Minnesota Water Quality

Minnesota Pollution Control Agency
Report to Congress Section 305 (b)

Minnesota Water Quality

A REPORT TO THE CONGRESS OF THE UNITED STATES BY THE STATE OF MINNESOTA PURSUANT TO SECTION 305(b) OF THE FEDERAL WATER POLLUTION CONTROL ACT

JUNE 1977

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CHAPTER I: INTRODUCTION, SUMMARY AND RECOMMENDATIONS

INTRODUCTION

This report was prepared by the Minnesota Pollution Control Agency pursuant to Section 305(b) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). The statutory requirements of the Act dictate that this report, commonly called the 305(b) report, shall include the following information:

A. A description of the water quality of all navigable waters in such state during the preceding year;

B. An analysis of the extent to which all navigable waters of such state provide for the protection and propagation of a balanced population of shellfish, fish and wildlife, and allow recreational activities in and on the water;

C. An analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish and wildlife and allows recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to additional action necessary to achieve such objectives and for what waters such additional action is necessary;

D. An estimate of (i) the environmental impact, (ii) the economic and social costs necessary to achieve the objective of the Act in such state, (iii) the economic and social benefits of such achievement, and (iv) an estimate of the date of such achievement; and

E. A description of the nature and extent of non-point sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the costs of implementing such programs.

The purpose of this report is to address these requirements of the Act and thereby provide an assessment of the current water quality of the major waterways in the State of Minnesota to the Congress and the people of the state.

SUMMARY

Water quality conditions of 26 rivers plus Lake Superior are assessed in this report. The rivers are grouped and presented according to the eleven basins. The study utilized chemical and physical data from a total of 75 state monitoring stations for the water year 1976. Primary network monitoring stations used in this report are normally located at points representative of the most critical reaches in a stream. Therefore, the average water quality of the stream as a whole will generally be better than the quality at specific monitoring stations.

The existing water quality in each basin was compared with the national goal of "fishable", "swimmable" water which is to be achieved by July 1, 1983. In lieu of any further clarification by the Environmental Protection Agency (EPA) of what is meant by this objective, this goal is commonly equated to class 2B in the State of Minnesota water quality standards. Thus, the frequency of violations of the state water quality standards is indicative of which areas and to what extent this goal has been achieved in Minnesota.

This study indicated that the majority of the rivers in the state are currently in conformance with this goal. However, large areas of particular rivers and a substantial number of localized areas presently appear to be in noncompliance with applicable water quality regulations and the interim goal. A total of 23% of the 75 water quality monitoring stations assessed in this report are considered to currently be in noncompliance with either the "fishable" and/or the "swimmable" aspect of the 1983 goal. Rivers or reaches of rivers placed in this category are the Mississippi River below Minneapolis-St. Paul, Zumbro River below Rochester, Cedar River below Austin, Buffalo Creek below Glencoe, Center Creek below Fairmont, and the headwater tributaries of the Missouri and the Des Moines rivers.

Assuming the current grant programs are continued at existing funded levels, it is expected that the Missouri and the Des Moines rivers headwater tributaries and the metro segment of the Mississippi River, or 11% of the total 27 waterways assessed, will not conform with the interim goal by 1983. The reason for this projected inability of these rivers to conform with the goal by 1983 is primarily money. In the Des Moines and Missouri rivers headwater tributaries, increased funding is necessary to both upgrade inadequate municipal treatment facilities and implement rigorous non-point source regulatory controls. These two watersheds have particularly acute non-point source problems attributable to both agricultural activities and natural conditions. In the Twin Cities metro segment of the Mississippi River, it appears that massive amounts of funds would be required to control or eliminate combined sewer overflows, to control urban runoff, and to better insure the removal of pathogens from municipal treatment plants so that the fishable-swimmable goal can be met.

Even if all industrial and municipal point sources are brought into compliance, non-point loadings will continue to cause and contribute to many water quality problems in Minnesota. This is particularly apparent in the watersheds where agricultural activities are the dominant land use. There is a potential that agricultural activities may be adversely affecting the water quality in much of the state. The highest potential areas are the south central and southwestern sections of the state. In the Minneapolis-St. Paul Twin Cities metro area and in the other urban centers of the state, urban storm water runoff is a major water quality problem. Other significant types of non-point sources which impact water quality in Minnesota include silviculture, mining, residual waste disposal, construction activities, and dredging. The MPCA is actively involved in continuing statewide planning to develop programs for the control or abatement of non-point source pollution. Key programs in this effort include Section 208 areawide planning, in the Twin Cities metro area, and outstate, and the ongoing activities of the many local, state, and federal agencies which have traditionally been involved in programs related to non-point source control.

Many municipal treatment facilities with construction needs are being delayed until federal funds can be obtained by the community. Current levels of federal funding for municipal wastewater treatment plants and the control of non-point sources are hopelessly insufficient when considered in relation to the total estimated needs in Minnesota. The 1974 Municipal Needs Survey of Minnesota indicated that the total municipal needs, excluding

storm water treatment, are approximately $1,608,000,000 (1976 dollars).

The Soil Conservation Service estimates the cost to adequately control non-point sources of pollution from cropland and pastureland would total approximately $320 million (1975 dollars) and would result in an estimated 45% reduction in waste loadings. Reducing streambank erosion would require multimillion dollar expenditures, while corrective measures on lakeshore erosion are estimated at $400 million (1975 dollars). Similarly, the SCS estimated the cost of programs to correct erosion in roadside right-of-way areas at $15 million (1974 dollars).

Annual cost estimates have also been developed for control of runoff from urban construction sites. Statewide annual costs are estimated at $6 million (1975 dollars), of which approximately $3.8 million is attributable to construction activities in the Twin Cities metro area.

RECOMMENDATIONS

This report makes the following recommendations:

1. If the interim goal of the Act for swimmable waters is to be achieved on a statewide basis in Minnesota by July 1, 1983 or, for that matter, by any later date, adequate funding must be allocated for the planning and the construction of municipal wastewater treatment plants, corrective programs for non-point sources and the administration of existing state programs.

2. In recognition of the water pollution control improvements which have been achieved and the initiative which has been demonstrated by the state regulatory agencies, it is recommended that the implementation of the provisions of the Act continue to be administered on the state level in conjunction with and in support of existing state programs.

3. The state 305(b) reports should be required on a biennial basis rather than on the current yearly basis. State efforts could more profitably be channeled into direct pollution abatement activities while still reporting progress every two years.

4. Additional funding should be allocated by the federal government to the states for expanding additional monitoring activities.

5. In order to meet the interim and subsequent goals of the Act throughout the entire State of Minnesota, local and federal funds will have to be used for the control of non-point sources. An adequate non-point source control program will require a close working relationship and increased funding for the many regulatory governmental agencies which are directly or indirectly involved in the control of non-point sources.

6. Non-point source (NPS) pollution control is to a great degree dependent upon an informed populous. Both urban and rural NPS pollution could be significantly lessened if

each citizen understood how their actions ultimately affect the state's water quality.

7. Funds should be allocated to support the Section 314 "Clean Lakes" program as outlined in the Act.

CHAPTER II: STATEWIDE ANALYSIS OF WATER QUALITY

WATER QUALITY STANDARDS

There are over 15,000 lakes and an estimated 25,000 miles of streams in the State of Minnesota. The first step in controlling degradation of this valuable resource is to identify polluted areas. Therefore, it is necessary to compare existing water quality with desired water quality.

From a national point of view (Federal Water Pollution Control Act Amendments of 1972), this desirable level of water quality has been described as having waters which are suitable for both fishing and swimming. This goal is to be achieved by July 1, 1983.

At the state level, the Minnesota Pollution Control Agency (MPCA) has responsibility for determining the best current uses to which the state's water may be put and the quality of the waters necessary to meet these uses. The MPCA has defined six desirable use classes and has grouped each of the state's waters into one or more of the following classes:

- Domestic Consumption
- Fisheries and Recreation
- Industrial Consumption
- Agriculture and Wildlife
- Navigation and Waste Disposal
- Other Beneficial Uses

Most waters in the state are classified (2B) to permit the propagation and maintenance of cool or warm water sport or commercial fishing and to be suitable for aquatic recreation of all kinds, including bathing. This classification is commonly considered as being equivalent to the national goal of "swimmable," "fishable" water. The limiting concentrations or ranges of water quality substances or characteristics which should not be exceeded are summarized in Table 1. These water quality standards represent minimal goals. It has been the policy of the MPCA that all water in which the existing quality is better than the water quality standards will be maintained at high quality. Regulations prescribing water quality standards and classifications for the waters of the State of Minnesota are available through the Documents Section, Department of Administration, Room 140, Centennial Office Building, St. Paul, Minnesota 55155.

DATA SOURCES

The state monitoring program supplies the quantitative data needed to determine the existing water quality of the state's

TABLE 1
WATER QUALITY STANDARDS FOR FISHABLE, SWIMMABLE WATERS IN MINNESOTA (CLASS 2B)

Substance or Characteristic	Limit or Range
Dissolved oxygen	Not less than 6 milligrams per liter from April 1 through May 31, and not less than 5 milligrams per liter at other times.
Temperature	5°F above natural in streams and 3°F above natural in lakes, based on monthly average of the maximum daily temperature, except in no case shall it exceed the daily average temperature of 86°F.
Fecal coliform organisms	200 most probable number per 100 milliliters.
Turbidity value	25
pH value	6.5 – 9.0
Ammonia (N)	1 milligram per liter
Chromium (Cr)	0.05 milligram per liter
Copper (Cu)	0.01 milligram per liter or not greater than 1/10 the 96 hour TLM value
Cynides (CN)	0.02 milligram per liter
Oil	0.5 milligram per liter
Phenols	0.01 milligram per liter and none that could impart odor or taste to fish flesh or other fresh-water edible products such as crayfish, clams, prawns and like creatures. Where it seems probable that a discharge may result in tainting of edible aquatic products, bioassays and taste panels will be required to determine whether tainting is likely or present.
Radioactive materials	Not to exceed the lowest concentration permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.

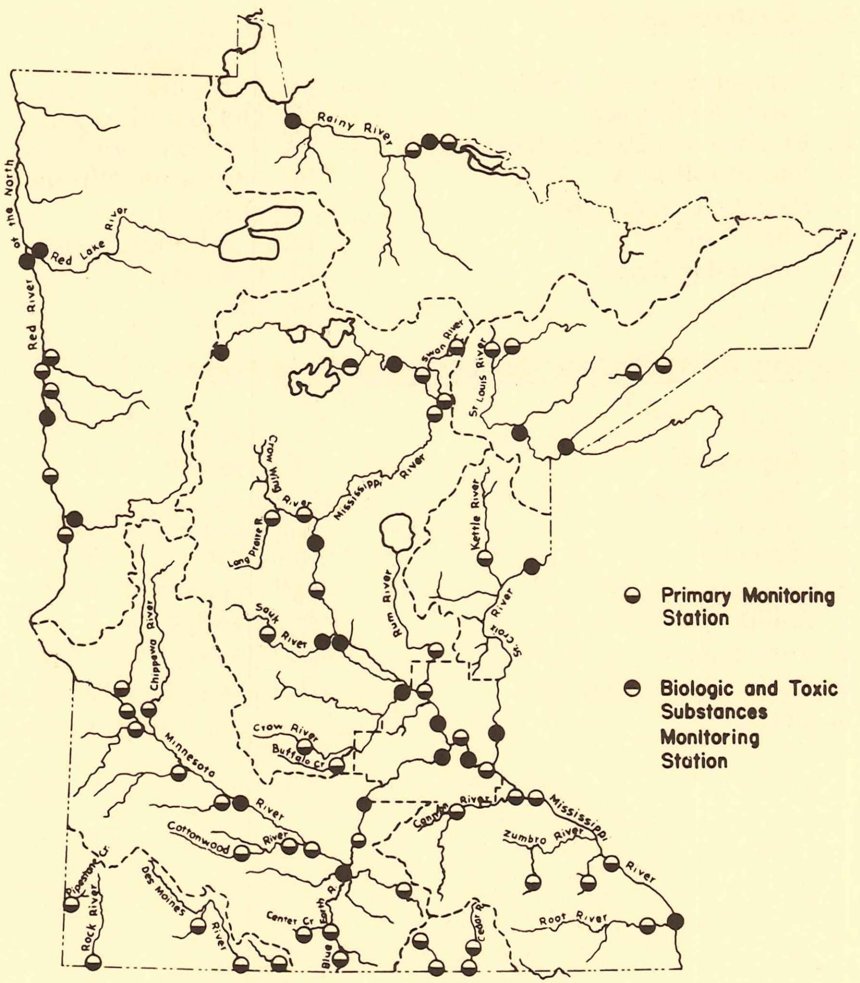
surface waters and, thereby, assess the effectiveness of its water pollution control activities. The monitoring program consists of statewide primary monitoring, toxic substances and biological monitoring, intensive monitoring surveys, and compliance monitoring.

The primary monitoring network provides the major source of the water quality monitoring data presented in this report. In this program during water year 1976, water samples were collected at 85 sampling locations distributed throughout the state. (Map 1) All stations are sampled monthly and two continuous monitors are operated near East Grand Forks on the Red Lake River and Red River of the North. This study utilizes data from 75 of these stations.

Many of the primary network monitoring stations are located at points representative of the most critical reaches in a stream. Approximately half of the monitoring stations are located directly below significant urban or industrial concentrations which are known or suspected to exert major influences on downstream quality. Other station locations are: at critical points found in intensive surveys; at station pairs above/below major population and industrial areas; and at locations associated with major high quality water-use areas. Therefore, the average water quality of the streams as a whole will generally be better than the quality detected at specific monitoring stations.

A toxic substances and biological monitoring program was initiated in 1976. The program consists of biological sampling, and water and sediment sampling for toxic substances at twenty-five locations throughout the state. (Map 1) Locations were selected to show pollution impacted levels and natural background levels of toxic substances and their effects on biological organism diversity. The water and sediment samples were analyzed for selected heavy metals, pesticides and other organic chemicals. The biological monitoring program consists of benthos samples and chlorophyll a determinations. The purpose of the program is to determine baseline levels of toxic substances and biological organism diversity and numbers so that long term trends in levels of these toxic substances and the diversity of organisms can be established.

MAP 1
WATER QUALITY MONITORING STATIONS, 1977



POLLUTANTS ANALYZED

Samples collected as a part of the primary monitoring networks are routinely analyzed for the following physical, chemical, and micro-biological parameters:

Monthly Analyses

1. Temperature – C (field)
2. Dissolved Oxygen
3. Biochemical Oxygen Demand
4. Fecal Coliforms
5. Specific Conductivity
6. Total Solids
7. Suspended Solids
8. Turbidity
9. Organic Nitrogen
10. Ammonia Nitrogen
11. Nitrite and Nitrate Nitrogen
12. Total Phosphorus
13. Chloride
14. pH

Quarterly Analyses (July, October, January and April)

1. Calcium
2. Magnesium
3. Total Hardness
4. Alkalinity
5. Sulfate
6. Fluoride
7. Sodium
8. Potassium
9. TOC
10. Copper
11. Cadmium
12. Nickel
13. Zinc
14. Manganese
15. Lead
16. Iron
17. Mercury
18. Arsenic
19. Selenium

GENERAL ASSESSMENT OF "FISHABLE" "SWIMMABLE" WATERS

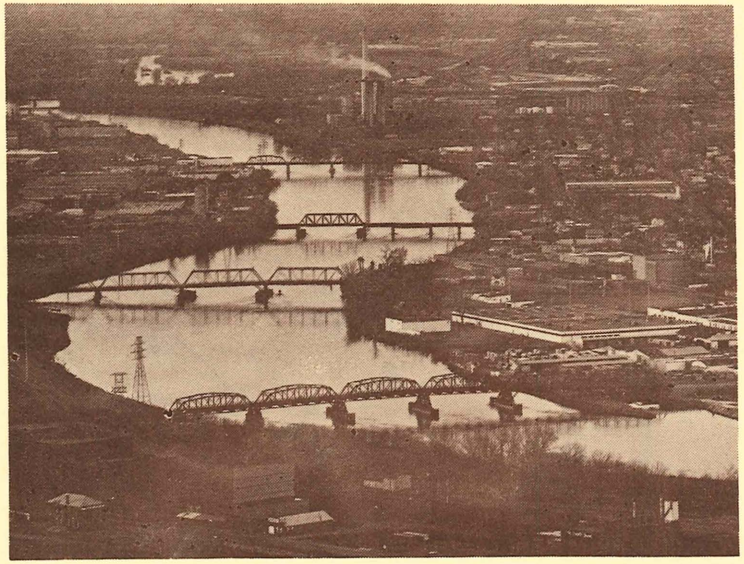
The Federal Water Pollution Control Act Amendment of 1972 sets the national goal of having waters suitable for both fishing and swimming. This goal is to be achieved by July 1, 1983.

For the purpose of determining the fishable aspect of this goal, six related parameters were grouped together. These parameters include: temperature, dissolved oxygen, turbidity, ammonia (N), pH and copper. These parameters were considered to be appropriate and a viable indication of whether the surface water will support the propagation of fish.

Violations described in this analysis were determined using the state water quality standard for the appropriate reach of the waterway. In some cases, the water quality standard for a specific reach of a waterway may be more restrictive than those shown in Table 1, based on the applicable water use classification. A violation is considered indicative of a polluted condition which is actually or potentially deleterious, harmful, detrimental or injurious with respect to the designated uses of the state's surface waters. Data used in the analysis are from the primary water quality monitoring network collected during water year 1976, October 1, 1975 to September 30, 1976.

Temperature

Temperature affects the palatability of water, water treatment processes, the value of water for many industrial uses such as cooling, the water's suitability as a habitat for aquatic life, the amount of dissolved oxygen which water can hold, and the oxygen demand made upon water due to the rate of organic bacterial decomposition. It may influence the toxicity of a toxic compound in an aquatic environment. A sharp rise or decline in temperature in an aquatic environment over a short period of time can be critical to the fauna and flora of that environment and is a serious pollution problem.

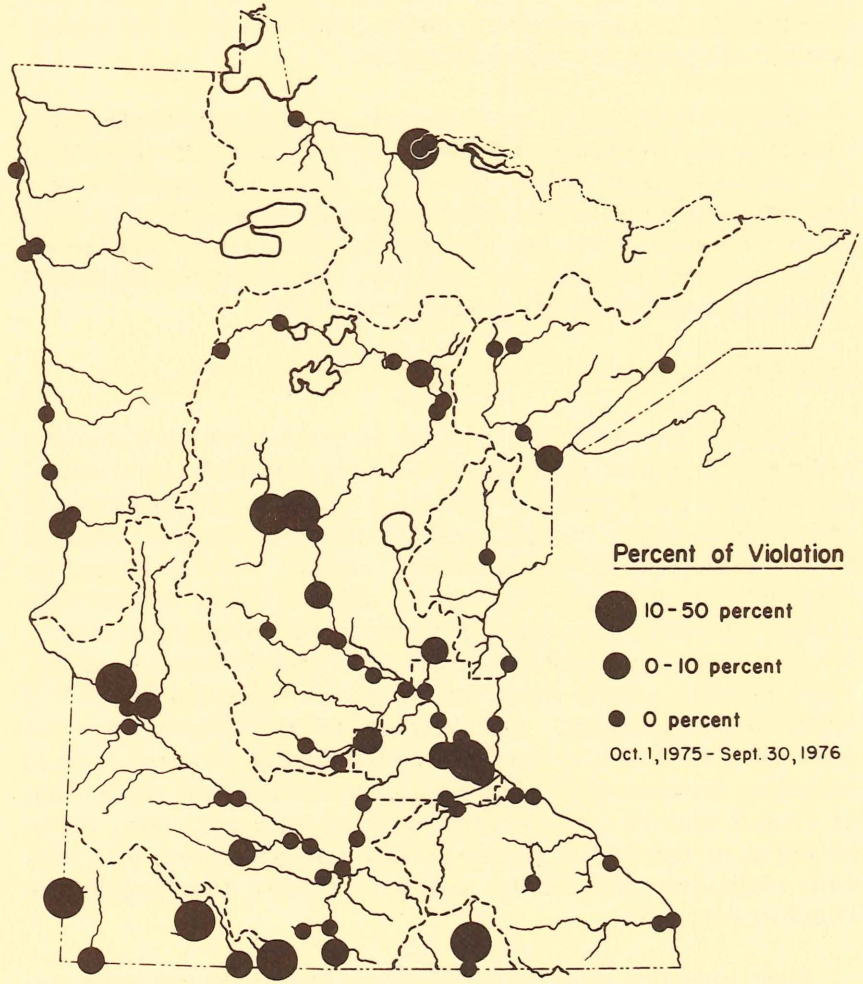


During the water year 1976, there were no temperature violations of state standards measured in the water quality monitoring network. However, there was a fish kill in the Otter Tail River in Fergus Falls below the Otter Tail Power Company's discharge which was caused by thermal stress resulting from elevated river temperatures.

Dissolved Oxygen

(Map 2) Dissolved oxygen represents the oxygen dissolved in the water of a stream or lake. The dissolved oxygen is derived from the surrounding air directly and from oxygen given off from aquatic plants in their process of photosynthesis. Inadequate dissolved oxygen in surface waters may contribute to an unfavorable environment for fish and other aquatic life, and the absence of dissolved oxygen may give rise to odoriferous products of

MAP 2
DISSOLVED OXYGEN VIOLATIONS



anaerobic decomposition. The presence of dissolved oxygen in municipal water supplies is seldom considered deleterious, for it has no adverse physiological effect and actually increases the palatability of the water. For many industrial uses of water, zero dissolved oxygen is desirable as a means of inhibiting corrosion, especially in cooling water or in boiler water. Ample dissolved oxygen is vitally necessary to maintain a satisfactory fishery and stream biota, and to prevent nuisance conditions from the decomposition of sewage and industrial wastes.

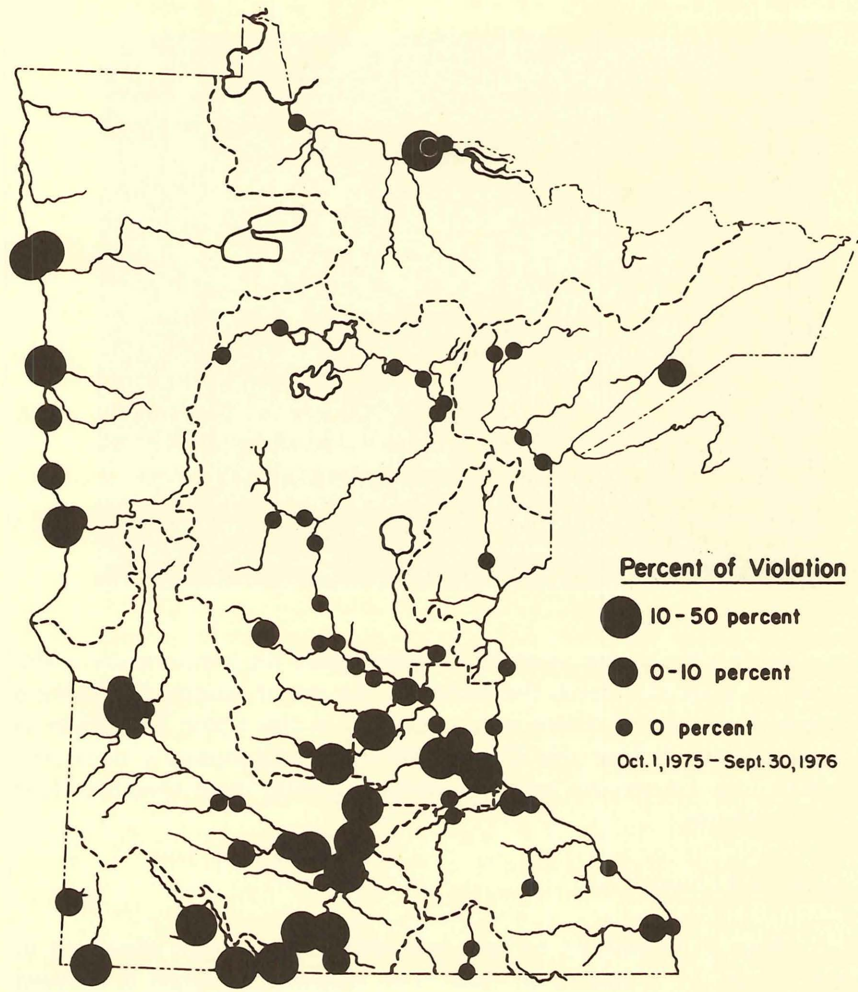
Map 2 shows there are violations of state standards below industrial and municipal discharges. Thirty-eight (38) percent of the samples taken below the Twin Cities metropolitan area indicated violations of the dissolved oxygen standards. Dissolved oxygen concentrations are affected by temperature and stream flow. Last summer's drought and high temperatures exaggerated dissolved oxygen problems throughout the state.

Turbidity

(Map 3) The turbidity of water is attributable to suspended and colloidal matter, the effect of which is to disturb clearness and diminish the penetration of light. It is a measure of the extent to which the intensity of light passing through the water is reduced by the suspended colloidal matter. Turbidity may be caused by micro-organisms or organic detritus, silica or other mineral substances, including zinc, iron, and manganese compounds, clay or silt, industrial and municipal wastes, and natural erosion products. High turbidity affects water quality in the following ways. It is esthetically undesirable with respect to recreational use and palatability of water. It interferes with industrial processes such as laundries, laundering, bottling beverages, brewing, the production of various textiles, and the production of pulp and paper. It can be lethal to fish life at extremely high concentrations, interferes with biological productivity, and may modify the temperature structure of ponds.

High turbidity values were measured in agricultural areas particularly in the Red, Des Moines, Missouri and Minnesota Basins. Other areas with high turbidity readings were below the Twin Cities metro area and below International Falls on the Rainy River. (Map 3)

MAP 3
TURBIDITY VIOLATIONS



Ammonia

(Map 4) Ammonia in surface or groundwaters generally results from the decomposition of nitrogenous organic matter. There appears to be no human physiological harm resulting from concentrations of ammonia which might occur in natural or polluted waters. High concentrations of ammonia are toxic to fish, and this effect is markedly increased at low concentrations of dissolved oxygen and a high pH and high temperature.

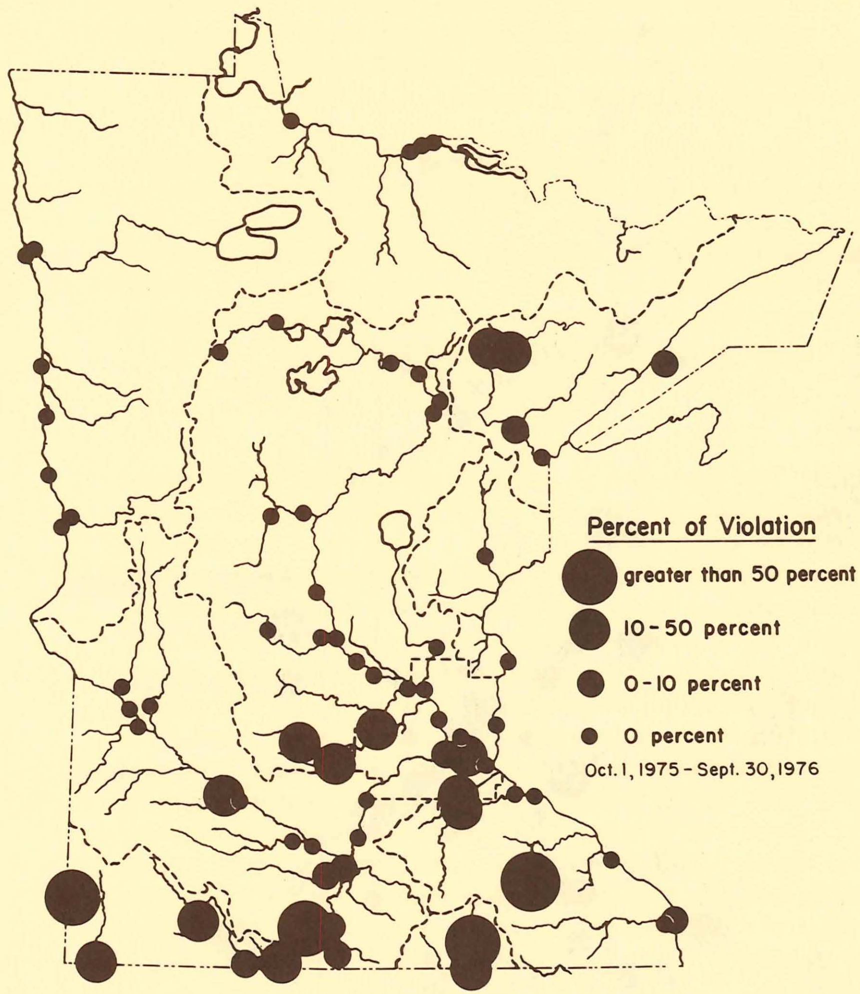
High ammonia concentration were found primarily below municipal and industrial wastewater discharges in small streams. (Map 4)

pH

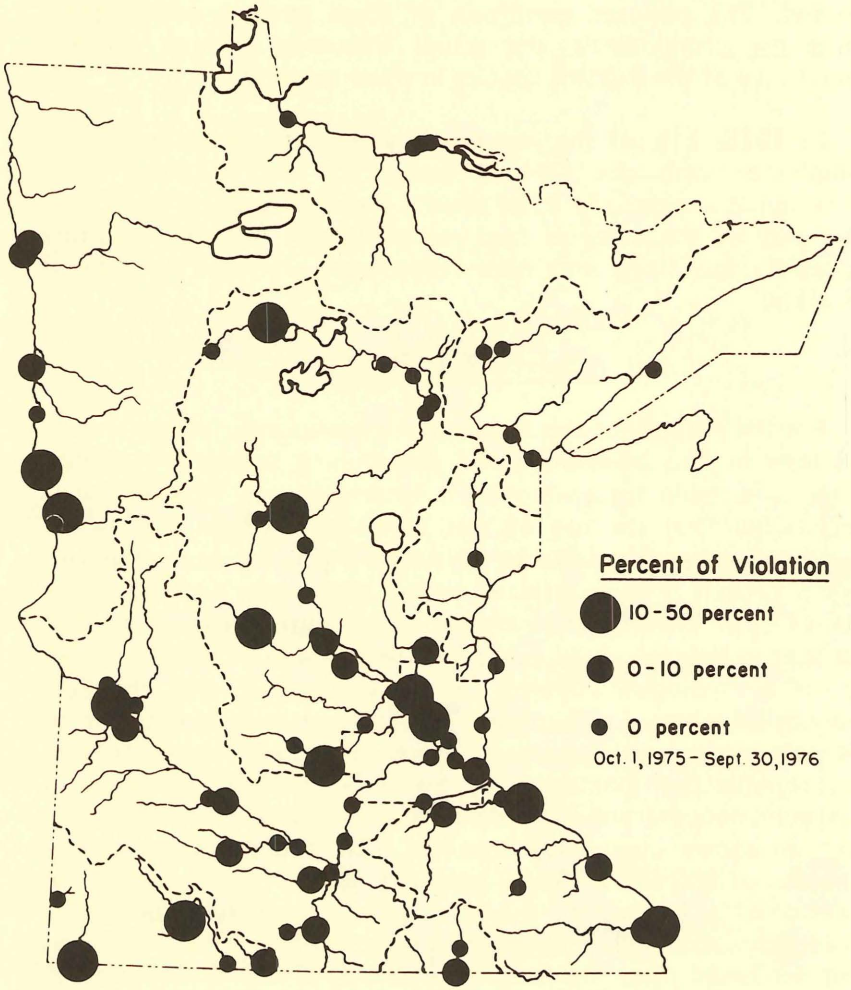
(Map 5) The symbol "pH" is used as a way of expressing hydrogen ion concentration and is a measure of potential pollution. pH controls the degree of dissociation of many substances and may be a highly significant factor in determining limiting or threshold concentrations. Most domestic sewage is neutral or slightly alkaline, with a strong buffering action. Many industrial wastes are so strongly alkaline or acid that they may have a marked effect upon the pH of receiving waters. Included among the acid wastes are tanning liquors, acid dyes and sulfite wastes. Strongly alkaline wastes include wool scouring wastes, soda and sulfite pulp rinse water, laundry wastes, and bottle wash waters. For domestic water supplies, pH is important in that it affects taste, corrosion, effectiveness of chlorination, and treatment processes such as coagulation. In industry, the desirable pH of water varies with respect to each specific industrial process. The optimum pH for irrigation water depends on the type of crop to be grown and the physical and chemical properties of the soil. The permissible range of pH for fish and aquatic life depends upon many factors such as temperature, dissolved oxygen, prior acclimatization, and the content of various anions and cations.

Violations of state pH standards seem to be spread evenly throughout the state. (Map 5)

MAP 4
AMMONIA VIOLATIONS



MAP 5
pH VIOLATIONS



Copper

(Map 6) High concentrations of heavy metals such as copper may be an indication of contamination by industrial waste. Although copper in trace amounts is considered essential for the growth of living organisms, in excessive quantities, it has been found to be toxic to a wide variety of aquatic organisms ranging from bacteria to fish.

Copper was chosen to be analyzed as an example of a heavy metal contaminant. Map 6 indicates there are few problems with copper in Minnesota waters.

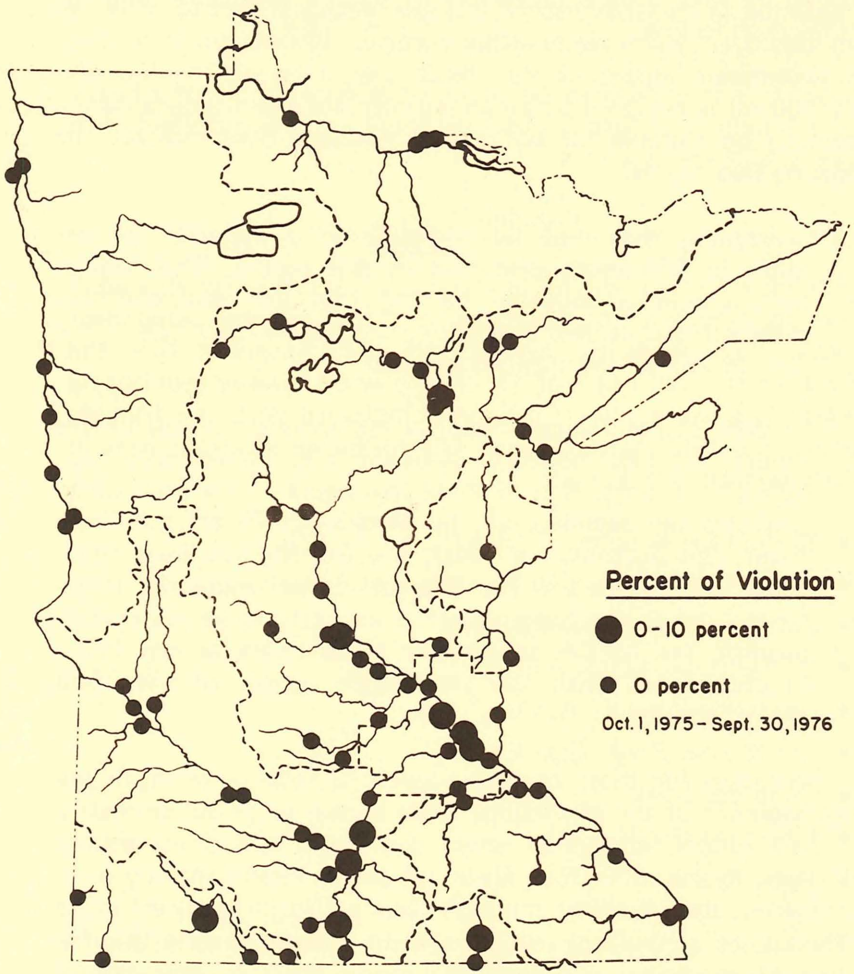
"Fishable" Waters

For determining whether a waterway meets the fishable goal, the average frequency of violations for the six selected parameters was calculated. When the average frequency exceeded 10%, the goal was considered not met. Of the 75 water quality monitoring stations, 12% were not in general compliance with the fishable aspect of the 1983 national goal. The following locations were in non-compliance with the goal:

- Buffalo Creek below Glencoe
- Mississippi River below Minneapolis-St. Paul
- Zumbro River below Rochester
- Center Creek below Fairmont
- Cedar River below Austin
- Des Moines River, East Fork
- Okabena Creek
- Pipestone Creek
- Rock River

The causes of this non-compliance are considered to be due to the combined effects of non-point sources, such as agricultural runoff, and point source discharges from industries and municipalities. The monitoring stations located on these rivers magnify the impact of human influence since the stations are commonly located downstream from municipalities.

MAP 6
COPPER VIOLATIONS



It must be emphasized that these rivers and the other unsampled rivers in each watershed do consistently support at least some species of fish such as carp, bullheads, suckers, and the like. However, the monitoring data presented in this report indicate that designated use of these waters for fishing is probably restricted. The polluted condition of these streams undoubtedly limits the productivity, the actual frequency of use, and the desirability of the existent species in these streams.

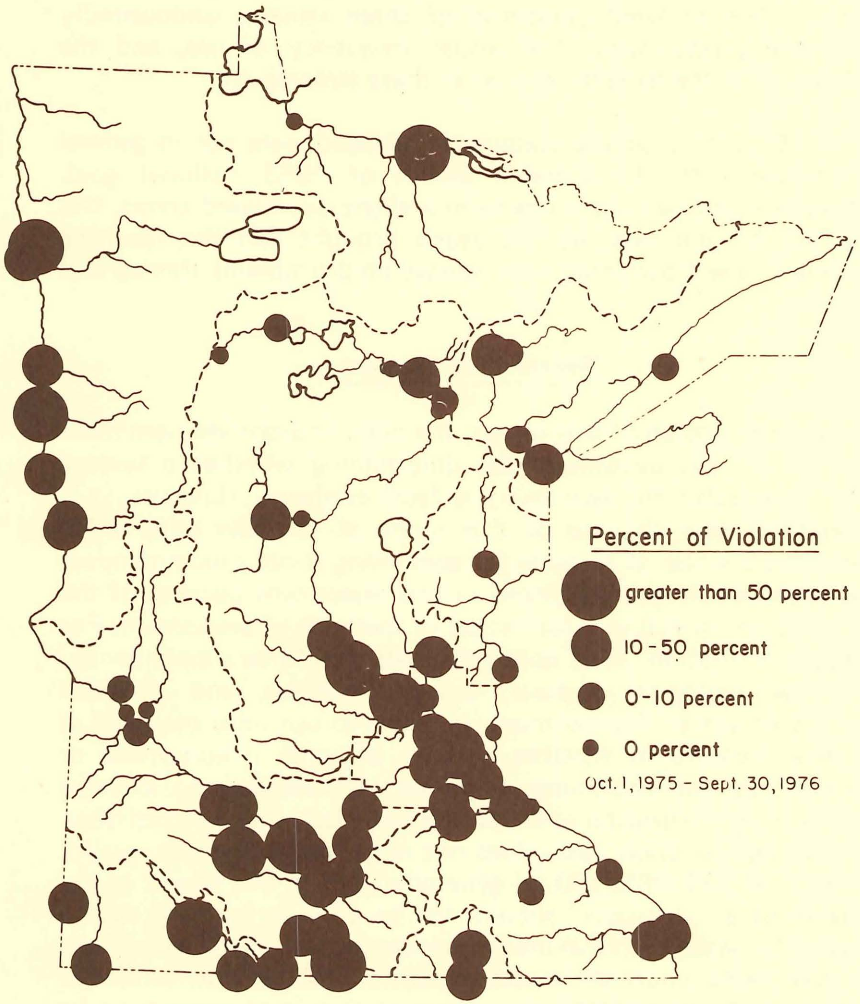
In 1975, 11% of the waterways assessed were not in general compliance with the fishable aspect of 1983 national goal. Although it appears there has been a slight downward trend, this may not be the case, as last year's drought and the resulting extremely low flows may have exaggerated problems throughout the state.

"Swimmable" Waters

For the purpose of this report, the most appropriate parameter available in this assessment for determining whether a surface water is suitable for swimming is fecal coliform. However, it is emphasized that the use of this index as the sole criteria for classifying a water as suitable for swimming is not recommended. This approach is being utilized in this assessment because of the lack of other available information or methods of assessment. For a proper evaluation, fecal coliform levels should be supplemented by other biological indeces, sanitary surveys, and chemical analyses of water. Furthermore, in order to use fecal coliform as the sole measure of whether a body of water is acceptable or unacceptable for swimming, it would be necessary to know a maximum concentration at which the water becomes unacceptable. Such an agreed upon value does not exist, and the water quality standard of 200 MPN/100 ml generally used in this report as the measure of a "violation" should not be considered to be such a universally accepted maximum concentration. This level was adopted based upon the recommendation of the Environmental Protection Agency (EPA). The basis of this level appears to be primarily a result of limited available research studies coupled with a very liberal factor of safety to protect public health.

The frequency of violation for fecal coliform for each river is shown on Map 7. As can be seen, fecal coliform levels in excess of

MAP 7
FECAL COLIFORM VIOLATIONS



the applicable standard are both common and widespread throughout Minnesota.

Considering these numerous violations of the applicable standard for fecal coliform and the inherent limitations of this index for defining swimmable waters, it is speculative at best to conclude from this data which rivers either meet or do not currently meet the swimmable aspect of the 1983 goal. However, if the 200 MPN/100 ml is assumed to be an appropriate goal for considering waters to be suitable for swimming, the data does indicate the following two points:

1. Swimming may not be advisable in a majority of the rivers in Minnesota discussed in this report. This indication is pointed out by the fact that the fecal coliform standard is exceeded at a frequency greater than 10% of the time at 76% of the stations assessed.

2. In 20% of the 75 water quality monitoring stations in this report, the fecal coliform standard is exceeded more than 50% of the time. It is in these five rivers – the Twin Cities metropolitan segment of the Mississippi River, the Crow River, the Cottonwood River, the Des Moines River headwater tributaries, and the Missouri River headwater tributaries – that the bacteriological integrity is so poor as to prompt the MPCA to classify these rivers as not being in compliance with the swimmable aspect of the 1983 goal of the Act.

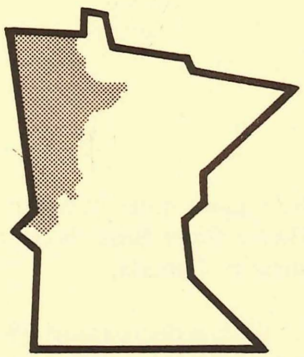
The causes for these excessive levels of fecal coliform in the metro segment of the Mississippi River appear to be due primarily to urban runoff, combined sewer overflows, and point source discharges. In the other four areas, which are nearly entirely rural in character, the causes of the high fecal coliform levels are more likely due to agricultural runoff and to a lesser degree the discharges of municipal and industrial point sources. The natural bacteriological quality of the waters in these areas would be poor due to rural runoff, and it is speculated that were it not for man's activities, these areas would boast substantially improved bacteriological water quality.

In 1975, 19% of the waterways assessed were not in general compliance with the swimmable aspect of 1983 national goal. Although it appears there has been a slight downward trend, this may not be the case, as last year's drought and the resulting extremely low flows may have exaggerated problems throughout the state.

Minnesota also has no less than 15,291 lakes. These lakes, as opposed to the rivers of the state, are generally the preferred site for swimming and aquatic recreation in Minnesota. Minnesota's lakes are aesthetically more pleasing for swimming, provide for a more diversified recreational experience such as fishing and boating, and are characterized by better overall water quality. The use of rivers for swimming is quite limited in Minnesota.

CHAPTER III: ANALYSIS OF INDIVIDUAL RIVER BASINS

This section of the report takes a closer look at the water quality and factors affecting water quality in each of the eleven major basins of the state. The specific information presented for individual basins includes: relevant background information, the number of point source discharges, water uses, affects of programs on water quality, and specific water quality concerns or problems.



RED RIVER OF THE NORTH

The Red River of the North Basin consists of 17,372 square miles in the northwestern portion of Minnesota. It is only a small section of the entire natural Red River of the North drainage basin which extends into Canada, North Dakota, and South Dakota.

The population of the basin in 1970 totaled 236,850. During the last census period, the larger cities increased in population at the sake of the small rural communities which decreased in population. Although modest industrial expansion is projected through 1980, agricultural related industries and activities continue to dominate the economy of the Red River Basin. The major agricultural commodities in the basin are sugar beets, potatoes, wheat, barley, livestock and poultry.

Surface water in this basin is not generally abundant due to the relatively low annual precipitation combined with permeable soils, flat topography, and a high rate of evapotranspiration. These climatic and topographic conditions result in the basin being typified by radical extremes of very low flow during droughts contrasted with extremely high flows during the spring. Spring flooding is a particular problem associated with the Red River of the North because the headwaters of the river in the south tend to thaw before the downstream sections.

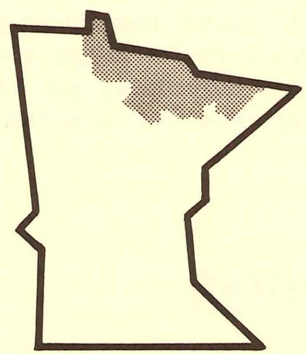
Surface water in the Red River of the North Basin is used extensively and for a variety of purposes. One important use of the basin waters is for the municipal water supplies of several major communities in Minnesota including East Grand Forks, Breckenridge, Crookston, Thief River Falls, and Fergus Falls. Moorhead uses both surface and groundwater supplies. The food and kindred products industry has major water requirements, many of which are satisfied by surface water. Surface water is also used for water-related recreational activities such as swimming, boating, hunting, fishing and camping.

There is a total of 126 known point source dischargers in the basin. Of that total, 84 are municipal plants, 26 are industrial facilities, 16 are municipal water treatment plants, and two are miscellaneous dischargers such as state parks, nursing homes, or the like.

The Garrison Diversion Project as proposed is expected to have a significant impact on the water quality of the Red River. This U.S. Bureau of Reclamation project, located in the southeastern and north central area of the State of North Dakota, involves the transfer of Missouri River water from Lake Sakakawea to irrigate 250,000 acres of land in North Dakota. This diversion may provide surface waters for municipal and industrial uses, and flood control. Much of this irrigation return flow will reach the Red River of the North in the vicinity of Moorhead via the Sheyenne and Wild Rice Rivers. The accrual of irrigation return flows, seepage, and operational losses from the Garrison Diversion Unit will have impacts on the municipal, industrial, agricultural, and recreational uses of the river as well as on the aquatic ecosystems and aesthetic amenities.

Levels exceeding the water quality standards were recorded on the Red River for fecal coliform, turbidity, and total hardness. These violations indicate that the designated uses for the Red River of the North may not be advisable or possible in some reaches. The parameter exhibiting the highest frequency of violation, total hardness, is not considered to be the most significant problem. The applicable water quality standard for hardness (250 mg/l) is associated in state regulations with the use of the waters for general industrial purposes. However, the Red River is not used extensively for industrial consumption. These relatively high levels of hardness found in the Red River are not considered to be indicative of pollution by point sources, but rather are caused by the natural leaching of salts to the river.

The national water quality goal is to provide a level of water quality that permits propagation and maintenance of sport fish and whole body contact recreation by 1983. In the Red River of the North Basin, heavy loadings from municipal and industrial sources, periodic low flows, runoff from non-point sources and natural conditions are major hindrances to the consistent maintenance of water quality standards. Because of low flows, point source dischargers must achieve high levels of wastewater treatment for a continuous discharge or the secondary level of treatment if discharge occurs only during high stream flow periods. When point source dischargers come into compliance with their final standards, basin streams will be generally protected from point source caused water quality violations. However, available water quality data indicate that controlling point source dischargers will be only a partial solution to the water pollution problem in the basin. Agricultural runoff, other non-point sources and natural conditions will continue to cause violations in some areas. Pollution from these non-point sources will, in localized areas, make difficult the uses designated for the basin's streams until appropriate controls on these sources are initiated and become effective.



RAINY RIVER

The Rainy River Basin comprises 11,292 square miles in northeastern Minnesota. The total area in the Rainy River Basin is over 27,000 square miles, most of which is in Ontario, Canada.

The basin had a 1970 population of 51,428, a decrease of 5% from 1960. There are no large municipalities in this basin, and the five cities with populations of 1,000-7,000 all decreased in population between 1960 and 1970. The population density is quite low (average 4.6/square mile) throughout the basin.

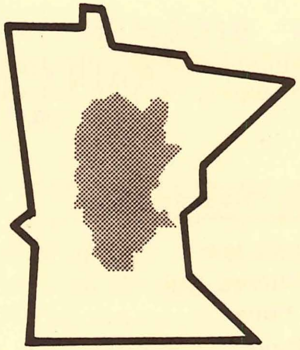
The major economic activity in the basin is the pulp and paper industry. The tourist industry is rapidly expanding and is becoming a major source of income, particularly in the eastern portion of the basin. Of lesser economic importance are crop and dairy farming, iron ore mining, commercial fishing, and fur farming. Recreational activity in the basin is rapidly increasing, particularly in the Boundary Waters Canoe Area (BWCA), in the Superior National Forest and in the Voyageurs National Park which is currently being developed. There is an increasing danger of over use in this area. Mining activity, particularly copper and nickel, may increase sharply in the future.

There are twelve municipal dischargers and one industrial discharger in the basin. There is also one municipal water treatment works and several miscellaneous point source dischargers, including a U.S. Air Force base, a trailer park, and a campground.

Data from the four monitoring stations which are presented in Map 7 indicate that a major water quality problem in the Rainy River as described in last year's 305(b) submission continues to be fecal coliform. Upon a closer analysis, it is clear that this indicator of water quality is not violated basin wide but, rather, is restricted to the single monitoring station located below the outfalls of two large pulp and paper mills and the International Falls municipal treatment plant. Figure 1 illustrates increased concentrations in this river reach for biochemical oxygen demand which ultimately causes reduced dissolved oxygen levels.

Since the International Falls treatment plant is comparatively small and producing a relatively high quality effluent, it is probable that the sources of these levels are the two major paper mills, one Canadian and the other located in the United States, which discharge to the Rainy River in the Fort Francis, Ontario, International Falls area.

The U.S. paper mill owned by Boise-Cascade Corporation is in the process of upgrading its treatment facility. However, significant problems have been encountered.



UPPER UPPER MISSISSIPPI RIVER

The watershed area of the Mississippi River in Minnesota has been divided into three distinct basin planning areas; the Upper Portion Upper Mississippi River, the Twin Cities Metro Mississippi River Area, and the Lower Portion of the Upper Mississippi River.

The Upper Upper Mississippi River Basin comprises 18,582 square miles in central Minnesota and extends from the source of the Mississippi River at Lake Itasca to approximately the city of Elk River, which is located just upstream from the Twin Cities metropolitan area.

The basin had a 1970 population of 484,384, a 10% increase over 1960. Most of this increase is occurring in the basin's larger towns, many of which are experiencing rapid population growth. Rural and small town populations are declining, and the trend is expected to continue.

The economy of the Upper Upper Mississippi Basin is strongly based on a diversified range of agricultural activities, including dairy farming, crop production and livestock feeding. Milk and other food processing is the leading industry, and this industry makes heavy use of surface waters. Most of the streams in this basin have periodic low flows which can limit their waste assimilative capacities. As a result of this, water quality violations do occur below major municipalities and industries which discharge on a continuous basis.

There are many lakes in the basin, and recreational use is high in localized areas. There are also many state parks and state

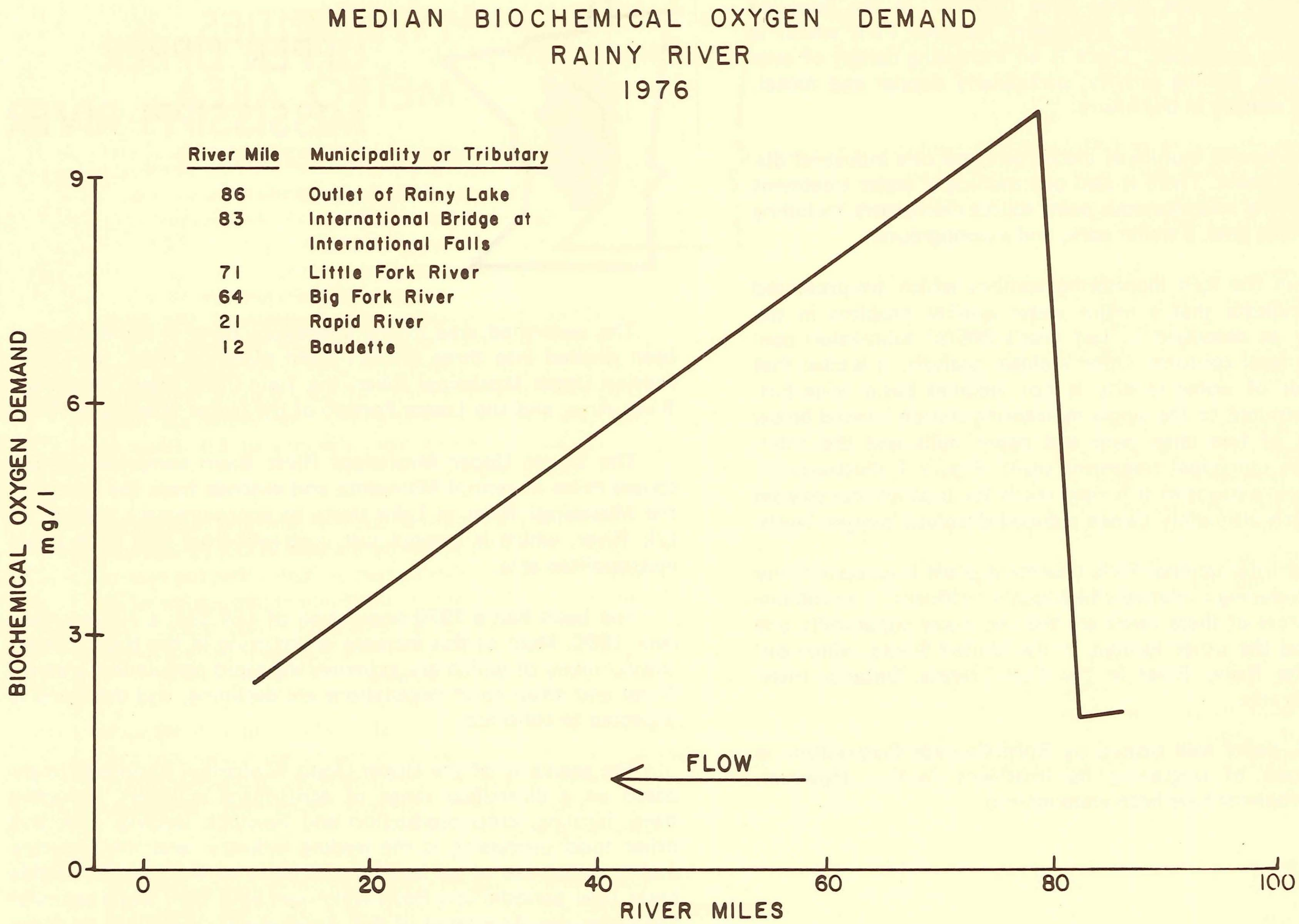

MEDIAN BIOCHEMICAL OXYGEN DEMAND
RAINY RIVER
1976
River Mile
Municipality or Tributary
86 Outlet of Rainy Lake
83 International Bridge at International Falls
71 Little Fork River
64 Big Fork River
21 Rapid River
12 Baudette
BIOCHEMICAL OXYGEN DEMAND mg/l
0
3
6
9
FLOW
0
20
40
60
80
100
RIVER MILES

FIGURE 1

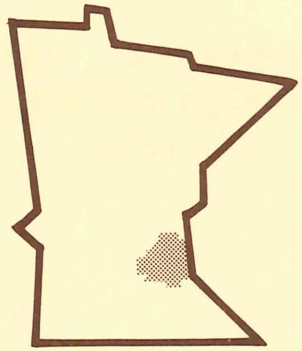
forests, particularly in the northern portion of the basin. Itasca State Park, at the headwaters of the Mississippi River, is the most heavily used state park in Minnesota. The Mississippi River is used for drinking water in St. Cloud, which is the only major use of surface waters for domestic consumption in the basin.

A total of 141 municipalities and 96 industrial facilities are known to be discharging wastewater within the basin. In addition, thirteen municipal water treatment works and nine miscellaneous facilities have discharges to surface waters.

Data from the monitoring stations assessed in this report indicate that the major water quality problem in this segment of the Mississippi River is excessive levels of fecal coliform. This indicates that whole-body contact recreation is probably not advisable in a number of areas.

Although the Mississippi River has been divided into three segments in this assessment, the entire length of the Mississippi River in Minnesota is presented in Figure 2 in order to facilitate a good overview of the river. Ammonia is presented as an example of the fluctuating quality of the river as a result of pollution loadings. In the succeeding section of this report, the Twin Cities metro segment and the lower Mississippi River will be discussed.

The quality of the tributaries in this basin area which were assessed in this report are generally comparable to or slightly better in quality than that found in the Mississippi River. The exception to this observation is the Crow River which is in a worse condition than the Mississippi River for all of the parameters presented in the Maps in Chapter II.



TWIN CITIES METRO AREA

The Twin Cities metropolitan area consists of the seven counties surrounding the two largest cities in Minnesota, Minneapolis and St. Paul. The metropolitan area encompasses a total area of 2,820 square miles, of which 147 square miles consists of numerous lakes and streams. The stretch of the Mississippi River comprising this segment extends from the city of Elk River to Lock and Dam #2 near Hastings.

The present total population is about 2 million and is expected to increase to more than 2.8 million by the year 2000. An analysis of the population trends and distribution indicates that the central cities of Minneapolis and St. Paul are declining in population while suburban growth continues at a relatively steady pace. This migration to the suburbs has resulted in a downward trend in the population density of the urban centers.

The economy of the basin is very diversified and includes such activities as grain milling and marketing, machinery manufacturing, food processing, and electronics. The area is also a regional center for railroads, inland shipping, livestock marketing, wholesale trade, and higher education.

Stream flow records indicate that the three major rivers in this basin, the Mississippi, Minnesota, and St. Croix rivers, are not characterized by extremely low flow conditions relative to the other basins. However, the relatively high population versus streamflow ratio in the metropolitan area is reflected in the number of localized water quality problems that have occurred.

MEDIAN AMMONIA CONCENTRATION
MISSISSIPPI RIVER
1976

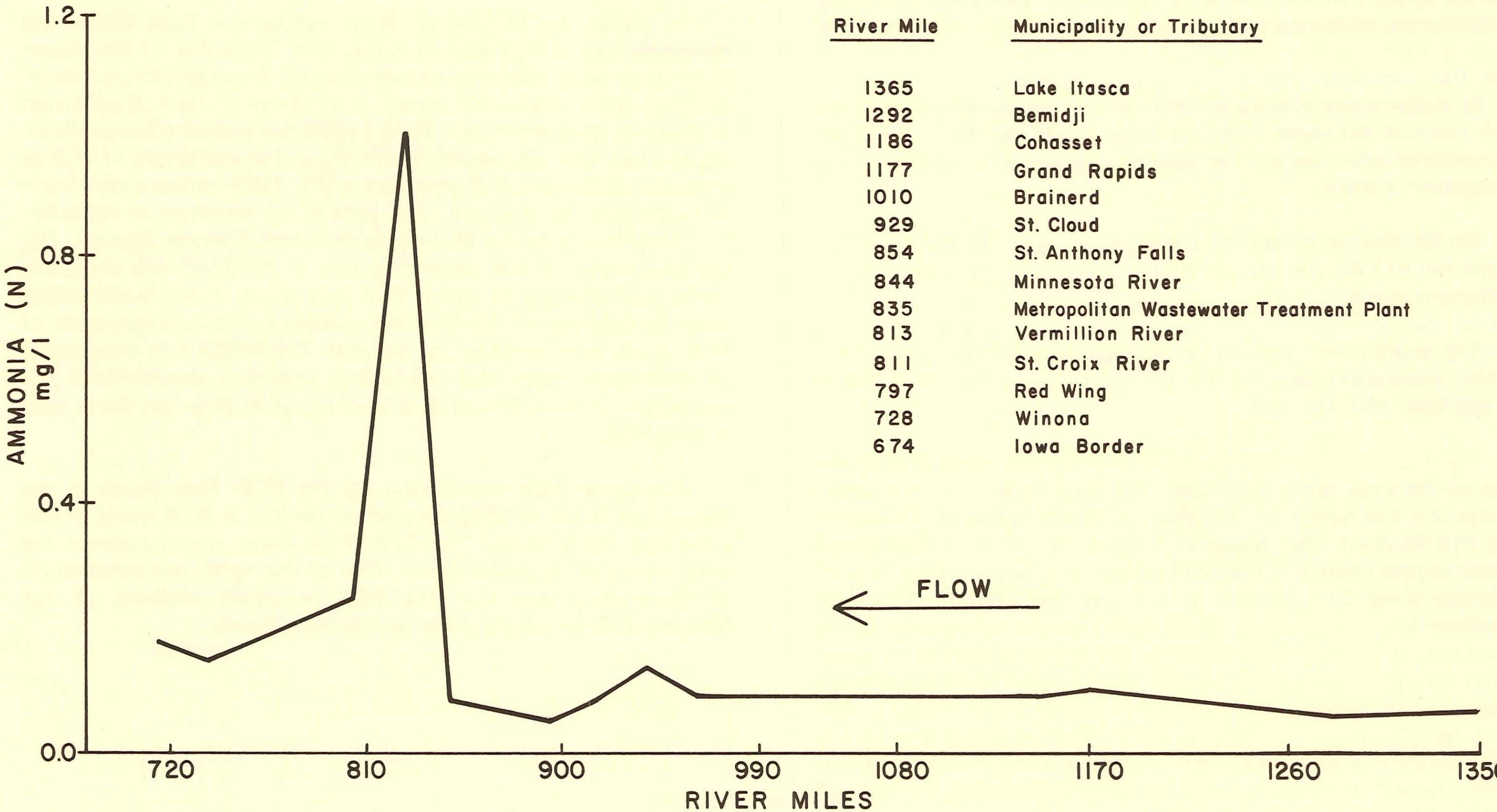


FIGURE 2

The Mississippi River and the Rice Creek watershed chain of lakes north of St. Paul are used as water supplies for Minneapolis, St. Paul, and a large number of the suburbs. The other remaining suburbs and the rural fringe areas of the basin obtain their drinking water from the plentiful groundwater aquifers located within the Twin Cities metropolitan area. The abundant groundwater resources in the metropolitan area result from a distinctive geologic structure of sedimentary rocks commonly referred to as the Twin Cities artesion basin.

Surface waters in the basin are used for numerous applications such as cooling water for thermal power plants, navigation, recreational activities such as boating, fishing, and swimming and sewage and waste disposal.

Within this basin planning area, there are 100 municipal dischargers, 142 industrial dischargers, and eight municipal water treatment plants.

The monitoring stations on the Mississippi River in the Twin Cities metro area indicate general water quality problems as shown on the Maps in Chapter II.

The fecal coliform standard was periodically violated at all the stations located both upstream and downstream of the urban center and the outfall of the Metropolitan Wastewater Treatment Plant. This plant, the largest municipal discharger in Minnesota, serves approximately 1,458,000 people and has a design flow of approximately 218 million gallons per day (MGD). The fecal coliform level in this river reach is not attributable solely to the discharge of the municipal facility, but is also impacted by headwater concentrations, other point sources, combined sewer overflows, urban runoff, and tributary runoff, most notably that contributed by the Minnesota River. Due to these diverse and hard to control sources of bacteriological contamination, whole body contact recreation is not advisable in affected portions of this river reach.

During the summer of 1976, an intensive water quality survey of the Mississippi River through the metro area was conducted by the Minnesota Pollution Control Agency and the Metropolitan Waste Control Commission (MWCC). The full report of the survey is not available at the present time. Preliminary dissolved oxygen information is available and is shown in Figure 3. The dissolved oxygen reached zero below the Metropolitan Wastewater Treatment Plant at the time of the survey. These low dissolved oxygen values were caused by poor treatment at the Metro Plant and low water flows in the river.

In 1975, the Mississippi River below the Twin Cities was shown to have a PCB pollution problem. Some fish in the Mississippi River were shown to exceed the U.S. Food and Drug Administration action level of 5 mg/kg. In response to the PCB pollution problem in Minnesota, the 1976 Legislature passed a law prohibiting the use, sale, possession, purchase and manufacture of PCB or products containing PCB after January 1, 1978, unless a certificate of exemption for that use, sale, possession, purchase or manufacture was issued by the Minnesota Pollution Control Agency. The law also required that beginning July 1, 1978, all new products, items, or materials to which PCB was added in the manufacture must be labeled to disclose the presence and concentration of PCB in the item, product, or material. The MPCA is in the process of developing rules and regulations regarding requirements for certificate of exemptions and labeling of PCB or products containing PCB.

Additional PCB monitoring by the PCB Task Force in the Mississippi River in 1976 showed no decline in PCB levels in fish from the 1975 levels. The PCB Task Force has completed the final report of its investigation. One of the significant conclusions of the report was that the PCB pollution problem of the Mississippi River would linger on for many years.

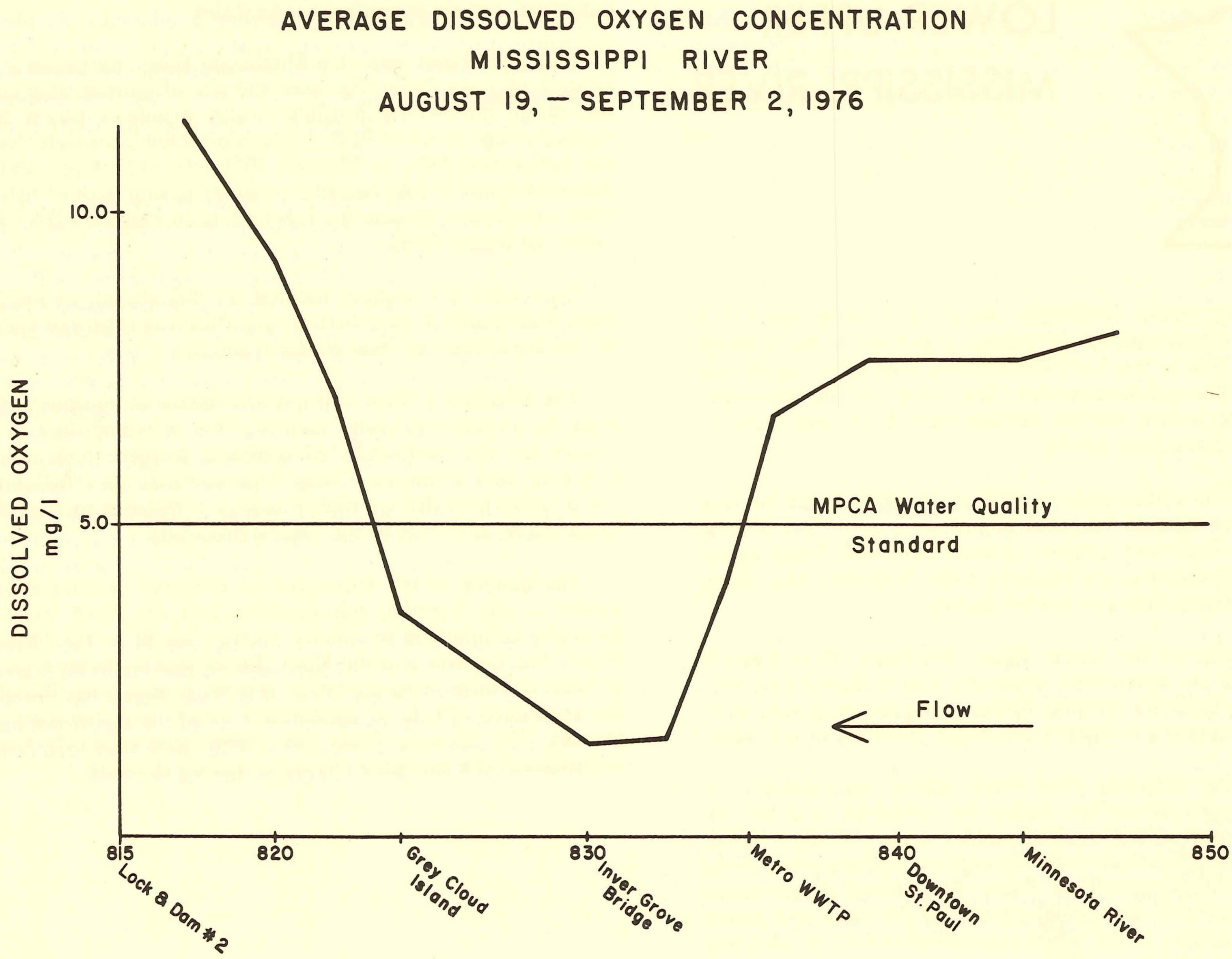
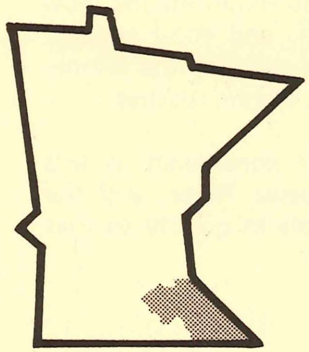

AVERAGE DISSOLVED OXYGEN CONCENTRATION
MISSISSIPPI RIVER
AUGUST 19, — SEPTEMBER 2, 1976
DISSOLVED OXYGEN
mg/l
10.0
5.0
MPCA Water Quality
Standard
Flow
815
820
830
840
850
Lock & Dam #2
Grey Cloud
Island
Inver Grove
Bridge
Metro WWTP
Downtown
St. Paul
Minnesota River

FIGURE 3



LOWER UPPER MISSISSIPPI RIVER

The Lower Upper Mississippi River Basin comprises 5,773 square miles in southeastern Minnesota. A portion of the drainage basin is contained in the Twin Cities Metro Area Basin, which was considered in the previous section. The stretch of the Mississippi River discussed in this section extends from Lock and Dam #2 near Hastings to the Iowa border.

The basin had a population in 1970 of 313,771, a 10% increase over 1960. This increase has occurred primarily in the several large cities such as Rochester, Owatonna and Northfield. These trends are expected to continue, particularly in the Rochester area. Rural population is experiencing an overall decline.

The economy of the Lower Upper Mississippi River Basin is strongly based on agricultural activities and is diversifying into various industries. Dairy farming, livestock and poultry production, and related processing industries are major activities in the basin.

All of these activities have major water requirements. In addition, the uses of surface waters for irrigation and for the disposal of power plant cooling waters occur in some areas. Recreational use of surface waters is high in localized areas of the Lower Upper Mississippi River Basin. The Memorial Hardwood State Forest covers a substantial portion of the basin and visitor use here, particularly in the Whitewater Wildlife Area, is relatively high. The basin also has a high concentration of trout streams. Surface waters are not used for domestic consumption, as groundwater supplies are fairly abundant in the basin.

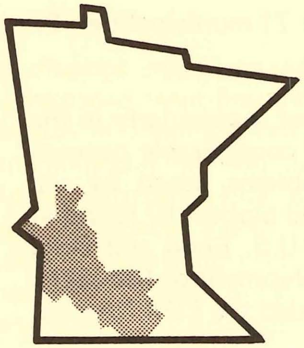
Dischargers in this planning area include 71 municipalities, 67 industries, and six miscellaneous facilities.

During the past year, the Mississippi River, particularly in the vicinity of Lake Pepin, has been the site of considerable concern and study concerning possible health problems posed by the relatively high levels of PCBs (polychlorinated biphenyls) found in the indigenous fish. In May of 1975, the U.S. Food and Drug Administration (FDA) halted the interstate shipment of fish taken from Lake Pepin because the fish flesh exceeded the FDA "Action Limit" of 5 ppm PCBs.

Data from the stations located on this stretch of the Mississippi River indicate that there are significant numbers of violations for the parameters of fecal coliform and pH.

The Mississippi River in the stretch below Minneapolis-St. Paul tends to improve in water quality. This is exemplified in those figures for the parameters of dissolved oxygen, fecal coliform, turbidity, and ammonia. These improvements are attributable to the dilution provided by higher quality tributaries such as the St. Croix River, as well as to the natural processes.

The quality of the tributaries in this area considered in this report – the Cannon, the Zumbro, and the Root Rivers, are generally comparable in quality to that found in the Mississippi River. The Cannon and the Root Rivers have relatively high levels of fecal coliform. This condition is most probably attributable to the combined effects of agricultural runoff and municipal point sources. The Zumbro River has experienced relatively frequent violations of the ammonia (N) water quality standard.



MINNESOTA RIVER

The Minnesota River Basin comprises 13,783 square miles in southwestern Minnesota. The basin had a population of 396,240 in 1970, a slight decrease of 1.9% from 1960. However, most of the larger municipalities in the basin are growing in population. Rural areas generally show decreasing population.

The economy of the basin is strongly based on agriculture, including crop production, dairy farming and livestock feeding. Food processing is the leading industry. All of these activities have major water requirements. In addition, a limited amount of water is used for irrigation.

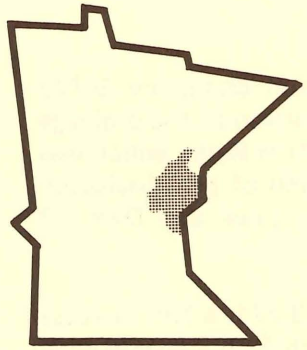
All of the streams in this basin, including the upper portion of the Minnesota River, have periodic low flows. The seasonal low flows severely limit the waste assimilative capacity of the basin's streams. As a result of this, serious water quality violations can occur below major municipalities or industries which discharge continuously. The potential for non-point pollution in the basin is high, particularly from agricultural runoff.

Recreational use of surface waters in the Minnesota River Basin is relatively limited, although there are several state parks located along the Minnesota River and in other areas. There are very few trout streams in the basin. Surface waters are not generally used for domestic consumption, as ground water supplies are abundant in the basin.

There are 141 municipal dischargers, 54 industrial dischargers, 37 municipal water treatment plants, and three miscellaneous facilities located within this planning area.

The Minnesota River experiences frequent violations for fecal coliform, turbidity, ammonia (N), hardness, and total copper. These violations indicate that the designated uses for the Minnesota River may not be advisable or possible in certain reaches.

The tributaries of the Minnesota River considered in this report — the Blue Earth River, the Chippewa River, and the Cottonwood River — generally are comparable in quality to that found in the Minnesota River.



ST. CROIX RIVER

The St. Croix River Basin planning area consists of 2,509 square miles of area in Minnesota drained by the St. Croix River and its tributaries.

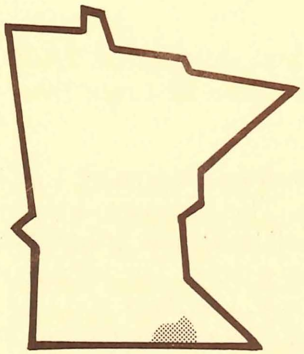
The basin has a 1970 population of 54,075, which is concentrated in the southern portion of the basin, mainly Chisago County. The economy of the basin is primarily based on agricultural activities (i.e., dairy farming), but is diversifying into various other industries. This change is most marked in the southern portion of the basin, which is also experiencing rapid population growth. Much of this new growth in population is due to the close proximity of this portion of the basin to the Twin Cities metro area. The St. Croix River Basin is heavily used as a recreational resource because of its high quality water and its close proximity to Minneapolis-St. Paul. The major streams in the basin generally are of sufficient quality to permit swimming and propagation of various species of game fish.

There is a total of 32 known point source dischargers in this basin area. Of that total, 22 are municipalities, five are industries, four are municipal water treatment plants, and one is a nursing home.

The St. Croix River has been included among the nation's rivers protected by the Wild and Scenic Rivers Act (PL 90-542, 1968). This river is preserved, managed, and administered by the National Park Service, and the Department of Natural Resources of Minnesota and Wisconsin.

This area, particularly southern Chisago County, is experiencing rapid growth and will have increasing pollution potential in the future. Proper planning will be necessary to insure this growth does not overburden present or proposed treatment systems to the extent that water quality standards are violated.

The water quality of the St. Croix River is generally excellent.



CEDAR RIVER

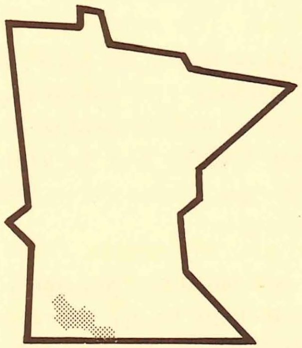
The Cedar River Basin comprises 1,034 square miles in south central Minnesota. The total area drained by the Cedar River and its tributaries is much larger, and most of this area is in Iowa.

The basin had a 1970 population of 76,150, a 5% decrease from 1960. There are two relatively large municipalities in this basin, Austin (population 25,074) and Albert Lea (population 19,418). In general, the population in cities in the basin is remaining stable while the rural population is decreasing.

The major economic activities in the basin are agriculture (mainly hog production and various crops) and meat processing. Two major meat packing plants, Hormel and Company in Austin and Wilson and Company in Albert Lea, are the predominant employers in the planning area. Municipal and industrial use of surface waters is high in this basin, and heavy waste loadings coupled with periodic low flows cause serious pollution problems. In addition, runoff from farms and feedlots has high potential for polluting surface waters in this basin. Recreational use of surface waters is low in this basin relative to other areas in Minnesota.

Point source dischargers in this river basin include 19 municipalities, 18 industries, three municipal water treatment works, and a mobile home park.

The Maps in Chapter II indicate that there are currently significant water quality violations in this river for the parameters of fecal coliform and ammonia (N). The excessive levels of fecal coliform and ammonia appear to be due primarily to non-point source runoff in the rural areas of the basin coupled with point source additions and urban runoff from the city of Austin.



DES MOINES RIVER

The Des Moines River Basin consists of 1,539 square miles in southwestern Minnesota. It is only a small part of the entire Des Moines River Basin which includes a total of 14,540 square miles located primarily in Iowa.

The general economy of the basin is based upon agricultural activities, including the processing of food products and agricultural support services.

In 1970, the basin had a population of 35,162. A comparison of census data from 1960 to 1970 indicates that the population of the basin in general is decreasing while the larger urban areas in the basin are growing in size.

Stream flow records indicate that there is a trend toward low flow periods in late summer to early autumn and throughout the winter. The important fact for management of water quality is that although the mean flow is generally adequate, extremely low flows occur with considerable regularity.

At present, very little surface water is used for industrial or domestic purposes. Water use projections indicate that groundwater sources should continue to be adequate, except in the city of Worthington area, which will probably require additional supplies from other sources.

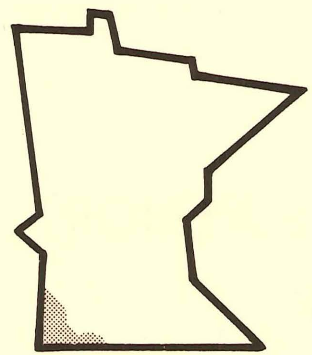
There are twelve municipalities and seven industrial facilities in this basin which have wastewater discharges. In addition, six municipal water treatment plants and one state park are known to have a discharge to surface waters in this basin.

The primary monitoring stations located in this watershed are generally located at critical points on the streams, i.e., below the larger municipalities in each watershed which include Worthington (population 9,916), Sherburne (population 1,190), and Jackson (population 3,550). Thus, it is evident that data presented in this report emphasizes the effects of these dischargers.

The water quality data presented in the Maps in Chapter II indicate that this basin is associated with high levels of fecal coliform, ammonia, and turbidity. Applicable State of Minnesota water quality standards were violated for fecal coliform, for ammonia (N), and turbidity.

Potential non-point source pollution by animal wastes and nutrient fertilizers is high in the Des Moines Basin, and runoff containing these pollutants may be a cause of the fecal coliform, Biochemical Oxygen Demand and the nutrient levels in the streams.

Available water quality data indicate that controlling point source dischargers will be only a partial solution to the water pollution problem in the basin. Agricultural runoff and other non-point sources will continue to cause violations. Pollution from these non-point sources will generally restrict the uses designated for the basin's streams and the ability to comply with the 1983 national goal until appropriate controls on these sources are initiated and become effective.



MISSOURI RIVER

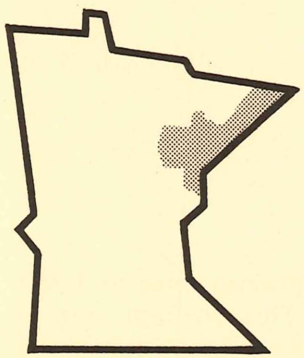
The Missouri River Basin comprises a drainage area of 1,782 square miles in southwestern Minnesota. This drainage area in Minnesota is composed of a number of small headwater tributaries which finally flow into the Missouri River proper. The economy of the basin is based primarily on agriculture. Livestock and feedlot operations are of particular importance. The population of the Missouri River Basin planning area totaled 47,205 in 1970.

Stream flow in most of the basin is quite erratic and is characterized by a very low flow or a zero flow condition during prolonged periods of drought. Only a relatively small volume of water is used for either domestic or industrial purposes. Presently, groundwater supplies the domestic and industrial needs. Streams in the basin are not used for commercial water traffic, hydroelectric power generation, or industrial cooling waters because of the erratic and relatively low flow characteristics of the basin.

Dischargers in this area include seventeen municipalities, four industries, five small commercial operations and one state park.

The two monitoring stations located in this basin area indicate that these waters have relatively excessive levels of fecal coliform, ammonia, and turbidity. The frequency of violations indicates that these waters continue to be in a polluted condition which may actually or potentially be deleterious to the designated water uses such as fishing and swimming.

As with the Des Moines River Basin, available water quality data indicate that controlling point source dischargers will be only a partial solution to the water pollution problem in the basin. In order to meet the national goals of the Act, further effort will be needed to understand non-point source problems and implement control techniques.



LAKE SUPERIOR BASIN

The Lake Superior Basin planning area comprises a total land drainage area of 6,403 square miles in Minnesota and contains a total population of 237,848.

The economy of the basin is dominated by iron and taconite ore mining and processing. Manufacturing of forest products, and paper and allied products. Shipping and tourism are other major contributors to the basin's economy. The basin is noted for its recreational areas and activities such as fishing, hunting, canoeing, and camping.

Consistent with the majority of the basins already discussed, tributaries in the Lake Superior Basin experience low flow conditions during certain periods of the year and during the years characterized by low rainfall.

Surface water supplies are adequate to meet anticipated future demand through 1990, although problems with collection and distribution in localized areas may occur. Water supply shortages are not anticipated with respect to municipal supplies. Most municipal supplies are obtained from the groundwater in the area, and it is believed that sufficient groundwater is available to adequately supply increased demands of the municipalities in the area. Municipalities located on the north shore of Lake Superior continue to obtain their water supply from Lake Superior. These communities are constructing facilities to provide further treatment of Lake Superior water or seeking alternative sources of drinking water. This effort was initiated because of asbestos levels recently detected in Lake Superior caused by the discharge of taconite tailings to the lake by Reserve Mining Company. Probably the most critical factor affecting water demand in the future is the location of future and expanding taconite processing facilities and, in particular, their water withdrawal locations. Another mining development which could require large amounts of water is the proposed development of the extensive deposits of low grade copper and nickel. These projected increases in domestic and industrial demands for water will affect the maintenance of adequate flow and quality in the waters of the basin for the propagation of wildlife and recreational uses.

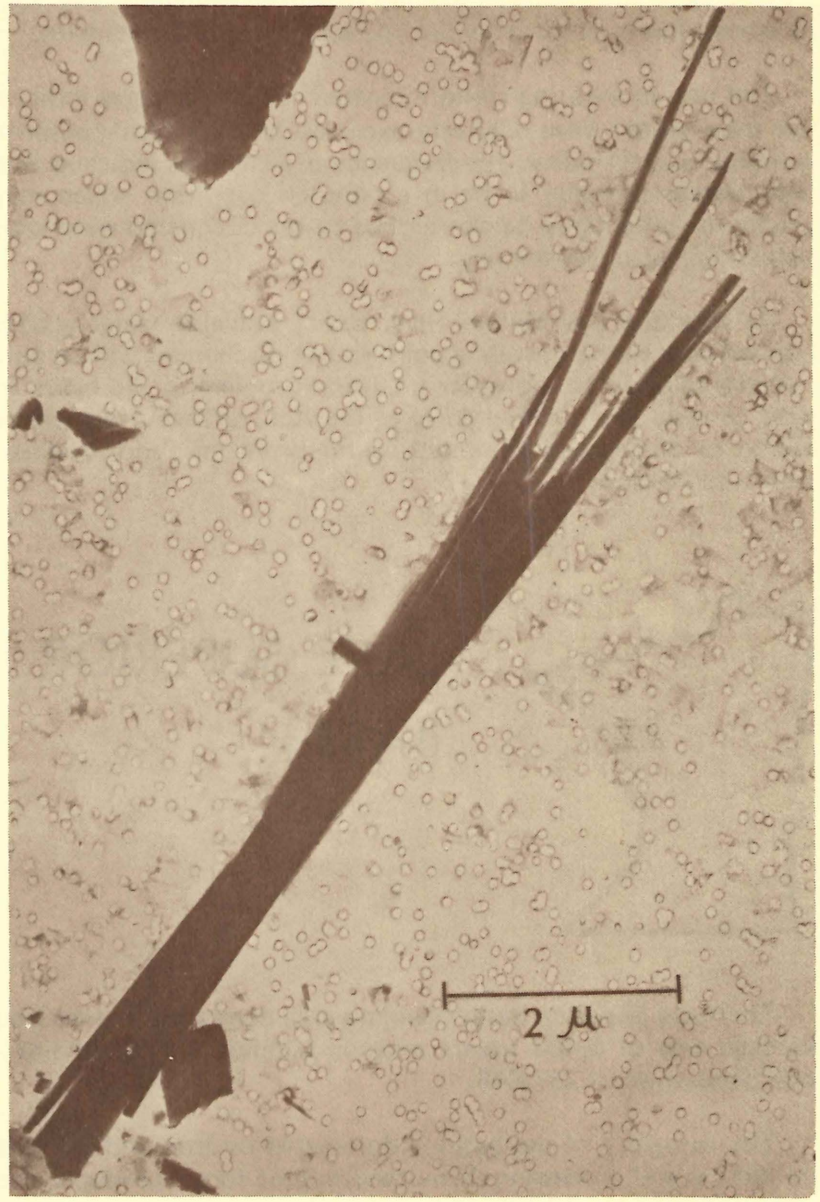
There are 26 municipal dischargers, 29 industrial dischargers, five municipal water treatment plants, and ten miscellaneous dischargers located within the Lake Superior planning area.

The water quality of Lake Superior is considered excellent and is in compliance with the national goal of the Act of maintaining clean waters throughout the nation. The major single concern in maintaining the integrity of the lake is to terminate the discharge of Reserve Mining Company to Lake Superior. In this regard, the MPCA and its associate plaintiffs are still actively engaged in court proceedings.

Another project which is expected to substantially improve water quality in the area and in the St. Louis River, in particular, is the new regionalized wastewater treatment facility which is presently under construction in Duluth. The Western Lake Superior Sanitary District (WLSSD) facility will replace the existing municipal treatment plants, as well as the municipal treatment plants at Cloquet and a number of other small communities. It will also treat discharges from two paper mills in Cloquet.

The tributaries of Lake Superior are of lower overall water quality than the lake itself. The data obtained on seventeen tributaries sampled in a recently concluded tributary study reveal that these streams are generally of very good water quality with the exception of the lower St. Louis River and to a lesser degree, the Nemadji River.

The lower reach of the St. Louis River below the city of Cloquet is periodically in violation of applicable state water quality standards, particularly for the parameters of fecal coliform and dissolved oxygen. These violations appear to be attributable to the point source dischargers from the Cloquet area.



Electron Microscope Photograph of an Asbestos Fiber

CHAPTER IV: LAKES

The State of Minnesota contains some 15,291 lake basins, of which approximately 12,000 are water filled. Due to man's influence, many of Minnesota's lakes are now impacted to some degree by the effects of eutrophication.

"Eutrophication" is a commonly used term in the field of water pollution control, and it has been defined as a state of overnourishment. The eutrophic state often results in an excess of biologic growths which can be detrimental to the lake and its various uses. As a result of the eutrophic state, lakes experience a series of ecologic successions characterized by increased productivity and sedimentation. This has been simply illustrated in Figure 4.

Eutrophication can result from both natural and cultural nutrient input factors. Examples of naturally eutrophic lakes in Minnesota are those that are found within the prairie-grassland regions of southwestern, western, and northwestern Minnesota. Soils in these regions are characteristically of high fertility; therefore, lakes which are dependent to a large degree on their respective watersheds for hydrologic and nutrient inputs may reflect an overnourished condition.

Cultural eutrophication has been defined as a man-induced overnourishment of lakes resulting from point or non-point source pollution. Point source impacts are those that may be caused by industrial, municipal, or commercial waste system discharges or confined agricultural feedlot discharges. Non-point sources are generally defined as those not considered to be point sources such as erosion or drainage of cultivated farmlands, urban runoff and septic tank systems.

Control, or at least a slowing down of the cultural eutrophication of lakes can be achieved principally through the implementation of Sections of Public Law 92-500. Significant upgrading or the elimination of point sources to lakes can be expected to improve the water quality of those lakes which receive a major input of nutrients from those sources.

The achievement of an overall assessment of non-point source pollution through the implementation of the Section 208 planning process will assist in the definition of this problem with recommended remedial actions as it relates to land uses and geologic characteristics in Minnesota.

The most important program created and initiated to date to deal specifically with lakes and the control of cultural eutrophication is the "Clean Lakes" portion of Public Law 92-500. This section was created and directed at the restoration of our nation's publically owned freshwater lakes through the implementation of watershed non-point source pollution controls and/or certain in-lake measures.

The enactment of Section 314 with the $38 million appropriated thereunder, brought about the initiation of the Federal Clean Lakes Grant Program administered by the U.S. Environmental Protection Agency (EPA). Since January of 1976, Minnesota has received six grant awards for lake restoration projects. Table 2 delineates these grant projects. The grant awards total of $2,721,598 amounts to nearly 13% of the total appropriations enacted by Congress for the Clean Lakes Program. Minnesota's receipt of these awards illustrates the state's strong interest in the restoration and protection of its publicly owned freshwater lakes.

Continued interest in its publicly owned freshwater lakes has prompted the Minnesota Pollution Control Agency (MPCA) to propose legislation aimed at the establishment of a state lake restoration and protection grant program.

During 1976, the MPCA Board adopted Regulation WPC 37 which called for a ban on the sale of phosphate based laundry detergents and certain other cleaning products. WPC 37 was scheduled to become effective on January 1, 1977, however, the Soap and Detergent Association and FMC Corporation sought and obtained an order in Ramsey County District Court temporarily

EUTROPHICATION

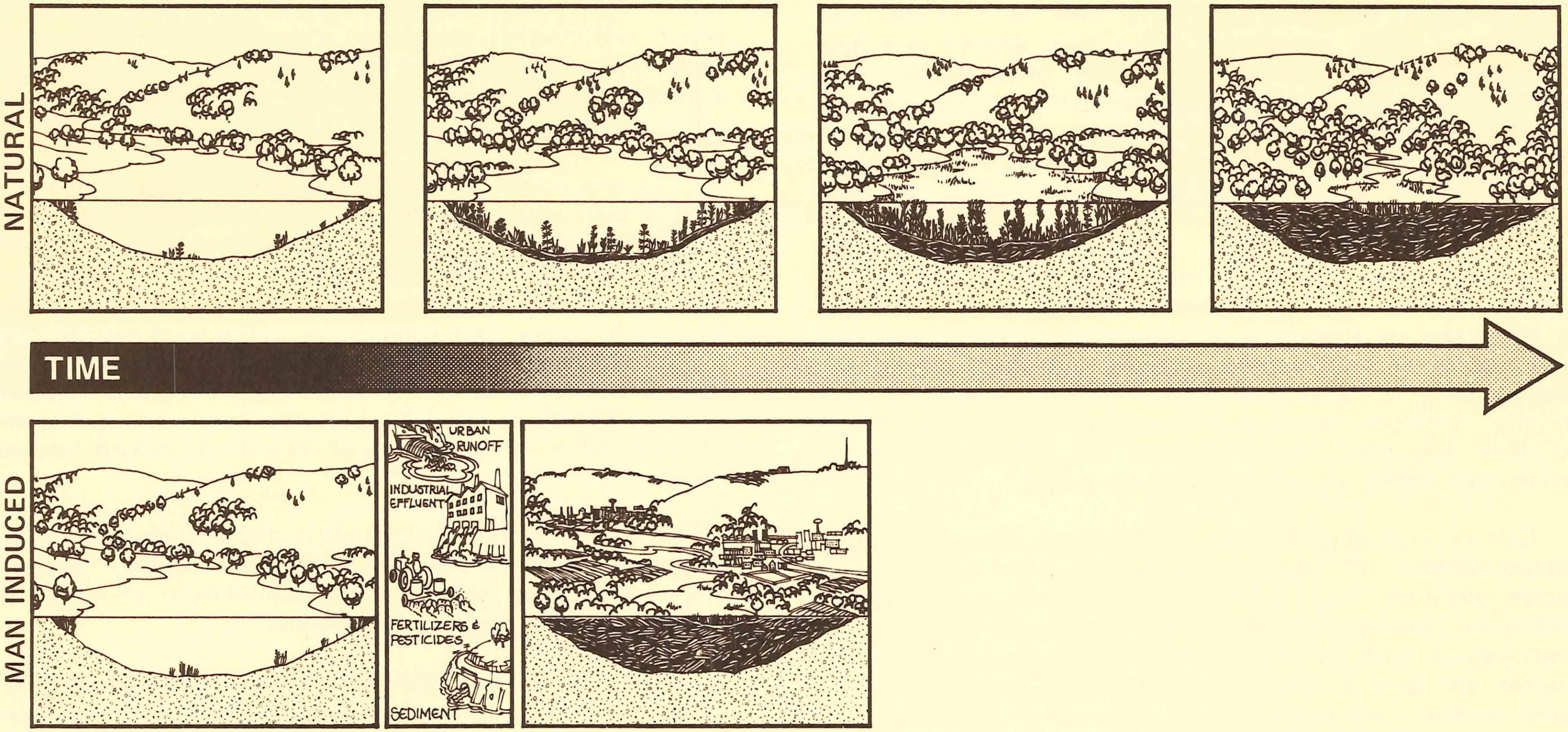


FIGURE 4

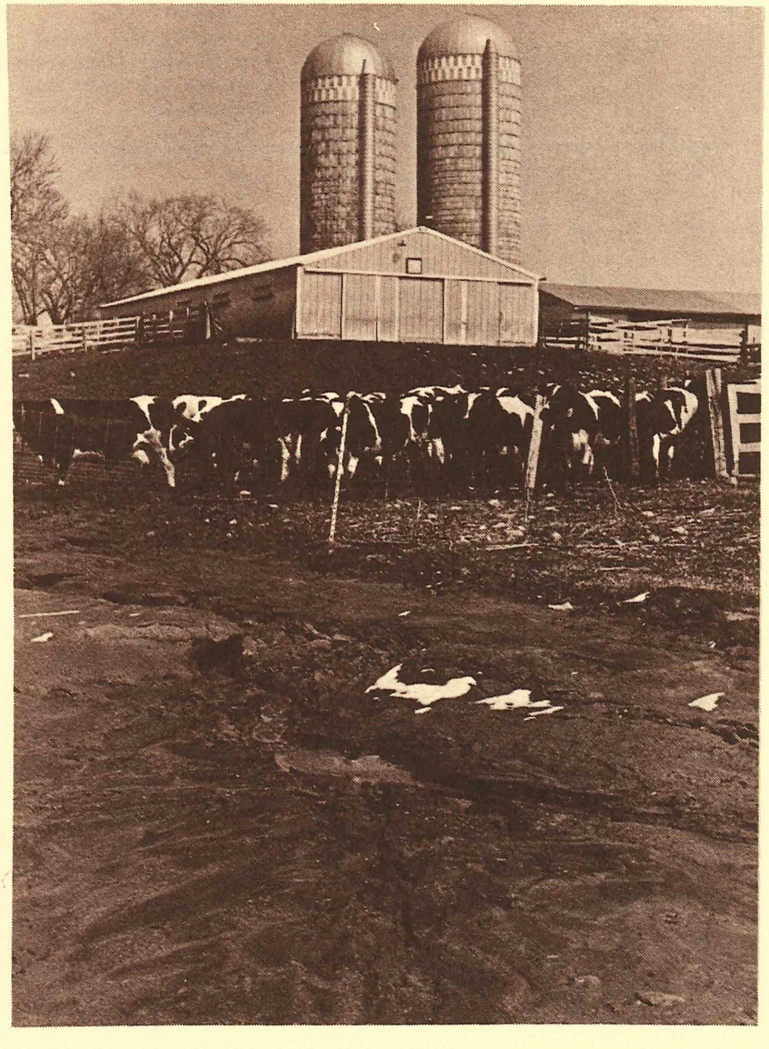
enjoining enforcement of the regulation pending resolution of their respective legal challenges to the regulation. Eventual implementation of this regulation will substantially reduce the amount of phosphorus emanating from municipal point sources.

TABLE 2
MINNESOTA LAKE RESTORATION PROJECTS

Grant Awardee	Lake(s)	Grant Award
Freeborn County	Fountain Lake	$ 302,800
City of Minneapolis	Harriet Lake Lake of the Isles	179,000
City of Waseca	Clear Lake	269,075
Hennepin County Park Reserve District	Hyland Lake	98,325
Rice Creek Watershed District	Long Lake Chain	1,296,715
Ramsey County	Phalen Lake Chain	575,683
	Total Grant Awards:	$2,721,598

CHAPTER V: NON-POINT SOURCE POLLUTION

Municipal and industrial point sources of pollution are currently the highest priority for corrective efforts to meet the nation's 1983 water quality goals. Although remedies for point sources are not always simple, the sources are at least relatively easy to locate and identify, and a level of necessary effluent quality can be prescribed.



A more perplexing problem is that of non-point sources of pollution from such activities as agriculture, septic tanks systems, silviculture, urban runoff, mining and dredging. The problem is twofold: first, the sources of non-point pollutants are difficult to define; second, the means of transport and control of the pollutants to the receiving water are vaguely understood.

Section 208 of the Act directs the Agency to identify and evaluate feasible measures to control point and non-point pollution sources, develop an integrated plan to control these sources and establish a management program for implementation. At the present time, the 208 planning programs in the state are just being initiated.

It is anticipated that these plans will identify and evaluate alternative procedures and methods to control non-point sources contributing to water quality standard violations. Such procedures may include, among others, land use controls. An evaluation of methods would consider technical, legal, institutional, economic and environmental impacts, and feasibility of such procedures and methods.

The non-point source pollution program is in its infancy. These reports will only attempt to describe the general distribution of potential non-point source pollution contribution across the state and within each basin. Table 3 indicates potential pollution from non-point source related activities in Minnesota's eleven basins.

TABLE 3
INDICATORS OF NON-POINT SOURCE POLLUTION POTENTIAL

	AGRICULTURE			PROPORTION OF LAND		SILVICULTURE	MINING		CONSTRUCTION	RESIDENCES	OVERALL
BASIN	Livestock BOD 1969 (lbs/Square Mile/Day)	Commercial Fertilizers Purchased, 1969 (Dollars/Square Mile/Year)	Chemicals Purchased Other Than Fertilizers and Lime, 1969 (Dollars/Square Mile/Year)	In Soil Formations With Major Erosion Problems	In Clay Soils	Commercial Forests, 1962 (% of Land Covered By)	Iron Ranges or Copper-Nickel Exploration Sites	Sand and Gravel Produced, 1969 (1000 Tons/ Square Mile/ Year)	Net Change in Housing Units, 1960-1970 (Per Square Mile/ 10 Years)	Approx. Unsewered Population, 1970 (Pop./ Square Mile)	Relative Non-Point Pollution Potential
Red River	44 Low	961 Medium	190 Low	Low	High	24 Medium	–	0.380 Low	0.17 Low	7 Low	Med-High
Rainy	5 Low	32 Low	4 Low	Low	Medium	76 High	Iron and Copper-Nickel	0.210 Low	–0.11 Low	5 Low	Low
Upper Upper Mississippi	82 Low	522 Low	153 Low	Medium	Medium	44 High	Iron	0.430 Low	0.84 Med-Low	14 Med-Low	Med-Low
Twin Cities Metro Area	120 Medium	1110 Medium	406 Medium	Medium	Medium	12 Low	–	6.070 High	41.97 High	40 High	High
Lower Upper Mississippi	225 High	1860 Med-High	703 High	High	Low	14 Low	Some Iron	0.530 Low	2.24 Med	21 Medium	Med-High
Minnesota	140 Medium	2417 High	856 High	High	High	3 Low	–	0.540 Low	0.48 Med-Low	13 Low	High
St. Croix	69 Low	273 Low	64 Low	Low	High	48 High	–	1.060 Medium	1.21 Med-Low	16 Medium	Med-Low
Cedar	207 High	2926 High	1235 High	High	Medium	3 Low	–	1.010 Medium	0.16 Low	19 Medium	High
Missouri	242 High	1885 Med-High	623 Med-High	High	Low	1 Low	–	0.590 Low	0.25 Low	12 Low	High
Des Moines	191 High	2266 High	806 High	High	High	1 Low	–	0.380 Low	0.01 Low	13 Low	High
Lake Superior	6 Low	16 Low	2 Low	Low	Low	71 High	Iron and Copper-Nickel	0.370 Low	–0.04 Low	6 Low	Low
State	85	1027	326	Medium	High	34	Iron and Copper-Nickel	0.59	1.75	12	–

The values found in the table under each activity for each basin were derived by computing a total activity value for each county in the state, and dividing that value by the number of square miles for each particular county to obtain a per-square mile concentration.

Dredging operations on the Upper Mississippi River, Duluth-Superior Harbor and other waters of the state, have significant environmental effects on water quality. Traditionally, the disposal method used has been dependent upon the type of equipment available, the distance to be covered from dredging to "spoiling," the geographical setting involved in the operation, and the economics of the operation. More recently, the pollution character of the dredged soil material has become important in deciding where "spoiling" is to take place. Expanded monitoring programs for dredging operations should determine the environmental cause-effect relationships associated with dredging activities and the pollution status of the bottom sediments. The U.S. Army Corps of Engineers has worked cooperatively with the Minnesota Pollution Control Agency to correct the problems which have been identified.

CHAPTER VI: ECONOMICS OF WATER POLLUTION CONTROL

BACKGROUND

Historically, municipalities and industries have continued to demand clean water for domestic consumption and industrial use and yet have been reluctant to expend funds for wastewater treatment. Therefore, water intakes have been generally located upstream of consumers, and the waste discharges are generally downstream. However, this has created limitations on downstream uses since adequate dilution or assimilative capacity is normally not sufficient to negate the wastewater impact unless a high level of waste treatment is provided. As a result of population and industrial expansion, degraded areas multiplied to levels which activated public concern. The public began to realize that there doesn't have to be a degraded area below each developed area and that these waters in close proximity to their homes have recreational potential. Municipalities and industries, as a result, are now treating their wastewater or constructing facilities to treat wastewater to levels which will insure that downstream uses are not jeopardized, and the excuse that degraded waters are necessary because of cost consideration is becoming obsolete.

With this in mind, most expenditures for pollution control facilities have had the intent of protecting or upgrading a designated reach of a waterway. Many of the waterways in Minnesota can be upgraded to acceptable levels by controlling these municipal and industrial point sources of pollution. However, it has now also become apparent that in many areas, non-point sources of pollution must also be controlled. Man's activities of restructuring his environment for specific purposes such as agriculture, development adjacent to waterways and urban development have enabled rainwater to wash massive wasteloads into the waterways. Due to the diffused nature and resulting costs to control this form of pollution, an accelerated program to control this wasteloading is only now being considered and implemented. Most of the reqources have been expended on the more easily controllable concentrated loadings from the point sources. As a result, the most extreme degraded areas below point sources will be eliminated first, and then as non-point source controls become effective, the more generalized degraded areas will be reduced.

MUNICIPAL AND INDUSTRIAL COSTS

Industries are required to upgrade to achieve Best Practicable Treatment by 1977, while municipalities are required to upgrade to achieve secondary treatment by July 1, 1977. In addition, dischargers must upgrade to a level which will insure that applicable water quality standards in the receiving waters are not violated. Listed in Table 4 is a summary of funds being expended by major municipal and industrial dischargers to upgrade their waste treatment to achieve these levels. Costs to achieve the 1983 goal of Best Available Treatment by industries and Best Practicable

Technology by municipalities are not included in the table since guidelines have not been finalized. Costs for discharges in compliance with existing effluent limitations are based on recent expenditures and costs for dischargers currently upgrading are based on projections. Also, the cost summary only considers major dischargers and is not intended to be all inclusive. The intent is to give an indication of the level of expenditures which is being spent in Minnesota. It is also noted that industrial costs can only be estimated since industries are not obligated to inform the State of costs incurred to achieve designated effluent limitations.

Some of the dischargers in the table will not meet the 1977 goal in P.L. 92-500 on time, for various reasons; however, normal upgrading is continuing. As an example, the Metro Plant in Minneapolis-St. Paul will not achieve secondary treatment until 1981, but construction is continuing.

TABLE 4

COST ESTIMATES TO UPGRADE MUNICIPAL AND INDUSTRIAL WASTEWATER TREATMENT

Discharger	In Compliance With Existing Effluent Limitations	Upgrading or Planning in Progress	Cost to Upgrade in Millions of $
RED RIVER			
Moorhead		X	$ 10
American Crystal Sugar (E. Grand Forks and Moorhead)	X		
Red Lake River			
Thief River Falls	X		$ 1
Crookston	X		
American Crystal Sugar (Crookston)	X		
Ottertail River			
Fergus Falls		X	*
RAINY RIVER			
Boise Cascade (International Falls)		X	$ 16
UPPER UPPER MISSISSIPPI RIVER			
Bemidji		X	$ 7
Grand Rapids	X		6
Brainerd		X	4
Little Falls	X		5
St. Cloud	X		16
Potlach Inc. (Brainerd)		X	3
St. Regis Paper Co. (Sartell)	X		
Wausau Paper Mills (Little Falls)		X	1
Lake Winona			
Alexandria Lake Sanitary District		X	$ 14
Lake Wagonga			
Willmar		X	$ 8
TWIN CITIES METRO**			
Anoka (Mississippi R.)	X		
Metro Plant (Mississippi River)		X	$300
Cottage Grove (Mississippi River)		X	*
Seneca (Minnesota R.)	X		
Blue Lake (Minnesota River)	X		$ 7
Lakeville-Farmington (Vermillion River)		X	$ 22
Hastings (Mississippi R.)	X		

Discharger	In Compliance With Existing Effluent Limitations	Upgrading or Planning in Progress	Cost to Upgrade in Millions of $
TWIN CITIES METRO** **(Continued)**			
Koch Refinery (Mississippi River)		X	$ 9
Northwest Refinery (Mississippi River)	X		
Minnesota Mining & Manufacturing (Mississippi River)		X	*
MINNESOTA RIVER			
St. Peter	X		
Mankato	X		$ 5
New Ulm	X		6
Redwood River			
Marshall	X		$ 5
ST. CROIX RIVER			
Stillwater	X		
CEDAR RIVER and SHELL ROCK RIVERS			
Austin (Cedar River)		X	$ 2
Albert Lea (Shell Rock River)		X	17
MISSOURI RIVER HEADWATER TRIBUTARY			
No Major Dischargers			
DES MOINES RIVER HEADWATER TRIBUTARY			
Worthington		X	$ 8

Discharger	In Compliance With Existing Effluent Limitations	Upgrading or Planning in Progress	Cost to Upgrade in Millions of $
LOWER UPPER MISSISSIPPI RIVER			
Red Wing		X	$ 4
Winona	X		
Cannon River			
Owatonna		X	*
Faribault		X	$ 4
Northfield		X	*
Zumbro River			
Rochester		X	$ 35
Whitewater River			
Dover-Eyota-St. Charles		X	$ 4
LAKE SUPERIOR BASIN			
Two Harbors	X		$1.5
Reserve Mining		X	300
St. Louis River			
Hibbing	X		$ 2
Virginia	X		3
Western Lake Superior Sanitary Dist.		X	105
U.S. Steel Corp.		X	.5

*Plans for upgrading being developed and no costs finalized at this time.

**A study consistent with Section 208 in P.L. 92-500 is being conducted which may establish more restrictive effluent limitations for the various dischargers.

The total reported needs for all municipalities in Minnesota are presented in the following list which represents a value of $1,608,000,000.

Need Category	Value Reported For 1976 Needs Survey (Millions of Dollars, 1976)
Category I (Secondary Treatment)	$ –0–
Category II (Tertiary Treatment)	874
Category III-A (Infiltration/Inflow Corrections)	24
Category III-B (Major Sewer Rehabilitations)	10
Category VI-A (New Collectors Sewers)	170
Category IV-B (New Interceptor Sewers)	307
Category V (Combined Sewer Overflow Corrections)	223
Total	$1,608

Only $172 million in federal and $34.5 in state matching grant funds were available for municipalities in Fiscal Year (FY) 1976. Therefore, unless more grant money is made available, upgrading of all the municipal dischargers will be a long process. Many of the municipalities which will be last to receive funding are the smaller ones located on small waterways or intermittent streams of marginal quality. These forms of waterways will not be fully upgraded until non-point controls are also implemented.

NON-POINT NEEDS*

The "1976 Minnesota Water Quality Inventory" identified three waterways in the state which will not meet the 1983 goal of P.L. 92-500. This goal states that "wherever attainable, an interim goal of water quality which provides for the protection and propogation of fish, shellfish, and wildlife and provides for recreation in and on the waters be achieved by July 1, 1983." These waters are the Des Moines and Missouri headwater tributaries which are heavily affected by agriculture runoff and the metro segment of the Mississippi River in Minneapolis-St. Paul which is heavily affected by storm and combined sewers and point source dischargers. It was also indicated that fecal coliform levels were high in many of the state waters. In these cases, funds to control non-point sources are desperately needed if the goal is ever going to be met. As indicated previously, programs to control non-point sources of pollution are only now being accelerated, and only generalized costs throughout the state can be estimated at this time. Excessive amounts of nitrogen, phosphorus, sediments, fecal coliform, and a high biochemical oxygen demand constitute the most significant elements of non-point source pollutants.

Agricultural Land:

Gross sheet and rill erosion on all agricultural land in Minnesota is presently estimated at 130 million tons per year. Erosion control on this land would result in an estimated 45% reduction in this loading and cost an estimated $320 million (1975 dollars). The control of applied nutrients, herbicides and pesticides is largely a management program and no costs have been estimated. Animal wastes from the 64,000 dairy, beef and swine operations are also a large potential source of pollution. The total cost for this form of waste control is estimated to be $320 million (1975 dollars). The highest priority area for the control of pollution from agricultural land is in the southwestern part of the state where agricultural activity is intense and the small waterways are heavily degraded.

*Non-point needs were developed by the U.S. Soil Conservation Service.

Bank Erosion:

Streambank erosion is a controllable and significant source of contaminants to Minnesota's waterways. However, only limited efforts have been expended in this area. Lakeshore erosion, as a result of development, is also significant. It is estimated that 1,000 lakes in the state need extensive upgrading at a total cost of $400 million (1975 dollars). It is estimated that 10,000 acres of roadway right-of-way are in need of corrective measures at a cost of approximately $15 million (1974 dollars).

Urban Construction:

Urban construction is a major source of non-point pollution. The estimate of costs to control soil loss for the metropolitan Minneapolis-St. Paul area is $3,800,000. The metro area costs would only be a part of the estimated statewide annual cost of $1,500 per acre or $6 million per year (1975 dollars). This does not include the massive costs to treat storm water from the cities throughout Minnesota.

Limited funds are being expended to control non-point source pollution. As an example, the U.S. Soil Conservation Service is working with limited funding to solve some of the problems in the agricultural areas, and a total of $500,000 has been authorized by the state for the control of erosion of highway right-of-ways. In addition, $1.8 million in 208 federal funds have been awarded to Minnesota which will be combined with $.6 million state funds to study the extent and possible control of non-point sources of pollution. This study will also evaluate storm water discharges to determine the impact on the environment.

BENEFITS

A large amount of income in Minnesota is based on expenditures for recreation and this requires that the existing high water quality be maintained and that degraded areas be improved. As an example, Minnesota residents alone registered more than 444,000 watercraft in the state in 1974. This demand for clean water is accelerating every year.

Income from commercial fishing must also be protected. The PCB contamination in Lake Pepin on the Mississippi River has resulted in an economic burden both on commercial fishermen and on the recreation facilities.

With increased development, there is an increased demand on surface waters for municipal and industrial water supplies. The discharge of asbestos from Reserve Mining has jeopardized the use of Lake Superior as a source of water for domestic consumption. As a result, Duluth has installed a water filtration system and Cloquet, Two Harbors, Beaver Bay and Silver Bay are in the process of installing these systems. Considering existing technology, this form of degradation should not be permitted.

Table 4 reviewed the expenditures for waste treatment by the major dischargers in Minnesota. Table 5 reviews water quality violations downstream of those dischargers which are in the process of upgrading. These violations are based upon twelve sample dates and, therefore, may not fully depict the intensity of the problem which normally will occur during low flow periods. Upgrading of the waste treatment facilities in the listed communities should greatly reduce the frequency of water quality violations except for those resulting from non-point sources. This should, in turn, increase the recreational potential of the affected waterway.

TABLE 5

PROBLEM AREAS PERCENT VIOLATION OF WATER QUALITY STANDARDS IN 1976

Waterway	Problem Area Results From and is Downstream of:	Discharger	Ammonia (N)	Dissolved Oxygen	Fecal Coliform Organisms	Turbidity	Type of Treatment* Plant Upgrading
Red River of the North	Moorhead	Moorhead			18	42	Biochemical Oxygen Demand (BOD_5) and Total Suspended Solids (TSS) removal to achieve 15 mg/l.
Ottertail River	Fergus Falls	Fergus Falls			18	8	Phosphorus removal to 1 mg/l along with improvements to secondary treatment facilities.
Rainy River	International Falls	Boise Cascade		17	100	17	BOD_5 and TSS removal to achieve secondary treatment.
Upper Upper Mississippi River	Bemidji	Bemidji			8		BOD_5 and TSS removal to achieve secondary treatment and phosphorus removal to achieve 1 mg/l.
	Brainerd	Brainerd Potlatch, Inc.			33		BOD_5 and TSS removal to achieve secondary treatment or BPT.
Twin Cities Metro (Mississippi River)	Minneapolis	Metro Plant Cottage Grove Koch Refinery Minnesota Mining	23	38	73	4	BOD_5 and TSS and ammonia removal to achieve secondary treatment or BPT.
(Vermillion River)		Lakeville and Farmington	17		33		BOD_5, TSS and ammonia removal to achieve 10 mg/l, 10 mg/l and 1.0 mg/l, respectively.
Cedar River	Austin	Austin	58	17	25		Upgrading to secondary treatment recently completed and study being conducted to determine tertiary treatment needs.

Waterway	Problem Area Results From and is Downstream of:	Discharger	Ammonia (N)	Dissolved Oxygen	Fecal Coliform Organisms	Turbidity	Type of Treatment* Plant Upgrading
Shell Rock River	Albert Lea	Albert Lea	25	8	25	25	Discharge point to be relocated and tertiary treatment to be provided.
Lower Upper Mississippi River							
Cannon River	Faribault	Faribault Northfield	27		42		BOD_5 and TSS removal to achieve secondary treatment.
Zumbro River	Rochester	Rochester	58		8		BOD_5, TSS, and ammonia removal to achieve tertiary treatment requirements.
Lake Superior		Reserve Mining					Establishment of on-land disposal for taconite tailings.
St. Louis River	Duluth Cloquet	Western Lake Superior Sanitary District		42	25		BOD_5 and TSS removal to achieve secondary treatment and phosphorus removal to achieve 1 mg/l total phosphorus.

*All municipal treatment plants are presently required to achieve secondary treatment, as a minimum, which includes limitations of 25 mg/l BOD_5, 30 mg/l TSS, 25 turbidity, and 200 MPN/100 ml fecal coliform.

NOTES