COMBINED SEWER OVERFLOW LOADINGS INVENTORY FOR GREAT LAKES BASIN

Final Report

GCA

GCA CORPORATION
Technology Division

213 Burlington Road
Bedford, Mass. 01730

GCA-TR-82-90-G

Prepared for

U.S. Environmental Protection Agency
Great Lakes National Program Office
Chicago, IL 60605

Contract No. 68-01-6421
Work Assignment No. 010

EPA Project Officer

Paul J. Horvatin

COMBINED SEWER OVERFLOW LOADINGS INVENTORY FOR GREAT LAKES BASIN

Final Report

March 1983

Prepared by

John Patinskas
Thomas Nunno
Richard Rehm
Tim Curtin

GCA CORPORATION
GCA/TECHNOLOGY DIVISION
Bedford, Massachusetts 01730

DISCLAIMER

This Final Report was furnished to the Environmental Protection Agency Region V by the GCA Corporation, GCA/Technology Division, Bedford, Massachusetts 01730, in partial fulfillment of Contract No. 68-01-6421, Work Assignment No. 010. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency or of cooperating agencies. Mention of company or product names is not to be considered as an endorsement by the Environmental Protection Agency. Phosphorous loading data contained herein were based on available information from numerous diverse sources. Where necessary, best engineering judgement has been used to draw conclusions from limited data.

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

FIGURES

FIGURES (continued)

TABLES

TABLES (continued)

TABLES (continued)

ACKNOWLEDGMENTS

The authors wish to thank Mr. Paul Horvatin, EPA Work Assignment Manager, who has provided GCA with several valuable documents which have served to expedite this project. In addition, the authors wish to thank personnel of the consulting firms, and state and local agencies who have provided GCA with necessary information.

SECTION 1

INTRODUCTION

BACKGROUND

The Great Lakes Water Quality Agreement of 1978 between the United States and Canadian governments recommended objectives to minimize eutrophication problems and to prevent degradation with regard to phosphorous and other pollutants in the boundary waters of the Great Lakes system. To develop and implement these objectives, accurate estimates of annual phosphorous loadings to the lakes from point sources and nonpoint sources are required. The annual loadings reflect the effectiveness of remedial programs for these sources. The difficulties in accurately measuring and estimating phosphorous inputs from municipal Combined Sewer Overflow, bypass and Separate Sewer Overflow sources in the Great Lakes basin have been recognized. The variance associated with the load estimates is due to differing procedures used by each of the eight Great Lakes states to maintain and compute the loads. This report provides the most recent available Combined and Separate Sewer Overflow Phosphorous loadings.

OBJECTIVES AND SCOPE OF THE PROJECT

The primary objective of this report was to identify and compile flow volumes and phosphorous loadings to the Great Lakes from all Sewer Overflows, and Bypasses from 17 of the largest metropolitan areas in the basin. These areas have been further broken down into the 27 areas listed in Table 1-1. A secondary objective was to identify and reference other CSO pollutants of significant importance and their reported loadings, concentrations and rates. Reports on municipal Combined Sewer Overflow phosphorous loadings to the Great Lakes were compiled for the most current year of record as data were available. All information contained in this report was obtained from existing data bases. As part of a special review of phosphorous loadings to the western basin of Lake Erie, a report on 1979 total phosphorous loads from all Detroit sewer overflows by storm event in addition to the total annual load was prepared. A special review of phosphorous loadings from separate sewer stormwater discharges was also conducted for all study areas located in New York. For these areas, annual stormwater phosphorous loadings are included with the CSO summaries.

The study of each metropolitan area was conducted in two phases. The first phase consisted of researching and reviewing data availability. Much of the Phase 1 effort was devoted to phone contact with all potential data sources. These sources generally included 208 planning agencies and sewer

TABLE 1-1. LIST OF GREAT LAKES BASIN STUDY AREAS

1. Milwaukee, Wisconsin
2. Kenosha, Wisconsin
3. Racine, Wisconsin
4. Chicago, Illinois
5. Hammond, Gary, East Chicago, Indiana
6. Grand Rapids, Michigan
7. Kalamazoo, Michigan
8. Muskegon, Michigan
9. Midland, Michigan
10. Saginaw, Michigan
11. Bay City, Michigan
12. Flint, Michigan
13. Detroit, Michigan
14. Detroit Suburbs, Michigan
15. Monroe, Michigan
16. Toledo, Ohio
17. Oregon, Ohio
18. Lorain, Elyria, Ohio
19. Cleveland, Ohio
20. Akron, Ohio
21. Erie, Pennsylvania
22. Buffalo, New York
23. Tonawanda, North Tonawanda, New York
24. Niagara Falls, New York
25. Rochester, Irondequoit, New York
26. Oswego, New York
27. Syracuse, New York

authorities at the local level as well as State Pollution Control Agencies and regional EPA offices. As a result of these phone contacts, several reports were identified and obtained for many of the study areas. Additional data were obtained through field trips to the EPA Region V office in Chicago, Illinois and the Michigan Department of Natural Resources office in Lansing, Michigan.

The second phase included collecting, compiling, calculating and reporting on Combined Sewer Overflow phosphorous loadings. Generally, the data obtained in Phase 1 contained information on flow, duration of storm events, frequency of sewer overflow and plant bypass, analytical phosphorous concentration data, etc. However, in many cases data were lacking to some extent. For example, in some instances CSO flow was quantified but phosphorous concentration data were absent. In such cases, sound engineering judgment was applied to estimate the representative phosphorous load, specific attention being paid to whether or not each metropolitan area was affected by a phosphorous ban.

ORGANIZATION OF THE REPORT

The remainder of this report is devoted to quantifying phosphorous loads from overflows, and bypasses in each of the metropolitan areas listed in Table 1-1. Section 2 provides a summary and discusion of phosphorous loadings, grouping metropolitan areas by lake basin. Sections 3 through 30 address specific metropolitan areas, reporting annual phosphorous loadings from CSOs as well as separate sewer overflows and bypasses when available. Most of these sections also include data on the areal extent of combined sewers, flow rates, rainfall information (e.g., wet year, dry year, average rainfall year), the technical basis for any calculations, and a discussion on data accuracy. When data sources have provided quantitative data on other pollutant contaminants, this information is either included in the section or is referenced by volume and page number.

SECTION 2

EXECUTIVE SUMMARY

As stated in Section 1, the primary objective of this report has been to quantify volumes and phosphorous loadings from overflows and bypasses located in major metropolitan areas (shown in Figure 2-1) of the Great Lakes Basin. The methodology for achieving this goal has been to access existing data bases at the federal, state and local levels. Data availability was found to vary considerably, from very extensive for some areas, to almost nonexistent for others. For most metropolitan areas, data on CSOs were found to be adequate for calculating overflow volumes and total phosphorous loads. Conversly, data necessary to calculate flow rates and loadings from sanitary sewer overflows and pump stations, flow equalization basins and treatment plant bypasses were found to be generally lacking.

Table 2-1 provides a summary of the data obtained for each of the metropolitan areas. These data include the areal extent of the combined sewer service area, the annual overflow volume and the annual total phosphorous load, expressed as P. All flow and loading data are provided for an average rainfall year except where noted differently. The phosphorous loadings in Table 2-1 represent CSOs only, in most cases. Estimated loadings from bypasses and sanitary overflows are included where sufficient data were found to be available. The study areas listed in Table 2-1 are grouped by lake drainage basin, i.e., Lake Michigan, Lake Huron, Lake Erie and Lake Ontario.

Overflow and bypass loadings to Lake Michigan were investigated for 11 metropolitan areas. These 11 areas contribute an annual phosphorous load of approximately 207.0 metric tons (MT). The City of Milwaukee is responsible for the largest phosphorous load, estimated at 66.1 metric tons. Other major sources of overflow phosphorous loadings to Lake Michigan include Gary, East Chicago and Hammond which discharge 48.6, 41.4 and 39.2 metric tons, respectively. Relatively minor quantities are discharged from the Chicago North Shore Sanitary District, Grand Rapids, Kenosha and Racine. The City of Chicago is an unusual case in that CSO discharges reach Lake Michigan only during "backflow events" caused by excessive rainfall or snow melt. It is highly probable that Chicago's annual CSO loading to Lake Michigan averages less than 5.5 MT per year. The Cities of Kalamazoo and Muskegon are serviced by separate sanitary and storm sewer systems which have no reported overflows by passes.

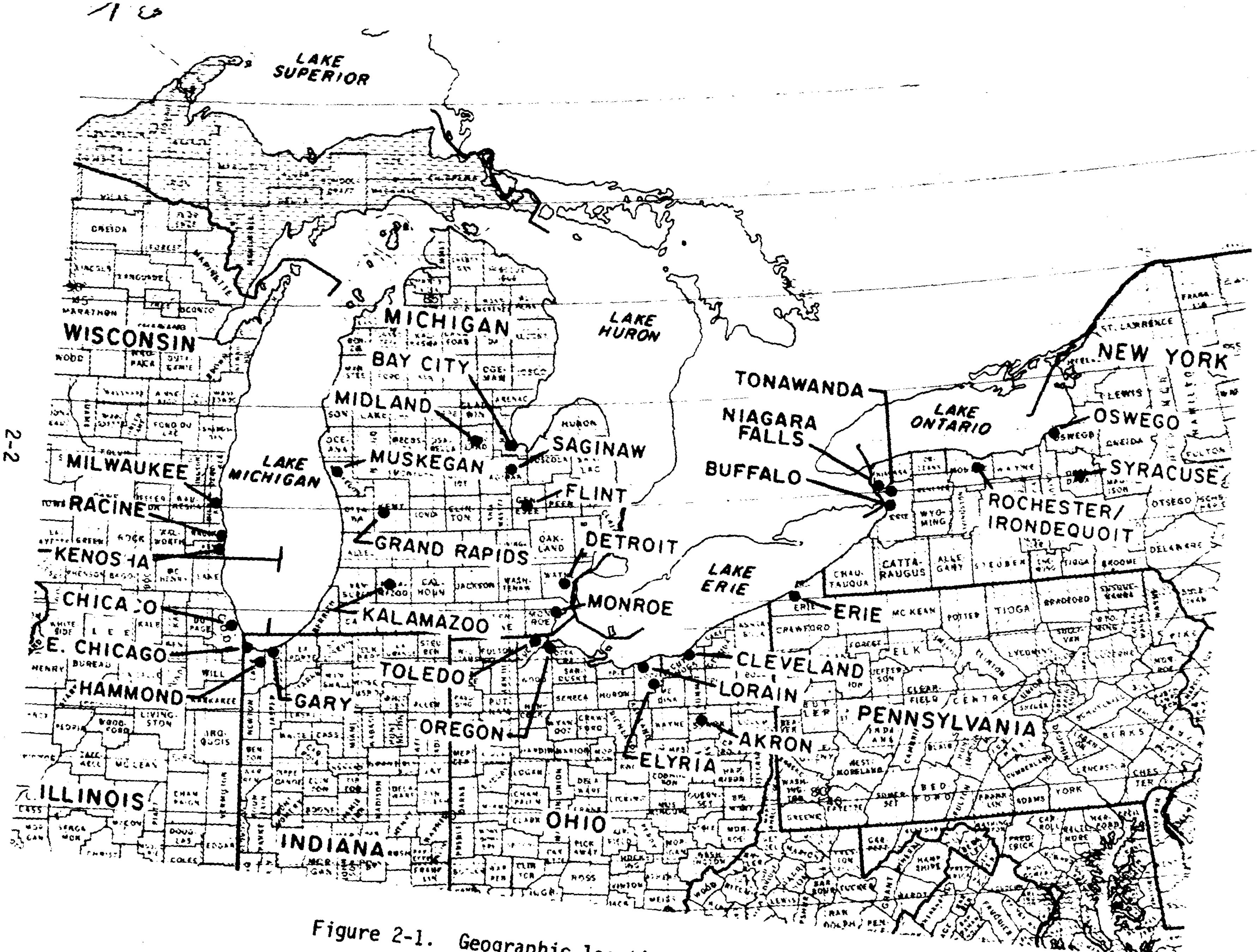


Figure 2-1. Geographic location of study areas.

TABLE 2-1. SUMMARY OF ANNUAL PHOSPHOROUS LOADINGS TO THE GREAT LAKES BASIN FROM OVERFLOWS AND BYPASSES

Metropolitan area	Combined sewer service area, acres	Overflow, MG	Total annual phosphorous load as P, lbs (MT)
Lake Michigan			
Milwaukee, WI	14,720	4,827	145,357 (66.1)
Kenosha, WI	150	17	413 (0.2)
Racine, WI	509	90	1,126 (0.5)
Chicago NSSD	NA	943	15,134 (6.9)
Chicago, IL	NA	NA	NA[a]
Hammond, IN	NA	3,444	86,167 (39.2)
Gary, IN	NA	4,274	106,936 (48.6)
East Chicago, IN	NA	3,643	91,148 (41.4)
Grand Rapids, MI	5,550	441	9,166 (4.2)
Kalamazoo, MI	0	0	0
Muskegon, MI	0	0	0
Subtotal			455,447 (207.0)
Lake Huron			
Midland[b], MI	375	NA[c]	NA[c]
Saginaw, MI	5,580	2,620	74,191 (33.7)
Bay City[b], MI	NA	NA[c]	NA[c]
Flint, MI[b]	0	9	300 (0.1)[d]
Subtotal			74,491 (33.8)
Lake Erie			
Detroit, MI	85,800	16,800	353,100 (160.5)[e]
Detroit, MI suburbs[b]	33,100	13,973	144,726 (65.8)
Monroe, MI	NA	122	2,035 (0.9)
Toledo, OH	12,000	NA	166,440 (75.7)
Oregon, OH	0	0	0
Lorain/Elyria, OH	271	68	3,045 (1.4)
Cleveland, OH	NA	5,738	258,895 (117.7)
Akron, OH	10,450	1,062	17,707 (8.0)[f]
Erie, PA	NA	NA	NA[g]
Buffalo, NY	[h]	2,600	61,130 (27.8)
Subtotal			1,007,078 (457.8)

(continued)

TABLE 2-1 (continued)

Metropolitan area	Combined sewer service area, acres	Overflow, MG	Total annual phosphorous load as P, lbs (MT)
Lake Ontario			
Buffalo, NY	h	5,800	84,480 (38.4)
Tonawanda/North Tonawanda, NY	1,929	NA	6,600 (3.0)
Niagara Falls, NY	6,600	NA	24,300 (11.0)
Rochester/Irondequoit, NY	23,400	1,900	39,456 (17.9)
Oswego, NY	445	1,096	31,028 (14.1)
Syracuse, NY	6,827	1,660	48,466 (22.0)
Subtotal			234,330 (106.4)
Total			1,771,346 (805.2)

[a]Less than 12,000 lbs (5.5 MT).

[b]Collection system equipped with flow equalization basin(s).

[c]Likely to be very small.

[d]Based on rough estimated, no measured data.

[e]Based on 27.5 in. annual rainfall (6 percent greater than average year).

[f]Based on 34.5 in. annual rainfall (7 percent greater than average year).

[g]Likely to be less than 2.7 MT.

[h]Total combined sewer service area = 26,200 acres.

NA = Not available.

The four Michigan study areas discharging to Lake Huron are identified as Midland, Saginaw, Bay City and Flint. Of these, the only major source of phosphorous is Saginaw, which discharges 33.7 metric tons annually. Approximately 0.1 metric tons of phosphorous overflow from an equalization basin at Flint's Wastewater Treatment Plant. Additional sewer discharges within the Flint Metropolitan Area are attributed to surcharges through manholes in low-lying areas and bypasses at pump stations. However, the volume of flow from these sources has never been quantified. Combined sewer overflow volumes and phosphorous loads for Midland's collection system were also found to be unavailable. The Midland combined sewer service area covers only 375 acres and the treatment plant is equipped with a flow equalization basin to reduce overflows. Consequently, Midland's overflow volume and associated phosphorous load are likely to be small relative to other areas. Bay City has recently upgraded the collection system by installing five flow equalization basins. The volume of overflow from these basins has not been determined. However, the basins are designed to eliminate overflow from storms as large as the 10 year event, thus the average rainfall year phosphorous load is likely to be insignificant.

Annual overflow phosphorous loadings to Lake Erie total 457.8 metric tons. The largest annual loadings are discharged by Detroit (160.5 metric tons), Cleveland (117.7 metric tons), Toledo (75.7 metric tons), the suburban Detroit area (65.8 metric tons), Buffalo (27.8 metric tons) and Akron (8.0 metric tons). Relatively minor loadings are attributed to the Lorain/Elyria and Monroe areas. Due to recent remedial actions taken to reduce Erie's CSO discharge, GCA was unable to quantify the present annual overflow volume with any degree of accuracy. Limited data suggests that Erie's current annual phosphorous load is less than 2.7 metric tons. The City of Oregon has recently upgraded its collection system, eliminating all overflows and bypasses.

The annual CSO phosphorous loading to Lake Ontario is given in Table 2-1 as 106.4 metric tons. Substantial phosphorous loads are attributed to the metropolitan areas of Buffalo (38.4 MT), Syracuse (22.0 MT), Rochester/Irondequoit (17.9 MT), Oswego (14.1 MT) and Niagara Falls (11.0 MT). Note that Oswego's overflow volume and phosphorous load are disproportional to the area serviced by combined sewers. Oswego's uncharacteristically high phosphorous load results from the continual discharge of raw sewerage into the Oswego River through combined sewers on the West Side. An interceptor sewer, designed to correct this condition, is currently under construction and should be in operation by the end of 1983.

The total phosphorous loads from the major metropolitan area overflow sources effluent to the four Great Lake Basins of concern is calculated to be 805.2 metric tons. The greatest portion of this loading is attributed to Lake Erie overflows which together account for 457.8 MT or 56.8 percent of the basinwide loading. Lake Michigan sources discharge 207.0 MT (25.8 percent) while Lake Ontario and Lake Huron receive 106.4 MT (13.2 percent) and 33.8 MT (4.2 percent), respectively

In addition to combined sewer overflow and bypass phosphorous loadings, stormwater phosphorous loads were investigated for those metropolitan areas located in the State of New York. Table 2-2 provides a summary of stormwater loading results. In general, data on stormwater loads were found to be very limited. The stormwater phosphorous loading from the Rochester/Irondequoit area was found to be the largest at 14.5 MT. Note that the Rochester/Irondequoit stormwater study area included several surrounding communities while the other metropolitan study areas were restricted to corporate boundaries. Stormwater phosphorous loads from Tonawanda/North Tonawanda, Syracuse, and Oswego were found to be relatively small in comparison to loadings from CSOs. Stormwater loads from separated systems in Buffalo and Niagara Falls are minimal due to the combined nature of the collection systems in these areas.

TABLE 2-2. SUMMARY OF STORMWATER PHOSPHOROUS LOADS FROM SOURCES LOCATED IN NEW YORK

Metropolitan area	Total annual phosphorous load, lbs (MT)
Buffalo, NY	0[a]
Tonawanda/North Tonawanda, NY	11,300 (5.1)
Niagara Falls, NY	0[a]
Rochester/Irondequoit, NY	31,916 (14.5)[b]
Oswego, NY	1,182 (0.53)
Syracuse, NY	8,627 (3.9)

[a]All stormwater transported by combined sewers.

[b]Study area covers 169 square miles including eastern portions of Rochester and several surrounding communities.

SECTION 3

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF MILWAUKEE, WISCONSIN

BACKGROUND

The Milwaukee Metropolitan Sanitary District (MMSD) is a 268,800 acre area which includes the city of Milwaukee and surrounding suburban areas. Approximately 14,720 acres (5.5 percent) of the MMSD are serviced by combined sewers. Figure 3-1 is a map of the MMSD indicating the relative location of the Combined Sewer Service Area (CSSA). The CSSA is centered at the confluence of three rivers, the Milwaukee River, the Menomonee River and the Kinnickinnic River. The CSSA extends from Hampton Avenue on the north to Oklahoma Avenue on the south and from 43rd Street on the west to Lake Michigan on the East.

The CSSA contains 550 miles of interceptor sewer lines which collect and deliver wastewater to Milwaukee's Jones Island Treatment Plant. These sewers, which 50 years ago could handle flow during most events have lost their effectiveness due to population growth and general urbanization. During major storm events the water volume can increase by as much as 60 times the dry weather flow volume, necessitating flow diversion into receiving waters by intercepting structures and crossover devices. During periods of wet weather, discharge is possible at 112 CSOs within the CSSA; 23 discharging to the Kinnickinnic River, 26 discharging to the Menomonee River, 61 discharging to the Milwaukee River, and two effluent to Milwaukee's outer harbor. An additional 377 sewer sytem relief points, including three treatment plant bypasses are located throughout the MMSD. These reliefs discharge either to the Fox River, the Kinnickinnic River, the Menomonee River, the Milwaukee River, Oak Creek, the Root River or directly into Lake Michigan.

TOTAL PHOSPHOROUS LOADINGS

Phosphorous loading data were obtained from reports by the Southeastern Wisconsin Regional Planning Commission (SEWRPC)[1] and Milwaukee's Program Management Office (PMO).[2] Both sources group data by receiving water (e.g., Milwaukee River, Kinnickinnic River, Menomonee River) and neither source provided breakdown phosphorous loads by CSO.

Phosphorous loadings as determined in both studies are compared in Table 3-1. In the SEWRPC study phosphorous loads were estimated for an average year, a dry year and a wet year; dry year loads being calculated as 64.3 percent of average year loads and wet year loads calculated as

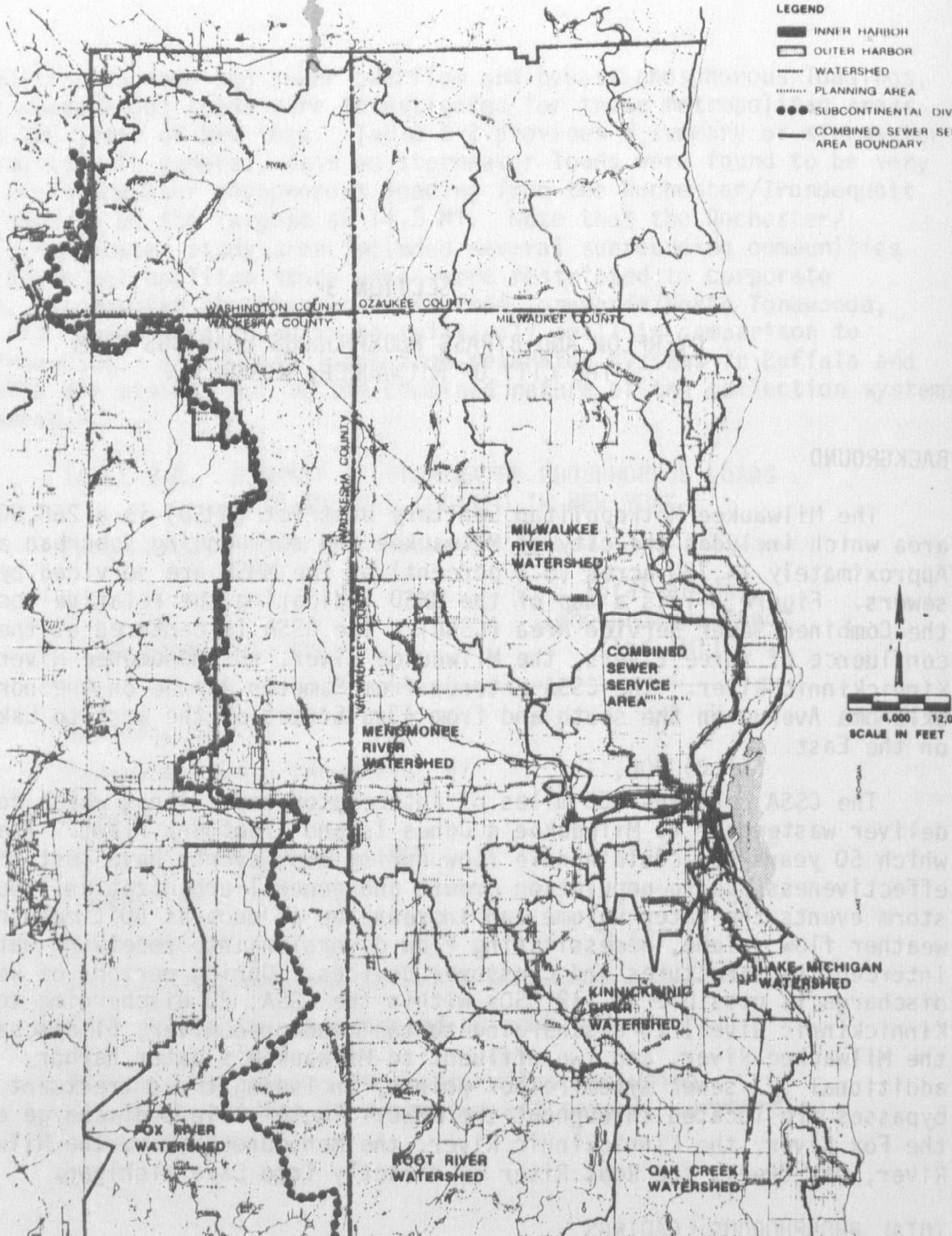


Figure 3-1. Milwaukee metropolitan sanitary district.

TABLE 3-1. PHOSPHOROUS LOADINGS FROM CSOs AND SANITARY SEWER RELIEFS[1,2]--MILWAUKEE, WI

			Total phosphorous load as P, lbs			
			SEWRPC study			PMO study
No.	Watershed	CSSA area, acres	Average year	Dry year	Wet year	Average year
1.	Milwaukee River:	5,952				
	• CSO		54,670	35,150	74,950	58,000
	• Other reliefs		2,460	1,580	3,370	NA
	Subtotal		57,130	36,730	78,320	
2.	Menomonee River:	5,780				
	• CSO		54,880	35,290	75,240	45,500
	• Other reliefs		2,320	1,490	3,180	NA
	Subtotal		57,200	36,780	78,420	
3.	Kinnickinnic River:	2,697				
	• CSO		21,520	13,840	29,500	19,100
	• Other reliefs		190	120	260	NA
	Subtotal		21,710	13,960	29,760	
4.	Outer Harbor	880				
	• CSO		5,671[a]	3,646	7,775	5,671[a]
	• Other reliefs		3,516	2,261	4,820	NA
	Subtotal		9,187	5,907	12,595	
5.	Rock River	0				
	• CSO		0			
	• Other reliefs		130	84	178	NA
	Subtotal		130	84	178	
	Areawide	15,309				
	• CSO		136,741	87,926	187,465	128,271
	• Other reliefs		8,616	5,535	11,808	
	Total		145,357	93,461	199,273	

[a]Calculated by GCA.

137.1 percent of average year loads. The PMO study provides phosphorous loadings for an average rainfall year only. The PMO study was also limited in that it provided no data on sanitary sewer reliefs or CSO discharges to the outer harbor. Outer harbor discharges were calculated from flow data provided in the SEWRPC study and phosphorous concentration data from the PMO study. Using this data GCA used the following equation to calculate loadings:

$$\text{load} = \text{flow}\ \frac{(10^6\ \text{gal})}{\text{yr}} \times 3.4\ \frac{\text{mg}}{\text{l}} \times \frac{8.34\ \text{lbs}}{\text{mg/l-}10^6\ \text{gal}}$$

All other loadings were obtained directly from the literature sources and are reported as total phosphorous (as P).

In an average rainfall year the SEWRPC estimated total phosphorous load from CSOs to be 136,741 lbs (62 MT) compared to 128,271 lbs (58.3 MT) for the PMO study. The SEWRPC study estimated an additional 8,616 lbs (3.9 MT) from sanitary relief devices bringing the annual total to 145,357 lbs (66.1 MT). During dry and wet weather SEWRPC reported the expected load to be 93,461 lbs (42.5 MT) and 199,273 lbs (90.6 MT), respectively. According to the SEWRPC study the largest loadings are to the Menomonee and Milwaukee Rivers, which receive annual loads of 57,200 and 57,130 lbs, respectively. Approximately 21,710 lbs of phosphorous are released to the Kinnickinnic River from CSOs and reliefs with lesser amounts released to the outer harbor and Root River. The PMO study estimates annual phosphorous loadings to the Milwaukee River to be the largest at 58,000 lbs (26.4 MT) annually followed by the Menomonee and Kinnickinnic Rivers with 45,500 lbs (20.7 MT) and 19,100 lbs (8.7 MT), respectively.

DATA ON OTHER POLLUTANTS

In addition to phosphorous data, the PMO and SEWRPC studies provided data on biochemical oxygen demand, fecal coliforms, sediment and total nitrogen. Table 3-2 provides a summary of loadings from these pollutants.

DATA QUALITY

Documentation of the method used to calculate phosphorous loads in the SEWRPC study was not provided. The PMO study relied on STORM model flows and concentrations from monitoring CSO events. In calculating the phosphorous loads the PMO study assumed 10 percent of the flow contains a first flush concentration and 90 percent contains an extended flow concentration. The flow weighted average phosphorous concentration was determined to be 3.4 mg/l. Wisconsin had a detergent phosphorous ban in effect from July 1, 1979 until it "sunset" three years later on June 30, 1982. Calculated phosphorous loadings reflect the time periods covered by the studies and interim detergent formulation changes by the manufacturers. The PMO study was made during the detergent phosphorous ban while the SEWRPC study used 1975 pre-ban data. Consequently, the SEWRPC data is likely to best represent current non-ban conditions.

TABLE 3-2. ANNUAL LOADINGS OF OTHER POLLUTANTS--MILWAUKEE, WI

	WATERSHED					
	Milwaukee River[a]		Menomonee River		Kinnickinnic River	
Parameter[b]	SEWRPC	PMO	SEWRPC	PMO	SEWRPC	PMO
Biochemical Oxygen Demand	1,093,370	3,026,000	1,097,540	1,556,000	430,340	637,000
Fecal Coliform	350,000,000	591,000,000	350,000,000	460,000,000	140,000,000	200,000,000
Sediment	1,640	2,585	1,645	2,200	645	975
Total Nitrogen	109,340	196,283	109,750	148,000	43,030	60,962

[a]Includes load to Lincoln Creek.

[b]Loads presented in pounds per year except for fecal coliform presented in counts x 10^6 per year and sediment presented in tons per year.

REFERENCES

1. Southeastern Wisconsin Regional Planning Commission. Sources of Water Pollution in Southeastern Wisconsin: 1975, Technical Report Number 21, September 1978.

2. Milwaukee Metropolitan Sewerage District. Combined Sewer Overflow. Volume 4, Part 2, June 1, 1980.

CONTACTS

1. Mr. Robert Biebel. Southeast Wisconsin Regional Planning Commission. (414) 547-6721.

2. Ms. RoseMary Murphy. Metropolitan Sewage District. (414) 278-2028.

SECTION 4

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF KENOSHA, WISCONSIN

BACKGROUND

The City of Kenosha is located in the southeast corner of Wisconsin on the shore of Lake Michigan. The combined sewer system is controlled at four combined sewer overflow regulators. Table 4-1 presents a list of these regulators, their locations, classifications, and drainage areas. During dry weather periods, the combined sewers normally flow into an interceptor sewer running along 3rd Avenue to the treatment plant. In wet weather, when the regulatory orifice is exceeded, the combined sewerage overflows directly into Lake Michigan. The location of these combined sewer overflow regulators are illustrated in Figure 4-1.

The City of Kenosha is currently in the process of conducting a combined sewer separation program. Prior to this program the combined sewer system overflows approximately 20 times each year. Combined sewer overflows were produced by a rainfall intensity as low as 0.2 inches per hour. Of the total annual pollutants discharged into Lake Michigan in the Kenosha area, combined sewer overflows accounted for about 3 percent of the suspended solids, 7 percent of the BOD_5, 4 percent of the phosphorous, and 85 percent of the fecal coliforms. In fact, Lake Michigan beaches were closed to whole-body contact for a period of 48 hours following a rainstorm accumulation of 0.1 inch or greater. Based on past rainfall history, the beaches in Kenosha were closed approximately 1 out of every 3 days during the months of May to September.

COMBINED SEWER OVERFLOW VOLUMES

Combined sewer overflows data for the years of 1967 through 1976 are presented in Table 4-2.* The table covers the months of March to October, inclusive. No reason is given to exclude the winter months. However, the reason might be that overflows do not occur during these months because precipitation runoff is inhibited by subfreezing temperatures.

---

*Pre-separation project data.

TABLE 4-1. COMBINED SEWER OVERFLOW REGULATORS--KENOSHA, WISCONSIN

Name	Location	Classification (%)				Drainage area, acres
		Residential	Commercial	Industrial	Undeveloped	
57th St.	57th St. and 3rd Ave.	73.1	26.9	--	--	97.3
59th St.	59th St. and 3rd Ave.	45.6	34.3	20.1	--	106.5
67th St. 75th St.	67th St. and 3rd Ave. 75th St. and 3rd Ave.	83.3	--	13.4	2.8	947.0

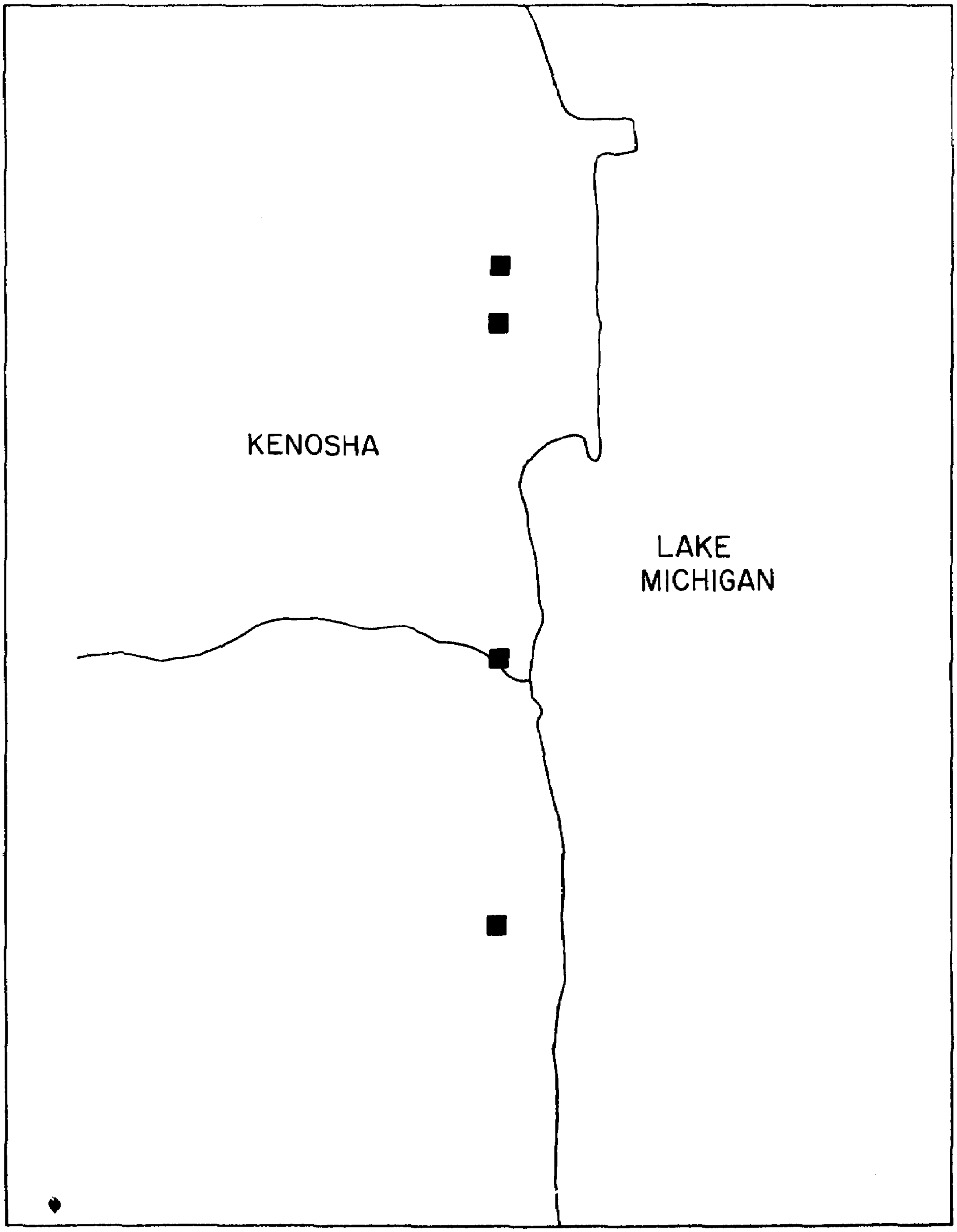


Figure 4-1. Combined sewer overflow locations--Kenosha, WI.

TABLE 4-2. VOLUMES AND POLLUTANTS OF CSO EVENTS--KENOSHA, WISCONSIN[a]

	No. of CSO events	Vol. of CSO, MG	Suspended solids, lbs. x 1,000	BOD, lbs. x 1,000	Fecal coliforms, MPN x 10^{13}	Total P, lbs. x 1,000
1967	20	149	673	77	178	3.67
1968	17	145	554	64	150	3.57
1969	19	147	586	70	167	3.62
1970	20	100	566	65	145	2.46
1971	10	68	378	44	92	1.68
1972	27	247	1,070	124	270	6.09
1973	21	117	650	73	158	2.88
1974	20	147	644	75	173	3.62
1975	18	69	417	50	116	1.70
1976	15	100	475	54	120	2.46
Avg.	19	129	601	70	157	3.18

[a]Accumulations are for periods of March-October for each year.

The number of overflows activated during a storm ranged from 10 to 27 during the 8 months, with an average of 19. The volume of the overflows ranges from 68 to 247 million gallons during the same time span with an average of 129 million gallons per storm.

The data presented in Table 4-2 are the result of monitoring 6 wet weather events. It should be noted that no overflow was recorded at the 75th Street regulator. In the summer of 1977, a Manning dipper flow recorder was placed at each of the four combined sewer overflow points. Due to problems with setup, operation, and maintenance of these instruments, the report warns that the data may be of limited usefulness. However manual measurements were also obtained and the combination of both manual and automatic measurements were used to calculate flows.

During the spring of 1978, combined sewer overflow monitoring efforts were expanded and modified to provide a more reliable and comprehensive data base. The Manning dippers were replaced with sonic level recorders which provide more accurate monitoring data. In addition, actual velocity measurements were made during wet weather events.

TOTAL PHOSPHOROUS CONCENTRATIONS

During 1977 and 1978, 158 total phosphorous concentrations were determined for 3 of the 4 overflow regulators. No samples were taken from the 75th Street regulator because no overflow occurred there. The results of the sampling were combined to form 18 composite results as presented in Table 4-3. The total phosphorous concentrations ranged from 0.83 to 5.10 mg/l as P with an average concentration of 2.96 mg/l.

TOTAL PHOSPHOROUS LOADINGS

Average combined sewer overflow total phosphorous loadings were calculated by multiplying the average total phosphorous concentration by the 8 month average combined sewer overflow volume. The result of this calculation is 3,179 pounds of phosphorous being discharged directly to Lake Michigan from combined sewer overflows. This loading is indicative of conditions prior to the combined sewer separation project and the 1979 Wisconsin phosphorous ban. To provide a range of this value, the average total phosphorous concentration was multiplied by the highest and lowest reported combined sewer overflow volume. These calculations yielded a range from 1,675 to 6,087 pounds of phosphorous per 8-month period. Table 4-2 presents these loadings for all the reported combined sewer overflow events. The average total phosphorous concentration was used for these calculations instead of maximum and minimum concentrations because the average concentration better represents the concentration existing during the 8 month period for which the flow data exists. For example, using the maximum total phosphorous concentration would be similar to assuming that each overflow event is a first flush event where the maximum concentrations are observed.

The loading estimates provided above apply to conditions existing between 1967 and 1976. In 1977, Kenosha, Wisconsin instituted the combined sewer separation program. Table 4-4 depicts the progress and schedule on a project

TABLE 4-3. COMBINED SEWER FLOW COMPOSITE QUALITY DATA FOR THE MONITORED STORM EVENTS--KENOSHA, WISCONSIN

	Sampling location	Suspended solids, mg/l	Volatile suspended solids, mg/l	BOD, mg/l	COD, mg/l	NH_3-N, mg/l	NO_2+ NO_3-N, mg/l	Total P, mg/l
8/13/77	57th St. & 3rd Ave.	252	147	55	277	4.85	0.88	5.10
	59th St. & 3rd Ave.	358	197	60	315	1.50	0.23	4.20
	67th St. & 3rd Ave.	507	226	56	372	2.77	0.05	4.50
9/15/77	57th St. & 3rd Ave.	245	177	142	278	9.30	0.52	4.80
	59th St. & 3rd Ave.	35	21	36	78	1.90	0.58	1.20
	67th St. & 3rd Ave.	128	73	66	174	2.00	0.05	2.60
4/5-6/78	57th St. & 3rd Ave.	1,525	1,347	149	432	4.3	2.20	3.50
	59th St. & 3rd Ave.	203	94	--	116	0.68	0.73	0.83
	67th St. & 3rd Ave.	400	176	113	285	1.18	0.91	2.43
4/10/78	57th St. & 3rd Ave.	188	89	47	253	2.70	3.40	2.60

(continued)

TABLE 4-3 (continued)

	Sampling location	Suspended solids, mg/l	Volatile suspended solids, mg/l	BOD, mg/l	COD, mg/l	NH_3-N, mg/l	NO_2+ NO_3-N, mg/l	Total P, mg/l
4/10/78 (con't)	59th St. & 3rd Ave.	145	68	29	116	1.17	1.30	0.88
	67th St. & 3rd Ave.	212	87	46	190	1.05	1.46	1.68
5/12-13/78	57th St. & 3rd Ave.	327	129	96	304	6.50	2.20	3.50
	59th St. & 3rd Ave.	376	208	36	148	1.50	0.82	1.00
	67th St. & 3rd Ave.	474	179	89	293	1.70	0.77	2.30
6/07/73	57th St. & 3rd Ave.	527	280	202	446	6.10	0.03	5.10
	59th St. & 3rd Ave.	491	188	99	545	0.30	0.24	2.69
	67th St. & 3rd Ave.	1,059	395	159	498	1.10	0.33	4.40
AVERAGE		414.0	226.7	87.1	284.4	2.81	0.93	2.96

TABLE 4-4. CURRENT STATUS OF KENOSHA, WISCONSIN CSO SEPARATION PROJECT

Project No.	Area Covered	Percent Complete
77-32	60th Street - 21st Avenue to 30th Avenue	100%
77-33	Washington Road to 45th Street - Sheridan Road to 13th Court	100%
77-36	60th Street - 30th Avenue to 39th Avenue	100%
78-32	75th Street to 80th Street - 22nd Avenue to 30th Avenue	100%
78-35	56th Street to 65th Street - 7th Avenue to 22nd Avenue	100%
79-32	56th Street to 60th Street - 14th Avenue to 22nd Avenue	100%
79-33	74th Street to 78th Street - 22nd Avenue to 30th Avenue	100%
79-35	65th Street - Sheridan Road to 21st Avenue	100%
79-37	52nd Street to K.D. R.R. - 30th Avenue to 35th Avenue	100%
80-36	60th Street to 65th Street - Sheridan Road to 14th Avenue	100%
80-37	73rd Street - Lake Michigan to 7th Avenue	100%
80-38	64th Street and 65th Street - 21st Avenue to 30th Avenue	100%
80-40	60th Street to 63rd Street - 22nd Avenue to 30th Avenue	100%
81-32	65th Street to 68th Street - 14th Avenue to 18th Avenue	100%
81-36	75th Street to 78th Street - 14th Avenue & 15th Avenue	100%
81-38	75th Street - 7th Avenue to 21st Avenue	50%
81-39	63rd Street to 67th Street - 22nd Avenue to 30th Avenue	100%
82-32	73rd Street - 20th Avenue to 27th Avenue	0%
82-33	K.D. R.R. to 69th Street - 30th Avenue to 39th Avenue	0%
82-34	63rd Street to 69th Street - Sheridan Road to 22nd Avenue	100%
83-??	73rd Street - 27th Avenue to 31st Avenue	0%
83-??	69th Street to 75th Street - 30th Avenue to 39th Avenue	0%

by project basis. As of mid-October 1982 corrections had been completed in 87 percent of the area initially served by the combined sewers. Assuming flow is directly proportional to the area served by combined sewers, the current loading can be roughly estimated as 413 pounds per year. Note that this estimate does not reflect detergent phosphorous ban conditions existing between July 1979 and June 1982.

Projects 81-38, 82-32, and 82-33, listed in Table 4-4 are schedued for completion in 1983. The remaining two projects are expected to be underway in 1983 with possible completion by year-end or some time in 1984. At that time, the sewer system will be completely separated, eliminating future overflows.

DATA ON OTHER POLLUTANTS

Table 4-2 presents 8 month loads of suspended solids, BOD, and fecal coliform for the 10 years of reported data. Table 4-3 presents combined sewer overflow concentrations of total suspended solids, volatile suspended solids, BOD, COD, NH_3 nitrogen, and NO_2 plus NO_3 nitrogen. These values are the result of sampling and analysis during six combined sewer overflow events.

DATA QUALITY

Total phosphorous loads discharged into Lake Michigan were estimated based on concentrations and flow rates of combined sewer overflows. The concentration data are an average of 18 composite samples collected during 6 overflow events at 3 combined sewer regulators. Continuous recording flow measuring instruments were used for flow determinations. In general, these data should accurately indicate pollutant loads from combined sewer overflows to Lake Michigan.

REFERENCES

1. Donohue & Associates, Inc., Overflow Study/Facilities Plan for the Konosha Service Area, Kenosha, Wisconsin, 1978, Volumes 1 and 2.

2. Donohue & Associates, Inc., Combined Sewer Overflow Study/Facilities Plan for the Kenosha Service Area, February 5, 1979, Volumes 1 and 2.

3. Letter Report from the U.S. Environmental Protection Agency, Great Lakes National Program Office to Dr. Keith Booman, The Soap and Detergent Association. March 2, 1982.

CONTACTS

1. Mr. Robert Biebel. Southeast Wisconsin Regional Planning Commission. (414) 547-6721.

2. Mr. Harvey D. Elmer, City Engineer. City of Kenosha. (414) 656-8040.

SECTION 5

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF RACINE, WISCONSIN

BACKGROUND

The City of Racine, Wisconsin is located in southwestern Wisconsin on the shores of Lake Michigan. Within the city limits of Racine sanitary and combined collector sewers serve approximately 7,400 acres, or 88 percent of the land area. The Racine sanitary sewerage facilities also serve the Village of North Bay, the Town of Caldonia Sewer Utility District No. 1, and the Town of Mt. Pleasant. In 1974, it was estimated that 110,200 people were served by the system. There are over 225 miles of sanitary and combined sewers in the Racine system area. These sewers range from 4 inches to 90 inches in diameter.

Prior to 1981 four combined sewer service areas (CSSAs) totaling approximately 1,070 acres existed in the City of Racine. Over the last two years a combined sewer separation program has eliminated much of combined sewer area. As shown in Table 5-1, combined sewers in the North, South and Luedtke Court areas have been separated, eliminating a total of 486 acres. An additional 76 acres of the Central CSO area around State Street have also been eliminated. Although efforts are currently underway to eliminate the entire Central CSO area, the remaining 509 acres are essentially combined.

Figure 5-1 indicates the relative locations of the existing CSSA (Central) and CSSAs which have recently been separated (North, South, Luedtke Ct.). The Central CSSA discharges to the Dodge Street Interceptor. During periods of wet weather flow exceeding the interceptor capacity is discharged to the Root River through several outfalls. Land use in the area is mixed between residential, commercial. industrial and undeveloped areas.

COMBINED SEWER OVERFLOW VOLUMES

The estimated quantities of combined sewer overflow for Racine, Wisconsin are shown in Table 5-2. Based on this information, no overflows occur if rainfall is less than 0.45 inches. Using the information in Table 5-2 along with local climatological data from the nearest National Weather Service monitoring station (Milwaukee) combined sewer overflow volumes were calculated from 1977 through 1980 (Table 5-3). Overflow volumes ranged from 131.2 to 272 million gallons annually, averaging 191.4. However, this estimate does not take into account the elimination of 562 acres (53 percent) of the CSSA. Assuming the separation program has also eliminated 53 percent of the flow, the present annual overflow volume is estimated to be approximately 90 million gallons.

TABLE 5-1. CURRENT STATUS OF RACINE, WISCONSIN CSO PROJECT

CSSA	Project No.	Project Name	% Completed
South	13-79	Olive St. Sewer Separation (203 acres)	100
North	14-79	Augusta St. Sewer Separation (227 acres)	100
Luedtke Ct.	6-80	Harriet St. Sewer Separation (56 acres)	100
	16-79	State St. Sewer Separation (76 acres)	100
Central	10-82	Near North Side Separation[a]	5
	11-82	Prospect St. Sanitary Sewer	0

[a]Acreage not available.

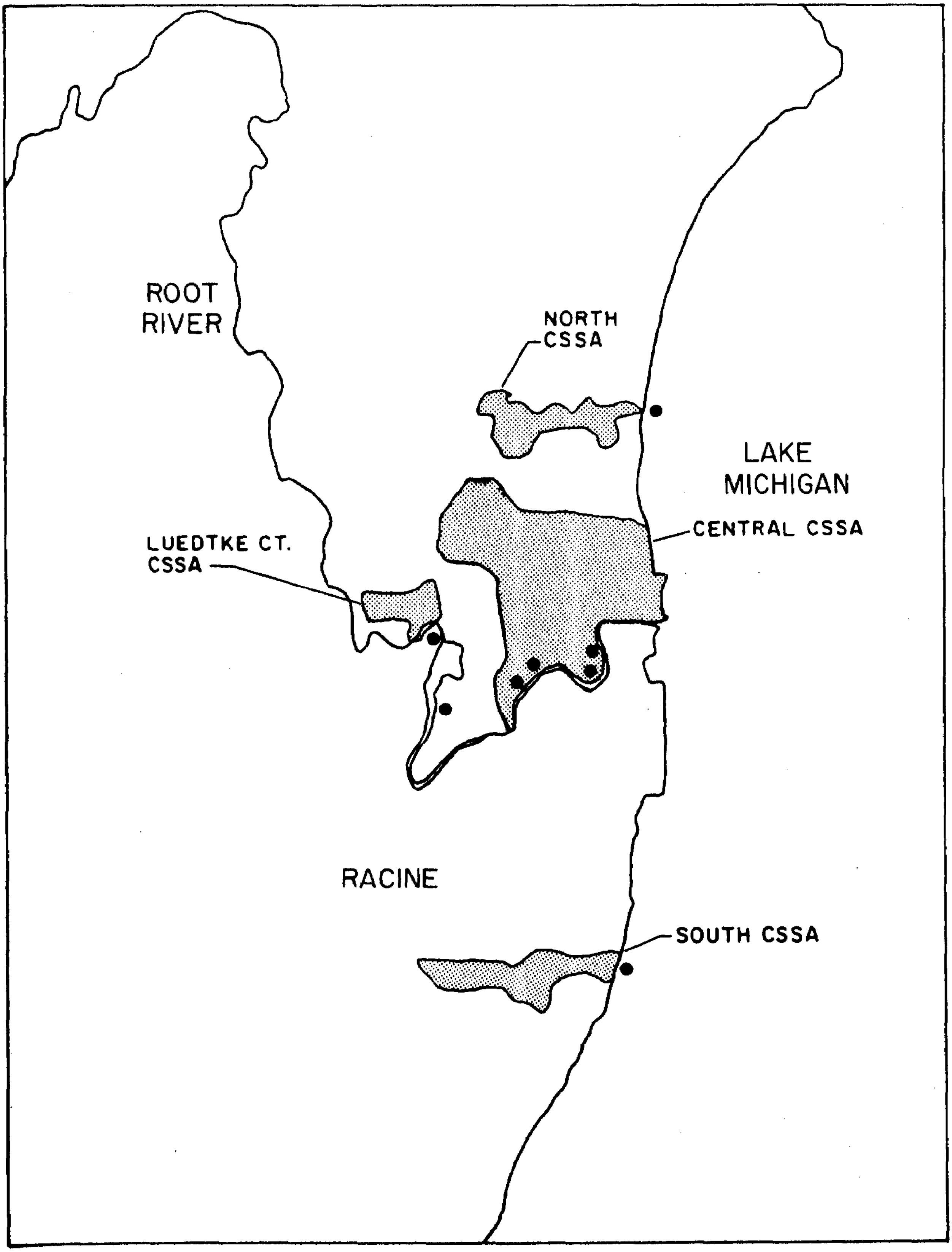


Figure 5-1. Combined sewer overflow locations--Racine, WI.

TABLE 5-2. ESTIMATED QUANTITIES OF COMBINED SEWER OVERFLOW--RACINE, WISCONSIN

Total accumulated rainfall in inches	Estimated combined sewer overflow in gallons
0	0
0.25	0
0.50	1,000,000
0.75	5,500,000
1.0	10,000,000
1.25	14,500,000
1.50	19,000,000
1.75	23,500,000
2.0	28,000,000
2.5	37,000,000
3.0	46,000,000
3.5	55,000,000
4.0	64,000,000

TABLE 5-3. STORM DATA AND COMBINED SEWER OVERFLOW VOLUMES FOR RACINE, WISCONSIN, 1977-1980[a]

Date	Rainfall, inches	Overflow, 10^3 gal.	Date	Rainfall, inches	Overflow, 10^3 gal.
03/03/77	0.45	100	01/01/78	0.50	1,000
03/17/77	0.48	640	01/26/78	0.76	5,680
03/18/77	0.53	1,540	04/06/78	1.30	15,400
03/28/77	1.04	10,720	04/10/78	0.58	2,440
04/04/77	0.50	1,000	04/18/78	0.90	8,200
04/19/77	0.57	2,260	04/23/78	0.54	1,720
06/08/77	2.18	31,240	05/12/78	1.52	19,360
06/11/77	0.50	1,000	05/13/78	2.02	28,360
06/28/77	0.98	9,640	06/07/78	0.66	3,880
06/30/77	1.35	16,300	06/16/78	1.18	13,240
07/16/77	0.99	9,820	06/17/78	1.48	18,640
07/17/77	1.33	15,940	06/20/78	0.45	100
07/18/77	1.89	26,020	07/01/78	1.69	23,420
07/24/77	0.63	3,340	07/02/78	1.31	15,580
08/05/77	0.54	1.720	07/20/78	0.70	4,600
08/13/77	0.76	5,680	07/31/78	0.98	9,640
08/28/77	1.08	11,440	08/08/78	0.96	9,280
09/04/77	0.56	2,080	08/18/78	1.27	14,860
09/12/77	0.51	1,180	09/11/78	0.74	5,320
09/24/77	0.62	3,160	09/12/78	1.52	19,360
09/30/77	1.04	10,720	09/13/78	1.73	23,140
10/07/77	1.14	12,520	09/17/78	1.15	12,700
11/01/77	0.77	5,860	09/20/78	0.97	9,460
11/25/77	0.56	2,080	10/05/78	0.60	2,800
12/08/77	0.52	1,360	10/16/78	0.47	460
12/20/77	1.48	18,640	11/17/78	0.69	4,420
	TOTAL	206,000		TOTAL	272,060

(continued)

TABLE 5-3 (continued)

Date	Rainfall, inches	Overflow, 10^3 gal.	Date	Rainfall, inches	Overflow, 10^3 gal.
01/13/79	1.32	15,760	01/16/80	0.46	280
01/24/79	0.50	1,000	04/03/80	0.53	1,540
03/03/79	0.96	9,280	04/14/80	0.88	7,840
03/24/79	0.66	3,880	05/17/80	0.85	7,300
03/30/79	0.90	8,200	06/02/80	0.55	1,900
04/11/79	1.39	17,020	06/05/80	1.86	25,480
04/24/79	0.53	1,540	06/06/80	0.61	2,980
04/25/79	1.54	19,720	06/07/80	0.81	6,580
04/26/79	0.50	1,000	07/16/80	0.68	4,240
05/02/79	0.56	2,080	07/26/80	1.10	11,800
05/30/79	0.89	8,020	08/04/80	1.01	10,180
06/07/79	0.49	820	08/07/80	1.36	16,480
06/08/79	0.78	6,040	08/11/80	0.52	1,360
06/28/79	0.62	3,160	08/19/80	0.56	2,080
08/05/79	0.61	2,980	09/12/80	0.63	3,340
08/09/79	0.56	2,080	09/16/80	0.78	6,040
08/17/79	0.54	1,720	09/20/80	0.72	4,960
08/20/79	0.52	1,360	10/16/80	0.67	4,060
08/22/79	0.78	6,040	10/17/80	0.54	1,720
08/27/79	0.80	6,400	11/13/80	0.75	5,500
10/19/79	0.47	460	12/02/80	0.52	1,360
10/22/79	0.49	820	12/06/80	0.62	3,160
11/21/79	1.06	11,080	12/07/80	0.50	1,000
11/25/79	0.49	820		TOTAL	131,180
12/24/79	1.84	25,120			
	TOTAL	156,400			

[a]Pre-separation program data.

TOTAL PHOSPHOROUS LOADINGS

The average phosphorous concentrations measured from Racine combined sewer overflows is 1.5 mg/l as P. When this concentration is multiplied by the average overflow volume, 1,126 lb (0.5 MT) of phosphorous are discharged to Lake Michigan from Racine combined sewer overflows. Since data were collected prior to the 1979 detergent phosphorous ban, this loading is consistant with the present post-ban conditions. The Near North Side and the Prospect Sanitary Sewer projects are scheduled for completion sometime in 1983. At that time, all of Racine's sewers will be separated, eliminating future overflows.

DATA ON OTHER POLLUTANTS

Information on other pollutants from Racine combined sewer overflows can be found in Reference 2.

DATA QUALITY

For the 4 years used to determine combined sewer overflow volumes, annual overflows ranged from 131 to 272 MG with a mean of 191.4 MG. The mean value was reduced by 53 percent to reflect the current status of the combined sewer separation program.

The average concentration of total phosphorous (1.5 mg/l) used to determine annual loadings was obtained from Reference 2. The accuracy of this value is unknown.

REFERENCES

1. Combined Sewer Overflow Report for Racine Wisconsin. Donohue and Associates, Incorporated. Sheboygan, Wisconsin. 1978.

2. Appendices for Combined Sewer Overflow Report for Racine, Wisconsin. Donohue and Associates, Incorporated. Sheboygan, Wisconsin. 1978.

3. Local Climatological Data for General Mitchell Field, Milwaukee, Wisconsin. National Oceanic and Atmospheric Administration, Environmental Data and Information Service. Asheville, North Carolina.

CONTACTS

1. Mr. Robert Biebel, Southeast Wisconsin Regional Planning Commission. (414) 547-6721.

2. Mr. James Blazek, City Engineer. City of Racine. (414) 636-9191.

SECTION 6

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE NORTH SHORE SANITARY DISTRICT, LAKE COUNTY, ILLINOIS

BACKGROUND

The North Shore Sanitary District (NSSD) is located in Lake County, Illinois with the boundaries extending from the Lake-Cook County Line north to the Wisconsin border and lying entirely east of the Illinois Tollway. The 1980 population was estimated to be 221,865 people. The area is serviced by a total of 4 municipal wastewater treatment plants (WWTP). The Waukegan Plant treats wastewater from the communities of Winthrop Harbor, Zion and Waukegan east of Green Bay Road. The North Chicago WWTP provides partial secondary treatment for North Chicago sewage. Effluent from this plant along with raw sewage from the Great Lakes Naval Training Station and Abbott Laboratories is pumped to the Gurnee WWTP for further treatment. The Gurnee Plant also treats raw sewage from the Village of Gurnee, Waukegan west of Green Bay Road and from the Lake County Public Works Department north central area which includes the communities of Wildwood and Grayslake. The Clavey Road WWTP accepts wastewater from the communities of Lake Bluff, Lake Forest, Highland Park, Highwood and North Chicago west of Green Bay Road, along with sewage from Fort Sheridan.

COMBINED SEWER OVERFLOW VOLUMES

The Waukegan WWTP has a treatment capacity of 19.9 MGD. Wet weather flow exceeding this limit is diverted to a sedimentation basin which in turn discharges to a series of three retention basins, which have a combined capacity of 38 million gallons. When wet weather flow subsides the sedimentation and retention basins are drained by gravity back to the raw sewage pump wet well. Accumulated solids are flushed and are also returned to the wet well. If the event is large enough such that the total retention capacity is exceeded, the accumulated wastewater is discharged to Lake Michigan following chlorination. Overflow volumes were measured during each event in 1979. Overflow events were recorded on 37 days discharging a total overflow volume of 356 million gallons.

Raw sewerage entering the North Chicago WWTP is split between primary and primary/secondary treatment operations. Effluent from this plant is discharged to the Gurnee WWTP via the North Chicago Pumping Station. During wet weather periods, when influent sewerage contains excessive contributions of infiltration and inflow, a portion of the flow is diverted to two retention basins. These basins have a combined capacity of 1.9 million gallons. Following a rainfall event, the retention basins are emptied by dewatering pumps which transport wastewater to the North Shore Pumping Station. During relatively large rainfall events, the basins fill to capacity and overflow to Lake Michigan. In 1979, overflow events were recorded on 50 days. The total overflow volume was measured at 392 million gallons.

Wastewater is transported to the Gurnee WWTP through the Gurnee Intercepting Sewer, the Lake County Intercepting Sewer and the North Chicago-Gurnee Force Main. At present there are no retention facilities at the Gurnee plant and all sewerage received at this plant must receive total treatment.

The Clavey Road WWTP has a treatment capacity of 17.8 MGD. During normal dry weather conditions raw sewerage is pumped from the Middle Fork, Skokie Outlet and Cary Avenue Interceptors through a distribution chamber to primary, secondary and advanced treatment operations. During wet weather periods, when flow exceeds treatment capacity, excess flow is diverted to two presedimentation/ retention basins which provide solids removal and chlorination. These basins have a combined storage capacity of 20.4 million gallons. In 1979, thirty-two overflow events were recorded at the Clavey Road facility, resulting in an annual overflow of 195 million gallons. The basins overflow to the Skokie River. The Skokie River has been diverted to the Chicago River which has in turn been diverted away from Lake Michigan via the Chicago Sanitary and Ship Canal. Consequently, loadings from the Clavey Road basins occur only during backflow events at the Wilmette Pumping Station and the Chicago River Controlling Works (see Section 7). Given the infrequent occurance of such events and the diluting effects of the Chicago River, the overflow which reaches Lake Michigan from the Clavey Road basins is likely to be insignificant.

TOTAL PHOSPHOROUS LOADINGS

Phosphorous loading estimates for the NSSD are provided in Table 6-1. In 1979, total phosphorous was measured during most overflow events at the Waukegan WWTP, yielding a mean concentration of 1.53 mg/l as P. Multiplying this value by the annual overflow volume, the 1979 phosphorous load was found to be 4,542 pounds. Phosphorous was also monitored during overflow events at the North Chicago WWTP. The annual mean phosphorous concentration was found to be relatively high at 3.24 mg/l. The annual phosphorous load was calculated to be 10,592 pounds by multiplying the phosphorous concentration by the overflow volume (392 million gallons). Combining the two loadings the total annual loading from the NSSD is found to be 15,134 lbs (6.9 MT).

TABLE 6-1. 1979 PHOSPHOROUS LOADINGS FROM CSOs--NORTH SHORE SANITARY DISTRICT

Overflow location	Overflow volume, MG	Phosphorous concentration, mg/l	Phosphorous load, lb (MT)
Waukegan WWTP	356	1.53	4,542 (2.1)
North Chicago WWTP	392	3.24	10,592 (4.8)
Total	748	-	15,134 (6.9)

The loading presented above is based on 1979 rainfall data. Chicago received 37 inches of rain in 1979, a 17 percent increase over the 31.72 inches expected in an average year rainfall.

DATA ON OTHER POLLUTANTS

Data indicating concentrations of fecal coliforms, BOD_5, and total suspended solids in retention basin overflows are provided in Appendix A of Reference 1.

DATA QUALITY

Estimated total discharge volumes at Waukegan and Clavey Road overflows were determined by monitoring overflow during each event. Overflows in North Chicago were indirectly estimated by examining records of flow pumped at the North Chicago Pumping Station, and relating this volume to the weir formula. The phosphorous concentrations used to calculate Waukegan and North Chicago loadings represent the mean of wastewater analyses during each overflow event. For the most part, data were obtained by actual measurement as opposed to modeling. Loadings for the NSSD should therefore be relatively accurate for the study year (1979).

REFERENCES

1. North Shore Sanitary District, Lake County, Illinois. 201 Facility Plan, Preliminary Draft. Greeley and Hanson, December 1980.

CONTACTS

1. Mr. H. W. Byers, General Manager. North Shore Sanitary District. (312) 623-6060.

2. Mr. Chacks, Greeley and Hanson Engineers. (312) 648-1155.

SECTION 7

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF CHICAGO, ILLINOIS

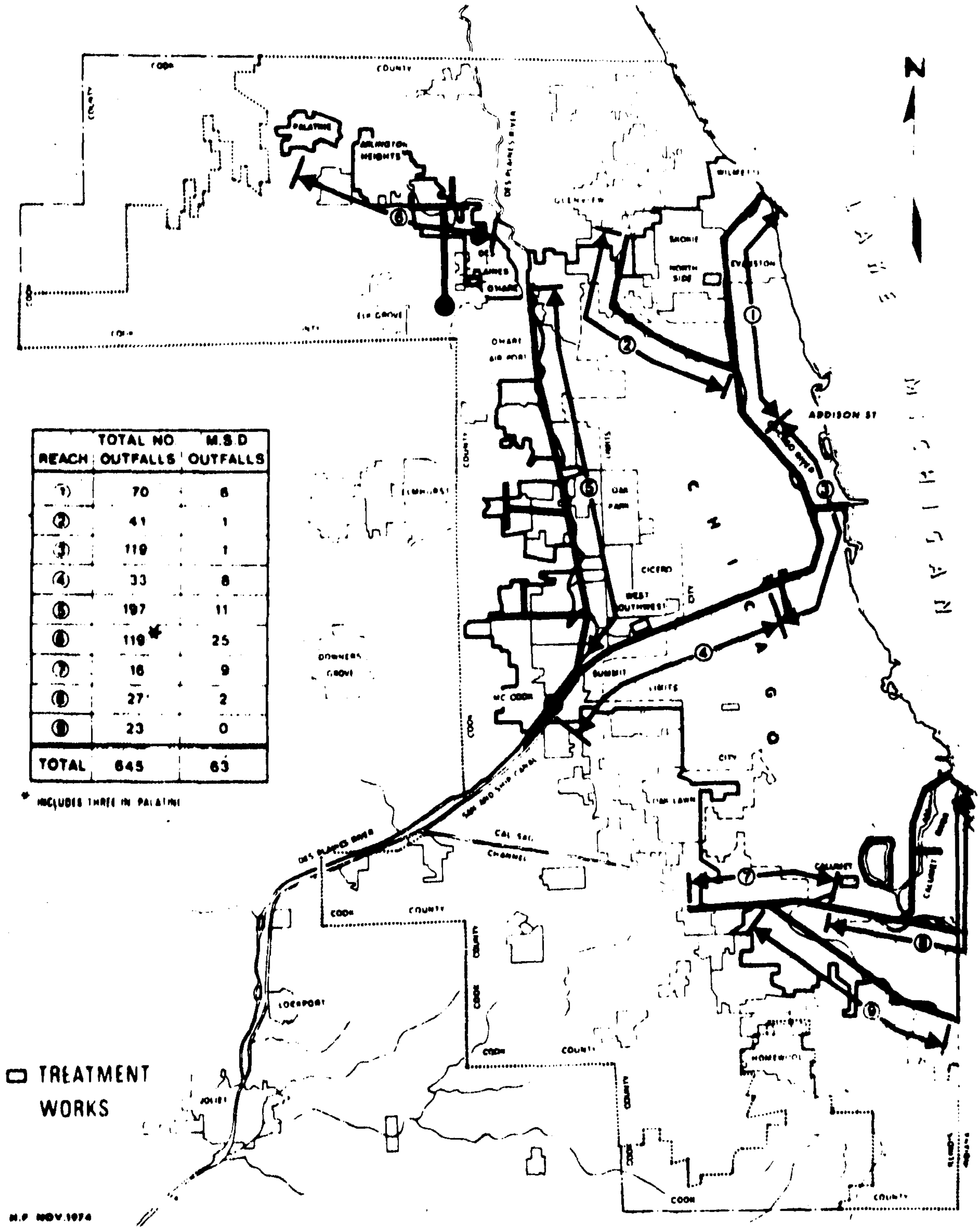
BACKGROUND

The Metropolitan Sanitary District of Greater Chicago (MSDGC) is located in northeast Illinois, at the southern tip of Lake Michigan. The MSDGC is located primarily within the boundaries of Cook County, Illinois, serving an area of approximately 872 square miles. This area includes 124 member municipalities with a combined population of approximately 5,100,000. The District owns and operates seven wastewater treatment plants, which have a total combined capacity of 1,869 MGD.

The combined sewer service area (CSSA) of Greater Chicago encompasses approximately 375 square miles and contains 645 combined sewer overflows (CSOs). The areal distribution of CSOs within the CSSA is depicted in Figure 7-1. During precipitation, collection system storage and flow capacity is rapidly exceeded, producing a surcharge condition. Rainfalls of one-tenth inch or greater results in combined sewer overflows. On average, such events occur at 4-day intervals. The total combined sewer discharge capacity for Greater Chicago is approximately 100,000 cfs, compared to the interceptor capacity of only 3,000 cfs.

In the 1870's and 1880's Chicago had the highest typhoid rate in the country. To protect Lake Michigan, the areas main water supply, the flow of the Calumet and Chicago River system was reversed and diverted to the Mississippi River Basin via the Chicago Ship and Sanitary Canal. As shown in Figure 7-2, there are three regulating works located at sites on Lake Michigan. These are identified as the Wilmette Pumping Station, the Chicago River Controlling Works, and the O'Brien Lock and Dam. These structures protect Greater Chicago's primary water supply by preventing polluted water from entering the Lake and also allow Lake Michigan water into the canal system for navigational make-up and to dilute wastewater flows. The Chicago Ship and Sanitary Canal extends from the South Branch Chicago River to the southwest where it parallels, and eventually joins with, the Des Plaines River below the Lockport Lock and Dam. The Lockport Powerhouse and the Lockport Controlling Works are used to regulate the water level and flow in the upstream canal system which helps prevent backflows to Lake Michigan.

On occasion, the discharge of stormwater and combined sewer overflows into the canal system has raised the water level to the extent that flooding of the CSSA is threatened. Such conditions are attributable to extreme



REACH	TOTAL NO OUTFALLS	M.S.D OUTFALLS
1	70	6
2	41	1
3	119	1
4	33	8
5	197	11
6	119*	25
7	16	9
8	27	2
9	23	0
TOTAL	645	63

* INCLUDES THREE IN PALATINE

Figure 7-1. Outfalls in combined sewered area--Chicago, MSD.

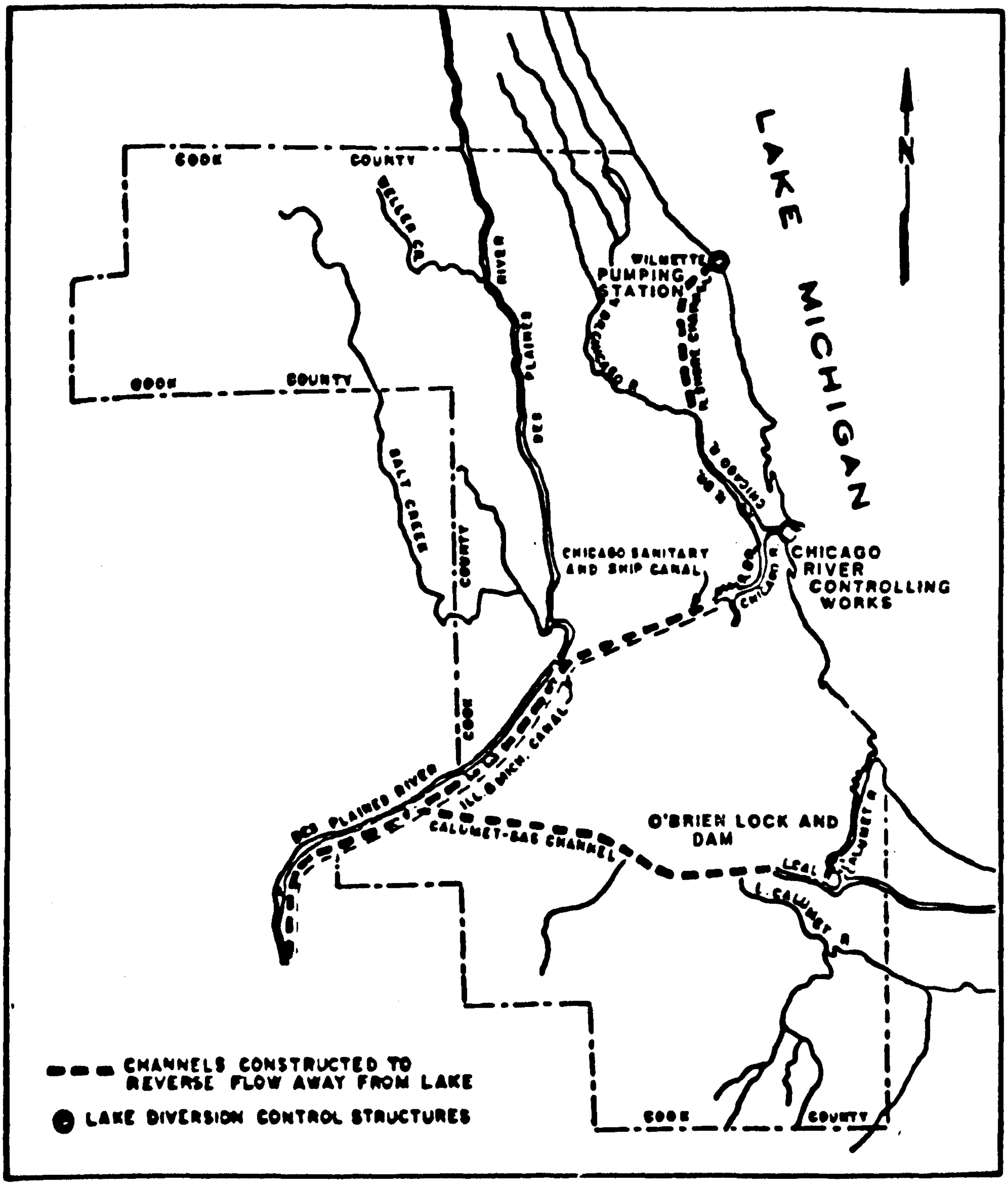


Figure 7-2. Principal watercourses--Chicago, MSD.

precipitation events (e.g., events in which rainfall exceeds 2 inches in a 12-hour period) and/or snowmelt. When the water level in the canal system reaches a predetermined level, the controlling works on Lake Michigan are used to "backflow" the canal system to relieve the danger of flooding.

The peak discharge at Lockport has increased over the years as a result of increases in upstream channel hydraulic capacity. Originally, the maximum discharge was between 14,000 and 16,000 cfs. Although the geometry of the main channel has not changed since 1900, the addition of the North Shore Channel, the Calumet-Sag Channel, and the Chicago River Controlling Works have increased the flow rate to approximately 25,000 cfs. Operation of the O'Brien Lock in 1965 increased the capacity to 28,500 cfs at Lockport. In 1975, a project to widen the Calumet-Sag Channel was completed, resulting in the present maximum peak flow rate of 36,000 cfs.

Operational procedures for the canal system are designed to prevent backflows of combined sewage to Lake Michigan. When a precipitation event is forecast, discharges are increased at the Lockport Dam prior to the start of the storm. By opening gates at Lockport, water level downdraw creates a momentum of flow in the canal system, which is normally operated at a nearly horizontal hydraulic gradient, towards the Lockport Dam. The magnitude of the drawdown is dependent upon the predicted size and intensity of the storm event. The time required to effect an efficient drawdown of the canal system is generally 5 hours after the initial gate operations.

HISTORY OF BACKFLOW EVENTS

The chronology of historical backflow events at each of the three control points in the canal system, beginning in 1947, is listed in Table 7-1. The magnitude, time and duration of each event are also listed where such data are available. Estimates of backflow volumes were determined by the MSDGC.

O'Brien Lock and Dam Backflows

Prior to the operation of the O'Brien Lock and Dam in 1965, the Calumet-Sag Channel was controlled by a lock and dam at Blue Island. During this time backflows were fairly frequent, a total of 13 backflow events were recorded from 1945 to 1965. With the construction of the O'Brien Lock, there were two backflow events within the first year of operation. Two additional backflows were recorded in June 1981 and in December 1982.

Chicago River Controlling Works Backflows

The Chicago River Controlling Works were constructed in 1938. During the period of 1947 through 1982 there have been a total of ten backflows recorded on the Chicago River for an average of once every three to four years. The total volume of discharge to Lake Michigan during this time period is estimated at 7,454 MG, or an average of 745 MG per event.

TABLE 7-1. HISTORY OF BACKFLOW EVENTS--CHICAGO MSD

	Wilmette		Chicago River		O'Brien	
Date	Million cu ft (ac-ft)	Time	Million cu ft (ac-ft)	Time	Million cu ft (ac-ft)	Time
04/05/47	N/A	N/A	-	-	a	a
03/19/48	N/A	N/A	-	-	a	a
03/24 - 03/25/54	N/A	N/A	-	-	a	a
10/09 - 10/11/54	172.8 (3967)	N/A	129.6 (2975)	N/A	a	a
07/12 - 07/13/57[b]	N/A	N/A	302.1 (6935)	N/A	a	a
09/14/61[b]	N/A	N/A	226.0 (5188)	N/A	a	a
09/25/61	N/A	N/A	-	-	a	a
07/02/62	N/A	N/A	-	-	a	a
12/23 - 12/25/65	-	-	-	-	120.0 (2755)	N/A
05/11 - 05/12/66	N/A	N/A	-	-	154.0 (3535)	N/A
06/10/67	18.6 (427)	N/A	-	-	-	-
08/15 - 08/17/68	20.6 (473)	N/A	71.3 (1637)	N/A	-	-
10/10 - 10/11/69	8.4 (193)	N/A	-	-	-	-
06/14/72	2.7 (62)	2340-0105	-	-	-	-
08/25 - 08/26/72	25.5 (585)	2145-0400	7.9 (181)	0115-0245	-	-
09/17/72	12.0 (276)	2103-2423	-	-	-	-
04/18/75	12.0 (276)	1740-2315	151.0 (3466)	1830-2415	-	-
08/21/75	17.4 (399)	2400-0330	-	-	-	-
04/24/76	18.0 (413)	0840-1610	-	-	-	-
06/11/77	5.4 (124)	0520-0650	-	-	-	-

(continued)

TABLE 7-1 (continued)

	Wilmette		Chicago River		O'Brien	
Date	Million cu ft (ac-ft)	Time	Million cu ft (ac-ft)	Time	Million cu ft (ac-ft)	Time
06/30/77	3.9 (90)	1122-1331	39.7 (911)	1150-1445	-	-
07/21/78	13.0 (298)	2136-0158	-	-	-	-
09/13/78	4.4 (101)	0400-0545	-	-	-	-
09/17/78	13.2 (303)	2020-2418	-	-	-	-
03/04/79	6.0 (138)	0335-0535	-	-	-	-
04/11/79	1.5 (34)	2325-0110	-	-	-	-
07/21/80	21.1 (484)	0000-0410	24.6 (565)	0051-0345	-	-
04/28/81	3.3 (76)	1433-1616	-	-	-	-
05/29/81	1.4 (32)	2045-2145	-	-	-	-
06/13/81	-	-	-	-	50.4	1754-2237
07/12/81	27.0 (620)	0914-1403	-	-	-	-
08/14/81	13.1 (301)	2129-2254	-	-	-	-
07/22/82	0.3 (7)	1030-1044 1051-1106	-	-	-	-
08/07/82	-	-	11.1 (255)	1846-2118	-	-
12/02-03/82	19.1 (438)	2208-0323 12/2-12/3	33.1 (760)	0011-0340 12/3	16.6 (381)	0608-0825 12/3

[a]O'Brien Lock & Dam became operational in 1965. Prior to that time, different hydraulic and backflow regime existed on the Calumet River.

[b]*Accuracy of backflow volume at Chicago Harbor is 15 percent for these events.*

N/A = Data not available.

Wilmette Pumping Station Backflows

Backflow from the North Shore Channel to Lake Michigan is accomplished at the Wilmette Pumping Station. At Wilmette, there have been a total of 32 backflow events since 1947 for an average of almost once per year. Most of the occurrences prior to 1967 were not monitored as to the quantity and duration of spill. Since that time, there have been 23 backflows, 12 within the last 5 years, with an average volume and duration of 87 MG and 3.3 hours, respectively.

Due to the increased capacity and predictive capabilities that have evolved over the years, a decline in the number of backflows and corresponding increase in the size of precipitation events required to cause a backflow would be expected. However, such a trend cannot be discerned from recorded data. This may be explained by urbanization which has been accompanied by an increase in impervious area and expansion of sewer system networks. To a great degree, increased peak runoff has offset advantages gained in increasing canal capacity and efficient operation.

BACKFLOW VOLUMES

Backflow events have been recorded at the Wilmette Pumping Station 32 times in 35 years or once every 1.1 years. The long term average annual backflow volume from Wilmette can be estimated at 69 MG. Discharges from the Chicago River Controlling Works occur less often but are of greater magnitude. Ten backflow events, with a long term annual average discharge of 213 MG, have been recorded over the past 35 years. Backflows at the O'Brien Lock and Dam have been recorded on four occasions in 18 years of operation. The long term average discharge is approximately 146 MG. Summing the values for Wilmette, Chicago Harbor, and the O'Brien Lock and Dam, the total long term average annual discharge is calculated as 423 MG. This estimate is limited in that it relies solely on historical backflow data and does not account for changes in land use and precipitation patterns, and watercourse and operating procedure improvements.

Without future modifications to counteract the consequences of future urbanization within the watershed and other watershed improvements, the frequency and magnitudes of flow reversals is likely to increase. However, the MSDGC is implementing a Tunnel and Reservoir Plan (TARP) which is designed to eliminate combined sewer overflows from the 375 square mile combined sewer area. TARP is basically a system of conveyance tunnels (131 miles) connecting the existing CSOs to three storage reservoirs (127,550 acre-feet).[1] Effluent from the reservoirs will be pumped to MSDGC treatment plants for complete treatment. The TARP Mainstream System Phase I (except the North Branch Tunnel) will be completed and placed into operation in 1985. This tunnel's capacity for storing combined sewer overflow will have the immediate effect of eliminating most backflows to Lake Michigan at the Wilmette Pumping Station and the Chicago River Controlling Works. The Calumet Phase I tunnel, expected to be operational in 1984, will reduce backflow volume at the O'Brien Lock and Dam.[3]

CSO WATER QUALITY

Combined sewer overflow concentrations are available for several parameters including BOD_5, and suspended solids. The mean BOD_5 concentration is 69 mg/l with discrete sample concentrations ranging from 24 to 346 mg/l. Suspended solids concentrations range from 32 up to 1,090 mg/l. Data reporting CSO phosphorous concentrations were found to be unavailable. Typically, a value of 3.4 mg/l is assigned to areas affected by a detergent phosphorous ban. However, since backflows occur only during relatively large precipitation events, the CSO phosphorous concentration during backflows should be lower due to a relatively high fraction of relatively low phosphorous stormwater in proportion to domestic sewerage.

TOTAL PHOSPHOROUS LOADINGS

The calculation of total phosphorous loadings from the Greater Chicago CSOs to Lake Michigan requires estimates of the volume of backflow, the fraction of backflow contributed by CSOs, and the CSO phosphorous concentration. The expected long-term average year backflow is 423 MG. Due to the high CSO flows during storm events, the CSO contribution to backflows may be substantial. However, the CSO contribution is also variable, depending on the quantity of backflow and dilution ratios specific to each lakefront control point.

Assuming a worst case scenario in which backflows would contain essentially undiluted CSO effluent, a typical CSO phosphorous concentration of 3.4 mg/l could be applied to the long term average annual flow of 423 MG. The resulting annual total phosphorous load would be 12,000 lbs (5.4 MT). However, since backflows occur only during large rainfall events, the CSO phosphorous concentration is likely to be less than 3.4 mg/l due to a relatively large fraction of stormwater in proportion to domestic sewage. In addition, much of the backflows may originate from Lake Michigan make-up water and the relatively clean treatment plant effluent. The long term annual average CSO phosphorous load to Lake Michigan is therefore likely to be less than 12,000 pounds. Additional monitoring data would be required to provide an accurate estimate.

REFERENCES

1. The Metropolitan District of Greater Chicago Facilities Planning Study Update Supplement and Summary Action Plan. Metropolitan Sanitary District of Greater Chicago, May 1982.

2. Investigation of Backflows. Volume 1. Results and Discussion. Chicago District US Army Corps of Engineers, Contract No. DACW 23-79-0-0038, Work Order No. 0002. February 1980.

3. Letter to Mr. Paul Horvatin, U.S. EPA from Mr. Bill Macaitis, Assistant Chief Engineer, MSDGC. December 8, 1982.

CONTACTS

1. Mr. Bill Macaitis, Assistant Chief Engineer. Metropolitan Sanitary District of Greater Chicago. (312) 751-5806.

2. Mr. Cecil Lue-Hing, Director Research and Development. Metropolitan Sanitary District of Greater Chicago. (312) 751-5806.

SECTION 8

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITIES OF HAMMOND, EAST CHICAGO AND GARY, INDIANA

BACKGROUND

This area is located in the Northwest corner of Indiana and contains three major sanitary districts known as the Hammond Sanitary District (HSD), the East Chicago Sanitary District (ECSD), and the Gary Sanitary District (GSD). A map of the area indicating CSO locations is provided in Figure 8-1. The HSD was formed in 1938 and includes the corporate boundaries of the cities of Hammond and Munster. The HSD also provides sewer service to the cities of Whiting, Griffith and Highland by contracted agreement. The total population served is estimated at 175,000. As shown in Table 8-1 the HSD contains 5 CSOs, the relative locations of which are shown in Figure 8-1.

The ECSD provides sewer service for the City of East Chicago. This area contains two CSOs to the Grand Calumet River and one to the Indiana Harbor Ship Canal. The three outfalls are identified in Table 8-1. Figure 8-1 shows the relative locations of these outfalls.

The Gary Sanitary District was formed in 1938 and now serves over 200,000 people and various industries in Gary, East Gary and Merrillville. The GSD contains seven CSOs which discharge to the Grand Calumet River. These outfalls are identified in Table 8-1. CSO locations are identified in Figure 8-1.

COMBINED SEWER OVERFLOW VOLUMES

Combined sewer overflow annual discharge volumes are provided in Table 8-1. Hammond combined sewers account for 3,444 million gallons annually while CSOs in East Chicago and Gary have annully discharges of 3,643 and 4,274 million gallons, respectively. Adding these three values, the total overflow volume from the Grand Calumet-Indiana Harbor Ship Canal Basin is calculated to be 11,361 million gallons.

TOTAL PHOSPHOROUS LOADING

The total phosphorous concentration of combineo sewer overflows in East Chicago was found to be 3.0 mg/l as P.[2] The annual phosphorous load was determined from the annual overflow discharge volumes assuming an average phosphorous concentration of 3.0 mg/l. As shown in Table 8-1 the phosphorous loads from CSOs in Hammond, East Chicago and Gary were found to be 86,167 lbs

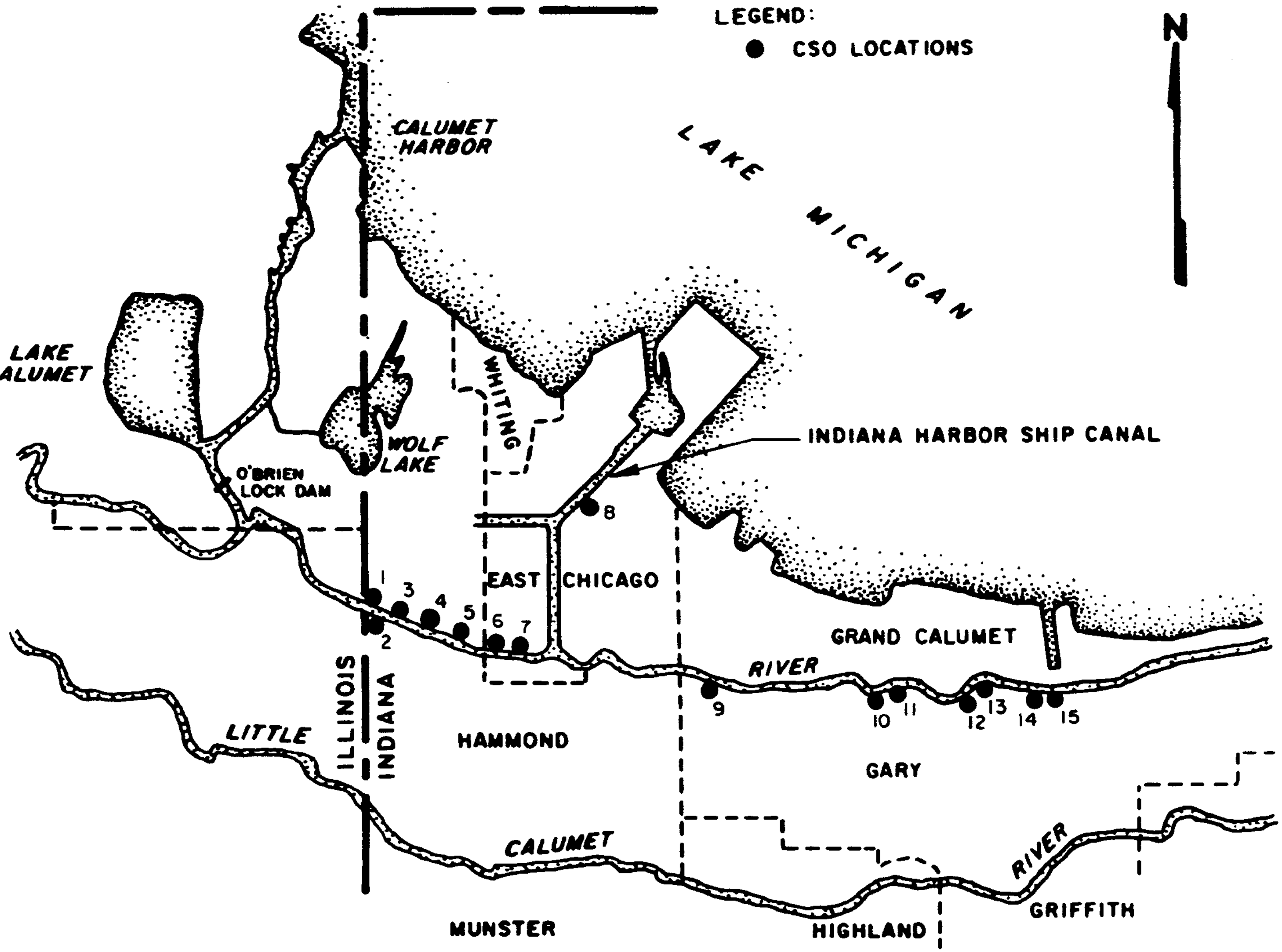


Figure 8-1. Combined sewer overflow locations--Hammond, East Chicago and Gary, IN.

TABLE 8-1. ANNUAL LOADINGS OF CSOs--HAMMOND, EAST CHICAGO, AND GARY, IN

No.	City	Location	Receiving water	River mile	Sewer size, in.	Annual overflow, MG	Total P concentration, mg/l	Annual P load, lbs/yr (MT)
1.	Hammond	Johnson Ave. pumping station	Grand Calumet	State line 1.0	90	157	3.0	3,928 (1.8)
2.	Hammond	Sohl Ave. pumping station	Grand Calumet	State line 1.0	108	176	3.0	4,403 (2.0)
3.	Hammond	Columbia Ave. pumping station	Grand Calumet	State line 1.0	108	1,220	3.0	30,524 (13.9)
4.	Hammond	Columbia Ave.	Grand Calumet	State line 1.7	2-42	88	3.0	2,201 (1.0)
5.	Hammond	Kennedy Ave.	Grand Calumet	State line 4.6	90 & 84	1,803	3.0	45,111 (20.5)
TOTAL HAMMOND						3,444		86,167 (39.2)
6.	East Chicago	Indianapolis Blvd.	Grand Calumet	State line 3.1	NA	2,925	3.0	73,183 (33.3)
7.	East Chicago	Cline Ave.	Grand Calumet	State line 6.4	NA	486	3.0	12,160 (5.5)
8.	East Chicago	Ship turnaround of Ship Canal	Ship Canal	NA	96	232	3.0	5,805 (2.6)
TOTAL EAST CHICAGO						3,643		91,148 (41.4)
9.	Gary	Colfax St.	Grand Calumet	7.4	96	749	3.0	18,740 (8.5)
10.	Gary	West of Chase St.	Grand Calumet	9.8	132	891	3.0	22,293 (10.1)
11.	Gary	Bridge St.	Grand Calumet	10.2	90	432	3.0	10,809 (4.9)
12.	Gary	Pierce St.	Grand Calumet	11.5	70	273	3.0	6,830 (3.1)
13.	Gary	Polk St.	Grand Calumet	11.6	78	89	3.0	2,227 (1.0)
14.	Gary	Alley 9, East	Grand Calumet	13.0	96	587	3.0	14,687 (6.7)
15.	Gary	Rhode Island Ave.	Grand Calumet	13.1	32	1,253	3.0	31,350 (14.3)
TOTAL GARY						4,274		106,936 (48.6)

(39.2 MT), 91,148 lbs (41.4 MT), and 106,936 lbs (48.6 MT), respectively, amounting to a total areawide loading of 284,251 lbs (129.2 MT). These loadings should be consistant with the present detergent phosphorous ban conditions.

DATA ON OTHER POLLUTANTS

Loadings of BOD_5, suspended solids and total nitrogen are provided in Table V-6 of Reference 2, Volume III.

DATA QUALITY

Estimates of CSO flow volumes and phosphorous loads were obtained from Table V-6 of Reference 2 of Volume 3 . It is not possible to assess the accuracy of these data since this document did not indicate the method used to calculate flows (e.g. direct measurement, calibrated models, etc.) nor did it indicate the procedure used to identify the phosphorous concentration.

REFERENCES

1. Water Pollution Investigation. Calumet Area of Lake Michigan. EPA-905/9-74-011a.

2. Williams, G. G. East Chicago Lab and Field Data, Volumes 1, 2 and 3. Howard, Needles, Tammen and Bergendoff. September 1981.

CONTACTS

1. Mr. Susan Cook, Howard, Needles, Tammen, and Bergendoff. (317) 872-3160.

2. Mr. Bob Hawkins, Ten Ech Environmental Engineers, Inc. (502) 636-3565.

3. Mr. Glen Williams, Howard, Needles, Tammen, and Bergendoff. (317) 872-3160.

4. Northwest Indiana Regional Planning Commission. (219) 923-1060.

SECTION 9

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF GRAND RAPIDS, MICHIGAN

BACKGROUND

The City of Grand Rapids, Michigan is located on the Grand River in western Michigan. It has a sewered area of 38,000 acres, serving a population of 197,600 people (1970). Approximately 5,500 acres, or 15 percent of the area is served by combined sewers. During dry weather, flow is transported by gravity interceptor to the Grand Rapids wastewater treatment plant. During wet weather, flows exceeding interceptor capacity enter the Grand River, which flows into Lake Michigan.

Three types of overflow regulators presently exist within the Grand Rapids sewer system: fixed weir, gate, and a combination of Fabridam and gate. There are ten fixed weir regulators, six of which are located on the west side of the City, and four are located on the east side. Five regulators have pneumatically operated dams (Fabridams). Only three regulators are installed with gates. Table 9-1 lists each of the combined sewer overflows, while Figure 9-1 shows the location of the overflows.

The regulator's Fabridams and gates were installed by the City in 1972 to provide the City with 8.2 MG of storage within their sewer system. The 8.2 MG is based on having all the Fabridams fully inflated, which is the City's present mode of operation. System storage enables the City to retain 8.2 MG of wet weather flow prior to initiating overflows at the pumping stations.

The City has adopted a sewer separation policy which focuses on sewer separation in areas scheduled for major rehabilitation programs. Furthermore, all new developments have to be served with separated sewers. To date, areas tributary to four overflow regulators (Nos. 2, 19, 20 and 23), have been completely separated and the regulators abandoned. Abandonment included removal of the gate and/or Fabridam and bulkheading of sewers as required.

PUMPING STATION OVERFLOWS

The City has three major pumping stations: Market Avenue, Wealthy and Butterworth. The Market Avenue Pumping Station is comprised of four dry weather sewage pumps, two of which are variable speed having a rated capacity of 7 to 22 MGD, and two are constant speed units rated at 22 MGD. For operation during storms, the station has four stormwater pumps, each rated at 45 MGD capable of pumping to the plant, the river, or to both; and four

Buffalo flood pumps, each rated at 40 MGD to enable pumping combined sewage to the Grand River during high river stages. In addition, there are six flood gates which can be operated only during wet weather periods when the river level is less than El.100.0-ft. (local datum).

Each of the Butterworth and Wealthy Pumping Stations has two 20 MGD pumps which can pump wet weather flow to the Grand River. Pumping operation is level dependent and is controlled so as to initiate pumping whenever the Market Avenue wet well exceeds the 102.0 ft elevation. Running time of each pump is monitored and provides a record of overflow events. Dry weather flow from these pumping stations flows by gravity to Market Avenue Pumping Station. These pumping stations also have the capability of overflowing during wet weather periods by gravity to the Grand River by means of one flood gate at each location.

The City's present mode of sewer system operation is schematically shown in Figure 9-2. With the usage of in-system storage, all overflows are deferred to downstream points. The west side of the City, north of the Grand River, is tributary to either the Wealthy or Butterworth Pumping Stations, which convey their flow to the Market Avenue Pumping Station. The east side of the City is tributary to Market Avenue Pumping Station. Sewage from the southwest portion of the City flows by gravity directly to the wastewater treatment plant.

During wet weather events, the Grand River receives overflows from the fixed weir regulators and overflows either by pumping or gravity from Butterworth, Wealthy and Market Avenue Pumping Stations in addition to storm runoff from the City of Grand Rapids and the remaining tributary area. Overflows at Butterworth and Wealthy Pumping Stations are dependent on wet well levels at the Market Avenue Pumping Station. Random operator response to wet weather conditions at Market Avenue Pumping Station controls overflows at Butterworth and Wealthy. Levels in the wet well as the Market Avenue Pumping Station are related to the levels at Butterworth and Wealthy. When levels at Butterworth and Wealthy Pumping Stations reach a set elevation, one pump at each station is automatically started. Under normal operations, no flow is discharged to the river by means of the flood gates at Butterworth and Wealthy.

COMBINED SEWER OVERFLOW VOLUMES

The City's present mode of overflow operation for the three pumping stations has been practiced since 1979. From 1979 to 1981, Grand Rapids measured overflows from the Market Avenue Pumping Station during the summer months. Overflows from Wealthy and Butterworth Stations were measured during the summer of 1981. In order to determine annual overflows from the Market Avenue Station, measured overflows were plotted against peak hourly rainfall (Figure 9-3). A relatively good correlation was obtained ($r = 0.80$). Based on this information, annual overflows were determined for the Market Avenue Station using local climatological rainfall data obtained from the National Weather Service. Based on this information, approximately 280 million gallons overflow from the Market Avenue Pumping Station during an average rainfall year. It was also determined that overflows from the Butterworth and Wealthy

TABLE 9-1. COMBINED SEWER OVERFLOW LOCATIONS--GRAND RAPIDS, MI

Number	Location	Type
001	Monroe Avenue	Fabridam
003	Fulton Street	Fabridam
004	Ionia Avenue	Gate
005	Ionia Avenue	Fabridam
006	Summer Avenue	Fabridam
010	Stevens Street	Fabridam
011	Mall Street	Gate
012	First Street	Gate
013	Eleventh Street	Fixed Weir
014	Park Drive	Fixed Weir
015	Sibler Street	Fixed Weir
016	California Street	Fixed Weir
017	Bride Street	Fixed Weir
018	Lake Michigan Boulevard	Fixed Weir
021	Plainfield Avenue	Fixed Weir
022	Carrier Street	Fixed Weir
024	Alexander Street	Fixed Weir
025	Alexander Street	Fixed Weir

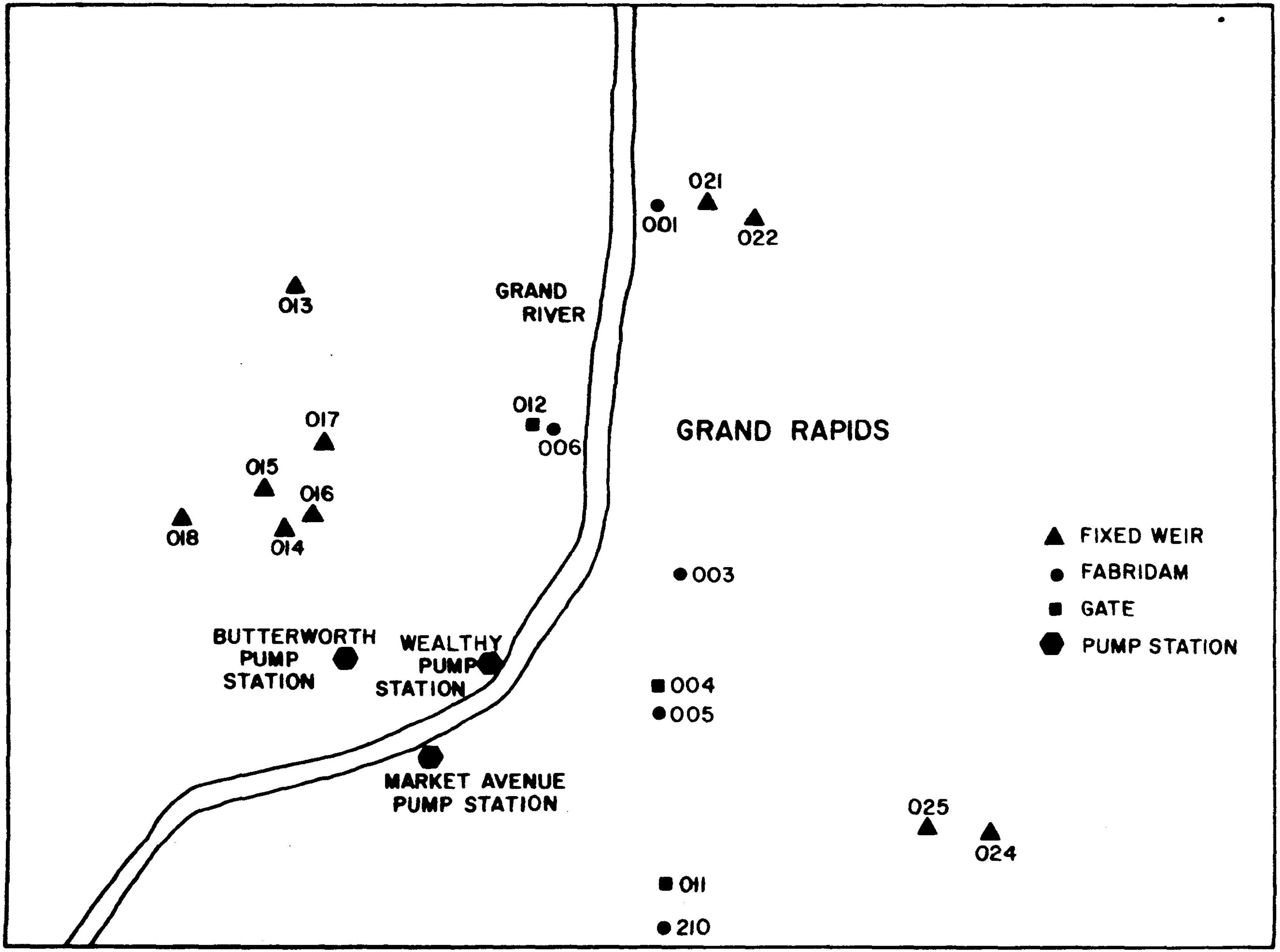


Figure 9-1. Combined sewer overflow locations--Grand Rapids, MI.

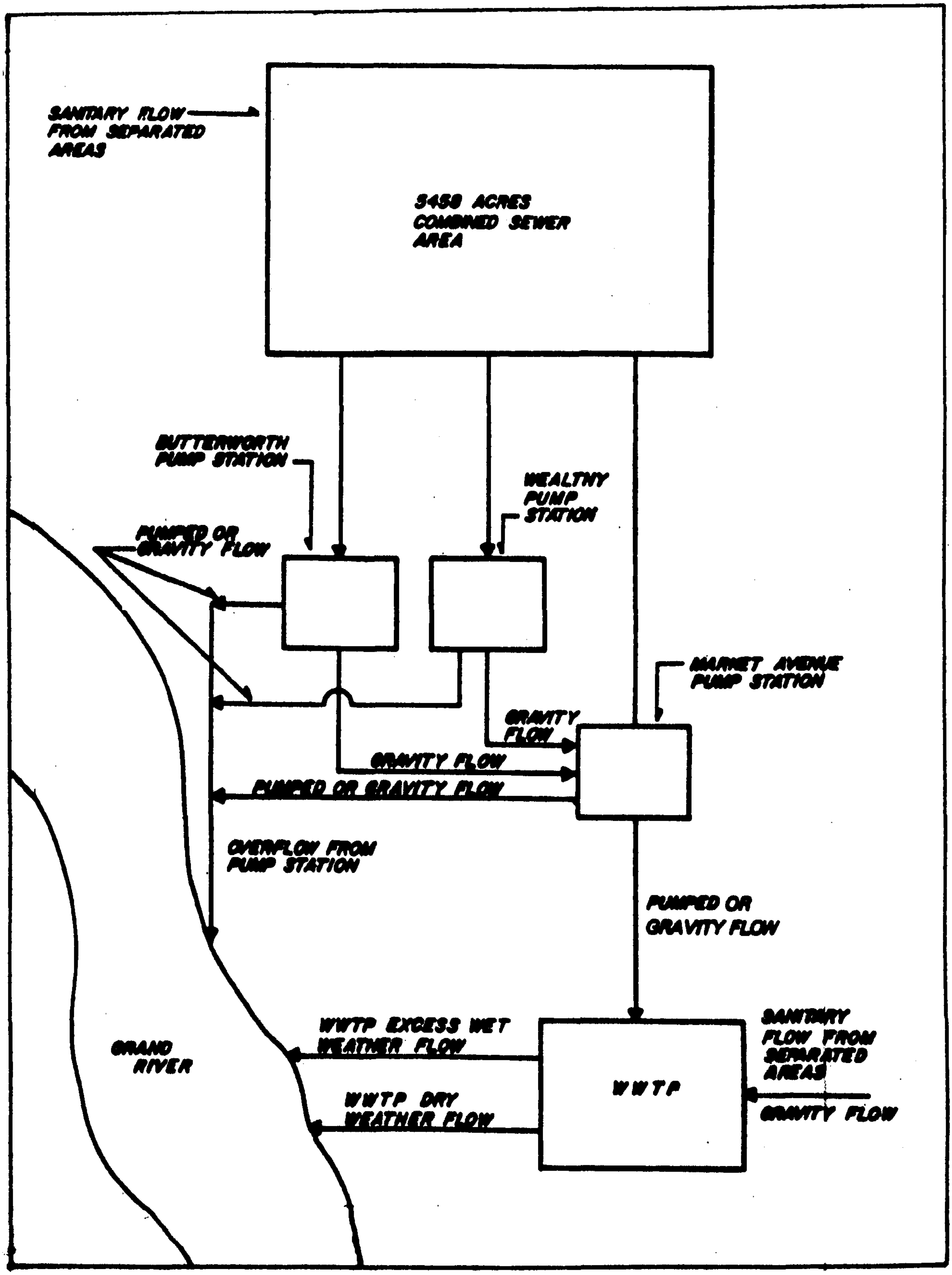


Figure 9-2. Schematic of Grand Rapids sewer system.

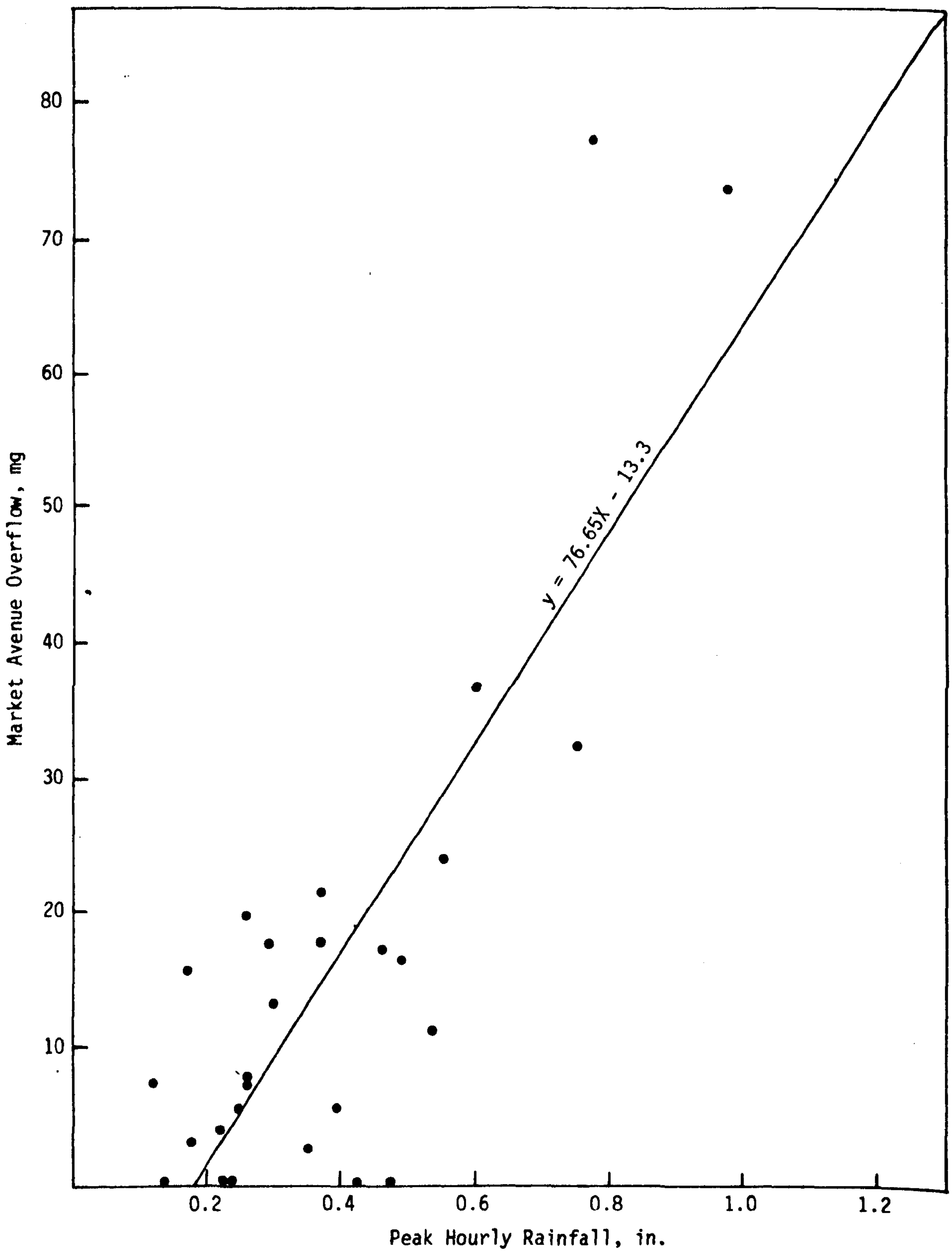


Figure 9-3. Market avenue overflow vs. peak hourly rainfall.

Pumping Stations are approximately 43 percent less than the Market Avenue Station. Total overflows from all three pumping stations would then be 441 million gallons annually.

TOTAL PHOSPHORUS LOADINGS

Wet weather concentrations of total phosphorus have been measured to be 2.49 mg/l (as P) at the Market Avenue Station. Applying this concentration to the 441 million gallons which overflow annually, total phosphorus loadings to the Grand River from combined sewer overflows amount to 9,166 lbs (4.2 MT). Since the data were collected in 1981, this loading is representative of post-1977 detergent phosphorous ban conditions.

DATA ON OTHER POLLUTANTS

Table 9-2 lists the concentration of other parameters which were measured at the Market Street Pumping Station during wet weather flows. Table 9-2 also lists the loading to the Grand River based on overflow volumes.

DATA QUALITY

The concentration of phosphorous used to determine the annual loading to the Grand River was measured at the Market Street Pumping Station during the summer months. Higher concentrations of phosphorous have been measured during the winter months (4.3 mg/l vs. 2.49 mg/l). However, since most overflows occur during the summer, the lower number was used.

Annual flows were estimated based on peak hourly rainfall, since overflows were only measured during the summer months. Peak hourly rainfall was plotted against overflow volumes at the Market Avenue Station. A relatively good correlation was obtained (r = 0.80). Rainfall data was measured by National Weather Service at the Kent County airport.

TABLE 9-2. ANNUAL LOADINGS OF OTHER POLLUTANTS--GRAND RAPIDS, MI

Parameter	Concentration, mg/l	Loading, lb/yr
BOD_5	77	287,190
Nitrate	1.18	4,400
Cyanide	0.673	2,510
Chloride	88	328,210
Total cadmium	0.009	33
Total chromium	0.27	1,007
Total copper	1.09	4,065
Total iron	10.4	38,790
Total lead	0.57	2,126
Total nickel	0.32	1,194
Total zinc	0.575	2,145
Total mercury	0.0042	16

REFERENCES

1. Combined Sewer Overflow Control Analysis for the City of Grand Rapids, Michigan -- Phase 2 Report. Prepared by McNamee, Porter, and Seeley Consulting Engineers, Ann Arbor, Michigan. April 1982.

2. Local Climatological Data for the Kent County, Airport, Grand Rapids, Michigan. National Oceanic and Atmospheric Administration, Environmental Data and Information Service. Asheville, North Carolina.

CONTACTS

1. Mr. Barry Bitrick, West Michigan Planning Commission. (616) 454-9375.

2. Mr. Jack Hornback, Grand Rapids City Engineer. (616) 456-3060.

3. Mr. Robert Sullivan, West Michigan Planning Commission. (616) 454-9375.

4. Mr. Ron Wood, Michigan DNR. (616) 456-6231.

5. Mr. Phil Youngs, McNamee, Porter and Seeley. (313) 665-6000.

SECTION 10

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF KALAMAZOO, MICHIGAN

BACKGROUND

The city of Kalamazoo sewer system contains approximately 275 miles of sewer ranging in size from 6 in. to 72 in. in diameter, 8-in. sewers representing about 68 percent of this total length. Approximately 50 percent of the system has been constructed within the last 20 years. There are no intended stormwater connections and no combined sewers. Kalamazoo also accepts sewage generated in the Townships of Comstock, Oshtemo, Texas, Portage, Parchment, Galesburg, Vicksburg, August, Kazoo and Pavillion.[1,2,3]

OVERFLOW DATA

Although there are no combined sewers, an estimated 1,200 million gallons of extraneous flow enters the sanitary sewer system annually. Of this total, approximately 6.4 percent is due to inflow and 93.6 percent is due to infiltration.[1] The treatment plant was equipped with a bypass, but this was reportedly removed.[3] Potential overflow points were identified at the Gibson Street Interceptor (currently being replaced), and the Stadium Drive Trunk Sewer, both of which may have insufficient capacity to transport maximum expected flows.[1] Data on overflow frequency and quantity are not available. Consequently, the phosphorous load cannot be determined. However, overflow from this system is likely to be extremely small relative to other Great Lakes overflow sources.

REFERENCES

1. Facilities Plan for the Kalamazoo Metropolitan Area. Volume 1. Jones & Henry Engineers, Ltd., September 1976.
2. City of Kalamazoo, Michigan Sewer System Evaluation Survey. Jones & Henry Engineers, Ltd., December 1980.
3. Written Communication, Paul A. Blakeslee, Chief of Wastewater Operations, Michigan DNR.

CONTACTS

1. Mr. Mike Brey, Michigan DNR. (517) 373-6473.
2. Mr. Sherman, South Central Michigan Planning Agency. (616) 665-4221.
3. Mr. Richard Sims, City of Kalamazoo Sewage Works. (616) 385-8157.

SECTION 11

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF MUSKEGON, MICHIGAN

To obtain relevant sewer system data, telephone inquires were made to the West Michigan Shoreline Regional Planning Commision (WMSRPC), the Michigan Department of Natural Resources (DNR) and the Muskegon County Drain Commission.[1,2,3] From these conversations it was confirmed that there are no combined sewer overflows or bypasses in Muskegon. Reference 4 provides data on Muskegon's stormwater collection system.

REFERENCES

1. Telecon. Mr. John Koches, West Michigan Shoreline Regional Development Commision (616) 722-7878 and Mr. John Patinskas, GCA/Technology Division. April 16, 1982.

2. Telecon. Mr. Ernie Josma, Michigan Department of Natural Resources (616) 456-6231 and Mr. John Patinskas, GCA/Technology Division. June 8, 1982.

3. Telecon. Mr. Pat Kelly, Muskegon County Drain Commission. (616) 853-2291 and Mr. Tim Curtin, GCA/Technology Division. September 21, 1982.

4. West Michigan Regional Development Commission. Muskegon County Stormwater BMP Implementation Project. April 1982.

CONTACTS

1. Mr. Pat Kelly, Muskegon County Drain Commissioner. (616) 853-2291.

2. Mr. John Koches, West Michigan Regional Development Commission. (616) 722-7878.

3. Mr. Ernie Josma, Michigan DNR. (616) 456-6231.

SECTION 12

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF MIDLAND, MICHIGAN

BACKGROUND

The City of Midland, Michigan is located around the confluence of the Tittabawassee and Chippewa Rivers in the east central portion of the lower Michigan peninsula, 18 miles west of the Saginaw River and Lake Huron. In 1974, the estimated population was 37,500. Midland has 761,500 feet of sanitary sewers of which 76,700 feet, or approximately ten percent, are combined sewers with the remaining 90 percent being separate sanitary sewers. The combined sewer system encompasses an area of 375 acres with sewers ranging in size from 6 inches to 72 inches.

The combined sewer system is located in the downtown, older section of the City. It is bounded by Eastman Road, Carpenter Street, Jefferson Avenue, and the Chesapeake and Ohio Railroad. The sewage from this area flows to six overflow regulators which are located along the interceptor sewer on the north side of the Tittabawassee River. When the flow in the combined sewer exceeds the capacity of the interceptor sewer, the excess flow is diverted directly to the river. The interceptor sewer and overflow structures were constructed in 1939 and are located along the north side of the Tittabawassee River from Revere Street to State Street. The combined sewer overflows are listed in Table 12-1 while their locations are shown in Figure 12-1.

The six overflow structures were originally constructed with weirs and dams to divert the dry weather flow to the treatment plant. Since then, regulating valves have been installed in each overflow chamber except the Revere Street location. These valves are remotely controlled from the wastewater treatment plant to control the quantity of flow entering the interceptor during wet weather. They must be closed during periods of flood stage to prevent the river from flowing back into the interceptor sewer and flooding out the main pumping station at Wyman Street.

COMBINED SEWER OVERFLOW VOLUMES

There are no historical records that indicate how much wet weather flow is required to begin bypassing to the river at each of the six regulators. During the spring and summer of 1977, the City monitored the six overflow regulators in an attempt to determine how much rainfall it takes to start bypassing wet weather flow in each of the regulators. The results of this monitoring program are shown in Table 12-2.

TABLE 12-1. COMBINED SEWER OVERFLOWS--MIDLAND, MI

Overflow regulator	Combined sewer area, acres	Percent of total combined sewer area
Revere Street	18	4.8
Benson Street	20	5.3
Hubbard Street	3	0.8
St. Nicholas Street	14	3.7
Gordon Street	111	29.6
State Street	209	55.8
Total	375	

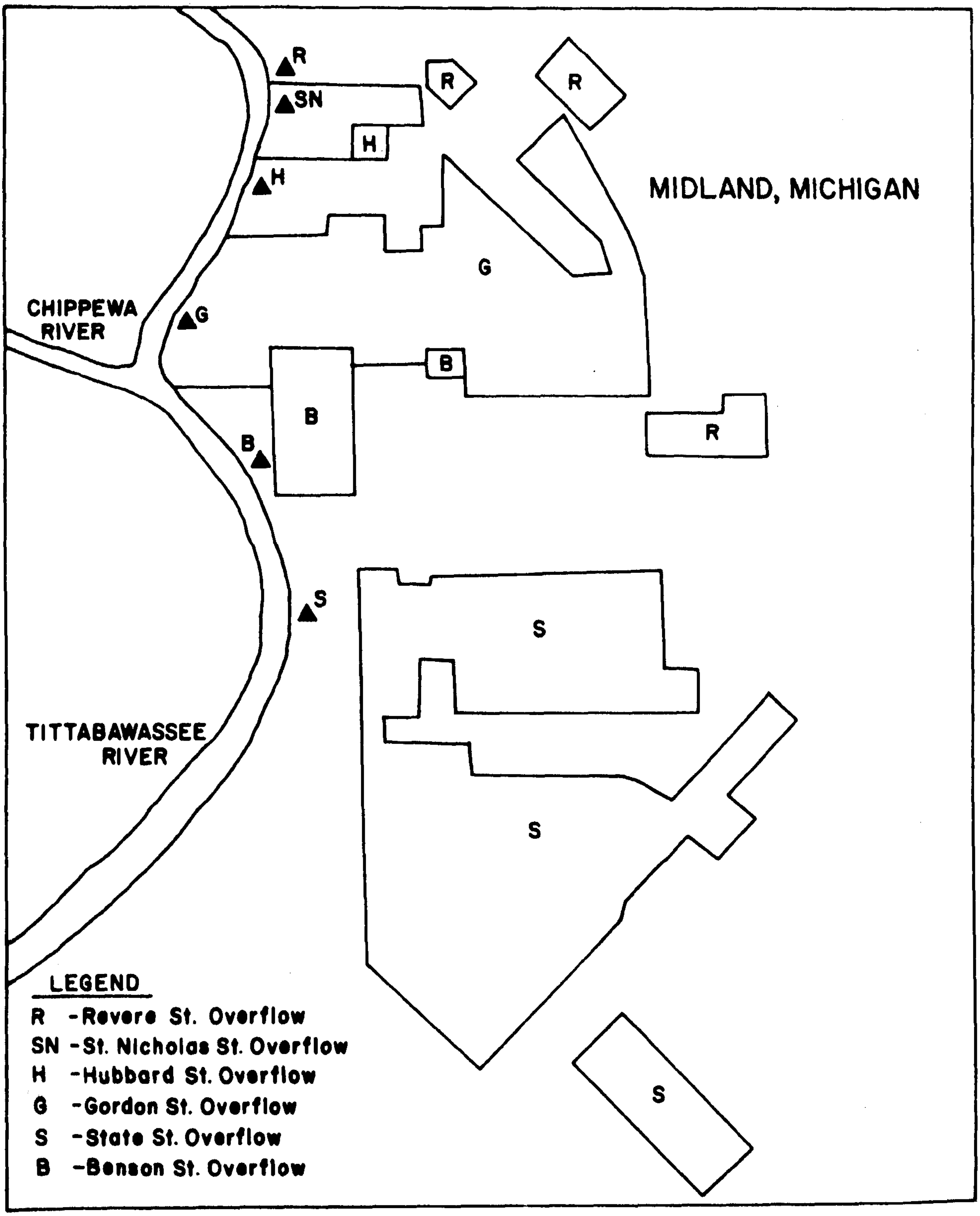


Figure 12-1. Combined sewer overflow locations--Midland, MI.

TABLE 12-2. RAINFALL VERSUS BYPASSING FOR SIX OVERFLOW REGULATORS--MIDLAND MI

Date	Precipitation, inches	Overflow regulator					
		Revere Street	Benson Street	Hubbard Street	St. Nicholas Street	Gordon Street	State Street
05/05/77	0.08						X
05/31/77	0.16					X	X
06/01/77	0.25					X	X
06/06/77	0.89				X	X	X

As shown in Table 12-2, the State Street regulator bypassed sewage to the river during all four rainfall events; the Gordon Street regulator bypassed during the last three; and the St. Nicholas regulator discharged during the June 6th rainfall only. The remaining three overflow regulators, namely Revere Street, Hubbard Street, and Benson Street did not bypass any wet weather flow to the river during this period. To date, no method has been devised to measure the volume of overflow from the overflow structures during wet weather and no estimation of the overflow volume can be provided. However, since the combined sewer service area covers only 375 acres, the annual phosphorous load is likely to be relatively small.

REFERENCES

1. City of Midland, Michigan Infiltration/Inflow Analysis. McNamee, Porter, and Seeley Consulting Engineers. Ann Arbor, Michigan. August 1978.

2. Telecon. Mr. Steve Young, City of Midland (517) 835-7711 and Mr. Samuel Duletsky, GCA Corporation, Chapel Hill, North Carolina. September 15, 1982.

CONTACTS

1. Mr. Jim Scott, Michigan DNR. (517) 373-6473.

2. Mr. Steve Young, City of Midland. (517) 835-7711.

SECTION 13

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF SAGINAW, MICHIGAN

BACKGROUND

The City of Saginaw, Michigan, with a population of 91,900 (1970) is located on the Saginaw River in the east-central portion of the State. The City occupies both banks of the river for a stretch of about five miles, and is approximately eighteen miles from Lake Huron. The City has a combined sewer system which collects sewage from 5,580 acres on the west bank of the river and 3,889 acres on the east bank. During dry weather periods, sewage flows through an interceptor on each side of the river. The interceptors eventually join on the east side where the sewage is treated by a secondary treatment plant. Wet weather flow exceeding interceptor capacity overflows into the Saginaw River.

The combined sewer system overflows approximately 60 times per year, during wet weather and spring thaw. Combined sewer overflows can affect water quality by reducing the dissolved oxygen in the river from 6 mg/l to 4 mg/l, and are the most significant source of bacteria loadings for the river above Bay City (approximately 10 miles downstream). Overflows may occur at 34 regulator chambers and five pump stations located along the interceptors as shown in Figure 13-1.

COMBINED SEWER OVERFLOW VOLUMES

Annual overflow estimates are presented in Table 13-1 for seven major overflow points and the rest of the overflow points on the east and west sides of the city. Total combined sewer overflows discharge approximately 2.62 billion gallons into the Saginaw River each year.

TOTAL PHOSPHOROUS LOADINGS

The phosphorous concentration from combined sewer overflows in Saginaw was not reported in available literature, however, loadings of total suspended solids (TSS) and biochemical oxygen demand (BOD) were reported. Total phosphorous loadings were therefore calculated by using a typical post-ban concentration of 3.4 mg/l as P. By multiplying the CSO volume by this factor, the total phosphorous loading from Saginaw's combined sewer overflows is estimated to be 74,191 lbs (33.7 MT) per year.

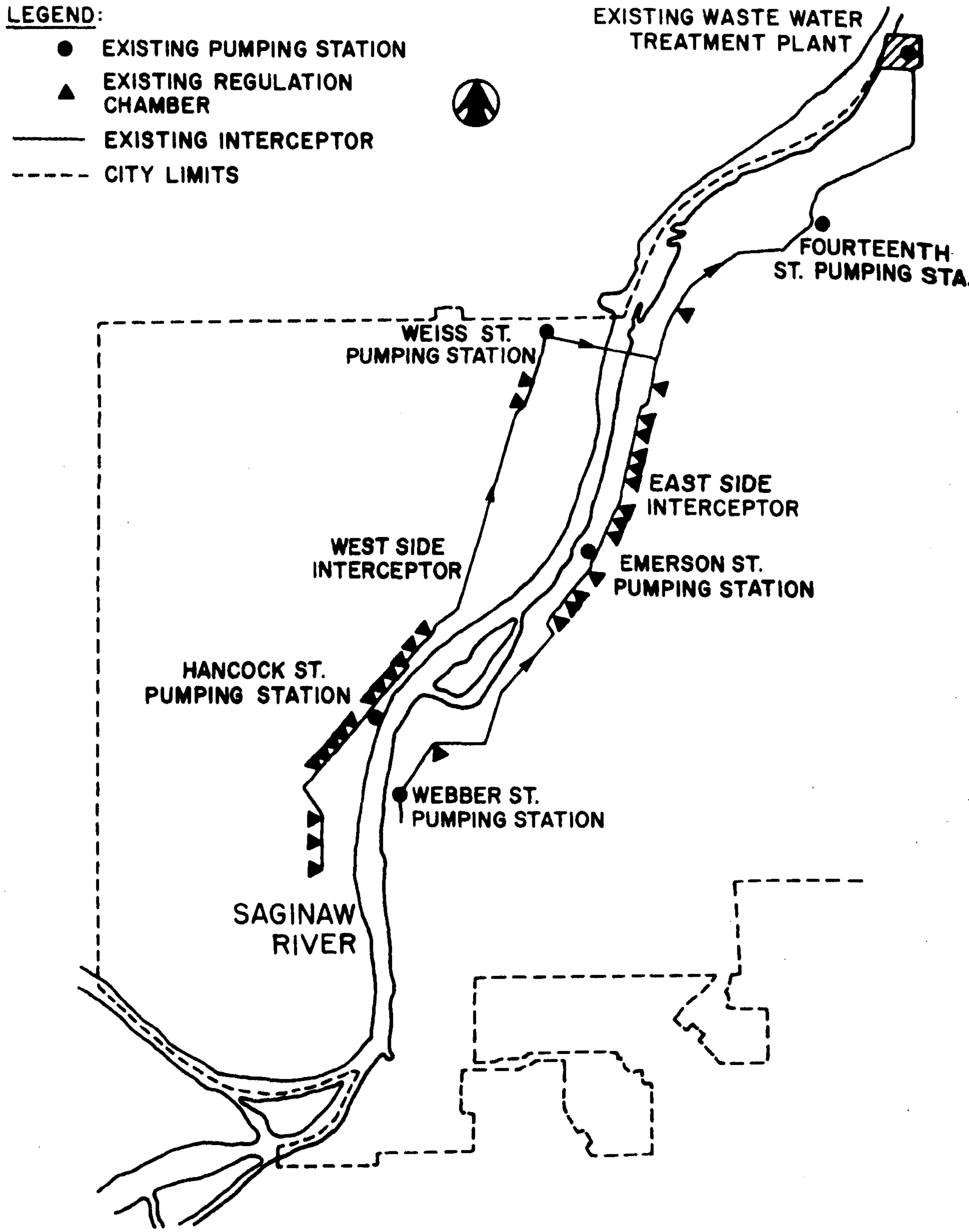


Figure 13-1. Combined sewer interceptor system--Saginaw, MI.

TABLE 13-1. ESTIMATED ANNUAL CSO VOLUMES--SAGINAW, MI

Overflow source	Overflow volume for typical year - 1977, MG
West Side	
Fraser regulator	64.3
Hancock pumping station	501.6
Weiss regulator	390.2
Weiss pumping station	462.9
Remaining regulators	229.9
Total West Side -	1,648.9
East Side	
Webber pumping station	273.6
Emerson pumping station	6.2
Fourteenth Street pumping station	245.1
Remaining regulators	442.6
Total East Side -	967.5
TOTAL	2,616.4

The estimated phosphorous loading was verified by using an average of known phosphorous-to-TSS ratios of combined sewer overflows for selected U.S. cities. The average phosphorous-to-TSS ratio, 0.0158, was reduced by 32 percent to reflect post-ban conditions and multiplied by the estimated TSS loading of 8.08 million pounds from Saginaw's combined sewer overflows for a typical rainfall year (1977). The resulting estimate of phosphorous loading (86,812 lbs/yr) compares favorably with the phosphorous loading estimated above.

DATA ON OTHER POLLUTANTS

The annual loadings of TSS and BOD to the river from combined sewer overflows are estimated to be 8.08 million pounds and 1.95 million pounds, respectively.

DATA QUALITY

Actual measurements of the phosphorous loading of combined sewer overflows were not reported. The concentration of phosphorous from combined sewer overflows was assumed to be equal to typical concentrations found under post-ban conditions.

The volume of combined sewer overflows was estimated using a mathematical model developed specifically for Saginaw. The model itself was not contained in the report. The values for two parameters of the model, hourly rainfall and dry weather sewage flow, were obtained from actual measurements. Values for two other parameters of the model, street washoff and dry weather sewage deposition, were obtained from empirical equations and a literature survey of BOD street accumulation rates. The model was checked by comparing simulation results against actual sewer flow data collected during dry weather and wet weather. Flows predicted by the model matched well with flows measured during an actual rain event.

REFERENCES

1. Facility Plan for the Control and Treatment of Combined Sewer Overflows to the Saginaw River. Environmental Design and Planning, Incorporated. March 1981.

CONTACTS

1. Mr. Steve McGuire, The Chester Engineer. (412) 771-4320.

2. Mr. William Pisano, Environmental Design and Planning. (617) 787-4200.

3. Mr. Jim Scott, Michigan DNR. (517) 373-6473.

4. Mr. William Yokum, East Central Michigan Regional Planning Commission. (517) 752-0100.

SECTION 14

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF BAY CITY, MICHIGAN

BACKGROUND

Bay City, Michigan is located near the mouth of the Saginaw River in the east-central portion of the State. Bay City and surrounding townships have an estimated population of 105,000 (1977). Approximately half of the sewage collection system of Bay City is served by combined sewers.

Two regional wastewater treatment plants are located in Bay City. The Bay City regional plant, with a capacity of 12 million gallons per day, is located on the east bank of the Saginaw River and serves Bay City and Hampton Township. The West Bay County regional plant, located on the west bank of the river, treats wastewater from Bangor, Monitor, Frankenlust, and Williams Townships. Flow from the combined sewers in Bay City is treated at the Bay City regional wastewater treatment plant. The loations of the two treatment plants, as well as the location of the Essexville Wastewater Treatment Plant, are shown in Figure 14-1.

In 1980 Bay City began operating five retention basins which temporarily store excess combined interceptor flow during rain events and spring thaws. The retention basins, each in a different location in the City, are designed to store combined sewer overflow from storms as great as ten-year rain events. Excessive interceptor flow, which previously overflowed to the Saginaw River, is chlorinated for disinfection as it enters the basins then retained in the basins until flow decreases and interceptor capacity becomes available. When combined sewer overflow exceeds basin storage capacity, combined sewage overflows a weir wall from the basin to the river. The retention basins are dewatered when interceptor flow decreases after storm events.

Prior to the construction of the West Bay County Regional Wastewater Treatment Plant and the five retention basins, the combined sewer system overflowed approximately 70 times per year from 30 different points. The Bay City combined sewer system presently overflows four to six times per year. However, based on literature review and contact with Bay City, quantification of annual overflow volume has not been made.

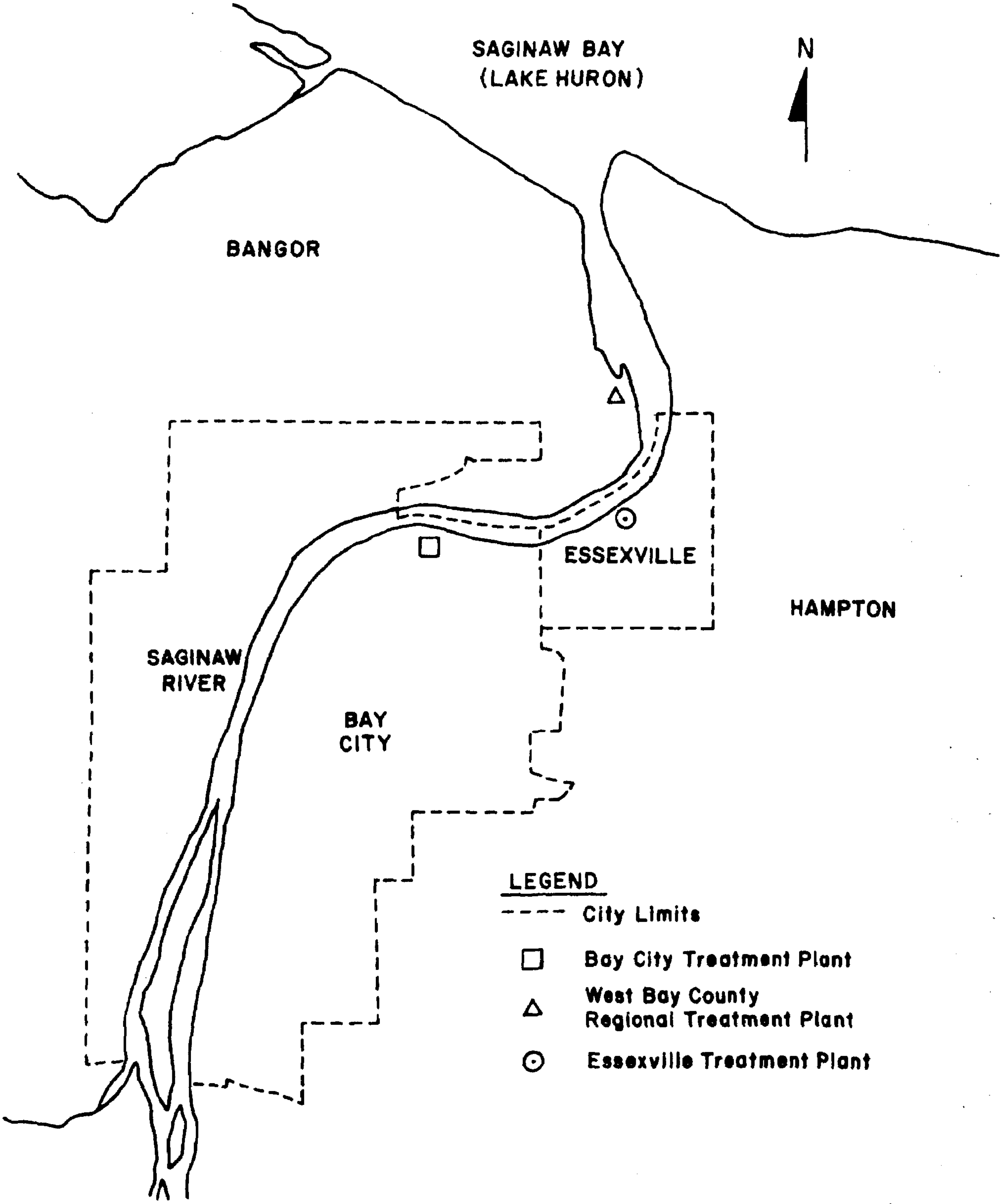


Figure 14-1. Bay City area wastewater treatment plants.

REFERENCES

1. Facilities Planning Study, Bay City Study Area. Hubbell, Roth & Clark, Incorporated, Bloomfield Hills, Michigan. February 1977.

2. Telecon. Mr. Tom Heffelbower, City Engineer. Bay City, Michigan (517) 894-8181 and Mr. Samuel Duletsky, GCA Corporation, Chapel Hill, North Carolina. September 17, 1982.

CONTACTS

1. Mr. Willard Grevel, Bay City Wastewater Treatment Plant Operator. (517) 893-5121.

2. Mr. Tom Heffelbower, City Engineer, Bay City Michigan. (517) 894-8181.

3. Mr. Jim Scott, Michigan DNR. (517) 373-6473.

4. Mr. William Yokum, East Central Michigan Regional Planning Commission. (517) 752-0100.

SECTION 15

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF FLINT, MICHIGAN AND SURROUNDING AREAS

BACKGROUND

In 1977 a report evaluating the Genesee County wastewater collection system was prepared by Hubble, Roth and Clark. A map of the study is provided in Figure 15-1. The total area covers approximately 368 square miles and includes the Beecher Metropolitan District and the Cities of Flint, Clio, Swartz Creek, Grand Blanc, Burton, Davidson, Mt. Morris, Mundy and Vienna. The Townships of Davidson, Flushing, Gaines, Richfield, Thetford, Flint, Genesee, Grand Blanc, Mt. Morris, Montrose, Mundy, Vienna and Clayton are also included. The study area is serviced by an interceptor system ranging in size from 21 in. to 108 in. diameter. The main trunk, also shown in Figure 15-1, originates in Genessee Township, circles the City of Flint in a clockwise direction and terminates at the Anthony Ragnone Wastewater Treatment Plant, a 50 MGD advanced treatment facility. The City of Flint and surrounding areas have no CSOs. However, wastewater is occasionally bypassed at several pump stations and can overflow from manholes located in low lying areas.

BYPASSES

The system contains a total of seven bypasses. Locations include the Farrand Road Pump Station in Vienna, Carpenter Road and Clubock Drive in the Beecher Metropolitan District, Pump Station No. 6 and Genesee Road in Genesee, the 3rd Avenue Pump Station in Flint, and the Northwest pump station, located on the treatment plant grounds in Flint Township. Sewage was bypassed at Pump Station No. 6 three times in 1975 and three times in 1976 to prevent basement flooding. The Northwest Pump Station also overflows a couple of times each year on average. However, flow volumes from these overflows have not been measured. Data on operation and flow rates at the other bypasses are not available.

EQUALIZATION BASIN OVERFLOW

According to Mr. David Brady of Hubble, Roth and Clark a 10 million gallon flow equalization basin was recently installed at the treatment plant. During wet weather periods, when the treatment plant capacity is exceeded, a portion of the flow is diverted to the basin. As the flow rate to the treatment plant declines below capacity, water stored in the basin is metered back to the plant. When the 10 million gallon basin storage capacity is exceeded, wastewater is bypassed to the Flint River following chlorination and

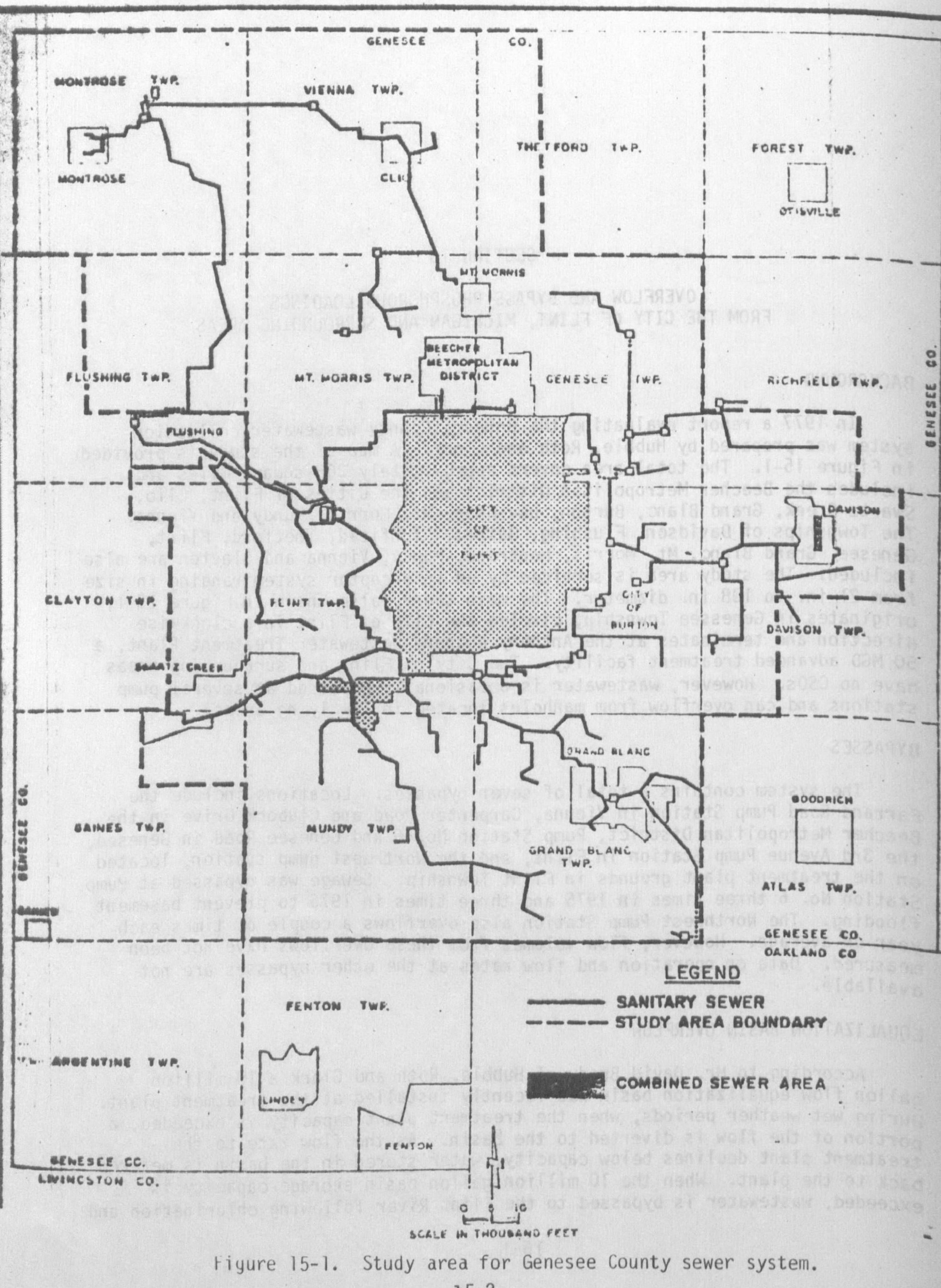


Figure 15-1. Study area for Genesee County sewer system.

sedimentation. An additional 10 million gallons of storage will be provided upon completion of a relief tunnel system running throughout the City of Flint. The projected tunnel system completion date is September 30, 1983. Mr. Brody stated that there are likely to be five or six events per year when the basin capacity will be exceeded and flow will be bypassed. Flow during these events is reportedly not measured. Based on in-house data Mr. Brody estimated the annual phosphorous load to be in the range of 100 to 500 lb.[2]

FOOTING DRAIN INFLOW

Footing drains are connected to the sanitary sewer system in the City of Davidson, the City of Burton, the City of Swartz Creek and in the Beecher Metropolitan District. These drains can add substantial flow to the sewer system during periods of wet weather. The largest area of footing drains is located in the Beecher Metropolitan District. When wet weather flow in Beecher exceeds 6.5 CFS excess flow is diverted through the previously mentioned Clubock Drive bypass.

SANITARY SEWER OVERFLOWS

There are 48 points in the Flint area where wastewater overflows occur through sewer manhole tops. These manholes are located primarily in low lying areas in the vicinity of pump stations. Repairs have reportedly been made in some of these areas to prevent surcharging and inflow. The previously mentioned relief tunnel system is expected to eliminate future sanitary sewer overflows.

COMBINED SEWER AREAS

As shown in Figure 15-1, combined sewers are confined to a small area within the City of Davidson. However, there are no overflows serving the combined sewer system. All flow enters the County System, except during high flow conditions when a sluice gate at the west city limit is closed and backups occur through manhole tops in the Black Creek Interceptor.

SUMMARY OF FINDINGS

The City of Flint and surrounding areas contain no combined sewer overflows. However, flow can be increased substantially during periods of wet weather due to footing drain input and sewer system inflow. As flow exceeds capacity, raw sewage is diverted to natural waters at five bypass locations. Overflow can also occur through surcharged manholes in low lying areas. Although the treatment plant is equipped with a flow equalization basin wastewater is periodically bypassed during wet weather. Given the lack of data it is not possible to accurately determine annual phosphorous loads from the overflow and bypass points. Since the sewer system is essentially separate and excess wet weather flow is primarily due to inflow and runoff to footing drains the annual phosphorous load is likely to be small relative to typical combined sewer systems serving metropolitan areas of similar size.

REFERENCES

1. Genesee County Metro Planning Area. Volume 1. Hubble, Roth and Clark, Inc. September 1977.

2. Telecon. Mr. David Brody, Hubble, Roth and Clark, Bloomfield Hills, Michigan (313) 538-9620 and Mr. John Patinskas, GCA/Technology Division. May 21, 1982.

CONTACTS

1. Mr. David Brody, Hubble, Roth and Clark. (313) 766-7210.

2. Mr. Stan Butynski, Superintendent, Genesee County Sewer System. (313) 732-7870.

3. Mr. Robert Karwowski, Genesee-Lapeer-Shiawassee Planning and Development Commission. (313) 234-0340.

4. Mr. Jim Scott, Michigan DNR. (517) 373-6473.

SECTION 16

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF DETROIT, MICHIGAN

BACKGROUND

The Detroit Water and Sewerage Department (DWSD) provides wastewater collection and treatment services over an area encompassing 1,683.5 km^2 (650 square miles). Service is provided for an estimted 3,200,000 people and over 1500 industrial dischargers. About 62 percent of the service area is served by separate sanitary and storm sewers; combined sewers providing collection in the remaining area.[1] The collection system contains 83 combined sewer overflows (CSOs) which can divert wastewater to the Rouge and Detroit Rivers. During a 1978 to 1980 study, conducted by Giffels/Black and Veatch,[2] the system was modeled to determine pollutant loads released to the Rouge and Detroit Rivers through Detroit CSOs. This study provided the data base which GCA used to develop storm event phosphorous loads for the spring of 1979.

ANNUAL TOTAL PHOSPHOROUS LOAD

The study by Giffels/Black and Veatch[2] involved the collection of CSO and treatment plant flowrate and water quality monitoring data. These data were used to calibrate a computer model for computation of pollutant loading data. The model used was a variation of the EPA Storm Water Management Model (SWMM). The program output provided annual pollutant loadings by CSO and total annual pollutant loadings for all CSOs combined. The 1979 annual loading[a] of total phosphorous[b] was found to be 353,100 lbs (160.5 MT). The five most active overflows (Leib, Hubbel-Southfield, Connor Creek, Freud, and 6-Mile) contributed 82 percent of the annual total phosphorous load.

---

[a]The year 1979 is defined in Reference 2 as starting on March 29 and ending December 31. 1979 rainfall was reported to be 27.5 inches over 36 analyzed events. Rainfall in 1979 was 6 percent greater than expected in an average year.

[b]Total Phosphorous reported as mg/l P.

STORM EVENT ANALYSIS - SPRING 1979

The Detroit wastewater collection system contains a total of 83 CSOs. Thirty-four CSOs were monitored for flow and quality during the Giffels/Black and Veatch study. During the 5 events of interest which occurred from 29 March 1979 to 12 April 1979, flow and pollutant monitoring data were obtained on 23 of these CSOs. The 23 monitored CSOs accounted for 62.2 percent of the annual total phorphorous load. Total phosphorous loadings for all measured CSOs during March/April 1979 are presented in Table 16-1.

Due to a lack of flow data for Hubbel-Southfield during events 1 through 5, GCA synthesized flow data using rainfall data and a "modified" runoff coefficient. The "modified" coefficient was developed by correlating Hubbel-Southfield data on rainfall and flow for the 10 events occuring between 24 May 1981 and 28 November 1981. Data used to determine the "modified" runoff coefficient are given in Table 16-2 and the correlation is graphed in Figure 16-1. The Hubbel-Southfield CSO was found to account for 26.6 percent of the annual total phosphorous load. As shown in Table 16-1, 89.2 percent of the annual total phosphorous load is accounted for by combining the synthesized Hubbel-Southfield data with the monitored overflows. The remaining 58 unmonitored CSOs contribute approximately 10.8 percent of the annual total phosphorous load.

Table 16-1 provides flow, phosphorous concentration and loading data by CSO for each of the five events of interest. In some cases, flow data were found to be incomplete. Flow data were not given for event days in which data were not required by the SWMM program. In some instances, monitors malfunctioned or were vandalized. However, it was generally found that missing data corresponded to days with little or no rainfall or for CSOs where flow is typically very small or zero. CSO flows were therefore assumed to be zero during all days where missing data were indicated.

As indicated in Table 16-1, measured phosphorous concentration data were very limited. For events 1 and 3, Leib and 6-Mile were the only CSOs with phosphorous concentration data. For event 2, concentration data were provided for Conner Creek and Leib. Concentration data were given for Conner Creek, Fischer, Leib, Dubois, First-Hamilton, Summit and Baby Creek CSOs during event 4. When available, individual event phosphorous data were used to calculate phosphorous loadings. In cases where the storm event phosphorous concentrations were not provided, the annual average phosphorous concentrations were used.

Ideally, the study by Giffels/Black and Veatch[2] would have used flow weighted composites to calculate pollutant loads. However, because the flow data could not be made available prior to laboratory analysis, the samples were time composited. Storm event phosphorous concentrations displayed in Table 16-1 represent time weighted composites taken over the entire event. The annual average phosphorous concentrations (Table 16-1, Column 3) were derived by the SWMM model from calculated annual phosphorous loadings. Although specific laboratory procedures for phosphorous analysis were not given, the following documents were referenced:

- Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

TABLE 16-1. PHOSPHOROUS LOADING DATA--DETROIT, MI

CSO No.	Overflow name	Annual average phosphorous concentration, mg/l[a]	Annual phosphorous load, lb[a]	Annual contribution, % of total	Event No. 1 3/29/79 to 3/30/79 Rainfall = 0.80 in. Flow, 10^6 ft^3	Event No. 1 Average phosphorous concentration, mg/l[a]	Event No. 1 Total phosphorous load, lb[a]	Event No. 2 3/30/79 Rainfall = 0.25 in. Flow, 10^6 ft^3	Event No. 2 Average phosphorous concentration, mg/l[a]	Event No. 2 Total phosphorous load, lb[a]
401	Conner Creek	3.30	60,100	17.0	6.69	N/A	1,378	5.25	5.00	1,639
402	Conner Pumping Station	1.96	1,660	0.5	0	N/A	0	4.32	N/A	529
403	Freud Pumping Station	1.97	4,760	1.3	9.73	N/A	1,196	5.17	N/A	639
405	McClellan-Cadillac	0	0	0	0.63	N/A	0	0	N/A	0
406	Fischer CSO	2.00	1,330	0.4	0	N/A	0	0	N/A	0
410	Leib CSO	3.00	124,000	35.1	7.28	3.30	1,500	15.73	4.10	4,026
414	Dubois CSO	2.09	279	0.1	0.71	N/A	93.0	0	N/A	0
425	First-Hamilton	2.01	2,060	0.6	1.06	N/A	133	0	N/A	0
436	Scotten	2.88	351	0.1	0	N/A	0	0	N/A	0
438	Summit CSO	3.01	4,780	1.4	1.31	N/A	246	0	N/A	0
441	Junction CSO	2.94	1,360	0.4	0	N/A	-	0	N/A	0
457	Baby Creek CSO	2.09	2,270	0.6	3.34	N/A	436	0	N/A	0
460	Tireman CSO	1.93	4,220	1.2	1.23	N/A	148	0	N/A	0
461	W. Chicago-East	1.98	2,250	0.6	0	N/A	0	0	N/A	0
462	W. Chicago-West	N/A	0	0	0[b]	N/A	0	0	N/A	0
463	Plymouth Road	N/A	0	0	0.05	N/A	0	0	N/A	0
471	Puritan	N/A	0	0	0.24	N/A	0	0	N/A	0
474	6-Mile (McNichols)	2.02	7,650	2.2	1.54	1.00	96	0	N/A	0
476	7-Mile CSO, West	N/A	0	0	0	N/A	0	0	N/A	0
477	7-Mile CSO, East	0	0	0	0	N/A	0	0	N/A	0
478	Frisbee CSO	N/A	0	0	0	N/A	0	0	N/A	0
479	Pembroke CSO	0	0	0	0	N/A	0	0	N/A	0
482	Oakwood CSO	1.93	3,790	1.1	0.68	N/A	82	0	N/A	0
458	Hubbel-Southfield[c]	1.95	94,000	26.6	38.32	N/A	4,665	0	N/A	0
Subtotal			314,860	89.2	72.81		9,973	30.47		6,833
All other sources			37,767	10.8	8.73		1,196	3.65		820
Total			352,627	100.0	81.54		11,169	34.12		7,653

(continued)

TABLE 16-1 (continued)

CSO No.	Overflow name	Event No. 3 4/1/79 to 4/4/79 Rainfall = 0.65 in. Flow, 10^6 ft^3	Average phosphorous concentration, mg/l[a]	Total phosphorous load, lb[a]	Event No. 4 4/8/79 to 4/10/79 Rainfall = 1.40 in. Flow, 10^6 ft^3	Average phosphorous concentration, mg/l[a]	Total phosphorous load, lb[a]	Event No. 5 4/11/79 to 4/12/79 Rainfall = 1.15 in. Flow, 10^6 ft^3	Average phosphorous concentration, mg/l[a]	Total phosphorous load, lb[a]
401	Conner Creek	13.84	N/A	2,851	55.66	4.02	13,969	0	0.458	0
402	Conner Pumping Station	1.90	N/A	232	14.59	N/A	1,785	0	N/A	0
403	Freud Pumping Station	2.12	N/A	261	15.91	N/A	1,957	0	N/A	0
405	McClellan-Cadillac	0.50	N/A	0	5.09[b]	N/A	0	2.05[b]	N/A	0
406	Fischer CSO	0[b]	N/A	0	0[b]	3.63	0	0[b]	N/A	0
410	Leib CSO	25.38	4.10	6,496	54.91	4.80	16,454	2.96	N/A	554
414	Dubois CSO	0.59[b]	N/A	77	2.57[b]	N/A	335	0[b]	N/A	0
425	First-Hamilton	0[b]	N/A	0	3.64[b]	5.90	1,341	0[b]	N/A	0
436	Scotten	0[b]	N/A	0	0[b]	N/A	0	0[b]	N/A	0
438	Summit CSO	0.35[b]	N/A	66	1.14[b]	3.1	221	0[b]	N/A	0
441	Junction CSO	0[b]	N/A	0	0[b]	N/A	0	0[b]	N/A	0
457	Baby Creek CSO	0	N/A	0	27.65	0.98	1,692	7.20	N/A	939
460	Tireman CSO	0[b]	N/A	0	0.44[b]	N/A	53	0[b]	N/A	0
461	W. Chicago-East	0[b]	N/A	0	0[b]	N/A	0	0[b]	N/A	0
462	W. Chicago-West	0[b]	N/A	0	0[b]	N/A	0	0[b]	N/A	0
463	Plymouth Road	0[b]	N/A	0	0.08[b]	N/A	0	0[b]	N/A	0
471	Puritan	0[b]	N/A	0	0.28[b]	N/A	0	0[b]	N/A	0
474	6-Mile (McNichols)	0.05[b]	2.80	9	3.28[b]	1.2	246	0.18[b]	N/A	23
476	7-Mile CSO, West	0[b]	N/A	0	0[b]	N/A	0	0[b]	N/A	0
477	7-Mile CSO, East	0[b]	N/A	0	0[b]	N/A	0	0[b]	N/A	0
478	Frisbee CSO	0[b]	N/A	0	0[b]	N/A	0	0[b]	N/A	0
479	Pembroke CSO	0[b]	N/A	0	0.35[b]	N/A	0	0[b]	N/A	0
482	Oakwood CSO	0.36	N/A	44	0.87	N/A	104	0	N/A	0
458	Hubbel-Southfield[c]	27.41	N/A	3,337	81.95	1.47	7,521	63.77	N/A	7,763
Subtotal		72.50		13,373	268.41		45,678	76.16		9,279
All other sources		8.70		1,604	32.20		5,479	9.14		1,113
Total		81.20		14,977	300.61		51,157	85.30		10,392

[a]Total phosphorous as mg/l P.

[b]Flow data incomplete; assumed 0 for days during event without flow data.

[c]Synthesized from events 9-26.

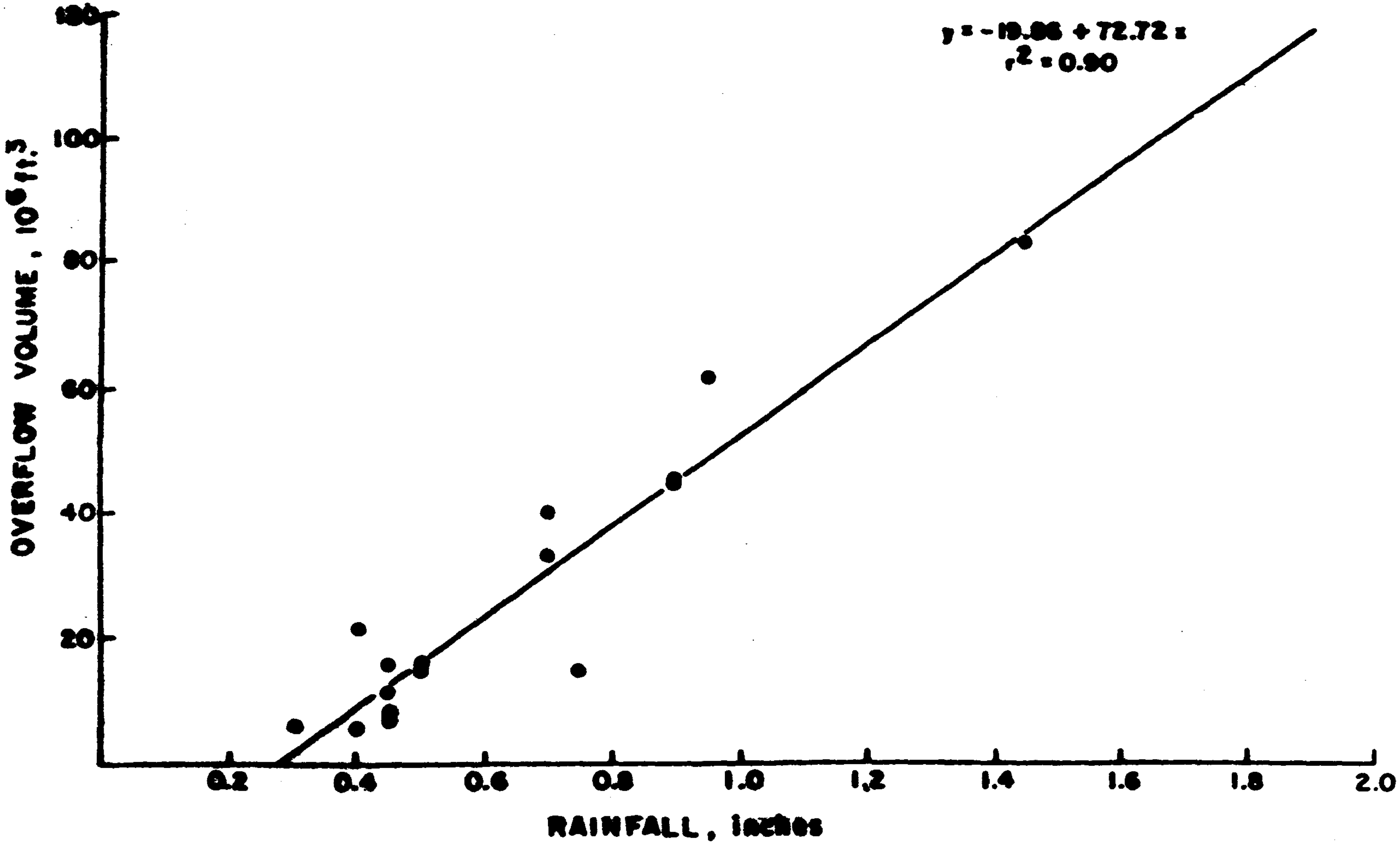


Figure 16-1. Hubbel-Southfield overflow volume versus rainfall.

TABLE 6-2. RAINFALL-FLOW DATA FOR HUBBEL-SOUTHFIELD[a,b] CSO--DETROIT, MI

Event No.	Date	Rainfall, inches	Volume, 10^6 ft^3
9	05/24/79	1.45	16.94[c]
10	06/10/79	0.45	8.06
11	06/18/79	0.45	11.31
12	06/29/79	0.90	45.53
13	07/04/79	0.40	5.52
14	07/09/79	1.50	143.62[c]
15	07/25/79	0.30	5.03
16	08/17/79	0.90	45.76
17	08/23/79	0.40	21.28
18	09/13/79	0.70	40.25
19	10/01/79	0.75	14.09
20	10/06/79	0.45	16.60
21	11/01/79	0.45	7.21
22	11/09/79	0.50	14.84
23	11/22/79	0.70	33.87
24	11/23/79	1.45	82.93
25	11/25/79	0.95	60.81
26	11/27/79	0.80	37.09

[a]Data are graphed in Figure 14-1.

[b]Overflow volume = -19.86 + 72.72 (rainfall).

[c]Data not used in correlation.

- Standard Methods for the Examination of Water and Wastewater. 14th Edition.

A summary of total phosphorous loadings for storm events in April 1979 along with pertinent flow and storm event data is given in Table 16-3. Event 4 produced by far the greatest total phosphorous load, releasing approximately 23.2 metric tons. The combined phosphorous load, resulting from the 5 events was 95,348 lbs (43.2 MT). This compares to a 1979 annual load of 353,100 lbs (160.5 MT) (March 29 through December 31).

DATA QUALITY

The following can be expected to introduce significant error to the estimate of phosphorous loadings:

- Analytical techniques. Based on average total phosphorous concentrations, reported in Reference 1, of between 1 and 4 mg/1, the relative standard deviation can be expected to fall between 11 and 15 percent.[a,3]

- Flow measurement technique. Depth of flow was calculated by vertical hydrostatic pressure. Accuracy was reported as ± 0.11 feet. Velocity was measured using a Marsh McBirneu Model 201 portable water current meter. Accuracy for this type of device can be expected to be in the range of ± 2 percent.[4]

- Sample compositing technique. As previously mentioned, analyses were run on time-weighted composites. This compositing procedure can be expected to introduce significant error.

- Quality calibration. The calibration of quality constituents focused on obtaining agreement between measured and modeled total pollutant loadings for all CSOs and at the wastewater treatment plant. Measured runoff quality data were adjusted to obtain a close agreement with treatment plant loading records and measured CSO quality and loading data. However, no verification of the calibrated model was conducted using an independent data set.[5] Based on the description of quality calibration presented in Reference 2 an error of 20% can be expected for the 95 percent confidence limit.

- Phosphorous load calculation method. Phosphorous loads in Table 2 were calculated using actual measured CSO phosphorous concentrations where possible. However, in many cases annual averages had to be used. Actual measured total phosphorous concentrations were found to vary by 3 to 86 percent. These differences can result in substantial error in calculating individual CSO and event loadings.

---

[a]Assuming the persulfate plus stannous chloride method was used.

TABLE 16-3. SUMMARY OF PHOSPHOROUS LOADING DATA--DETROIT, MI

Event No.	Dates of storm event	Rainfall, inches	Duration, days	Flow volume, 10^6 ft^3	Total Phosphorous load,[a] lbs (MT)
1	3/29/79 -3/30/79	0.80	2	81.54	11,169 (5.1)
2	3/30/79	0.25	1	34.12	7,654 (3.5)
3	4/01/79 -4/04/79	0.65	4	81.20	14,977 (6.8)
4	4/08/79 -4/11/79	1.40	3	300.61	51,157 (23.2)
5	4/11/79 -4/12/79	1.15	2	85.30	10,392 (4.7)
Total		4.25		582.77	95,348 (43.3)

[a]As molecular phosphorous, P.

Due to the number of potential sources of error, it is difficult to quantitatively assess the accuracy of phosphorous loading data provided herein. Based on statistical data provided in similar studies and engineering judgement, an accuracy estimate of ± 50 percent is reasonable at a 95 percent confidence limit. The total phosphorous load for the 5 events of interest can therefore be expected to fall between 21 and 65 metric tons (i.e. 43 tons ± 50 percent).

REFERENCES

1. Upmeyer, D. W., R. T. Kummler and G. T. Roginski. Impacts of Detroit's Combined Sewer Overflow Discharges on the Detroil River. In: Proceedings of the 54th Annual WPCF Conference. 1981.

2. Giffels/Black and Veatch. Quality and Quantity of Combined Sewer Overflows. CS-806 Final Facilities Plan Interim Report. Volumes I, II, and III. 1980.

3. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, AWWA, WPCF. 1981.

4. Digiano, F. A., D. D. Adrian and P. A. Mangarella. Applications of Stormwater Management Models. EPA-600/2-77-065. 1977.

5. Jewell, T. K., T. J. Nunno and D. D. Adrain. Methodology for Calibrating Stormwater Models. Journal of the Environmental Engineering Division, American Society of Civil Engineers. Volume 104, No. EE5. 1978.

CONTACTS

1. Mr. Pat Brunett, Southeast Michigan Council of Governments. (313) 961-4266.

2. Mr. Robert Buckley, U.S. EPA. (313) 226-7269.

3. Mr. Jerry Conkle, Black and Veatch Consulting Engineers. (313) 259-5300.

SECTION 17

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM SUBURBAN AREAS OF DETROIT, MICHIGAN

SUMMARY

This section addresses phosphorous loadings from CSOs located in areas adjacent to the City of Detroit. As shown in Figure 17-1, these areas are identified as Evergreen-Farmington, Fox Creek, Rouge Valley, Dearborn, Ecorse Creek, the South Macomb Sanitary District, and the Southeast Oakland County District. The total phosphorous loads for suburban Detroit area CSOs range from 37 lbs for Fox Creek to 26.8 metric tons for Ecorse Creek, as indicated in Table 17-1. The total annual phosphorous load from CSOs in these areas is 65.8 metric tons.

EVERGREEN-FARMINGTON

As shown in Figure 17-1 the study area is located in southern Oakland County and includes the communities of Orchard Lake Village, Keego Harbor, Bloomfield Hills, West Bloomfield, Bloomfield, Birmingham, Farmington Hills, Farmington, Beverly Hills, Lathrup Village and Southfield. Combined sewer service areas are located in Bloomfield Hills (220 acres), Bloomfield Township (1,623 acres), Birmingham (1,446 acres) and Beverly Hills (650 acres). The total combined sewer service area is 3,939 acres. The area contains 52 overflow points, all tributary to the Rouge River Basin.

In 1979 a facilities plan was prepared by Hubble, Roth and Clark, Inc.[1] In this study it was determined that in an average rainfall year (from April to October) under present conditions there will be 41 overflows per CSO, each overflow lasting an average of 189 hours. The total yearly flow (April through October) was found to be 609 million gallons. The annual BOD_5 and suspended solids loads were reported at 300,000 lb and 1,122,000 lb, respectively. Phosphorous concentrations and loadings were not provided. Assuming a typical average CSO total phosphorous concentration of 3.4 mg/l as P, the phosphorous load is estimated below for the period of April through October of an average rainfall year:

$$609 \text{ million gal} \times 3.4 \text{ mg/l} \times \frac{8.34 \text{ lb}}{(\text{million gal})(\text{mg/l})} = 17{,}287 \text{ lb (7.8 metric tons)}$$

Winter flows were not determined due to difficulties in assessing runoff from snow melt.

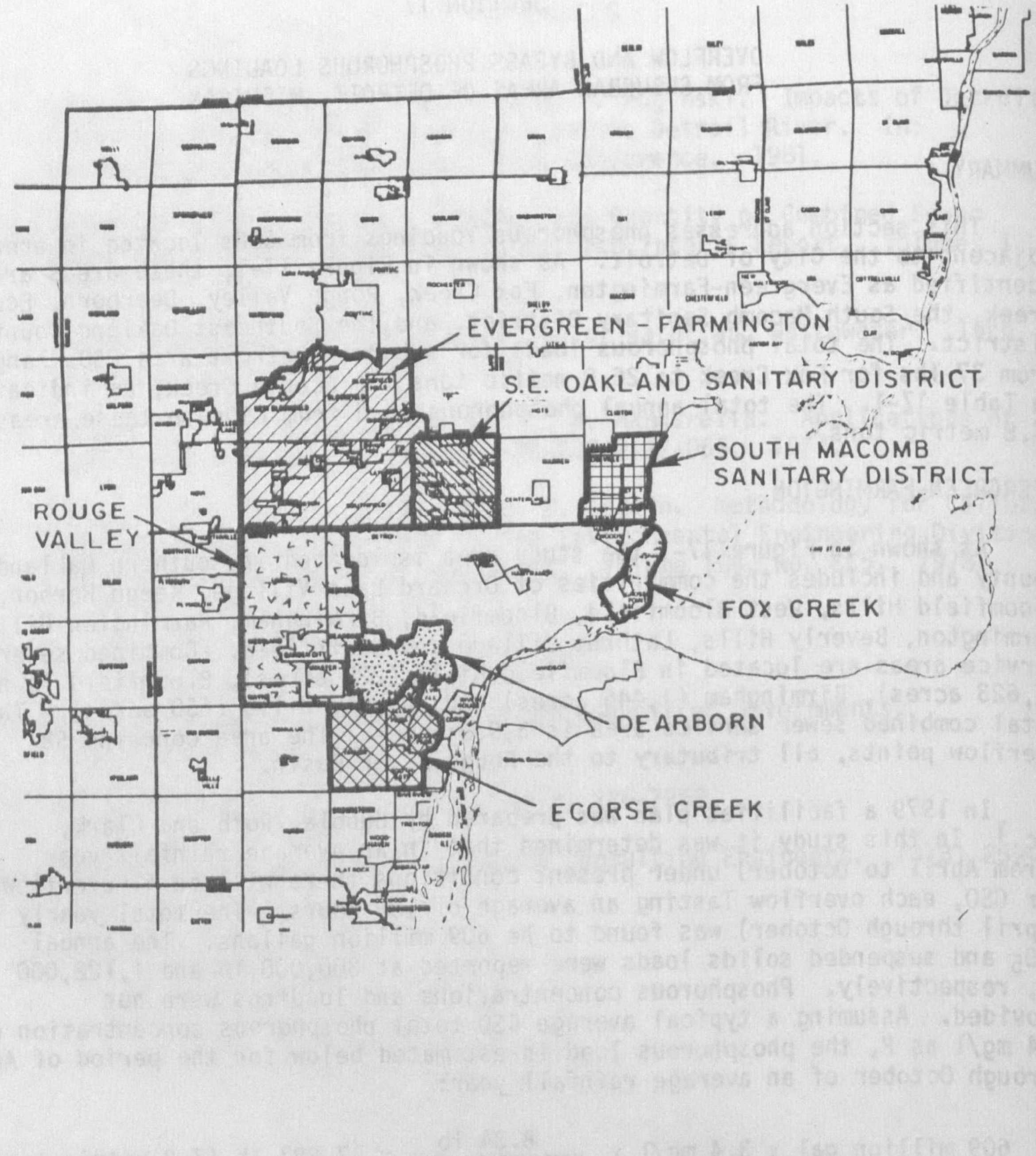


Figure 17-1. Suburban Detroit CSO study areas.

TABLE 17-1. SUMMARY OF ANNUAL CSO PHOSPHOROUS LOADINGS--DETROIT SUBURBS

Area	Total phosphorous as P, lb	(MT)
Evergreen-Farmington	17,287	(7.8)[a]
Fox Creek	968	(0.4)
Rouge Valley	35,200	(16.0)[a]
Dearborn	19,686	(9.0)
Ecorse Creek Basin	58,850	(26.8)
South Macomb Sanigary District	37	
Southeast Oakland County District	12,698	(5.8)
Total	144,726	(65.8)

[a]Based on April through October.

FOX CREEK

A Facility Plan for the Fox Creek area was completed in 1981 by Consulting Engineering Associates, Inc. The study area included the Village of Grosse Pointe and the Cities of Grosse Pointe, Grosse Pointe Farms and Grosse Pointe Park. The study area borders the western shore of Lake St. Clair in northeastern Wayne County and covers 4,475 acres.

Sewers in the Fox Creek study area are part of a large network of sewers in northeast Wayne and southwest Macomb Counties. Sanitary and combined sewers in this network drain to the Conner Creek District in Detroit. Combined sewer outfalls are located along Lake St. Clair and the Fox Creek. Combined sewage from this area also overflows at Conner Creek in Detroit. Phosphorous loads were calcualted using a desk top SWMM Model. These loads reflect population projections for the year 2000. The annual phosphorous load (presumably for an average rainfall year) is reported as 968 lb (0.44 metric tons) as P. The Conner Creek phosphorous load is quantified in Section 16 of this report.

ROUGE VALLEY

As shown in Figure 17-1, the Rouge Valley Planning Area is located in northwest Wayne County. The planning area covers approximately 95 square miles and includes Cities of Livonia, Garden City, Westland, Inkster, Redford Township and portions of the Cities of Dearborn Heights, and Romulus and Plymouth Township. Approximately 8,600 acres of the planning area are serviced by combined sewers (14 percent of the total area). The combined sewer area contains 63 overflow points which bypass flow to the Rouge River during periods of wet weather. Separate sewer systems located upstream of the CSO areas also contribute to wet weather overflow through inflow (defects, footing drains, etc.) and infiltration.

In June 1982 a Facility Planning Study was completed by Wade, Trim and Associates, Inc.[3] In this study it was concluded that CSO flows represent a large portion of the wet weather sewer flow. A Preliminary Sewer Overflow Model (PRE-SOM) was used to determine CSO flow rates and pollutant loadings. Model load calculations were based on mass balance, storage, conveyance and overflow. The model was also applied to various CSO control alternatives to assess pollutant load reductions.

Phosphorous loadings were calculated on the basis of an average rainfall year. By examining 30 years of precipitation data (1941-1970) the average year rainfall was determined to be 31.7 in. In an average year 905 million gallons of flow are discharged from CSOs to the Rouge River system. The average wet weather phosphorous concentration was found to be 4.3 mg/l[a] (as P) compared to 6.7 mg/l for dry weather flow. The annual total phosphorous load was given as 35,200 lb (16 metric tons).[3] Annual loads for other monitored pollutants are presented in Table 17-2 by stream branch.

---

[a]Post-ban concentration.

TABLE 17-2. ESTIMATED CSO VOLUME AND POLLUTANT LOADS--DETROIT SUBURBS

	Upper branch	Bell branch	Main rouge	Middle branch	Lower branch	System total
Volume of overflow MG	5	100	215	435	150	905
BOD_5, lb x 10^3	5	115	250	510	175	1,055
TKN, lb x 10^3	0.8	15	35	75	25	150.8
Fecal coliform organisms, mpn x 10^{18}	0.3	0.60	1.30	2.80	0.90	5.63
Total suspended solids, lb x 10^3	20	410	875	1,775	610	3,690
Volatile suspended solids, lb x 10^3	10	225	485	980	340	2,040
Lead, lb	10	190	410	835	290	1,735
Zinc, lb	25	450	970	1,960	675	4,055

DEARBORN

The City of Dearborn is located in the southeastern portion of the lower peninsula of Michagan, in approximately the center of Wayne County. Dearborn covers an area of 15,680 acres, approximately 13,642 acres (87 percent) of the total sewered area is serviced by combined sewers. The collection system is made up of 454.46 miles of sewer. Wet weather flow is bypassed at 21 CSOs located throughout the city.

A Facility Plan for the City of Dearborn was prepared by Hubble, Roth and Clark, Inc. in 1981.[4] Flow data reported in this study were determined using an analytical method detailed by C. K. Chen and W. W. Saxton in the WPCF Journal, March 1973. Rainfall records for the period 1969 through 1977, recorded at the Detroit Metropolitan Airport were used to establish the probable number of storms, total amount of rainfall, and average duration of each rainstorm to be expected in average yearly intervals. CSO flow was determined for the warm weather months only (April through October) because the model used is not applicable to runoff from snow melt. During the period of April through October of an average rainfall year the model predicts an overflow of 694.25 million gallons through CSOs. The Dearborn study did not provide data on phosphorous or other quality parameters. Assuming a typical post-ban CSO total phosphorous concentration of 3.4 mg/l as P the annual loading is estimated below for the period of April through October:

$$694.25 \text{ million gal/hr} \times 3.4 \text{ mg/l} \times \frac{83.4 \text{ lb}}{(\text{million gal})\ (\text{mg/l})} =$$

$$19{,}686 \text{ lb/hr } (9.0 \text{ metric tons})$$

ECORSE CREEK BASIN

The Ecorse Creek Basin contains 12,201 acres of land falling within Allen Park, Lincoln Park, Ecorse, Taylor and Southgate. Combined sewers are located primarily within Allen Park. The majority of combined sewage discharge occurs through a single outfall to Ecorse Creek. Many of the dwelling units in the basin have footing drains connected to the sewer system, thus contributing to the wet weather flow.

In 1973 Wade, Trim and Associates, Inc., in conjunction with Pate, Hirn and Bogue, Inc. and L. N. Hayden, Inc. prepared a facility planning study for the Ecorse Creek Basin.[5] In this study, flow and quality data were collected at three outfalls identified as Cleveland Ave., LeBlanc Drain, and King Ave. Based on data from three storm events the average rainfall was determined to be 0.65 in., with an average intensity of 0.04 in. per hour. Rainfall data was obtained from the U.S. Weather Services Office at the Detroit Metropolitan Airport. The study also reported that during an average year rainfall there will be an overflow equivalent of 50 to 60 average events. Following completion of the 1973 study, separation projects have eliminated the majority of overflow contributions from Lincoln Park and Taylor.

From data obtained during three monitored events, the average event overflow from the LeBlanc drain was found to be 100 MG. Assuming 55 such events will occur annually, the yearly CSO flow can be roughly calculated to be 5,500 MG. This flow is extremely large considering the size of the drainage area. The large flow may be due, in part, to the basin being located in a zone of relatively high rainfall.[6] Footing drains and downspouts also contribute to the excessive flow. The current annual flow may be somewhat lower due to recent separation projects in communities surrounding Allen Park.[7,8]

During the 1973 study only Biochemical Oxygen Demand (BOD) and Suspended Solids (SS) were monitored. For an average rainfall year the Allen Park BOD and SS loads were found to be 1.8 and 5.5 million pounds per year, respectively. Although phosphorous was not monitored, the total phosphorous load can be roughly approximated as a function of the SS load. Under post-ban conditions, the ratio of total phosphorous to SS averages approximately 0.0107, leading to the following calculation:

$$5{,}500{,}000\ \frac{\text{lbs}}{\text{yr}}\ \text{SS} \times 0.0107\ \frac{\text{lb P}}{\text{lb SS}} = 58{,}850\ \text{lbs (26.8 MT)}$$

This loading corresponds to an average phosphorous concentration of 1.3 mg/l. This concentration is not unreasonably low due to the high potential for dilution resulting from the relatively high ratio of stormwater to domestic wastewater.

SOUTH MACOMB SANITARY DISTRICT

The South Macomb Sanitary District (SMSD) includes the communities of St. Clair Shores, East Detroit, and Roseville. The sewer system consists of both combined and separate sewers. The area contains a total of four major sewers, identified as the Martin Drain, the Nine Mile Drain, the Eight and One-Half Mile Drain and the Jefferson Interceptor. Overflow from the SMSD enters one of two retention facilities known as the Chapaton Basin and the Martin Basin. When storage capacities are exceeded the combined sewage spills to Lake St. Clair.

In a phone conversation with Mr. Ken Cloft of the SMSD it was learned that over a 6-year period the Chapaton Basin has overflowed an average of 244 hours during 11 storm events. Overflow is recorded as anything from a trickle up to the basin's maximum capacity of 1,500 CFS.[9] The Chapaton Basin also has a bypass with a capacity of 400 CFS. However, this bypass has not been used in over a year. Six years of recorded data indicate that the Martin Basin has an average annual operation of 225 hours during 12 events. Maximum flow at the Martin Basin is 400 CFS. Both the Chapaton and Martin Basins are used for suspended solids removal, reportedly achieving reductions of up to 80 percent. However, removal efficiency may decrease sharply with increasing flow.

Daily maximum flow rates and average phosphorous concentrations, obtained from NPDES Permit Files,[10] were used to calculate phosphorous loads. Reported average flow rates were reported as 0.17 MGD for the Chapaton Basin and 0.23 MGD for the Martin Basin. Total phosphorous concentrations were reported as 0.7 mg/l and 1.50 mg/l for the Chapton Basin and Martin Basin, respectively. The following equations were used to calculate the average annual total phosphorous load:

- Chapaton Basin--

  0.17 MGD x 10.2 d/yr x 0.7 mg/l x 8.34 lb/(mg/l)(MG) = 10.1 lb/yr

- Martin Basin--

  0.34 MGD x 9.375 d/yr x 1.508 mg/l = 27.1 lb/yr

Summing the two values, the annual load of total phosphorous from overflows within SMSD for an average year is found to be 37.2 lb/yr. According to one SMSD source,[9] the Martin basin does, at times, discharge at flow rates up to the 1500 cfs capacity. Under such conditions, a much higher annual phosphorous load is likely. However, flow volumes are not recorded and higher loadings cannot be verified. The above loading should therefore be treated as a very rough approximation.

SOUTHEAST OAKLAND COUNTY DISTRICT

The Southeast Oakland County District includes the communities of Hazel Park, Pleasant Ridge, Royal Oak Township, Berkley, Clawson, Ferndale, Huntington Woods, Madison Woods, Oak Park and parts of Beverly Hills, Birmingham, Southfield and Troy. The sewer system consists of both separate and combined sewers. The Twelve Towns Drain is utilized as a wet weather storage facility. When the storage capacity is exceeded, overflow is channeled to the Red Run Drain. Data on Red Run Drain overflows were obtained from Michigan DNR NPDES permit application files. The average annual overflow was found to be 435 MG. Because phosphorous is not a monitored discharge parameter, a typical phosphorous concentration of 3.5 mg/l (as P) was assumed. Applying this concentration to the yearly flow (435 MG), the annual phosphorous load is estimated to be 12,698 lbs (5.8 MT).

REFERENCES

1. Evergreen-Farmington Pollution Control Facilities. Volume 2--Pollution Control for Combined Sewer Overflows. Hubble, Roth and Clark, Inc. October 1979.

2. Fox Creek Facilities Plan. EPA Project C-262601-01. Consulting Engineering Associates, Inc., June 1981.

3. Rouge Valley Multimunicipal Facility Planning Study. Wayne County, Michigan, Draft Report. EPA C-262762-01. June 1982.

4. City of Dearborn, Michigan Facility Plan. Hubble, Roth and Clark, Inc., February 1981.

5. Facilities Planning Study Pollution Abatement of Ecorse Creek. Wade, Trim and Associates, Inc., Pate, Hirn and Bogue, Inc. and L. N. Hayden, Inc. 1975.

6. Precipitation in Southeast Michigan. Southeast Michigan Council of Governments. March 1976.

7. Telecon. Mr. Joseph Goetz, Wayne County Drain Commission, Detroit, Michigan (313) 224-5600 and Mr. John Patinskas, GCA/Technology Division. January 10, 1983.

8. Telecon. Mr. Doug Watson, Wade, Trim and Associates (313) 291-5400 and Mr. John Patinskas, GCA/Technology Division. January 10, 1983.

9. Telecon. Mr. Ken Cloft, South Macomb Sanitary District, Michigan, (313) 772-3425 and Mr. John Patinskas, GCA/Technology Division. September 16, 1982.

10. NPDES Permit No. MI0025453. South Macomb Sanitary District.

CONTACTS

1. Mr. Ken Cloft, South Macomb Sanitary District. (313) 772-3425.

2. Mr. Joseph Goetz, Wayne County Drain Commission. (313) 224-5600.

3. Mr. William Shaw, Michigan DNR. (517) 373-6473.

4. Mr. Tom Snyder, Southeast Oakland County Sanitary District. (313) 858-0968.

5. Mr. David Waring, Hubble, Roth, and Clark. (313) 338-9241.

6. Mr. Doug Watson, Wade, Trim and Associates. (313) 291-5400.

SECTION 18

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF MONROE, MICHIGAN

BACKGROUND

The City of Monroe, Michigan is located on the River Raisin on the western shore of Lake Erie. Sewage is transported to the Monroe Metropolitan Area Wastewater Treatment Plant through four interceptors. The interceptors collect flow from the City of Monroe, Frenchtown Township, and Monroe Township.

The sewered area, which contains approximately 183 miles of sewer line, was not designed to be combined. However, sixteen catch basins are known to discharge to the sanitary sewerage system during storms or periods of thawing. Plans for the separation of these catch basins from the sanitary sewer have been approved by the Michigan Department of Natural Resources. Separation of the catch basins may begin as early as Spring 1983. The sanitary sewer also carries inflow from footing drains. In addition, during periods when the River Raisin floods its banks, river water may enter the sewer system through basement drains.

When flows exceed interceptor capacity, flows from two portions of the sewered area are diverted to two industrial sewers. The industrial sewers bypass primary treatment at the wastewater treatment plant, entering directly into secondary treatment. In addition, an overflow/bypass structure located at the confluence of the North interceptor and South interceptor discharges excessive interceptor flow to the River Raisin. This overflow bypass structure initially discharges excess wet weather flows in the interceptor by gravity overflow. When overflow by gravity is slowed or prevented by high river levels, four pumps in the structure, each with a capacity of 5 MGD, discharge sewage to the river. The structure discharges to the river 30 to 40 times per year. The interceptor system and the location of the overflow/bypass structure are shown in Figure 18-1.

COMBINED SEWER OVERFLOW VOLUMES

The overflow and bypass volumes were estimated for 1973. During that year the overflow/bypass structure overflowed 30 times, discharging an estimated volume of 122 million gallons to the river.

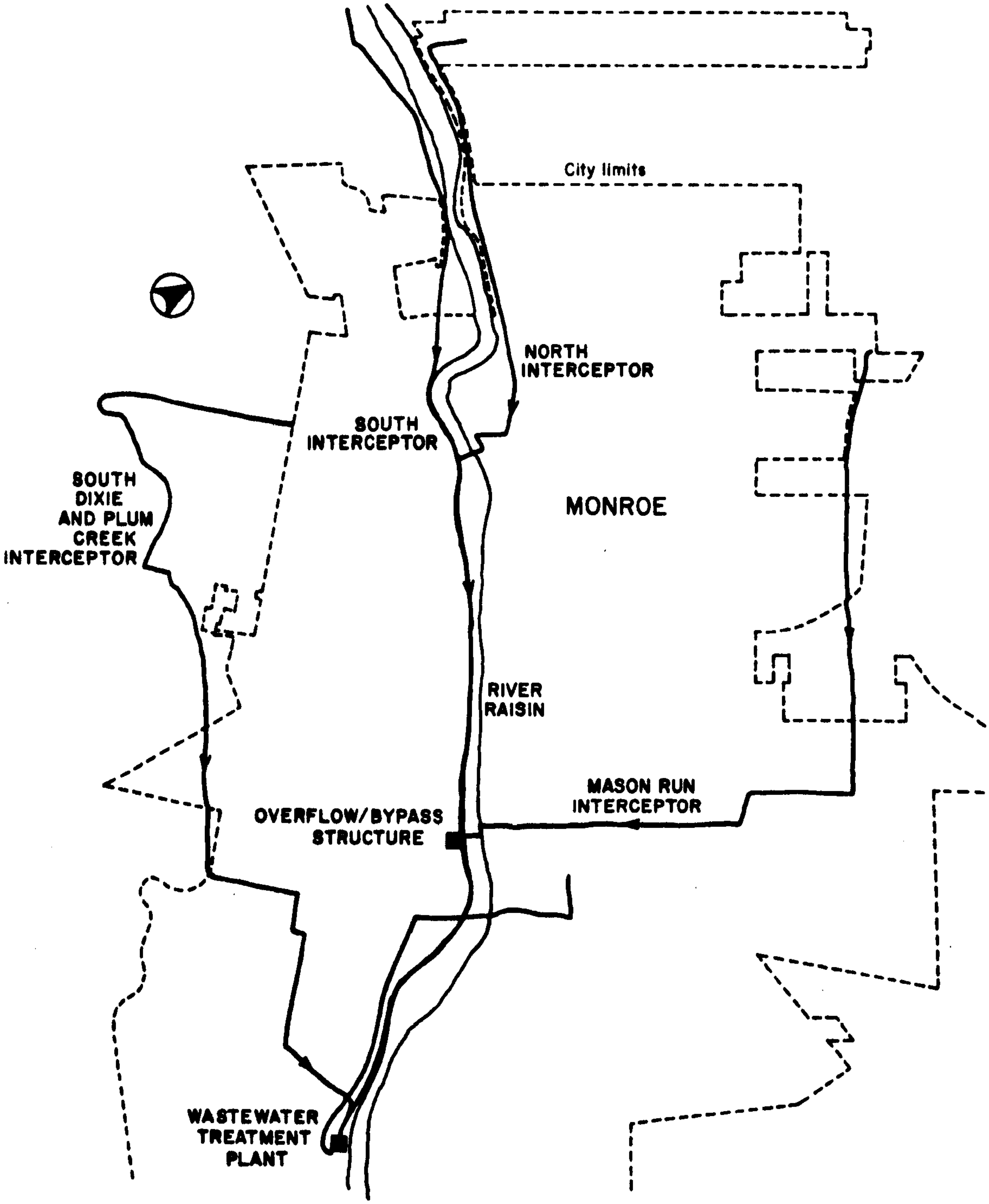


Figure 18-1. Wastewater interceptor system--Monroe, MI.

TOTAL PHOSPHOROUS LOADINGS

The overflow from the sewer system contributes an estimated 2,035 lbs (0.9 MT) of phosphorous to the River Raisin per year based on an estimated post-ban total phosphorous concentration of 2.0 mg/l as P. This was derived from the concentration of phophorous in samples taken during wet weather following primary treatment at the wastewater treatment plant.

DATA ON OTHER POLLUTANTS

Sewer overflows discharge approximately 85,000 pounds of BOD, and 183,000 pounds of suspended solids to the Raisin River during an average rainfall year.

DATA QUALITY

The volume listed in the engineering reports for each overflow occurrence was estimated, while the volumes of the four pump bypass occurrences were calculated. The method used to estimate overflow volumes is not known. The concentrations of phosphorous, BOD, and suspended solids were measured after primary treatment during wet weather flow conditions. The concentration of these pollutants before primary treatment were estimated by assuming removal efficiencies found in the literature.

REFERENCES

1. Infiltration/Inflow Analysis for the Sewer System Tributary to the Monroe Metropolitan Wastewater Treatment Plant. Consoer, Townsend & Associates in Michigan. Flint, Michigan. November 1974.

2. Interim Report on Sewer System Evaluation Survey for the Sanitary Sewer Conveyance System of the Monroe Metropolitan Wastewater Treatment Plant. Consoer, Townsend & Associates in Michigan. Flint, Michigan. November 1976.

3. Telecon. Mr. Donald Link, Director of Engineering, City of Monroe (313) 243-0700 and Mr. Samuel Duletsky, GCA Corporation, Chapel Hill, North Carolina. September 14, 1982.

CONTACTS

1. Mr. Pat Brunett, Southeast Michigan Council of Governments. (313) 961-4266.

2. Mr. Donald Link, Director of Engineering, City of Monroe. (313) 243-0700.

3. Mr. Terry Walkington, Michigan DNR. (517) 373-6473.

SECTION 19

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF TOLEDO, OHIO

BACKGROUND

The City of Toledo, Ohio is located on the most westerly shore of Lake Erie. The wastewater collection system covers an area of 77,300 acres and includes the incorporated area of the City of Toledo and the neighboring communities of Rossford, Walbridge, and Ottawa Hills and portions of Northwood, Wood County, and Lucas County. The City of Toledo encompasses approximately 54,600 acres and serves about 100,000 users. Combined sewers drain runoff from almost 12,000 acres of urban land within the City of Toledo.

The collection system dates back to the 1800's when storm sewers were first installed. These became combined sewers as water service was expanded and indoor plumbing became the norm. During the 1920's the city began installing a system of interceptor sewers parallel to the major rivers and constructed a wastewater treatment plant. Since 1920, all new sewers have been separated, i.e., storm sewers for strictly storm water, and sanitary sewers for sanitary wastewater. No new interceptors were built after that time.

The existing combined sewers overflow into the Maumee, Swan, and Ottawa Rivers. The combined sewers are connected to the interceptor sewers with semi-automatic regulators. These regulators consist of large chambers with float activated gates. When the gates are open, flow from the combined sewers enter the interceptor. When the combined sewer flow level increases, the float causes the gate to close, allowing the combined sewer flow to enter the rivers over a weir or small dam. Two types of combined sewer overflows occur in this system. The above description discusses the normal overflows. Abnormal overflows occur when the gates become stuck during relatively dry weather and allow raw sanitary wastewater to flow into the rivers. Other abnormal overflows occur when the river water level gets high enough to allow river water into the interceptor sewer. This is most common during periods of relatively high northeast winds which cause Lake Erie to back up into the rivers.

There are 35 regulators in the City of Toledo, as indicated in Figure 19-1. Thirty four of these regulators are semi-automatic and one is a static regulator (Regulator No. 50). Table 19-1 presents the drainage area and location of the thirty-five regulators. The data provided in Table 19-1 were obtained from Reference 1. The purpose of the referenced report was to determine the extent of pollution in the rivers from the combined sewered

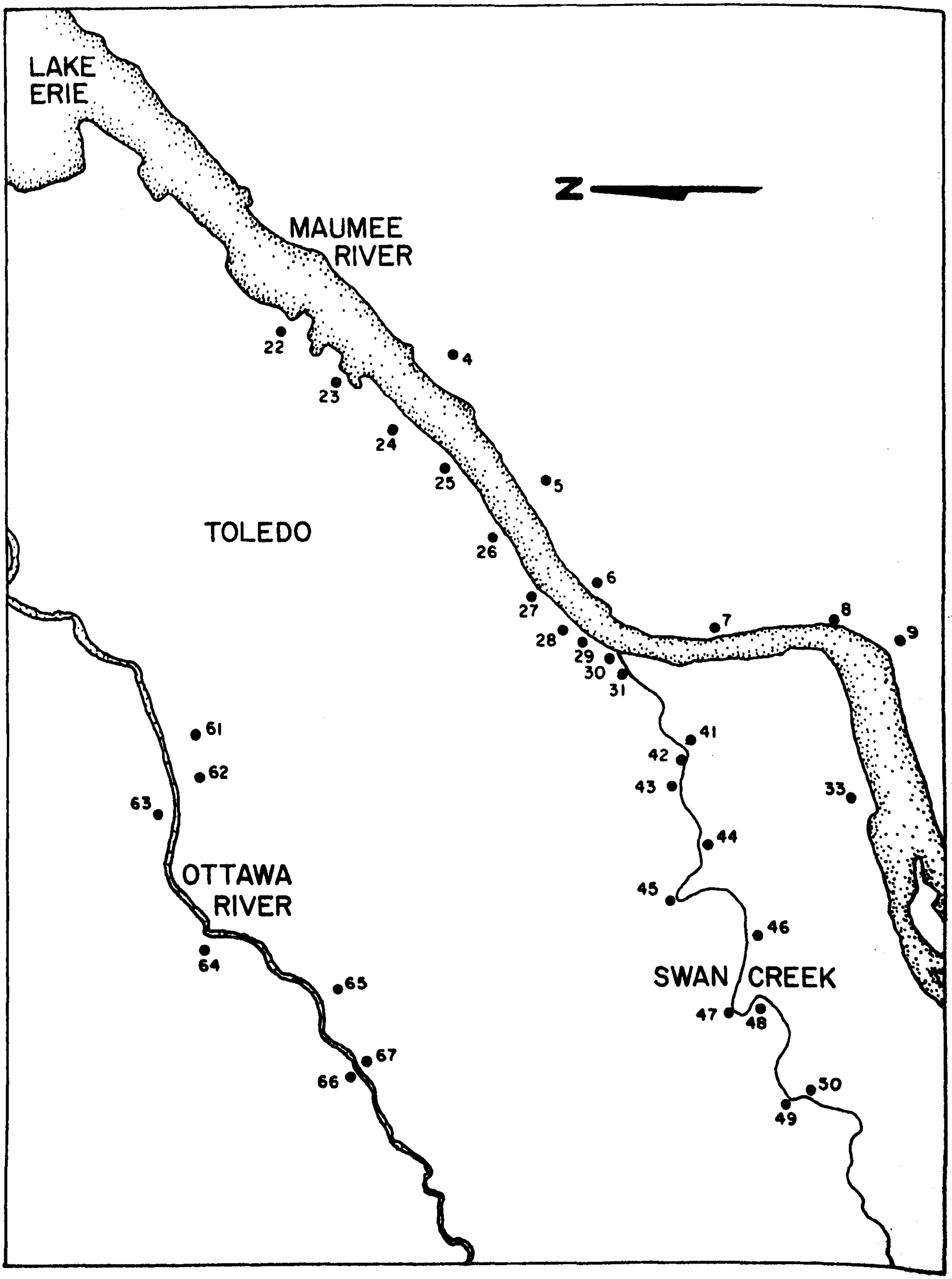


Figure 19-1. Combined sewer overflow locations--Toledo, OH.

TABLE 19-1. COMBINED SEWER OVERFLOW REGULATORS--TOLEDO, OH

Regulator		Location	Drainage area		Receiving stream
Number	Name		Sanitary, acres	Storm, acres	
4	Paine	Paine Ave. & Front St.	380.2	296.0	Maumee River
5	Dearborn	Dearborn Ave. & Front St.	523.7	352.0	Maumee River
6	Main	Main St. at Sports Arena	207.8	174.7	Maumee River
7	Nevada	Nevada & Miami St.	581.6	608.0	Maumee River
8	Fassett	Fassett St. & Miami St.	116.9	104.6	Maumee River
9	Oakdale	Oakdale Ave. & Miami St.	638.2	467.1	Maumee River
22	New York	New York & Summit St.	116.8	44.9	Maumee River
23	Columbus	Columbus St. & Summitt St.	675.9	204.9	Maumee River
24	Galena	Galena St. & Summit St.	27.6	27.5	Maumee River
25	Ash	Ash St., Summit St. & I-280	75.7	101.9	Maumee River
26	Magnolia	Magnolia St. & Summit St.	143.3	121.2	Maumee River
27	Locust	Locust St. Below Summit St.	141.2	111.5	Maumee River
28	Jackson	Jackson Below Summit St.	630.2[a] (28 and 29 combined)	630.2 (28 and 29 combined)	Maumee River
29	Adams	Adams Below Summit St.			Maumee River
30	Jefferson	Jefferson Below Summit St.	435.9[a] (30 and 31 combined)	440.3 (30 and 31 combined)	Maumee River
31	Bostwick	Monroe St. Below Summit St.			Maumee River
32	Williams	Ottawa St. NE of Williams St.	70.3	59.9	Maumee River
33	Maumee	Maumee Ave. & Orchard St.	345.5	343.6	Maumee River
41	Knapp	St. Clair, S of Williams St.	77.3	57.8	Swan Creek
42	Erie	Erie St., S of Hamilton	40.2	37.5	Swan Creek
43	Hamilton	Hamilton & Anthony Wayne Trail	292.7	349.8	Swan Creek
44	City Park	City Park, S of Bridge	37.9	22.2	Swan Creek
45	Ewing	Ewing St. & Hamilton	261.9	220.2	Swan Creek
46	Hawley	Hawley St., S of Bridge	508.3	470.9	Swan Creek
47	Junction	Pere West, E of Gibbons St.	867.4	841.3	Swan Creek
48	Hillside	Hillside & Chester St.	190.5	49.3	Swan Creek
49	Woodsdale	Woodsdale & South St.	547.3	17.9	Swan Creek
50	Highland	Fearing St. in Highland Park	230.6	209.3	Swan Creek

(continued)

TABLE 19-1 (continued)

Regulator Number	Regulator Name	Location	Drainage area: Sanitary, acres	Drainage area: Storm, acres	Receiving stream
61	Lagrange	Lagrange St. & Manhattan Blvd.	555.2	167.1	Ottawa River
62	Windemere	Windemere & Manhattan Blvd.	958.3	865.6	Ottawa River
63	DeVilbiss[b]	Detroit Ave. & Phillips Ave.	933.7[a]	921.4	Ottawa River
64	Lockwood	Lockwood Ave. & I-75			Ottawa River
65	Ayers	Ayers Ave. & S. Cove Blvd.	283.5	213.4	Ottawa River
66	Monroe 2[b]	Monroe St., W of Bridge	3,763.0	0.0	Ottawa River
67	Monroe 1	Monroe St., E of Bridge	980.8	310.2	Ottawa River
Total 35			15,639.4	8,842.2	

[a]Collection system with two regulators interconnected.

[b]Sanitary flow only to these regulators.

areas and develop alternatives to alleviate the problem. Existing pollution sources including urban and rural runoff, industrial discharges, and other point and nonpoint sources, were also examined.

COMBINED SEWER OVERFLOW VOLUMES

Reference 1, which supplied the majority of information for this report, does not specify the frequency of combined sewer overflows. However, some data are presented on the amount and patterns of rainfall for the Toledo area and overflow volumes in units of gallons/acre/inch of rain. None of these data are related to any units of time. Consequently, the frequencies and volumes of combined sewer overflows could not be quantified. The calculation of such data may be misleading because about half of the combined sewer pollution is the result of abnormal overflows. These occur most frequently during high lake level periods.

TOTAL PHOSPHOROUS LOADINGS

Information in Reference 1 estimates that the average CSO phosphorous loading to the Maumeee River is 210 lbs/day phosphorous (as P). This approximation was developed from phosphorous concentration and selected CSO flowrate data. The phosphorous basin load, computed by dividing the total load by the Maumee Run stormsewer drainage area, is 0.0514 lbs P/acre-day.

Very little data exist to quantify phosphorous loadings to either the Swan Creek or Ottawa River. Thus, the following estimate applies the phosphorous basin loading from the Maumee Run basin to the remaining drainage basins, based on storm sewer area. Table 19-2 presents the resulting area weighted phosphorous loading estimates.

The results given in Table 19-2 yield an average phosphorous load of 456 lbs/day to Lake Erie. The annual phosphorous load would be 166,440 lbs/yr (75.7 MT/yr) based on a 12-month year. Actual loadings may be slightly less due to reduced winter overflow volumes.

DATA ON OTHER POLLUTANTS

Most of the available data is the result of stream sampling, rather than combined sewer overflow sampling. However, BOD_5 loadings for combined sewer overflows were reported as 350,000 lbs/year to the Ottawa River, 307,000 lbs/year to the Swan Creek, and 498,000 lbs/year to the Maumee River. In addition, the suspended solids loadings to the Maumee River were reported as 3,650,000 lbs/year.

DATA QUALITY

The pollutant loading estimates presented in this report are the result of a minimum number of measurements and a few assumptions. The phosphorous loads to the rivers from combined sewer overflows are reportedly the result of concentration and flow rate measurements. However, the only available published phosphorous data are the loads to the Maumee River. The BOD_5 and suspended solids data are also only reported as loads to the receiving

TABLE 19-2. PHOSPHOROUS LOADINGS FROM CSOs--TOLEDO, OH

River	Number of regulators	Combined sewer drainage areas, acres			Phosphorous[b] load, lb/day (as P)[a]
		Sanitary	Storm	Total	
Maumee Run	18	5,110.8	4,088.3	9,199.1	210
Swan Creek	10	3,054.1	2,276.2	5,330.3	118
Ottawa River	7	7,474.5	2,477.7	9.952.2	128
Total	35	15,639	8,842.2	24,481.6	456

[b]Phosphorous load based on storm sewer area-weighted loading, assuming a phosphorous load of 0.0514 lbs P/acre-day.

streams. The majority of pollutant data is the result of river sampling, not source sampling and a substantial quantity of the measured pollution is inherited from upstream of the greater metropolitan Toledo area. Consequently, the Toledo pollution loading estimates are subject to measurement variation of high strength upstream loads. Thus, these estimates represent an order-of-magnitude estimate of loadings from the Toledo area.

REFERENCES

1. Jones & Henry Engineers, Limited. City of Toledo, Ohio. Combined Sewer Overflow Study. January 1978.

2. Jones & Henry Engineers, Limited. City of Toledo, Ohio. Areawide Facilities Plan General Summary. October 1978.

CONTACTS

1. Mr. Ed Hammet, Toledo Metropolitan Area Council. (419) 241-9155.

2. MR. Thomas J. Kovacik, Director, City of Toledo Environmental Services Agency. (419) 247-6524.

3. Mr. John Sadzewicz, Ohio EPA. (614) 466-8945.

4. Mr. Steve Wortleman, Jones and Henry Engineers. (419) 473-9611.

SECTION 20

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF OREGON, OHIO

As a first step in assessing phosphorous loadings from overflows and bypasses in Oregon, Ohio, GCA contacted state and city officials.[1,2] It was learned that Oregon's sewer system was reconstructed five years ago and no longer has overflows and bypasses. Consequently, no further investigation was pursued.

REFERENCES

1. Telecon. Mr. John Sadzewicz, Ohio Environmental Protection Agency (614) 462-6304 and Mr. John Patinskas, GCA/Technology Division. May 3, 1982.

2. Telecon. Mr. Donald Surface, Service Director, City of Oregon, Ohio (419) 698-7049 and Mr. John Patinskas, GCA/Technology Division. June 8, 1982.

CONTACTS

1. Mr. Ed Hammet, Toledo Metropolitan Area Council. (419) 241-9155.

2. Mr. John Sadzewicz, Ohio EPA. (614) 462-6304.

3. Mr. Donald Surface, Service Director, City of Oregon, Ohio. (419) 698-7049.

SECTION 21

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITIES OF LORAIN AND ELYRIA, OHIO

BACKGROUND

The Cities of Lorain and Elyria are neighboring communities in north central Ohio. In telephone conversations with Lorain's City Engineer[1] and Department of Utilities personnel,[2] it was confirmed that Lorain has no CSOs. The treatment plant is equipped with a bypass located between primary and secondary treatment operations. Data on the operation of this bypass could not be obtained. The City of Lorain also has four pump station bypasses. However, these are operated only during power failures. Bypass flow volumes could not be determined. Since Lorain has no CSOs and since no data is provided on bypass flows and loadings, the remainder of this section addresses phosphorous loadings from Elyria.

Elyria's combined sewer service area (CSSA) is relatively small, serving an area of approximately 271 acres. The CSSA dates back to the early 1900's and was constructed in the section of the City between East and West branches of the Black River, immediately south of their confluence. The CSSA, shown in Figure 21-1, contains 33 overflow locations. Data on the trunk sewer size, weir length, weir height and area served by each CSO are provided in Table 21-1.

The Elyria CSSA contains two types of regulator devices. One is a low height broad crested weir placed at an angle to the flow to divert dry weather flows to the sanitary sewer and allow excess wet weather flow to be discharged directly to the storm sewers. The second type is a diversion structure made by placing a tee-section in the invert of the trunk sewer allowing the dry weather flow to drop through to the sanitary sewer. During wet weather, not all flow is able to pass through the drophole and therefore some flows are routed to the storm sewer. Due to the small size of the trunk and intercepting sewers, malfunction due to clogging can result in overflows during dry weather.

COMBINED SEWER OVERFLOW VOLUMES

Limited data on overflow volumes were obtained from Reference 3. In this study, flow monitors were set up at seven overflow locations. In total, these monitored CSOs service approximately 137.4 acres or 50.7 percent of the CSSA. These CSOs were chosen based on their representativeness of the land use distribution. Field measurements were conducted during two storm events.

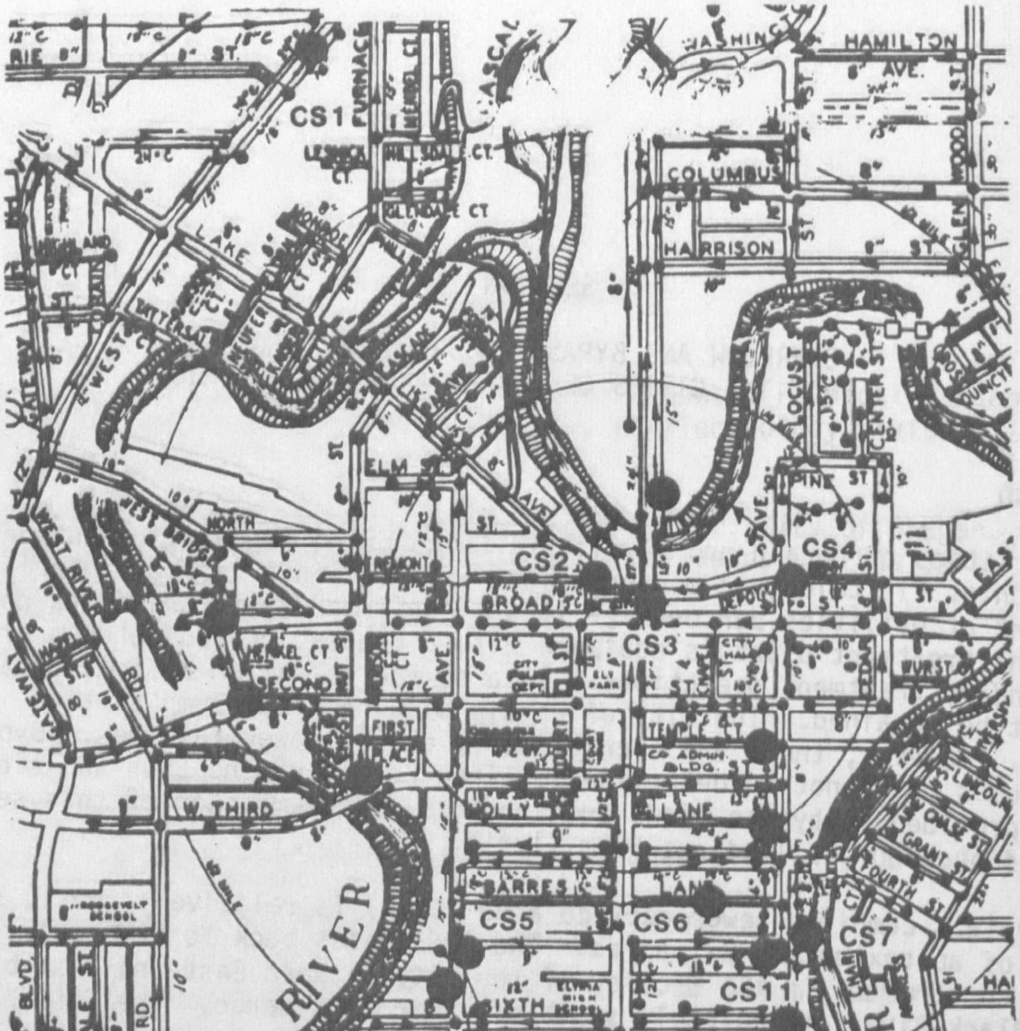


Figure 21-1. Combined sewer overflow locations[a]--Elyria, OH.

[a]An additional six CSOs are located beyond map boundaries.

TABLE 21-1. COMBINED SEWER OVERFLOW LOCATIONS--ELYRIA, OH

CSO No.	Location	Trunk Sewer Diameter, inches	Weir Length, Ft.	Weir Height, Ft.	Tributary area, acres
102	Columbus Ave. @ St. Clair St.	10	1.08	0.21	10
103	Washington Ave. north of bridge	15	1.67	0.86	(1)
104	Washington Ave. @ Depot St.	24	Drop branch = 1.00		13
105	Twelfth St. near Middle Ave.	12	3.00	0.85	3
107	Middle @ 12th	12	3.00	0.85	(4)
120	Dewey Ave. @ Lorain Blvd.	12	3.83	0.42	5
121	Bond St. @ Jefferson St. Alley	24	--	--	2
130	Furnace St. @ Florence Ct.	24	Drop branch = 1.00		55
132	Cascade St. @ Lake Ave.	12	--	--	(2)
133	Lake Ave. @ Tremont St.	24	3.17	0.38	13
142	Fourth St. @ West Ave.	12	3.00	0.42	8
144	West Ave. @ Fifth St.	15	Broken drop branch		(3)
145	West Ave. @ Elyria H.S.	15	Drop branch = 0.50		7
146	West Ave. @ Ninth St.	25x22	2.00	0.67	20
150	East Ave. @ Fourth St.	15	2.50	1.00	(2)

(continued)

TABLE 21-1 (continued)

CSO No.	Location	Trunk Sewer Diameter, inches	Weir Length, Ft.	Weir Height, Ft.	Tributary area, acres
152	Fifth St. @ East Ave.	18	1.30	0.19	6
153	Sixth St. @ East Ave.	12	1.25	0.33	7
155	Seventh St. @ East Ave.	12	1.00	0.33	6
156	Eighth St. @ East Ave.	18	1.50	0.35	7
158	Ninth St. @ East Ave.	12	1.33	0.20	6
159	Gates Ave. @ East Ave.	10	1.33	0.23	7
160	Howe St. @ East Ave.	10	1.00	0.35	6
161	George St. @ East Ave.	15	1.83	0.29	4
162	Wooster St. (middle)	10	2.00	0.57	4
163	Wooster St. @ East Ave.	8	4.00	0.50	3
164	1241 East Ave.	24	2.29	0.80	24
170	East Ave. @ Depot St.	18	Drop Branch = 1.00		19
171	Temple Ct. @ East Ave.	10	1.25	0.20	2
172	Holly Lane @ East Ave.	10	1.00	0.20	2
180	Third St. @ Chestnut St.	10	1.50	0.42	4

(continued)

TABLE 21-1 (continued)

CSO No.	Location	Trunk Sewer Diameter, inches	Weir Length, Ft.	Weir Height, Ft.	Tributary area, acres
181	Second St. @ Water	18	3.67	0.92	18
182	Broad St. @ Water St.	12,18	2.50	0.35	7
191	Buckeye St. @ East Branch St.	12	Drop Branch = 0.50		4

(1)Collects flow from CSO 104 & 170

(2)Should be separate sewers

(3)Collects flow from CSO 142

(4)Collects flow from CSO 105

From these data it was determined that a 0.45 in. storm will produce 470,972 gallons of overflow and a 0.58 in. storm results in 571,884 gallons of overflow from the monitored CSOs. Assuming a linear relationship between rainfall and overflow, a one-inch storm should produce approximately 1,016,000 gallons of overflow from the monitored CSOs. Assuming the overflow volume is directly proportional to the area served by combined sewers, the total CSSA overflow volume from a 1 in. rainfall is roughly estimated:

$$\frac{1,016,000 \text{ gallons}}{0.507} = 2,004,000 \text{ gallons}$$

Based on a mean annual precipitation of 33.73 inches, the annual overflow volume is estimated as:

$$\frac{2,004,000 \text{ gallons}}{\text{inch}} \times 33.73 \text{ inches} = 67.6 \text{ million gallons}$$

TOTAL PHOSPHOROUS LOADINGS

The overflow phosphorous concentration was assumed to equal 5.4 mg/l, the average measured in selected U.S. cities which do not have a detergent phosphorous ban.[4] This concentration was then multiplied by Elyria's average annual CSO overflow volume to yield the average annual phosphorous load. The average rainfall year total phosphorous load was found to be 3,045 pounds (1.4 MT) as P. Noting the extremely rough method of calculation, this value provides an order of magnitude estimate at best.

DATA ON OTHER POLLUTANTS

The available literature does not provide annual loadings on any pollutants. However, Reference 3 does provide some limited loading data on BOD_5, COD, SS and fecal coliforms for some selected storm events on pages III-3 through III-5.

DATA QUALITY

Annual phosphorous loadings contained in this report are based on flow monitoring data for two rainfall events obtained at seven CSO locations. These seven CSO areas represent approximately 50.7 percent of the total CSSA. The method(s) used to monitor flow was not provided. Since no phosphorous concentration data were given, a national average value had to be used. For these reasons, the annual phosphorous load could not be calculated with a high degree of accuracy. However, at 271 acres, Elyria's CSSA is very small relative to other study areas. Consequently, the rough phosphorous loading estimate reported herein should give a reasonable CSO load.

REFERENCES

1. Telecon. City Engineer's Office, Lorain (216) 244-1300 and Mr. John Patinskas GCA/Technology Division. April 30, 1982.

2. Telecon. Mr. John Rybarczyk, Lorain Department of Utilities (216) 245-1100 and Mr. John Patinskas, GCA/Technology Division. May 3, 1982.

3. 201 Facility Plan Combined Sewer Overflow. Supplement No. 3. Havens and Emerson, Inc. August 1981.

4. U.S. EPA, Nationwide Evaluation of Combined Sewer Overflows and Urban Stormwater Discharges. Volume III Characterization of Discharges. EPA-600/2-77-064c. August 1977.

CONTACTS

1. Mr. John Beaker, Northeast Ohio Regional Planning District. (216) 241-2414.

2. Mr. John Sadzewicz, Ohio EPA. (614) 462-6304.

SECTION 22

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF CLEVELAND, OHIO

BACKGROUND

The City of Cleveland is located in northern Ohio on the southern shore of Lake Erie. The City is divided into three major sewer districts, the Westerly, Southerly, and Easterly Districts, each served by its respective wastewater treatment plant. Figure 22-1 shows the sewer districts and the location of the wastewater treatment plant which serves each district.

The Westerly Sewer District[1] contains a total area of 10,100 acres in the City of Cleveland and suburbs. The Walworth Run[2] area, a portion of the Westerly Sewer District, consists of 5,400 acres, of which 3,900 are directly tributary to a combined sewer system. There are 51 overflow and by-pass structures in the Walworth Run area, all of which are in the combined sewer system. Approximately 25 of these are sources of major combined sewer overflows. The Northwest Interceptor area in the Westerly District contains 4,700 acres, of which 4,050 acres are served by a combined sewer system.

The Easterly Sewer District contains 17,000 acres located in the City of Cleveland served by a combined sewer system, and 25,000 suburban acres served by a separated sewer system.[3] There are 77 overflow points in the Easterly District.

The Southerly Sewer District, the largest of the three sewer districts, contains approximately 62,000 acres. Combined sewers service approximately 19,600 acres within the District.[4] Combined sewer overflows occur from 165 regulator points in the District.[5]

Cleveland's combined sewers normally overflow approximately 70 times per year. Overflow is discharged to several small creeks, the Cuyahoga River, and directly to Lake Erie. Lake Erie eventually receives all overflows from Cleveland.

COMBINED SEWER OVERFLOW VOLUMES

The volume of combined sewer overflow has not actually been measured, but the volume has been estimated by the use of mathematical models to be 5.74 billion gallons per year. This estimate does not include any overflow from

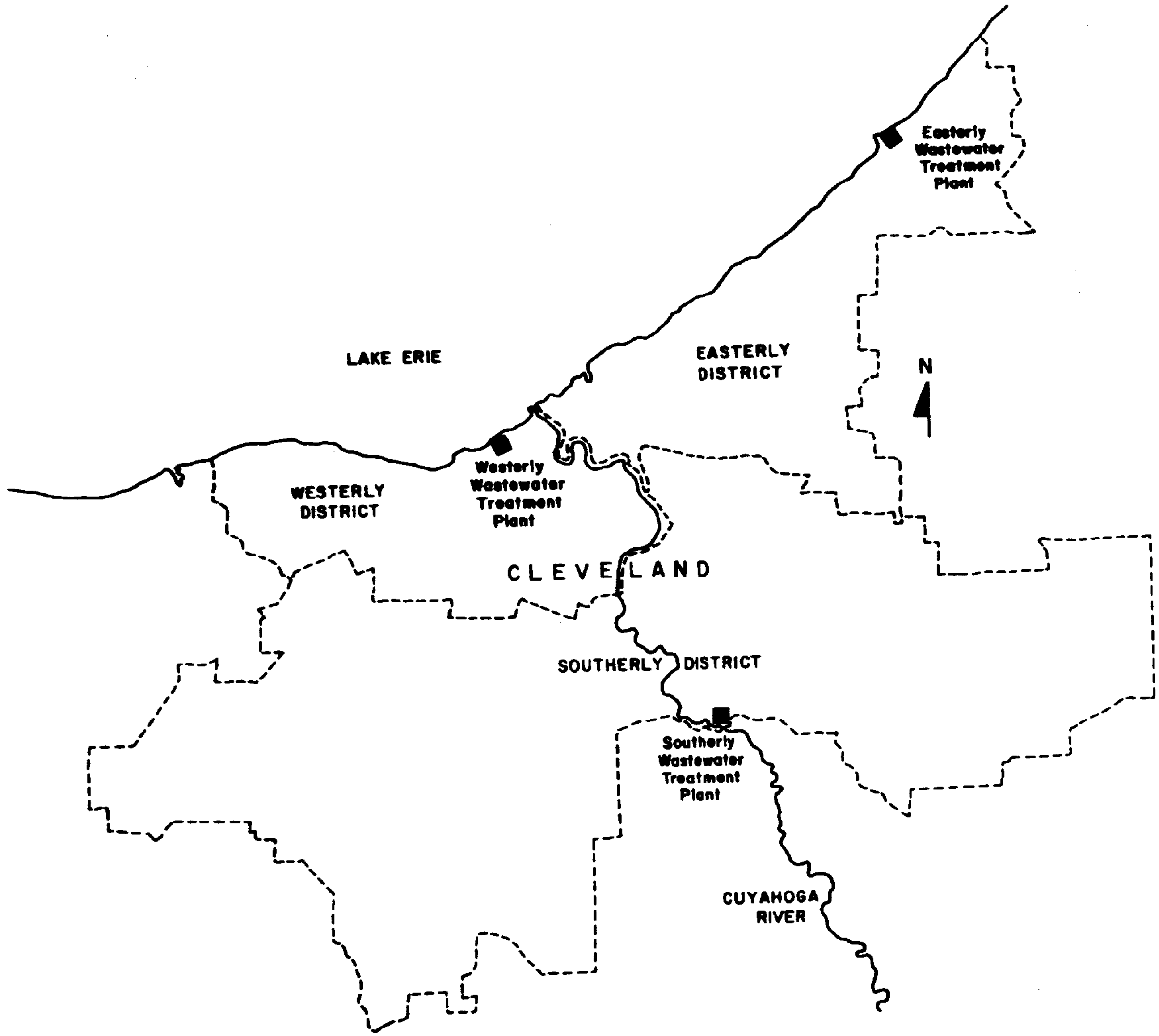


Figure 22-1. Sewer districts and wastewater treatment plants--Cleveland, OH.

the relatively small area served by the Westerly Interceptor in the Westerly District. Annual modeled overflow volume for each sewer district is listed in Table 22-1.

TOTAL PHOSPHORUS LOADINGS

Total phosphorus loadings from Cleveland's CSOs were was not reported in available literature. However, CSO flows and loadings of total suspended solids (TSS) and biochmeical oxygen demand (BOD) were reported. Therefore, total phosphorus loadings were calculated by taking an average phosphorus concentration (5.4 mg/l) measured in selected U.S. cities* and Cleveland CSO volume estimates. The total phosphorus loading from Cleveland's combined sewer overflows is estimated to be 258,895 lbs (117.7 MT) per year. Table 22-1 shows the estimates of phosphorus loadings predicted by the above method.

Two other estimation methods, employing the average phosphorus-to-BOD ratio and phosphorus-to-TSS ratio from selected U.S. cities,[6] were used to check the annual phosphorus loading presented above. Estimates of the BOD and TSS loadings are shown in Table 22-1. The average phosphorus-to-BOD ratio, (0.0444), was multiplied by the estimated annual BOD loading of 3.862 million pounds from Cleveland's combined sewer overflows. This results in an estimated phosphorous loading of 171,472 lbs (77.9 MT) per year. The annual phosphorus-to-TSS ratio (0.0158), was multiplied by the estimated annual TSS loading from combined sewer overflows of 9.933 million pounds. This results in an estimated annual phosphorus loading of 156,940 lbs (71.3 MT). Given the results of these two estimatnig methods, it is important to recognize that the estimate presented in Table 22-1 may be high.

DATA ON OTHER POLLUTANTS

The annual loadings of BOD and TSS from Cleveland's CSOs were estimated to be 3.862 million pounds and 9.933 million pounds, respectively.

DATA QUALITY

Actual measurements of the phosphorus loading of combined sewer overflows were not reported. The concentration of phosphorus in combined sewer overflows was estimated by using the average of measured phosphorus concentrations in combined sewer overflow in selected U.S. cities.[6]

The volumes of combined sewer overflows were estimated using mathematical models. The Cleveland Combined Sewer Mathematical Model was used for predicting the overflows from the Southerly Sewer District and the Northwest Interceptor in the Westerly Sewer District. Measured input parameters for the model were rainfall, dry weather flow, and hydraulic characteristics of the collection system. For the Easterly Sewer District and the Walworth Run area

---

*This concentration is representative of Ohio's unregulated use of phosphorus in detergent (Reference 6).

TABLE 22-1. ESTIMATED CSO POLLUTANT LOADINGS--CLEVELAND, OH

Sewer district	Overflow, MG	Total phosphorous, lb (as P)	BOD_5, lb	TSS, lb
Westerly[a]	1,361	61,408	905,200	2,632,800
Easterly	3,102	139,960	2,198,000	4,397,000
Southerly	1,275	57,527	758,775	2,903,095
Total	5,738	258,895	3,861,975	9,932,895

[a]Northwest Interceptor and Walworth Run area only. Does not include area served by Westerly Interceptor.

of the Westerly Sewer District, the Storm Water Management Model (SWMM) was used with some modifications. The references did not report any comparison of the predicted overflow volume with an actual measurement of overflow volume.

Rainfall data for the Cleveland Combined Sewer Mathematical Model was obtained from a citywide rain measurement program. The rainfall for the year 1958, considered to be a typical year, was used to predict flows with the SWMM model.

REFERENCES

1. A Preliminary Design for Combined Sewer Overflow Pollution Control for the Northwest Area Interceptor Sewer. Watermation, Incorporated. Cleveland, OH. April 1974.

2. Report to Cleveland Regional Sewer District on Combined Sewer Overflows Walworth Run Area. Metcalf & Eddy/Engineers. Boston, MA. February 1978.

3. Report to Cleveland Regional Sewer District on Combined Sewer Overflows Easterly District. Metcalf & Eddy/Engineers. Boston, MA. February 1978.

4. A Preliminary Design for Combined Sewer Overflow Pollution Control Southerly Interceptor Area. Watermation, Incorporated. Cleveland, OH. December 1973.

5. Anderson, D. J., R. Adams, and D. C. Simpson. A Report on the Temporary Data Acquisition System (TDACS) for the Southerly District - Description, Results, and Data Usage. Watermation, Incorporated. Cleveland, OH. August 1973.

6. U.S. EPA, Nationwide Evaluation of Combined Sewer Overflows and Urban Stormwater Discharges. Volume III Characterization of Discharges. EPA 600/2-77-064c. August 1977.

CONTACTS

1. Mr. Ted Buczek, Northeast Ohio Areawide Coordinating Agency. (216) 641-6000.

2. Mr. John Sadzewicz, Ohio EPA. (614) 462-6304.

ADDITIONAL REFERENCES

1. A Preliminary Design for Combined Sewer Overflow Pollution Control Big Creek Interceptor Area. Watermation, Incorporation. Cleveland, OH. September 1973.

2. A Preliminary Design for Combined Sewer Overflow Pollution Control Mill Creek Interceptor Area. Watermation, Incorporated. Cleveland, OH. December 1973.

SECTION 23

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF AKRON, OHIO

BACKGROUND

The City of Akron contains a sewered area of approximately 31,700 acres, 33 percent (10,450 acres) of which is serviced by combined sewers. During dry weather periods flow is transported by gravity interceptor sewers to the Akron wastewater treatment plant. Wet weather flows exceeding the interceptor capacity overflow to the Ohio Canal, the Little Cuyahoga Creek and the Cuyahoga River. These receiving waters are in turn tributary to Lake Erie.

The combined sewer system overflows an estimated 50 to 60 times each year, substantially increasing pollutant concentrations in receiving streams. During such events, water quality standard violations are common. Combined sewer overflows are the largest source of pollution for Akron area streams during periods of wet weather. Small, frequent storms have been found to produce the most adverse impacts on receiving streams.

The combined sewer system is located within the older central core of the city. The system contains 38 points of overflow, each of which serves a separate subsystem. Table 23-1 is a listing of the CSOs, their service areas and their receiving streams.

Data provided in Table 23-1 were obtained from Reference 1. The referenced study was conducted for the City of Akron to achieve the following goals:

- Quantify the pollutant loads discharged from combined sewer systems.
- Quantify the total pollutant load carried by the Cuyahoga River below Akron.
- Identify the impact of total pollutant load on the Cuyahoga River water quality.
- Determine relationships between Cuyahoga River water quality, combined sewer overflows and present and potential Akron water treatment facilities.

The results were based on flow measurement data taken on CSOs which discharge to the Ohio Canal and on phosphorous concentration measurements made on CSO

TABLE 23-1. COMBINED SEWER OVERFLOWS--ARKON, OH

No.	Name	Area (Acres)	Receiving Water
1	Springfield Center Road	15	Springfield Lake Outlet to Little Cuyahoga River
2	Weston Road Outlet	539	Little Cuyahoga River
3	South Arlington Street District	337	Little Cuyahoga River
4	Mill Street	99	Ohio Canal
5	River Street	32	Little Cuyahoga River
6	Factory Street	112	Little Cuyahoga River
7	Case Avenue	95	Little Cuyahoga River
8	North Case and Dubling	46	Little Cuyahoga River
9	Williams Street	20	Little Cuyahoga River
10	Case Avenue - Newton Street District	215	Little Cuyahoga River
11	Hazel Street Trunk	412	Little Cuyahoga River
12	Home Avenue District	969	Camp Brook to Little Cuyahoga River
13	Maderia Street	72	Little Cuyahoga River
14	North Forge Street	240	Little Cuyahoga River
15	Forest Hill District	232	Little Cuyahoga River
16	Wolf Ledge Trunk	64	Ohio Canal
17	Exchange Street	176	Ohio Canal
18	Willow Run Trunk	1,669	Ohio Canal
19	West Market Street	144	Ohio Canal
20	West North Street	45	Ohio Canal
21	North Howard Street	104	Little Cuyahoga River
22	North Hill Trunk	436	Little Cuyahoga River
23	North Maple Street	50	Little Cuyahoga River
24	West Market Street Outlet	369	Little Cuyahoga River
25	Otto Street	83	Little Cuyahoga River
26	Aqueduct Street Outlet	160	Little Cuyahoga River
27	Uhler Avenue	97	Little Cuyahoga River
28	Tallmadge Avenue (Memorial Parkway)	304	Little Cuyahoga River
29	Uhler Avenue - Carpenter Street	138	Little Cuyahoga River
30	North Howard Street	69	Little Cuyahoga River
31	Portage - Sunnyside District	309	Little Cuyahoga River
32	Carpenter Heights District	280	Cuyahoga River
33	Northside Interceptor	48	Cuyahoga River
34	Riverside Boulevard District	83	Cuyahoga River
35	Gorge Boulevard District	691	Cuyahoga River
36	Merriman Road Outlet	189	Cuyahoga River
37	Bowery Street	38	Ohio Canal
38	South Broadway	1,446	Ohio Canal
Total		10,427	

[a]Source: Reference 1.

Nos. 18 and 28 (see Table 23-1). These data were collected over a 12-month period extending from September 1, 1971 through August 31, 1972. During this interval, 57 overflow events were observed.

COMBINED SEWER OVERFLOW VOLUMES

Monthly rainfall data and overflow volumes are reported in Table 23-2. During the study period Akron received a total of 34.50 inches of rainfall, compared to the 10 year average of 37.26 inches. The measured overflow volumes represent overflows from CSO Nos. 4, 16, 18, 19, 20, 32 and 38 (i.e., all CSOs discharging to the Ohio Canal). These CSOs service approximately 35 percent of the combined sewer system. Assuming that CSO discharge is directly proportional to area, measured monthly overflow volumes were projected to the total system. The annual overflow volume was found to be 1,062 MG using the following relationship:

$$\text{Total CSO volume} = \text{Measured CSO volume} \; \frac{\text{total CSO service area}}{\text{monitored CSO service area}}$$

TOTAL PHOSPHOROUS LOADINGS

Concentrations of total phosphorous measured at two different CSO locations ranged from 3.9 to 14.3 mg/l as PO_4. The mean phosphorous concentration was found to be 9.0 mg/l as PO_4 or 2.94 mg/l as P.

Monthly phosphorous loadings were calculated based on projected overflow volumes and the mean of measured phosphorous concentration data. The total annual phosphorous load was found to be 26,040 lbs (11.8 MT). However, this phosphorous loading reflects mean phosphorous concentrations measured prior to Akron's 1978 phosphorous ban. Assuming the ban has reduced CSO phosphorous concentrations by 32 percent (based on data contained in Reference 2) a current annual loading of approximately 17,700 lbs (8.0 MT) is expected.

DATA ON OTHER POLLUTANTS

Table 23-3 provides data on additional pollutants addressed in Reference 1. These pollutants include COD, BOD_5, suspended solids, fecal coliforms and ammonia nitrogen. The sampling stations labeled Rack 18 and Rack 28 are CSO sites. The station "Lock 15" is a site downstream of the monitored CSOs which was used in the study to indicate the impact of CSO discharges on water quality.

DATA QUALITY

Little information on flow measurement and sampling and analysis procedures were provided in the Akron CSO report, making it difficult to estimate the accuracy of flow and quality data provided. CSO flow data included eight CSOs, representing only 35 percent of the CSO serviced area. In estimating the total CSO overflow it was assumed that flow is directly proportional to the area serviced. Projecting measured loadings to the total CSO area is subject to substantial error. Based solely on Reference 1, the accuracy of the phosphorous loading data is likely to be within $\pm$ 50 percent.

TABLE 23-2. SUMMARY OF MONTHLY PRECIPITATION, CSO FLOW AND LOADING DATA--AKRON, OH

Month (1971-1972)	Precipitation, inches	Number of overflows	Measured overflow volume, MG[a]	Total overflow volume, MG	Phosphorous concentration as P, mg/l	Total phosphorous load as P, lbs[c,d]
September	2.67	4	82	234	2.94[b]	5,738
October	1.38	3	6	17		417
November	2.57	3	6	17		417
December	4.32	3	48	137		3,359
January	1.19	1	2	6		147
February	1.68	3	3	9		221
March	3.49	7	19	54		1,324
April	4.16	5	56	160		3,923
May	2.58	4	11	31		760
June	4.78	6	61	174		4,266
July	3.52	11	64	183		4,487
August	2.16	7	14	40		981
Totals	34.50	57	372	1,062		26,040

[a]Represents 35 percent of the total CSO area.

[b]Reported as 9.0 mg/l as PO_4.

[c]Load = Overflow volume (MG) x phosphorous conc. (mg/l) x 8.34 lbs/MG/mg/l.

[d]Data for loadings prior to 1978 phosphorous ban.

TABLE 23-3. QUALITY OF COMBINED SEWER OVERFLOWS--AKRON, OH

Station	Number of events sampled	Concentration of pollutant, mg/l except as noted											
		COD		BOD_5		Suspended solids		Fecal coliform (1,000 per 100 ml)		Total PO_4		NH_3-N	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Lock 15[a]	12	260	30-730	85	15-260	800[b]	150-2,400	380	60-1,300	5.1	0.5- 9.4	0.9	0.2-2.9
Rack 18	6	220	70-340	75	40-130	270	200- 320	850	300-1,200	9.0	3.9-14.3	5.1	1.9-9.0
Rack 28	3	75	-	50	-	220	-	1,000+	9.0	1.9			

[a]Values as adjusted for Lock 2 releases.

[b]This value may be affected by bank scour in the Ohio Canal during overflows and/or by resuspension of solids deposited in the low-flow pools of the canal.

Source: "Combined Sewer Overflow Supplement to Report and General Plan for Advanced Wastewater Treatment."

REFERENCES

1. Burgess and Niple, Limited. Akron Facilities Plan, Appendix M, Combined Sewer Overflow Analysis. 1977.

2. Letter to Dr. Keith Booman of the Soap and Detergent Association from the United States Environmental Protection Agency, Great Lakes National Program Office. March 2, 1982.

CONTACTS

1. Mr. Jack Pearson, City of Akron. (216) 253-4196.

2. Mr. John Sadzewicz, Ohio EPA. (614) 462-6304.

SECTION 24

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF ERIE, PENNSYLVANIA

BACKGROUND

Erie, Pennsylvania is located in the northwest corner of the State on the southern shore of Lake Erie. It has a sewered area of 9,454 acres serving a population of 129,000 (1970). During dry weather periods, flow is transported by gravity interceptor sewers to the Erie wastewater treatment plant. Wet weather flows exceeding interceptor capacity overflow to Mill Creek, Garrison Run, and Outer Erie Harbor. Mill Creek and Garrison Run are tributary to Presque Isle Bay as shown in Figure 24-1.

The Erie sewer system consists of sanitary sewers, storm sewers, and combined sewers. Sewers built within the last 30 years are separate, however, older lines dating back to the 1870's are combined. References 1 and 2 indicate that the combined sewer system contains 59 overflow points. However, more recent remedial actions have reduced this number to 56. Table 24-1 provides a summary of the combined sewer overflows identified in Reference 1. Figure 24-1 depicts the relative locations of the overflow points. Although the majority of CSOs existing in 1975 are still present, the overflow volume has been significantly reduced due to the installation of a relief interceptor on the west side.

COMBINED SEWER OVERFLOW VOLUMES

Table 24-2 provides pre-1975 annual overflow volumes to Mill Creek, Garrison Run, and the East Side and West Side Lake Erie discharges. According to Table 24-2, a total of 300 million gallons overflowed during an average year rainfall. However, with the installation of the west side relief interceptor most of the 45 million gallons overflowing annually from the west side has been eliminated. In addition, the relief interceptor has reportedly reduced overflow to Mill Creek and Garison Run.[3] Since flow reduction to Mill Creek and Garison Run has not been determined, the present average annual overflow volume cannot accurately be quantified. Assuming the west side overflow is essentially reduced to zero, the annual overflow can be reported as being less than 255 million gallons (MG). Note that these volumes are high estimates. Actual volumes are likely to be less than 255 MG.

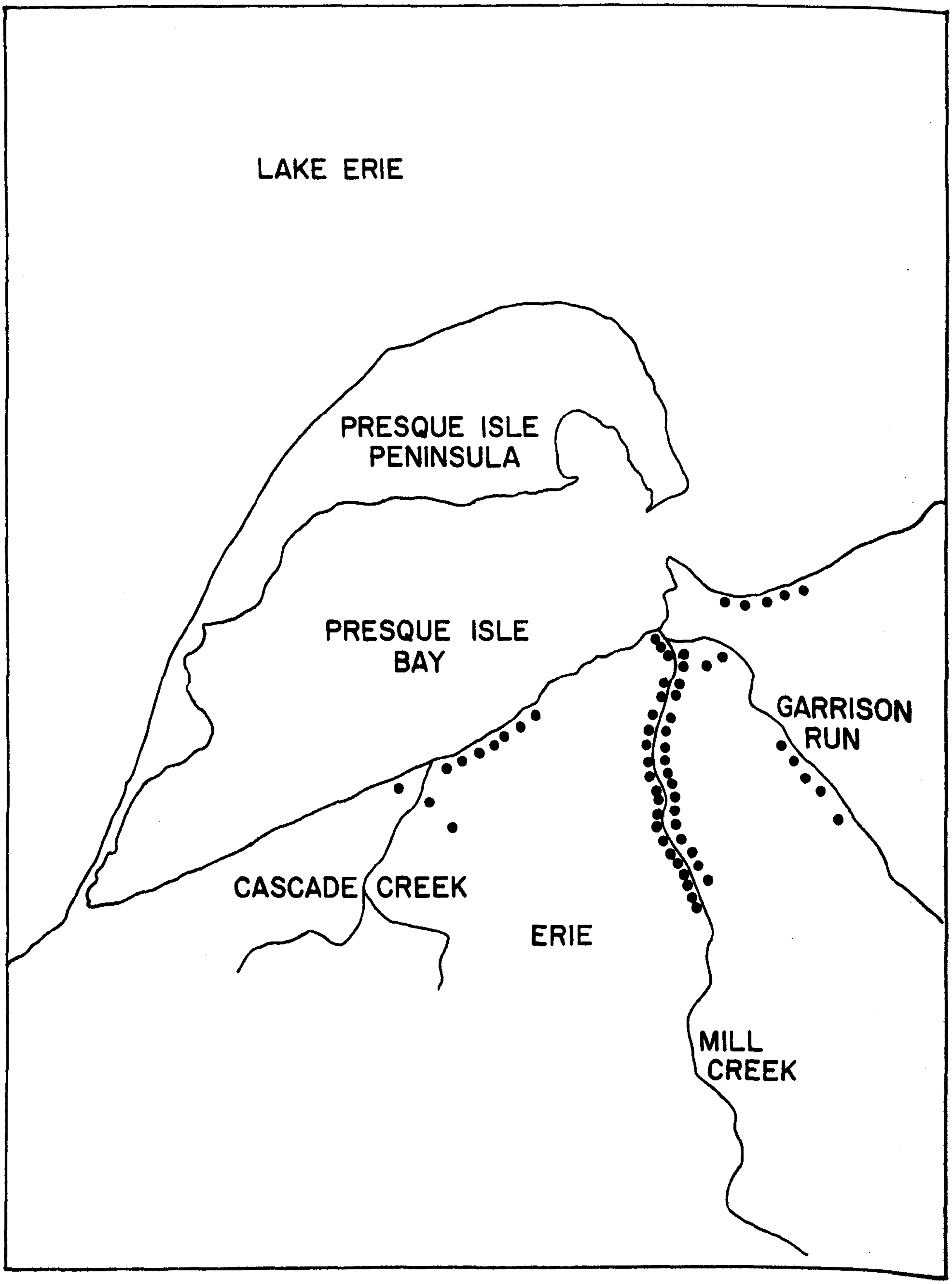


Figure 24-1. Combined sewer overflow locations--Erie, PA.

TABLE 24-1. COMBINED SEWER OVERFLOWS[a]--ERIE, PA

Overflow number	Location	Current estimated average dry weather flow, MGD	Flow rate when overflow commences, MGD	Volume of overflow for each average storm occurrence, MG	Receiving stream
1	Foot of Wallace	32.5	52	0.823	Mill Creek Tube
2	2nd-Parade & Wallace, W.	0.076	19	-	Mill Creek Tube
3	2nd-Parade & Wallace, E.	0.220	0.78	0.014	Mill Creek Tube via storm sewer
4	3rd-Parade & Wallace	0.068	11	-	Mill Creek Tube
5	4th & Parade, S.E.	1.66	2.3	0.547	Mill Creek Tube
6	4th & Parade, E.	1.66	3.6	-	Mill Creek Tube
7	5th West of Parade	0.905	1.6	0.111	Mill Creek Tube
8	6th West of German	0.044	0.32	-	Mill Creek Tube
9	6th East of German	0.025	1.6	-	Mill Creek Tube
10	7th West of German	0.031	1.2	-	Mill Creek Tube
11	8th West of Holland	0.026	0.12	-	Mill Creek Tube
12	8th East of Holland	0.022	0.14	0.051	Mill Creek Tube
13	9th-French & Holland, W.	0.031	0.24	-	Mill Creek Tube
14	9th-French & Holland, E.	0.040	0.23	-	Mill Creek Tube
15	10th-French & Holland, W.	1.43	22	-	Mill Creek Tube
16	10th-French & Holland, E.	1.43	19.5	-	Mill Creek Tube
17	11th & French	0.025	4.35	-	Mill Creek Tube via storm sewer
18	11th-French & Holland	0.204	1.0	0.046	Mill Creek Tube
19	13th & French	0.098	0.57	-	Mill Creek Tube
20	Commerce - N. of 14th	0.032	0.04	-	Mill Creek Tube
21	14th W. of Commerce	0.076	3.4	0.0035	Mill Creek Tube
22	14th & Commerce	1.90	1.95	0.041	Mill Creek Tube via storm sewer
23	14th & French	0.237	1.0	0.032	Mill Creek Tube
24	16th & French	0.047	1.0	0.045	Mill Creek Tube
25	17th & State	1.03	4.26	0.49	Mill Creek Tube via storm sewer
26	17th & French	0.040	0.94	0.152	Mill Creek Tube
27	Ash N. of 18th	0.80	2.1	0.23	Mill Creek Tube
28	18th E. of State	0.044	0.39	-	Mill Creek Tube
29	18th & French	0.094	2.3	0.06	Mill Creek Tube
30	21st-State & French, W.	0.20	1.6	0.25	Mill Creek Tube
31	21st-State & French, E.	0.059	0.077	-	Mill Creek Tube
32	23rd-State & French	0.11	0.85	-	Mill Creek Tube via storm sewer
33	24th-State & French	0.06	0.41	-	Mill Creek Tube
34	26th & French, N.	0.136	0.86	-	Mill Creek Tube via storm sewer
35	26th & French, S.	0.075	0.32	0.031	Mill Creek Tube
36	Glenwood Park & Hill	0.40	4.0	0.26	Mill Creek Tube
37	34th & State	0.070	1.65	-	Mill Creek Tube
38	Colorado & South Shore	2.17	2.8	-	Lake Erie via storm sewer
39	1st & Plum	0.018	1.27	-	Lake Erie
40	2nd & Cherry, N.W.	16.5	31	-	Lake Erie
41	2nd - West of Cherry	16.5	50	-	Lake Erie
42	Front East of Sassafras	0.062	1.62	0.004	Lake Erie
43	2nd & Myrtle	0.105	4.1	-	Lake Erie via storm sewer
44	2nd - Sassafras & Peach	0.155	1.5	0.036	Lake Erie
45	Sassafras & Peach N. of 3rd	2.0	4.5 (Estimated)	0.61	Lake Erie
46	4th & Cranberry	2.76	18	-	Cascade Creek
47	11th & Liberty	8.80	12	-	Lake Erie via storm sewer
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] storm sewer
49	Foot of Cranch Avenue	0.25	4	-	Lake Erie via storm sewer
50	Lakeside W. of Chautaqua	0.018	0.5	-	Lake Erie
51	Foot of Chautaqua	0.018	0.5	-	Lake Erie
52	Eastlake East of Euclid	0.31	0.8	-	To Overflow No. 51
53	4th & Ash	1.66	22	-	Garrison Run via storm sewer
54	East Avenue & Commercial	2.3	-	-	Garrison Run
55	23rd between East & Penna.	0.16	1.3	-	Garrison Run
56	25th & Brandes	0.06	1.17	-	Garrison Run via storm sewer
57	28th - East & Penna.	0.003	1.1	-	Garrison Run
58	32nd & East Avenue	0.36	1.3	-	Garrison Run via storm sewer
59	24th & Penna.	0.14	-	(1)0.07 mgd. continuous	Garrison Run via storm sewer

TOTAL PHOSPHORUS LOADINGS

Prior to the installation of the west side relief interceptor the average annual CSO total phosphorous load was approximately 7,000 lbs. Since the interceptor is likely to have reduced overflow by at least 45 million gallons (15 percent) the current average annual phosphorous load can best be reported as being less than 5,950 lbs (2.7 MT).

TABLE 24-2. TOTAL ANNUAL COMBINED SEWER OVERFLOW VOLUMES (PRE-1975)--ERIE, PA

Location	Flow, MG	Total phosphorus, lbs/yr
Mill Creek	220	4,020
Garrison Run	26	2,160
West Side	45	730
East Side	9	90
Total	300[a]	7,000[a]

[a]These data represent loadings prior to recent remedial measures; actual current loadings are likely to be reduced.

DATA ON OTHER POLLUTANTS

Table 24-3 provides pre-1975 data on biochemical oxygen demand and total suspended solids due to combined sewer overflows. These data reflect conditions existing prior to the construction of the west side relief interceptor.

TABLE 24-3. BOD AND TSS LOADING FROM COMBINED SEWER OVERFLOWS (PRE-1975)--ERIE, PA

Location	BOD_5, lbs/yr.[a]	TSS, lbs/yr.[a]
Mill Creek	71,000	645,700
Garrison Run	37,000	37,000
West Side	15,700	98,800
East Side	4,300	25,500
Total	128,000	807,000

[a]These data represent loadings prior to recent remedial measures; actual current loadings are likely to be reduced.

DATA QUALITY

Combined sewer overflow data for the City of Erie were obtained prior to 1975. Since that time, a relief interceptor has been installed to reduce overflow of untreated sewerage. Data on overflow volumes and phosphorous loadings expected under present conditions are unavailable. Consequently, the phosphorous loadings reported herein are subject to substantial inaccuracy.

REFERENCES

1. U.S. Environmental Protection Agency. Water Pollution Investigation: Erie, Pennsylvania Area. EPA-905/9-74-015. Region V. Enforcement Division. Chicago, Illinois. March 1975.

2. Interim Report for the Comprehensive Waste and Water Quality Management Study of Pennsylvania Portion of the Erie Basin and the Erie Standard Metropolitan Statistical Area. Engineering Science, Incorporated. Cleveland, Ohio. March 1974.

3. Letter to Mr. Paul Horvation, U.S. EPA from Mr. James E. Erb, P.E., Regional Water Quality Manager, Pennsylvania Department of Environmental Resources, Bureau of Water Quality Management. October 27, 1982.

CONTACTS

1. Mr. Ken Bartel, Pennsylvania Department of Environmental Resources. (717) 783-3638.

2. Mr. James Erb, Pennsylvania DER. (814) 724-8550.

3. Mr. Wasenda Mohka, Erie City Engineer. (814) 456-8561.

4. Mr. Chuck Vrenna, Erie County Department of Public Health. (814) 454-5811.

SECTION 25

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF BUFFALO, NEW YORK

BACKGROUND

The City of Buffalo, New York is located on Lake Erie at the head of the Niagara River. It has a sewered area of 26,200 acres, serving a city of 463,000 people (1970). During periods of dry weather, flow is transported by interceptors to the Bird Island sewage treatment plant. Wet weather flows exceeding the interceptor capacity overflow to the Buffalo River, Cazenovia Creek, Scajaquada Creek, and the Niagara River. Cazenovia Creek is a tributary of the Buffalo River, which flows into Lake Erie. Scajquada Creek flows into the Niagara River.

The combined sewer system overflows approximately 70 times each year, substantially increasing pollutant concentrations in receiving streams. The International Joint Commission Great Lakes Water Quality Board has identified combined sewer overflows as a major pollutant loading source to the Buffalo River.

The City of Buffalo's combined sewer system includes over 800 miles of combined sewers which vary in size from a 10-inch diameter lateral to a 33-inch x 14 foot combined relief sewer. Over 75 percent of the sewers were constructed prior to 1930, while 60 percent were constructed before 1910. The system contains 63 overflow points. Combined sewer overflows and receiving streams are listed in Table 25-1. Figure 25-1 depicts the location of the overflow points.

COMBINED SEWER OVERFLOW VOLUMES

It is estimated that 8.4 billion gallons overflow during an average rainfall year. Of this amount, 2.6 billion gallons overflow into the Buffalo River, the remainder entering Scajaquada Creek and the Niagara River.

TOTAL PHOSPHORUS LOADINGS

Combined sewer overflows from Buffalo contribute a post-ban loading of 145,610 lbs (66.2 MT) of phosphorus per year to surrounding waterways. Buffalo River receives 47,960 lbs/yr; Niagara River 46,690 lbs/yr; Scajaquada Creek 37,790 lbs/yr; and Cazenovia Creek 13,170 lbs/yr.

TABLE 25-1. COMBINED SEWER OVERFLOWS--BUFFALO, NY

Name	Receiving stream	Stream mile
Buffalo CSO Outfall No. 1	Niagara River	32.30
Buffalo CSO Outfall No. 2	Niagara River	32.87
Buffalo CSO Outfall No. 3	Niagara River	33.30
Buffalo CSO Outfall No. 6	Scajaguada Creek	0.21
Buffalo CSO Outfall No. 7	Scajaguada Creek	0.32
Buffalo CSO Outfall No. 8	Scajaguada Creek	1.79
Buffalo CSO Outfall No. 10	Scajaguada Creek	3.11
Buffalo CSO Outfall No. 11	Scajaguada Creek	1.63
Buffalo CSO Outfall No. 13	Scajaguada Creek	0.45
Buffalo CSO Outfall No. 14	Niagara River	34.05
Buffalo CSO Outfall No. 15	Niagara River	34.20
Buffalo CSO Outfall No. 16	Niagara River	34.30
Buffalo CSO Outfall No. 17	Niagara River	34.40
Buffalo CSO Outfall No. 18	Niagara River	34.40
Buffalo CSO Outfall No. 19	Niagara River	34.55
Buffalo CSO Outfall No. 20	Niagara River	34.65
Buffalo CSO Outfall No. 21	Niagara River	34.80
Buffalo CSO Outfall No. 22	Niagara River	34.90
Buffalo CSO Outfall No. 23	Niagara River	34.95
Buffalo CSO Outfall No. 24	Niagara River	35.55
Buffalo CSO Outfall No. 26	Niagara River	36.65
Buffalo CSO Outfall No. 27	Niagara River	37.08
Buffalo CSO Outfall No. 28	Niagara River	37.22
Buffalo CSO Outfall No. 29	Niagara River	37.35
Buffalo CSO Outfall No. 30	Buffalo River	0.40
Buffalo CSO Outfall No. 31	Buffalo River	0.63
Buffalo CSO Outfall No. 32	Buffalo River	0.70
Buffalo CSO Outfall No. 33	Buffalo River	0.74
Buffalo CSO Outfall No. 34	Buffalo River	0.80
Buffalo CSO Outfall No. 35	Buffalo River	0.91
Buffalo CSO Outfall No. 36	Buffalo River	1.36

CONTINUED

TABLE 25-1 (continued)

Name	Receiving stream	Stream mile
Buffalo CSO Outfall No. 37	Buffalo River	1.65
Buffalo CSO Outfall No. 38	Buffalo River	2.00
Buffalo CSO Outfall No. 39	Buffalo River	3.60
Buffalo CSO Outfall No. 40	Buffalo River	4.60
Buffalo CSO Outfall No. 42	Buffalo River	4.90
Buffalo CSO Outfall No. 43	Buffalo River	5.60
Buffalo CSO Outfall No. 44	Buffalo River	5.60
Buffalo CSO Outfall No. 47	Buffalo River	6.68
Buffalo CSO Outfall No. 48	Buffalo River	6.87
Buffalo CSO Outfall No. 50	Buffalo River	6.87
Buffalo CSO Outfall No. 51	Buffalo River	6.50
Buffalo CSO Outfall No. 53	Buffalo River	5.85
Buffalo CSO Outfall No. 54	Buffalo River	5.58
Buffalo CSO Outfall No. 55	Buffalo River	5.50
Buffalo CSO Outfall No. 57	Buffalo River	5.22
Buffalo CSO Outfall No. 58	Buffalo River	5.22
Buffalo CSO Outfall No. 59	Cazenovia Creek	0.40
Buffalo CSO Outfall No. 60	Cazenovia Creek	0.45
Buffalo CSO Outfall No. 61	Cazenovia Creek	0.53
Buffalo CSO Outfall No. 62	Cazenovia Creek	0.80
Buffalo CSO Outfall No. 63	Cazenovia Creek	0.85
Buffalo CSO Outfall No. 64	Cazenovia Creek	0.90
Buffalo CSO Outfall No. 65	Cazenovia Creek	1.02
Buffalo CSO Outfall No. 66	Cazenovia Creek	1.07
Buffalo CSO Outfall No. 68	Cazenovia Creek	1.93
Buffalo CSO Outfall No. 71	Cazenovia Creek	1.02
Buffalo CSO Outfall No. 72	Cazenovia Creek	0.94
Buffalo CSO Outfall No. 73	Cazenovia Creek	0.53
Buffalo CSO Outfall No. 74	Cazenovia Creek	0.27
Buffalo CSO Outfall No. 75	Cazenovia Creek	0.17
Buffalo CSO Outfall No. 76	Cazenovia Creek	0.15
Buffalo CSO Outfall No. 77	Cazenovia Creek	0.02

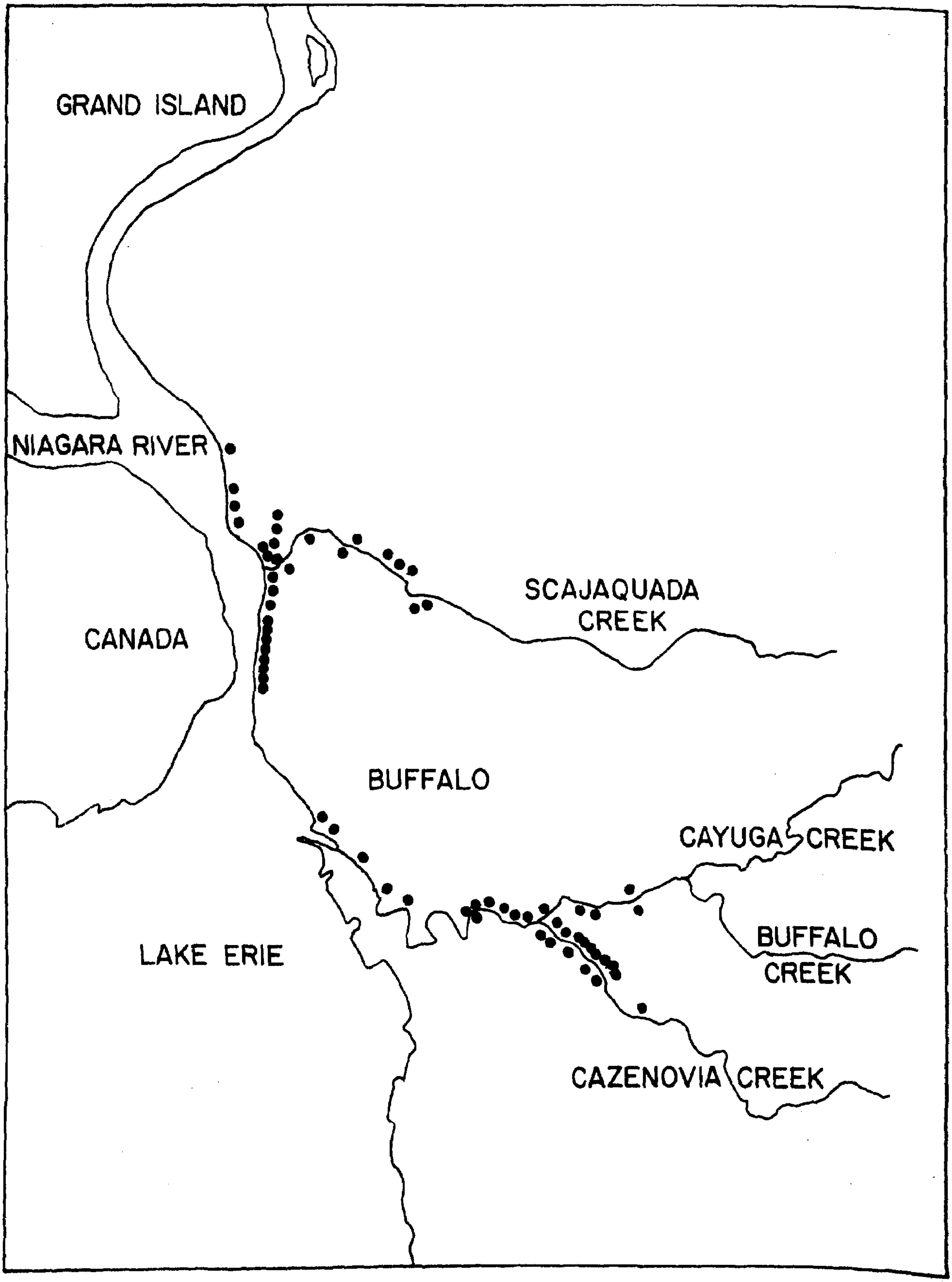


Figure 25-1. Combined sewer overflow locations--Buffalo, NY.

DATA ON OTHER POLLUTANTS

Table 25-2 provides data on other pollutants due to combined sewer overflows. As this table shows, the Buffalo River receives the highest loadings from CSO's, followed closely by the Niagara River.

TABLE 25-2. ANNUAL LOADINGS FROM COMBINED SEWER OVERFLOWS--BUFFALO, NY

	Loadings lbs/yr			
	Buffalo River	Niagara River	Scajaquada Creek	Cazenovia Creek
BOD_5	1,873,000	1,852,000	1,505,000	521,400
TSS	3,327,000	2,520,000	1,717,000	640,100
TOC	2,495,000	2,223,400	1,702,000	561,400
COD	12,960,000	12,974,000	10,650,000	3,715,000
TVS	13,040,000	7,885,000	4,089,000	1,523,000
Oil & Grease	2,333,000	1,779,300	1,288,000	491,000
Ammonia	77,740	79,810	64,510	20,430
Chloride	6,880,000	5,606,000	4,047,000	1,389,000
TKN	460,000	432,100	346,400	124,000
Nickel	528,000	195,680	150	1,910

STORMWATER

Information supplied by the Erie and Niagara Counties Regional Planning Board indicates that the City of Buffalo's sewerage system is entirely combined. Approximately 13 billion gallons of stormwater runoff are generated annually. Of this amount, 8.4 billion gallons overflow, while the remainder is transported to the Bird Island wastewater treatment plant. Because of this fact, phosphorus loadings due to separate storm drainage in the City of Buffalo are minimal.

DATA QUALITY

Total phosphorus loadings were based on a combined sewer overflow sampling program conducted by the Erie and Niagara Counties Regional Planning Board. Combined sewer overflows in residential, commercial, and industrial areas were sampled. As a rainstorm approached, close contact with the Weather Bureau was maintained in order to arrive at the sampling sites ahead of the rainstorm. Upon arrival at the sites, rain gauges were set up, and lithium chloride dispensing units designed to dispense a set concentration of lithium chloride were set upstream. Grab samples of downstream flow were analyzed for the concentration of diluted lithium ions. The amount of dilution which occurred determined the flow in the sewer. Frequency of grab sampling depended on the intensity of the storm. Following sampling and analysis, the resulting data were modeled using STORM, a continuous simulation model that can be used for prediction of the quantity and quality of stormwater and domestic sewage.

REFERENCES

1. Interim Report on Water Quality. Buffalo Combined Sewer Overflow Study. Buffalo Sewer Authority. Buffalo, New York. February 1982.

2. 208 Areawide Waste Treatment Management and Water Quality Improvement Program. Draft Final Report No. 8 - Combined Sewer Overflow Problems/ Analysis. Erie and Niagara Counties Regional Planning Board. Amherst, New York. December 1977.

3. Telecon. Spencer Scofield, Erie and Niagara Counties Regional Planning Board (716) 625-8114 and Richard Rehm, GCA Corporation, Chapel Hill, North Carolina. August 31, 1982.

CONTACTS

1. Mr. Robert Leary, Calocerinos and Spina Consulting Engineers. (716) 847-1630.

2. Mr. Leo Nowak, Jr., Director, Erie and Niagara Regional Planning Board. (716) 625-8114.

3. Mr. Spencer Scofield, Erie and Niagara Regional Planning Board. (716) 625-8114.

SECTION 26

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE TOWNS OF TONAWANDA AND NORTH TONAWANDA, NEW YORK

BACKGROUND

The Towns of Tonawanda, and North Tonawanda, New York are located north of Buffalo on the Niagara River. The towns have a sewered area of 1,929 acres, serving a population of 57,900 (1970).[1]

The combined sewer systems for these two towns overflow an average 74 times a year. Wet weather flows exceeding interceptor capacity overflow to Elliot Creek, Tonawanda Creek, and the Niagara River. Elliot Creek and Tonawanda Creek flow into the Niagara River, which in turn flows into Lake Ontario. The system contains 16 overflow points: six on Elliot Creek, one on Tonawanda Creek, and nine on the Niagara River. Figure 26-1 shows the location of these overflows.

TOTAL PHOSPHOROUS LOADINGS

Combined sewer overflows from Tonawanda and North Tonawanda contribute a post-ban loading of 6,600 lbs/yr (3.0 MT) of total phosphorous (as P) to the Niagara River. The combined sewer overflows on Elliot and Tonawanda Creeks contribute 200 lbs/yr (3 percent of the total load). The four combined sewer overflows located in Tonawanda on the Niagara River contribute 1,800 lbs/yr; while the five combined sewer overflows on the Niagara River in North Tonawanda contribute 4,600 lbs/yr. Overall, total phosphorous loadings from combined sewer overflows to the Niagara River from Tonawanda and North Tonawanda are minor compared to Buffalo and Niagara Falls. Tonawanda contributes 2.3 percent of the overall loading while North Tonawanda contributes 5.9 percent. Conversely, Buffalo contributes 60.3 percent and Niagara Falls 31.5 percent of the Niagara River loading.[1]

DATA ON OTHER POLLUTANTS

Table 26-1 provides data on other pollutants due to combined sewer overflows to Tonawanda and North Tonawanda. Like total phosphorous, combined sewer overflows from Tonawanda and North Tonawanda contribute a small percentage of the other pollutant loadings to the Niagara River.

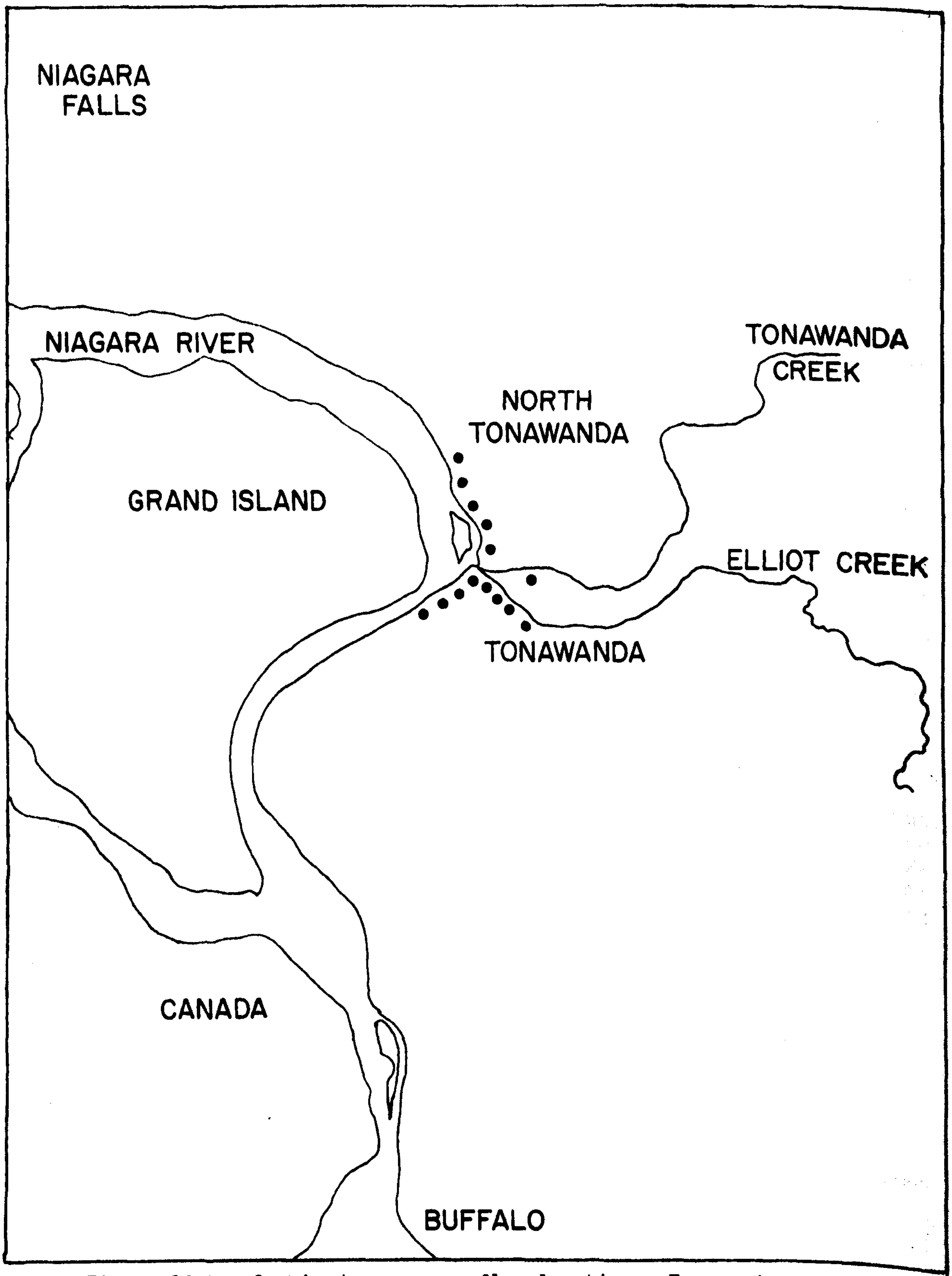


Figure 26-1. Combined sewer overflow locations--Tonawanda and North Tonawanda, NY

TABLE 26-1. ANNUAL LOADINGS FROM CSOs--TONAWANDA AND NORTH TONAWANDA, NY ANNUAL LOADINGS, lbs

	North Tonawanda	Tonawanda	
	Niagara River	Niagara River	Elliot Creek
BOD_5	180,700	71,910	7,995
TSS	302,400	84,170	9,144
TOC	237,200	79,770	8,843
COD	1,251,000	510,200	56,540
TVS	1,152,000	199,500	2,164
Oil & Grease	203,300	63,760	6,836
Ammonia	7,706	2,984	341
Chloride	639,300	192,300	21,100
TKN	43,540	16,750	1,833
Nickel	44,510	54	3

[a]Reference 1.

STORMWATER LOADINGS

The Erie and Niagara Counties Regional Planning Board modeled storm runoff from Tonawanda and North Tonawanda for two storms; August 23-25, 1975, and September 17-18, 1976.[2] The calculated storm runoff for these two storms is shown in Table 26-2. From the information presented in Table 26-2, it was determined that for every inch of rainfall, 108 million gallons of water runs off from the Tonawanda/North Tonawanda area. Total rainfall in the Tonawanda area averages 36.12 inches per year, therefore 3.9 billion gallons of rainwater runs off annually. The storm runoff phosphorous concentration was not monitored during these events. However, a recent report[3] indicates that runoff in Rochester, New York has an average total phosphorous concentration of 0.347 mg/l as P. Due to similarities in land use and geographical location a 0.347 mg/l phosphorous concentration was assigned to Tonawanda/North Tonawanda stormwater. Applying the average phosphorus concentration to the annual runoff volume, the annual stormwater phosphorus loading is estimated to be 11,300 lbs (5.5 MT) total phosphorus (as P) from the Tonawonda/North Tonawanda area.

TABLE 26-2. RUNOFF FROM TWO SELECTED STORMS[a]--TONAWANDA AND NORTH TONAWANDA, NY

Storm	Hour	Rainfall, inches	Runoff, MG		
			Tonawanda Creek	Elliot Creek	Total
08/23-24/75	1	0.03	0.37	1.69	2.06
	2	0.58	11.22	51.21	62.43
	3	0.07	1.35	6.15	7.50
	4	0.40	7.74	35.28	43.02
	5	0.88	17.02	77.75	94.77
	6	0.06	1.11	5.28	6.39
	7	0.02	0.39	1.76	2.15
09/17-18/76	1	0.14	2.13	9.67	11.80
	2	0.55	10.64	48.52	59.16
	3	0.60	11.61	52.94	64.55
	4	0.11	2.13	9.67	11.80
	5	0.01	0.19	0.88	1.07
	6	0.07	1.35	6.15	7.50
	7	0.01	0.19	0.88	1.07
	8	0.03	0.58	2.64	3.22
	9	1.30	25.13	114.89	140.02
	10	0.02	0.39	1.76	2.15

[a]Reference 2.

DATA QUALITY

Total phosphorous loadings were based on a combined sewer overflow sampling program conducted by the Erie and Niagara Counties Regional Planning Board. Combined sewer overflows in residential, commercial, and industrial areas were sampled. Lithium chloride dispensing units were used to measure flow. Frequency of grab sampling depended on the intensity of the storm. Overall, seven combined sewer outfalls were sampled in Erie and Niagara Counties. Total loadings were computed from these seven sampling stations, using the U.S. Army Corp of Engineers Storage, Treatment, Overflow Runoff Model (STORM).[2]

Stormwater runoff volumes are based on limited runoff volume data obtained during two rainfall events.[2] The runoff phosphorus concentration is an estimated value based on aggregate land use. Due to limited data on runoff volume and the use of an assumed phosphorus concentration, the stormwater phosphorus load provided herein should be considered a rough estimate. Additional monitoring data will be required to provide a more accurate estimate.

REFERENCES

1. 208 Areawide Waste Treatment Management and Water Quality Improvement Program. Draft Final Report No. 8-Combined Sewer Overflow Problems/ Analysis. Erie and Niagara Counties Regional Planning Board. Amherst, New York. December 1977.

2. 208 Areawide Waste Treatment Management and Water Quality Improvement Program. Draft Final Report No. 8-Addendum: Storm Modeling. Erie and Niagara Counties Regional Planning Board. Amherst, New York. December 1977.

3. County of Monroe and O'Brien and Gere Engineers, Inc. National Urban Runoff Program, Irondequoit Bay Study. Draft Final Report. November 1982.

CONTACTS

1. Mr. Leo Nowak, Jr., Director, Erie and Niagara Regional Planning Board. (716) 625-8114.

2. Mr. Spencer Scofield, Erie and Niagara Regional Planning Board. (716) 625-8114.

SECTION 27

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF NIAGARA FALLS, NEW YORK

BACKGROUND

The City of Niagara Falls, New York is located on the Niagara River, north of Buffalo. It has a sewered area of 6,660 acres, serving a population of 85,600 (1970).[1] During periods of dry weather, flow is transported by combined sewers to the Niagara Falls wastewater treatment plant. The City's sewer system is 100 percent combined sewers and during significant rainfall events, wet weather flows exceeding interceptor capacity overflow to Gill Creek and the Niagara River. Gill Creek flows into the Niagara River, which, in turn, flows into Lake Ontario.

TOTAL PHOSPHORUS LOADINGS

Combined sewer overflows contribute 24,300 lbs (11.0 MT) of phosphorus (as P) to the Niagara River annually for an average rainfall year. This loading is calculated from data obtained after the 1973 New York phosphorous ban. Seven of the combined sewer overflows discharge directly to the Niagara River from the Gorge Interceptor. Only one combined sewer overflow discharges to Gill Creek. Niagara Falls is responsible for 31 percent of the total phosphorus loadings from CSO's to the Niaraga River. The combined sewer overflows located in Niagara Falls are listed in Table 27-1.[2] Figure 27-1 shows the location of the overflow points.

DATA ON OTHER POLLUTANTS

Table 27-2 provides data on other pollutants discharged from combined sewer overflows. Combined sewer overflows in Niagara Falls contribute 952,800 lbs of BOD_5 and 1,645,000 lbs of TSS annually to the Niagara River.

STORMWATER LOADINGS

Information supplied by the Erie and Niagara Counties Regional Planning Board indicates that the entire Niagara Falls sewerage system is combined. Because of this fact, phosphorus loadings due to separate storm drainage in Niagara Falls is minimal.

TABLE 27-1. COMBINED SEWER OVERFLOWS--NIAGARA FALLS, NY

Overflow number	Location	Receiving stream
001A	Niagara Street	Niagara River
002	Walnut Street	Niagara River
003	Ashland Avenue	Niagara River
005	Bath Avenue	Niagara River
006	Chasm Avenue	Niagara River
007	Maple Avenue	Niagara River
008	Garfield Avenue	Niagara River
009	Weston Avenue	Gill Creek

TABLE 27-2. ANNUAL LOADINGS FROM COSs--NIAGARA FALLS, NY

Parameter	Loading, lbs/yr
BOD_5	952,800
TSS	1,645,000
TOC	1,269,000
COD	6,584,000
TVS	6,419,000
Oil & Grease	1,098,000
Ammonia	40,580
Chloride	3,455,000
TKN	230,700
Nickel	257,700

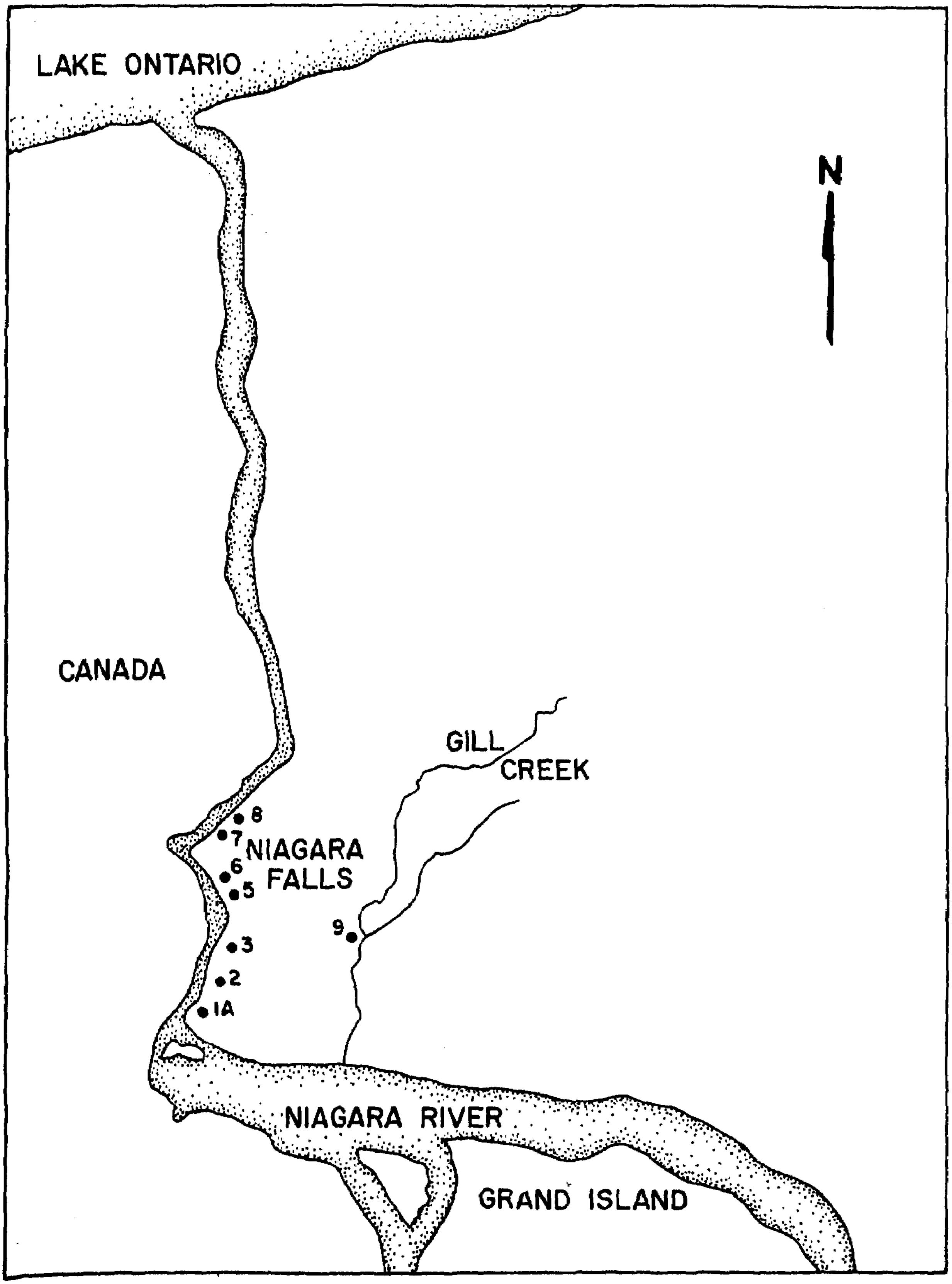


Figure 27-1. Combined sewer overflow locations--Niagara Falls, NY.

DATA QUALITY

Total phosphorus loadings were based on a combined sewer overflow sampling program conducted by the Erie and Niagara Counties Regional Planning Board. Combined sewer overflows in residential, commercial, and industrial areas were sampled. CSO flow data were developed from lithium chloride dye dilution studies. As a rainstorm approached, close contact with the Weather Bureau was maintained in order to arrive at the sampling sites, rain gauges were set up, and lithium chloride dispensing units designed to dispense a set concentration of lithium chloride were set upstream. Grab samples of downstream flow were analyzed for the concentration of diluted lithium ions. The amount of dilution which had occurred determined the flow in the sewer. Frequency of grab sampling depended on the intensity of the storm. Following sampling and analysis, the resulting data were modeled using Water Resources Engineers STORM (Storage, Treatment, Overflow, and Runoff Model), a continuous simulation model that can be used for prediction of the quantity of stormwater and domestic sewage.

REFERENCES

1. 208 Areawide Waste Treatment Management and Water Quality Improvement Program. Draft Final Report No. 8 - Combined Sewer Overflow Problems/ Analysis. Erie and Niagara Counties Regional Planning Board. Amherst, New York. December 1977.

2. Improvements to Wastewater Facilities Report on Completion of Facilities Plan for Flow Reduction for City of Niagara Falls, New York. Camp, Dresser, and McKee. Boston, Massachusetts. November 1981.

CONTACTS

1. Mr. Robert Mathews, Director of Utilities, City of Niagara Falls. (617) 742-5151.

2. Mr. Leo Nowak, Jr., Director, Erie and Niagara Regional Planning Board. (716) 625-8114.

3. Mr. Spencer Schofield, Erie and Niagara Regioal Planning Board. (716) 625-8114.

SECTION 28

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS
FROM THE CITY OF ROCHESTER, NEW YORK

BACKGROUND

The City of Rochester, New York is located in the western portion of New York State and borders on the south shore of Lake Ontario. The major receiving water bodies in the area, in addition to Lake Ontario, are the Genessee River, which roughly bisects the City, and Irondequoit Bay, which lies to the northeast. Rochester has a sewered area of 23,400 acres, serving a population of 242,000 (1980). The sewerage system is largely combined. During dry weather, flow is transported by trunk sewers and interceptors to the Van Lare Wastewater Treatment Plant located on Lake Ontario. During wet weather, flows exceeding interceptor capacity enter the Genessee River and Irondequoit Bay.

Within the City of Rochester there are 13 major combined sewer overflow points. Nine of these overflow to the Genessee River, while four overflow to Irondequoit Bay. Figure 28-1 shows the location of the overflow points. Overflows to the Genessee River and Irondequoit Bay occur approximately 66 days per year. The CSOs impose heavy pollutant loadings on these receiving bodies, and cause bacterial contamination of the public bathing beaches along Lake Ontario in the vicinity of the mouth of the Genessee River. Monroe County is currently implementing a CSO control measures program to reduce the impact of CSOs.

COMBINED SEWER OVERFLOW VOLUMES

Combined sewer overflows that discharge to the Genessee River have been evaluated and reported in available literature. Data on combined sewer overflows which discharge to Irondequoit Bay are not currently available, therefore, most of the information in this report focuses on overflows to the Genessee River.[1]

Annual overflows to the Genessee River are estimated to be 1.67 billion gallons from nine combined sewer overflows. The overflow location and volume are listed in Table 28-1. In addition, it has been reported that a total of 1.9 billion gallons overflow from all of Rochester's CSO's, based on results from a simplified version of EPA's stormwater management model (SWMM).[2]

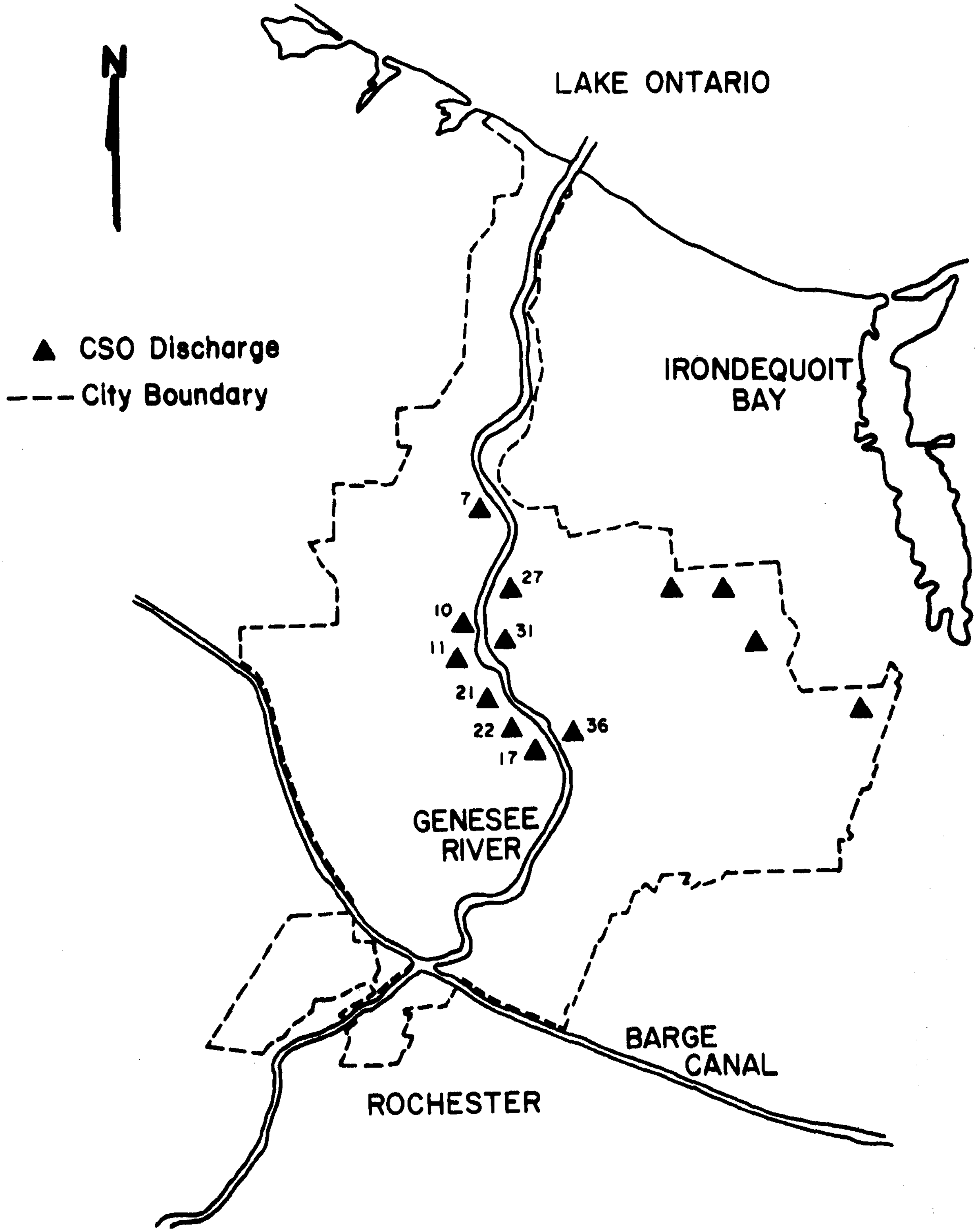


Figure 28-1. Combined sewer overflow locations--Rochester, NY.

TABLE 28-1. ANNUAL LOADINGS FROM COSs TO THE GENESSEE RIVER--ROCHESTER, NY

Site no.	Name	Mean TIP[a] concentration, mg/l	Overflow, MG	TIP loads, lbs/yr
7	Maplewood	1.21	84	850
10	Lexington	0.95	73	580
11	WSTS	2.33	588	11,430
17	Spencer	1.28	62	660
21	Mill and Factory	1.01	129	1,090
22	Front	1.43	230	2,740
27	Seth Green	1.22	174	2,770
31	Carthage	2.32	144	2,790
36	Central	0.78	186	1,210
Total			1,670	23,120

[a]Total Inorganic Phosphorus.

TOTAL PHOSPHOROUS LOADINGS

The nine combined sewer overflows which discharge to the Genessee River contribute 23,120 pounds to total inorganic phosphorous (TIP) annually. Based on information from Metcalf and Eddy, two-thirds of total phosphorous in CSOs is inorganic.[3] Assuming this is true for Rochester, 34,680 lbs (15.8 MT) of of phosphorous (as P) are discharged to the Genessee River from nine combined sewer overflows.

Annual CSO discharge to Irondequoit Bay is estimated to be 230 million gallons. Assuming the phosphorous concentration is similar to that of Genessee River CSOs the Irondequoit Bay CSO load is estimated to be 4,776 lbs (2.2 MT). The total annual CSO phosphorous load from Rochester is therefore 39,456 lbs (17.9 MT).

Monroe County is currently implementing a CSO control measures program, which will significantly reduce the number and duration of overflow events.[4] These measures should be considered when projecting future loads.

DATA ON OTHER POLLUTANTS

Information is available on the discharge of other pollutants to the Genessee River from combined sewer overflows. The reader should refer to Reference 1 for further information.

STORMWATER LOADINGS

A study quantifying stormwater phosphorous loads to the Irondequoit Bay area of Lake Ontario has recently been prepared.[5] The study area includes a watershed of approximately 169 square miles. The predominant land types are identified as urban, suburban and rural. As indicated in Figure 28-2, the area includes eastern portions of the City of Rochester and the Townships of Irondequoit, Webster, Brighton, Henrietta, Penfield, Pittsford, Perinton and Mendon. Also included are portions of the Townships of Victor, West Bloomfield, and Macedon.

A stormwater runoff model known as EPAMAC was used to calculate phosphorous loads. This model provides a simplified mathematical representation of rainfall-runoff-loading. Runoff phosphorous loadings were calculated by multiplying concentration by the volume of runoff corresponding to the phosphorous concentration. To account for variations in land type and runoff patterns, the area was divided into four subbasins. Runoff coefficients were determined for each subbasion from flow monitoring and land use studies. These coefficients were found to have substantial seasonal variation. Phosphorous concentration data were obtained by sampling at several monitoring sites during storm events. Phosphorous concentration data also showed significant seasonal variation. The model was calibrated and verified using observed loadings from several storm events. Loadings predicted by the model were found to closely simulate observed values.

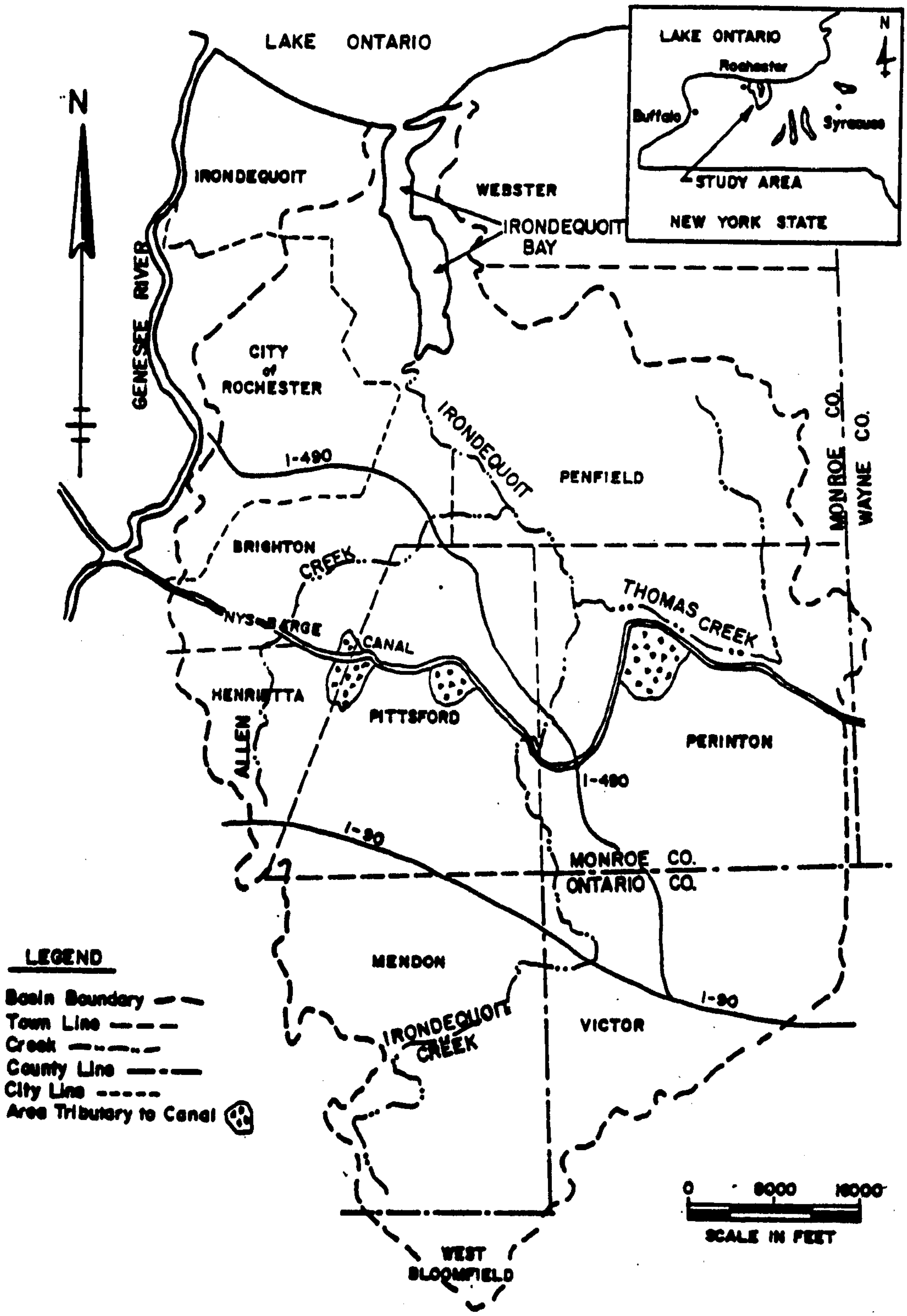


Figure 28-2. Stormwater study area location[4]--Rochester, NY.

Table 28-2 provides estimates of annual phosphorous loads for each of the four subbasins. The subbasin area and associated runoff coefficients and phosphorous concentrations are also provided. The lowest runoff coefficients are found in rural areas, the highest being associated with urban and suburban areas. A similar pattern can be seen with the average annual phosphorous concentrations. Table 28-2 also provides annual unit loads and total annual phosphorous loads by subbasin. In total, the stormwater phosphorous load to Irondequoit Bay is given as 32,054 lbs (14.6 MT).

DATA QUALITY

Information on flow and total inorganic phosphorous concentrations to the Genessee River from combined sewer overflows is detailed and well-documented. All nine overflow points were monitored for 1 1/2 years. In addition to flow, BOD, TSS, TKN, and TIP were monitored. Overflows were recorded for each rainfall event. EPA's Storm Water Management Model was utilized to determine annual overflow volumes. It was estimated that total inorganic phosphorous accounted for two-thirds of the total phosphorous, based on information in Metcalf and Eddy.[3]

Stormwater loadings were determined in a recent modeling study.[5] Extensive monitoring data was used to calibrate and verify the model. Rochester area stormwater phosphorous loads are therefore relatively accurate. Loadings are not provided for portions of Rochester located west of the Genesee River. However, this area is likely to have a minimal stormwater loading as all sewers are reportedly combined.

TABLE 28-2. STORMWATER PHOSPHOROUS LOADINGS DATA--ROCHESTER, NY

Subbasin	Predominant land type	Area, acres	Annual average runoff coefficient	Average phosphorous concentration, mg/l	Unit loading, lb/a/yr	Phosphorous load, lbs/yr
Thornell	Rural	28,437	0.10	0.097	0.41	11,659
Thomas CK	Rural/some suburban	18,254	0.20	0.105	0.16	2,920
Allen CK	Suburban/some urban	19,280	0.32	0.260	0.62	11,954
Centeal	Suburban/some rural	25,620	0.28	0.193	0.21	5,383
						31,916

REFERENCES

1. Best Management Practices Implementation Rochester, New York. EPA-905/9-81-002. Great Lakes National Program Office. U.S. Environmental Protection Agency. Chicago, Illinois. April 1981.

2. Combined Sewer Overflow Abatement Program Rochester, New York - Volume 1 Abatement Analysis. EPA-600/2-79-031a. Great Lakes National Program Office. U.S. Environmental Protection Agency. Chicago, Illinois. July 1979.

3. Wastewater Engineering: Collection, Treatment, Disposal. Metcalf & Eddy, Incorporated. McGraw-Hill, Inc. New York, NY. 1978.

4. Written Communication, Mr. Phillip DeGaetano, P.E. Director Metropolitan Projects Bureau New York DEC to Thomas J. Nunno, GCA/Technology Division, 26 April 1983.

5. County of Monroe and O'Brien and Gere Engineers, Inc. National Urban Runoff Program, Irondequoit Bay Study. Draft Final Report. November 1982.

CONTACTS

1. Mr. John Davis, Monroe County Department of Wastewater Management. (716) 428-5090.

2. Dr. Neil Murphy, O'Brien and Gere. (315) 451-4700.

SECTION 29

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS FROM THE CITY OF OSWEGO, NEW YORK

BACKGROUND

The City of Oswego is located on the shore of Lake Ontario at the mouth of the Oswego River. The Oswego River flows through the center of Oswego, dividing the city into areas identified as the East Side and the West Side. Due to this division duplicate collection systems have been installed to provide sewer service to both sections of the city. The CSO analysis for this report focuses on the West Side system because all discharges from that system are untreated.

The East Side is serviced by both combined and separate sewers. The East Side combined sewer service area (CSSA) is in the older sections, adjacent to the River. During dry weather all East Side combined and separate sewage is conveyed to the East Side Wastewater Treatment Plant. During periods of wet weather the East Side combined sewers have the capacity to transport three times the normal dry weather flow. When this flow is exceeded, the excess is diverted to one of two available 0.75 MG retention basins. Wastewater is screened prior to entering the basins. The basins are designed to provide a minimum storage time of 15 minutes to allow sedimentation and chlorine contact. Both basins are effluent to the Oswego River. The available data sources provide no estimates of flow rates and water quality of the basin discharges. Consequently, the phosphorous load from the East Side CSSA could not be determined.

The West Side of Oswego is also serviced by both combined and separate sewers. Approximately 980 acres of the West Side are serviced by separate sewers. This area contains 19 miles of sanitary sewers and 5 miles of storm sewers. The West Side CSSA covers approximately 445 acres and contains 16 miles of sewer. Wastewater collected in the sanitary system is conveyed to the West Side Treatment Plant. At the present time all sanitary sewage and stormwater collected in the CSSA are conveyed to the Oswego River and dischared untreated through 16 outfalls. The relative locations of these outfalls are provided in Figure 29-1.

COMBINED SEWER OVERFLOW VOLUMES

Flow volume from the West Side CSSA was based on the distribution of storms expected during an average rainfall year. This distribution is graphically represented by probability curves of daily average flow rate and peak flow rate shown in Figure 29-2. The average daily flow data indicates a

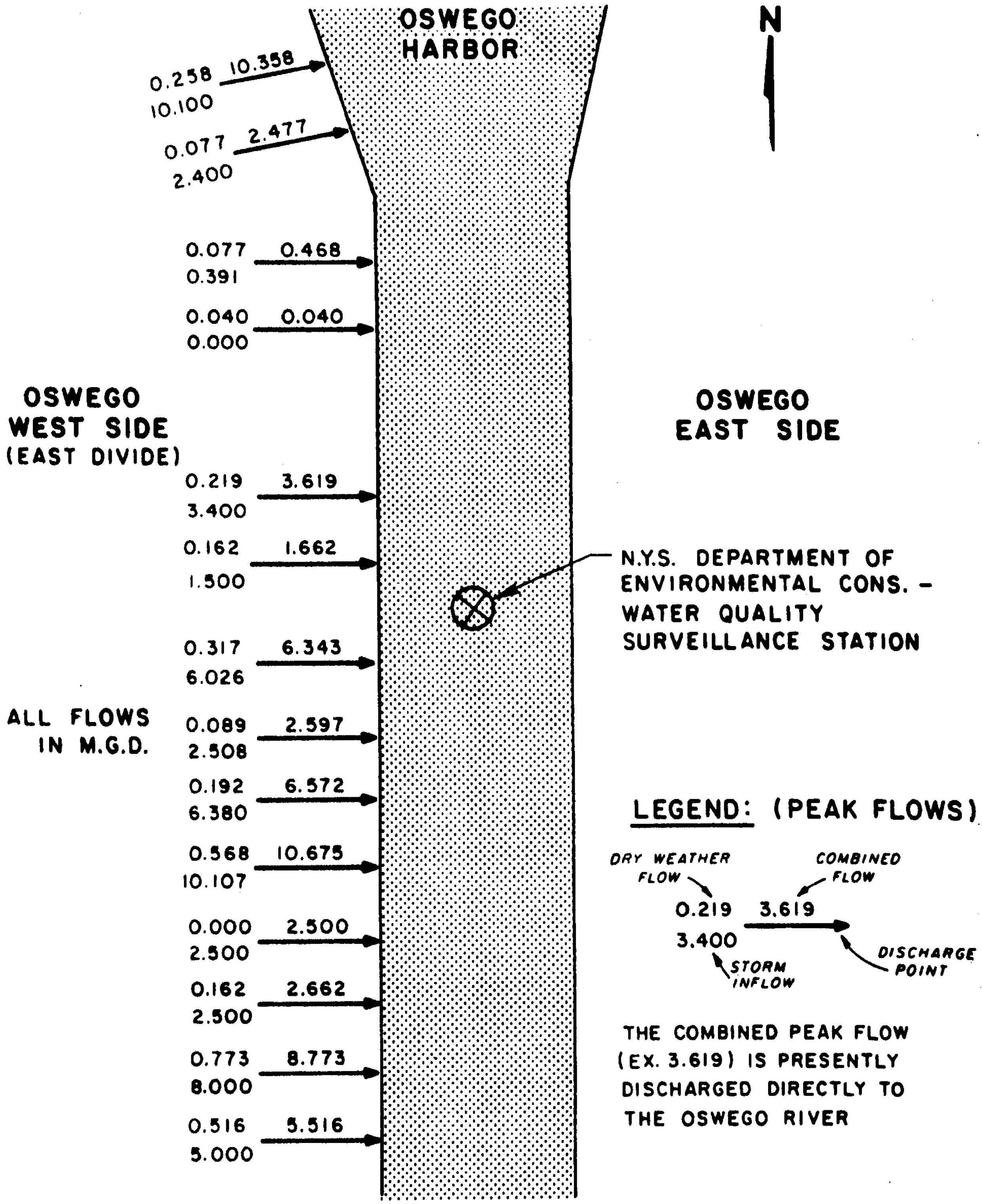


Figure 29-1. West Side CSSA outfalls--Oswego, NY.

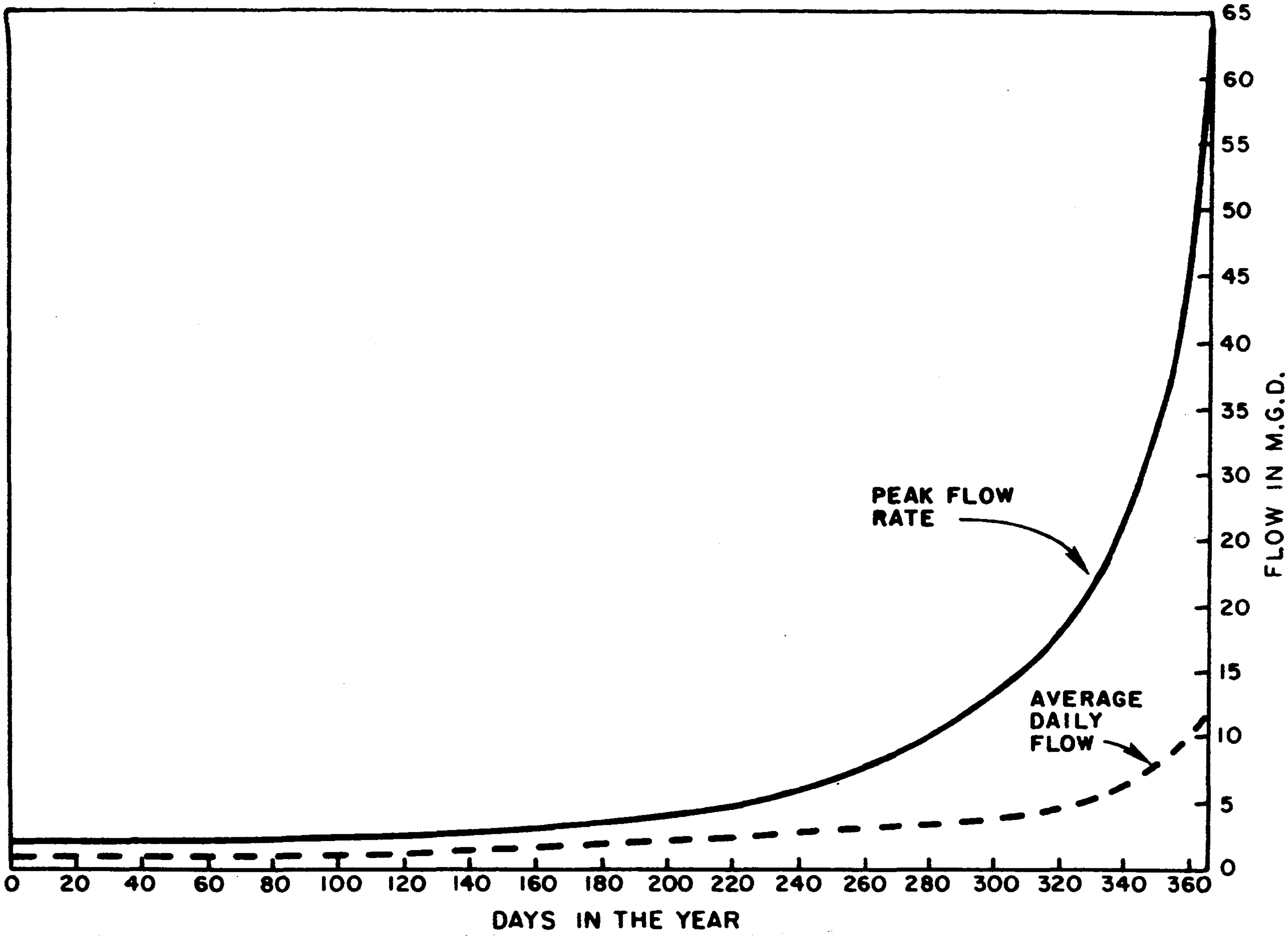


Figure 29-2. West Side CSO peak and average flow probability curves--Oswego, NY.

dry weather base flow of 1.15 MGD during an expected 120 dry days. The flow volume increases exponentially up to the 365th day which represents the 1-year event. By determining the area bounded by the curve, the total annual volume of untreated flows discharged by the West Side system was found to be 1,096 million gallons.

TOTAL PHOSPHOROUS LOADINGS

Phosphorous concentrations are not reported in the available literature. To provide a loading estimate, a post-ban phosphorous concentration of 3.4 mg/l as P was assumed to be typical of Oswego combined sewer discharges. Applying this concentration to the annual flow volume (1,096 MG) the loading was found to be 31,028 lbs (14.1 MT). At the present time, an interceptor is being constructed to collect and transport CSSA wastewater to the West Side Treatment Plant. This interceptor will handle a maximum flow rate of 3.45 MGD; three times the average dry weather flow. In the future, excess flow will be diverted to a swirl concentrator for solids removal followed by discharge to the Oswego River. This equipment is expected to be in operation by the end of 1983.

DATA ON OTHER POLLUTANTS

Pollutant loadings are not provided in the available literature. Limited data on BOD_5, SS, and VSS concentrations are given on page 3 of Reference 1.

STORMWATER LOADINGS

Data on stormwater phosphorous loads for Oswego were found to be unavailable. Consequently, it was necessary to develop this data from land use maps and related studies on areas similar to Oswego. Oswego area land use maps were obtained from the Research Information Laboratory of Cornell University. Data correlating land use to runoff volume and stormwater phosphorous concentrations were found in Reference 3 which provides runoff coefficient and phosphorous concentration data for urban, suburban, and rural land uses in the Rochester, New York area. Additional data on runoff coefficients were obtained from Reference 4.

As shown in Figure 29-3, the City of Oswego was divided into four zones based on land use. The west side of Oswego covers an area of approximately 1,900 acres. Using land use maps, a total area of 644 acres were identified as being urban (Zone 1), 200 acres of which are serviced by separate sewers. The remaining 1260 acres of the west side identified as Zone 2, are predominantly suburban, the major land uses being medium density residential and inactive urban.

The east side of Oswego covers approximately 2200 acres. The urbanized portion of the east side, identified as Zone 3, covers 750 acres. Although estimates are not available, portions of the east side are known to be serviced by combined sewers. Assuming the CSSA covers 550 acres, the remaining storm sewer service area is 200 acres. Predominant land uses in the remaining 1450 acres (Zone 4) of the east side are inactive agricultural and forested land with some low density residential areas. Overall, the non-urban portion of the east side is best classified as being rural.

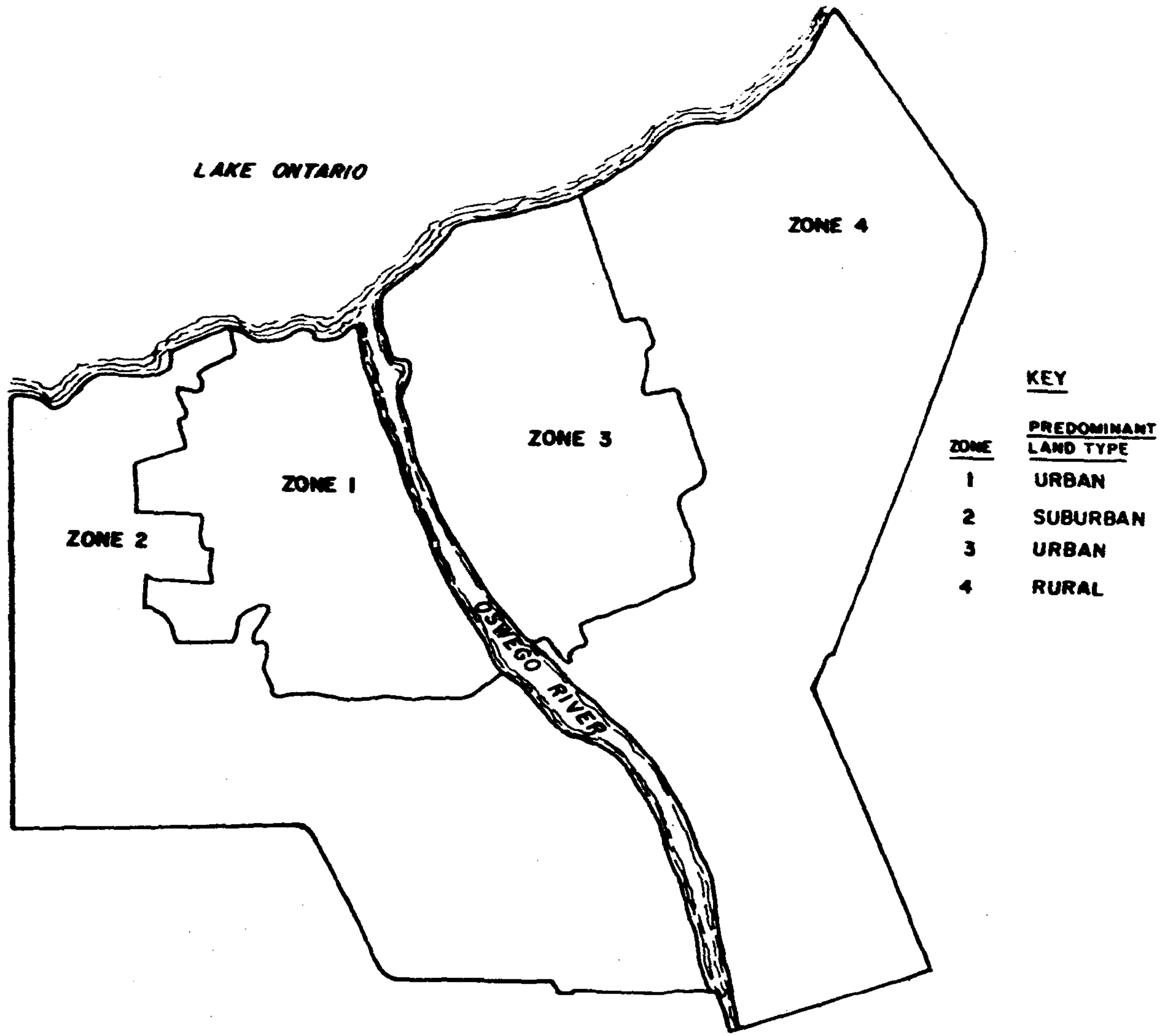


Figure 29-3. Land use zones--Oswego, NY.

Annual phosphorous loads along with area, runoff coefficients, and phosphorous concentration estimates are provided in Table 29-1 for four Oswego subareas. Loadings are based on an average annual rainfall of 35 inches. Applying the average phosphorous concentration to the annual runoff volume, the annual stormwater phosphorous loading is estimated to be 1,182 lbs (0.53 MT) total phosphorous (as P) from the Oswego area.

DATA QUALITY

Combined sewer flow volumes are based on monitoring data obtained at several outfall locations. The method used to monitor flow was not provided. Phosphorous concentration data was found to be unavailable, necessitating the use of an assumed value to calculate loadings. Phosphorous concentrations are expected to be substantially reduced by the end of 1983, after which combined sewage will be rerouted to treatment facilities.

Stormwater loadings were obtained from available data on land use in Oswego and typical runoff coefficients and stormwater phosphorous concentrations associated with each land use type. Since assumed values had to be applied, rather than actual monitoring or modeling data, the stormwater loadings given are subject to significant inaccuracies.

TABLE 29-1. ANNUAL STORMWATER LOADINGS--OSWEGO, NY

Zone	Area, acres	Runoff coefficient, decimal	Runoff volume, MG	Phosphorous concentration, mg/l	Annual phosphorous load, pounds
West side, urban	200	0.40	76	0.347	220
West side, suburban	1,260	0.28	335	0.183	512
East side, urban	200	0.40	76	0.347	220
East side, rural	1,450	0.20	276	0.100	230
			763		1,182 (0.53 MT)

REFERENCES

1. City of Oswego, New York. West Side - East Divide Combined Sewer Overflow Project, Desk Top Study. Nussbaumer and Clark, Inc. May 1980.

2. Environmental Assessment for the Proposed Sewage Collection Facilities, City of Oswego, New York, West Side. Ecology and Environment, Inc. for Nussbaumer and Clark, Inc. April 1977.

3. County of Munroe and O'Brien and Gere Engineers, Inc. National Urban Runoff Program, Irondequoit Bay Study. Draft Final Report. November 1982.

4. Huber, W. C., J. P. Heaney, K. J. Smolenyak, and D. A. Aggidis. Urban Rainfall-Runoff-Quality Data Base. EPA-600/8-79-004. August 1979.

CONTACTS

1. Mr. Ray Cleary, Chief Operator, East Side Treatment Plant. (315) 342-2501.

2. Mr. Don Davis, Chief Water Resources Chemist, West Side Treatment Plant. (315) 312-3777.

3. Mr. Tony Leota, Engineer, City of Oswego. (315) 342-5600.

SECTION 30

OVERFLOW AND BYPASS PHOSPHOROUS LOADINGS
FROM THE CITY OF SYRACUSE, NEW YORK

BACKGROUND

Combined sewer systems are employed in portions of the central urbanized area of Onondaga County, an area consisting of the City of Syracuse, and adjacent sections of the suburban towns of Dewitt, Salina, and Geddes. Sewage is conveyed either to the Metropolitan Sewage Treatment Plant (Metro) or to the Ley Creek Sewage Treatment Plant. The Ley Creek Plant provides intermediate treatment only, effluent from which is conveyed to the Metro plant via a force main. The collection system consists of the following three major interceptor systems:

- Main Intercepting Sewer (MIS). The system follows Onondaga Creek and is tributary to the Metro treatment plant. The sewer runs approximately 27,000 feet and services a total area of about 10,800 acres. The service area is located within the City of Syracuse and town of Dewitt.

- Harbor Brook Intercepting Sewer (HBIS). The HBIS System runs approximately 15,700 feet adjacent to Harbor Brook, ending at the Metro treatment plant. The service area consists of 1,600 acres, located entirely within the City of Syracuse.

- Ley Creek Intercepting System (LCIS). The LCIS is a 30,000 foot system tributary to the Ley Creek treatment plant. This sewer serves an 8,750 acre area located in and adjacent to the northeastern section of Syracuse.

Approximately 7,000 acres of the sewered area is serviced by combined sewers. A CSO service area breakdown is provided in Table 30-1. The locations of CSOs within the MIS and the HBIS are illustrated in Figures 30-1 and 30-2, respectively. The combined sewers are located primarily within the MIS and HBIS Systems. Overflows to Ley Creek are reported to occur only during certain unusual storm conditions. The MIS and HBIS systems have a combined maximum capacity of 150 MGD, about twice the anticipated dry weather flow. When this capacity is exceeded overflow begins at several of the overflow points, including two Metro treatment plant bypasses and seven manually controlled pumping station bypasses.

TABLE 30-1. ANNUAL PHOSPHOROUS LOADINGS FROM CSO--SYRACUSE, NY

CSO No.	CSO name	Interception sewer	Overflow drainage area, acres	% of total overflow	Overflow volume, MG	Annual Phosphorous Loading[a]
003	Hiawatha Blvd.	Harbor Brook	87.2	-	-	---
004	State Fair Blvd.	Harbor Brook	262.0	0.48	7.97	232.6
014	Delaware & Amy	Harbor Brook	178.1	9.04	150.06	4,380.3
020	Route 690-Butternut	Main-Lower	559.0	0.20	3.32	96.9
021	Route 690-Burnet	Main-Lower	465.0	3.48	57.77	1,686.3
022	Wallace & W. Genesee	Main-Lower	14.5	-	-	---
026	Fayette St.-West	Main-Lower	27.5	0.10	1.66	48.5
027	Fayette St.-East	Main-Upper	100.8	0.41	6.81	198.8
029	Walton St.-East	Main-Upper	5.8	0.20	3.32	96.9
030	Jefferson St.-East	Main-Upper	318.2	2.18	36.19	1,056.4
031	Jefferson St.-West	Main-Upper	17.3	0.87	14.44	421.5
034	Clinton & W. Onondaga	Main-Upper	131.6	16.08	266.93	7,791.7
036	West Onondaga	Main-Upper	175.0	4.07	67.56	1,972.1
039	Tallman St.-East	Main-Upper	276.9	3.47	57.60	1,681.3
042	Midland-West	Main-Upper	266.7	14.63	242.86	7,089.1
043	Midland-East	Main-Upper	303.0	4.86	80.68	2,355.0
044	West Castle & South Ave.	Main-Upper	117.9	2.63	43.66	1,274.4
052	Elmhurst & Hunt	Main-Upper	236.0	0.99	16.43	479.6
058	West St. & Tracy	Main-Upper	1.9	0.02	0.33	---
060	West Collin & Creek	Main-Upper	409.0	0.45	7.47	218.0
062	Emerson Ave. Northeast	Main-Upper	70.0	1.74	28.88	843.0
073	Teall Ave.	Main-Upper	436.0	1.19	19.75	576.5
074	Springs & Hiawatha	Main-Upper	387.0	0.23	3.82	111.5
076	Brighton & Midland	Main-Midland	44.7	13.75	228.25	6,662.6
080	Erie Blvd.	Main-Lower	761.0	1.95	32.37	944.9
	Remaining CSOs		1,175	16.98	281.87	8,227.8
	Total		6,827	100.00	1,660	48,445.7

[a]Based on average total phosphorous concentration of 3.5 mg/l as P.

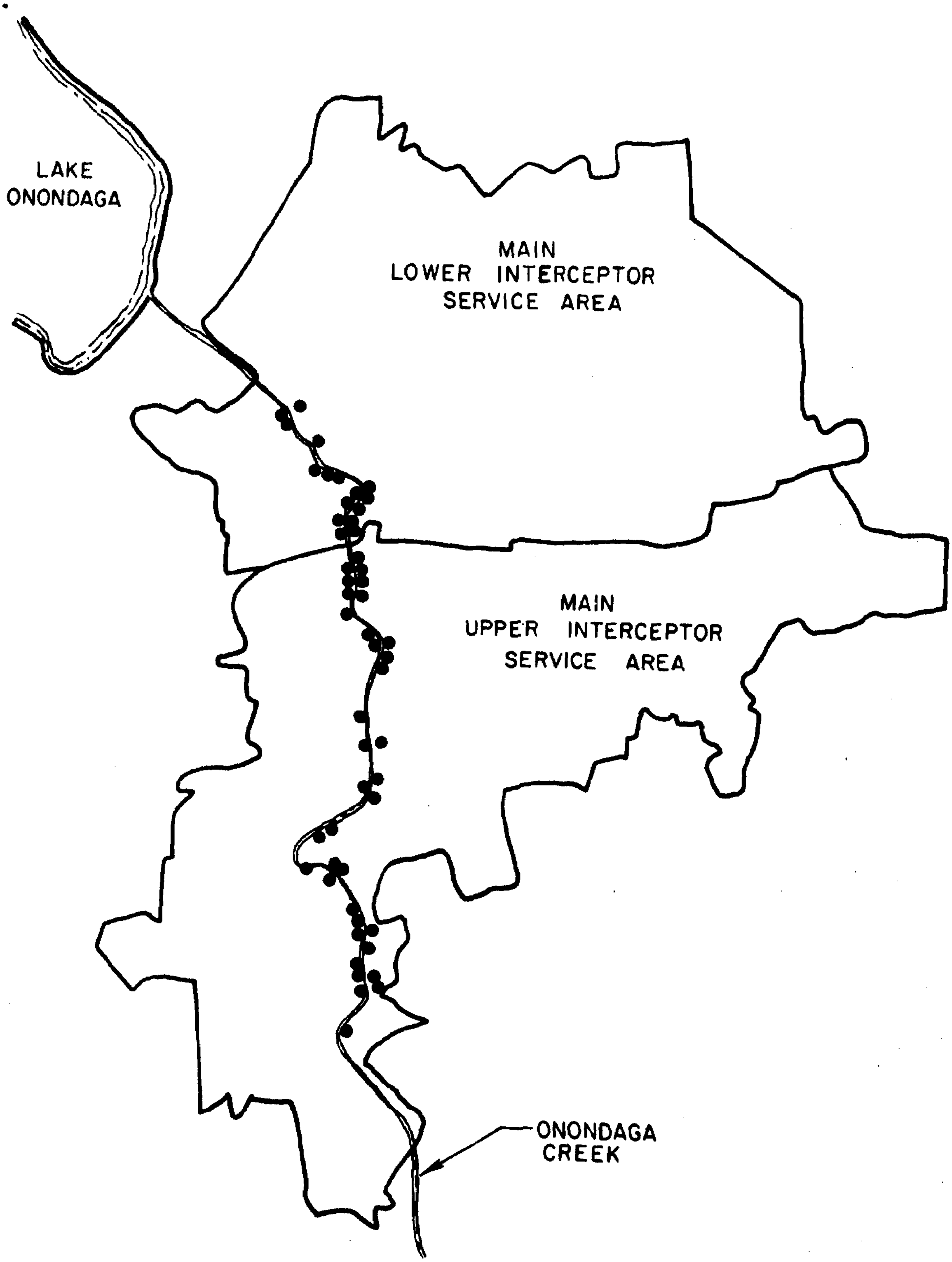


Figure 30-1. MIS combined sewer overflow locations--Syracuse, NY.

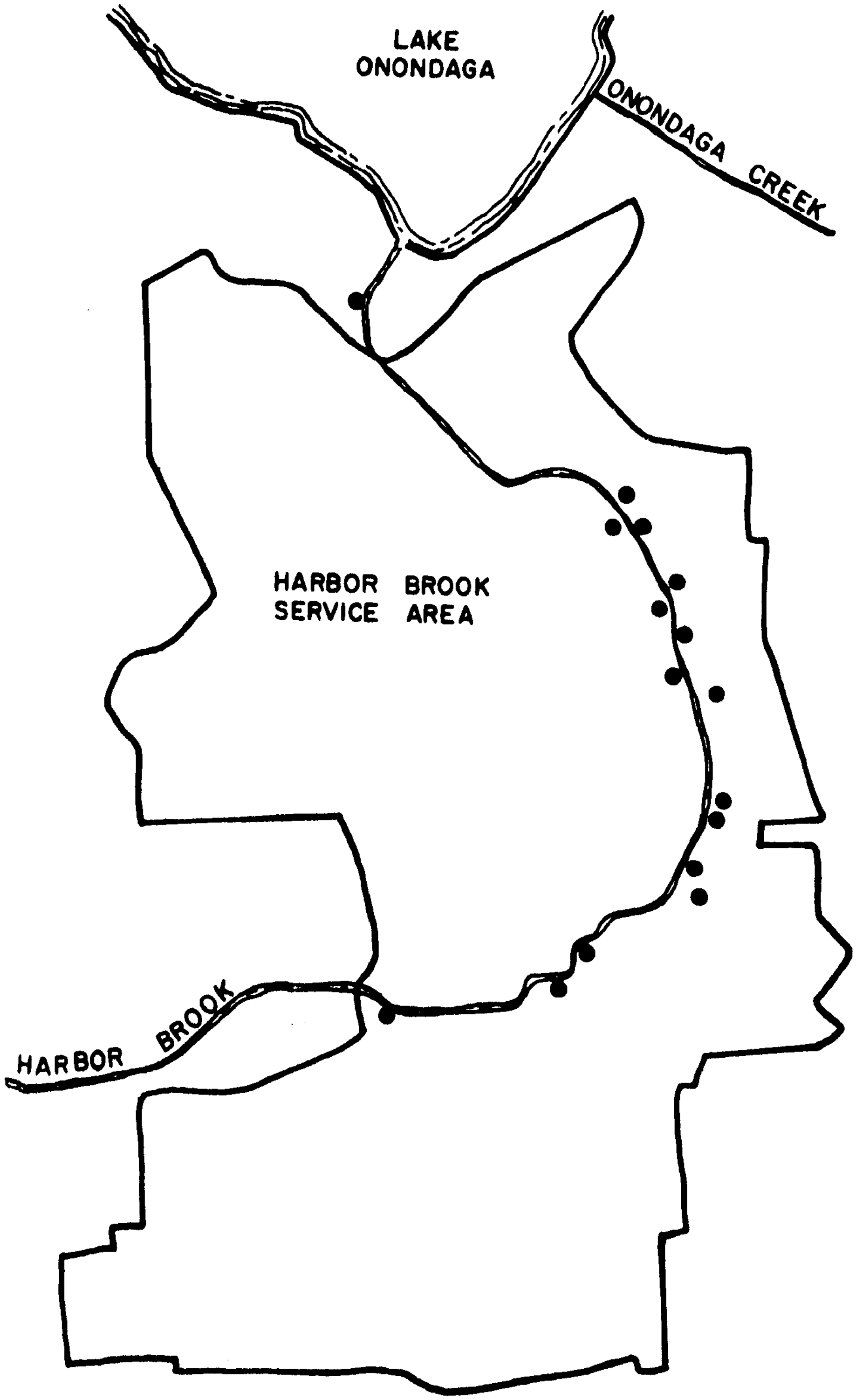


Figure 30-2. HBIS combined sewer overflow locations--Syracuse, NY.

In 1977, the consulting firm of O'Brien and Gere conducted an extensive CSO study for the Onondaga County Department of Drainage and Sanitation. Of the 84 overflow points, 25 sites (identified in Table 30-1), representing 83 percent of the overflow were monitored. Monitoring of flow and water quality was conducted from January through June of 1977. In this time period 280 individual overflows during 13 storm events were observed.

COMBINED SEWER OVERFLOW VOLUMES

A simplified version of EPA's Stormwater Management Model (SWMM) was used to simulate overflow volumes. This model accounts for total rainfall on a mass balance-volumetric basis. The major input data requirements are land area in acres, the gross runoff coefficient, and the system storage capacity and treatment rate. Flow measurement data was used to calibrate the model. During an average year the model predicts the total annual overflow to be 1,660 million gallons. Using this estimate of total annual flow, GCA calculated annual overflow volumes for each of the monitored sites listed in Table 30-1 and provided a combined estimate of flow from the unmonitored CSOs. The following technique was used to estimate annual flow for individual CSOs:

$$\text{Annual CSO flow} = \frac{\text{Measured CSO flow, MG (Jan.-June 1977)}}{\text{Measured Total flow, MG (Jan.-June 1977)}} \times \begin{matrix}\text{total}\\ \text{annual}\\ \text{flow}\end{matrix} \quad \frac{\text{MG}}{\text{year}}$$

Input data required for this Equation are provided in Reference 1.

COMBINED SEWER OVERFLOW QUALITY

The O'Brien and Gere study reported phosphorous as total inorganic phosphorous for each of 25 monitored CSOs. In general, these phosphorous concentrations were found to be very low, ranging from 0.11 mg/l to 1.06 mg/l with an average value of 0.45 mg/l. Further inquiry with the Syracuse Department of Drainage and Sanitation led to the conclusion that these values are unrealistically low and were likely determined from filtered samples.[2] Influent phosphorous concentration data obtained from the Metro plant indicates a mean total phosphorous concentration of 3.5 mg/l. Total phosphorous concentrations were found to be independent of weather conditions.

TOTAL PHOSPHOROUS LOADINGS

Phosphorous loading data on the 25 monitored CSOs are presented in Table 30-1. By summing the CSO phosphorous loads, the total annual load was found to be 48,466 lbs (22 MT). The CSOs discharge to either Harbor Brook or Onondaga Creek which in turn discharge to Lake Onondaga (a body of water measuring approximately 1 x 4.5 miles) located at the northern boundary of Syracuse. The lake is effluent to the Oswego River which flows north to Oswego where it discharges into Lake Ontario.

DATA ON OTHER POLLUTANTS

During the CSO study additional quality data were obtained for Total Suspended Solids (TSS), Volatile Suspended Solids (VSS), Total Kjeldahl Nitrogen (TKN) and Fecal Coliforms (F. Coli.) Table 30-2 provides quality data for these pollutants on the 25 monitored CSOs. Flow data provided in Table 30-1 can be used to determine average yearly loadings.

STORMWATER LOADINGS

Sources at the Onandaga County Department of Drainage and Sanitation indicated that there have been no studies on stormwater loadings in the Syracuse area.[2] Consequently, GCA's estimation of the stormwater phosphorous load is be based on Syracuse land use data, and runoff and phosphorous concentration data developed in related studies for similar areas. Land use maps were obtained from the Research Information Laboratory of Cornell University. Runoff coefficient and phosphorous concentration data were obtained from Reference 3, a study quantifying stormwater phosphorous loads in the Rochester, New York area, and Reference 4, which provides data relating rainfall to urban runoff for several metropolitan areas.

Using land use maps, the total urban area within the corporate limits of Syracuse was found to be approximately 14,400 acres. Subtracting out the area serviced by combined sewers of approximately 7,000 acres (to avoid double counting), storm sewers are shown to service approximately 7,400 acres within urban areas of Syracuse. Suburban land types within the city occupy approximately 1,200 acres.

Annual stormwater phosphorous loads are presented in Table 30-2. Also included are acreage, runoff coefficients and phosphorous concentrations used to calculate loadings. Loadings are based on an annual average rainfall of 35 inches which results in a total runoff of 3,132 MG. In total, the annual stormwater phosphorous load from Syracuse was found to be 8,627 lbs (3.9 MT); 8,140 lbs (3.7 MT) from urban areas and 487 lbs (0.2 MT) from suburban areas.

DATA QUALITY

As previously stated, the total overflow volume for Syracuse was calculated using a simplified SWMM Model. The model was calibrated using 6 months of monitored flow data at 25 CSO locations. Phosphorous concentration data in Reference 1 is highly suspect due to the extremely low values reported. This data was therefore substituted with the mean phosphorous concentration (3.5 mg/l) reported for the treatment plant influent. This concentration compares closely with that given for other areas subject to a detergent phosphorous ban.

Stormwater loadings for Syracuse were obtained by quantifying area by land use category and then applying typical runoff coefficients and stormwater phosphorous concentrations which were developed in related studies. Since this analysis required the application of unverified, estimated values, the Syracuse stormwater loadings presented herein should be considered rough order-of-magnitude estimates.

TABLE 30-2. SUMMARY OF QUALITY DATA FOR SELECTED PARAMETERS ON A SITE-BY-SITE BASIS--SYRACUSE, NY

Site No.	Geometric mean of selected parameters				
	TSS, mg/l	VSS, mg/l	BOD_5, mg/l	TKN, mg/l	Fecal forms, mpn
003	579	208	104	2.74	1,548,760
004	282	67	43	1.20	3,108,610
014	270	93	49	2.09	1,366,320
020	92	34	61	1.83	-
021	131	59	35	1.42	241,639
022	759	127	36	0.41	124,961
026	179	103	44	1.08	594,155
027	392	247	116	3.45	-
029	177	59	53	1.18	626,230
030	367	152	91	5.17	1,284,940
031	469	34	155	2.41	-
034	103	61	23	1.62	4,157,600
036	553	294	141	7.00	1,616,410
039	138	77	59	2.77	1,271,180
042	201	109	90	6.72	4,806,170
043	499	165	70	5.88	1,725,810
044	298	140	52	2.28	2,632,920
052	442	156	55	3.38	1,437,630
058	-	-	-	-	-
060	1,736	264	112	5.53	3,213,820
063	632	105	48	3.86	80,738
073	194	-	30	0.70	222,199
074	185	38	23	1.22	6,830,100
076	1,327	171	17	0.40	62,548
080	756	55	41	0.93	409,242

TABLE 30-3. ANNUAL STORMWATER LOADINGS--SYRACUSE, NY

Land use	Area, acres	Runoff coefficient, decimal	Runoff volume, MG	Phosphorous concentration, mg/l	Annual phosphorous, lbs
Urban	7,400	0.40	2,813	0.347	8,140
Suburban	1,200	0.28	319	0.183	487
			3,132		8,627 (3.9 MT)

REFERENCES

1. O'Brien and Gere. Progress Report Combined Sewer Overflow Abatement Program, Metropolitan Service Area. Prepared for: Onondaga County Department of Drainage and Sanitation. 1977.

2. Telecon. Mr. Randy Ott, Onondaga Department of Drainage and Sanitation (315) 457-4115 with Mr. John Patinskas, GCA Corporation. September 9, 1982.

3. County of Monroe and O'Brien and Gere Engineers, Inc. National Urban Runoff Program, Irondequoit Bay Study. Draft Final Report. November 1982.

4. Huber, W. C., J. P. Heaney, K. J. Smolenyak, and D. A. Aggidis, Urban Rainfall-Runoff-Quality Data Base. EPA-600/8-79-004. August 1979.

CONTACTS

1. Mr. Randy Ott, Onandaga County Department of Drainage and Sanitation, (315) 457-4115.

APPENDIX A

GLOSSARY

CFS Cubic feet per second

CSO Combined sewer overflow

CSSA Combined sewer service area

lbs Pounds

MG Million gallons

mg/l Milligrams per liter

MT Metric tons

WWTP Wastewater treatment plant