Shoulder Miles within your corporate limits	Approximate frequency of sweeping operations (please indicate units-per day, per week, per month—as appropriate)				
		Central Business District	Other Commercial Districts	Industrial Districts	Residential Districts	Other
Freeways and Expressways						
U.S. and S.T. Highways other than Freeways & Expressways						
C. T. Highways						
Local Arterials						
Local Collector Streets						
Local Land Access Streets						
Other-alleys, park drives, pedestrian malls, parking lots						
Totals						

3. What is the estimated average efficiency of the sweeping operation (percentage of the total refuse material in the path of the cleaner that is picked up)?

   ________percent

4. Please indicate the amount of material (pounds per mile and tons per year) picked up in street sweeping in each of the following general areas in your corporate limits:

Area	Central Business Districts	Other Commercial Districts	Industrial Districts	Residential Districts	Other
Pounds per average mile					
Tons per year					

5. Where and how are the street sweepings disposed of?

6. What percentage of the total curb miles within your corporate limits is provided with catch basins as part of the stormwater drainage system?____percent.

7. Are street sweeping operations conducted for streets equipped with catch basins?______

8. Is the frequency of sweeping in these areas different than for other streets?________
   How?

9. When and how do you dispose of the material removed from catch basins?

   What is the frequency of cleaning of the catch basins?______________________

   What is the estimated total tonnage removed per year?____________tons/year.

10. What are the estimated typical annual costs for catch basin cleaning for the communities (e.g., 1975)?

Operation and maintenance of equipment $ ________
Personnel $ ________
Disposal $ ________
Total $ ________

11. For how many curb miles, if any, are the streets swept by hand instead of by machine?

12. What are the typical annual costs for the street sweeping operation for the community (e.g., 1975)?

Operation and maintenance of equipment $ ________
Personnel $ ________
Disposal $ ________
Total $ ________

13. Do you anticipate any changes in your street sweeping operations which might affect their efficiency or effectiveness? If so, please explain.

14. To your knowledge, how many acres of parking areas, if any, are swept by private concerns in privately owned portions of your corporate area?

15. To your knowledge, where and how are the privately collected parking lot sweepings disposed of?

II. SALTING/SANDING, AND PLOWING/SNOW-CLEARING OPERATIONS

1. a. How much of each type of chemical or abrasive was used in the past winter season (1975-1976)?

Dry Calcium ________ tons
Liquid Calcium ________ gal.
Salt (Sodium Chloride) ________ tons
Salt/Sand Mixture ________ tons (indicate % salt ______ %)
Sand or other Abrasive ________ tons

1. b. How much of each type of chemical or abrasive was used during the period of the storm of January 15 and 16, 1976?

Dry Calcium ________ tons
Liquid Calcium ________ gal.
Salt (Sodium Chloride) ________ tons
Salt/Sand Mixture ________ tons (indicate % salt ______ %)
Sand or other Abrasive ________ tons

1. c. At what rate do you typically attempt to apply each of the chemicals or abrasives?

Dry Calcium ________ pounds per lane-mile
Liquid Calcium ________ gallons per lane-mile
Salt (Sodium Chloride) ________ pounds per lane-mile
Salt/Sand Mixture ________ pounds per lane-mile
Sand or other abrasive ________ pounds per lane-mile

2. Please complete the following table and if possible, attach a copy of your route map for salting, sanding, and plowing operations.

	Total No. of lane miles in your corporate limits	Approximate % included in your salting operations	Approximate % included in your plowing operations	Type of Chemical or Abrasive Used
Freeways and Expressways				
U.S. and S.T. Highways other than Freeways & Expressways				
C. T. Highways				
Local Arterials				
Local Collector Streets				
Local Streets				
Other-alleys, park drives, pedestrian malls, parking lots				
Total				

3. Under what weather conditions do you initiate your chemical/abrasive applications? (e.g., temperature, amount of snow, duration of snow, etc.)

4. Under what weather conditions do you initiate your plowing operations (e.g., temperature, amount of snow, duration of snow, etc.)?

5. Where do you store snow and ice control chemicals?

6. Are these sites covered or open?

7. What were the annual costs for salting/sanding and plowing, (e.g., 1975)?

Operation and maintenance of equipment $ ________
Personnel $ ________
Chemicals $ ________
Total $ ________

What were the annual costs for salting/sanding and plowing for the period of the storm of January 15 and 16, 1976?

Operation and maintenance of equipment $ ________
Personnel $ ________
Chemicals $ ________
Total $ ________

8. To your knowledge, what is the approximate total area, if any, of plowing that is done by private concerns in your corporate limits? Where?

9. To your knowledge, what is the approximate total area, if any, of salting or sanding that is done by private concerns in your corporate limits?

10. What is the number of lane-miles, or the percentage of total lane-miles in your corporate limits for which the snow is hauled for disposal?

11. Where do you dispose of the snow, and how far is the nearest stream or lake from the point(s) of disposal?

12. Do you anticipate any changes in your salting/sanding or plowing/snow clearing operations which might affect their efficiency or effectiveness? If so , please explain.

III. GENERAL COMMENTS

1. Have there been any experiments conducted in your community on street sweeping, catch basin cleaning, snow removal, or salting and sanding operations to evaluate their effectiveness or their impact on stormwater runoff? If so, please describe the experiment briefly and give the name of a person who could be contacted for more information.

2. The Commission would welcome and appreciate any additional comments or suggestions you might have to offer concerning the topics in this questionnaire.

Name of individual providing data and where he may be contacted:

____
(Name)

____
(Title)

____
(Agency or Community)

____
(Phone)

Date of completion of questionnaire: ________________
(Date)

Appendix L

SUMMARY OF FERTILIZER APPLICATION, CROPPING, AND PESTICIDE APPLICATION PRACTICES BY COUNTY

INTRODUCTION

The following comments present a characterization of the generally accepted agricultural practices for each county in the Southeastern Wisconsin Region as of 1975, and include descriptions of specific cropping methods and land management techniques used by farmers in the production of specific crops. The information has been assembled for use in the areawide water quality planning program conducted by the Southeastern Wisconsin Regional Planning Commission. The description of practices for each county is based on information provided by the Soil and Water Conservation District, the University of Wisconsin-Extension Service (UWEX), District Conservationists and office staffs of the U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS), and the staffs of the USDA Agricultural Stabilization and Conservation Service (ASCS), as well as by agricultural operators throughout the Region. As necessary, supplemental information was obtained from specialists in the central offices of the University of Wisconsin-Extension Service in Madison. The descriptions are presented as a basis for the analysis of agricultural land management and the potential effects of such management on water quality in the streams and lakes of the Region. It should be recognized by all concerned that the information herein is representative of average or typical operations: therefore, only general conclusions can be drawn from the information.

GENERAL PESTICIDE USE IN SOUTHEASTERN WISCONSIN

The pesticides most commonly used in Southeastern Wisconsin are summarized in Table L-1. The data were developed on the basis of information provided by the above-cited county agricultural staffs, and were integrated for the Region on the basis of personal communications with pesticide speciality of the University of Wisconsin-Extension Services in Madison. The integration was necessary due to source usage differences reported by county, and due to reporting of data for only selected crops in each county response. The data reported by county are set forth in the following sections of this Appendix.

General Agricultural Practices in Kenosha County

Small Grain Crops: Oats is the most popular small grain sown in the County, because of its versatility—it can be sown alone or used as a nurse crop for hay. Oats sown with the hay can be harvested the first season while giving the hay an opportunity to mature for cropping the following season. Manure can be spread during the fall and spring, preceding planting. However, most manure in Kenosha County is applied to corn lands or hay stands. Approximately 5 percent of the county farmers stockpile their manure during the winter rather than spreading it on the frozen ground and creating the potential for direct runoff and contamination of surface waters. The seedbed is generally prepared using the traditional tillage method of fall moldboard plowing, followed by spring-tooth harrowing or disking in spring to break up the clods, also known as "peds," thrown up by the plow. Spring plowing is generally done only by necessity, with fall plowing the preferred practice. Of recently developed conservation tillage methods the most popular is chisel plowing, which is reportedly used on less than 5 percent of the county agricultural land as an alternative to moldboard plowing. Chisel plowing loosens the soil by forcing the chisel point along the surface of the field, rather than turning the soil over as traditional moldboard plowing does, thereby leaving a portion of the residue from the previous crop on the surface to control soil erosion by runoff. It should be noted that a gradual increase to as high as 20 percent of the agricultural land in portions of the County has been observed by the SCS staff. Other minimum tillage practices are reportedly used on only perhaps 2 percent of the acreage devoted to agriculture.

Once the spring working of the soil and the incorporation of the spread manure is completed, the seedbed is ready to plant in April or May with a grain drill in narrow rows. This procedure is known as solid seeding. If fertilizer is to be added to the soil, it is done at this time, adding 200 pounds per acre of 6-24-24 if the oats crop is seeded alone, and 300 pounds per acre of 0-14-46 if the oats crop is seeded with hay. The numbers used to designate the various types of fertilizers indicate the percent by weight of elemental nitrogen, phosphorus (as P_2O_5), and potassium (as K_2O) present in the fertilizer applied. Thus, 200 pounds of 6-24-24 contains a blend of 6 percent of nitrogen, 24 percent P_2O_5, and 24 percent K_2O. The element proportions of the fertilizer used depend on the chemical characteristics of the soil in a field, as compared to the nutrients needed to support crop growth. Nitrogen is generally left out of fertilizers used on grain-seeded hay, because the hay fixes nitrogen from the atmosphere and adds sufficient nitrogen for the grain. Whether the soil lacks the required nutrients can be determined by a soil test, prepared with the assistance of the University of Wisconsin-Extension Service Soil Testing Program administered through the ASCS. In 1975, 90 farmers in Kenosha County took advantage of this testing program. This compares to 1,778 landowners identified as possessing holdings of 10 acres or more. The low response is attributed to withdrawal of ASCS wage support for a soil tester and the incorrect assumption by the farmers that once a soil test has been taken, there is no longer a need for this service. Currently, the farmer must take his own samples and have UWEX or ASCS send the samples out for analysis. Soil samples are only required for those farmers who apply for ASCS cost-sharing on vegetative cover practices. Some fertilize dealers also take soil samples for farmers. The results of these samples are not recorded unless the samples are analysed at a university laboratory. Response analysis shows that in 1967, when soil tests were supported by ASCS, 148 Kenosha County farmers had soil tests taken. After 1967, when the support was removed, the number of farms which had soil tests run dropped significantly.

No further agricultural management techniques are employed until harvest time in late July or August. If the oats crop was seeded with hay, no fall tillage is required after the harvest. However, if the grain was seeded alone, the plowing method and time will depend on the crop planned for the following year. It is reported that generally no pesticides are used on oats crops—as noted in Table L-2 Herbicides and insecticides, used on all crops grown in the County, generally are not applied at rates exceeding the label directions because of the high cost of these chemicals, and the possibility that chemical damage to the crop by over-application could exceed the damage by the pest of concern if the crop were unprotected. Soil conditions, microclimates, and operator preferences cause differences in crop treatment in the Towns of Salem, Somers, and Pleasant Prairie. These differences probably result from a greater cash crop production, less livestock production, the soil types, and alternative employment opportunities.

Spring wheat crops are handled in much the same way as an oats crop might be if seeded alone. Method and timing of tillage, planting, harvest, and herbicide and manure application are all similar to the practices used for oats. Fertilizer, in the form of 10-26-26 at 200 to 300 pounds per acre, is applied to the wheat crop. Winter wheat differs from spring wheat only in planting time and harvest time. Winter wheat is planted in September or October after the previous year's crop has been harvested and the field has been tilled. Harvest for winter wheat occurs in mid-July to early August and precedes the spring wheat harvest period by one to two weeks. Winter wheat does offer the dual advantage of providing winter cover to reduce soil loss and reducing the farmer's work load at spring planting time.

Hay Crops: In any given year, hay can be categorized into three groups—grain-seeded hay, hay seeded alone, and standing hay. Hay is a general term used for all perennial crops which are harvested for animal consumption, and in Kenosha County consists of alfalfa, brome grass, timothy, canary grass, red clover, alsike clover, ladino clover, orchard grass, and combinations of the above. Grain-seeded hay has been discussed above in conjunction with oats, and is the most commonly used in establishing a new stand of hay. As noted above, hay is seldom seeded without a nurse crop, because a grain nurse crop gives the new hay plants some protection from the weather, and holds the soil in place during runoff periods while the hay plants are becoming established.

Both organic and inorganic fertilizers are applied during the growing season to existing hay stands. Manure is generally applied to hay land during the winter, or during the growing season if there is no other land to spread it on. However, most manure is spread on corn land. Inorganic fertilizer, in the form of 0-14-45 at 300 pounds per acre, is applied to existing stands either in early spring or in June. Once a hay crop has been established it remains on the same field for three to five years, depending on the farmer's preferences and the soil fertility of the field. The hay is harvested by cutting, drying, and baling three to four times per season, depending on the condition of the stand and the weather conditions that season. If the hay is "green chopped" for immediate feeding or anaerobic storage or silage, it can be cropped up to four times in a growing season. After the final hay harvest in the last year of a hay crop, the hay sod is turned under the surface with the traditional moldboard plow. Chisel plowing is not popular for this purpose as it does not break up the hay sod sufficiently to allow for the planting of another crop the following spring. Moldboard plowing is the popular practice, since it breaks up the heavy clay soils comprising about 75 percent of the county soils. The fall plowing and the winter freeze-thaw cycles together break up the large clods or "peds" to make the soil workable in spring.

Sudan grass is an annual forage crop planted like a grain crop and harvested three times during the growing season to provide a supplement to hay for animal feed. It can be either green chopped and fed directly to the animals, stored in a silo, or cut, dried, baled, and stored for later use as animal feed. Sudan grass is harvested three to four times per year, depending upon the weather conditions from June to the first frost, but after the first frost the crop becomes poisonous and must be plowed under. The only fertilizer—other than manure—which may be applied at planting if necessary is 10-10-10 fertilizer at the rate of 300 pounds per acre. Sudan grass is the most popular in the Towns of Brighton and Somers.

Row Crops: Corn is being planted in increasing amounts as a cash crop in the County. A farmer has two options when planting corn—to plant an early crop in spring or a late crop in June or July. Early corn is planted in April or early May on a bare field which had been plowed the previous fall and worked again in the preplant stage in spring. If the farmer also runs an animal operation, he may have added nitrogen, in the form of manure, to the soil in fall before plowing and again in spring in the preplant stage. Some chisel plowing, as described above, is used on corn acreage. However, more pesticides are required when chisel plowing instead of traditional moldboard plowing is used to till the soil, since chisel plowing leaves more residue from the past year's crop on the surface to harbor weed seeds and insects and to promote growth of pest populations. Chisel tillage also allows for only one cultivation of a corn crop, thereby promoting additional weed growth when compared to the repeated cultivation practices used in conventional tillage which destroy the weed plants. Likewise, when chisel tillage is used, the remaining residue harbors insect pests necessitating the application of more insecticides such as Thimet, Furadan, or Counter in the pre- or post-emergent stage of the crop than are necessary for moldboard tilled crops. Because corn requires an abundant supply of nitrogen for growth, county farmers generally add 100 pounds of nitrogen per acre to the soil in addition to up to 300 pounds per acre of 6-24-24 at planting time. Variations occur due to personal preferences, training and experience, product availability, previous crops on the field, soil type, and soil test results where they are available. Harvesting of early corn takes place in the fall after the corn cobs have dried to about 20 percent moisture, but before the ground is frozen and becomes too hard to plow. On the average, about 90 percent of the farm operators in the County plow in the fall. Deviations do occur in those years when the fall is exceptionally wet, when the ground freezes very early, and when the operator does not have the opportunity to plow in fall for other reasons.

Late corn follows the same pattern of treatment, except for fertilizer application and harvesting techniques. This second type of corn is seeded in the soil of an old hay stand, which was turn-plowed in late spring or early summer, after one cutting of hay in early June after severe damage to the hay crop from winterkill has become apparent, or after an early canning crop is harvested. In the case of winterkill, the use of the field for delayed corn offers the only means for a farmer to produce a crop on the field that year. If the field is manured, it is done before plowing. Herbicides and insecticides are applied in the same manner as for early field corn; but since the previous crop was hay, only 250 pounds of 7-26-26 fertilizer per acre is typically needed. Little nitrogen is added at this time, as the previous hay crop is generally assumed to have added enough nitrogen to the soil to support the growth of a corn crop. Late corn is grown for silage feeding rather than for cob corn, as the cobs would not mature in the short amount of time remaining in the growing season. The corn is chopped from August to October and either fed directly to the animals or put into the silo for fermentation and storage for livestock feeding in winter.

Soybeans are grown as an important cash crop in the County, and approximately the same amount of acres is planted every year. The crop is planted in spring or summer in narrow rows or solid-seeded in a manner similar to that for small grains. Soybeans, as well as any other crop, can be planted in narrow rows, according to the operators' discretion. This type of planting reduces row width from 30"-48" to 20"-30," thereby allowing the farmer to plant more rows on one field and to produce higher yields. It has been estimated that approximately 40 percent of the soybean acreage in the County is planted in narrow rows. However, solid seeding is preferred as it reduces the weed problem and the need for herbicides. As insect pests are a minor problem, no insecticides are applied in a typical operation. Fertilizer is added to the soil in the amount of 150 pounds per acre of 0-14-42 at planting time.

Vegetable Crops: Cabbage is the only canning crop grown in Kenosha County. This crop and the fresh market crops of potatoes, beets, sweet corn, and set onions are grown primarily in the Towns of Somers and Paris, with smaller acreages in the Towns of Bristol and Pleasant Prairie. The low soils with their high organic content and moisture-retaining properties make this area of the County especially conductive to the raising of such vegetable crops without the need of irrigation water. Potatoes raised in this area are either sold direct from roadside stands or used for the production of potato chips. Most of the beets grown are sold fresh in the Waukesha County community of Sussex. Only small amounts of onions are grown and these are in the form of set onions rather than onions for consumption. Sweet corn is grown for sale at roadside stands or farmers markets.

All the vegetable crops are planted in April or May on a smooth seedbed cleared of debris. The seedbed is prepared using the traditional moldboard plow, disk, or spring-tooth harrow, and the drag. The fields designated for these vegetable varieties are heavily fertilized before planting. Cabbage growers typically add 1,000 pounds per acre of a fertilizer containing equivalent amounts of nitrogen, phosphorus, and potassium, such as 12-12-12, as well as magnesium and zinc, in quantities determined by soil tests to be necessary for each field. Fertilizers added to sweet corn are 14-14-14 and 6-24-24 in the amounts of 400 to 500 pounds per acre and 250-500 pounds per acre, respectively. Beet fields receive 700 pounds per acre of 7-25-25, and boron may also be applied depending on soil test recommendations. Set onions reportedly require 500 to 1,500 pounds per acre of 6-24-24 and 20 pounds per acre of nitrogen to produce a satisfactory crop. Herbicides and insecticides commonly applied to these crops and the timing of their application are illustrated in Table L-2. The vegetables are harvested at their peak of ripeness—from July to August for corn, August to October for cabbage and beets, and July to October for potatoes.

Specialty Crops: Mint is a specialty crop indigenous to the Town of Wheatland in Kenosha County, and grown in a rotation with sweet corn on low-lying heavy muck soils. Cuttings are planted in late April and allowed to grow until harvest in August when the mint is mowed, dried, and chopped like alfalfa and distilled for mint oil. Sinbar is the major herbicide applied before planting to curb weed growth; additional weeds are removed by hand. As the mint is grown in muck soils, 300 pounds per acre of potassium and 300 pounds per acre of 6-24-24 are applied as fertilizers.

Sod farms are located on low-lying, heavy soils in the Town of Bristol. The crop is planted on carefully turned, cleared, and smoothed soil in April or May. Proper growth is promoted by sprinkle irrigation when conditions warrant, herbicide application after planting to deter unwanted weed growth, and application of 500 pounds per acre of 6-10-10 fertilizer before planting. The sod crop is harvested whenever the growth is sufficient to allow cutting. Properly done, the harvest cut is shallow enough for the remaining roots to spur regrowth, thereby allowing several sod crops per growing season to be harvested from each sod field.

Animal Waste-Handling and - Disposal Practices: Animal waste-handling and - disposal practices in Kenosha County vary according to the size and type of operation, as well as by personal preferences and capital resources of the operator. Extensive pasturing is uncommon, with most animals kept in a barnyard or small field of 20 acres or less. Waste-handling systems vary widely in sophistication from manual loading and tractor hauling combinations to slurried collection and transmission facilities; but the vast majority of livestock operators in the County use tractor-scoop loading or mechanized gutter-cleaners to clean out barns and barnyards. Regardless of the time of year, the stockpiling of manure—mixed with bedding materials—is common in areas which are conveniently near the barnyards. Virtually all animal wastes generated in agricultural operations within the County are disposed of on the land surface. An estimated 85 percent of the operators haul and spread manure in the winter, despite the frozen ground and the potential contamination of nearby surface waters. It is unusual for an operator to have a specially designed manure storage facility, and this type of facility is included in the operations of less than 5 percent of the farm operators within the County. The notable exceptions are fur or fowl farms, or the very largest beef or dairying operations in which the animal wastes generation problems are of a major proportion. Such sources are addressed within the point source and industrial wastewater discharge inventories being conducted under the areawide water quality planning program for southeastern Wisconsin.

General Agricultural Practices in Ozaukee County

Small Grain Crops: Oats is the most popular small grain sown in the County, because of its versatility—it can be sown alone or used as a nurse crop for hay. Oats sown with the hay can be harvested the first season while giving the hay an opportunity to mature for cropping the following season. Manure is spread on the crop during the fall and spring, preceding planting. It is estimated that up to 20 percent of the county farmers stockpile their manure during the winter rather than spreading it on the frozen ground and creating the potential for direct runoff and contamination of surface waters. The seedbed is generally prepared using the traditional tillage method of fall moldboard plowing, followed by spring-tooth harrowing or disking in spring to break up the clods, also known as "peds," thrown up by the plow. Spring plowing is generally done only by necessity, with fall plowing the preferred practice. Of recently developed conservation tillage methods, the most popular is chisel plowing, which is reportedly used on 5 percent of the county agricultural land as an alternative to moldboard plowing. Chisel plowing loosens the soil by forcing the chisel point along the surface of the field rather than turning the soil over as traditional moldboard plowing does, thereby leaving a portion of the residue from the previous crop on the surface to control soil erosion by runoff. No other minimum tillage practices are used on the acreage devoted to agriculture in Ozaukee County, as reported by the University of Wisconsin-Extension office.

Once the spring working of the soil and the incorporation of the spread manure is completed, the seedbed is ready to plant in April or May, usually in narrow rows using a grain drill. This procedure is known as solid seeding. If fertilizer is to be added to the soil, it is done at this time, adding 200 pounds of 0-20-20 per acre if the oats crop is seeded alone, and 200 pounds per acre of 0-10-30 if the oats crop is seeded with hay. The numbers used to designate the various types of fertilizers indicate the percent by weight of elemental nitrogen, phosphorus (as P_2O_5), and potassium (as K_2O) present in the fertilizer applied. Thus, 200 pounds of 0-20-20 would be a blend of 20 percent P_2O_5 and 20 percent K_2O. The element proportions of the fertilizer used depend on the chemical characteristics of the soil in a field, as compared to the nutrients needed to support crop growth. Nitrogen is generally left out of fertilizers used on grain-seeded hay, because the hay fixes nitrogen from the atmosphere and adds sufficient nitrogen for the grain. Whether the soil lacks the required nutrients can be determined by a soil test. Although UWEX does operate two soil analysis laboratories, most Ozaukee County soil tests are run by fertilizer dealers as a technical service. Because the Ozaukee County office of UWEX does not receive copies of the soil analyses, it is not known what proportion of the 1,393 land owners of parcels had soil tests taken.

No further agricultural management techniques are employed until harvest time in late July or August. If the oats crop was seeded with hay, no fall tillage is required after the harvest. However, if the grain was seeded alone, the plowing method and time will depend on the crop planned for the following year. Pesticide usage rates as well as times and methods of application are presented for all crops in Table L-3. Herbicides and insecticides, used on all crops grown in the County, generally are not applied at rates exceeding the label directions because of the high cost of the chemicals, and the possibility that chemical damage to the crop by over-application could exceed the damage by the pest of concern if the crop were unprotected.

Spring wheat crops are handled in much the same way as an oats crop might be if seeded alone. Method and timing of tillage, planting, harvest, and herbicide and manure and fertilizer application are all similar to the practices used for oats. Winter wheat differs from spring wheat only in planting time and harvest time. Winter wheat is planted in September or October after the previous year's crop has been harvested. Winter wheat is harvested in mid-July or early August of the following year and precedes the spring wheat harvest period by one to two weeks. Winter wheat does offer the dual advantage of providing winter cover to reduce soil loss and reducing the farmer's work load at spring planting time.

Hay Crops: In any given year, hay can be categorized into three groups—grain-seeded hay, hay seeded alone, and standing hay. Hay is a general term used for all perennial crops which are harvested for animal consumption, and in Ozaukee County consists of alfalfa, brome grass, timothy, canary grass, red clover, alsike clover, orchard grass, and combinations of the above. Grain-seeded hay has been discussed above in conjunction with oats, and is the most commonly used in establishing a new stand of hay. As noted above, hay is seldom seeded without a grain nurse crop, because, a grain nurse crop for hay gives the new hay plants some protection from the weather, and holds the soil in place during runoff periods while the hay plants are becoming established.

Both organic and inorganic fertilizers are applied at various times to existing hay stands. Manure is generally applied to hay land during the winter, or during the growing season if there is no other land to spread it on. Inorganic fertilizer, in the form of 0-0-60 at 200 pounds per acre, is applied to existing stands either in early spring or in June. Once a hay crop has been established it remains on the same field for two to three years, depending on the farmer's preferences and the soil fertility of the field. The hay is harvested by cutting, drying, and baling two to three times per season depending on the condition of the stand and the weather conditions that season. If the hay is "green chopped" for immediate feeding or anaerobic storage as silage, it can be cropped up to four times in a growing season. After the final hay harvest in the last year of a hay crop, the hay sod is turned under the surface with the traditional moldboard plow. Chisel plowing is not popular for this purpose as it does not break up the hay sod sufficiently to allow for the planting of another crop the following spring. Moldboard plowing is the popular practice since it breaks up the heavy clay soils comprising roughly 60-70 percent of the county soils. The fall plowing and the winter freeze-thaw cycle together break up the large clods or "peds" to make the soil workable in spring.

Sudan grass is an annual forage crop planted like a grain crop and harvested two to three times during the growing season to provide a supplement to hay for animal feed. It can be either green chopped and fed directly to the animals, stored in a silo, or cut, dried, baled, and stored for later use as animal feed. Sudan grass is harvested two to three times per year, depending upon the weather conditions from June to the first frost, but after the first frost the crop becomes poisonous and must be plowed under. Because sudan grass is grown only as an emergency crop in Ozaukee County, it is reportedly not necessary to apply any fertilizer to the field.

Row Crops: Corn is being planted in increasing amounts as a cash crop in the County. A farmer has two options when planting corn—to plant an early crop in spring or a late crop in June or July. If the farmer also runs an animal operation, nitrogen in the form of manure will have been added to the soil before plowing the previous fall and again in spring in the preplant stage. Some chisel plowing, as described above, is used on corn acreage. However, more pesticides are required when chisel plowing instead of traditional moldboard plowing is used to till the soil, since chisel plowing leaves more residue from the past year's crop on the surface to harbor weed seeds and insects and to promote growth of pest populations. Chisel tillage also allows for only one cultivation of a corn crop, thereby promoting additional weed growth when compared to the repeated cultivation practices used in conventional tillage which destroy the weed plants. Likewise, when chisel tillage is used, the remaining residue harbors insect pests necessitating the application of more pesticides such as Thimet, Furadan, or Counter in the pre- or post- emergent stage of the crop than are necessary for moldboard tilled crops. Because corn requires an abundant supply of nitrogen for growth, county farmers generally add 60 pounds of nitrogen per acre to the soil in addition to 250 pounds per acre of 7-28-28 at planting time. Variations occur due to personal preferences, training and experience, product availability, previous crops on the field, soil type, and soil test results where they are available. Harvesting of early corn takes place in the fall after the corn cobs have dried to about 26 percent moisture, but before the ground is frozen and becomes too hard to plow. On the average, about 95 percent of the operators in the County plow in the fall, if weather conditions permit, to take advantage of the winter's freeze-thaw action on the heavier clay soil.

Late corn follows the same pattern of treatment, except for the fertilizer application and harvesting techniques. Late corn, which constitutes an estimated 5 percent of all corn planted in the County in an average year, is seeded in the soil of an old hay crop which was turn-plowed in late spring or early summer after one cutting of hay early in June, after severe damage to the hay crop from winterkill has become apparent, or after harvest of early canning crops. In case of winterkill, the use of the field for corn offers the only means for a farmer to produce a crop on the field that year. If the field is manured, it is done before plowing. Herbicides and insecticides are applied in the same manner as for early field corn;

but since the previous crop was hay, only 250 pounds of 7-28-28 fertilizer per acre is typically needed. No nitrogen is added at this time, as the previous hay crop is generally assumed to have added enough nitrogen to the soil to support the growth of a corn crop. Late corn is grown for silage feeding rather than for cob corn, as the cobs would not mature in the short amount of time remaining in the growing season. The corn is chopped from August to October and either fed directly to the animals or put into the silo for fermentation and storage for livestock feeding in winter.

Soybeans are grown as a cash crop in the County, with increasing acreages planted every year. The crop is planted in spring or summer in a manner similar to that for corn. Manure can be applied to the field the previous fall before plowing, and in the spring before final use of a disk and/or spring-tooth harrow. As insect pests are a minor problem, no insecticides are applied in a typical soybean operation. Fertilizer is added to the soil at planting time in the amount of 200 pounds per acre of 0-20-20. Soybeans, as well as any other crop, can be planted in narrow rows, according to the operators' discretion. This type of planting reduces row width from 30"-48" to 20"-30", thereby allowing the farmer to plant more rows on one field and to produce higher yields. It has been estimated that none of the agricultural land in the County is planted in this manner, however, as the initial investment in new machinery to plant, till, and harvest a narrow row crop represents a relatively large proportion of the income of most farm operators.

Vegetable Crops: Crops grown for canning in Ozaukee County include peas, sweet corn, cabbage, beets, carrots, and onions. With the exception of sweet corn, most of these crops are grown on soils which ensure sufficient moisture for the growing season. Because the average annual precipitation in the County exceeds 30 inches, reportedly little or no irrigation is necessary for the satisfactory production of these crops. All the vegetable crops are planted in April or May on a smooth seedbed cleared of debris. This means that only the traditional moldboard plow, disk, or spring-tooth harrow, and drag can be used to prepare the seedbed. The fields designated for these canning vegetable varieties are heavily fertilized before planting. Cabbage growers typically add 1,200 pounds per acre of 17-17-17, as well as magnesium and zinc, in quantities determined by soil tests to be necessary for each field. Fertilizer added to sweet corn is 7-28-28 in the amount of 200 pounds. Beet fields receive 150 pounds per acre each of 50-20-20B (B-boron) and 10-10-10. The 50-20-20B fertilizer contains 50 percent nitrogen, 20 percent P_2O_5, and 20 percent K_2O, with two to three pounds of boron added. Fertilizers applied to carrot fields generally include 900 pounds per acre of 0-10-40 and 30 pounds per acre of nitrogen. Onions reportedly require 80 pounds per acre of nitrogen and 1,200 pounds per acre of 0-10-30 to produce a satisfactory crop. Peas need 30 to 40 pounds per acre of nitrogen—depending on the organic content of the soil—and 12 to 30 pounds each of phosphorus and potassium, depending on soil test recommendations. Herbicides and insecticides commonly applied to these crops and the timing of their application are illustrated in Table L-3. The vegetables are harvested at their peak of ripeness—from July to August for peas and corn and August to October for cabbage, beets, carrots, and onions.

Potatoes are grown on truck farms for direct sale to consumers. Planting is in April or May, and harvest occurs from July to October. The seedbed is prepared using conventional tillage methods to keep the soil loose and free of debris. Usually potatoes are grown on low heavy soils that retain moisture, reportedly precluding the need for irrigation. Herbicide and insecticide use and timing of application are presented in Table L-3. The most commonly used fertilizer is 10-10-10, applied at 500 pounds per acre.

Animal Waste-Handling and - Disposal Practices: Animal waste-handling and - disposal practices in Ozaukee County vary according to the size and type of operation, as well as by personal preferences and capital resources of the operator. Extensive pasturing is uncommon in Ozaukee County, with most animals kept in a barnyard or small field of five acres or less. Waste-handling systems vary widely in sophistication from manual loading and tractor hauling combinations to slurried collection and transmission facilities; but the vast majority of livestock operators in the county use tractor-scoop loading or mechanized gutter-cleaners to clean out barns and barnyards. Regardless of the time of year, the stockpiling of manure—mixed with bedding materials—is common in areas which are conveniently near the barnyards. Virtually all animal wastes generated in agricultural operations within the County are disposed of on the land surface. An estimated 80 percent of the operators haul and spread manure in the winter, despite the frozen ground and the associated potential contamination of nearby surface waters. It is unusual for an operator to have a specially designed manure storage facility, and this type of facility is included in the operations of less than 5 percent of the farms within the County. The notable exceptions are fur or fowl farms, or the very largest beef or dairying operations in which the animal wastes generation problems are of a major proportion. Such sources are addressed within the point source and industrial wastewater discharge inventories being conducted under the areawide water quality planning program for southeastern Wisconsin.

General Agricultural Practices in Racine County

Small Grain Crops: Oats is the most popular small grain sown in the County, because of its versatility—it can be sown alone or used as a nurse crop for hay. Oats sown with the hay can be harvested the first season while giving the hay an opportunity to mature for cropping the following season. Manure can be spread on the crop during the fall and spring, preceding planting. Approximately 25 percent of the county farmers stockpile their manure during the winter rather than spreading it on the frozen ground and creating the potential for direct runoff and contamination of surface waters. The seedbed is generally prepared using the traditional tillage method of fall moldboard plowing, followed by spring-tooth harrowing or disking in spring to break up the clods, also known as "peds," thrown up by the plow. Spring plowing is generally done only by necessity, with fall plowing the preferred practice. Of recently developed conservation tillage methods the most popular is chisel plowing, which is reportedly used on 30 percent of the county's agricultural land as an alternative to moldboard plowing. Chisel plowing loosens the soil by forcing the chisel point along the surface of the field rather than turning the soil over as traditional moldboard plowing does, thereby leaving a portion of the residue from the previous crop on the surface to control soil erosion by runoff. Other minimum tillage practices are used on less than 15 percent of the acreage devoted to agriculture.

Once the spring working of the soil and the incorporation of the spread manure is completed, the seedbed is ready to plant in April or May, usually in narrow rows using a grain drill. This procedure is known as solid seeding. If fertilizer is to be added to the soil, it is done at this time, adding 250 pounds of 6-24-24 per acre if the oats crop is seeded alone, and 300 pounds per acre of 6-24-24 if the oats crop is seeded with hay. The numbers used to designated the various types of fertilizers indicate the percent by weight of elemental nitrogen, phosphorus, (as P_2O_5) and potassium (as K_2O) present in the fertilizer applied. Thus, 250 pounds of 6-24-24 contains a blend of 6 percent nitrogen, 24 percent of P_2O_5 and 24 percent K_2O. The element proportions of the fertilizer used depend on the chemical characteristics of the soil in a field, as compared to the nutrients needed to support crop growth. Nitrogen is generally left out of fertilizers used on grain-seeded hay, because the hay fixes nitrogen from the atmosphere and adds sufficient nitrogen for the grain. Whether the soil lacks the required nutrients can be determined by a soil test, prepared with the assistance of the University of Wisconsin-Extension Service Soil Testing Program administered through the ASCS. In 1975, 175 Racine County farmers took advantage of this service, submitting their soil samples to the ASCS or UWEX offices to be sent to the UWEX laboratory for analysis. This compares to 2,621 landowners in the County identified as possessing holdings of 10 acres or more.

No further agricultural management techniques are employed until harvest time in late July or August. If the oats crop was seeded with hay, no fall tillage is required after the harvest. However, if the grain was seeded alone, the plowing method and time will depend on the crop planned for the following hear. Herbicide and insecticide usage rates as well as time and methods of application are presented for all crops in Table L-4. Herbicides and insecticides, used on all crops grown in the County, generally are not applied at rates exceeding the label directions because the high cost of the chemicals, and the possibility that chemical damage to the crop by over-application could exceed the damage by the pest of concern if the crop were unprotected. Few oats are grown in the Towns of Norway and Waterford because of the muck soils which, based on previous experience by the farmers, are better suited to the production of specialty or vegetable crops.

Spring wheat crops are handled in much the same way as an oats crop might be if seeded alone. Method and timing of tillage, planting, harvest, and herbicide and manure and fertilizer application are all similar to the practices used for oats. Winter wheat differs from spring wheat only in planting time and harvest time. Winter wheat is planted in September or October after the previous year's crop has been harvested and the field has been tilled. Harvest for winter wheat occurs in mid-July to early August of the following year and precedes the spring wheat harvest period by one to two weeks. Winter wheat does offer the dual advantage of providing winter cover to reduce soil loss and reducing the farmer's work load at spring planting time.

Hay Crops: In any given year, hay can be categorized into three groups—grain-seeded hay, hay seeded alone, and standing hay. Hay is a general term used for all perennial crops which are harvested for animal consumption, and in Racine County consists of alfalfa, brome grass, timothy, red clover, and combinations of the above. Grain-seeded hay has been discussed above in conjunction with oats, and is the most commonly used in establishing a new stand of hay. As noted above, hay is seldom seeded without a nurse crop, because a grain nurse crop gives the new hay plants some protection from the weather, and holds the soil in place during runoff periods.

Both organic and inorganic fertilizers are applied at various times to existing hay stands. Manure is generally applied to hay land during the winter, or during the growing season if there is no other land to spread it on. Inorganic fertilizer, in the form of 0-20-20 at 200 pounds per acre, is applied to existing stands either in early spring or in June. Once a hay crop has been established it remains on the same field for four to eight years depending on the farmer's preferences and the soil fertility of the field. The hay is harvested by cutting, drying, and baling two to three times per season, depending on the condition of the stand and the weather conditions that season. If the hay is "green chopped" for immediate feeding or anaerobic storage as silage, it can be cropped up to five to six times in a growing season. After the final hay harvest in the last year of a hay crop, the hay sod is turned with the traditional moldboard plow. Chisel plowing is not popular for this purpose as it does not break up the hay sod sufficiently to allow for the planting of another crop the following spring. Moldboard plowing is the most popular practice, since it serves to break up the heavy clay soils comprising roughly 70 percent of the county soils. The fall plowing and the winter freeze-thaw cycle together break up the large clods or "peds" to make the soil workable in spring.

Sudan grass is an annual forage crop planted like a grain crop and harvested twice during the growing season to provide a supplement to hay for animal feed. It can be either green chopped and fed directly to the animals, store in a silo, or cut, dried, baled, and stored for later use as animal feed. Sudan grass is harvested two to three times per year, depending upon the weather conditions from June to the first frost, but after the first frost the crop becomes poisonous and must be plowed under. It is reported that fertilizer is generally not applied to Sudan grass in Racine County.

Row Crops: Corn is being planted in increasing cost amounts as a cash crop in the County. It is generally planted in April or May on a bare field. If the farmer also runs an animal operation, nitrogen in the form of manure may have been added to the soil before plowing the previous fall and before the soil was again worked in the preplant stage in spring. Some chisel plowing, as described above, is used on corn acreage. However, more pesticides are required when chisel plowing instead of traditional moldboard plowing is used to till the soil, since chisel plowing leaves more residue from the past year's crop on the surface to harbor weed seeds and insects and to promote growth of pest populations. Chisel tillage also allows for only one cultivation of a corn crop, thereby promoting additional weed growth when compared to the repeated cultivation practices used in conventional tillage which destroy the weed plants. Likewise, when chisel tillage is used, the remaining residue harbors insect pests necessitating the application of more Thimet, Furadan, or Counter in the pre- or post- emergent stage of the crop than are necessary for moldboard tilled crops. Because corn requires an abundant supply of nitrogen for growth, county farmers generally add 100 pounds of nitrogen per acre in the form of anhydrous ammonia to the soil in addition to 200 pounds per acre of 5-20-20 at planting time. Variations occur due to personal preferences, training and experience, product availability, previous crops on the field, soil type, and soil test results where they are available. Harvesting takes place in the fall after the corn cobs have dried to about 22 percent moisture, but before the ground is frozen and becomes too hard to plow. On the average, about 90 percent of the operators in the County plow in the fall to take advantage of the winter's freeze-thaw action on the heavier clay soil.

Soybeans, grown as a cash crop in the County, are planted in spring or summer in a manner similar to that for corn. Manure can be applied to the field the previous fall before plowing, and in the spring before final use of a disk and/or spring-tooth harrow. Because insect pests are a minor problem, no insecticides are applied in a typical operation. Fertilizer is added to the soil at planting time in the amount of 200 pounds per acre of 5-20-20. Soybeans, as well as any other crop, can be planted in narrow rows, according to the operators' discretion. This type of planting reduces row width from 30"-48" to 20"-30", thereby allowing the farmer to plant more rows on one field and produce higher yields. It has been estimated that less than 5 percent of the agricultural land in the County is planted in this manner, however, as the initial investment in new machinery to plant, till, and harvest a narrow row crop represents a relatively large proportion of the income of most farm operators.

Vegetable Crops: Crops grown for canning in Racine County include sweet corn, cabbage, and onions. With the exception of sweet corn, most of these crops are grown on sandy loam and muck soils, which ensure sufficient moisture for the growing season. The average annual precipitation in the County exceeds 30 inches, which reportedly provides enough moisture, making irrigation unnecessary. The vegetable crops are planted in April or May on a smooth seedbed cleared of debris. The seedbed is prepared using the traditional moldboard plow, disk, or spring-tooth harrow and the drag. The fields designated for these canning vegetable varieties are heavily fertilized before planting. Cabbage growers typically add 1,000 pounds per acre of 12-12-12, as well as magnesium and zinc, in quantities determined by soil tests to be necessary for each field. Fertilizers added to sweet corn are 5-20-20, 6-24-24, and nitrogen in the amounts of 250, 200, and 100 pounds, respectively. Onions reportedly require 90 pounds per acre of nitrogen and 800 pounds per acre of 10-10-30 to produce a satisfactory crop. Herbicides and insecticides commonly applied to these crops and the timing of their application are illustrated in Table L-4. The vegetables are harvested at their peak of ripeness—from July to August for corn and August to October for cabbage and onions.

Potatoes are grown on truck farms for direct sale to consumers or to potato chip plants. Planting is in April or May, and harvest occurs from July to October. The seedbed is prepared using conventional tillage methods to keep the soil loose and free of debris. Usually potatoes are grown on low heavy soils that retain moisture, reportedly making irrigation unnecessary. Herbicide and insecticide use and timing of application are presented in Table L-4. The most commonly used fertilizer is 10-20-30, applied at 200 pounds per acre. Potatoes are grown primarily on the muck soils in the Towns of Norway and Mt. Pleasant.

Specialty Crops: Sod farms are located on low-lying heavy soils throughout the County. The crop is planted on carefully turned, cleared, and smoothed soil in April or May. Proper growth is promoted by sprinkle irrigation when conditions warrant, herbicide application after planting to deter unwanted weed growth, and application of 200 pounds per acre of 23-10-6 fertilizer before planting. The sod crop is harvested whenever the growth is sufficient to allow cutting. Properly done, the harvest cut is shallow enough for the remaining roots to spur regrowth, thereby allowing several sod crops per growing season to be harvested from each sod field.

Animal Waste-Handling and - Disposal Practices: Animal waste-handling and - disposal practices in Racine County vary according to the size and type of operation as well as by personal preferences and capital resources of the operator. Extensive pasturing is uncommon in Racine County, with most animals kept in a barnyard or small field of three acres or less. Waste-handling systems vary widely in sophistication from manual loading and tractor hauling combinations to slurried collection and transmission facilities; but the vast majority of livestock operators in the county use tractor-scoop loading or merchanized gutter-cleaners to clean out barns and barnyards. Regardless of the time of year, the stockpiling manure—mixed with bedding materials—is common in areas which are conveniently near the barnyards. Virtually all animal wastes generated in agricultural operations within the County are disposed of on the land surface. An estimated 75 percent of the operators haul and spread manure in the winter, despite the frozen ground and the associated potential contamination of nearby surface waters. It is unusual for an operator to have a specially designed manure storage facility, and this type of facility is included in the operations of only about 5 percent of the farms within the County. The notable exceptions are fur or fowl farms, or the very largest beef or dairying operations in which the animal wastes generation problems are of a major proportion. Such sources are addressed within the point source and industrial wastewater discharge inventories being conducted under the areawide water quality planning program for southeastern Wisconsin.

General Agricultural Practices in Walworth County

Small Grain Crops: Oats is the most popular small grain sown in the County, because of its versatility—it can be sown alone or used as a nurse crop for hay. Oats sown with the hay can be harvested the first season while giving the hay an opportunity to mature for cropping the following season. Manure is spread on the crop during the fall and spring preceding planting. Approximately 10-25 percent of the county farmers stockpile their manure during the winter rather than spreading it on the frozen ground, and creating the potential for direct runoff and contamination of surface waters. The seedbed is prepared using the traditional tillage method of fall moldboard plowing, followed by spring-tooth harrowing or disking in spring to break up the clods, also known as "peds," thrown up by the plow. Spring plowing is generally done only by necessity, with fall plowing the preferred practice. The agricultural inventory results indicate that the recently developed conservation tillage methods, including chisel tillage, are not practiced on a significant portion of the agricultural land in the County. Chisel plowing loosens the soil by forcing the chisel point along the surface of the field, rather than turning the soil over as traditional moldboard plowing does, and thus leaves a portion of the residue from the previous crop on the surface to control soil erosion.

Once the spring working of the soil and the incorporation of the spread manure is completed, the seedbed is ready to plant in April or May, usually in narrow rows using a grain drill. This procedure is known as solid seeding. If fertilizer is to be added to the soil, it is done at this time, adding 200 pounds of 0-10-30 per acre if the oats crop is seeded alone, and comparable amounts of a similar fertilizer if the oats crop is seeded with hay. The numbers used to designate the various types of fertilizers indicate the percent by weight of elemental nitrogen, phosphorus, (as P_2O_5) and potassium, (as K_2O) present in the fertilizer applied. Thus, 200 pounds of 0-10-30 contains a blend of 10 percent P_2O_5 and 30 percent K_2O. The element proportions of the fertilizer used depend on the chemical characteristics of the soil in a field, as compared to the nutrients needed to support crop growth. Nitrogen is generally left out of fertilizers used on grain-seeded hay, because the hay fixes nitrogen from the atmosphere and adds sufficient nitrogen for the grain. Whether the soil lacks the required nutrients can be determined by a soil test, prepared with the assistance of the University of Wisconsin-Extension Service Soil Testing Program administered through the ASCS. In 1975, 450 farmers in Walworth County took advantage of this service, submitting their soil samples to the ASCS or UWEX offices to be sent to the UWEX laboratory for analysis. This compares to 3,014 landowners in the county identified as possessing holdings of 10 acres or more.

No further agricultural management techniques are employed until harvest time in late July or August. If the oats crop was seeded with hay, no fall tillage is required after the harvest. However, if the grain was seeded alone, the plowing method and time will depend on the crop planned for the following year. Pesticide usage rates as well as times and methods of application are presented for all crops in Table L-5. Herbicides and insecticides, used on all crops grown in the County, generally are not applied at rates exceeding the label directions because of the high cost of the chemicals, and the possibility that chemical damage to the crop by over-application could exceed the damage by the pest of concern if the crop were unprotected.

Oats is not a significant crop in the Towns of Sharon, Richmond, Darien, Whitewater, Bloomfield, East Troy, and Walworth. This situation is the direct result of the shifting emphasis in Walworth County from dairy cattle to cash cropping. As oats is raised basically as a nurse crop for alfalfa or hay which are raised for dairy cattle feed, it is no longer needed in a cash cropping operation.

Spring wheat crops are handled in much the same way as an oats crop might be if seeded alone. Method and timing of tillage, planting, harvest, and manure and fertilizer application are all similar to the practices used for oats. Winter wheat differs from spring wheat only in planting time and harvest time. Winter wheat is planted in September or October after the previous year's crop has been harvested. Harvest for winter wheat occurs in mid-July to early August and precedes the spring wheat harvest period by one to two weeks. Winter wheat does offer the dual advantage of providing winter cover to reduce soil loss and reducing the farmer's work load at spring planting time. Wheat is only planted in significant amounts in the Towns of Richmond, Spring Prairie, Darien, Sugar Creek, Bloomfield, and Lyons, since the soil type in these townships is more conducive to higher production.

Hay Crops: In any given year, hay can be categorized into three groups—grain-seeded hay, hay seeded alone, and standing hay. Hay is a general term used for all perennial crops which are harvested for animal consumption, and in Walworth County consists of alfalfa, brome grass, timothy, orchard grass, and combinations of the above. Grain-seeded hay has been discussed above in conjunction with oats, and is the most commonly used in establishing a new stand of hay. As noted above, hay is seldom seeded without a nurse crop, because a grain nurse crop gives the new hay plants some protection from the weather, and holds the soil in place during runoff periods while the hay plants are becoming established.

Both organic and inorganic fertilizers are applied at various times to existing hay stands. Manure can be applied after every harvest, which is two to three times per growing season. However, little manure is applied because the animal-acreage ratio is low and most manure is applied to corn land. Inorganic fertilizer in the form of 0-0-60 or 0-10-30 at 300 pounds per acre is applied to existing stands either in early spring or in June. Once a hay crop has been established it remains on the same field for three to five years, depending on the farmer's preferences and the soil fertility of the field. The hay is harvested by cutting, drying, and baling two to three times per season, depending on the condition of the stand and the weather conditions that season. If the hay is "green chopped" for immediate feeding or anaerobic storage as silage, it can be cropped up to four times in a growing season. After the final hay harvest in the last year of a hay crop, the hay sod is turned under the surface with the traditional moldboard plow. Chisel plowing is not popular for this purpose as it does not break up the hay sod sufficiently to allow for the planting of another crop the following spring. Moldboard plowing is the preferred practice, since it breaks up the heavy clay soils comprising roughly one-third of the county soils. The fall plowing and the winter freeze-thaw cycle together break up the large clods or "peds" to make the soil workable in spring.

Sudan grass is an annual forage crop planted like a grain crop and harvested twice during the growing season to provide a supplement to hay for animal feed. It is planted in a very limited amount in Walworth County, and is primarily green chopped and fed directly to the animals.

Row Crops: Corn is being planted in increasing amounts as a cash crop in the County. It is planted in April or May on a bare field. If the farmer also runs an animal operation, he may have added nitrogen, in the form of manure, to the soil in fall before plowing and again in spring in the preplant stage. Because corn requires an abundant supply of nitrogen for growth, county farmers generally add 80-100 pounds of nitrogen per acre to the soil in addition to 250 pounds per acre of 6-24-24 at planting time. Variations occur due to personal preferences, training and experience, product availability, previous crops grown on the field, soil type, and soil test results where they are available. Harvesting takes place in the fall after the corn cobs have dried to about 25 percent moisture, but before the ground is frozen and becomes too hard to plow. On the average, most of the operators in the County plow in the fall to take advantage of the winter's freeze-thaw action on the heavier clay soil.

Soybeans are grown as a cash crop in the County, with increasing acreages planted every year. The crop is planted in spring or in summer in a manner similar to corn. Manure is seldom applied to soybean acreages. Since insect pests are a minor problem, no insecticides are applied in a typical operation. Fertilizer is added to the soil in the amount of 175 pounds per acre of 0-10-30 at planting time. Soybeans, as well as any other crop, can be planted in narrow rows, according to the operators' discretion. This type of planting reduces row width from 30"-48" to 20"-30", thereby allowing the farmer to plant more rows on one field and to produce higher yields. It has been estimated that less than 10 percent of the agricultural land in the County is planted by this method, as the initial investment in new machinery to plant, till, and harvest a narrow row crop represents a relatively large proportion of the income of most farm operators.

Vegetable Crops: Crops grown for canning in Walworth County include peas, sweet corn, cabbage, beets, carrots, and onions. With the exception of sweet corn, which can be grown on higher, drier soils, most of these crops are grown on low, wet soils which ensure sufficient moisture for the growing season. At times these vegetables may need additional moisture, and a significant amount of irrigation is done in the County. Although the average annual precipitation in the County exceeds 30 inches, from 4 to 8 inches of water may be added by irrigation. All the vegetable crops are planted in April or May on a smooth seedbed cleared of debris. The seedbed is prepared using the traditional moldboard plow, disk, and/or spring-tooth harrow, and the drag. The fields designated for these canning vegetable varieties are heavily fertilized before planting. Cabbage growers typically add 1,200 pounds per acre of 17-17-17, as well as magnesium and zinc, in quantities determined by soil tests to be necessary for each field. Fertilizers added to sweet corn are 6-24-24 in the amount of 250 pounds per acre, the same are added to field corn. Beet fields generally receive 150 pounds per acre each of 50-20-20B (B-boron) and 10-10-10. The 50-20-20B fertilizer contains 50 percent elemental nitrogen, 20 percent P_2O_5, and 20 percent K_2O, with two to three pounds of boron added. Fertilizers applied to carrot fields generally include 900 pounds per acre of 0-10-40 and 30 pounds per acre of nitrogen. Onions reportedly require 80 pounds per acre of nitrogen and 1,200 pounds per acre of 0-10-30 to produce a satisfactory crop. Peas need 15 to 30 pounds each of phosphorus (P_2O_5) and potassium, (as K_2O) depending on soil test recommendations. Pesticides commonly applied to these crops and the timing of their application are illustrated in Table L-5. The vegetables are harvested at their peak of ripeness—from July to August for peas and corn and August to October for cabbage, beets, carrots, and onions.

Specialty Crops: Mint is a specialty crop in Walworth County grown in a rotation with sweet corn on low-lying heavy muck soils. Cuttings are planted in late April and allowed to grow until harvest in August when the mint is mowed, dried, and chopped like alfalfa and distilled for mint oil. Sinbar is the major herbicide applied before planting to curb weed growth; additional weeds are removed by hand. As the mint is grown in muck soils, 300 pounds per acre of potassium and 300 pounds per acre of 6-24-24 are applied as fertilizers.

Sod farms are located on low-lying heavy soils throughout the County. The sod crop is planted on carefully turned, cleared, and smoothed soil in April or May. Proper growth is promoted by sprinkle irrigation when conditions warrant, herbicide application after planting to deter unwanted weed growth, and application of 500 pounds per acre of 6-10-10 fertilizer before planting. The sod crop is harvested whenever the growth is sufficient to allow cutting. Properly done, the harvest cut is shallow enough for the remaining roots to spur regrowth, thereby allowing several sod crops per growing season to be harvested from each sod field.

Animal Waste-Handling and - Disposal Practices: Animal waste-handling and - disposal practices in Walworth County vary according to the size and type of operation, as well as by the personal preferences and capital resources of the operator. Extensive pasturing is uncommon in Walworth County, with most animals kept in a barnyard or small field of three acres or less. Waste-handling systems vary widely in sophistication from manual loading and tractor hauling combinations to slurried collection and transmission facilities; but the vast majority of livestock operators in the County use tractor-scoop loading or mechanized gutter-cleaners to clean out barns and barnyards. Regardless of the time of year, the stockpiling of manure—mixed with bedding materials—is common in areas which are conveniently near the barnyards. Virtually all animal wastes generated in agricultural operations within the County are disposed of on the land surface. An estimated 90 percent of the operators haul and spread manure in the winter, despite the frozen ground and the associated potential contamination of nearby surface waters. It is unusual for an operator to have a specially designed manure storage facility, and this type of facility is included in the operations of only about 10 percent of the farms within the County. The notable exceptions are a fur or fowl farms, or the very largest beef or dairying operations in which the animal wastes generation problems are of a major proportion. Such sources are addressed within the point source and industrial wastewater discharge inventories being conducted under the areawide water quality planning program for southeastern Wisconsin.

General Agricultural Practices in Washington County

Small Grain Crops: Oats is the most popular small grain sown in the County, because of its versatility—it can be sown alone or used as a nurse crop for hay. Oats sown with hay can be harvested in the first season, while giving the hay an opportunity to mature for cropping the following season. Manure can be spread on the crop during the fall and spring, preceding planting. Approximately 10-15 percent of the county farmers stockpile their manure during the winter rather than spreading it on the frozen ground and creating the potential for direct runoff and contamination of surface waters. The seedbed is generally prepared using the traditional tillage method of fall moldboard plowing, followed by spring-tooth harrowing or disking in spring to break up the clods, also known as "peds," thrown up by the plow. Spring plowing is generally done only by necessity, with fall plowing the preferred practice. Of recently developed conservation tillage methods the most popular is chisel plowing, which is used on 5 percent of the county agricultural land as an alternative to moldboard plowing. Chisel plowing loosens the soil by forcing the chisel point along the surface of the field, rather than turning the soil over as traditional moldboard plowing does, thereby leaving a portion of the residue from the previous crop on the surface to control soil erosion by runoff. Other minimum tillage practices are used on less than 5 percent of the acreage devoted to agriculture.

Once the spring working of the soil and the incorporation of the spread manure is completed, the seedbed is ready to plant in April or May, usually in narrow rows using a grain drill. This procedure is known as solid seeding. If fertilizer is to be added to the soil, it is done at this time, adding 200 pounds of 5-20-20 per acre whether the oats crop is seeded alone or with hay. The numbers used to designate the various types of fertilizers indicate the percent by weight of elemental nitrogen, phosphorus, (as P_2O_5) and potassium (as K_2O) present in the fertilizer applied. Thus, 150 pounds of 5-20-20 contains a blend of 5 percent nitrogen, 20 percent P_2O_5, and 20 percent K_2O. The element proportions of the fertilizer used depend on the chemical characteristics of the soil in a field, as compared to the nutrients needed to support crop growth. Nitrogen is generally left out of fertilizers used on grain-seeded hay, because the hay fixes nitrogen from the atmosphere and adds sufficient nitrogen for the grain. Whether the soil lacks the required nutrients can be determined by a soil test, prepared with the assistance of the University of Wisconsin-Extension Service Soil Testing Program administered through the ASCS. In 1975, approximately 500 farmers in Washington County took advantage of this service, submitting their soil samples to the ASCS or UWEX office to be sent to the UWEX laboratory for analysis. This compares to 3,614 landowners in the County identified as possessing holdings of 10 acres or more.

No further agricultural management techniques are employed until harvest time in late July or August. If the oats crop was seeded with hay, no fall tillage is required after the harvest. However, if the grain was seeded alone, the plowing method and time will depend on the crop planned for the following year. Pesticide usage rates, as well as times and methods of application, are presented for all crops in Table L-6. Herbicides and insecticides, used on all crops grown in the County generally are not applied at rates exceeding the label directions because of the high cost of these chemicals, and the possibility that chemical damage to the crop by over-application could exceed the damage by the pest of concern if the crops were unprotected. Lesser amounts of grain crops are grown in the Towns of Jackson, Richfield, and Germantown as the lower, more organic, soils of these towns are better suited to the cultivation of vegetable crops.

Spring wheat crops are handled in much the same way as an oats crop might be if seeded alone. Method and timing of tillage, planting, harvest, and herbicide and manure and fertilizer application are all similar to the practices used for oats. Winter wheat differs from spring wheat only in planting time and harvest time. Winter wheat is planted in September or October after the previous year's crop has been harvested and the field has been tilled. Harvest for winter wheat occurs in mid-July to early August and precedes the spring wheat harvest period by one to two weeks. Winter wheat does offer the dual advantage of providing winter cover to reduce soil loss and reducing the farmer's work load at spring planting time.

Hay Crops: In any given year, hay can be categorized into three groups—grain-seeded hay, hay seeded alone, and standing hay. Hay is a general term used for all perennial crops which are harvested for animal consumption, and in Washington County consists of alfalfa, brome grass, timothy, canary grass, red clover, sudan grass, and combinations of the above. Grain-seeded hay has been discussed above in conjunction with oats, and is the most commonly used in establishing a new stand of hay. As noted above, hay is seldom seeded without a nurse crop, because a grain nurse crop gives the new hay plants some protection from the weather, and holds the soil in place during runoff periods while the hay plants are becoming established.

Both organic and inorganic fertilizers are applied at various times to existing hay stands. Manure is generally applied to hay land during the winter, or during the growing season if there is no other land to spread it on. Inorganic fertilizer, in the form of 0-0-20 at 200-300 pounds per acre, is applied to existing stands either in early spring or in June. Once a hay crop has been established it remains on the same field for two to three years, depending on the farmer's preferences and the soil fertility of the field. The hay is harvested by cutting, drying, and baling one to three times per season, depending on the condition of the stand and the weather conditions that season. If the hay is "green chopped" for immediate feeding or anaerobic storage as silage, it can be cropped three or four times in a growing season. After the final hay harvest in the last year of a hay crop, the hay sod is turned under the surface with the traditional moldboard plow. Chisel plowing is not popular for this purpose as it does not break up the hay sod sufficiently to allow for the planting of another crop the following spring. Moldboard plowing is the popular practice, since it serves to break up the heavy clay soils comprising roughly 20 percent of the county soils. The fall plowing and the winter freeze-thaw cycle together break up the large clods or "peds" to make the soil workable in spring.

Sudan grass is an annual forage crop planted like a grain crop and harvested twice during the growing season to provide a supplement to hay for animal feed. It can be either green chopped and fed directly to the animals, stored in a silo, or cut, dried, baled, and stored for later use as animal feed. Sudan grass is harvested one to two times per year, depending upon the weather conditions from June to the first frost, but after the first frost, the crop becomes poisonous and must be plowed under. The only fertilizer—other than manure—which can be applied at planting if necessary is 5-20-20 at the rate of 200 pounds per acre.

Row Crops: Corn is being planted in increasing amounts as a cash crop in the County. A farmer has two options when planing corn—to plant an early crop in spring or a late crop in June or July. If the farmer also runs an animal operation, he may have added nitrogen, in the form of manure, to the soil in the fall before plowing and again in spring in the preplant stage. Some chisel plowing, as described above, is used on corn acreage. However, more pesticides are required when chisel plowing instead of traditional moldboard is used plowing to till the soil, since chisel plowing leaves more residue from the past year's crop on the surface to harbor weed seeds and insects and to promote growth of pest populations. Chisel tillage also allows for only one cultivation of a corn crop, thereby promoting additional weed growth when compared to the repeated cultivation practices used in conventional tillage which destroy the weed plants. Likewise, when chisel tillage is used, the remaining residue harbors insect pests necessitating the application of more insecticides such as Thimet, Furadan, or Counter in the pre- or post- emergent stage of the crop than are necessary for moldboard tilled crops. Because corn requires an abundant supply of nitrogen for growth, county farmers generally add 100 pounds of nitrogen per acre to the soil in addition to 200-300 pounds per acre of 5-20-20 at planting time. Variations occur due to personal preferences, training and experience, product availability, previous crops on the field, soil type, and soil test results where they are available. Harvesting of early corn takes place in the fall after the corn cobs have dried to about 30 percent moisture, but before the ground is frozen and becomes too hard to plow. On the average, about 75 percent of the operators in the County plow in the fall to take advantage of the winter's freeze-thaw action on the heavier clay soil.

Late corn follows the same pattern of treatment, except for the fertilizer application and harvesting techniques. Late corn, which constitutes an estimated 10 percent of all corn planted in the County in an average year, is seeded in the soil of an old hay crop which was turn-plowed in late spring or early summer after one cutting of hay early in June, after severe damage to the hay crop from winterkill has become apparent, or after a canning crop has been harvested. In case of winterkill, the use of the field for delayed corn offers the only means for a farmer to produce a crop on the field that year. If the field is manured, it is done before plowing. Herbicides and insecticides are applied in the same manner as for early field corn; but since the previous crop was hay, only 200 pounds of 5-20-20 fertilizer per acre is typically needed. No nitrogen is added at this time, as the previous hay crop is generally assumed to have added enough nitrogen to the soil to support the growth of a corn crop. Late corn is grown for silage feeding rather than for cob corn, as the cobs would not mature in the short amount of time remaining in the growing season. The corn is chopped from August to October and either fed directly to the animals or put into the silo for fermentation and storage for livestock feeding in winter.

Soybeans are grown as a cash crop in the County, with increasing acreages planted every year. The crop is planted in spring or summer in a manner similar to that for corn. Manure can be applied to the field the previous fall, before plowing, and in the spring before final use of a disk and/or spring-tooth harrow. Because insect pests are a minor problem, no insecticides are applied in a typical soybean operation. Fertilizer is added to the soil in the amount of 300 pounds per acre of 0-20-20 at planting time. Soybeans, as well as any other crop, can be planted in narrow rows, according to the operators' discretion. This type of planting reduces row width from 30"-48" to 20"-30", thereby allowing the farmer to plant more rows on one field and to produce higher yields. It has been estimated that less than 5 percent of the agricultural land in the County is planted in this manner, however, as the initial investment in new machinery to plant, till, and harvest a narrow row crop represents a relatively large proportion of the income of most farm operators.

Vegetable Crops: Crops grown for canning in Washington County include peas, sweet corn, cabbage, beets, carrots, and onions. With the exception of sweet corn, most of these crops are grown on low, wet soils which ensure sufficient moisture for the growing season. At times these vegetables may need additional moisture, and a significant amount of irrigation is done in the County. Although the average annual precipitation in the County exceeds 25 inches, from 3 to 5 inches of water may be added by irrigation. All the vegetable crops are planted in April or May on a smooth seedbed cleared of debris. The seedbed is prepared using the traditional moldboard plow, disk, or spring-tooth harrow, and drag. The fields designated for these canning vegetable varieties are heavily fertilized before planting. Cabbage growers typically add 1,200 pounds per acre of 17-17-17, as well as magnesium and zinc, in quantities determined by soil tests to be necessary for each field. Fertilizers added to sweet corn are 6-24-24 and nitrogen in the amounts of 200-250 and 100 pounds, respectively. Beet fields receive 150 pounds per acre of 50-20-20B (B-boron) and 10-10-10 each. The 50-20-20B fertilizer contains 50 percent nitrogen, 20 percent P_2O_5, and 20 percent K_2O, with two to three pounds of boron added. Fertilizers applied to carrot fields generally include 900 pounds per acre of 0-10-40 and 30 pounds per acre of nitrogen. Onions reportedly require 80 pounds per acre of nitrogen and 1,200 pounds per acre of 0-10-30 to produce a satisfactory crop. Peas need 30 to 40 pounds per acre of nitrogen—depending on the organic content of the soil—and 12 to 30 pounds each of phosphorus (as P_2O_5) and potassium (as K_2O), depending on soil test recommendations. Pesticides commonly applied to these crops and the timing of their application are illustrated in Table L-6. The vegetables are harvested at their peak of ripeness—from July to August for peas and corn and August to October for cabbage, beets, carrots and onions.

Potatoes are grown on truck farms for direct sale to consumers. Planting is in April or May and harvest occurs from July to October. The seedbed is prepared using conventional tillage methods to keep the soil loose and free of debris. Potatoes are usually grown on low heavy soils that retain moisture, but if necessary the crop may be spray-irrigated during the growing season. Pesticide use and timing of application are presented in Table L-6. The most commonly applied fertilizer is 6-24-24, applied per acre at 600 pounds.

Specialty Crops: Sod farms are located on low-lying heavy soils throughout the County. The sod crop is planted on carefully turned, cleared, and smoothed soil in April or May. Proper growth is promoted by sprinkle irrigation when conditions warrant, herbicide application after planting to deter unwanted weed growth, and application of 500 pounds per acre of 6-10-10 fertilizer before planting. The sod crop is harvested whenever the growth is sufficient to allow cutting. Properly done, the harvest cut is shallow enough for the remaining roots to spur regrowth, thereby allowing several sod crops per growing season to be harvested from each sod field.

Animal Waste-Handling and - Disposal Practices: Animal waste-handling and - disposal practices in Washington County vary according to the size and type of operation, as well as by personal preferences and capital resources of the operator. Extensive pasturing is uncommon in Washington County, with most animals kept in a barnyard or small field of 10 acres or less. Waste-handling systems vary widely in sophistication from manual loading and tractor hauling combinations to slurried collection and transmission facilities; but the vast majority of livestock operators in the County use tractor-scoop loading or mechanized gutter-cleaners to clean out barns and barnyards. Regardless of the time of year, the stockpiling of manure—mixed with bedding materials—is common in areas which are conveniently near the barnyards. Virtually all animal wastes generated in agricultural operations within the County are disposed of on the land surface. It was further reported—during a workshop held by the University of Wisconsin-Extension Office staff to assist the Commission and attended by about 90 farm operators—that virtually all of the dairy farmers haul and spread manure in the winter, despite the frozen ground and the associated potential contamination of nearby surface waters. Other livestock operations were reportedly operated in similar fashion. It is unusual for an operator to have a specially designed manure storage facility, and this type of facility reportedly is included in the operations of less than 1 percent of the farms within the County. The notable exceptions are fur or fowl farms, or the very largest beef or dairying operations in which the animal wastes generation problems are of a major proportion. Such sources are addressed within the point source and industrial wastewater discharge inventories being conducted under the areawide water quality planning program for southeastern Wisconsin.

General Agricultural Practices in Waukesha and Milwaukee Counties[1]

Small Growing Crops: Oats is the most popular small grain sown in the Counties, because of its versatility: it can be sown alone or used as a nurse crop for hay. Oats sown with the hay can be harvested the first season while giving the hay an opportunity to mature for cropping the following season. Manure can be spread on the crop during the fall and spring, preceding planting. Approximately 5 percent of the counties' farmers stockpile their manure during the winter rather than spreading it on the frozen ground and creating the potential for direct runoff and contamination of surface waters. The seedbed is generally prepared using the traditional tillage method of fall moldboard plowing, followed by spring-tooth harrowing or disking in spring to break up the clods, also known as "peds," thrown up by the plow. Spring plowing is generally done only by necessity, with fall plowing the preferred practice. Of recently developed conservation tillage methods, the most popular is chisel plowing, which is used on 10 percent of the agricultural land in the Counties as an alternative to moldboard plowing. Chisel plowing loosens the soil by forcing the chisel point along the surface of the field, rather than turning it over as traditional moldboard plowing does, thereby leaving a portion of the residue from the previous crop on the surface to control soil erosion by runoff. Other minimum tillage practices are used on 5 percent of the acreage devoted to agriculture.

Once the spring working of the soil and the incorporation of the spread manure is completed, the seedbed is ready to plant in April or May, usually in narrow rows using a grain drill. This procedure is known as solid seeding. If fertilizer is to be added to the soil, it is done at this time, adding 150 pounds of 3-9-27 per acre whether the oats crop is seeded alone, or with hay. The numbers used to designate the various types of fertilizers indicate the percent by weight of elemental nitrogen, phosphorus (as P_2O_5), and potassium (as K_2O) present in the fertilizer applied. Thus, 150 pounds of 3-9-27 would be a blend of 3 percent nitrogen, 9 percent P_2O_5, and 27 percent K_2O. The element proportions of the fertilizer used depends on the chemical characteristics of the soil in a field, as compared to the nutrients needed to support crop growth. Nitrogen is generally left out of fertilizers used on grain-seeded hay, because the hay fixes nitrogen from the atmosphere and adds sufficient nitrogen for the grain. Whether the soil lacks the required nutrients can be determined by a soil test, prepared with the assistance of the University of Wisconsin-Extension Service Soil Testing Program administered through the ASCS. In 1975, 300 farmers in Waukesha County took advantage of this program, submitting their soil samples to the ASCS or UWEX office to be sent to the UWEX laboratory for analysis. This compares to 3,327 landowners in the County identified as possessing holdings of 10 acres or more. No data are available for Milwaukee County regarding soil tests.

No further agricultural management techniques are employed until harvest time in late July or August. If the oats crop was seeded with hay, no fall tillage is required after the harvest. However, if the grain was seeded alone, the plowing method and time will depend on the crop planned for the following year. Pesticide usage rates, as well as the methods and times of application, are presented for all crops in Table L-7. Herbicides and insecticides, used on all crops grown in the Counties, generally are not applied at rates exceeding the label directions because of the high cost of the chemicals, and the possibility that chemical damage to the crop by over application could exceed the damage by the pest of concern if the crop were unprotected.

Spring wheat crops are handled in much the same way as an oats crop might be if seeded alone. Method and timing of tillage, planting, harvest, and pesticide manure and fertilizer application are all similar to the practices used for oats. Winter wheat differs from spring wheat only in planting time and harvest time. Winter wheat is planted in September or October after the previous year's crop has been harvested. Harvest for winter wheat occurs in mid-July to early August and precedes the spring wheat harvest period by one to two weeks. Winter wheat does offer the dual advantage of providing winter cover to reduce soil loss and reducing the farmer's work load at spring planting time. Although individual preferences vary, farmers in the western half of Waukesha County reportedly prefer planting spring wheat, while eastern Waukesha and Milwaukee County farmers generally plant winter wheat. This is probably attributable in part to the Lake Michigan effect on weather, causing a somewhat later spring in eastern Waukesha and Milwaukee Counties, and to the fact that the heavier soils in eastern Waukesha and Milwaukee Counties are more difficult to work and plant early enough for spring wheat.

Hay crops: In any given year, hay can be catagorized into three groups—grain-seeded hay, hay seeded alone, and standing hay. Hay is a general term used for all perennial crops which are harvested for animal consumption, and in Waukesha and Milwaukee Counties consists of alfalfa, brome grass, timothy, canary grass, red clover, orchard grass, trefoil, and combinations of the above. Grain-seeded hay has been discussed above in conjunction with oats, and is the most commonly used in establishing a new stand of hay. As noted above, hay is seldom seeded without a nurse crop, because a grain nurse crop gives the new hay plants some protection from the weather, and holds the soil in place during runoff periods while the hay plants are becoming established. In the Towns of Merton and Ottawa in Waukesha County, legume grasses have been planted in sod in an attempt to renovate pasturelands, and in this case would be used for grazing rather than harvesting purposes.

Both organic and inorganic fertilizers are applied at various times to existing hay stands. Manure is generally applied to hay land during the winter, or during the growing season if there is no other land to spread it on. Inorganic fertilizer, in the form of 0-10-40 at 100 pounds per acre, is applied to existing stands either in early spring or in June. Once a hay crop has been established it remains on the same field for three to four years, depending on the farmer's preferences and the soil fertility of the field. The hay is harvested by cutting, drying, and baling two to three times per season, depending on the condition of the stand and the weather conditions that season. If the hay is "green chopped" for immediate feeding or anaerobic storage as silage, it can be cropped up to three times in a growing season. After the final hay harvest in the last year of a hay crop, the hay sod is turned under the surface with the traditional moldboard plow. Chisel plowing is not popular for this purpose as it does not break up the hay sod sufficiently to allow for the planting of another crop the following spring. Moldboard plowing is the popular practice, since it breaks up the predominantly heavy clay soils occuring in portions of the two Counties. The fall plowing and the winter freeze-thaw cycle together break up the large clods or "peds" to make the soil workable in spring.

Sudan grass is an annual forage crop planted like a grain crop and harvested up to three times during the growing season to provide a supplement to hay for animal feed. It can be either green chopped and fed directly to the animals, stored in a silo, or cut, dried, baled, and stored for later use as animal feed. Sudan grass is harvested three to four times per year, depending upon the weather conditions from June to the first frost, but after the first frost the crop becomes poisonous and must be plowed under. The only fertilizer—other than manure—which can be applied at planting if necessary is 6-24-24 at a rate of 200 pounds per acre.

Row Crops: Corn is being planted in increasing amounts as a cash crop in the two Counties. A farmer has two options when planting corn—to plant an early crop in spring or a late crop in June or July. If the farmer also runs an animal operation, he may have added nitrogen, in the form of manure, to the soil in fall before plowing and again in spring in the preplant stage. Some chisel plowing, as described above, is used on corn acreage. However, more pesticides are required when chisel plowing instead of traditional moldboard plowing is used to till the soil, since chisel plowing leaves more residue from the past year's crop on the surface to harbor weed seeds and insects and to promote growth of pest populations. Chisel tillage also allows for only one cultivation of a corn crop, thereby promoting additional weed growth, as compared to the repeated cultivation practices used in conventional tillage which destroy the weed plants. Likewise, when chisel tillage is used, the remaining residue harbors insect pests necessitating the application of more insecticides such as Disyston, Furadan, or Counter in the pre- or post- emergent stage of the crop than are necessary for moldboard tilled crops. Because corn requires an abundant supply of nitrogen for growth, farmers in the two Counties generally add 80 pounds of nitrogen per acre to the soil in addition to 200 pounds per acre of 6-24-24 at planting time. Variations occur due to personal preferences, training and experience, product availability, previous crops on the field, soil type, and soil test results where they are available. Harvesting of early corn takes place in the fall after the corn cobs have dried to about 28 percent moisture, but before the ground is frozen and becomes too hard to plow. On the average, about 60 percent of the operators in the Counties plow in the fall except in the Towns of Menomonee Falls, New Berlin, and Muskego, where up to 90 percent may plow in fall to take advantage of the winter's freeze-thaw action on the heavy clay soil. The majority of Milwaukee County farmers plow in fall.

Late corn follows the same pattern of treatment, except for the fertilizer application and harvesting techniques. Late corn, which constitutes an estimated 5 percent of all corn planted in the Counties in an average year is seeded in the soil of an old hay crop which was turn-plowed in late spring or early summer, after one cutting of hay early in June, after severe damage to the hay crop from winterkill has become apparent, or after a canning crop is harvested. In case of winterkill, the use of the field for corn offers the only means for farmers to produce a crop on the field that year. If the field is manured, it is done before plowing. Herbicides and insecticides are applied in the same manner as for early field corn;

[1]*Because so little agricultural land was in active production in Milwaukee County as of 1975, and because the pesticides used were essentially the same as those used in Waukesha County, a single inventory presentation was prepared.*

but if the previous crop was hay, only 200 pounds of 6-24-24 fertilizer per acre is typically needed. No nitrogen is added at this time, as the previous hay crop is generally assumed to have added enough nitrogen to the soil to support the growth of a corn crop. Late corn is grown for silage feeding rather than for cob corn, as the cobs would not mature in the short amount of time remaining in the growing season. The corn is chopped from August to October and either fed directly to the animals or put into the silo for fermentation and storage for livestock feeding in winter.

Soybeans are grown as a cash crop in the Counties, with increasing acreages planted every year. The crop is planted in spring or in summer in a manner similar to that for corn. Manure can be applied to the field the previous fall before plowing, or in spring before final use of a disk and/or spring-tooth harrow. Since insect pests are a minor problem, no insecticides are applied in a typical soybean operation. Fertilizer is added to the soil in the amount of 150 pounds per acre of 5-10-30 at planting time. Soybeans, as well as any other crop, can be planted in narrow rows, according to the operators' discretion. This type of planting reduces row width from 30"-48" to 20"-30", thereby allowing the farmer to plant more rows on one field and to produce higher yields. It has been estimated that less than 2 percent of the agricultural land in Waukesha and Milwaukee Counties is cropped in this manner, however, as the initial investment in new machinery to plant, till, and harvest a narrow row crop represents a relatively large proportion of the income of most farm operators.

Vegetable Crops: Crops grown for canning in Waukesha and Milwaukee Counties include peas, sweet corn, cabbage, beets, carrots, and onions, which are grown for direct sale in a fresh market. With the exception of sweet corn, most of these crops are grown on low, wet soils which ensure sufficient moisture for the growing season. At times, these vegetables may need additional moisture, and a significant amount of irrigation is done in the Counties. Although the average annual precipitation in the Counties exceeds 30 inches, from 4 to 8 inches of water may be added by irrigation.

All the vegetable crops are planted in April or May on a smooth seedbed cleared of debris. The seedbed is prepared using the traditional moldboard plow, disk, or spring-tooth harrow, and the drag. The fields designated for these vegetable varieties are heavily fertilized before planting. Cabbage growers typically add 700 pounds per acre of 14-14-14, as well as magnesium and zinc, in quantities determined by soil tests to be necessary for each field. Fertilizers added to sweet corn are typically 6-24-24, 8-14-23, and 17-17-17 in the amounts of 200, 250, and 200 pounds, respectively. Beet fields receive 500 pounds per acre of 3-9-27B, a 3-9-27 fertilizer with two to three pounds of boren added. Onions reportedly require 70 pounds per acre of nitrogen and 600 pounds per acre of 0-15-40 to produce a satisfactory crop. Peas need 30 to 40 pounds per acre of nitrogen, depending on the organic content of the soil, and 150 to 200 pounds each of phosphorus and potassium in 0-20-20, depending on soil test recommendations. Pesticides commonly applied to these crops and the timing of their application are illustrated in Table L-7. The vegetables are harvested at their peak of ripeness—from July to August for peas and corn and August to October for cabbage, beets, and onions.

Potatoes are grown on truck farms for direct sale to consumers. Planting is in April or May, and harvest occurs from July to October. The seedbed is prepared using conventional tillage methods to keep the soil loose and free of debris. Usually, potatoes are grown on low heavy soils that retain moisture, but, if necessary, the crop maybe spray irrigated during the growing season. Pesticide use and timing of application are presented in Table L-7. The fertilizer most commonly applied to potatoes is 17-17-17 at 800 to 1,000 pounds per acre. Operators planting potatoes in the Towns of Ottawa and Waukesha in Waukesha County fertilize their potato acreage more heavily because the sandy soils of those areas are not as naturally nutrient-rich as the soils in other areas of the Counties.

Specialty Crops: Sod farms are located on low-lying, heavy soils throughout the two Counties. The crop is planted on carefully turned, cleared, and smoothed soil in April or May. Proper growth is promoted by sprinkle irrigation when conditions warrant, herbicide application after planting to deter unwanted weed growth, and application of 500 pounds per acre of 6-10-10 fertilizer before planting. The sod crop is harvested whenever the growth is sufficient to allow cutting. Properly done, the harvest cut is shallow enough for the remaining roots to spur regrowth, thereby allowing several sod crops per growing season to be harvested from each sod field.

Animal Waste-Handling and - Disposal Practices: Animal waste-handling and - disposal practices in Waukesha and Milwaukee Counties vary according to the size and type of operation, as well as by personal preferences and capital resources of the operator. Extensive pasturing is uncommon in Waukesha and Milwaukee Counties, with most livestock animals kept in a barnyard or small field of five acres or less. Waste-handling systems vary widely in sophistication from manual loading and tractor hauling combinations to slurried collection and transmission facilities; but the vast majority of livestock operators in the Counties use tractor-scoop loading or mechanized gutter-cleaners to clean out barns and barnyards. Regardless of the time of year, the stockpiling of manure—mixed with beeding materials—is common in areas which are conveniently near the barnyards. Virtually all animal wastes generated in agricultural operations within the Counties are disposed of on the land surface. An estimated 90 percent of the operators haul and spread manure in the winter, despite the frozen ground and the associated potential contamination of nearby surface waters. It is unusual for an operator to have a specially designed manure storage facility, and this type of facility is included in the operations of less than 1 percent of the farms within the Counties. The notable exceptions are fur or fowl farms, or the very largest beef or dairying operations in which the animal wastes generation problems are of a major proportion. Such sources are addressed within the point source and industrial wastewater discharge inventories being conducted under the areawide water quality planning program for southeastern Wisconsin.

Table L-1

POPULAR PESTICIDE USE PRACTICES IN SOUTHEASTERN WISCONSIN

	Insecticide[a]		Herbicide		
Crop	Type	Insect Pest and Application	Type[b]	Amount[c] (pounds per acre)	Application
Oats, Wheat	Heptachlor Lindane Diazinon Malathion Cythion Dylox Parathion	Seed treatment for Wire Worms, Aphids, and White Grubs	2,4-D MCPA	1/4 1/4-1/2	– –
Hay	Sevin Malathion Cygon or Defend Alfatox Dylox Proxol	Grasshoppers Aphids, Lygus, Bugs, Weevils, Army Worms	–	–	–
Sudan Grass	–	–	–	–	–
Corn	Lindane Heptachlor Parathion Thimet Furadan Counter Lannate	White Grubs, Army Worms	Atrazine Lasso Aatrex Bladex Sutan 2,4-D Eradicane Banvel	1-1/2-3 1-1/2-2-1/2 1-1/2-3 1-1/2-3 3-3-1/2 1/2 3-3-1/2 1/4	–
Soybeans	–	–	Lasso Lorox Sencor Amiben Treflan Basagran	1-1/2-2-1/2 1/2-1 1/4-1/2 4-6 3/4-1 3/4-1	–
Specialty Crops					
Sweet Corn	Same as corn—no Furadan	See Corn	Lasso Atrazine Bladex Sutan 2,4-D Eradicane	1-1/2-3 1-2 1-1/2-3 3-3-1/2 1/2 3-3-1/2	–
Peas	Sevin Parathion Cygon Diazinon Phosdrin	Army Worms, Aphids—one aerial application if necessary	MCPB Treflan Dowpon MCPA	1/2 1/2-3/4 3/4 1/8-1/4	–
Beets	–	–	Roneet Pyramine	3 4	–
Carrots	Sevin Parathion Diazinon	Aster Leaf Hopper	Lorox Tok Petroleum Solvent	1/2-2 1/2-3 77 gallons per acre	Multiple applications
Cabbage	Diazinon Dyfonate Lannate Dipel Parathion Monitor	Cabbage Maggot, Worm-Larvae Complex and Thrips	Treflan Tok	1/2-3/4 3	–
Potatoes	Disyston	In Furrow at Planting	Maloran Lorox Eptam Sencor Lasso	1-3 1-2 4 (average) 1/4-2 2-3-1/2	–
Onions	Dasanit Ethion Phosdrin Parathion	Root Maggot—In Furrow at Planting, Thrips—Spray 1-2 Times as Necessary	CIPC Randox Tok Dacthol	8 16 Up to 3 8 - 10	Pre-emerge; upland soil
Sod	–	–	Silvex 2,4-D Banvel	1 1-1/2 1/2	–

[a] *Does not include insects which attack stored crops; also, amounts used not available.*

[b] *Given in order – most used to least used.*

[c] *Amount of active ingredient.*

Source: University of Wisconsin-Extension - Madison Pesticide Specialists.

Table L-2

REPORTED PESTICIDE AND FERTILIZER USE PRACTICES POPULAR IN KENOSHA COUNTY, WISCONSIN

	Insecticide			Herbicide			Fertilizer[a]			Manure	
Crop	Type	Amount (per acre)	Application	Type	Amount (per acre)	Application	Element	Amount (pounds per acre)	Application	Applied	Amount (tons per acre)
Oats	–	–	–	2,4-D	1/2-2 pints	Early summer	N P K	0-24 10-96 30-120	–	–	–
Wheat	–	–	–	2,4-D	1/2-1-1/2 pints	Late spring	N P K	18-48 36-78 36-78	–	x	5-8
Hay	Alfatox	3/4 pound	–	Tolban	1/2 gallon	–	N P K	0 0-138 113-352	Topdress	x	4-10
Sudan Grass	–	–	–	None	–	–	N P K	18-22 67-72 67-72	Spring	x	30
Corn	Furadan Thimet Counter Dyfonate	8 pounds 4-10 pounds 6-8 pounds 3/4 pound	Spring at planting –	Atrazine Lasso Bladex 2,4-D Sutan Banvel Aatrex	2-1/2-5 pounds 2 quarts 3 pounds 1/2-1 pint 2 quarts 1/2 pint-1 quart 2-4 pounds	–	N P K N P K Nitrogen	0-33 28-132 72-231 7-46 28-96 24-91 80-200	Plowdown Starter Sidedress	x	3-25
Soybeans	Buxten	10 pounds	–	Lasso Lorox Sencor Treflan Basagran Amiben	2-2-1/2 quarts 2 pounds 1 pound 2 quarts 1 quart 10 pounds	–	N P K N P K	0-15 14-60 24-135 7 28 28	–	–	–
Truck Crops and Other											
Sweet Corn	Sevin Thimet	2-4 pounds 5 pounds	–	Lasso Sutan Atrazine	8-10 pounds 2 quarts 1-1/2 pounds	–	Nitrogen N P K	100-150 15-70 56-120 56-120	Plowdown Sidedress	–	–
Tomato, Pepper, Melon, Eggplant	Varies with crop	–	–	Varies with crop	–	–	N P K	30-60 60-120 60-120	–	–	–
Barley	–	–	–	2,4-D	1-1/2 quarts	–	N P K	28 28 28	–	–	–
Cabbage	Monitor Lannate Parathion Dipel Diazinon	1-2 pints 1-1/2 pints 1/2 pint-2-1/2 gallons 1/2-3/4 pound 1 pound	2-8 applications 2 applications	Treflan	1-1/2-2 pints	–	N P K	21-120 42-216 42-324	–	–	–
Beets	–	–	–	Roneet Pyramine	4 pounds	–	N P K	49 175 175	–	–	–
Onions	Ethion Parathion	15-20 pounds 1 pint	–	Dacthol Randox	18-20 pounds –	–	N P K	30-90 120-360 120-360	–	–	–
Potatoes	Parathion Monitor Sevin Thimet Manager	2 pounds 2 pints 2 pounds 10-30 pounds 1 quart	4-5 times 3 times 1-2 times – 2 times	Eptam Sencor Lorox Lasso	1 gallon 1-2 pounds 1-3 pounds 1/2 gallon	–	Nitrogen N P K	100 30-168 120-432 120-432	–	–	–

[a] *Rates shown reflect the amounts of nitrogen as elemental nitrogen, phosphorus as P_2O_5, and potassium as K_2O.*

Source: Kenosha County Office of the University of Wisconsin-Extension Service.

Table L-3

REPORTED PESTICIDE AND FERTILIZER USE PRACTICES POPULAR IN OZAUKEE COUNTY, WISCONSIN

	Insecticide			Herbicide			Fertilizer[a]			Manure	
Crop	Type	Amount (per acre)	Application	Type	Amount (per acre)	Application	Element	Amount (pounds per acre)	Application	Applied	Amount (tons per acre)
Oats	–	–	–	–	–	–	N P K	0 20-40 40-60	–	–	–
Wheat	–	–	–	–	–	–	–	–	–	–	–
Hay	–	–	–	–	–	–	N P K	0 0 120	–	–	–
Sudan Grass	–	–	–	–	–	–	–	–	–	–	–
Corn	–	–	–	–	–	–	Nitrogen N P K	60 17 70 70	–	–	–
Soybeans	–	–	–	–	–	–	N P K	0 40 40	–	–	–
Truck Crops and Other Sweet Corn	–	–	–	–	–	–	N P K	14 56 56	–	–	–

[a] *Rates shown reflect the amounts of nitrogen as elemental nitrogen, phosphorus as P_2O_5, and potassium as K_2O.*

Source: Ozaukee Cou[illegible] Office of the University of Wisconsin-Extension Service.

Table L-4

REPORTED PESTICIDE AND FERTILIZER USE PRACTICES POPULAR IN RACINE COUNTY, WISCONSIN

	Insecticide			Herbicide			Fertilizer[a]			Manure	
Crop	Type	Amount (per acre)	Application	Type	Amount (per acre)	Application	Element	Amount (pounds per acre)	Application	Applied	Amount (tons per acre)
Oats	None	–	–	2,4-D	1/2-2 pints	May-June	N P K	15-18 60-72 60-72	Drill	x	10-12
Wheat	None	–	–	2,4-D	1/2-2 pints	May-June	N P K	– – –	Drill	x	10-12
Hay	None	–	–	None	–	–	N P K	0 40 40	Broadcast	–	–
Sudan Grass	None	–	–	None	–	–	None	–	–	–	–
Corn	Furadan Thimet	–	April-May	Atrazine Sutan	2-1/2-5 pounds 2 quarts	Preplant and postplant	Nitrogen N P K	100 10 40 40	Preplant Row at planting	x	10-12
Soybeans	Sevin	–	July-August	Lasso Amiben	2-2-1/2 quarts 10 pounds	Preplant May Pre-emerge	N P K	10 40 40	Row	–	–
Truck Crops and Other Sweet Corn	Sevin Thimet	–	Post-emerge, July-August	Lasso Sutan	8-10 pounds 2 quarts	June-August	Nitrogen N P K	100 12-13 48-50 48-50	Row	x	10
Peas	–	–	–	–	–	–	–	–	–	–	–
Cabbage	Lannate Dipel	–	May-September	Tok	–	May-July	N P K	120 120 120	Row	–	–
Onions	Dasanit Phosdrin	–	May-June	Tok	–	June	Nitrogen N P K	90 80 80 240	Row	–	–
Potatoes	Thimet Thiodan	–	June-August	Lasso	–	May	N P K	70 140 210	Band	–	–
Sod	Diazinon	–	June-July	2,4-D	–	April-May	N P K	– – –	Broadcast	–	–

[a] *Rates shown reflect the amounts of nitrogen as elemental nitrogen, phosphorus as P_2O_5, and potassium as K_2O.*

Source: Racine County Office of the University of Wisconsin-Extension Service.

Table L-5

REPORTED PESTICIDE AND FERTILIZER USE PRACTICES POPULAR IN WALWORTH COUNTY, WISCONSIN

	Insecticide			Herbicide			Fertilizer[a]			Manure	
Crop	Type	Amount (per acre)	Application	Type	Amount (per acre)	Application	Element	Amount (pounds per acre)	Application	Applied	Amount (tons per acre)
Oats	–	–	–	None	–	–	N P K	0-7 20-42 30-126	Seeded down	–	–
Wheat	–	–	–	–	–	–	Nitrogen N P K	25-40 0-12 20-48 48-75	Topdress Broadcast	–	–
Hay	–	–	–	Eptam	–	–	N P K	0-3 0-56 90-180	Topdress	–	11.3- 14.1
Sudan Grass	–	–	–	–	–	–	–	–	–	–	–
Corn	Furadan Thimet	6-10 pounds 6-10 pounds	At planting –	Aatrex Bladex Lasso	2-4 pounds 1-1/2-2 quarts 1-2 quarts	– – –	N P K N P K Nitrogen	0-14 28-42 30-180 10-30 40-80 10-60 80-100	Plowdown Starter –	x	5.6- 16.4
Soybeans	–	–	–	Lasso Lorox Sencor	2-10 quarts 1-3 pounds 3/4 pound	– – –	N P K	0-12 20-54 13-90	–	–	4.7
Truck Crops and Other											
Sweet Corn	Sevin Furadan Thimet	2-4 pounds	–	–	–	–	–	–	–	–	–
Peas	Sevin	3 pounds	–	–	–	–	N P K	18 72 72	–	–	–
Cabbage	Diazinon	4-5 pounds	–	–	–	–	N P K	40 40 40	–	–	–
Mint	Diazinon	3 pounds	–	–	–	–	N P K	18 72 72	–	–	–
Sod	–	–	–	Silvex	1 quart	–	N P K	35 35 35	–	–	–

[a] *Rates shown reflect nitrogen as elemental nitrogen, phosphorus P_2O_5, and potassium as K_2O.*

Source: Walworth County Office of the University of Wisconsin-Extension Service.

Table L-6

REPORTED PESTICIDE AND FERTILIZER USE PRACTICES POPULAR IN WASHINGTON COUNTY, WISCONSIN

Crop	Insecticide			Herbicide			Fertilizer[a]			Manure	
	Type	Amount (per acre)	Application	Type	Amount (per acre)	Application	Element	Amount (pounds per acre)	Application	Applied	Amount (percent)
Oats	–	–	–	–	–	–	N P K	10 40 40	–	x	0-10
Wheat	–	–	–	–	–	–	–	–		x	0-10
Hay	–	–	–	–	–	–	N P K	0-63 0-60 0-180	–	x	10-25
Sudan Grass	–	–	–	–	–	–	N P K	10 40 40	–	x	10-25
Corn	Thimet Furadan Counter	7-10 pounds 7-10 pounds 6-1/2-7 pounds	– – –	Atrazine Lasso Aatrex Bladex Sutan	2-3 pounds 2 quarts 2-3 pounds 2 pounds 2-2-1/2 quarts	– – – – –	N P K N P K Nitrogen	0-41 0-120 0-126 10-27 40-96 32-90 70-300	Plowdown Starter	x	60-85
Soybeans	–	–	–	–	–	–	N P K	0 60 60	–	–	–
Truck Crops and Other Sweet Corn	Thimet Sevin Dyfonate	7-10 pounds 2 pounds 7-10 pounds	– – –	Banvel Lasso Aatrex Atrazine Bladex	– 2 pounds – 3-1/2 pounds 2 pounds	–	Nitrogen N P K	100-250 12-15 48-60 48-60	–	x	60-85
Peas	–	1 pint	–	Treflan MCPA MCPB	1 pint 1/4 pint	–	N P K	12-15 48-60 48-60	–	–	–
Beets, Carrots, Onions	Thimet Diazinon	5-20 pounds 1 pint	– –	Roneet Lasso	1-3 quarts 2 quarts	–	N P K Nitrogen Borate	0-27 0-81 0-180 66-82 8	–	–	–
Potatoes	–	–	–	–	–	–	N P K	36 144 144	–	–	–
Cabbage	–	–	–	–	–	–	N P K	25 100 100	–	–	–

[a] *Rates shown reflect nitrogen as elemental nitrogen, phosphorus as P_2O_5, and potassium as K_2O.*

Source: Washington County Office of the University of Wisconsin-Extension Service.

Table L-7

REPORTED PESTICIDE AND FERTILIZER USE PRACTICES POPULAR IN WAUKESHA AND MILWAUKEE COUNTIES, WISCONSIN

	Insecticide			Herbicide			Fertilizer[a]			Manure	
Crop	Type	Amount (per acre)	Application	Type	Amount (per acre)	Application	Element	Amount (pounds per acre)	Application	Applied	Amount (tons per acre)
Oats	–	–	–	2,4-D Ester	1-1/2 pints	Early June	N P K	0-12 25-48 48-100	At planting, broadcast and topdressed	x	10
Wheat	–	–	–	–	–	–	N P K	0-12 25-48 48-100	At planting, broadcast and topdressed	x	10
Hay	–	–	–	Princep 2,4-D Amine Eptam	1 quart 1-1/2 pints –	Fall, early June April-May	N P K	0 0-25 90-100	Early spring broadcast	x	10
Sudan Grass	–	–	–	–	–	–	N P K	9 36 36	At planting, broadcast	x	10
Corn	Counter Furadan Thimet Disyston	6-10 pounds 5-9 pounds 6-10 pounds 5-8 pounds	May at planting	Atrazine Lasso Bladex Prowl	1-5 pounds 2 quarts 2 quarts 1-1-1/2 quarts	May at planting	Nitrogen N P K	100 0-15 0-60 60	Broadcast and row	x	4
Soybeans	–	–	–	Treflan Amiben Lasso Lorox	2 quarts 10 pounds (3 pounds actual ingredients) 1 quart 1 quart	May preplant	N P K	0 15 60	Preplant, broadcast and row	–	–
Truck Crops and Other											
Sweet Corn	Counter Thimet Disyston Sevin granulated liquid	6-10 pounds 6-10 pounds – – 1 pint	May at planting July	Atrazine Lasso Bladex Prowl	1-5 pounds 2 quarts 2 quarts 1-1-1/2 quarts	May at planting	Nitrogen N P K	100 0-15 0-60 60	Broadcast and row	x	2
Peas	Diazinon Malathion	–	June	MCPA Treflan	1-1/2 pints 1-1/2 pints	April preplant	–	–	–	–	–
Cabbage	Thiodan Sevin	–	Periodic	Trylan Tok Dacthal	–	April-May	N P K Mg, Zn	204 204 204 Soil test	Preplant, broadcast and row	–	–
Onions	Diazinon Dasanit Ethion	–	At planting	Tok Randox CIPC	–	April-May	Nitrogen N P K	80 0 120 360	Preplant, broadcast and row	–	–
Potatoes	Sevin Thiodan Furadan	–	Periodic	Eptam Treflan	–	April-May	N P K	50 50 50	Preplant	–	–
Sod	Chlordane	3 pounds	As needed	2,4-D Banvel	–	Periodic	N P K	50 50 50	Preplant, broadcast	–	–

[a] *Rates shown reflect nitrogen as elemental nitrogen, phosphorus as P_2O_5, and potassium as K_2O.*

Source: Waukesha County Office of the University of Wisconsin-Extension Service.

Appendix M

INVENTORY OF SOIL AND WATER CONSERVATION PRACTICES IMPLEMENTED OVER THE PERIOD 1965-1975

Since the early 1930's it has been a national objective to preserve and protect agricultural soil from wind and water erosion. Soil and water conservation practices are primarily implemented through programs provided by the U. S. Department of Agriculture (USDA), Soil Conservation Service and USDA Agricultural Stabilization and Conservation Service. The Commission conducted an inventory by county of conservation practices installed since 1965 in southeastern Wisconsin. The inventory results were compiled from an analysis of 1" = 400' scale aerial photographs by the staffs of the Soil Conservation Service, Soil and Water Conservation Districts, and the Commission, working with local farmers. The results of that inventory are presented in the table below.

Table M-1

USDA AGRICULTURAL STABILIZATION AND CONSERVATION AND SOIL CONSERVATION SERVICE PRACTICES IMPLEMENTED ON THE LAND IN THE REGION OVER THE PERIOD 1965-1975

County	Permanent Vegetation Cover (acres)	Tree Stands (number)	Farm Ponds (number)	Strip Cropping (acres)	Wildlife Habitat (number)	Water and Grade Control Structures[a] (number)	Liming (acres)	Terraces (lineal feet)	Diversions (lineal feet)	Grassed Waterways (lineal feet)	Wind Erosion Controls (lineal feet)	Open Drains (lineal feet)	Tiling (lineal feet)	Mulching (acres)	Animal Waste Facilities (number)	Streambank Stabilization (lineal feet)	Interim Cover (acres)
Kenosha	716	61	65	646	15	18	2,902	–	6,793	175,569	40,143	33,144	794,145	–	2	2,000	–
Milwaukee	158	4	13	14	25	–	403	–	–	700	2,650	4,700	6,883	–	–	1,800	–
Ozaukee	3,942	49	98	936	38	3	101	6,635	27,353	229,681	45,039	60,148	805,624	–	–	3,250	–
Racine	1,153	37	29	260	37	20	760	975	10,166	168,259	26,360	40,489	359,305	545	2	6,440	23
Walworth	439	155	88	1,064	18	11	1,304	31,243	23,589	392,043	45,169	53,506	946,721	60	2	253	182
Washington	1,265	298	186	7,116	372	2	–	13,635	84,729	262,258	83,828	292,476	883,566	172	2	–	–
Waukesha	4,772	251	196	1,183	199	13	2,303	–	26,386	75,090	74,660	132,428	298,440	2	4	7,650	407
Region Total	12,445	855	675	11,219	704	67	7,773	52,488	179,016	1,303,600	317,849	616,891	4,094,684	779	12	21,393	612

[a] *Water and grade control structures include drop spillways, box inlets, chute spillways, pipe drop inlets, debris basins, and other such structures. These structures supplement vegetative practices by reducing the grade in watercourses, reducing the velocity and peak flow storm water runoff, storing water, trapping sediment, and providing surface water drainage to ditches.*

Source: U.S.D.A. Agricultural Stabilization and Conservation Service, U.S.D.A. Soil Conservation Service, and SEWRPC.