Minnesota Water Quality

Minnesota Pollution Control Agency
Report to Congress Section 305 (b)
1980

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, 1980

Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

TABLE OF CONTENTS

LIST OF FIGURES, MAPS, AND TABLES

Page No.

Figure

Map

Page No.

Map

Table

CHAPTER 1

INTRODUCTION, SUMMARY, AND RECOMMENDATIONS

INTRODUCTION

The state of Minnesota contains over 12,000 lakes of ten acres or more, and many miles of streams. Included in the state are three major river systems: the Mississippi, the Minnesota and the Red River of the North. Water flows from Minnesota in three directions: to Hudson Bay, the Atlantic Ocean, and the Gulf of Mexico. Very little water flows into Minnesota. With some limited exceptions, moderate to large quantities of ground water are available anywhere in the state.

This report concerning the quality of the state waters was prepared by the Minnesota Pollution Control Agency (MPCA) pursuant to Section 305(b) of the Federal Water Pollution Control Act Amendments of 1972 (the Act) (Public Law 92-500). Section 305(b) of the Act requires that the report include the following:

1. **A thorough description of existing water quality, including an analysis of the extent to which such waters currently support balanced populations of aquatic life and allow for recreational activity.**
2. **Projections of water quality conditions after implementation of the control programs specified in the Act.**
3. **An estimate of the environmental, social, and economic impacts of achieving or not achieving the goals of the Act. An estimate of the date of such achievement should be included.**
4. **An assessment of non-point source problems, along with recommendations for their control (including cost estimates for implementation).**
5. **An evaluation of the effectiveness of existing pollution control programs and recommendations for future modifications to those programs, if needed.**

The water quality goals are:

(a) those set forth in section 101 of the Act, including protection and propagation of fish, shellfish, and wildlife and provision for recreation in and on the water by 1983 wherever attainable; restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters; and prohibition of toxic substances in toxic amounts;

(b) achievement of water quality standards;

(c) protection of public health and welfare; and

(d) reduction of water pollutants from non-point sources to the maximum extent feasible.

The purpose of this report is to address these requirements and goals and thereby provide to the Congress and others who may be interested an assessment of water quality in Minnesota. Chapters 2-4 describe some of the various programs that involve water quality sampling by the MPCA Division of Water Quality and the program results as they relate to existing state water quality standards and the federal/state goals. Chapter 5 describes some specific water quality problems, and Chapter 6 is an overall program evaluation and a discussion of possible modifications to existing water pollution control programs to increase their effectiveness as tools in efforts to preserve and improve state waters.

SUMMARY

The water quality of streams in Minnesota during water years 1978-79 (October 1, 1977 to September 30, 1979) is assessed by the results of physical, chemical, and bacteriological monitoring; toxic substances monitoring; biological monitoring; and intensive surveys.

Stream sampling under the primary monitoring program was done in water years 1978-79 at a total of 53 stations located generally in reaches of streams that are considered critical from the standpoint of water quality.

The fishable goal of the 1983 federal/state goal is assumed to mean that all surface waters in the state, where suitable, will be capable of supporting fish by 1983.

Assessment of the data, resulting from the water years 1978-79 primary monitoring, for fishable aspects of the 1983 federal/state goal was done on the basis of selected parameters described on pages 8-12. The results of the assessment show that the waters monitored generally meet the fishable goal except at five locations.

The stations in compliance with the 1983 fishable goal represent 91 percent of the stations monitored in water years 1978-79. This compares with 88 percent in compliance in water years 1976-77 and 89 percent in 1975.

An assessment of the quality of waters sampled under the primary monitoring program in water years 1978-79 for swimmable aspects of the 1983 goal is based on the 200 most probable number per 100 milliliters (MPN/100 ml) fecal coliform water quality standard. For purposes of this report, it is assumed that waters may not be swimmable if this standard is exceeded. On this basis, the findings indicate that swimming may not be advisable in many Minnesota rivers discussed in this report because the fecal coliform standard is exceeded at a frequency greater than 10 percent of the time at 70 percent, and 20 percent of the time at 50 percent of the stations sampled.

During 1977 and 1978, biological samples were collected annually from a total of 21 stations located on major rivers and significant tributaries in Minnesota. At 14 of the stations no significant changes in diversity or equitability (for definitions of diversity and equitability, see pages 13 and 14) were found, and it was concluded that there had been little or no change in water quality. At seven of the stations, increases in diversity and equitability were noted, indicating an improvement in water quality (one station was considered slightly improved and another, **UM-826**, was considered temporarily improved because of the increased flows). In terms of "health" status, the data from the 21 stations reveal generally good water quality at seven stations, poor water quality at two, and indeterminate water quality at 12. In many cases the extreme fluctuations in flow made evaluation of the data difficult.

During the past several years, studies were conducted on toxic substances such as polychlorinated biphenyls (PCBs), mercury and other heavy metals, and pesticides. PCB and mercury concentrations found in fish samples collected have led to the establishment of fish consumption guidelines by the Minnesota Department of Health (MDH) for certain Minnesota lakes and streams.

The results of studies conducted on the concentrations of heavy metals and pesticides in the fish and sediments of various lakes and streams are delayed pending the completion of laboratory analyses.

Two major fish kills have occurred in Minnesota in the past two years — one being nearly an annual event involving southeastern Minnesota trout streams and suspected carbamate and organophosphorous-type insecticides, and another involving Spring Lake on the Mississippi River and a 100-ton spill of anhydrous ammonia.

During the past two years the MPCA has conducted load allocation intensive surveys (see page 21) on the Straight River at Owatonna, the Sauk River at Cold Spring, the Blue Earth River at Blue Earth and Winnebago, and Penobscott Creek at Hibbing.

The findings from the intensive surveys at these locations generally showed violations of state standards for dissolved oxygen, ammonia nitrogen, and fecal coliform, and demonstrated the need to upgrade local municipal and industrial wastewater treatment. In addition, non-point sources were found to be a problem at Blue Earth and Winnebago.

A combined sewer, wet weather intensive field survey in the Twin Cities Metropolitan Area has been conducted by MPCA and the Metropolitan Waste Control Commission (MWCC) under a U.S. Environmental Protection Agency (EPA) 201 grant during the past three years. Preliminary findings show that storm water and combined sewer overflows during wet weather conditions contribute significant loads of pollutants, including fecal coliforms and heavy metals, to the metropolitan segment of the Mississippi River.

Due to man's influence and natural causes, many of Minnesota's lakes are now impacted to some degree by the effects of eutrophication (see Figure 10).

A phosphate detergent ban adopted in 1976 is an important complement of the MPCA's nutrient control effort. Results of the ban indicate that a substantial degree of success was achieved in reducing the amount of phosphorus emanating from municipal point sources.

Another important program created and initiated to deal specifically with lakes and the control of eutrophication is the "Clean Lakes" section of the Clean Water Act of 1977 (Section 314, Public Law 95-217). In Minnesota, a total of seven (7) projects have received matching grants in the amount of $2,961,978 from the EPA. Together with state matching funds of $1,374,684 and the local share, the total cost of the projects amounts to $5,561,956.

One Clean Lakes project nearing completion is the Hyland Lake project located in the western portion of the city of Bloomington, Minnesota. After its first year, the project yielded dramatic improvements in lake water quality.

An integral part of the "Clean Lakes" program is the effort under Section 314(a) directed at the classification and priority ranking of the state's significant publicly-owned freshwater lakes in need of protection or restoration. The information developed, coupled with watershed data on land use, soils, and hydrologic characteristics, will provide assistance in developing a priority ranking of the freshwater lakes in need of restoration or protection.

A program of citizen participation in the collection of lake water quality data was in operation during the summer of 1979. This Citizen Lake Monitoring Program (CLMP) included weekly Secchi disc water transparency readings with optional monthly water sampling to obtain phosphorus and Kjeldahl nitrogen concentrations. Coupled with its forerunner, the Secchi Disc Program, the CLMP provided transparency data on 362 lakes from 1973 to 1978. The median of the average July-August transparencies for all 362 lakes was 6.5 feet, ranging from averages of less than 0.5 feet to 29 feet (see page 27).

A summary of phosphorus and nitrogen data collected on 135 CLMP lakes in 1979 indicates that the median total phosphorus concentration was 0.040 milligram/liter (mg/l), ranging from 0.005 mg/l to 0.594 mg/l (see page 28). The median Kjeldahl nitrogen level was 0.75 mg/l, ranging from less than 0.3 to 7.0 mg/l.

The MPCA programs involving groundwater include groundwater quality monitoring, land application, and spill control.

From February 1978 to February 1980, 210 wells and springs were sampled for ambient water quality and evaluation of some actual or potential regional problems of groundwater quality degradation. Only the 1978 data from 137 wells and springs has been evaluated. Since the program is relatively new, only limited conclusions can be drawn at this time. Probably the most significant results indicate that wells in surficial sand aquifers, generally in sand plain agricultural regions of the state, contain generally higher concentrations of coliform bacteria, nitrates, and suspended solids than other wells tested. About 24 percent of 33 wells tested in the surficial sand aquifers were found to have nitrate (N) concentrations in excess of the state standard of 10 mg/l.

Land application of wastes is becoming more common as tighter regulations restrict the use of surface waters for waste disposal. The MPCA currently oversees numerous special soil and groundwater studies and monitoring throughout the state that are conducted by local jurisdictions or industries.

For most land application systems, monitoring has just begun or insufficient data has been generated to observe specific trends. Generally, the data from sites with land application of municipal wastewater indicate minimal impact on the local groundwater. Also, data from sites with municipal wastewater stabilization ponds that have adequate seals and water levels indicate minimal impact, with the possible exception of increased soluble salt concentrations in shallow groundwater. Limited data from some industrial food-processing plants using wastewater irrigation also indicate that there may be some increase of soluble salts locally in shallow groundwater.

The monitoring of spills continues as a program of the MPCA. In all cases of underground leaks and in most cases of moderate and large spills on the ground, soil borings and subsequent groundwater monitoring are necessary to determine the progress of cleanup operations. At one site, groundwater monitoring consisted of sampling quarterly from seven wells over a period of five years.

Special water quality problems in Minnesota exist in the areas of wetlands, groundwater, drinking water supplies, water depletion, and acid rain.

Studies conducted for the U.S. Fish and Wildlife Service have indicated that in 19 western Minnesota counties the number of wetlands decreased by 40 percent during the period 1964-1974. Such changes are considered to significantly affect the ecology of the area. Section 208(i) of the Clean Water Act provides $8,000,000 for the U.S. Fish and Wildlife Service to complete a National Wetlands Inventory by December 31, 1981. This will provide much needed information on the extent and nature of existing wetlands. However, further study will be necessary to determine which wetlands serve critical water quality functions.

Some regional and site-specific actual or potential groundwater problems exist in Minnesota. Regional problems include the southeastern Minnesota Karst area, which is characterized by fractured limestone, solution channels and sinkholes, the potential effects of farmland irrigation on shallow groundwater supplies, and saltwater intrusion. Some site-specific problems include groundwater pollution in the city of St. Louis Park resulting from previous operations of a coal tar distillery and wood-treating plant, in St. Paul from operation of the Koppers Coke plant, and at a number of locations from storage of salt for de-icing purposes.

Drinking water supplies remain generally of good quality in Minnesota. In the past several years, however, there have been at least two instances where a public water supply has been contaminated with agricultural chemicals, and a number of cases involving the pollution of private wells with materials such as salt, pesticides, and petroleum or petroleum products. The Minnesota Department of Health (MDH) reports that in 1979 they had only about twelve violations of the safe drinking water standards for chemical parameters for community water systems.

While water quality standards violations resulting from depletion of a water resource are not known to have occurred in Minnesota, some degradation of groundwater has taken place as a result of heavy pumping and the migration of poor quality water from surface sources or highly mineralized water from lower aquifers to the pumped aquifer.

Acid rain has been identified as a potential pollution problem in Minnesota just in the past two or three years. Rain samples collected near Ely as part of the Regional Copper/Nickel Study were found to have a median pH of 4.7 (rain with a pH below 5.6 is considered acidic). The MPCA is planning modifications to existing monitoring programs as well as new programs to study the effects of acid rain, but project funding remains a problem.

Current levels of federal funding for municipal wastewater treatment plants continue to be insufficient when considered in relation to the total estimated needs in Minnesota. The 1978 Municipal Needs Survey indicated that the total municipal needs in Minnesota, excluding storm water treatment, were approximately $1,344,000,000 (1978 dollars). Under the 1980 authorization, Minnesota should receive $62,668,900 in the construction grant program for fiscal year 1980. During the remaining two-year period, Minnesota's share of the 1977 authorization totals approximately $125,337,800. Thus, at the current level of funding, upgrading all those municipal dischargers with needs will still be a very time-consuming process.

Generally, point sources are considered to be direct wastewater discharges via a pipe, conduit, ditch, etc., from places such as municipalities and industries, while non-point sources are usually areal in nature, such as farm fields that contribute wastewater or polluted runoff over the land or by seepage.

Even if all industrial and municipal point sources of water pollution are brought into compliance, non-point source loadings, such as farmland drainage, will continue to cause and contribute to many water quality problems throughout the state. This is particularly apparent in the watersheds where agricultural activities constitute the dominant land use. Because of the extensive water features and broad agricultural areas of the state, present levels of surface and ground water quality monitoring are not considered adequate to properly assess these and other actual or potential problems.

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, currently in progress in both the Twin Cities metro area and in the outstate area, 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. The initial Minnesota Water Quality Management Plan is completed and has been certified by the Governor to the U.S. Environmental Protection Agency.

RECOMMENDATIONS

The following recommendations are based on the experience of the MPCA in the administration and enforcement of the provisions of Public Law 92-500:

1. If the interim goal of the Act for fishable/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 administration of existing programs.

2. Since appropriations are decreasing, the funding dedicated to managing the program is also decreasing. The MPCA recommends that the Management Assistance Grants be based on 2 percent of the 1977 Clean Water Act authorized annual appropriation of $4.5 billion rather than the actual annual appropriation. This would provide stability in the funding of program management.

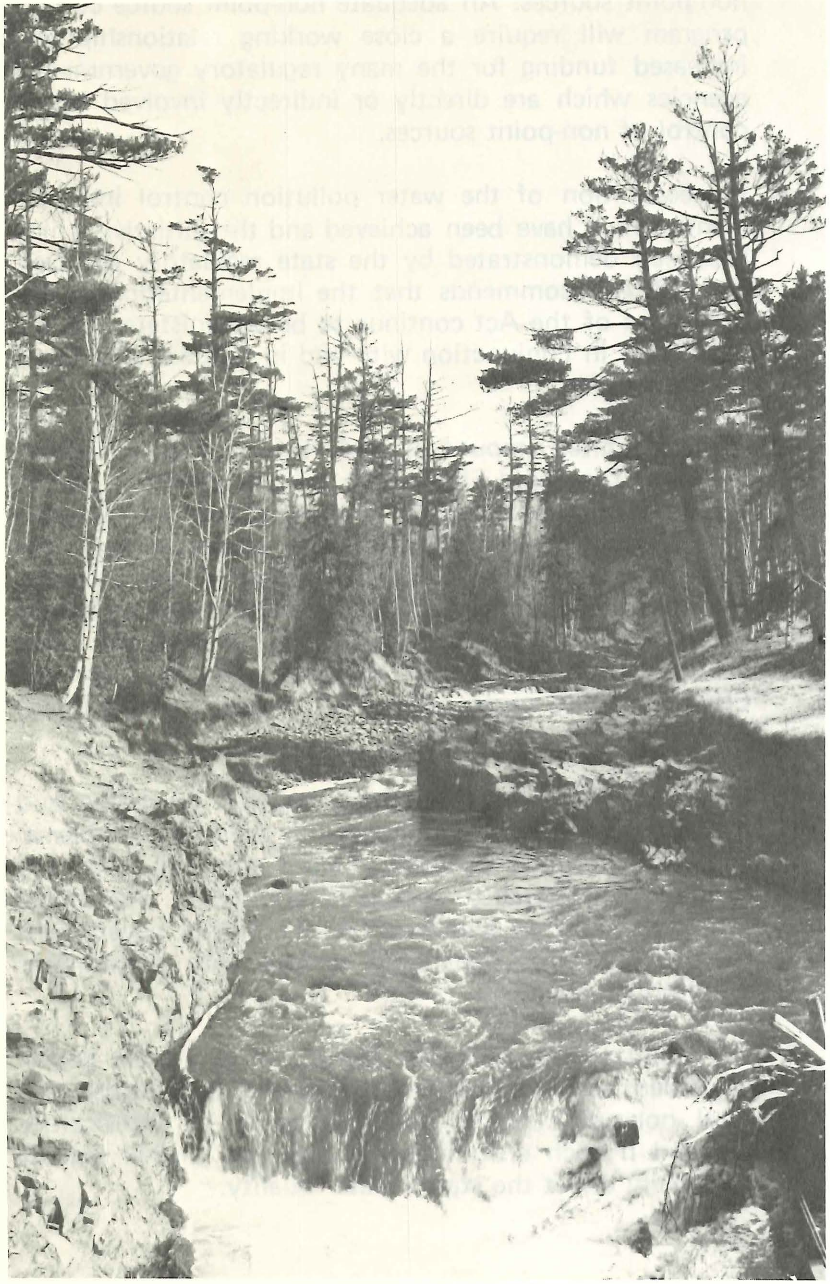
3. In order to meet the interim and subsequent goals of the Act throughout the entire state of Minnesota, local and federal funds will have to be used for the control of non-point sources. An adequate non-point source control program will require a close working relationship and increased funding for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

4. In recognition of the water pollution control improvements which have been achieved and the initiative which has been demonstrated by the state regulatory agencies, the MPCA recommends 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.

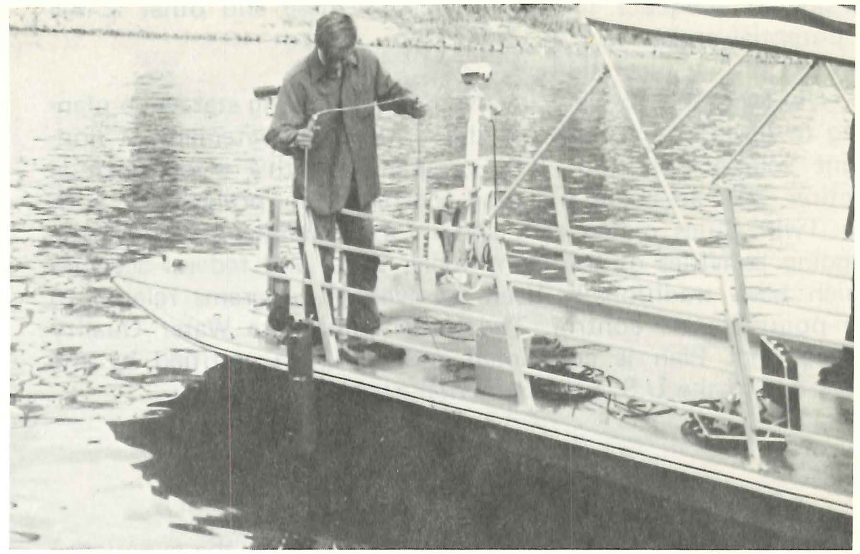
5. While a limited amount of EPA review of state National Pollutant Discharge Elimination System (NPDES) permit activities may be needed, it appears that the program would benefit by a shift of EPA resources from the administrative to the technical aspects of the program. More reliance should be placed on the states to handle the administrative functions. Many, if not all, states could better use additional technical assistance from the EPA, including more prompt promulgation of effluent guidelines.

6. Extensive field work is often required to define and measure point and non-point source pollution problems, and to determine progress toward meeting state and federal water quality standards and goals. Additional funding should be allocated by the federal government to the state for expanding surface and groundwater monitoring activities.

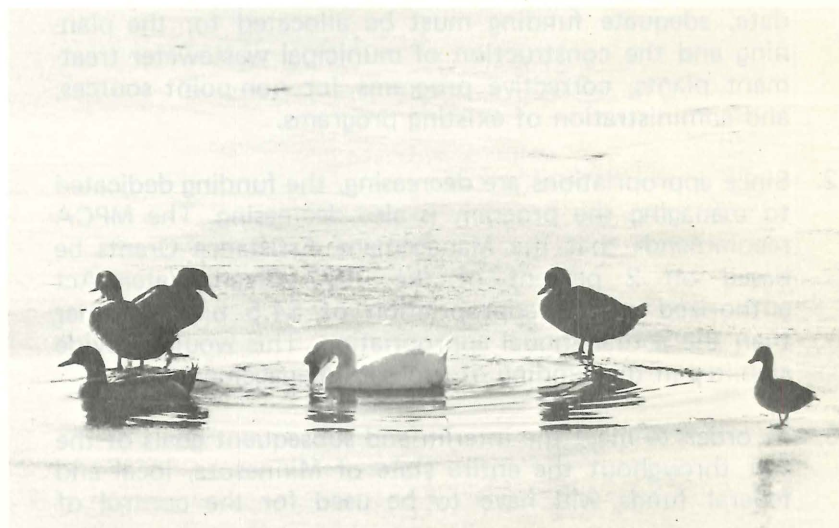
7. Non-point source pollution control is to a great degree dependent upon an informed populace. Both urban and rural non-point source pollution could be significantly lessened if each citizen understood how his/her actions ultimately affect the state's water quality.



North Shore stream



Stream sampling



MPCA programs benefit wildlife

CHAPTER 2
STREAM PROGRAMS

Water features of Minnesota are many and varied. It has been estimated that there are 25,000 miles of streams in the state, ranging from fast-flowing rivers in the east to intermittent drainage ditches in the west. State water quality sampling programs can provide data on only a small portion of these.

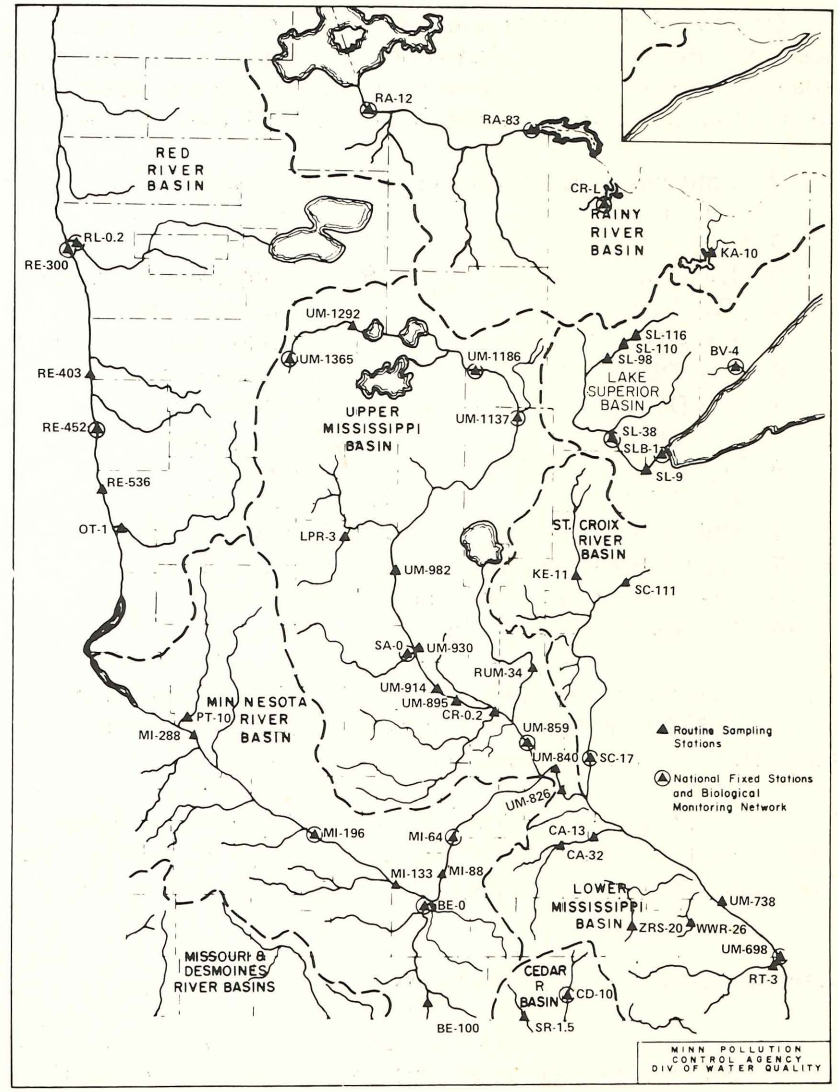
The Minnesota Pollution Control Agency (MPCA), Water Quality Division, has four important programs principally involved with stream monitoring. These are: Primary Monitoring, Biological Surveys, Toxic Substances Monitoring, and Intensive Surveys. This chapter describes these programs, together with their findings, as they may relate to state water quality standards and federal/state goals.

While the foregoing programs are essentially involved with streams, it should be understood that the work may occasionally involve lakes, particularly where a stream flows thorugh a lake.

PRIMARY MONITORING

The primary monitoring network provides the major source of the surface water quality monitoring data presented in this report. As part of this program, water samples were collected at 53 stations (Map 1) during water years 1978-79 (October 1, 1977 to September 30, 1979). Many of these stations are located at points representative of the most critical reaches in a stream. Approximately one-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.

MAP 1
PRIMARY MONITORING NETWORK WATER YEARS 1978-79



Samples collected monthly from the 53 primary monitoring stations are routinely analyzed for the following parameters:

1. Temperature — ^oC (field)
2. Dissolved Oxygen (field)
3. 5-Day Biochemical Oxygen Demand (BOD)
4. Fecal Coliforms
5. Suspended Solids
6. pH
7. Organic Nitrogen
8. Nitrate + Nitrite Nitrogen
9. Ammonia Nitrogen
10. Total Phosphorus
11. Conductivity

Of the 53 primary monitoring stations, 20 are part of the National Fixed Station Network. Additional toxic substance analyses shown in the following list are done on water, sediment, and fish samples collected annually at these 20 stations:

1. Polychlorinated Biphenyls (PCBs)
2. Aldrin
3. Dieldrin
4. Total DDT
5. o,p DDE
6. p,p' DDE
7. o,p DDD
8. p,p' DDD
9. o,p DDT
10. p,p' DDT
11. Chlordane
12. Cis isomer of chlordane
13. Trans isomer of chlordane
14. Cis isomer of nonachlor
15. Trans isomer of nonachlor
16. Endrin
17. Methoxychlor
18. Hexachlorocyclohexane-alpha BHC isomer
19. Hexachlorocyclohexane-gamma isomer
20. Pentachlorophenol
21. Arsenic, total
22. Cadmium, total
23. Copper, total
24. Chromium, total
25. Mercury, total
26. Lead, total

The results of field and laboratory determinations are entered into STORET, the U.S. Environmental Protection Agency (EPA) computerized national water quality data bank.

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

General Assessment — "Fishable Waters"

For the purpose of determining the fishable aspect of the federal goal, six related parameters were grouped together. These parameters include: temperature, dissolved oxygen, 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.

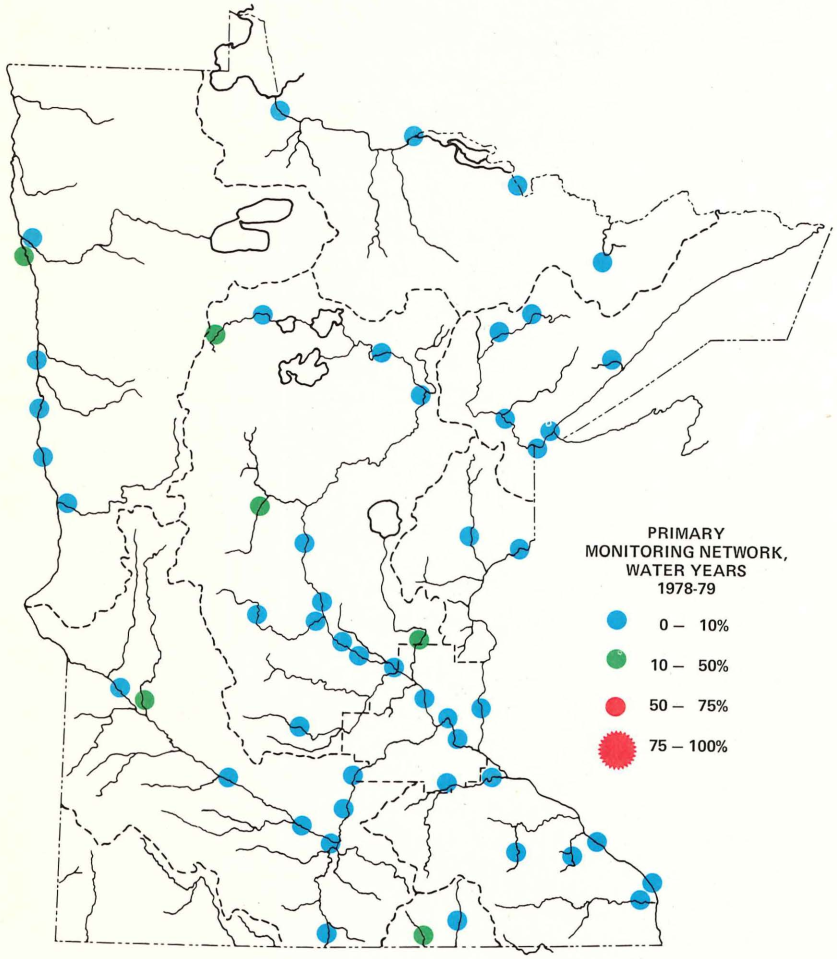
Violations described in this analysis were determined by using the state water quality standard for the appropriate reach of the waterway. A violation is considered indicative of a polluted condition which is actually or potentially detrimental or injurious with respect to the designated uses of the state's surface waters. Data from the primary water quality monitoring network collected during water years 1978-79 are used in the analysis. Parameters used to assess fishable waters are described as follows.

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 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 water years 1978-79, there were no temperature violations of state standards measured in the water quality monitoring network.

Dissolved Oxygen (Map 2) — Direct-measure units are made of the amounts of oxygen dissolved in the water of a stream or lake. Dissolved oxygen is derived from the surrounding air directly and from oxygen given off by aquatic plants through photosynthesis. Inadequate dissolved oxygen in surface water 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 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 vital for maintaining

MAP 2
DISSOLVED OXYGEN VIOLATIONS



a satisfactory fishery and stream biota, and for preventing nuisance conditions from the decomposition of sewage and industrial wastes.

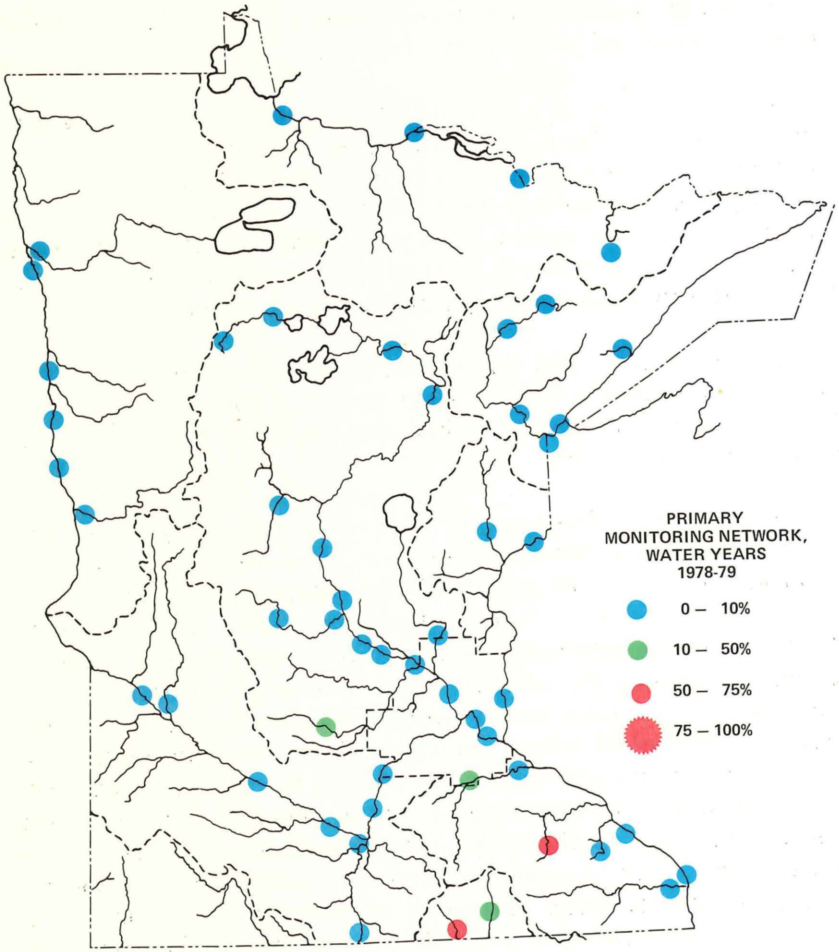
Map 2 shows that during water years 1978-79, very few dissolved oxygen violations occurred. Those that did occurred in smaller streams below dischargers during the winter months when frozen streams and snow cover over the ice inhibited photosynthesis and re-aeration.

Ammonia (Map 3) – Ammonia in surface or ground waters 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; this effect is markedly increased at low concentrations of dissolved oxygen, high pH, and high temperature.

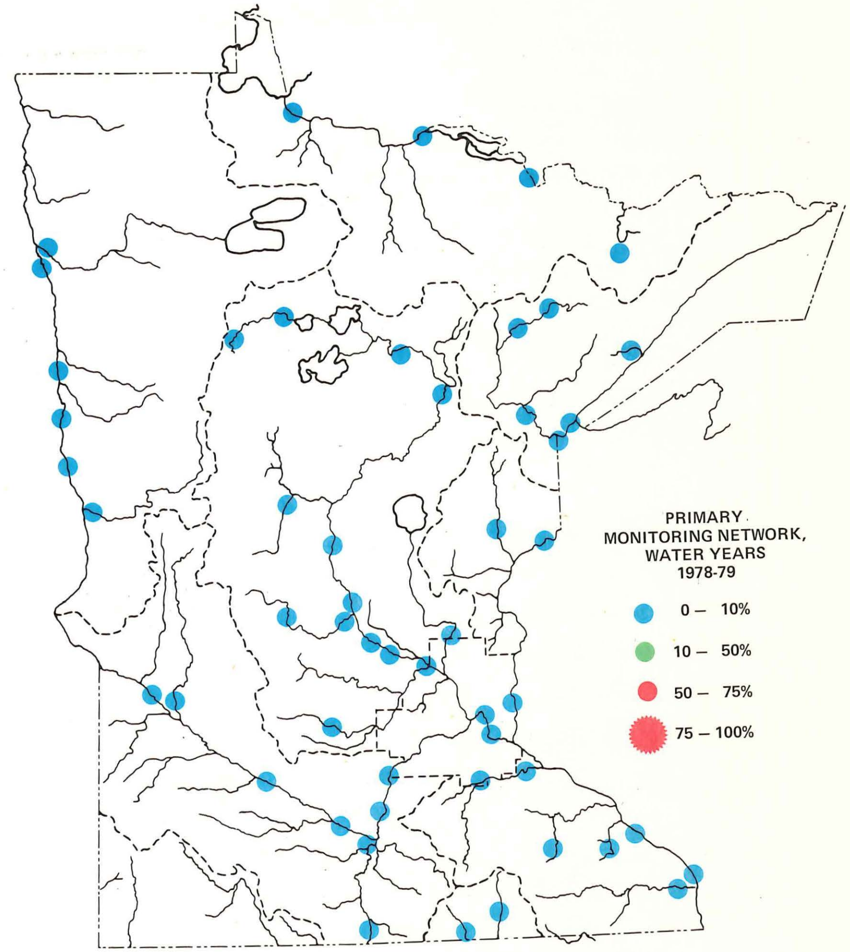
Map 3 indicates that 90 percent of the stations monitored did not have ammonia violations. High ammonia concentrations were found primarily below municipal and industrial wastewater discharges in small streams.

pH (Map 4) – The symbol "pH" is used as a way of expressing hydrogen ion concentration and is a measure of possible pollution. pH controls the degree of dissociation of many substances and may be a highly significant factor in determining their 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 acidic 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.

MAP 3
AMMONIA VIOLATIONS



MAP 4
pH VIOLATIONS



Throughout the state, practically no pH violations occurred during water years 1978-79.

Copper (Map 5) — 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 5 indicates that there are few problems with copper in Minnesota waters.

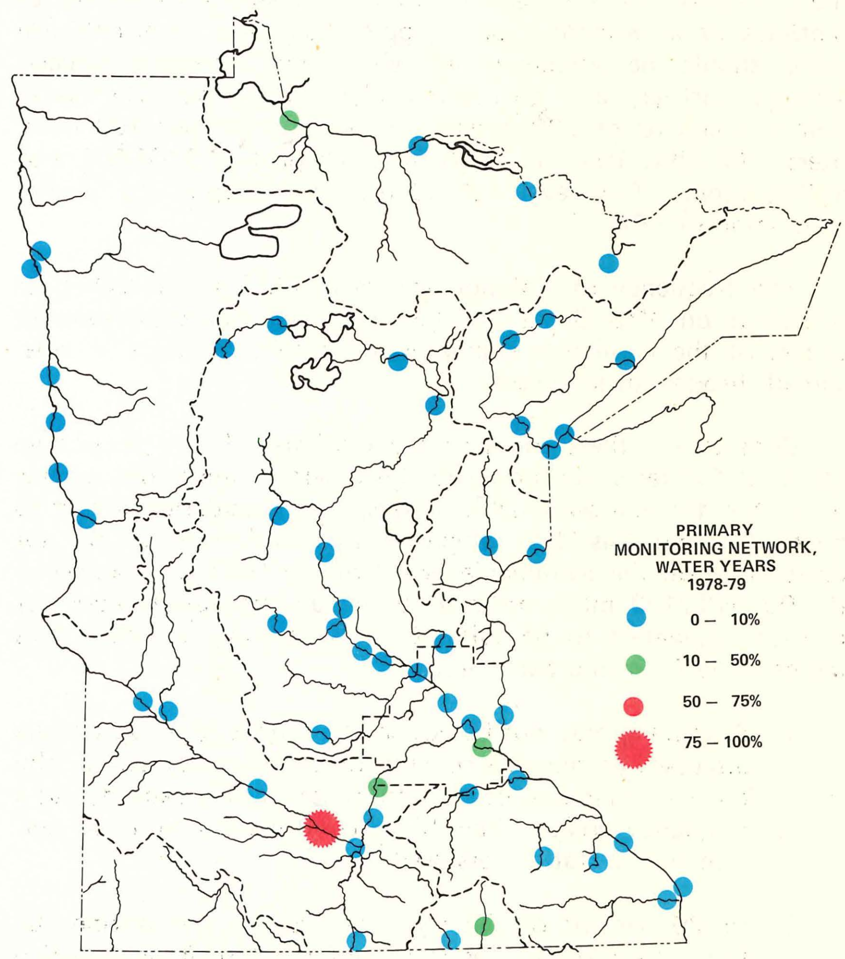
For determining whether a waterway meets the fishable goal, the average frequency of violations for the five selected parameters was calculated. When the average frequency exceeded 10 percent, the goal was considered not met. Of the 53 water quality monitoring stations, 91 percent were found to be in general compliance with the fishable aspect of the 1983 national goal. The following locations were found to be in noncompliance with the goal:

- Cedar River below Austin
- Rum River below St. Francis
- Shellrock River below Albert Lea
- Mississippi River below Minneapolis-St. Paul
- Zumbro River below Rochester

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

In 1975, 89 percent of the waterways assessed were in general compliance with the fishable aspect of the 1983 national goal. In 1976-77, 88 percent were in compliance. Increased precipitation during 1978-79 ended the drought of the two previous years and returned normal flows to most of the state's rivers. Therefore, the general trend during the 1978-79 water years has been toward improved water quality in Minnesota.

MAP 5
COPPER VIOLATIONS



General Assessment — "Swimmable Waters"

Fecal Coliform — 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 a sole criteria for classifying a water as suitable for swimming is not recommended. This approach is being used 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 with other biological indices, sanitary surveys, and chemical analyses of water. The water quality standard of 200 most probable number per 100 milliliters (200 MPN/100 ml) is used in this report as the measure of a "violation." This level was adopted based upon the recommendation of EPA.

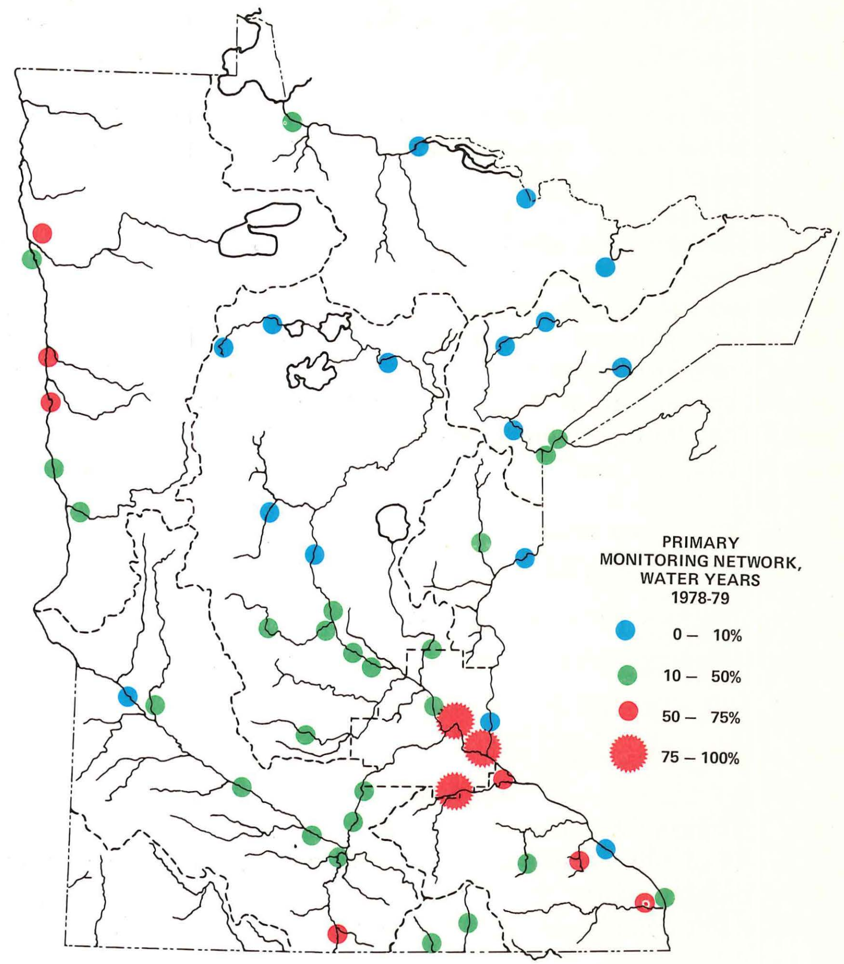
The frequency of violation for fecal coliform for each river is shown on Map 6. As can be seen, fecal coliform levels in excess of the applicable standards are both common and widespread throughout Minnesota.

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 200 MPL/100 ml is assumed to be an appropriate basis for considering waters to be suitable for swimming, the data does indicate the following two points:

1. Swimming may not be advisable in many Minnesota rivers 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 percent of the time at 70 percent of the stations assessed.

2. In 20 percent of the 53 water quality monitoring stations in this report, the fecal coliform standard is exceeded more than 50 percent of the time. The bacteriological integrity was so poor at the following locations that they are classified as not being in compliance with the

MAP 6
FECAL COLIFORM VIOLATIONS



swimmable aspect of the 1983 national goal:

- The Twin Cities metropolitan segment of the Mississippi River
- The mouth of the Crow River
- The Cannon River
- The Red River from Moorhead to Perley
- The mouth of the Red Lake River
- The Root River
- The Whitewater River

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 six 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, 81 percent of the waterways assessed were in general compliance with the swimmable aspect of the 1983 national goal. In 1976-77, 80 percent were in compliance.

However, the use of rivers for swimming is quite limited in Minnesota. The state's 12,000 lakes, as opposed to the rivers, are generally the preferred site for swimming and aquatic recreation. 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.

BIOLOGICAL SURVEYS

Biological surveys were initiated in 1976 as a pilot program of the EPA's Basic Water Monitoring Program. Twenty-one sampling sites were selected throughout the state at locations on major rivers and significant tributaries (see Map 1). At each sampling site, benthos samples and periphyton samples were collected once a year during early summer. The goals of the program include developing baseline biological data, assessing water quality based on biological data, and determining the relationship between water chemistry and the biological data. The biological surveys will provide very useful background biological information on Minnesota's water resources for present and future use. Biological surveys as an integral part of surface water quality monitoring programs compliment and theoretically should support water quality findings.

Biological investigation of the bottom-dwelling macroinvertebrates, such as insects, annelids, mollusks, flatworms, roundworms, and crustaceans, is the best way to evaluate the nature and extent of pollution-related disturbances of these organisms. The relatively stationary bottom-dwelling macroinvertebrate communities can be used as natural monitors because they respond in measurable and predictable ways to various pollutional stresses. Macroinvertebrate studies may show effects caused by various stresses that may not show up in a chemical monitoring program.

The Shannon-Weaver Index ($\bar{d}$) is a statistical tool for measuring the effect of induced stress on the structure of a macroinvertebrate community. This diversity index reflects two components; that is, the relationship between the species richness and the total number of each species in a sample. The use of the diversity index is based on the generally observed phenomenon that a relatively undisturbed environment supports communities having large numbers of different species, with no individual species present in overwhelming abundance, and thereby reflects high diversity. Conversely, a disturbed environment supports a community consisting of few numbers of different species containing a large number of individuals and reflects a low diversity.

Many forms of stress tend to reduce diversity by causing unsuitable conditions for some species or by giving other species a competitive advantage. For example, high organic loading often leads to a reduction in the number of species, with a subsequent increase in the density of pollution-tolerant species. Toxic pollution may eliminate all or most species normally found, or a flood could remove organisms normally found by the scouring action of the flood water or kill the organisms by depositing silt which smothers them.

Another statistical tool is equitability (e), which compares the number of species in the sample with the number of species expected from a mathematical model derived from ecological observations (MacArthur). The equitability ranges from values of 0 to 1, with levels below 0.5 generally considered stressed. Even slight levels of degradation have been found to reduce equitability below 0.5 and generally to a range of 0.0 to 0.3.

Qualitative examination of the macroinvertebrate species is another method to analyze the community structure (indicator organism). Individual species are classified on the basis of their tolerance or intolerance of various levels of pollution and of their presence or absence in different environments. For example, trout, mayflies, and stoneflies are typically clean water organisms, and their relative abundance and presence usually indicates good water quality. Some oligochaetes (aquatic earthworms) and chironomids (true midge flies) can tolerate high levels of pollution, and their presence and relative abundance could indicate poor water quality. In many cases, a stress situation can be detected when there is a species change over a given period of time. The presence and absence and relative abundance of these organisms in a sample can aid the biologist in the assessment of water quality at a given location.

Nine of the eleven river basins in the state are examined. No monitoring stations were located in the Missouri River Basin and the Des Moines River Basin. Station numbers, locations, values for $\bar{d}$ and e, and organism densities for 1977 and 1978 are shown in Table 1. A discussion of the results of the Biological Surveys follows.

Upper-Upper Mississippi Basin

UM-1365 and **UM-1186** are located on the Mississippi River and are characterized by pool-like environments exhibiting extensive growths of aquatic plants. Organic loadings, measured as five-day biochemical oxygen demand (BOD_5), are characteristically low, usually less than 3.0 milligrams per liter (mg/l). The reduction in the density at **UM-1365** from 1977 to 1978 is a function of the low dissolved oxygen (DO) content which was present at this station during mid-summer of 1978.

UM-1137 is located on the Mississippi River and is characterized by shifting sand bottoms, strong currents, and widely fluctuating flows. No benthic data was gathered in 1978 due to very high flows. BOD_5 levels are usually low, and DO levels are usually greater than 5 mg/l.

SA-O is located on the Sauk River. This station is a gravel and boulder riffle exhibiting good current velocity. Bethic collections at this station reveal a diverse and well balanced fauna. This is probably a function of the current velocity, high DO (usually 6 mg/l or greater), and the structure of the stream bottom.

Middle-Upper Mississippi Basin

UM-859 is located on the Mississippi River. The station exhibits strong current velocity and a sandy gravel substrate. Quantitative and qualitative assessments of the benthic organisms indicate that this station is relatively healthy — i.e., good water quality.

UM-826 is located on the Mississippi River and lies downstream from the Metropolitan Wastewater Treatment Plant, which is located at river mile 835 and the mouth of the Minnesota River, which is approximately river mile 843. At the time of this report, three years of benthic data, 1977-79, were available for this station. Figures 1 to 5 depict data from this station for 1977-79. These data indicated increases in the diversity and equitability of the benthic fauna in 1978 and 1979. These increases were accompanied by decreases from the high organism density recorded for 1977 (Figure 5). These temporary improvements in the structure of the benthic communities appear to correlate well with the changes of two important water quality parameters, DO and BOD_5, as depicted in Figures 1 and 2. These data reflect the maximum and mean values for the summer months of 1977-1979. These months were chosen for comparison because they correspond to the time period when benthic sampling is carried out.

TABLE 1
BIOLOGICAL MONITORING DATA
1977-78

Station	Location	$\bar{d}$ 1977	$\bar{d}$ 1978	e 1977	e 1978	Density (No. of Organisms/m^2) 1977	Density (No. of Organisms/m^2) 1978
	Upper-Upper Mississippi Basin						
UM-1365	Mississippi R. near Itasca	2.9	2.2	0.29	1.0	5,475	149
UM-1186	Mississippi R. near Cohasset	2.9	2.7	0.26	0.46	1,412	1,089
UM-1137	Mississippi R. near Jacobsen	1.7	–	0.21	–	7,504	–
SA-O	Sauk River near St. Cloud	3.6	2.8	0.50	0.42	5,626	3,583
	Middle-Upper Mississippi Basin						
UM-859	Mississippi R., Fridley	2.9	3.3	0.35	0.41	14,772	12,657
UM-826	Mississippi R., Cottage Grove	1.9	3.8	0.26	0.67	13,505	2,609
	Lower-Upper Mississippi Basin						
UM-698	Mississippi R., LaCrosse, WI	2.5	3.0	0.26	0.35	6,593	3,618
	St. Croix River Basin						
SC-17	St. Croix R., Hudson, WI	2.4	2.4	0.29	0.27	4,378	3,614
	Minnesota River Basin						
MI-196	Minnesota R., Morton	1.9	2.6	0.19	0.30	22,449	12,913
BE-O	Blue Earth R. at Mankato	3.9	2.9	0.92	0.58	3,987	2,164
MI-64	Minnesota R., Henderson	2.9	2.4	0.32	0.30	15,760	17,316
MI-7	Minnesota R., Bloomington	2.5	2.9	0.40	0.40	3,127	1,510
	Rainy River Basin						
RA-83	Rainy R., International Falls	2.5	3.3	0.60	0.56	406	2,183
RA-12	Rainy R., Baudette	4.2	3.5	0.93	0.70	741	518
	Cedar River Basin						
CD-10	Cedar R.,	3.9	3.2	0.48	0.81	7,912	750
	Lake Superior Basin						
BV-4	Beaver R. North shore of Superior	3.2	2.9	0.59	0.44	838	2,472
SL-38	St. Louis R., Brookston	2.4	3.6	0.25	0.50	4,388	1,616
SLB-1	St. Louis Bay; Superior, WI	2.0	1.6	0.25	0.18	13,499	4,837
	Red River Basin						
RE-452	Red River, Moorhead	0.7	2.9	0.06	0.34	17,270	3,577
RE-300	Red River, Grand Forks	3.0	3.2	0.48	0.62	1,663	3,068
RL-0.2	Red Lake R. at Grand Forks	3.1	3.7	0.41	0.61	2,781	1,316

The 1977 benthic data are characteristic of a river receiving oxidizable organic waste – i.e., low $\bar{d}$, low e, and a high number of individuals per square meter. Figure 2 shows that BOD_5 values, a good indicator of organic loading, were high in 1977 compared to 1978 and 1979.

Flow rates (cubic feet per second) are probably an important factor in the chemical and biological changes which were noted. Both 1978 and 1979 were "high-flow" years, with flows of three to four times greater than those recorded for 1977, which was a "low-flow" year. These data indicate that the river had a much increased assimilative capacity for the organic wastes it was receiving in 1978 and 1979 compared to 1977.

Lower-Upper Mississippi Basin

UM-698 is the only station monitored on this portion of the Mississippi River. The river is quite wide at this point, and the substrate is a sandy gravel. A slight improvement in the benthic communities can be noted from 1977 to 1978. Since the same

MISSISSIPPI RIVER STATION UM-826
SELECTED DATA, MAY-AUGUST 1977-1979

FIGURE 1
DISSOLVED OXYGEN, (mg/l)

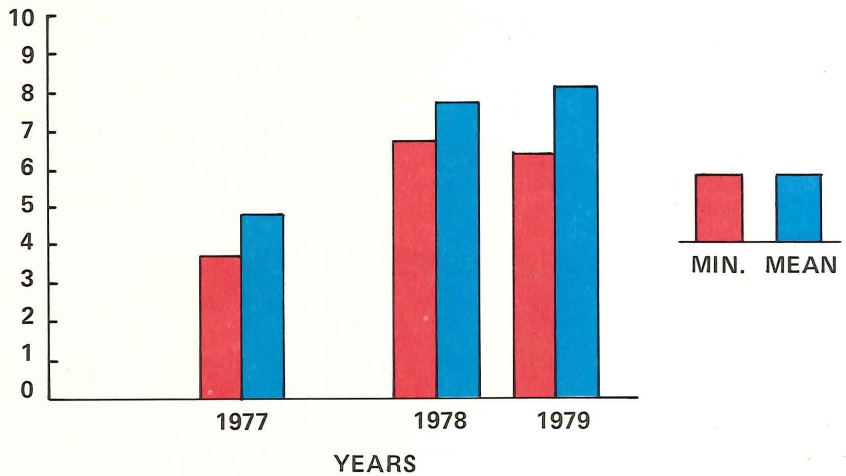


FIGURE 2
5-DAY BIOCHEMICAL
OXYGEN DEMAND, (mg/l)

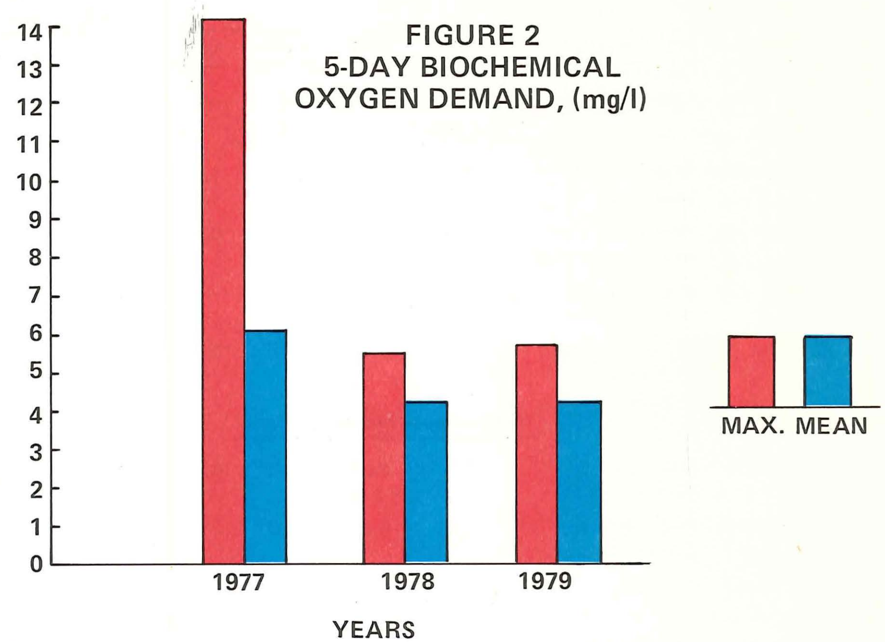


FIGURE 3
DIVERSITY, ($\bar{d}$)

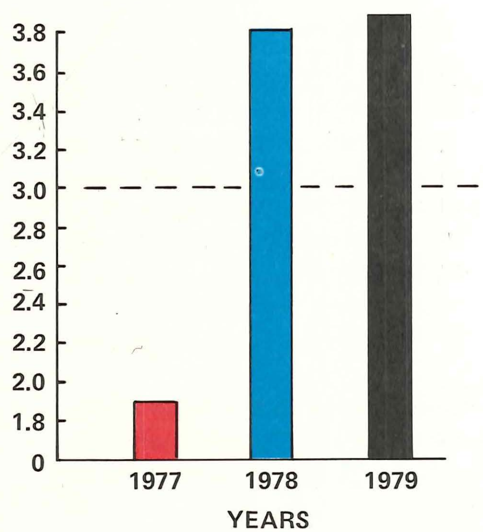


FIGURE 4
EQUITABILITY, (e)

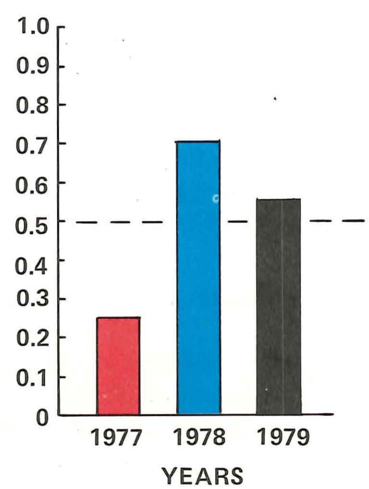
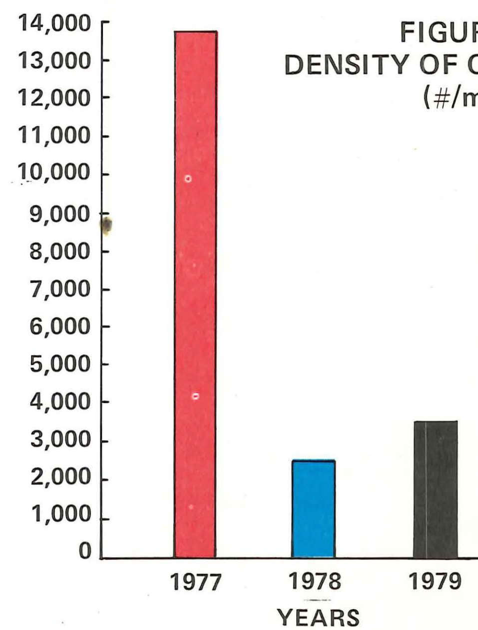


FIGURE 5
DENSITY OF ORGANISMS,
($\#/m^2$)



NOTE:
– – – – – – – values greater than this are usually indicative of clean water conditions.

number of taxa (kinds of species) were present in each sample, the differences in the $\bar{d}$ and e values for the two years would be a result of the higher-density population in the 1977 sample compared to 1978. The bulk of this difference was due to the predominance of a pollution-tolerant chironomid in the 1977 sample. This taxa comprised 54 percent of the total 1977 sample in contrast to 5 percent of the 1978 sample. These factors may indicate some improvement in the water quality at this station; but once again, this may be tied to the higher flows of 1978 versus the lower flows of 1977.

St. Croix River Basin

SC-17 is located in a sandy bay on the St. Croix in an area referred to as "Lake St. Croix." Thus, this station would not be subjected to the current, per se, but rather a wave action more characteristic of a lake. These data should not be compared with data from other rivers as a basis for assessing the "health" of this station. Quantitative and qualitative examinations of these data indicate that no significant changes occurred from 1977-78. These findings concur with the chemical data so as to indicate a good water quality.

Minnesota River Basin

MI-196 on the Minnesota River is characterized by a sandy substrate and a strong current velocity. The changes in the benthic population from 1977-78 were probably a function of the flows for these two years. 1977 was a "low-flow" year, while 1978 was a "high-flow" year, with flows three to four times greater than 1977.

BE-0 on the Blue Earth River is monitored near its confluence with the Minnesota River. No valid comparison can be made between the benthic data of 1977 and 1978 due to the extended exposure time (75 days versus 35 normally) for the 1977 samplers. This was due to a fivefold increase in flow from time of placement to the normal retrieval time.

MI-64 is located downstream from the mouth of the Blue Earth on the Minnesota River. It is quite similar to MI-196, exhibiting a sandy substrate and a strong current velocity. Quantitative and qualitative examinations of the benthic data indicate no significant change.

MI-7 on the Minnesota River exhibits a much weaker current velocity than MI-64 and a muddier substrate. The benthic data indicates little change in the fauna from 1977-78. No water chemistry data is available for this station.

Rainy River Basin

RA-83 is located in a bay of the Rainy River. The substrate at this station consists of sand overlain by wood debris. This station, as is RA-12, is characterized by a consistently high DO and a low BOD_5. The benthic data does not indicate any significant changes.

RA-12 on the Rainy River is characterized by dense aquatic vegetation along the shore and a sandy substrate. The benthic collections (in terms of organisms per square meter) were too sparse to allow for an accurate assessment of water quality at this station.

Lake Superior Basin

BV-4 on the Beaver River, located on the north shore of Lake Superior, is characterized by a steep gradient and high current velocity. The quantitative and qualitative benthic data show little change and seem to indicate a healthy assemblage of organisms. This, along with the chemical data, indicates good water quality at this station.

SL-38 on the St. Louis River is characterized by slow-moving water interspersed with boulder riffles and pooled areas. A qualitative comparison of 1971 and 1978 benthic data indicates no significant differences, but the quantitative data appears to indicate some improvement in the community structure in 1978. This may be a function of the higher flows of that year.

SLB-1 on the St. Louis River is located near the mouth of the river at Lake Superior. Since this station is more representative of a "lake situation," it is difficult to interpret the quantitative data. A qualitative analysis reveals a benthic population dominated by pollution-tolerant organisms.

Red River Basin

RE-452 on the Red River is characterized by very turbid water and a clay substrate. There was a significant shift in the benthic fauna from 1977-78, both qualitatively and quantitatively (Figures 6-8). This was probably tied to the difference in flows for these two years, as 1978 flows were well above normal and 1977 flows were below normal (approximately a twentyfold difference between the two years). The 1977 sample was dominated by very pollution-tolerant forms, while the 1978 sample exhibited a much more diverse fauna of less tolerant forms.

RE-300 on the Red River is similar to RE-452 in turbidity and morphology. The statistical data (Figures 6-8) indicate a slight improvement in the benthic community. A qualitative analysis indicates a shift from tolerant organisms in 1977 to less tolerant in 1978. Flow differences, once again, may be significant.

RL-0.2 on the Red Lake River is also fairly turbid, with a clay substrate. The benthic data indicates a fairly diverse and equitable fauna. This would seem to indicate fairly good water quality at this station in spite of the aesthetically displeasing turbidity.

TOXIC SUBSTANCES MONITORING

Toxic chemicals are liberated into the aquatic environment through various types of activities by agriculture, industry, commerce, etc. The toxic substances monitoring program involves the collection of samples and the evaluation of data from water bodies suspected or known to be contaminated with toxic chemicals.

Depending on the types of analyses desired, a variety of samples may need to be taken. Four basic sample types include water, sediment, fish, and benthic invertebrates. Field measurements for dissolved oxygen, pH, temperature, and transparency are usually taken in each investigation. Sample collection involves preparation of a representative, homogenous sample prior to submittal to the Minnesota Department of Health (MDH) for analysis. Samples are analyzed by the MDH laboratory for heavy metals, pesticides, and exotic organic chemicals; if deemed necessary, more samples are collected for additional evaluation. After all samples are analyzed, a determination is made as to the degree of health hazard involved, and appropriate action is taken for public and environmental protection.

During the past several years, studies were conducted on toxic materials such as polychlorinated biphenyls (PCBs), mercury, and other heavy metals, and pesticides. Information is provided in the following discussion under the headings of PCBs, Mercury, and Fish Kills.

PCBs

In 1975, the Mississippi River below the Twin Cities was shown to have a PCB pollution problem. Some fish in the Mississippi River exceeded the U.S. Food and Drug Administration (FDA) action level of 5 milligrams per kilogram (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 PCBs or products containing PCBs after January 1, 1978, unless a certificate of exemption for that use, sale, possession, purchase, or manufacture was issued by the MPCA. The law also required that beginning July 1, 1978, all new products, items, or materials to which PCBs were added in the manufacture must be labeled to disclose the presence and concentration of PCBs in the item, product, or material. The MPCA has developed rules and regulations regarding requirements for certificates of exemption and labeling of PCBs or products containing PCBs.

A PCB Task Force conducted studies on the Mississippi River in 1975, 1976, and in 1979. A graphic display of PCB concentrations in carp fillets for the three sampling years is shown in Figure 9. Mean PCB levels in fillets analyzed in 1979 were 1.49 mg/kg lower than the combined mean for 1975 and 1976. All stations sampled showed reduced levels of PCBs except for Station MS-3, Coon Rapids, which increased 0.89 mg/kg over the 1975-76 mean. PCB pollution seems to persist in areas

RED RIVER BASIN
SELECTED DATA 1977-1978

FIGURE 6
DIVERSITY, ($\bar{d}$)

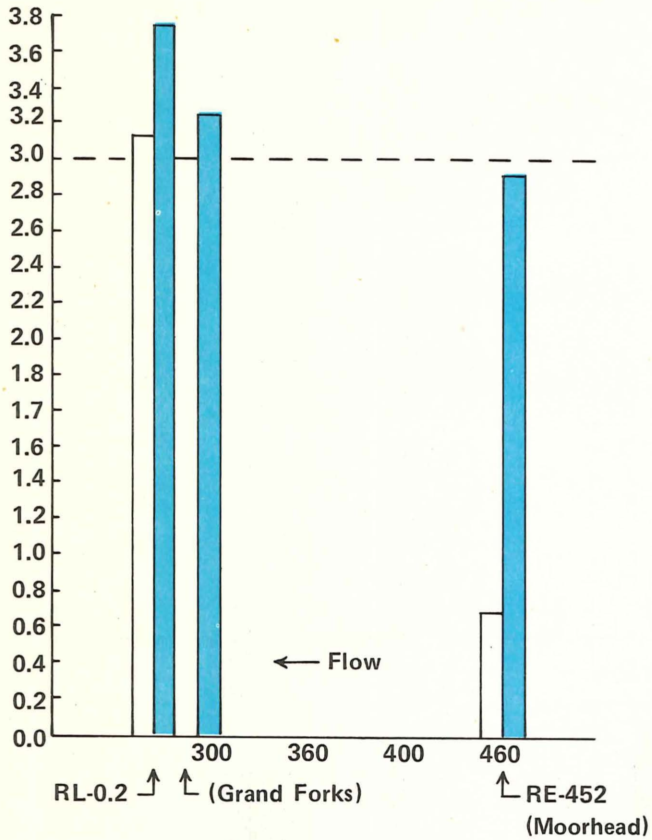


FIGURE 7
EQUITABILITY, (e)

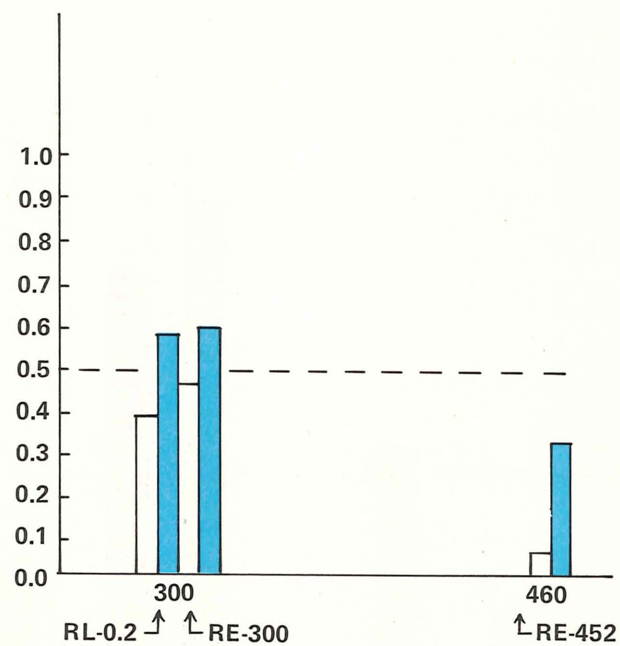
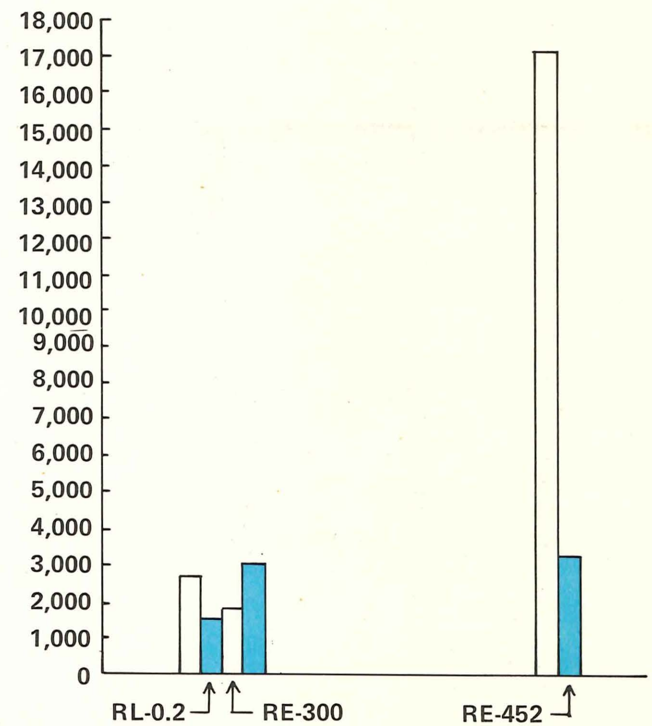
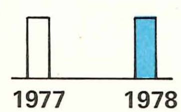


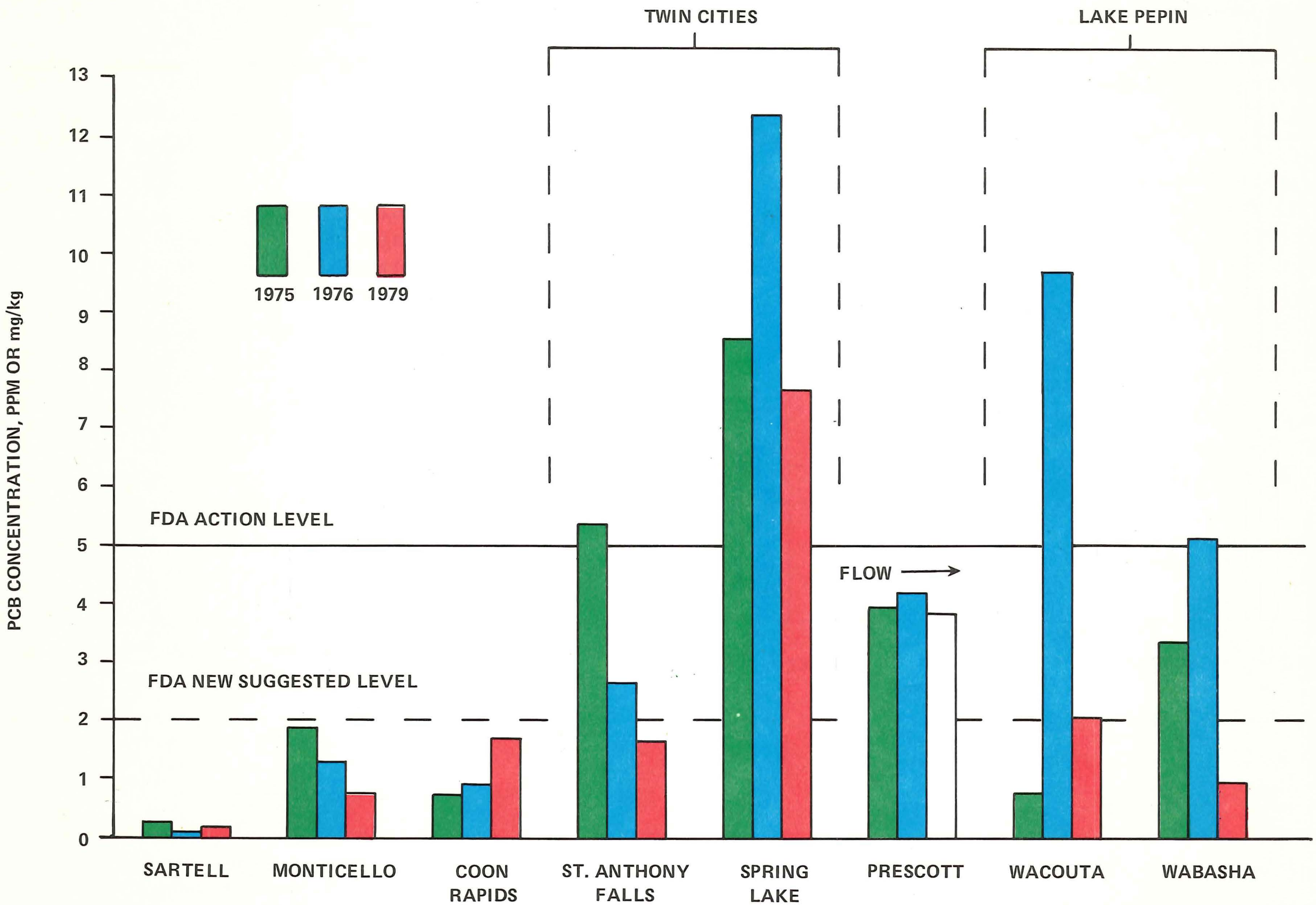
FIGURE 8
DENSITY OF ORGANISMS, (#/m^2)





NOTE:
– – – – values greater than this are usually indicative of clean water conditions.

FIGURE 9
CONCENTRATION OF PCBs IN THE MISSISSIPPI RIVER
SARTELL TO WABASHA, 1975, 1976, 1979



heavily contaminated. This is especially evident at Stations MS-6, Spring Lake, and MS-7, Prescott.

Sediment samples from the small streams emanating near Pipestone, Minnesota, have been shown to be contaminated with PCBs, and studies are continuing to identify potential sources of contamination.

Studies such as these and others done by various state and federal agencies revealing elevated levels of PCBs have led to the issuance of fish consumption guidelines by the MDH. Waters with suggested limited fish consumption due to PCB problems include: the Mississippi River from Minneapolis to Alma, Wisconsin; the Minnesota River from New Ulm to Minneapolis; and Lake Zumbro near Rochester.

Mercury

Waters shown to have persisting problems with mercury levels in fish flesh and thus suggested restricted consumption by the MDH are: various lakes within the Rainy Lake Watershed, the Mississippi River from Brainerd to St. Cloud, the Red River near Oslo, the St. Louis River from Brookston to Cloquet, and the Straight River from the Freeborn County border to Owatonna.

The mercury problem in northeastern Minnesota appears to be due to either background levels of available mercury or atmospheric deposition. Acidic precipitation in waters having a low buffering capacity, such as many Boundary Water Canoe Area (BWCA) lakes, may contribute to the mercury problem. As waters become more acid, they lend themselves to greater heavy metal availability and increase the potential for bioaccumulation of these chemicals.

Fish Kills

Investigations are conducted by the MPCA when other than natural environmental phenomena are suspected of causing a fish kill. These investigations involve the documentation of events leading up to and after the fish kill, plus recommendations for abatement of such circumstances.

A chronic, severe fish kill seems to occur annually in various southeastern Minnesota trout streams. The suspected killing agents in these trout streams are carbamate or organophosphorus-type insecticides used on agricultural land to control vaious types of insect pests. The kills usually occur shortly after a torrential downpour and subsequent suspected flushing of these insecticides into adjacent trout waters. Studies are being conducted to answer this puzzling question of trout stream destruction.

A 100-ton spill of anhydrous ammonia caused a major fish kill in the Spring Lake portion of the Mississippi River during the summer of 1979. The Minnesota Department of Natural Resources (MDNR) estimated that a minimum of 20,000 fish were killed as a result of the ammonia spill.

INTENSIVE SURVEYS

The MPCA conducts intensive monitoring activities aimed at assessing specific water quality problems in specific locations.

One class of intensive surveys are load allocation studies. The purpose of a load allocation study is to determine the allowable waste loads which can be discharged to a receiving water while still maintaining the applicable water quality standards in the receiving stream. As per the national experience, waste load allocations in Minnesota are primarily aimed at point source dischargers and the consideration of the impact of organic waste loads on downstream dissolved oxygen concentrations.

Assessing this relationship between municipal and industrial dischargers and receiving water quality can probably be best determined through the use of a water quality model. A water quality model is a mathematical representation describing how the river reacts to any selected configuration of waste loadings and ambient conditions. Intensive surveys are conducted to provide the necessary localized information needed to calibrate and verify the model for each river being studied.

Load allocation intensive surveys generally include the following activities: 1) the collection of stream and effluent samples; 2) stream gauging; 3) time of travel studies; 4) dissolved oxygen sag curve studies; 5) the maintenance of continuous dissolved oxygen monitors; 6) the measurement of river elevations; and 7) the measurement of sediment oxygen demand. In addition to collecting data for the dissolved oxygen modeling analysis, stream and effluent samples are also analyzed for toxic materials such as the heavy metals, ammonia, and trace organics.

This effort is particularly emphasized in those areas where the primary or toxic monitoring programs have already detected problems. If violations of state water quality standards are encountered or anticipated for those or any other water quality parameters, appropriate effluent limitations are determined and incorporated into the recommendations of the load allocation report.

The specific reach of a river sampled generally extends from a point above the point source dischargers downstream to a location where the dissolved oxygen concentration of the river has recovered from the impact of the discharge.

The number and location of the sampling stations are determined by the length of the study reach, the availability of sampling access points, the number of dischargers, and the number of tributaries impacting the river being studied. Minimum river sampling stations include a station above each significant discharger, all significant tributaries, and a sampling station at the end of the study reach.

Present staff levels permit the MPCA to perform approximately two complete load allocation studies per year. The MPCA also conducts less rigorous intensive surveys where a water quality model need not be calibrated and verified. These studies are conducted at selected dischargers where potential or demonstrated water quality problems exist or where information is needed to determine the applicable effluent limitations for the associated municipal and industrial dischargers. Current staff levels allow for approximately five such surveys per year.

The results of most of the surveys are incorporated into final reports that contain recommendations for obtaining compliance with the State standards and the national goal.

During the past two years, the MPCA has conducted load allocation intensive surveys on the Straight River at Owatonna, the Sauk River at Cold Spring, the Blue Earth River at Blue Earth and Winnebago, and Penobscott Creek at Hibbing.

The findings of each of these studies will be briefly described and summarized.

<u>The Straight River Survey</u> — The Straight River study demonstrated that advanced wastewater treatment will be needed at Owatonna. Dissolved oxygen levels were found to be below the state standard at certain sampling stations downstream from the city's discharge. This condition was primarily attributable to the combined effects of the municipal wastewater discharge and the exertion of a relatively high sediment (benthic) oxygen demand rate encountered in the pool areas of the river. Water quality violations were also noted for ammonia (N) and fecal coliform. Upon the completion of the proposed advanced wastewater treatment facility at Owatonna, it is expected that the downstream conditions will be improved and that the quality of the Straight River will meet the state standards.

<u>The Sauk River Survey</u> — A similar situation was encountered at Cold Spring on the Sauk River. Below Cold Spring, a reach of the Sauk River was found to suffer from very depressed dissolved oxygen levels and moderately-to-high levels of ammonia nitrogen. The Cold Spring Wastewater Treatment Plant was found to be the primary cause of these polluted conditions although this reach of the Sauk River is also impacted by the discharge from an Armour poultry-processing plant. The river was found to exhibit a relatively low capacity to assimilate organic loadings, primarily due to its relatively low rate of atmospheric reaeration. When the municipal plant and the Armour facility are upgraded, these conditions should be alleviated.

CHAPTER 3
LAKE PROGRAMS

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

The several programs that relate particularly to lakes are discussed under the headings of Eutrophication, The Phosphate Detergent Ban, The Clean Lake Program, and The Citizen Lake Monitoring Program (CLMP).

EUTROPHICATION

"Eutrophication" is a term commonly used in the field of water pollution control to define the enrichment of waters with biological nutrients. 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 10.

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.

Discharges which occur directly to or which affect a lake or reservoir are required to meet a maximum permissible effluent phosphorus limit of 1 mg/l. In addition, all discharges within the Lake Superior watershed are required to meet the same standard. Well over 100 Minnesota communities have been assigned effluent standards containing phosphorus limitations. These communities have and will continue to deal with this requirement in a variety of ways, including chemical treatment, on-land wastewater disposal, and effluent diversion from lakes. Significantly, 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 PHOSPHATE DETERGENT BAN

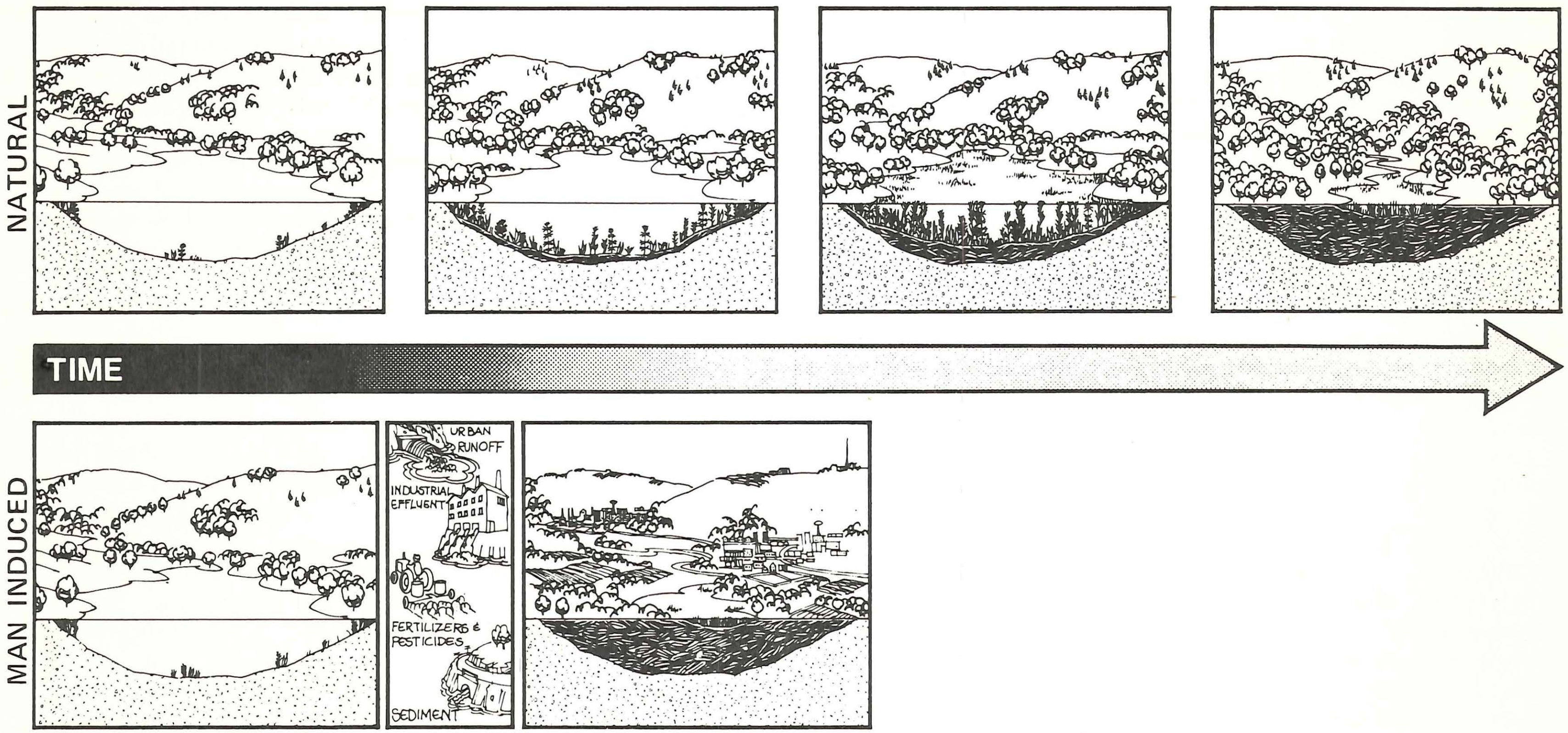
A phosphate detergent ban, enacted as a Minnesota Pollution Control Agency (MPCA) rule in 1976, is an important complement of the MPCA's nutrient control effort. Legal challenges to the rule and a resulting temporary injunction barred enforcement of the ban until late 1979. However, in the intervening period, better than 90 percent compliance was attained due to a voluntary changeover to non-phosphate products by major detergent makers. Results of the ban indicate a substantial degree of success was achieved in reducing the amount of phosphorus emanating from municipal point sources. A group of nine wastewater treatment facilities operated by the Metropolitan Waste Control Commission displayed reductions in phosphorus loadings equivalent to approximately 1.0 pounds per capita per year in incoming sewage and 0.85 pound per capita per year in sewage effluents. This represented an approximate 45 percent decrease in the amount of phosphorus discharged from these facilities.

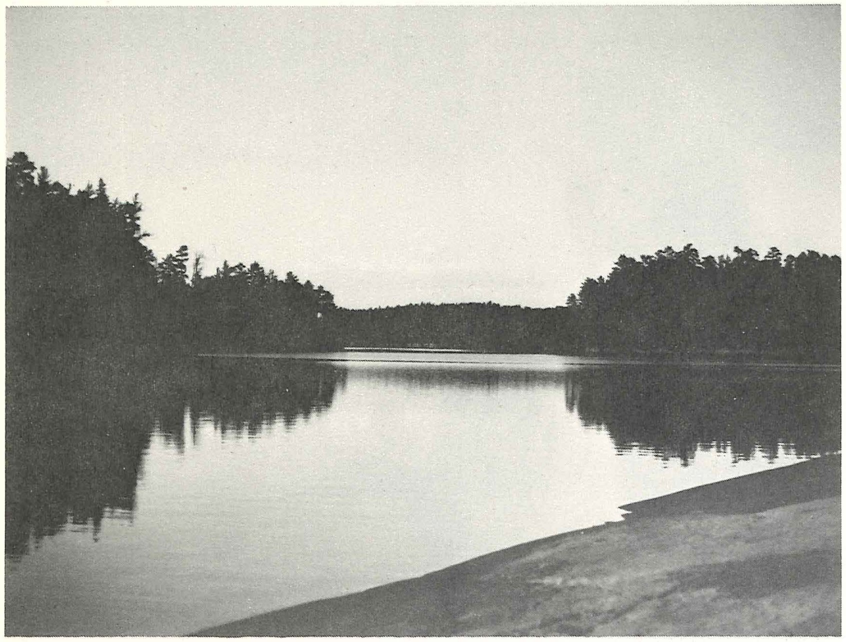
THE CLEAN LAKES PROGRAM

Another important program created and initiated to deal specifically with lakes and the control of cultural eutrophication

FIGURE 10

EUTROPHICATION





Lac La Croix *(Photo by Orbbie K. Webber)*

TABLE 2
MINNESOTA POLLUTION CONTROL AGENCY
DIVISION OF WATER QUALITY
SECTION 314
LAKE RESTORATION GRANT PROGRAM
FEBRUARY, 1980

	Grantee	Lake(s)	Federal Grant	State Grant	Project Cost
1)	Freeborn County	Fountain	$ 302,800	$ 151,400[1]	$ 605,600
2)	City of Waseca	Clear	358,682	164,537	717,364
3)	Hennepin County Park Reserve District	Hyland	161,198	78,599	318,396
4)	Rice Creek Watershed District	Long Lake Chain	1,296,715	648,357	2,593,430
5)	Ramsey County	Phalen Lake Chain	575,683	287,841	1,151,366
6)	City of Bloomington	Penn	87,900	43,950[2]	175,800
7)	City of Minneapolis	Lake of the Isles Harriet Lake	179,000	–0–	358,000
		TOTALS	**$2,961,978**	**$1,374,684**	**$5,561,956**

[1] A previous grant of $100,000 was given to Freeborn County by LCMR in 1976, pursuant to Minnesota Laws of 1975, Chapter 204, Section 55, Subd. 2, paragraph (2).

[2] Includes a state grant from the Department of Natural Resources in the amount of $22,000.

is the "Clean Lakes" section of the Clean Water Act of 1977 (Section 314, Public Law 95-217). This section provides grants assistance to states and local units of government to support pollution control activities in lake watersheds and, when applicable, for the implementation of inlake restorative techniques. Since its inception in fiscal year 1975, Congress has appropriated approximately $66 million in funds for eligible projects.

In Minnesota, a total of seven projects have received matching grants in the amount of $2,961,978 from the U.S. Environmental Protection Agency (EPA). Together with state matching funds of $1,374,684 and the local share, the total project's cost amounts to $5,561,965. Table 2 depicts the various projects within the state.

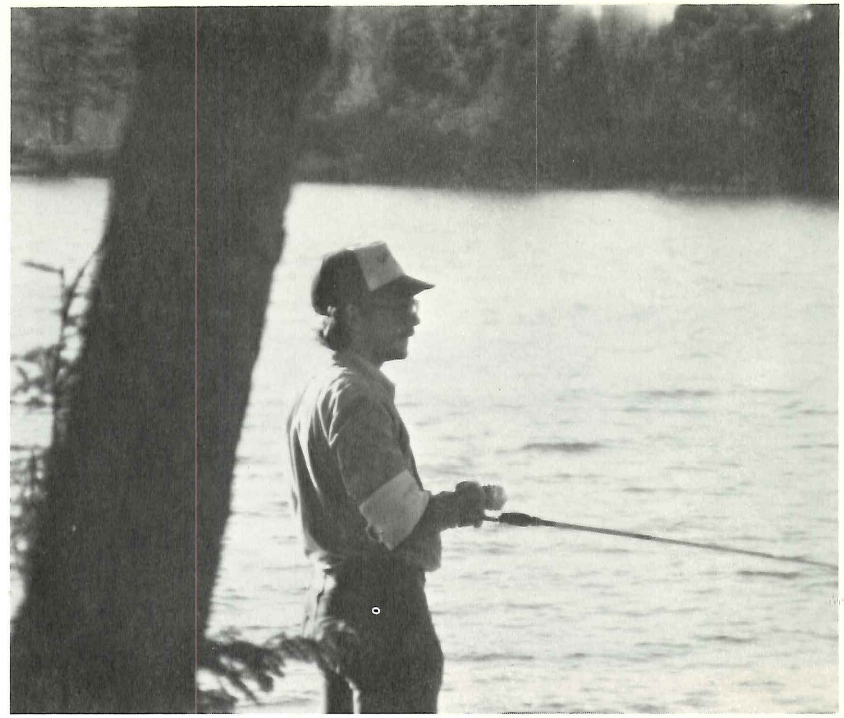
Each of the seven projects is unique in the sense that measures being implemented within the lake or its watershed must be designed for a lake's individual hydraulic, biologic, chemical, and/or watershed land-use characteristics. Such in-lake methods as lake-bed consolidation, dredging, biomanipulation, and aeration are being implemented on Hyland, Penn, and the Long Lake Chain projects. Control of the non-point source pollution within the watershed is quite varied with such techniques as vacuum street sweeping, "first flush" stormwater diversion, sediment catchment basins, stream-bed erosion control, and nonstructural treatment areas.

One Clean Lakes project nearing completion is the Hyland Lake project located in the western portion of the city of Bloomington, Minnesota. This project was initiated in August 1976 to improve the quality of water for recreation as well as to enhance the lake's scenic qualities and waterfowl habitats. The $340,600 project on this 90-acre lake included lake dewatering and lake-bed consolidation, stormwater treatment through nonstructural methods, groundwater augmentation with lake aeration-recirculation, and fish restocking. After its first year, the project yielded dramatic improvements in lake water quality. The lake's transparency increased from a mean value of 0.1 meter in 1977 and 0.5 meter in 1978 to 2.7 meters in 1979. Similar results were reflected in decreased nutrient levels and algal standing crop. Average total phosphorus concentrations in June through August declined from 343 micrograms per liter (μg/l) (1977) and 238 μg/l (1978) to 56 μg/l in 1979 while chlorophyll a decreased from average levels of 291 μg/l (1977) and 129 μg/l (1978) to 5 μg/l in 1979. While initial changes in water quality have been very dramatic, it is expected that the lake will revert to a somewhat more enriched condition. However, treatment of the urban runoff should prevent the re-establishment of pre-treatment conditions.

The MPCA recognizes that the "Clean Lakes" lake restoration grant program is still in its infancy, and there remains much to be learned about nutrient control techniques which are as yet unproven and how lakes respond to changes in their nutrient regime. As long as a commitment remains at the federal and state levels, this program will begin to bring about changes in the long-term protection of our freshwater lakes.

An integral part of the "Clean Lakes" program is the effort under Section 314(a) directed at the classification and priority ranking of a state's significant publicly-owned freshwater lakes in need of protection or restoration. On May 17, 1979, the MPCA received a $100,000 matching grant from EPA to conduct Phase I of a three-segment approach to classify and establish priorities for funding of Section 314 grants. Phase I is directed at the classification and priority ranking of approximately 150 lakes in the state. Phases II and III will be directed at the remaining 12,000 or more lakes. EPA has directed that states choosing to participate further in the Section 314 grant program must have this accomplished by January 1, 1982.

In general, the 314(a) project will involve the use of a wealth of historical data as well as major use of LANDSAT satellite imagery to classify lakes according to their water quality condition. This information, coupled with watershed data on land use, soils, and hydrologic characteristics, will provide assistance in developing a priority ranking of the freshwater lakes in need of restoration or protection.



Fisherman, Nina Moose Lake *(Photo by Orbbie K. Webber)*

THE CITIZENS LAKE MONITORING PROGRAM

A program of citizen participation in the collection of lake water quality data attained full operational status during the summer of 1979. This Citizen Lake Monitoring Program (CLMP) included weekly secchi disc water transparency readings with optional monthly water sampling to obtain phosphorus and Kjeldahl nitrogen concentration.

Coupled with its forerunner, the Secchi Disc Program, the CLMP provided transparency data on 362 lakes from 1973 to 1978, representing 51 of Minnesota's 87 counties. The median of the average July-August transparencies for all 362 lakes was 6.5 feet ranging from averages of less than 0.5 feet to 29 feet. This data is presented in Table 3 along with information from Peterson (1972) who studied water transparency in Minnesota lakes. Because the CLMP is citizen-based, some bias exists toward sampling of more heavily-developed and urbanized lakes.

TABLE 3
TRANSPARENCY OF MINNESOTA LAKES
(SECCHI DISC READ IN FEET)

Source	Median
Citizen Lake Monitoring Program (July-August Means, 1973-78)	6.5
Peterson (1972)	
• Northern fish lakes	8.5
• Southern fish lakes	5.5
• All fish lakes	7.8

Lake transparency by county is presented on Map 7. Comparison between waters of the northern lakes districts of Minnesota with those of central and southern agricultural areas show large differences in transparency. Water transparencies are generally lower in central and southern Minnesota, bearing relationships to such factors as the shallow nature of prairie lakes, the less desirable fish populations, and greater prevalence of agricultural or urban non-point sources.

A summary of phosphorus and nitrogen data collected on 135 CLMP lakes in 1979 is present in Figure 11. The median total phosphorus concentration was 0.040 milligram per liter (mg/l) ranging from 0.005 mg/l to 0.594 mg/l. Twenty-eight percent of all samples collected contained phosphorus in an amount less than 0.030 mg/l, a level frequently associated with relatively uncontaminated lake waters. The median Kjeldahl nitrogen level was 0.75 mg/l, ranging from less than 0.3 to 7.0 mg/l. As with Secchi disc readings, the wide range of nutrient enrichment reflects the variation in lake productivity due to differences in geographical location within the state.

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 regarding land uses and geologic characteristics in Minnesota.

MAP 7
AVERAGE JULY-AUGUST SECCHI DISC OF LAKES IN THE CITIZEN LAKE MONITORING AND SECCHI DISC PROGRAMS
1973-1978

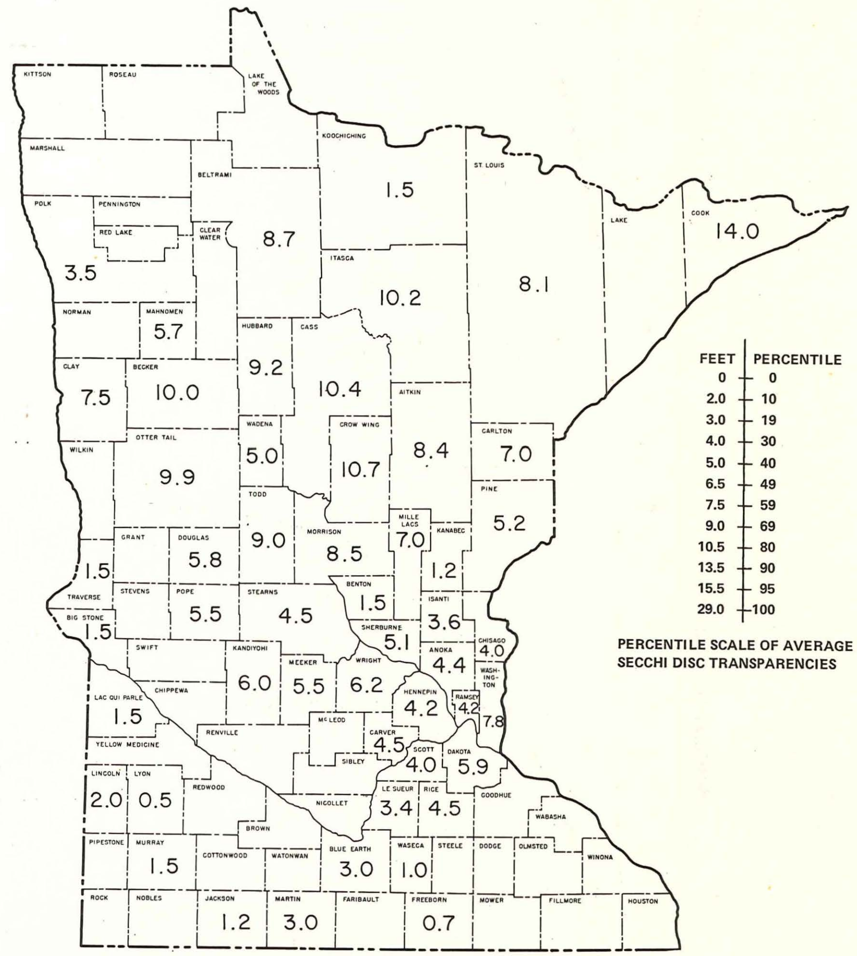
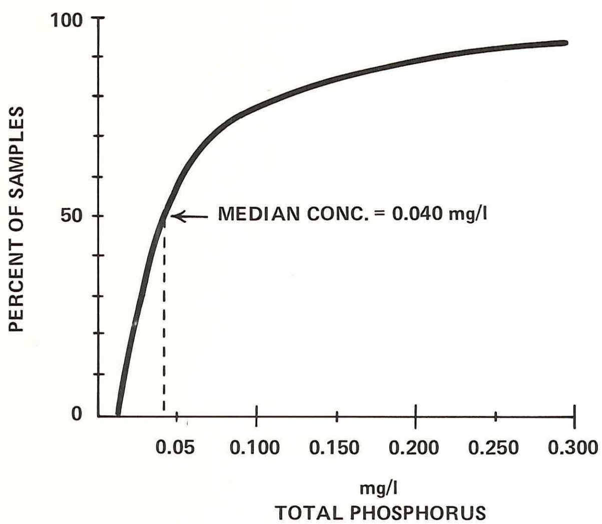
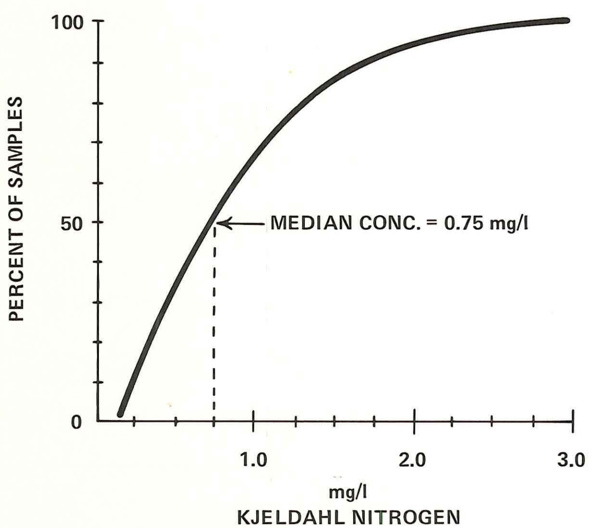


FIGURE 11
FERTILITY OF 135 MINNESOTA LAKES
SAMPLED IN THE 1979
CITIZEN LAKE MONITORING PROGRAM





CHAPTER 4
GROUNDWATER PROGRAMS

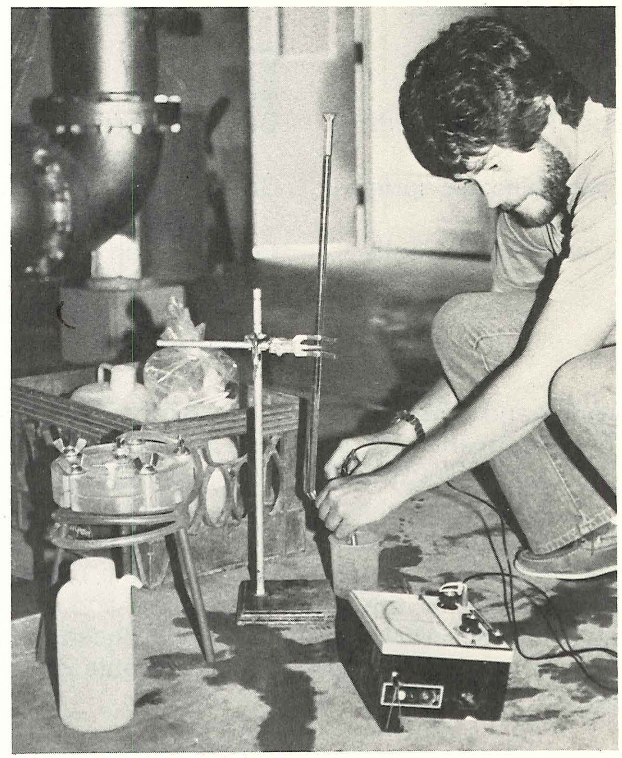
The state of Minnesota has an abundance of groundwater that is considered to be among the most important of the state's resources. Approximately two-thirds of the state population depends on groundwater for domestic water supply, and large quantities are used in industrial and agricultural operations.

It is the policy of the Minnesota Pollution Control Agency (MPCA) to consider the actual and potential use of the underground waters for potable water supply as the highest priority use and as such to provide maximum protection to underground waters. This policy is set forth in Minnesota Regulation WPC 22 (6 MCAR 4.8022). Minnesota Regulation WPC 14 (6 MCAR 4.8014), establishes specific standards of quality and purity for designated classes of intrastate waters of Minnesota, including underground waters.

Efforts by the MPCA to protect the state's groundwater are reflected in a number of programs aimed at water quality surveillance and corrective action. The programs are Groundwater Quality Monitoring, Land Application, and Spill Control under the MPCA, Division of Water Quality. These programs, together with some of the more significant results, are described in this chapter.

GROUNDWATER QUALITY MONITORING

The Section of Surface and Groundwaters is currently monitoring a statewide network of springs and wells for groundwater quality. The network, designed by the United States Geological Survey under the "208 program," consists of about 400 stations — some designed to be sampled on a one-time basis and some at various time intervals. The purpose of the program is to determine ambient or background water quality, and to discover and monitor long-term changes in groundwater quality in significant portions of principal state aquifers. Field sampling by the Section was initiated in February 1978; and as of February 1980, samples had been collected at 210 stations. The program is coordinated with other groundwater programs of the Agency, as well as with other governmental agencies active in groundwater work. Efforts are currently underway to expand the existing program to include more stations that specifically relate to actual or potential sources of groundwater pollution.



Titrating alkalinity at a municipal well.

Results — 1978 Groundwater Quality Monitoring Program

The groundwater quality data from work done in 1978 has been published in a report entitled, *Groundwater Quality Monitoring Program, A Compilation of Analytical Data for 1978,* MPCA, December 1979. The work in 1978 consisted of sampling and observations at 137 groundwater stations (see Map 8). Some sampling was repeated at a few of the stations. Table 4 shows the basic and selected parameters measured together with their STORET numbers and the number of samples collected.

Some limited evaluation of the results of the 1978 groundwater monitoring data has been done by grouping the water sources sampled and by comparing selected parameter values with water quality standards. The water source groups selected for this purpose are as follows:

Water Source	Aquifers
Surficial sand wells	Glacial drift
Buried sand wells	Glacial drift
Upper Paleozoic wells	Devonian through the middle Ordovician systems
Upper Paleozoic springs	Cedar Valley, Maquoketa, and Dubuque-Galena
Lower Paleozoic wells	Lower or early Ordovician system through the Hinckley sandstone in the Keeweenawan system

Tables 5-9 and Figure 12 show values for selected parameters for the five groups of water sources. The water quality standards shown represent the most restricted values from the MPCA water quality standards and the Minnesota Department of Health (MDH) standards for finished public drinking-water supplies. No attempt is made in this instance to apply the multiple sample provisions included in the MDH standards, and it should be understood that the MDH standards are included only for the purpose of comparing the data with acceptable drinking water standards.

In calculating the means shown in Tables 5-9 and Figure 12, all less than values "<" are disregarded and the values shown represent the arithmetic mean of the determinations except for a few anomalous values.

In determining the number of values that exceeded the standards shown in Tables 5-9, less than values "<" were considered to be zero.

MAP 8
GROUNDWATER QUALITY MONITORING NETWORK
1978

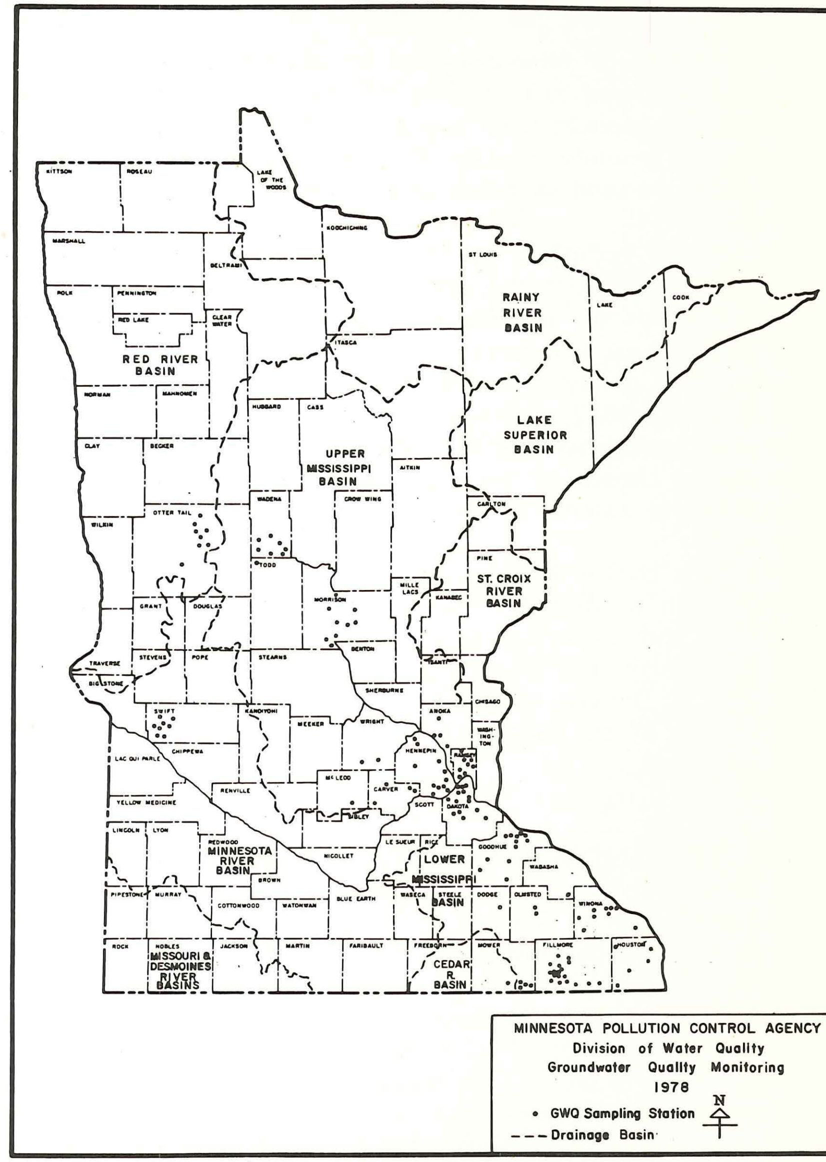


TABLE 4
GROUNDWATER QUALITY PARAMETERS
1978

Parameter	STORET Number	Number of Determinations
Water Temperature °C	00010	140
pH (Field) (Units)	00400	139
pH (Lab) (Units)	00403	138
Conductivity (Field, Micromho)	00094	139
Conductivity (Lab, Micromho)	00095	138
HCO_3 Alk ($CaCO_3$, mg/l)	00425	133
Color (PT-CO units)	00080	137
Total Organic Carbon (C, mg/l)	00680	137
MBAS (mg/l)	38260	81
Total Coliform (MPN/100 ml)	31505	135
Fecal Coliform (MPN/100 ml)	31615	136
Fecal Strep (MPN/100 ml)	31679	41
Total Hardness ($CaCO_3$, mg/l)	00900	138
Total Alkilinity (Field, mg/l)	00431	17
Total Alkalinity (Lab, $CaCO_3$, mg/l)	00410	138
Chloride (mg/l)	00940	139
Sulfate (Diss, mg/l)	00946	139
Sodium (NA, Diss, mg/l)	00930	137
Potassium (K, Diss, mg/l)	00935	137
NO_2 + NO_3 (N, Tot, mg/l)	00630	138
NO_2 (N, Tot, mg/l)	00615	138
Total Kjel Nitrogen (N, mg/l)	00625	138
Total Phosphorus (P, mg/l)	00665	138
Total Residue (Vol, mg/l)	00505	138
Residue (Diss, –180°C, mg/l)	70300	138
Calcium ($CaCO_3$, mg/l)	00910	138
Calcium (Diss, $CaCO_3$, mg/l)	00915	138
Fluoride (F, Diss, mg/l)	00950	138
Boron (B, Diss, µg/l)	01020	135
Magnesium ($CaCO_3$, mg/l)	00920	138
Magnesium (Diss, $CaCO_3$, mg/l)	00925	138
Silica (Diss, mg/l)	00955	138
Total Lead (PB, µg/l)	01051	139
Total Zinc (ZN, µg/l)	01092	138
Total Nickel (Ni, µg/l)	01067	137
Total Cadmium (CD, µg/l)	01027	137
Total Mercury (Hg, µg/l)	71900	137
Total Chromium (CR, µg/l)	01034	137
Manganese (MN, µg/l)	01055	137
Total Iron (FE, µg/l)	01045	137
Total Phenols (µg/l)	32730	41
Total Toxaphene (µg/l)	39400	22
Silvex (Whole sample, µg/l)	39760	24
DDT (Whole sample, µg/l)	39370	22
2,4-D (Whole sample, µg/l)	39730	24
2,4,5-T (Whole sample, µg/l)	39740	24
Total Chlordane (Tech and Met, µg/l)	39350	14
BOD (5 day, mg/l)	00310	13
Stream flow (Inst, CFS)	00061	12

Since the groundwater monitoring program is relatively new, trends or long-term changes in the quality of water in the principal state aquifers cannot be determined at this time. The following general comments on data shown in Tables 5-9 and Figure 12 relate to ambient water quality only:

1. Water from the wells sampled in the surficial sand aquifers was found to contain relatively low concentrations of chlorides and lead, and high concentrations of nitrates and dissolved solids.

2. Water from the wells sampled in the buried sand aquifers was found to contain relatively low concentrations of nitrates and higher concentrations of dissolved solids and lead.

3. The upper Paleozoic springs tested are not suitable as a source of drinking water because the water generally contains high concentrations of coliform organisms and in some instances elevated nitrates.

4. Water from the upper Paleozoic wells tested contains relatively higher concentrations of lead and lower concentrations of dissolved solids than other well sources tested.

5. The concentration of chlorides in the deeper aquifers was found to be generally higher than in the more shallow aquifers tested.

TABLE 5
ANALYTICAL DATA SURFICIAL SAND WELLS

Selected Parameters	Number of Determinations	Analytical Results Maximum	Minimum	Mean	State Standards	Number Exceeding Standards
pH, (Field), (Units)	33	7.9	6.1	7.3	6.5-8.5	2
Total Coliform (MPN/100 ml)	33	69	<2	–	0	3
Fecal Coliform (MPN/100 ml)	33	5	<20	–	0	1
Chlorides (mg/l)	33	70	0.95	11.9	250	0
Nitrate Nitrogen as N (mg/l)	33	35.93	<0.01	5.75	10	8
Dissolved Solids, 180°C (mg/l)	33	1400	150	3.90	500	7
Lead (μ g/l)	33	18	0.22	3.5	50	0
Zinc (μg/l)	33	720	1.9	142.62	5000	0
Cadmium (μg/l)	33	21	0.01	0.70	10	1
Mercury (μg/l)	33	0.5	0.1	0.2	2	0
Chromium (μg/l)	33	2.1	0.2	0.8	50[1]	0
Phenol (μg/l)	1	4.8	4.8	4.8	1	1
Toxaphene (μg/l)	7	0.1	0.1	0.1	5	0
Silvex (μg/l)	9	0.02	0.01	0.02	10	0
2,4-D (μg/l)	9	0.1	0.05	0.09	100	0
2,4,5-T (μg/l)	9	0.1	0.05	0.09	10	0

[1] Hexavalent Chromium

TABLE 6
ANALYTICAL DATA BURIED SAND WELLS

Selected Paremeters	Number of Determinations	Analytical Results Maximum	Minimum	Mean	State Standards	Number Exceeding Standards
pH, (Field), (Units)	10	7.9	7.2	7.5	6.5-8.5	0
Total Coliform (MPN/100 ml)	8	5	<2	–	0	1
Fecal Coliform (MPN/100 ml)	8	<2	<2	–	0	–
Chlorides (mg/l)	10	79	0.9	16.1	250	0
Nitrate Nitrogen as N (mg/l)	6	7.48	0.01	2	10	0
Dissolved Solids, 180°C (mg/l)	10	2600	260	568	500	1
Lead (μg/l)	10	64	0.18	8.1	50	1
Zinc (μg/l)	10	820	0.24	230.78	5000	0
Cadmium (μg/l)	9	5.1	0.01	0.63	10	0
Mercury (μg/l)	9	0.71	0.10	0.3	2	0
Chromium (μg/l)	9	2.6	0.5	0.99	50[1]	0
Phenol (μg/l)	5	<2	<2.0	–	1	–
Toxaphene (μg/l)	2	1	0.1	0.5	5	0
Silvex (μg/l)	2	0.02	0.01	0.01	10	0
2,4-D (μg/l)	2	3	0.05	1.52	100	0
2,4,5-T (μg/l)	2	0.1	0.05	0.07	10	0

[1] Hexavalent Chromium

TABLE 7
ANALYTICAL DATA UPPER PALEZOIC WELLS

Selected Paremeters	Number of Determinations	Analytical Results Maximum	Minimum	Mean	State Standards	Number Exceeding Standard
pH, (Field), (Units)	16	8.9	7.1	7.4	6.5-8.5	1
Total Coliform (MPN/100 ml)	16	330	<2	–	0	1
Fecal Coliform (MPN/100 ml)	16	<20	<2	–	0	0
Chlorides (mg/l)	16	450	<0.5	38.8	250	1
Nitrate Nitrogen as N (mg/l)	16	8.49	<0.01	1.05	10	0
Dissolved Solids, 180°C (mg/l)	16	1100	110	358	500	2
Lead (μg/l)	17	1900	0.3	9.7	50	2
Zinc (μg/l)	16	2800	15	139.3	5000	0
Cadmium (μg/l)	16	0.92	0.01	0.14	10	0
Mercury (μg/l)	16	0.39	<0.1	0.1	2	0
Chromium (μg/l)	16	2.3	<0.2	1	50[1]	0

[1] Hexavalent Chromium

TABLE 8
ANALYTICAL DATA, UPPER PALEOZOIC SPRINGS

Selected Parameters	Number of Determinations	Analytical Results Maximum	Minimum	Mean	State Standards	Number Exceeding Standard
pH, (Field), (Units)	13	7.3	6.8	7.2	6.5-8.5	0
Total Coliform (MPN/100 ml)	13	24000	49	–	0	13
Fecal Coliform (MPN/100 ml)	13	24000	<2	–	0	13
Chlorides (mg/l)	13	27	1.6	13.3	250	0
Nitrate Nitrogen as N (mg/l)	13	17.96	0.04	7.35	10	2
Dissolved Solids, 180°C (mg/l)	13	410	240	341	500	0
Lead (μg/l)	13	1.6	<0.01	5	50	0
Zinc (μg/l)	13	2.7	0.49	1.37	5000	0
Cadmium (μg/l)	13	0.02	<0.01	0.02	10	0
Mercury (μg/l)	13	0.11	<0.1	0.1	2	0
Chromium (μg/l)	13	3.1	<0.5	1.3	50[1]	0
Phenol (μg/l)	3	27	<2	–	1	1
Toxaphene (μg/l)	13	<1	<1	1	5	0
Silvex (μg/l)	13	0.13	<0.01	0.02	10	0
2,4-D (μg/l)	13	5.6	<0.05	0.87	100	0
2,4,5-T (μg/l)	13	<0.05	<0.05	0.05	10	0

[1] Hexavalent Chromium

TABLE 9
ANALYTICAL DATA, LOWER PALEOZOIC WELLS

Selected Parameters	Number of Determinations	Analytical Results Maximum	Minimum	Mean	State Standards	Number Exceeding Standard
pH, (Field), (Units)	69	8.6	7.0	7.4	6.5-8.5	1
Total Coliform (MPN/100 ml)	66	6	<2	–	0	5
Fecal Coliform (MPN/100 ml)	68	2	<2	–	0	1
Chlorides (mg/l)	69	490	0.50	40.5	250	3
Nitrate Nitrogen as N (mg/l)	59	42.99	<0.01	1.53	10	2
Dissolved Solids, 180°C (mg/l)	68	2700	140	383	500	11
Lead (µg/l)	68	21	0.10	12.9	50	0
Zinc (µg/l)	68	2100	0.50	157.84	5000	0
Cadmium (µg/l)	68	0.43	0.01	0.04	10	0
Mercury (µg/l)	68	3.50	0.10	0.2	2	1
Chromium (µg/l)	68	4.00	0.15	0.64	50[1]	0
Phenol (µg/l)	26	6.3	<2.0	2	1	2

[1]Hexavalent Chromium

LAND APPLICATION

The MPCA is currently overseeing numerous special soil and groundwater studies and monitoring programs throughout the state which are conducted by local jurisdictions or industries. The vast majority of these are at industrial waste disposal sites suspected of being inadequate for the type of wastes involved.

Groundwater quality is a primary concern when evaluating the effectiveness of any land disposal system. Not unlike the National Pollutant Discharge Elimination System (NPDES) program, which requires the monitoring of effluent discharged to surface waters, a similar program is needed with land disposal systems where it is necessary to protect groundwaters.

The State of Minnesota has a State Disposal System permit specifically for those facilities which have final disposal of wastes (either domestic or industrial) onto the land surface. Routine groundwater monitoring requirements for the facility are outlined in the permit. This specifies what parameters shall be monitored as well as the frequency of sampling. This information is required to be submitted for MPCA review. It is the responsibility of the permittee to install all monitoring devices (wells, soil moisture samplers) and to retrieve and analyze all groundwater samples pursuant to the permit requirements. To assure that all monitoring devices are properly located and samples are properly retrieved and analyzed, a monitoring plan must be submitted and approved prior to starting any monitoring program.

Results

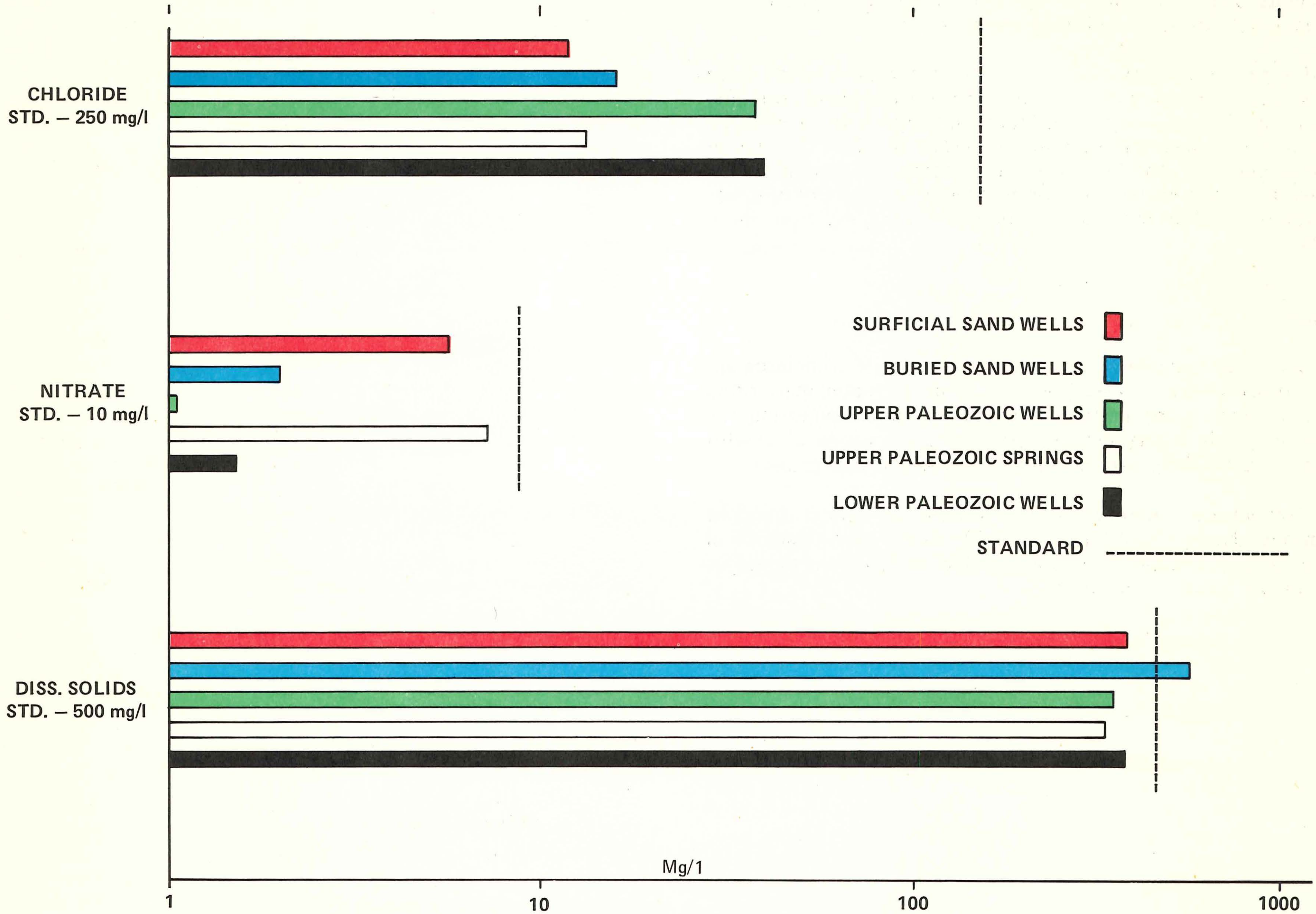
For most land treatment and disposal systems, either monitoring has just begun or insufficient data has been generated to observe specific trends. In general, data generated thus far at municipal wastewater stabilization ponds with adequate seals and water levels indicates minimal impact on groundwaters, with the possible exception of increased soluble salt concentrations in shallow groundwater.

Monitoring programs for other land treatment and disposal systems such as land-spreading and irrigation of industrial wastes, seepage systems, and ridge and furrow systems are generally just commencing. The MPCA is in the process of issuing or reissuing permits to land treatment/disposal facilities to ensure that adequate monitoring programs are being pursued. Limited data from some industrial food processors using wastewater irrigation indicate an increase of soluble salts in shallow groundwaters because of salts used in food processing.

SPILL CONTROL

Two types of groundwater monitoring have been and continue to be employed at spill sites. These are short-term monitoring, along with contaminant recovery and long-term monitoring. Short-term monitoring and contaminant recovery generally consists of drilling test holes, drilling holes for recovery operations, digging pits and trenches for recovery operations, and monitoring areas such as wells, sewer lines, or buildings which may be directly affected by the spilled material. Monitoring continues

FIGURE 12
MEAN CONCENTRATIONS FOR SELECTED PARAMETERS
1978 GROUNDWATER QUALITY MONITORING



until no further recovery is possible or feasible, no further unsafe or nuisance conditions exist, and no further adverse effects are expected. In all cases of underground leaks, and in most cases of moderate and large spills to the ground, soil borings and subsequent groundwater monitoring are necessary.

Long-term groundwater monitoring is necessary when large spills occur, when a spill continues to adversely impact drinking water supplies, buildings, or utilities, and when a spill cannot be adequately cleaned up in a short period of time. Long-term monitoring may continue from six months to several years. Presently, groundwater monitoring near a pipeline rupture was discontinued after five years of quarterly sampling from seven wells.

Results

Since approximately 90 percent of all spills in Minnesota are oils or petroleum distillates, almost all groundwater monitoring at spill sites is for petroleum contamination. Monitoring for other materials is very unique and is generally coordinated with other units and/or governmental agencies as a special project.

Groundwater monitoring was utilized at several hundred locations during fiscal year 1979-80. Since each instance is separate and unique, it is not possible to look for trends or summarize results at this time.

CHAPTER 5
SPECIAL WATER QUALITY PROBLEMS

Special water quality problems are discussed in this chapter under the following headings: Wetlands and Dredging, Groundwater, Drinking Water Supplies, Areas of Water Depletion, and Acid Rain. The problems, together with studies and other efforts to provide necessary corrective actions at the state level, are described.

WETLANDS AND DREDGING

In 1956, Minnesota had approximately 5,044,900 acres of wetlands which ranked number four in the contiguous United States for total wetland acreage. Of the 50 states, Minnesota ranked number one for wetlands rated as high value to waterfowl with 1,274,500 acres. The U.S. Department of Interior Fish and Wild Life Service Circular 39, 1956 *Wetlands of the United States* defines Types I-V Wetlands as follows:

I. Seasonally flooded basins or flats
II. Inland fresh meadows
III. Inland shallow fresh marshes
IV. Inland deep fresh marshes
V. Inland open fresh water

An interim study of wetlands conducted in 1974 for the U.S. Fish and Wildlife Service estimated that the number of wetlands other than Type I and II in 19 western Minnesota counties decreased by 40 percent in the ten-year period between 1964 and 1974. The study also reported changes from Type V wetlands to Type IV wetlands by consolidation of small wetlands into larger basins and the unsuccessful drainage of Type V wetlands, leaving the characteristics of Type IV wetlands in these areas. These changes significantly affect the ecology of the area. Other studies of the area have reported similar conclusions.

Over 300 Section 401 certification actions per year have been issued by the Minnesota Pollution Control Agency (MPCA) since 1977. Section 401 certification actions are a certification by the MPCA that a proposed project will meet requirements of state and federal pollution control laws and regulations. The number of Section 401 certifications processed by the MPCA are an indication of the number of U.S. Army Corps of Engineers' permits issued in Minnesota, the vast majority of which involve fill into wetlands adjacent to streams of greater than 5 cfs, or in wetlands of greater than 10 acres. Another indication of the extent of activity in wetlands is the number of Minnesota Department of Natural Resources (MDNR) permits issued. In the period 1972 through 1979, the MDNR issued 6,336 permits for work which altered the course, current, or cross-section of public waters in Minnesota. These waters are limited to Type III, IV, and V wetlands other than drainage projects specifically exempted by state law; therefore, they do not reflect the total number of activities which affect wetlands. Agricultural drainage, flood control projects, roadways, resorts, city, and industrial development continue to destroy or alter the character and extent of wetlands in the state. Studies will be necessary to determine the extent and effect of this destruction.

It is readily apparent that most existing data is outdated and that previously collected wetland data is not directly applicable to the current needs of water quality regulatory agencies. Previous studies have been conducted for the purpose of finding drainable wetlands or protecting wildlife habitat. Comprehensive studies on wetlands which serve water quality functions have not been available. Section 208(i) of the Clean Water Act provides $8,000,000 for the U.S. Fish and Wildlife Service to complete a National Wetlands Inventory by December 31, 1981. This will provide much needed information on the extent and nature of existing wetlands. However, further study will be necessary to determine which wetlands serve critical water quality functions.

Dredged and fill material is defined as a pollutant by Minnesota Statutes Chapter 115. The MPCA regulates the discharge of dredged or fill material to protect water quality through the issuance of State Disposal System permits and other action such as Section 401 certification. The MDNR has a parallel program of permit issuance which is directed toward protecting fish, wildlife, and other resources affected by dredge or fill activity.

An intensive survey of the sediment quality of the Mississippi River and the Duluth-Superior Harbor is currently being conducted by the U.S. Army Corps of Engineers, in fulfillment of MPCA permit requirements. The studies will be used to determine appropriate regulatory policy for the MPCA regarding the disposal of dredged material. The survey involves a systematic sediment sampling program and a series of bioassays which are intended to relate the sediment characteristics to the potential biological impacts. No guidelines or criteria for evaluating sediments currently exist on the Mississippi River.

GROUNDWATER

While the quality of groundwater in Minnesota is considered generally good, there exist certain situations where natural or man-induced conditions have resulted in actual or potential groundwater pollution problems. The problems may be either regional in nature or site-specific. Some are described in the following paragraphs.

Regional Problems

Southeastern Minnesota Karst Area — Although groundwater contamination problems are not limited to southeastern Minnesota, the nature of the geology of this area makes it a very sensitive area. Limestone formations outcrop at the surface or are covered by a thin mantle of glacial drift. The area is characterized by sink holes and underground channels. Contamination may readily enter the limestone formations through the sink holes at the surface or through improperly constructed or abandoned wells. While such conditions exist in nine southeastern Minnesota counties, four counties — Fillmore, Houston, Wabasha, and Winona — appear to have the most serious problems. Because of the Karst formations, the disposal of wastes in southeastern Minnesota may be a very real problem. It is known, for example, that at times all or some of the treated sewage effluent from some municipalities in the area is discharged into underground rock formations.

Some recent studies coordinated by the Minnesota Department of Health (MDH) have been made in the area concerning mathematical modeling techniques, health effects of well water, inter-flow in uncased multi-aquifer wells, and geology and subsurface drainage. One of the conclusions was that a majority of the wells in the Karst area had indications of coliform bacteria and/or elevated nitrate levels, and that further analysis of potential contaminant sources and land-use practices is needed. Further sampling and analysis of groundwater in the Karst region is planned under the MPCA groundwater quality monitoring program.

The MPCA is currently attempting to secure funding to conduct a special investigation of selected feedlots in the Karst area. The goal is to evaluate different feedlot designs and waste storage impoundments as potential contaminant sources for groundwater.

Irrigation — Farmland irrigation in sand-plain areas of Minnesota has increased substantially in the past few years. The results of 1978 groundwater quality work by the MPCA, generally in rural irrigation areas, indicate a possibility that nitrates and dissolved solids are being leached into the shallow groundwater from agricultural practices on the surface. Of 33 wells in surficial sand aquifers, about 24 percent were found to have water exceeding the state standard of 10 milligrams per liter (mg/l) for nitrate concentration, and about 50 percent were found to have water containing an excess of 3 mg/l nitrate. The MPCA plans to continue the monitoring of well water quality in irrigation areas of the state.

Salt-Water Intrusion — Heavy pumping of freshwater aquifers can cause the migration of highly mineralized water from lower aquifers into the freshwater aquifers under certain conditions. These conditions exist in southeastern and northwestern Minnesota. The effect on the water quality of the freshwater aquifers could be substantial with heavy pumping for industry or irrigation. A number of wells which may be subject to salt-water intrusion are being monitored under the MPCA groundwater program.

Site-Specific Problems

St. Louis Park — The MPCA is currently cooperating with federal and state agencies and local government on special soil and groundwater studies in the city of St. Louis Park. Contamination resulted from operations of a coal-tar distillation and wood-treating company. Hydrocarbon contaminants infiltrated the soil and percolated to the groundwater. Contaminants were also introduced into deeper aquifers through spillage into a deep well. The studies are attempting to define the extent of contamination, the hydrogeology of the area, and appropriate mitigative actions. The contamination is of special concern because major water-supply aquifers have been or have the potential to be affected. Municipal water wells near the site have been closed because of contaminated groundwater.

Koppers Coke Plant — The MPCA is overseeing a special soil and groundwater investigation at the site of the old Koppers Coke plant in the city of St. Paul. Although only first-phase work has been completed at the present time, results indicate significant levels of hydrocarbon contaminants in the soil and groundwater beneath the site. It appears that additional study will be necessary and that appropriate mitigative actions will be required.

Road De-Icing — The use of chemicals for snow and ice control on Minnesota roadways has resulted in some pollution problems. Many large and hundreds of small stockpiles of salt and salt-abrasive mixtures are located at various times at many locations in the state. In a number of instances, it has been found that salt piles and piles of mixed abrasives and salt are not adequately protected from the weather, and the leachate has caused pollution of groundwaters. The MPCA currently investigates and takes appropriate action in situations that are known to cause water pollution problems. Because of the potential for many similar problems, the MPCA has addressed the use of highway de-icing chemicals in the Minnesota 208 Water Quality Management Plan.

DRINKING WATER SUPPLIES

Drinking water supplies have been affected by spills or similar mishaps on a number of occasions during the past several years. Most of those affected have been groundwater sources, and only a few surface water sources have been impacted. Two situations involving the siphoning or injection of agricultural chemicals into public potable water distribution systems occurred. One was at Hayfield, Minnesota, and the other was Eagle Lake. In both instances, the accidents occurred during the cleaning or loading of equipment for the distribution of chemicals on agricultural land.

The Minneapolis water intake on the Mississippi River at Fridley has been threatened several times by oil discharges from upstream storm sewers. The sources of the oil have never been definitely determined although interstate highways and large railroad yards are both drained by the sewer system. Fortunately, quick reaction by state and federal agencies prevented serious problems and even allowed the intake to remain operational.

There are only 24 surface water intakes for municipal water supplies in the state. These are all well known by the Agency staff and appropriate protective measures can be instituted quickly if they become threatened.

Most potable water supplies that become contaminated are private wells. Numerous cases of petroleum and pesticide contamination have occurred in the past years. These wells are normally rehabilitated by recovery of the contaminating material and special filtering of the water.

The MDH has primary jurisdiction of public water supplies. They report that in 1979 they had only about twelve violations of the safe drinking water standards for chemical parameters for community water systems. These included two for arsenic, eight for nitrates, and two for fluorides. Some of the nitrate problems and both of the fluoride problems are considered to result from naturally occurring minerals.

Practically all of the wells being monitored by the MPCA under the groundwater quality monitoring program are used as a source of drinking water. In the event that analytical results show the water from a particular well does not meet the MDH drinking water standards, the MPCA takes steps to notify the well owner of these findings by mail, and copies are furnished to the MDH.

AREAS OF WATER DEPLETION

Water quality standards violations resulting from depletion of a water resource are not known to have occurred in Minnesota. This type of problem is not anticipated except that it is reported that there are areas in southeastern and northwestern Minnesota where heavy pumping can result in some migration of poor quality water from surface sources or highly mineralized water from lower aquifers into the pumped aquifer.

ACID RAIN

The impacts of acidic precipitation have recently been identified as a potential pollution problem in Minnesota. The burning of fossil fuels is considered to be the main cause of this nearly global problem. Oxides of sulfur and nitrogen released into the atmosphere can be transported long distances and may form strong acids which return to earth in the form of acidic rain or snow, or attached to dry particulates. Other materials which became airborne, such as soil dust, can have a buffering effect on these acids. Thus, the region over which the transport occurs is an important factor in determining the ultimate acidity of the precipitation. Also important is the source of the air mass yielding the precipitation and the meteorological conditions which produce the precipitation.

The source of acidic substances in precipitation falling on Minnesota has not been exactly determined, but there are indications that better than half are from sources outside the state.

Rain samples collected near Ely, Minnesota, as part of the Regional Copper/Nickel Study had a median pH of 4.7 (rain with a pH below 5.6 is considered acidic rain). Rain falling in western Minnesota usually has a somewhat higher pH.

Acidic precipitation can damage both terrestrial and aquatic ecosystems. In Minnesota, potential impacts will most likely be seen first in certain lakes in the northeastern part of the state. It is known that some lakes in the Voyageurs National Park Area and the Boundary Waters Canoe Area are very poorly buffered and are sensitive to acidic loading. If the pH of these lakes drops below about 6.0, impacts on the sensitive fish populations in them are likely.

The MPCA recognizes the need for more information about the nature and extent of this problem in Minnesota. Modifications to some ongoing monitoring programs are planned. This will produce data more valuable in assessing this problem than is now being obtained. Also, some new monitoring programs are in the initial planning stages. For example, a lake sampling program is needed to identify the sensitive lakes in Minnesota and document the rates at which acidification is occurring and is likely to occur in the future.

In a bill passed this session, the Minnesota Legislature recognized the extent and severity of the acid rain problem. The acid rain legislation designates the following three state agencies to conduct activities designed to identify, control and abate acid rain: the MPCA, the MDNR, and the MDH, with the MPCA serving as the lead agency. In addition to the work proposed under the legislation, the MPCA is also addressing the acid rain problem through an Acid Rain Task Force and through its APC-1 Review Committee, which is currently examining the state's air quality standards.

CHAPTER 6
WATER POLLUTION CONTROL PROGRAMS

This chapter will address some of the more important programs administered by the Minnesota Pollution Control Agency (MPCA), Division of Water Quality. The discussion covers the major activities of the various sections in 1978-79 and describes program accomplishments, problems, and in some instances, recommendations for program improvements.

SURFACE AND GROUNDWATERS SECTION

Major activities of the Surface and Groundwaters Section include water quality, biological, and toxic substances monitoring; water quality studies and related waste source surveys; development of water quality standards; and administration of the lake restoration grants program.

Accomplishments

Some of the major accomplishments of the Section of Surface and Groundwaters in 1978-79 include the initiation of new programs in the following areas: groundwater monitoring, toxic substances monitoring, clean lakes, acid rain, and bioassays (fish survival in an effluent stream). In addition, the Section continued the water quality and biological monitoring of surface water, the program for reduction of phosphate in cleaning agents, and completed the following special projects:

1. Promulgation and publication of a Quality Assurance Manual for field sampling;
2. Four intensive field surveys;
3. Participation in three combined sewer overflow studies on the Mississippi River in the Minneapolis-St. Paul metropolitan area; and
4. Revisions to the existing water quality standards and classifications of the state.

Problems

Some of the major problems encountered in the work of the Surface and Groundwaters Section in 1978-79 involved funding for the acid rain program and the lack of adequate laboratory facilities for organic analyses. The State Legislature has provided some limited funding to study the acid rain problem, but additional funding is needed.

The MPCA does not have adequate laboratory facilities available at this time to provide analyses for organic substances. While this service has been provided in the past by the Minnesota Department of Health, they report that they are now so overloaded that they can no longer handle the MPCA workload. Plans are currently being developed to contract for organic analyses with private laboratories for the short-term while the long-term alternatives are being studied.

PERMITS SECTION

The major function of the Permits Section is the preparation and issuance of permits. These include National Pollutant Discharge Elimination System (NPDES) permits for the discharge of wastewater from point sources to surface waters, and state permits for feedlots and on-land disposal of wastewater. The Section also administers the issuance of 401 certification for dredging operations.

Accomplishments

During fiscal year (FY) 1978, 25 NPDES permits were issued which increased the number of permitted facilities in the State of Minnesota from 1,358 to 1,383. Also during this period, 240 NPDES permits were reissued and another 40 modified. During FY 1979, 30 NPDES permits were issued which increased the total number of permitted facilities to 1,413. In addition, 335 NPDES permits were reissued and another 12 modified.

Problems

The main problem encountered in the NPDES permit program during FY 1978 concerned municipal noncompliance with the July 1, 1977, deadline for secondary and more restrictive state effluent requirements. The Clean Water Act of 1977 eliminated this situation by allowing many municipalities an extension of time to July 1, 1983, to achieve final compliance.

A problem that has been historically encountered in the NPDES permit program concerns technical aspects. The U.S. Environmental Protection Agency (EPA) has historically been slow in promulgating effluent guidelines concerning water quality control requirements for dischargers. At the same time, the EPA has devoted considerable staff resources toward reviewing delegated state program administrative activities ranging from how permits are processed to specific conditions contained in permits.

Recommendations

While a limited amount of EPA review of state NPDES permit activities may be needed, it appears that the program would benefit by a shift of EPA resources from the administrative to the technical aspects of the program. More reliance should be placed on the states to handle the administrative functions. Many, if not all, states could better use additional technical assistance from EPA, such as more prompt promulgation of effluent guidelines.

COMPLIANCE AND ENFORCEMENT SECTION

Major functions of the Section of Compliance and Enforcement include compliance tracking, spill control, and administration of complaints, together with the preparation of stipulation agreements and basic information for court actions necessary to ensure conformance with state and federal water pollution control permits and regulations.

Accomplishments

Compliance Tracking — The Compliance and Enforcement Section conducts compliance tracking on approximately 1,336 permittees within the state. These permittees include 47 major municipals, 29 major industrials, 9 major agricultural, approximately 500 minor municipals, and approximately 750 minor industrial dischargers. Major discharger files and self-monitoring reports are reviewed monthly, and compliance monitoring surveys (CMS) are conducted at each major discharge once per year. The MPCA currently conducts CMS at all of the major dischargers. Minor discharger files and self-monitoring reports are reviewed at least once per year with the significant minors (those with a more pronounced impact on the environment), being reviewed once per quarter. CMS are conducted on approximately 35 percent of the minor dischargers per year by the MPCA. EPA review of the MPCA Quarterly Noncompliance Reports reveals that approximately 75 percent of the major municipal, 80 percent of the major industrial, and 100 percent of the major agricultural permittees were in compliance with NPDES Permit, Enforcement Compliance Schedule Letter, or Stipulation Agreement requirements during the past year. Compliance and associated problems with major dischargers are tracked very closely on an individual basis while minor dischargers cannot be monitored as intensely due to lack of sufficient manpower.

Spill Control — A series of progressive changes over the past five years has significantly improved the effectiveness of the MPCA's Spills Program. The total number of spills handled by the staff annually has more than doubled since 1975. Experience with the large number of problems (more than 800 individual cases per year) has broadened the problem-solving capabilities of the staff and has allowed for refinement of investigation and enforcement techniques. Thus, investigation and resolution of underground leaks, for example, have vastly improved. Spill clean-up techniques used by private contractors and responsible parties have also improved as a result of MPCA input and support.

Stronger enforcement efforts, such as the increased use of stipulation agreements which impose monetary penalties and the required hydrostatic testing of two major pipeline systems, have effectively decreased the number of certain kinds of spills while acting as a warning for others to take preventive actions. Prevention of and preparation for spills response has also been promoted by increased training and informational meetings for the fire department, the Coast Guard, clientele, and State employees. All of these changes have improved the Spills Program and benefited the citizens of Minnesota.

Administration of Complaints – In FY 1979, the Complaint Unit received about 300 pollution related complaints with approximately two-thirds from the Twin Cities Metro Area. There was successful resolution of a good percentage of the situations. Whenever possible, complaints are transferred to an appropriate unit of local government for resolution.

Problems

Compliance Tracking – A few of the compliance tracking problems experienced with minor dischargers that are not common to major dischargers include the following:

1. There is reluctance to enter into State and Federal Construction Grants Programs. This reluctance requires extensive time and manpower to convince municipalities of its benefits as opposed to taking formal enforcement action.

2. Small industrial dischargers often do not have the capital necessary to upgrade to meet water quality limits.

3. Many minor municipal and industrial discharges repeatedly fail to comply with self-monitoring and reporting requirements. Self-monitoring is sometimes not conducted; and in many instances when it is conducted, the analytical procedures used do not produce accurate and reliable data. Again the MPCA does not have sufficient manpower to adequately track compliance deficiencies on all minor dischargers.

4. Some municipal wastewater treatment facilities are frequently overloaded or upset by industrial dischargers. The MPCA is currently initiating a pre-treatment program which will require the municipality to enforce pre-treatment requirements on industries which adversely affect municipal waste treatment requirements.

5. As in the past, there are still not enough grant monies available to allow all municipal wastewater treatment plants to upgrade to the point where water quality standards can be met.

One of the most significant discharges in the state which has failed to comply with water quality limits is the 220 million gallon per day discharge from the Metropolitan Wastewater Treatment Plant. This plant treats the sewage from Minneapolis-St. Paul and about sixty surrounding communities which accounts for about one-half of the sewered population of the state. A major plant expansion is underway with completion of solids processing facilities remaining as the last step required to attain secondary treatment. The solids processing limitation resulted in NPDES permit violations during much of 1979. These violations were addressed through a Stipulation Agreement negotiated by the Metropolitan Waste Control Commission, the Metropolitan Council, and the MPCA. The Agreement requires several remedial measures, including consultant's evaluation of plant operations and capabilities which should assure the best possible performance of the plant during the remaining construction period.

On a positive note, 16 municipalities have either constructed new facilities or upgraded their existing facilities to meet appropriate limitations during FY 1978 and 1979.

FACILITIES SECTION

Major functions of the Facilities Section involve plan review, operation, operator training, and administration of federal and state grant programs for wastewater treatment facilities.

Accomplishments

Construction Grants – Processed Step 1 (Facilities Plans), Step 2 (Plans and Specifications), and Step 3 (Construction) Wastewater Treatment Facility Construction Grants Program grant applications that amounted to $215 million during FY 1978 and 1979.

A formal agreement was entered into with EPA on March 14, 1979, for the purpose of accepting Construction Grants Program delegated tasks. This agreement established the schedule for assumption of designated tasks and outline the responsibilities of the MPCA and the EPA. As of the end of FY 1979, the MPCA was managing and operating a significant part of the Construction Grants Program.

Training – Operated an active sewage treatment training and technical assistance program which trained 2,000 operators in a variety of operation subjects, certified approximately 500 operators, and provided major operational assistance to over 30 projects.

Cost Projections* for Municipally-Owned Treatment Works – Projected costs to achieve pollution control for municipally-owned treatment works are divided by the category of need in the following:

Category I – Secondary Treatment: $12 million. This includes costs for facilities which are only required to provide secondary treatment standards.

Category II – More Restrictive than Secondary Treatment: $705 million. This includes costs for facilities which are required to provide treatment to meet effluent limitations more stringent than secondary treatment. (The state effluent limitation of 25 mg/l BOD_5 and 30 mg/l TSS is considered more restrictive than federal secondary treatment guidelines of 30 mg/l BOD_5 and 30 mg/l TSS.)

Category IIIA – Correction of Infiltration/Inflow: $28 million. This includes costs for correction for sewer system infiltration/inflow problems.

Category IIIB – Major Rehabilitation of Sewers: $12 million. This includes costs for replacement and/or major improvements.

Category IVA – New Collector Sewers: $153 million. This includes costs of construction of new collector sewer systems and appurtenances.

Category IVB – New Interceptor Sewers: $247 million. This category includes costs of construction of new interceptor sewers and transmission pumping stations necessary for the bulk transporting of wastewaters.

Category V – Control of Combined Sewer Overflow: $187 million. Costs included for this category were for facilities to prevent and/or control periodic bypassing of untreated wastes from combined sewers.

Problems

The uncertainty in the level of future funding for the Construction Grants Program and the State Management Assistance Program which provides funding for managing and operating the Construction Grants Program. Stability in funding is critical because, as the MPCA assumes additional delegated tasks from EPA, it also is required to add personnel. The states are placed in a position where caution in adding personnel would delay the assumption of delegated tasks, but rapid assumption of tasks without adequate funding could result in a situation where the State would be unable to perform the delegated tasks. Currently, funds for operating and managing the Construction Grants Program are based on 2 percent of the annual Congressional appropriation. The 1978 appropriation for all states was $4.5 billion; in 1979, it was $4.2 billion, and in 1980, $3.4 billion.

Recommendations

Since appropriations are decreasing, the funding dedicated to managing the program is also decreasing. It is recommended that the Management Assistance Grants be based on 2 percent of the 1977 Clean Water Act authorized annual appropriation of $4.5

*Basis of estimation is the 1978 Needs Survey of Municipal Wastewater Treatment Facilities and updating based on infiltration.

billion rather than the actual annual appropriation. This would provide stability in the funding of program management.

PLANNING SECTION

While the Planning Section existed during the time period covered by this report, the Section was abolished early in 1980. The Section activities are currently being continued under various other units of the Agency.

The Planning Section was responsible for the development of river basin water quality management plans and provided federal/state coordination in the program planning area to ensure a continuing planning process in water quality programs.

Accomplishments

During the period 1976-79, Minnesota conducted an extensive program to identify and plan for the abatement of non-point pollution sources. This effort, commonly called "208" planning, was led by the MPCA Water Quality Planning Section. Recommended courses of action on ten categories of non-point sources were reached through the organized input of 12 local advisory committees and various state agencies participating on a State Plan Development Task Force. The ten categories are:

Agricultural Activities	Roadside Erosion
Feedlots	Residual Wastes
Pesticides Use	Highway De-Icing Chemicals
Urban Runoff	Forestry Activities
Construction Activities	Mining

For greater detail and for information on the recommended actions on the ten categories, reference is made to MPCA "Minnesota Water Quality Management Plan." The recommended actions for the five highest-priority categories are described briefly in the following pages.

Agricultural Activities — The recommended action is a continuation of the existing voluntary federal and state cost-sharing programs which assist land occupiers in undertaking conservation practices, but with double the current funds. In addition, it is recommended that another federal incentive program, the Rural Clean Water Program, which has not yet been funded in Minnesota, be funded at a level which would allow intensive cleanup projects in certain watersheds of up to 200,000 acres. To encourage participation in these voluntary programs, an increased educational effort would be undertaken. Cost-share funds will be directed most heavily into areas with the greatest water pollution problems, as identified in the plan. A special project will be sought in one typical agricultural watershed to provide needed knowledge of the exact causes of pollution and the effectiveness of management practices. Pesticide monitoring would be included in this project.

At present, it is impossible to accurately estimate the cost of abating pollution from agricultural sources, as too little is known about the amounts of reduction needed and how these can be achieved. However, based on estimates by the Soil Conservation Service (SCS) of the costs of erosion prevention, it is likely that the cost will be at least hundreds of millions of dollars. The programs recommended in the Water Quality Management Plan would spend in the neighborhood of $15-25 million on the problem each year.

Feedlots — The recommended feedlot program will be an extension of the existing program based on the MPCA feedlot rules. The program will be extended by adding more personnel, educational resources, and cost-share money in selected high-priority target areas. Target areas would typically be about four counties in size. Once cleanup has been achieved in one target area, a new one would be selected.

The cost of installing corrective measures on all feedlots in the state has been estimated by the State Soil and Water Conservation Board and the SCS to be roughly $750 million (1979 dollars).

Pesticide Use — The existing federal and state programs for regulating pesticides and their use will be the main components of the recommended program. Additional components recommended are: 1) increased soil conservation efforts (see "Agricultural Activities", above) which will also reduce pesticide runoff; 2) an informational campaign on proper container disposal;

3) development of better programs for container recycling and disposal; and 4) a program to measure pesticides in agricultural and urban runoff.

Construction Activities — The recommended program will center on new state legislation requiring erosion control on construction sites. Management of the program would be at the local level except that the MPCA would handle public and large-scale projects. Prior to development, an erosion control plan must be prepared and approved. State funding will be sought to aid in local management.

For road construction, memoranda of agreement will be developed between road-building agencies and erosion-control authorities.

Urban Runoff — Studies of urban runoff in the Twin Cities area and elsewhere have demonstrated that it can play a significant role in water pollution. At present, the Metropolitan Council is preparing an urban runoff plan, and studies are being conducted in other Minnesota municipalities. Some case studies have indicated that urban runoff may be causing sufficient water pollution so that control efforts may be needed in these smaller urban areas. In addition, cost-effective management of urban runoff is a matter of considerable uncertainty. It is currently under study in almost thirty U.S. cities through a major EPA program called the National Urban Runoff Program (NURP), scheduled for completion in 1983.

In view of the present uncertainties and ongoing efforts to provide answers, no statewide management program is considered prudent at this time. The recommended action is to conduct a monitoring program in typical Minnesota cities, combine these results with those of the Metropolitan Council's planning and of the NURP, and design an appropriate management program based on these combined results.

Many components of the above programs cannot take effect until funding is made available or legislation is passed. Consequently, they must be viewed as recommendations only at the present time. One of the responsibilities of the MPCA is to assure that necessary steps are taken to bring the programs into effect.

Problems

Identification of non-point source problems and solutions was severely hampered by lack of data and knowledge of the mechanisms of pollutant generation, transport, and corrective measures.

Recommendations

The federal government should continue to sponsor basic research on non-point source pollution and improve dissemination of results. Current management programs should be modified as new information provides a basis for improvements. Greater funding for implementation of non-point source programs should be considered.

APPENDIX A
RECENT MAJOR WATER QUALITY ACCOMPLISHMENTS BY MINNESOTA POLLUTION CONTROL AGENCY

Western Lake Superior Sanitary District

The Western Lake Superior Sanitary District (WLSSD) was created by the Minnesota State Legislature in 1971. One of the mandates of the WLSSD was to provide a comprehensive and coordinated solution to an existing pollution problem on the St. Louis River and St. Louis Bay of Lake Superior. For this purpose, the WLSSD brought together the cities of Duluth, Cloquet, Carlton, Wrenshall, Scanlon, Hermantown, and Proctor and the townships of Silver Brook, Thomson, Twin Lakes, Canosia, Duluth, Grand Lake, Lakewood, Midway, Rice Lake, and Wolway. Domestic wastewater, as well as wastewater from several major industrial facilities located in this area, is conveyed to a new regional wastewater treatment facility through a 37-mile system of intercepting sewers. The new facility is located in Duluth and discharges to St. Louis Bay of Lake Superior.

Prior to start-up of the new facility in 1978, the following dissolved oxygen and 5-day biochemical oxygen demand levels in milligrams per liter and fecal coliform organism levels in most probable number per 100 milliliters were noted in the St. Louis River:

1973-1975	D.O.		BOD_5		Fecal Coliform	
	Mean	9.1	Mean	7.5	Geometric Mean	13,000
	Low	4.4	Maximum	27	Maximum	230,000

Subsequent to start-up of the new wastewater treatment facility, the corresponding readings were as follows:

1978-1979	Mean	10.35	Mean	3.0	Geometric Mean	6,900
	Low	6.1	Maximum	7.6	Maximum	20,000

Marked improvements in water quality have occurred in the very short time that the wastewater treatment facility has been in operation. Continued improvement in water quality is expected in the St. Louis River as well as in St. Louis Bay of Lake Superior. Since the new facility began operation, the fishery in this area has dramatically improved. A representative of the Minnesota Department of Natural Resources was quoted in the fall of 1979 as saying that the pollution control efforts in this area have resulted in walleye fishing second to none in the state.

Reserve Mining Company

Reserve Mining Company (Reserve) operates a taconite processing plant located in Silver Bay, Minnesota. At full production, this plant processes approximately 90,000 long tons per day of magnetic taconite into iron ore pellets. As a result of this operation, Reserve also discharges some 67,000 tons of waste tailings into Lake Superior each day.

During the past several years, a controversy had existed between Reserve, the State of Minnesota, and the federal government regarding the need for and location of an on-land disposal site for Reserve's tailings. Specifically, litigation was initiated on the basis that Reserve's discharge was in violation of the Refuse Act of 1899, a state permit issued in 1947, 1965 amendments to the Federal Water Pollution Control Act, a 1969 regulation (WPC 15) of the Minnesota Pollution Control Agency (MPCA), and the common law of nuisance. In addition, the Environmental Research Laboratory in Duluth, Minnesota, discovered the presence of cummingtonite-grunerite mineral fibers in Duluth's drinking water supply on June 15, 1973. Further investigations revealed that the mineral fibers originated from a unique geological deposition in Reserve's Peter Mitchell Mine at Babbitt, Minnesota, and the federal courts ruled that these fibers are virtually indistinguishable from commercial anosite asbestos fibers, a known carcinogen.

This discovery further complicated the case. However, in

April of 1977, the controversy regarding disposal of the tailings was settled when the Minnesota Supreme Court ordered construction of an on-land disposal basin at a site referred to as Mile Post 7. The site includes an area of approximately six square miles and is located about five miles northwest of the processing plant. Total cost of process modifications and construction necessary to initiate on-land disposal and to comply with air quality regulations will be, according to Reserve, in excess of $370,000,000.

Construction progress is on schedule, and it appears that Reserve is in compliance with the May 26, 1977, Federal Court Order to cease discharge into Lake Superior by April 15, 1980. Use of the on-land tailings disposal system is scheduled to start about May 26, 1980.

Lake Minnetonka

Lake Minnetonka is located in the Twin Cities metropolitan area and is Minnesota's 17th largest lake and one of the states most heavily-used lakes. Between 1930 and 1970, the number of people living within the Lake Minnetonka area increased from approximately 10,100 to 46,100. By the early 1960s, the lake's water quality was seriously degraded by high concentrations of phosphorus and nitrogen which originated from septic tanks, storm water drainage, and seven municipal secondary wastewater treatment facilities.

In 1969, the Minnesota Legislature created the Twin Cities Metropolitan Sewer Board (MSB), a centralized sanitary authority. One of the initial efforts of the MSB was devoted toward completing work that had begun prior to its creation concerning the removal of the wastewater treatment facility effluents from the lake. The plan had been developed and was implemented for an interceptor sanitary sewer to be constructed which would collect and convey wastewater to a new wastewater treatment facility called Blue Lake. The Blue Lake facility would provide secondary treatment and discharge to the Minnesota River.

By the end of 1971, the interceptor and portion of the Blue Lake facility were constructed, which allowed flows from two of the Lake Minnetonka wastewater treatment facilities to be diverted from the lake. The remaining portions of the treatment went on line in late 1973. In 1974, two additional treatment facilities were phased out and flows diverted. Two more are scheduled to be phased out in 1980. The facilities planning process is currently underway for the one remaining municipal wastewater treatment facility.

By October 1973, algae growths in the lower (eastern) portion of Lake Minnetonka had decreased approximately 50 to 70 percent from levels recorded in 1969. By 1974, the concentration of phosphorus in the lower lake was 70 percent of what it had been before the wastewater treatment facility effluents began to be diverted away from the lake. Today, the lake is far cleaner and clearer and its beaches and coves are attractive retreats for swimmers, nature lovers, and sportsmen. The lake is recognized as one of the better largemouth bass fishing lakes in this part of the state.

Walker, Minnesota

In the 1930's, Walker, Minnesota, constructed a trickling filter wastewater treatment facility designed to meet secondary treatment standards prior to discharging to Walker Bay, a portion of Leech Lake, adjacent to the city park and swimming beach.

In the late 1960's, the treatment facility was hydraulically and organically overloaded, primarily in the summer months due to the increased growth of seasonal residents. The facility also did not have provisions for phosphorus removal.

As a result of a June 24, 1970, stipulation agreement between the city of Walker and the MPCA, a land application facility was constructed in 1972. By diverting the wastewater to a land application system, the city removed the potential for health risks associated with full body contact in the city's swimming beach and removed nutrient rich wastewater from Leech Lake which aided in algae blooms.

In a state noted for high quality recreational lakes, this effort has served as a prized example of preservation of our lakes.

Erie Pier Diked Dredge Spoil Disposal Facility

Prior to the passage of PL 92-500, the disposal of dredged material was conducted in a relatively uncontrolled manner, often resulting in open water disposal of spoils. The addition of Section 404(t) to the Clean Water Act of 1977 specified that federal agencies were not exempt from regulation by state or interstate agencies for the discharge of dredge or fill material into navigable waters. Subsequently, on August 8, 1978, the MPCA issued a permit to the U.S. Army Corps of Engineers (Corps) for the construction and operation of a diked dredge disposal facility at Erie Pier in the Duluth-Superior Harbor, which is to be used in conjunction with the Corps maintenance dredging activities in the Harbor. The initial capacity is sufficient to contain 1.1 million cubic yards of dredged material from the Harbor area, which will allow the continued disposal of material for a period of approximately 10 years. The facility allows contained disposal of the dredged materials of the Duluth-Superior Harbor, thereby avoiding the detrimental effects of open water disposal while maintaining navigation in the harbor.

Detroit Lakes, Minnesota

The City of Detroit Lakes completed construction of a 1.4 million gallon per day wastewater treatment facility in 1977. Until that time, the city continuously discharged treated wastewater to a local chain of lakes. The wastewater treatment facility now utilizes infiltration basins and spray irrigation during the recreational season from mid-April through mid-October of each year.

This effort has eliminated a source of phosphorus from the chain of lakes and with time should slow the eutrophication of these highly valued recreational waters. This effort has also shown the compatibility of municipalities and that preservation of highly valued recreational waters is possible.

Paynesville, Minnesota

Paynesville's need stems from the inadequate treatment provided by the city's existing stabilization ponds. The facilities plan submitted to the MPCA identified four separate alternatives. The cost comparisons of the alternatives readily showed that stabilization ponds followed by land application would be by far the most cost-effective solution. The consultant took it one step farther. Since the initial cost estimates were derived from application rates based on crop usage, it was felt that costs developed on maximum irrigation rates should also be compared. Since land would then be purchased and in all probability be condemned, land costs would be higher, though acreage reduced. The costs shown below reflect this fact and also payments by farmers for the irrigation:

Alternative	Total Capital Cost	Annual O & M Cost	Total Annual Equivalent Cost
Maximum Rate Irrigation (City-owned Land)	$3,035,000	$31,000	$263,000
Crop-Usage Rate Irrigation (City-Farmer Agreement)	2,656,000	16,000	237,000
Savings	379,000	15,000	26,000

The city is currently utilizing spray irrigation as an interim measure to mitigate the overloading conditions and limit the phosphorus loading to the receiving waters. The program has worked extremely well with the farmer reporting an additional two to three cuttings of alfalfa along with marked increases in corn yields. The proposed expansion will allow all of Paynesville's treated wastewater to be irrigated with up to 94 percent state and federal funding.

Hyland Lake Restoration

The Hyland Lake restoration project was initiated in August 1976, pursuant to Section 314 of Public Law 92-500 to improve the quality of water for recreation as well as enhance the lake's scenic qualities and waterfowl habitat. The $340,600 project on this 90-acre lake included: lake de-watering, coupled with lake aeration/recirculation, and fish re-stocking. The 95 percent completed project has already yielded dramatic improvements in lake water quality. The lake's transparency increased from an average of 0.1 meter in 1977 and 0.5 meter in 1978 to 2.7 meters in 1979. Similar findings have been reflected in decreased nutrient levels and algal populations. Mean total phosphorus concentrations in June through August have gone from 343 μg/l (1977) and 238 μg/l (1978) to 56 μg/l in 1979 while chlorphyll a decreased from means of 291 μg/l (1977) and 129 μg/l (1978) to 5 μg/l (1979).

Phosphate Detergent Ban

In 1971, the Minnesota Legislature enacted a measure authorizing the MPCA to set standards limiting the amount of nutrients in household cleaning agents as a means to combat eutrophication of the state's waters. After extensive study, the MPCA adopted Rule WPC 37 restricting the amount of phosphorus contained in household laundry detergents and certain other cleaning products. For over two years, a temporary court injunction prevented enforcement of the rule; however, due to voluntary compliance by major detergent-makers, better than 90 percent of the laundry detergents sold in the state after January 1977, were phosphate-free.

Support for the control of phosphorus in detergents has been consistently strong among Minnesota consumers. Public opinion surveys conducted both before and after the change to phosphate-free months, 85 percent of a survey group rated their overall laundry results as good or excellent. Meanwhile, municipal wastewater treatment facilities experienced considerable reductions in influent phosphorus loading after the ban was enacted. A group of facilities operated by the Twin Cities Metropolitan Waste Control Commission had an average 45 percent reduction in influent phosphorus load. This reduction was especially impressive in light of the penetration of non-phosphate laundry detergents into the marketplace prior to 1977.