1994 Minnesota Water Quality

Report to The Congress of the United States

Minnesota Pollution
Control Agency

Water
Years
1992-
1993

1994 Minnesota Water Quality

Assessment Report to the Congress of the United States Pursuant to Section 305(b) of the 1972 Clean Water Act

Covering Water Years 1992-1993 (October 1991 - October 1993)

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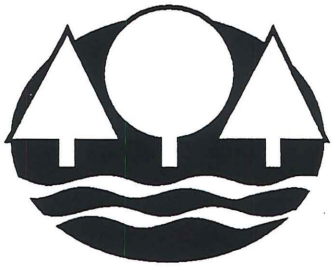

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The following list of appendices is included to aid the reader in cases where the text refers to an appendix number. However, none of these appendices are included in this published report. All the appendices are available by requesting the 1994 305(b) Report Appendices from:

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List of Appendices

Complete List of Acronyms

AOC	Areas of Concern
ASCS	Agricultural Stabilization and Conservation Service
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BCC	Bioaccumulative Chemicals of Concern
BWSR	Board of Soil and Water Resources
CBOD5	Five-day Carbonaceous Biochemical Oxygen Demand
CERCLIS	Comprehensive Environmental Response, Compensation, Liability Information System
CLMP	Citizen Lake Monitoring Program
CWA	Clean Water Act
CWP	Clean Water Partnership
CSGWPP	Comprehensive State Ground Water Protection Program
DO	Dissolved Oxygen
GIS	Geographic Information System
GLI	Great Lakes Initiative
GWMAP	Ground Water Monitoring and Assessment Program
GWPA	Ground Water Protection Act
HUC	Hydrologic Unit Code
HRL	Health Risk Limit
I & E	Information and Education
IBI	Index of Biotic Integrity
IJC	International Joint Commission
ISTS	Individual Sewage Treatment Systems
LaMP	Lakewide Management Plan
LAP	Lake Assessment Program
LCMR	Legislative Commission on Minnesota Resources
LGU	Local Government Units
LRVW	Limited Resource Value Waters
MAC	Metropolitan Airports Commission
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
MDOT	Minnesota Department of Transportation
MOU	Memorandum of Understanding
MPCA	Minnesota Pollution Control Agency
MRAP	Minnesota River Assessment Project
MWCC	Metropolitan Waste Control Commission
NAWQA	National Water Quality Assessment
NIPF	Nonindustrial Private Facility
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
ORVW	Outstanding Resource Value Waters
OTU	Operators Training Unit
PCB	Polychlorinated Biphenyls
PI	Private Industrial
QA	Quality Assurance
RAL	Recommended Allowable Limit
RAP	Remedial Action Plan
SCS	Soil Conservation Service
SDS	State Disposal System
STORET	Storage and Retrieval System
SWCD	Soil and Water Conservation District
TSI	Trophic State Index
TSS	Total Suspended Solids
US	United States
USCOE	United States Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VIC	Voluntary Investigation and Cleanup
VOC	Volatile Organic Compounds
VSQG	Very Small Quantity Generator
WCA	Wetland Conservation Act
WDNR	Wisconsin Department of Natural Resources
WHP	Wellhead Protection
WLSSD	Western Lake Superior Sanitary District

PART I. EXECUTIVE SUMMARY

Introduction

The intent of the 1972 Clean Water Act (CWA) was to improve and protect water quality sufficient to protect fish, shellfish and wildlife while providing for recreation wherever possible. Achieving the "swimmable-fishable" goal of the Act has been a large challenge. This report is required by the CWA for the United States Environmental Protection Agency (USEPA), Congress, and also provides the public with a biennial report of Minnesota's progress in meeting the CWA goal.

Assessment and monitoring are the principal tools for detecting changes in water quality, and they form the basis for the information in this report. Because of the sheer abundance of lakes and rivers in Minnesota, it is challenging to try to thoroughly monitor and assess the quality of water resources in the state. Over a period of 20 years only five percent of Minnesota's 91,944 river miles and 17 percent of its lakes have been assessed. The information currently available from assessment work, although extensive, still is not sufficient to accurately describe statewide water quality. With limited resources available, monitoring has been used mainly for areas with known or suspected pollution, and for following USEPA guidance and requirements. However, the state has made real progress toward meeting the "swimmable-fishable" goal, as the following report shows.

The Minnesota Pollution Control Agency (MPCA) Water Quality Division is currently evaluating water quality monitoring and assessment programs to determine if the information being gathered will be useful for making basin scale, resource based, and integrated water quality management decisions. The MPCA will revise its assessment methodology and develop a new monitoring strategy. The most extensive changes will be in the methods of assessing water quality condition and the uses supported in Minnesota's rivers. Future water quality assessments will include all credible physical, chemical and biological data collected by the MPCA and other organizations.

Monitoring Programs

Current monitoring includes chemical monitoring, biological monitoring, effluent toxicity testing, fish tissue sampling, sediment monitoring and intensive surveys. Biological surveys of fish, macroinvertebrate, plant and zooplankton communities were done in selected areas during the last two years. These were then used to develop field techniques and the biocriteria to be used for future evaluations of water quality and the associated biological communities. Monitoring of trends in nutrients in lakes in each ecoregion was done using minimally impacted lakes to serve as reference sites for natural conditions. Sediment sampling was initiated to establish background concentrations for selected heavy metals, and to find hotspots in the St. Louis harbor.

Water quality data are used in cooperative water planning by the MPCA, Minnesota Department of Natural Resources (MDNR), Minnesota Department of Agriculture (MDA), Minnesota Department of Health (MDH), Metropolitan Council, Wisconsin Department of Natural Resources (WDNR), United States Geological Survey (USGS), and local units of government. Previous assessments relied solely upon MPCA data. This 1994 Water Quality report makes use of USGS data and Clean Water Partnership (CWP) data in assessments, and in the future will include additional sources of monitoring data. Other assessment reports available for 1992-93 include the Section 319 *Nonpoint Source Assessment Report* and a series of *Minnesota Lake Water Quality Assessment Reports*.

The Minnesota River Assessment Project (MRAP) is a comprehensive study of water pollution in the Minnesota River basin. The project involves more than 30 federal, state and local agencies and was initiated to evaluate how pollution enters the river and affects its water quality. It is designed to estimate the reduction in nonpoint source (NPS) pollution needed to achieve water quality goals. The Minnesota River is one of the most polluted rivers in the state and water in its lower reaches often violates water quality standards for fecal coliform bacteria, turbidity and, at times, does not meet standards for dissolved oxygen and un-ionized ammonia. A comprehensive four-volume study of the river basin has been released to the public for comment.

Citizen Participation

The Minnesota River Citizens' Advisory Committee is facilitated by the MPCA and was established in 1992 with 30 individuals representing different interests and regions of the basin. The MPCA will consider recommendations from the advisory committee and the MRAP study into a plan for the Minnesota River basin.

As participants in the St. Louis River Remedial Action Plan (RAP), a 40 member Citizen Advisory Council meets regularly to help determine priorities for action.

The Citizen Lake Monitoring Program (CLMP) is a volunteer program in which individuals gather lake transparency measurements that are used to determine temporal trends in lake water quality. The number of lakes in this program increased from 483 in 1989 to about 600 in 1993.

The Lake Assessment Program (LAP) involves MPCA staff and local citizens. These cooperative studies serve to characterize the conditions of lakes and to determine the basic interaction of the lakes and their watersheds. By 1992, 70 LAP studies were completed and another 18 were initiated in 1993.

The River Watch/Water Watch Program was a two-year pilot for developing partnerships among citizens, schools, and local governments for education and monitoring and protection of local waters. Monitoring continues in the areas where programs were established.

**These figures represent a broad summary of a large and diverse area of water resources. They cannot reflect with precision, or be representative of, the condition of the entire waters of the state. These summary statistics should primarily be used for ongoing assessment of state water quality resources and definition of management directions.*

Assessment Methodology

The MPCA will continue to use integrated assessments of waterbodies using similar methods to those described in this report for rivers and streams. Other methodology changes will be implemented in future reports. This report describes a revised statewide assessment methodology (used outside of the Minnesota River basin) based on water chemistry as in previous reports. A pilot methodology is used for the Minnesota River basin that incorporates biological and habitat data with water chemistry data in the assessments.

For overall use support, if any use was not supported in the river reach then the entire river reach did not support overall use. Individual uses assessed for rivers include: Aquatic life, Recreation (swimming), Agricultural and Wildlife, Industrial, and Limited Resource Value Waters (LRVW) which are those rivers considered not attainable for aquatic life and swimming uses.

Future assessments will incorporate magnitude, duration and spatial extent of impairments along with the frequency of violations. Integrated assessments will involve interacting with local resource managers and scheduling monitoring and assessments on a five-year basin rotation.

Rivers and Streams

Of 3,440 total river miles assessed for overall use 22 percent were fully supporting designated uses, 18 percent fully supporting uses but threatened, 20 percent partially supporting uses, 38 percent not supporting uses, and for two percent of the river miles overall use is not attainable. River miles assessed for aquatic life were found to be 27 percent fully supporting and 46 percent with aquatic life use fully supporting but threatened. River miles assessed for recreational uses were 39 percent fully supporting.*

Lakes

Lake data collected between 1970-1993 with primary focus on the trophic state of the lake was used for this assessment. Lakes were assessed with use support thresholds based on ecoregion-specific phosphorus criteria. Lake use support status determined specifically by ecoregion provides a better reflection of water quality in Minnesota lakes than a scale that does not account for differences among the ecoregions.

Lake swimmable use assessment included 1.75 million acres, or 53 percent of all lake acres. Of acres assessed for swimmable uses 62 percent are fully supporting, 17 percent are fully supporting but threatened, and the rest are partially supporting or not supporting swimmable uses. Of lakes greater than 5,000 acres 63 percent fully support swimmable uses. Of lakes less than 5,000 acres 51 percent fully support swimmable uses.*

Overall, NPSs have relatively greater impact on lake use support than point sources of pollution. Nonpoint pollution from agricultural and urban storm water are the sources of primary concern. Nutrients are the primary pollutants that degrade water quality below use thresholds and phosphorus is the most significant of these.

Great Lakes

Minnesota cooperates in several multi-state and international efforts to protect and improve the water quality of Lake Superior. It is understood that to maintain its value as a resource, Lake Superior must have its ecological health protected. Minnesota is active in the binational program to restore and protect Lake Superior which is under a charge of the International Joint Commission (IJC).

Minnesota's activities include developing a Lakewide Management Plan (LaMP) together with Wisconsin, Michigan, Ontario, Environment Canada and the USEPA; developing a joint

Pollution Prevention Strategy with Wisconsin and Michigan; collecting 4,800 pounds of banned pesticides in the basin; surveying very small quantity generators of hazardous waste; conducting toxic awareness campaigns and waste collections; developing the Water Quality Guidance as part of the Great Lakes Initiative (GLI); conducting fish, sediment, and water toxic survey; and supporting the St. Louis River RAP.

Wetlands

During 1992 and 1993 Minnesota executed two regulatory measures to protect wetlands. First, the Wetlands Conservation Act (WCA) of 1991 rules were completed requiring local governments to regulate the draining and filling of all wetlands not classified as "public waters wetlands." Amendments made to Minnesota Rules ch. 7050 include specific definitions of wetlands in water quality standards, the assignment of water use classifications for wetlands, adoption of narrative nondegradation standards to protect wetlands, and the application of nondegradation standards to wetlands through the wetland mitigation process.

Simplification of wetland permits is being achieved through the cooperation of the Board of Water and Soil Resources (BWSR), MDNR, Minnesota Department of Transportation (MDOT), MPCA, and federal agencies such as the United States Army Corps of Engineers (USCOE), USEPA, United States Fish and Wildlife Service (USFWS) and Soil Conservation Service (SCS). These agencies have developed a single joint notification and application for wetland permitting. The USCOE has issued a public notice for a General Permit that will provide Section 404 permit approval for certain activities approved by local governments under the WCA.

In July 1993 Minnesota began comprehensive wetland conservation planning under the leadership of the MDNR to coordinate local, state and federal wetlands programs. Statewide wetlands goals and guidance will be developed. The MPCA has initiated a reference wetlands project for assessing the biological and chemical health of wetlands throughout the state. The project is funded in part by USEPA through the Office of Research and Development.

Public Health/Aquatic Life

Minnesota agencies annually survey fish tissue in lakes and streams to detect mercury and polychlorinated biphenyl (PCB) contamination. Once a year the MDH issues a fish consumption advisory that recommends meal limitations for specific waterbodies, based on the concentration of these contaminants in sampled fish tissue.

A conservative method was used to determine the classification categories for the summary of fish advisories. It uses the single most restrictive advice given for each waterbody. Also, the sites used for the contaminant studies were not selected by a random design and most likely represent those areas of suspected contamination. Furthermore, the MDH fish advisory is known to use one of the most restrictive set of consumption criteria among the states. These characteristics of the Minnesota fish consumption advisory provide a benefit in supplying the best information and the most protection to consumers of fish. However, it has the disadvantage of portraying Minnesota waters as more contaminated.

Conclusions

A great deal of work has been done for water quality assessment reports every two years since the 1972 CWA. With each report, a reevaluation of assessment methodologies along with advances in monitoring and laboratory techniques has resulted in better assessments of state water resources. The tools used for data processing and analysis have also improved and become more widely available. More opportunities for change and improvement will occur, and states will need to take advantage of them. Most importantly, the focus of pollution control efforts will continue to shift as new problem areas are defined and old ones resolved.

In redesigning these efforts it is critical to develop the potential information link between assessments and regulatory or management decisions. This could be accomplished through implementing basin management principles. For states the effective management of water resources is the foremost responsibility so assessment work should serve mainly to support good water resource management.

With repeated emphasis, these assessment data or summaries cannot be used to rank or compare states to each other or among regions. Assessment methodologies, the type and amount of state water resources, state pollution laws, and state administrative structures are vastly different from one state to another. It is imperative to avoid the misuse of this information for judgement or comparison across political boundaries. Instead, water quality assessment reports can be very useful as the best up-to-date scientifically derived descriptions of the quality of water resources in a given area.

PART II: BACKGROUND

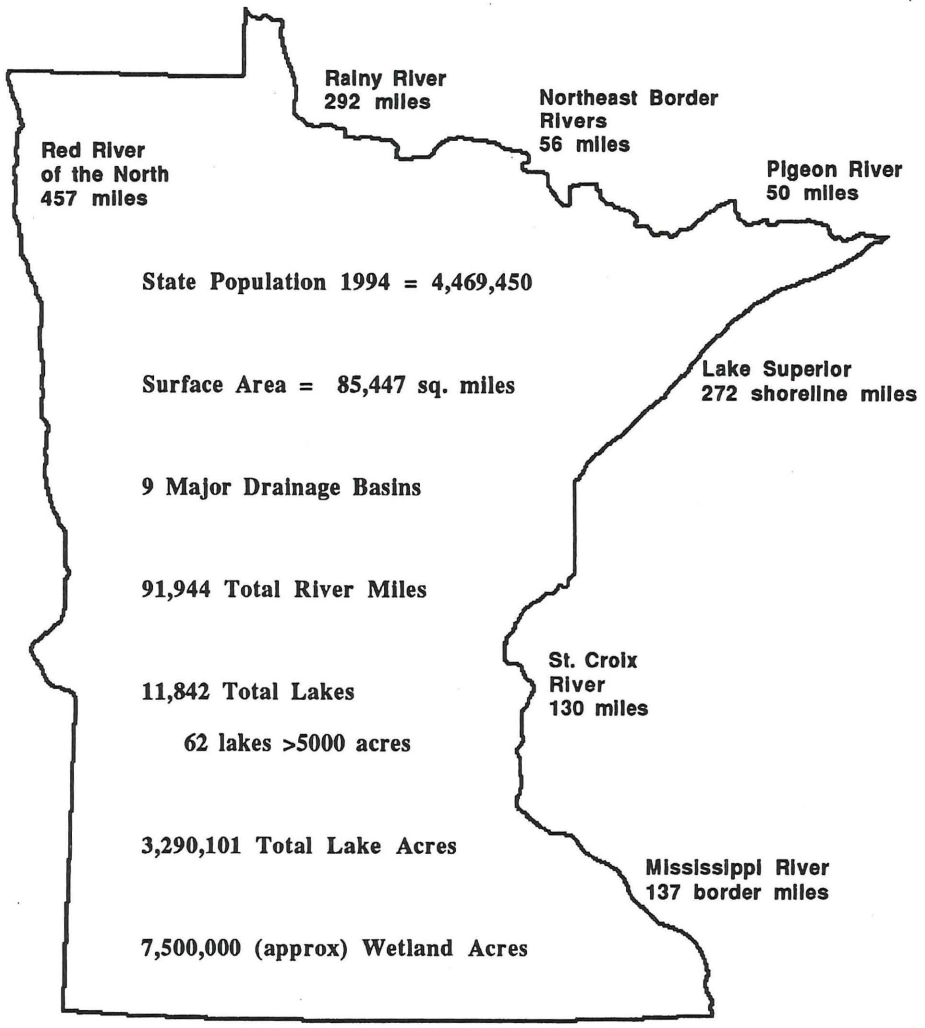
Introduction

Minnesota's water resources include 91,944 river miles and 3,290,101 acres of lakes and reservoirs (not including Lake Superior). Headwaters in Minnesota drain to Lake Superior, Hudson Bay and the Mississippi River. Figure II-1 displays some basic geographic information about Minnesota along with the locations and dimensions of the river and lake waterbodies that are found on the state's boundaries.

Minnesota contains some of the most pristine waterbodies in the country. Because there are vast areas of recreationally accessible water surface, Minnesotans enjoy enormous opportunities for fishing, boating, swimming and diving. The state economy depends on tourism, and residents share these resources with enthusiasts from out of the area. While Minnesota possesses abundant water resources, the people of the state carry a great responsibility in protecting these waters.

The designated uses of a waterbody are determined by their attainable water quality. Table II-1 provides a breakdown of river miles and lake acres by the seven water use classifications defined in Minnesota. All lakes in Minnesota are classified for fishable and swimmable use. Ninety-nine percent of Minnesota river miles are classified for fishable and swimmable use. All rivers are classified for agricultural, navigational and industrial use. Each use has a specific set of water quality standards that must be maintained in order for the waterbody to support that particular use. If these standards are not met, the waterbody is said to be not supporting or partially supporting the use, depending on how often available data shows that the standards associated with the use are violated.

Figure II-1. Minnesota Background Information and Border Waters



Water Quality Standards

Water quality standards can be thought of as consisting of three elements: water use classifications, numeric and narrative criteria designed to be protective of the designated use classifications, and a nondegradation policy. In common usage the criteria are often referred to as the "standard" when discussing either the numeric or narrative criteria.

Minnesota Rules ch. 7050 contains a multiple use classification system for all surface waters of the state. A classification is given to a waterbody for its existing or potential uses. These uses are consistent with the Federal CWA goals for protection of public health, and protection and propagation of fish, shellfish and wildlife and recreation where attainable.

Minnesota water use classifications are:

- Class 1 - Domestic Consumption
- Class 2 - Aquatic Life and Recreation
- Class 3 - Industrial Consumption
- Class 4 - Agriculture and Wildlife
- Class 5 - Aesthetic Enjoyment and Navigation
- Class 6 - Other Uses
- Class 7 - Limited Resource Value Waters

Water use Classes 1 through 4 are divided into subcategories that further divide these classes into more specific use classifications. They are identified with the use classification number and an assigned letter code. For example, the St. Croix River below the dam at Taylors Falls, Minnesota has assigned water use classifications as follows: Class 1C, 2Bd, 3B, 3C, 4A, 4B, 5 and 6. Translated, this stretch of the St. Croix River is classified for domestic consumption purposes (including drinking, culinary and food processing use, after treatment), cool and warm water fisheries, whole body recreational use, industrial consumption, agricultural and wildlife use, aesthetic enjoyment and navigation and other uses.

The state's water use classifications may contain both numeric and narrative standards designed to be protective of the designated uses. All of the water quality standards for each of the classifications apply. If the water quality standards for any particular parameter differ for the various use classes, the more restrictive of the standards applies. For instance, the pH standard applicable to the above cited stretch of the St. Croix River is a range of not less than 6.5 nor greater than 8.5 standard pH units. The pH range as listed for Class 2Bd is 6.5 to 9.0, while the pH range listed for Class 4A is 6.0 to 8.5. Therefore, for this river reach, the lower bound is established by the Class 2Bd standard and the upper bound is established by the Class 4A standard.

Table II-1. Summary of Total Sizes for Classified Uses

Classified Use	Rivers (miles)	Lakes (acres)	Lake Superior (shoreline miles)
Aquatic Life	91,144	3,290,101	272
Domestic Consumption	3,900*	636,600*	272
Recreation	91,144	3,290,101	272
Agriculture and Wildlife	91,144	3,290,101	272
Industrial Consumption	91,144	3,290,101	272
Aesthetic Enjoyment and Navigation	91,144	3,290,101	272
Limited Resource Value Waters	800		
Nondegradation**	90,344	All	All
Total	**91,944**	**3,290,101**	**272**

* Figures for total acres of waters in the Boundary Waters Canoe Area Wilderness are included in the lake acreage figures and not in the river mileage

** The level of protection provided by the nondegradation provision depends on the nature of the discharge and the characteristics of the receiving water

In Minnesota, nondegradation generally refers to the concept of maintaining water quality at its existing support level when the quality is better than the water quality standards. The state's nondegradation policies for waters of the state are outlined in Minnesota Rules pts. 7050.0180 and 7050.0185. Minnesota Rules pt. 7050.0185 is the nondegradation policy for all waters and is intended to protect Minnesota's waters from "significant degradation from point and NPSs and to maintain existing water uses, aquatic habitats, and the level of water quality necessary to protect these uses." Minnesota Rules pt. 7050.0180 specifies the nondegradation provisions applicable to waters designated as Outstanding Resource Value Waters (ORVW).

These waters are unique to the state in that they are exceptional recreational, cultural, aesthetic or scientific resources. There are two groupings under which an ORVW may be designated: the prohibited discharges and the restricted discharges categories. Waters designated as ORVWs are specifically identified as such in Minnesota Rules pt. 7050.0470.

As the name implies, the prohibited discharge provisions prohibit any new or expanded discharge of sewage, industrial or other wastes to a water designated under this category. Examples

of ORVWs designated under the prohibited discharges category are the waters within the Boundary Waters Canoe Area Wilderness and federal or state designated wild river segments.

Under the restricted discharges nondegradation provisions, new or expanded discharges to ORVWs in this category are restricted in two ways. First, discharges are not to be initiated or to increase in loading rate unless the MPCA determines that there is no prudent and feasible alternative to the new or expanded discharge. Second, if the discharge is permitted, it must be restricted to the extent necessary to preserve the existing high quality, or to preserve the wilderness, scientific, recreational, or other special characteristics that make the water an ORVW. Several examples of the type of waters designated as ORVWs under the restricted discharges provision are federal and state designated scenic or recreational rivers and calcareous fens.

Basin Management

Since the passage of the 1972 CWA, substantial success has been achieved in controlling point source pollution problems. Unfortunately, serious water pollution problems still exist. While some point source issues remain, the water quality problems at the forefront today are primarily NPSs of pollution, toxics, destruction of habitat, and the loss of wetlands.

As the focus for protecting and improving water quality shifts to these new sources, state and federal environmental agencies across the country are rethinking their management approaches. The MPCA, like many of these agencies, is proceeding toward a more integrated, water resource-based approach for its water quality management programs. This new approach is called basin management. The concepts of basin management are sometimes also referred to as watershed management, particularly when applied on a smaller scale.

Traditionally, water quality efforts have focused on specific pollutants and pollution sources, primarily municipal and industrial point sources. In contrast, basin management begins by focusing on the whole water resources themselves and considers each in terms of the cumulative effects from multiple pollution sources that may threaten or impair its use. By shifting the focus to the problems and needs of individual water resources, the basin management approach helps to link point source and nonpoint source programs together to form a coordinated management strategy.

The MPCA's basin management process will strengthen the connections between all water quality program activities - from monitoring and assessment to assistance and compliance. On a rotating cycle, priority water quality problems and concerns will be identified in each of Minnesota's nine major drainage basins. Point source and NPS program resources will then be targeted in a coordinated way to address those problems and concerns. Throughout the process, the MPCA will solicit input from citizens, local governments and other agencies

Through this basin management approach, the MPCA expects to increase its effectiveness by developing integrated water quality management strategies that are targeted to the areas where they are most needed and can be most effective. The MPCA also places great emphasis on using basin management to improve communication and coordination with local governments and other state and federal environmental agencies.

PART III: SURFACE WATER QUALITY ASSESSMENT

Chapter One: Surface Water Monitoring Program

Introduction

The MPCA Water Quality Division is in the final review stage of its monitoring and assessment planning. This is an effort to evaluate current monitoring and assessment activities, specifically how well they provide information necessary to making resource based water quality management decisions within a basin perspective. From this review, three broad categories of monitoring were identified along with information needs or key questions to be answered for each.

1) Condition Monitoring

What is the condition of Minnesota waterbodies to meet standards and support designated uses such as recreation and aquatic life? Specifically:

- What individual waterbodies are impaired or not supporting designated uses?
- What is the general condition of Minnesota waters?
- Is water quality improving or deteriorating?

2) Problem Investigation Monitoring

What actions need to be taken to prevent or resolve water quality impairments? Specifically:

- What are the specific causes of impairment in waterbodies and on a statewide basis?
- What are the loadings of impairment-causing pollutants from various sources into waterbodies and what reductions of loadings are needed to meet water quality goals?

3) Effectiveness Monitoring

How effective is the implementation of pollution control measures, best management practices and other remedial actions, in resolving water quality impairments and meeting water quality goals?

On the basis of this review, a new Water Quality Division monitoring and assessment strategy is being developed. A few elements of the strategy:

- Rotate monitoring and assessment activities by basin, when possible, so that each basin is emphasized once every five years.
- Develop monitoring goals for the basin based on the specific data needs identified through discussions with MPCA staff and other state, federal and local agencies.
- Make better use of monitoring and assessment activities as a management tool to help the Division set priorities and target program efforts.
- Incorporate quality assurance and quality control procedures into all steps of the monitoring and assessment process.
- Consider statistical assumptions in the design of the monitoring plans and data analysis.
- Develop written monitoring plans for each basin prior to monitoring.
- Train all field staff prior to the onset of the monitoring season.

The most extensive changes in approach are anticipated in the monitoring and assessments conducted to determine the condition and use support for Minnesota's rivers and streams. In the future, condition assessments will incorporate all credible physical, chemical and biological data collected by the MPCA and other organizations. The four types of sites that MPCA will monitor for condition assessment are:

1) *Longitudinal surveys*—intensive monitoring efforts covering the length of river reaches that are identified as monitoring priorities.

2) *Reference site monitoring*—used to determine expected values for biological community indices.

3) *Random site monitoring*—used to make valid estimates, with a given level of confidence, about statewide water quality condition and trends.

4) *Minnesota Milestones sites*—maintenance of long-term routine monitoring sites to allow detection of trends over time at specific sites.

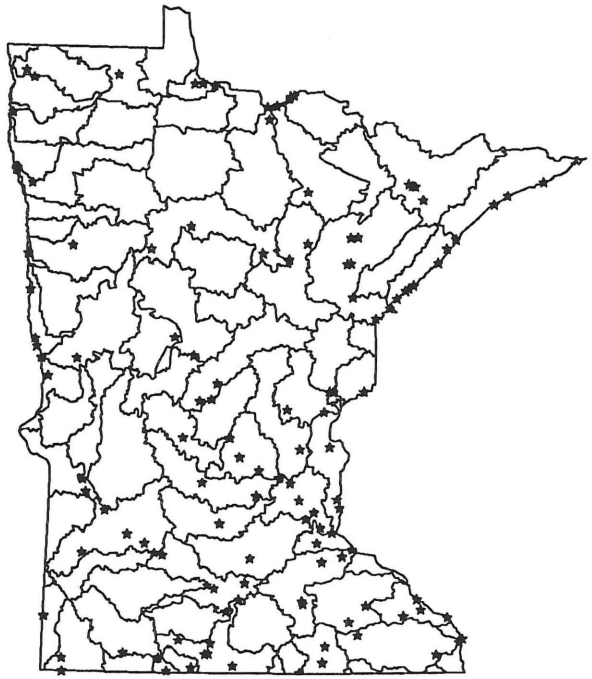
Current Monitoring Programs

Ambient (Routine) Stream Monitoring

There are currently 78 ambient stream stations monitored each year (Figure III-1). A three-year rotation of the area of emphasis among the southern, northeastern and northwestern areas of the state is done to add about 15 stations to the 60 statewide stations sampled every year. This sampling program began in 1953 and provides the most extensive source of computerized, long-term water quality data for Minnesota.

The basic parameters monitored include temperature, dissolved oxygen (DO), fecal coliform, biochemical oxygen demand (BOD), total suspended solids (TSS), pH, conductivity, nitrite+nitrate, total phosphorus, total kjeldahl nitrogen, ammonia nitrogen, and organic nitrogen. Other parameters are analyzed at selected stations either monthly or for certain months. Appendix Five is a complete list of the routine sampling locations and parameters sampled for fiscal year 1993-1994.

Figure III-1. Location of Routine Stream and River Monitoring Stations



Effluent Toxicity Testing

Toxicity tests are based on measurements of the response of *Ceriodaphnia dubia* and *Daphnia magna* (water fleas) to effluent from a discharger. Toxicity screening tests are done every year using actual effluent from selected municipal and industrial facilities. When screening indicates possible toxicity problems, MPCA staff do follow-up testing or require the permittee to do so. Chemical analysis of the effluent, when not already done in the original testing, is usually required at this point. Ammonia is a typical cause of toxicity in the effluent of minor (smaller) municipal facilities.

Major permittees, facilities that discharge more than one million gallons of wastewater each day, are required to perform toxicity tests on their effluent at least once every five years. These tests are done primarily by private laboratories.

Fish Tissue Sampling

The MDNR provides fish collections for tissue analysis, with guidance from an interagency work group from the MDNR, MDH, MDA and MPCA . Most fish are collected from waterbodies with suspected contaminant impacts or in heavily fished areas. The MDNR collects fish for laboratory analysis of levels of mercury and PCB in tissue. The MPCA uses the information to focus on assessing spatial and temporal trends. This program is further described in Part III, Chapter Seven, Public Health/Aquatic Life Concerns.

Sediment Monitoring

Sediment monitoring is often done for investigating a problem identified by earlier fish tissue monitoring. Sediment analysis can help to locate sources of pollution and areas of accumulation. Pollutants will tend to accumulate on organic material and small particles such as silts and clays. Dating of sediment cores will be useful to estimate changes in contaminant loads over time.

Fish consumption advisories are listed for the St. Louis River and Bay due to existing sediment contamination. A comprehensive sediment study was done during 1993 in the St. Louis River and Duluth-Superior harbor as part of the St. Louis River RAP. Sediments were examined from 40 sites in a cooperative effort by the MPCA, the WDNR and USEPA. A two-year study will begin in spring 1994 to develop a snapshot of sediment contamination in the harbor, which will involve sampling 120 randomly selected sites.

Sediment will be sampled during 1994 in the Mississippi River. Samples will be analyzed for PCBs, mercury and other contaminants to determine the effect of the 1993 floods.

Intensive Surveys

Intensive surveys provide data where streams and rivers are receiving discharges from wastewater treatment plants and where stream flows are considered inadequate to protect water quality. Data from the surveys are used to determine effluent limits so that water quality standards will be maintained and so the designated uses of the receiving water are protected. The effluent limits are regulated through the National Pollutant Discharge Elimination System (NPDES) permits administered by the MPCA.

The MPCA sets effluent limits to protect water quality standards at all flows greater than the 7Q10 low flow, which is the seven-day low flow with a recurrence interval of ten years. Intensive surveys are done during low flow conditions, usually in late summer or midwinter.

In each survey the stream is examined for hydrologic characteristics, biological characteristics, DO variation and fluctuations, and chemical water quality (including conventional pollutants and sometimes metals). During the last two years, Minnesota has not experienced low flow conditions.

New directions being pursued with regard to intensive surveys include:

- Contract and work cooperatively with USGS and MDNR so that stream flow data are accessible to MPCA staff and flow data are available for locations requiring evaluation of point and NPS pollution.
- Ensure that an MPCA compliance information system currently being developed will support effluent limit assignment and allow better integration of effluent data and ambient data.

• Pursue basin management to perform a more comprehensive evaluation of pollution sources and other water quality issues within a watershed for application when assigning limits.

Biological Surveys

Biological surveys involve collecting samples from streams, wetlands and lakes for description of a representative sample of a portion of the biological community. The MPCA has done biological surveys of fish, macroinvertebrates, plants and zooplankton communities. Many of the biological surveys undertaken in the last two years have been conducted for developing the field techniques and interpretative tools (biological criteria) used to establish meaningful water quality evaluations from biological community data. This work has involved sampling in a standardized fashion at least impacted reference sites.

Thirty-five reference wetlands were sampled in 1992 for macroinvertebrates and vegetation. This project is done to determine the characteristics of an environmentally sensitive macroinvertebrate community and to develop potential metrics for developing wetland biological criteria.

The MPCA, in cooperation with the MDNR Ecological Services Section, recently completed fish community surveys in streams and rivers of the Minnesota River basin. The surveys were done primarily to develop a fish community index, the Index of Biotic Integrity (IBI), from biological data collected at 50 reference sites within the basin. The development of an IBI for this region is a first product for the MPCA's effort toward establishing working numerical biological criteria. Within the Minnesota River basin, the Redwood River and the Blue Earth River watersheds were evaluated using the IBI. In these watersheds, 57 stations were sampled.

Field work began in 1993 to adapt and calibrate the IBI for application in the Red River of the North basin. The initial sampling effort focused on the Red River Valley ecoregion, with later years sampling expected to be done in other ecoregions in the basin. This biological survey project is a multiagency effort of USEPA Region 5 and 8, USGS, National Water Quality Assessment (NAWQA), MPCA, MDNR and the North Dakota Department of Health. Due to extremely high water volume in the basin during 1993, only 32 of the sites could be sampled. Appendix Seven contains a list of the sites. The remainder of the field work was postponed until 1994.

Minnesota River Assessment Project

The MRAP has involved more than 30 federal, state and local agencies in a comprehensive study of water pollution dynamics in the Minnesota River basin. This research study established a comprehensive sampling network in the basin and made an effort to identity critical reaches of the river and tributaries to estimate the NPS load reductions needed to achieve water quality goals.

Monitoring activities were designed to assess major nutrients, suspended sediments, BOD, organics, biological communities, toxicity and land use from 1989 through 1992. For more discussion on the assessment and implementation efforts from this work, see Part III, Chapter Three, Rivers and Streams.

Citizen Lake Monitoring Program

This is a citizen volunteer program which depends on assistance from citizens residing on lakes. Participants gather weekly lake transparency measurements during summer months. The data collected is extremely valuable for assessment and tracking of changes in the water quality of lakes over time. In many lakes, this is the only monitoring data available. The program provides primary data used to assess temporal trends in lake water quality. The number of lakes included in this program increased from 483 to about 600 between 1989 and 1993.

Lake Assessment Program

The LAP takes the CLMP goals one step further. This is a cooperative study of a lake, involving MPCA staff and local citizens that belong to lake associations and municipalities. The LAP studies characterize a lake's condition and provide basic information on the interaction of the lake and its watershed. The format used for the LAP studies provides valuable information for the local groups, MPCA and others interested in protecting or improving the water quality of a lake. While only 10 to 15 LAP studies are conducted each year, good baseline data is established for those lakes. By 1992, 70 studies had been completed, and another 18 began in 1993. In some instances, the local cooperators have elected to undertake further study, such as a Clean Lakes Program diagnostic feasibility project, or have instituted lake protection efforts as a result of LAP involvement.

Ecoregion Reference Lakes and Trend Monitoring

In this program lakes representative of minimally impacted lakes are selected from each ecoregion and sampled over two or three summers. A comprehensive data base for each region results. Data from these lakes have been used to develop phosphorus criteria for each ecoregion. Sediment sampling of a subset of ecoregion reference lakes began in 1992 for identifying background concentrations of selected heavy metals including mercury, lead, cadmium, chromium and nickel.

River Watch/Water Watch

River Watch/Water Watch was a two-year pilot program funded by the Minnesota Legislative Commission on Minnesota Resources (LCMR) for the MPCA, which developed partnerships with citizens, schools and local governments to participate in monitoring and protecting their local waters.

River Watch programs were established in Minnesota for the Mississippi River and the St. Louis River. The major cooperators, the Mississippi Headwaters Board and the St. Louis RAP Citizen Advisory Council, initially used the national River Watch Network model to begin a local program. River Watch programs involved citizen volunteers, teachers and students who collected and analyzed water samples from a river in their area. Students also collected, identified and quantified benthic macroinvertebrates (aquatic bugs living in the bottom of the river).

The St. Louis River Project included a variety of other citizen involvements. Examples include a Frog Watch and participation in Keepers of the Waters. Keepers of the Waters combines the efforts of scientists and artists who developed practical and compelling ways to disseminate technical water quality information. The MPCA staff provided technical assistance to insure that quality information was collected and that the data was analyzed and computerized to be compatible with other MPCA data.

Water Watch projects included work with the Itasca County Soil and Water Conservation District (SWCD). The county's Local Water Management Plan had identified the need for a county-wide lake monitoring and protection program. The MPCA provided technical assistance to the SWCD for designing monitoring and protection activities.

Monitoring activities continue in each of these areas. Through funding from the USEPA Great Lakes National Program Office the monitoring and educational efforts that began in the St. Louis River Project will be expanded to the entire Lake Superior basin in Minnesota, Wisconsin and Michigan. The Lake Superior River Watch will include development of high school water quality curriculum, development of water monitoring plans for schools, and development of presentations and demonstrations to educate community groups.

Data Management and Sharing

All chemical water quality data and fish tissue contamination data are entered into USEPA's Storage and Retrieval System (STORET). Toxicity test, biological survey and habitat data are computerized as appropriate. For water quality planning and management, data are shared among MPCA, USGS, MDNR, MDA, MDH, Metropolitan Council, WDNR and several local units of government. Ambient water quality data collected by some NPDES dischargers are also used.

The assessments done for this report have in the past used only data that the MPCA collected. This report also uses USGS data. In the future, additional credible data from other agencies will be used, as its comparability is determined. In addition to the organizations listed above, the MPCA provides data, upon request, to private citizens, community organizations, students and researchers.

Other Assessment Reports

Other major assessment reports include the 319 NPS Assessment Report and a series of Minnesota Lake Water Quality Assessment Reports. Staff who prepare these reports also prepare the corresponding portions of this report.

Quality Assurance for Water Monitoring

The overall quality assurance (QA) objective for the MPCA Water Quality Division's sampling and monitoring program is the implementation of procedures that will provide valid, usable water quality data and legally defensible results in a court of law. This would include specific procedures for field sampling, preservation of samples, chain of custody, data analysis, calibration, internal quality control, performance audits, preventive maintenance and corrective action. These procedures are described in detail in the MPCA Water Quality Sampling and Equipment Manual and in the quality assurance project plans that have been approved by the USEPA for specific sampling projects.

Any laboratory data generated and used in water quality assessment must be handled according to approved USEPA test methods, as listed in 40 CFR pt. 136. The principal criteria used to validate the laboratory data are:

1) Evaluation by the MPCA QA officer of holding times, calibration data, control limits, matrix spikes, duplicates, surrogate recoveries, blank measurements, detection limits and performance evaluation samples. All of these parameters should be within acceptable guidelines; and

2) Confirmation that the minimum USEPA goals for analytical precision and accuracy are met.

The MPCA Water Quality Division QA officer is responsible, along with the managers of projects, to ensure that the quality assurance goals listed above are met.

Chapter Two: Assessment Methodology

Introduction

The Water Quality Division is in the final stages of a Monitoring and Assessment Planning effort, as described in Chapter One. In critically reviewing the methodology for determining use support status in rivers and streams, the MPCA has seen the need for approaching assessments of waterbodies in a more integrated fashion. Future waterbody assessments will be produced from all credible information available from state, federal and local monitoring programs, including water chemistry data, habitat assessments and biological community information.

Based on recommendations made by the monitoring and assessment planning committee, some changes were made in the assessment methodology for all rivers and streams in this report. Additional changes were also incorporated in a pilot assessment methodology for rivers and streams in the Minnesota River basin. Some changes in assessment methodology will not be implemented until future 305(b) reporting periods.

Statewide Methodology Outside the Minnesota River Basin

River and stream use support assessments, outside the Minnesota River basin, were based solely on water chemistry monitoring data. Assessments were done usually for an entire river reach, combining all data collected on that reach over the last ten years. Data for these assessments came from the MPCA routine sites, past MPCA intensive surveys, USGS stations, CWP, and Clean Lakes program projects.

Use support was determined as follows:

Aquatic Life:

Use support determinations were based on the frequency of surface water standard violations for conventional parameters (DO, pH low and high, and turbidity) and on the frequency of surface water standard violations for toxic pollutants (unionized ammonia, arsenic, cadmium, chloride, chromium, lead, nickel, selenium, and zinc). Waterbodies that were fully supporting but with higher than expected ecoregion values indicative of NPS pollution (total phosphorus, nitrate/nitrite, TSS and BOD) were assessed as fully supporting but threatened.

- *Fully supporting* : Less than ten percent of the monitored values for any one conventional parameter violated the standard AND no more than one toxic violation in 36 observations (equivalent to three years of monthly data).
- *Fully supporting but threatened*: Same as fully supporting AND greater than ten percent of the monitored values for any one of the NPS indicators were above the estimated achievable ecoregion values.
- *Partially supporting*: Between 10 and 25 percent of the monitored values for any one conventional parameter violated the standard AND no more than one toxic violation in 36 observations.
- *Not supporting*: Greater than 25 percent of monitored values for any one conventional parameter violated the standard OR more than one toxic violation in 36 observations.

Primary Body Contact (Swimmable):

Use support was based on the frequency of samples exceeding 200 fecal coliform organisms per 100 milliliters. The geometric mean of samples taken from a reach for each month was determined and compared to 200 fecal coliform organisms per 100 milliliters.

- *Fully supporting*: Less than ten percent of the monthly geometric mean values were over 200 fecal coliform organism per 100 milliliters.
- *Partially supporting*: Between 10 and 25 percent of the monthly geometric mean values were over 200 fecal coliform organism per 100 milliliters.
- *Not supporting*: Greater than 25 percent of the monthly geometric mean values were over 200 fecal coliform organism per 100 milliliters.

Agriculture and Wildlife:

Use support determinations were based on the frequency of surface water standard violations for conductivity and pH. Support levels (not supporting, partially supporting and fully supporting) followed the percent categories as for other conventional parameters.

Industrial:

Use support determinations were based on the frequency of surface water standard violations for chloride. Support levels (not supporting, partially supporting and fully supporting) followed the percent categories as for other conventional parameters.

Limited Resources Value Waters (LRVW):

These rivers and streams have been analyzed for use attainability. Through Minnesota Rules ch. 7050 they have been classified as not able to support recreation and aquatic life. The LRVW's are assigned standards to protect secondary body contact use, to preserve ground water for potable water and for aesthetics. They are considered nonattainable for aquatic life and recreation. They are assessed by a specific set of criteria including fecal coliform bacteria, pH and DO. The levels of use support (not supporting, partially supporting and fully supporting) were determined for LRVW's with the same percent categories used for conventional parameters.

Overall Use Support:

Overall Use Support represents an assessment of whether a reach can support all of its designated uses. In most cases, where any one use was found not supported then overall use of the reach was considered not supported. For some reaches overall use was still considered supporting if aquatic life was supported but there was only limited monitoring information that indicated that another of the uses was not supported. The best professional judgement of MPCA staff was used in each individual case. River reaches classified as LRVW for the Overall Use Support Summary were considered not attainable of overall use.

Other 1994 Changes in Methodology

The new methodology includes the following changes from the 1992 305(b) report:

- Fish consumption advisory information is reported in the Public Health, Chapter Seven (since fish consumption is not a designated use, it is not included in use support assessments).
- Streams that do not meet aquatic life use because of metals violations were reviewed to determine the validity of this assessment.
- Streams that did not meet aquatic life use based on MPCA intensive survey data were reviewed to determine the validity of this assessment.

Pilot Methodology - Minnesota River Basin

This pilot assessment methodology represents a significant shift in approach. This methodology incorporates biological and habitat data with the water chemistry data. The Minnesota River basin was selected for the pilot because a set of working biocriteria have been developed in the basin, which has been extensively monitored recently.

The pilot methodology has these elements:

- Index of Biotic Integrity (IBI) values are used to summarize fish community survey results for aquatic life use support assessment: Waterbodies *fully supporting* had IBI values greater than 30, those *not supporting* had IBI values less than 30.
- Habitat information is used to determine the biological impairment caused by habitat degradation.
- The level of data sufficient to make an assessment was determined by best professional judgment.
- A weight of evidence approach is employed to handle differences in use support between water chemistry data and biological data.
- Discrepancies between chemistry and biological assessment are tracked.
- The number of miles of a reach that did not support a use was determined by best professional judgment.
- Data for the pilot assessment was collected from "all credible sources."

Future Changes in Methodology

In addition to changes made in the pilot assessment methodology, the following changes are being considered:

- Incorporate the magnitude, duration, and spatial extent of impairment into a use support assessment, not just the frequency of standards violations.
- Use an interactive approach with local resource managers, by seeking their comments and responses to initial assessments.
- Organize and focus monitoring and assessment for specific basins in a five-year rotational cycle.

Assessment Methodology for Lakes

Aquatic life use support was not assessed for lakes.

Swimmable Use:

See Part III, Chapter Four: Lake Water Quality Assessment for a full description of the new assessment methodology for swimmable use in lakes. Use support for lakes is based on the levels of phosphorus, chlorophyll_a and Secchi transparency measurements, which are combined to determine the Carlson's Status Index.

Ecoregion specific criteria rather than statewide criteria are used to assess swimmable use support. This is a change from previous Water Quality reports.

Chapter Three: Rivers and Streams

Water Quality Summary

The CWA establishes goals such that all waters, wherever attainable, be of sufficient quality that the public health, as well as the propagation and maintenance of fish, shell fish, wildlife and recreation are protected. As discussed in Part II, Background, Minnesota has adopted a use classification system consistent with these goals. Minnesota measures progress toward meeting the CWA goals by assessing whether uses established in Minnesota rule are being met. The methodologies used to make these assessments are outlined in Part III, Chapter Two: Assessment Methodology.

Table III-1, Overall Use Support Summary-River Miles, reports the condition of river reaches in terms of the level of overall use support.

River reaches classified as LRVW are considered not attainable of overall use. In general if any use was not supported, then overall use was not supported. The assessment results show 22 percent of assessed river miles fully support overall use, an additional 18 percent fully supported uses but were considered threatened, 20 percent partially supported uses, 38 percent did not support uses and two percent of assessed river miles were not attainable for overall use.

Table III-2, Individual Use Support Summary-River Miles, reports the total number of river miles that were considered supporting, partially supporting, not supporting or threatened for the individual uses: aquatic life, swimming, industrial, agriculture and wildlife, and LRVW. For those river miles assessed for aquatic life use, 27 percent fully supported and 46 percent fully support this use but were threatened. For those river miles assessed for recreation (swimming) 39 percent are fully supporting. River reaches classified as LRVW were considered not attainable for aquatic life and recreation. However, they might be attainable for LRVW, industrial and agriculture and wildlife uses.

The monitoring data used for these assessments were collected through a wide variety of programs and studies. The sites that were sampled were not selected by a random process but for programs and other specific information purposes. In addition, the frequency of sampling and the choice of parameters to be analyzed will have varied from one sampling site to another. For these reasons, assessments generated from this diverse data set cannot be considered or used to represent the overall water quality of Minnesota's rivers and streams.

Data were excluded from the use support assessments if they were considered outdated due to pollution control activities that occurred and would be expected to result in a change in the waterbodies' support condition. Table V-1 in Part V, Chapter One, Point Source Pollution Control Program lists the streams that were excluded from the use support assessments and the pollution control actions taken.

Table III-1. Overall Use Support Summary - River Miles

Degree of Use Support	Assessment Basis River Miles Monitored
Fully Supporting	750.2
Fully Supporting but Threatened	602.5
Partially Supporting	705.4
Not Supporting	1,320.1
Not Attainable	66.9
TOTAL	3,440.9

Table III-2. Individual Use Support Summary - River Miles

Use	Supporting	Supporting but Threatened	Partially Supporting	Not Supporting	Not Attainable
Aquatic Life Support	932.7	1,586.9	266.6	586.1	66.9
Recreation (Swimming)	1,080.8		582.7	1,014.1	66.9
Agriculture & Wildlife	2,430.6		448.0	295.7	
Industrial Consumption	1,463.0		5.0	40.0	
Limited Value Resource	38.8		4.3	13.5	

Causes and Sources of Nonsupport

Many pollutants or stressors can impair the uses of a waterbody. For river reaches that were not supporting or partially supporting, the causes of nonsupport were determined whenever possible. If the nonsupport was determined from the percent of ambient water chemistry measurements violating water quality standards, then the cause of the impairment was the particular parameter violating the standard. For example, if 25 percent of DO measurements from a river reach classified as a warm water fishery had DO values less than the standard, five milligrams per liter, then the cause of nonsupport is Organic Enrichment Low DO. When nonsupport is based on an integrated biological assessment the causes of the impairment were discerned from examination of the biological information, the habitat assessment, and any pertinent water chemistry data. For some assessments nonchemical stressors such as siltation and habitat modification were considered the causes of impairment. In some cases the cause was unknown.

The total number of river miles not supporting uses are listed by general categories of causes in Table III-4. If a river reach was found not supporting primarily due to one cause, then this cause was considered a major contributor to the impairment. If a river reach was found not supporting because of more than one cause factor, then each cause was considered a moderate/minor contributor. A river reach with several causes, then, would contribute to the number of river miles in several cause categories.

When more than ten percent of the monitored values for any one of the NPS pollution indicators fell above the estimated achievable ecoregion values, then the associated river reach was considered threatened for aquatic life. Table III-3 shows the number of river miles threatened listed by individual cause categories.

Table III-3. Total River Miles Threatened Listed by Cause Categories

CAUSE CATEGORY	MILES
Nutrients	2,138.5
Organic Enrichment	875.3
Other Habitat Alterations	14.9
Suspended Solids	1,539.8

The causes of impairment and threatened condition listed in Tables III-3 and III-4 come from various sources. Discharges that are discrete points of entry into a waterbody are called point sources. Point sources include discharges from municipal wastewater treatment plants and industrial treatment plants. Discharges from diffuse activities that result in polluted runoff or seepage are called NPS pollution. Nonpoint sources include runoff from agricultural fields, feedlots, construction sites, logging areas, mining sites, unsewered areas, and urban streets, lawns and parking lots.

Table III-5 indicates the number of river miles influenced by general categories of sources. When there was only one source of the impairment it was considered a major contributor to impairment. When more than one source impacted a river reach, each source was considered a moderate/minor contributor to impairment. The mileage for a river reach with more than one source was listed under all the sources that were in effect. Of the 1,956 river miles not supporting or partially supporting uses, 1,524 miles (78 percent) are assessed to be impaired by nonpoint sources and 432 miles (22 percent) by a combination of point sources, NPSs and other sources.

Table III-4. Total River Miles Not Fully Supporting Uses Listed by Cause Categories

CAUSE CATEGORY	CONTRIBUTION TO IMPAIRMENT	
	Major	Moderate/Minor
Metals	51.5	41.0
Unionized Ammonia*	0.0	253.0
pH	158.2	465.1
Siltation	0.0	141.0
Organics Enrichment/Low DO	172.6	323.6
Salinity/TDS/Chlorides	9.3	504.2
Thermal Modifications	0.0	1.5
Flow Alterations	0.0	10.0
Other Habitat Alterations	0.0	94.0
Pathogen Indicators	597.8	1,024.2
Turbidity	0.0	323.5

*There are also 71.1 miles in the Minnesota River basin, for which unionized ammonia was a cause of nonsupport, but because of pollution control actions taken, is no longer expected to be contributing to nonsupport. The cause categories Siltation, Thermal Modifications, Flow Alterations and Other Habitat Alterations were only assessed in the Minnesota River basin, so these numbers of river miles are only for that basin.

Table III-5. Total River Miles Not Fully Supporting Uses Listed by Source Categories

SOURCE CATEGORY	CONTRIBUTION TO IMPAIRMENT	
	Major	Moderate/Minor
Industrial Point Sources	0	14.2*
Municipal Point Sources	0	142.4*
Combined Source Overflow	0	*
Nonpoint Source-Agriculture	148.6	318.6
Nonpoint Source-Unspecified	1,425.4	192.2
Hydromodification	0	28.5
Other	9.3	188.1
Unknown	3.4	65.1

*Also 14.8 miles were assessed as impacted by CSO, 35.8 miles impacted by industrial dischargers and 51.3 miles by municipal dischargers for which specific control actions currently being taken and are not expected to be further contributing to nonsupport. The sources Nonpoint Source-Agriculture, Hydromodification, Other and Unknown were assessed only in the Minnesota River basin. The sources Combined Sewer Overflow and Nonpoint Source-Unspecified were assessed only outside the Minnesota River basin.

Minnesota River Basin

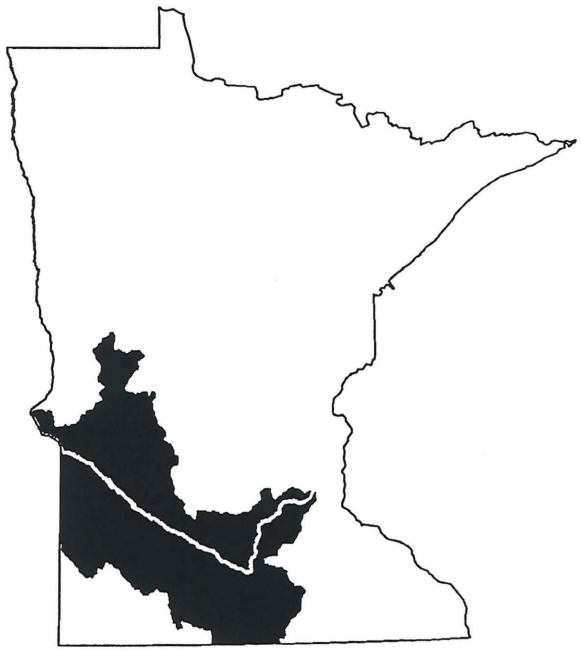
The Minnesota River is one of the most polluted rivers in Minnesota. Nonpoint source pollution degrades water quality throughout the basin, especially in the lower reaches near its confluence with the Mississipppi (see Figure III-2). The lower Minnesota River often violates standards for fecal coliform bacteria and turbidity, and at times does not meet standards for DO and unionized ammonia.

Two Metropolitan Waste Control Commission (MWCC) facilities, Blue Lake and Seneca, both located on the lower Minnesota River reach, were upgraded in the summer of 1991. In 1993, the MPCA issued a permit for the Minneapolis-St. Paul International Airport, which is also on the lower Minnesota River. This permit limits the substantial BOD loading from airport deicing chemicals. See Part V, Chapter Three: Special State Concerns and Recommendations for more information on the airport deicing chemicals. The permitted actions should significantly decrease this point source contribution to impairment of this reach.

Minnesota River Assessment Project

The MRAP evaluates how pollution enters the Minnesota River and how the river is affected by it. More than 30 federal, state and local agencies participated in the study. The Legislative Commission on Minnesota Resources, as well as local, state and federal agencies funded the study. The Minnesota Legislature committed $1.4 million and matching funds from cooperating agencies brought the total funding for the project to approximately $3 million over four years. The study consisted of three major study areas: physical and chemical assessment, a biological assessment and a land use study. The monitoring network identified critical mainstream reaches and the tributaries that are contributing significant NPS loadings. This information will be essential for estimating the NPS load reductions that might be needed to improve water quality in the basin. The final report of the MRAP was completed in January 1994. The results of the study are contained within four volumes and an executive summary. The four volumes report on these topics: Volume I, Workplan and Project Summary; Volume II, Physical and Chemical Assessment; Volume III, Biological and Toxicological Assessment; and Volume IV, Land Use Assessment.

Figure III-2. Location of the Minnesota River Basin



The MRAP team developed a set of recommendations for improving water quality in the Minnesota River basin. These recommendations are based on the report findings and will be used along with citizen recommendations to direct future NPS implementation efforts in the river basin. The major recommendations of the MRAP are summarized as follows:

- Establish phosphorus standards for the Minnesota River basin, using a participatory process for involving affected parties.
- Implement soil erosion control practices for transportation, construction, agriculture and urban areas.
- Help people recognize that the loss of fine-textured soil from gentle slopes contributes to water quality problems.
- Control erosion of cropland where BMP's are not currently used.
- Develop and implement plans for communities to manage urban storm water.
- Reduce nutrients (phosphorus and nitrogen) by promoting urban and agricultural fertilizer BMPs, controlling feedlot runoff, upgrading septic systems, and controlling inadequately treated point sources.
- Establish vegetated buffers alongside ditches and rivers in the basin.
- Perform additional stream bank assessments in target areas that need protection.
- Restore wetlands in selected locations to settle solids, remove nutrients and reduce peak flows.
- Design a long-term trend monitoring program for the entire Minnesota River basin.
- Limit stream channelization and river clearing and snagging.
- Establish land treatment goals.
- Determine strategies for addressing pollution problems and prioritize these problems so resources can be directed to address the most critical problems first.

Minnesota River Citizens Advisory Committee

The Minnesota River Citizens Advisory Committee was brought together by the MPCA in 1992 to collaborate on the development of goals and plans for improving water quality in the Minnesota River. The Citizens Advisory Committee consists of 30 individuals who represent different interests and various geographical areas of the river basin. The MPCA will consider the recommendations of the Citizens Advisory Committee along with the MRAP study to develop a basin plan for the Minnesota River. The citizen committee process will be concluded in the summer of 1994, and a summary document describing the recommendations of the committee will be distributed.

Future Directions

The MPCA's Water Quality Division is currently in the process of shifting its approach to managing water resources. The focus of the assessment and regulatory acitivities will be moved to the resources. Rather than manage resources according to programmatic structures, the division will be prioritizing and managing water resources within geographic areas of the state, specifically in the hydrologic groups called river basins. Basin planning will be the organizing principle to define the methods for integrating findings from MRAP and the input from citizens. The basin plan will be an integrated description of the manner in which the Division of Water Quality will focus efforts within this geographic area. The basin plan document will also address the basin's water quality issues in a more comprehensive and meaningful fashion and aid the process of choosing how staff time and resources will be used to accomplish water quality goals. Throughout this entire process, public participation will be utilized and local governments will be involved in the process.

Chapter Four: Lake Water Quality Assessment

Background and Lake Information

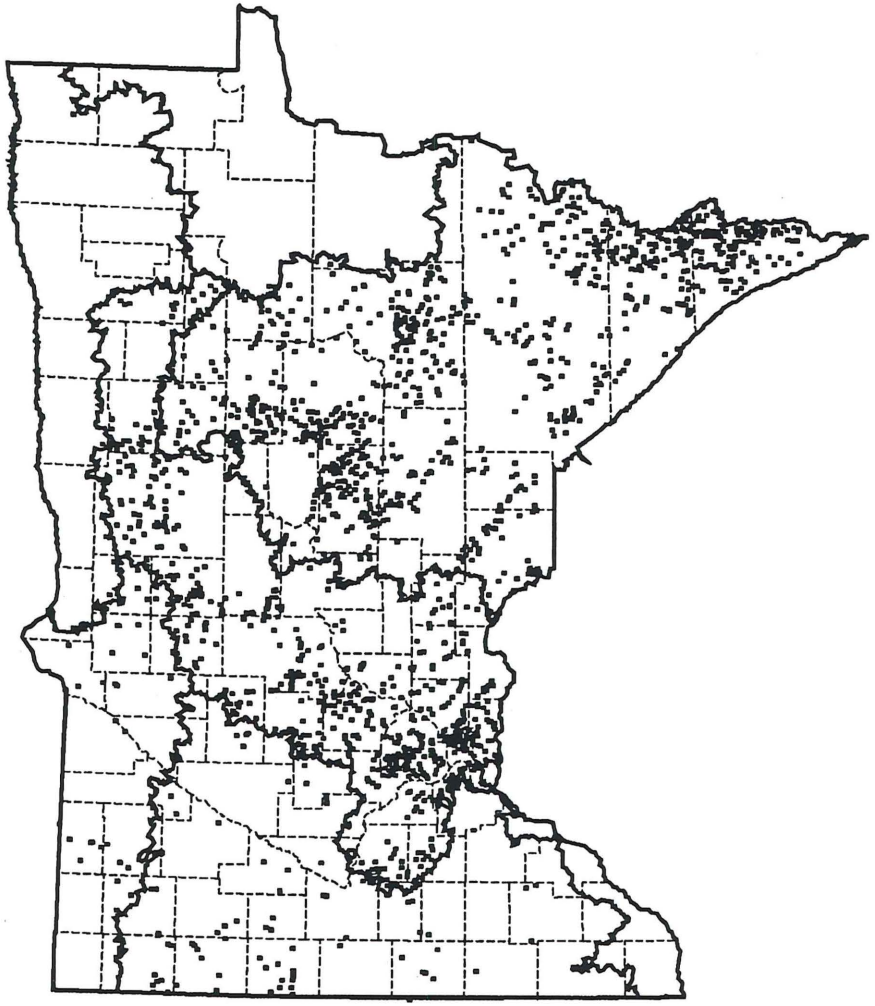
Minnesota's abundant lakes provide enjoyment for citizens and annually draw thousands of visitors to the state. The value of these lakes is directly related to their quality or purity.

Minnesota, the "Land of 10,000 Lakes," is in fact the land of 11,842 lakes that have a total area of 3,290,101 acres. A waterbody is considered a lake if it is larger than ten acres in size. Sixty-two of these lakes (less than one percent) have surface areas greater than 5,000 acres. These large lakes, however, represent approximately 1,000,000 acres, or roughly 30 percent of the total acreage.

Most lakes (70 percent) have surface areas between 10 and 100 acres. This report defines "significant lakes" as lakes at least ten acres in size that is publicly owned. Generally, these lakes are identified as Protected Waters by the MDNR in the Inventory of Protected Waters and Wetlands (1984-1985). That inventory is the basis for the above cited numbers and acreage of lakes.

Ninety-eight percent of Minnesota's lakes are in four of the state's seven ecoregions, the Northern Lakes and Forests, North Central Hardwood Forests, Northern Glaciated Plains and Western Corn Belt Plains. Land cover and use varies by ecoregion. The Northern Lakes and Forests is dominated by forests with some water and marsh, while the Northern Glaciated Plains and Western Corn Belt Plains are primarily cultivated with some pasture and open land. The North Central Hardwood Forest ecoregion consists of a mixture of land uses. The lake assessments in this report focus on the four ecoregions listed above. Figure III-3 shows the distribution of lakes included in this assessment.

Figure III-3. Locations of Lakes Used in Assessments



Assessment Process and Methods

Twenty-three years of data (1970-1993) from the USEPA STORET water quality data system were used for the lake assessments.

The focus of lake assessments is on trophic state and its relation to support and nonsupport of designated uses, specifically swimming and aesthetics uses. The parameters used to assess trophic state were epilimnetic total phosphorus, chlorophyll-a and Secchi transparency.

Data were used and analyzed as follows:

•***Monitored Data:*** Lakes with data collected between calendar years 1984-1993 with summer data (defined as the time period from June through September) were considered monitored. Summer data are preferred for assessments, to better represent the maximum productivity of a lake and yield the best agreement among trophic variables. They also reflect the maximum use period of the resource. Summer means were calculated for each variable.

•***Evaluated Data***: Lakes without data meeting monitored criteria but with total phosphorus, chlorophyll-a or Secchi transparency measurements collected between 1970-1983 were treated as evaluated. Summer data was used for calculating mean chlorophyll-a and Secchi transparency. Mean total phosphorus was calculated from data collected during the open water season (May - November). Expanding the season for total phosphorus allows for inclusion of a larger number of lakes in northern Minnesota. These lakes were often sampled only during spring or fall turnover as a part of the MPCA acid rain lake monitoring program.

Trophic Status was determined for each lake using Carlson's Trophic State Index (TSI). This index was developed using the relationship among summer Secchi transparency, epilimnetic concentrations of chlorophyll-a, and total phosphorus.

The TSI values are calculated as follows:

•*Secchi disk TSI* (TSIS)=60-14.41 ln (SD);

•*Total phosphorus TSI* (TSIP)=14.42 ln (TP)+4.15;

•*Chlorophyll-a TSI* (TSIC)=9.81 ln (Chl-a)+30.6;

(chlorophyll-a and total phosphorus in micrograms per liter and Secchi disk transparency in meters).

The index ranges from 0 to 100 with higher values indicating more eutrophic conditions. The TSI scale and corresponding use supports are shown in Figure III-4b. The TSI values were calculated for each variable then averaged for each lake.

Threatened and Impaired Status

The supporting, partially supporting, not supporting and threatened or impaired status of lakes was assessed by ecoregion. Phosphorus criteria (Heiskary and Wilson, 1988) for each ecoregion were used in conjunction with Carlson's TSI scale to establish use support thresholds (Figure III-4b). Phosphorus criteria are based on ecoregion characteristics and reflect several considerations such as lake morphometry, attainability and lake user perceptions (Heiskary and Wilson, 1988). Specific ecoregion phosphorus criteria are shown in Figure III-4a. Determining use support by ecoregion provides a more reflective picture of the condition of Minnesota lakes, as opposed to assessing all lakes by a single scale which ignores important regional differences such as lake morphometry and lake user perceptions.

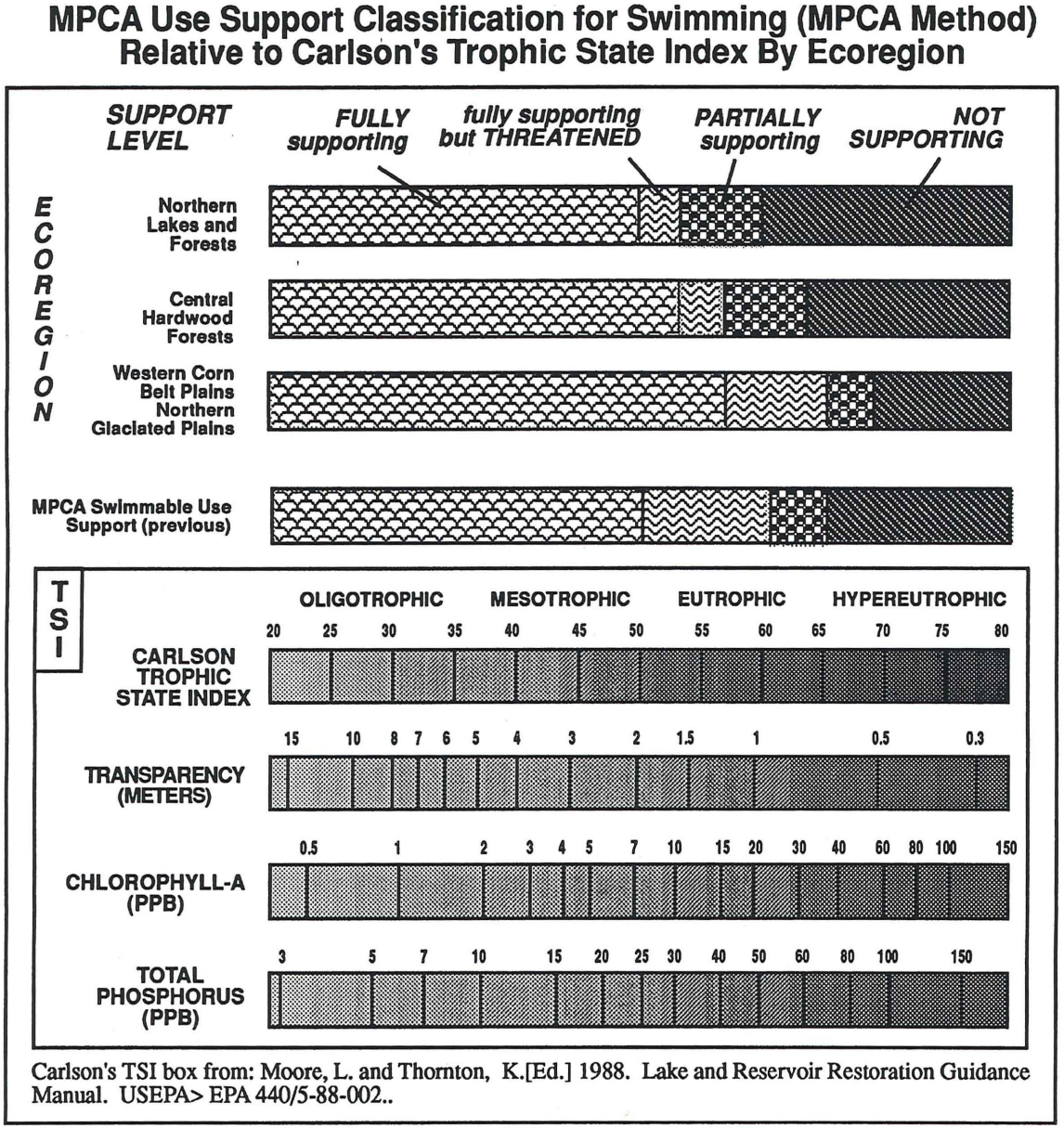
Use support thresholds for each ecoregion are defined in Figure III-4b. The previous thresholds are included for comparison. In general, use support thresholds for the Northern Lakes and Forests and North Central Hardwood Forests ecoregions are somewhat more restrictive than the previous thresholds, while those for the Western Corn Belt Plains and Northern Glaciated Plains ecoregions are somewhat less restrictive. Differences in lake user perceptions of "impaired swimming" and what constitutes nuisance algal blooms along with differences in lake morphometry and attainability are primary reasons for the regional differences.

The Northern Lakes and Forests and North Central Hardwood Forest ecoregions phosphorus criteria levels, 30 micrograms per liter and 40 micrograms per liter respectively, serve as the upper thresholds for full support but threatened of swimmable use. Those concentrations correspond to Carlson's TSI values of 53 and 57 respectively. Full support of swimmable use is set at slightly lower concentrations, 25 micrograms per liter and 30 micrograms per liter respectively, which ensure that conditions

Figure III-4a. Ecoregion Criteria for Phosphorus in Lakes

Ecoregion phosphorus Criteria, in micrograms per liter Most Sensitive Uses	Northern Lakes and Forests	Central Hardwood Forests	Western Cornbelt Plains	Northern Glaciated Plains
Drinking Water	15	30	40	
Cold Water Fishery	15			
Primary Contact Recreation and Aesthetics (Full Support)	30	40	40	
Recreation and Aesthetics			90	90

Figure III-4b. Carlson Trophic State Index Scale and Swimming Use Support Classification by Ecoregion



Carlson's TSI box from: Moore, L. and Thornton, K.[Ed.] 1988. Lake and Reservoir Restoration Guidance Manual. USEPA> EPA 440/5-88-002..

associated with "impaired swimming" would occur less than ten percent of the summer. Phosphorus concentrations above criteria levels would result in greater frequencies of nuisance algal blooms and increased frequencies of "impaired swimming." The upper threshold for partial support of swimmable use was set at 60 and 63 Carlson's TSI units, respectively, for these two regions. As phosphorus concentrations increase from about 30 micrograms per liter to 60 micrograms per liter, summer mean chlorophyll-a concentrations increase from about 10 micrograms per liter to 30 micrograms per liter and Secchi transparency decreases from about 1.7 m to 0.8 m (Figure III-4b). Over this range the frequency of nuisance algal blooms (greater than 20 micrograms per liter chlorophyll-a) increases from about five percent of the summer to about 70 percent of the summer (Heiskary and Wilson, 1990). The increased frequency of nuisance algal blooms and reduced Secchi transparency results in a high percentage of the summer (26-50 percent) perceived as "impaired swimming."

Phosphorus concentrations above 50 micrograms per liter (Northern Lakes and Forests) and 60 micrograms per liter (North Central Hardwood Forest) were associated with nonsupport of swimmable use. At phosphorus concentrations above 60 micrograms per liter, severe nuisance algal blooms (greater than 30 micrograms per liter chlorophyll-a) may occur over 40 percent of the summer. This will result in a high frequency (greater than 50 percent of summer) of impaired swimming and greater than 25 percent as "no swimming."

For the Western Corn Belt Plains and Northern Glaciated Plains the upper total phosphorus thresholds for fully supporting and fully supporting but threatened are 40 micrograms per liter and 50 micrograms per liter respectively, which correspond to Carlson's TSI units of 57 and 60. At a

total phosphorus concentration of 50 micrograms per liter, summer mean chlorophyll-a concentrations average 20-22 micrograms per liter and Secchi transparency is about one meter. Nuisance algal blooms (greater than 30 micrograms per liter chlorophyll-a for these regions) would occur for approximately 10 to 15 percent of the summer. Few lakes in these two ecoregions have total phosphorus concentrations of 40 micrograms per liter or less. Partial support, which corresponds to a total phosphorus concentration of 90 micrograms per liter or less (Carlson's TSI = 69), is a more reasonable goal for the majority of the lakes in these two ecoregions. Total phosphorus concentrations greater than 90 micrograms per liter are considered not supporting of swimmable use. At total phosphorus concentrations greater than 90 micrograms per liter, Secchi transparency averages 0.5 meters or less and nuisance algal blooms may occur at a level of 75 percent of the summer or more.

Five lakes in the Red River Valley ecoregion (using the North Central Hardwood Forests criteria), one lake in the Northern Minnesota Wetlands (using Northern Lakes and Forests criteria), and one lake in the Driftless Area, Lake Pepin (using Western Corn Belt Plains criteria) were assessed.

Changing the thresholds for use support affects the status of overall use support for the state and for the individual ecoregions. These changes should not be interpreted as an actual trend, instead they are modifications to the method of assessment. The change in assessment methodology will produce a more accurate measure of swimming use support in lakes.

Acres Assessed

A total of 1,751,205 acres (or approximately 53 percent of the state's lake acres) have been assessed for swimmable use. A total of 1,813 of the state's lakes by number (approximately 15 percent) are included in this assessment. This represents an increase of 26,348 acres over the total assessed in 1992. Assessments included 1,165,944 monitored acres representing 1,155 lakes. This is an increase of 112,552 acres over the total monitored acres reported in the 1992 Water Quality Report.

Table III-6, Overall Use Support Summary for Lakes, shows the total number of acres assessed for swimming, broken down by the number of acres in each support category, and for evaluated and monitored acres. Only swimmable use for lakes was assessed in this reporting period. Since only one use is designated for lakes there is no Individual Use Support Summary Table included here.

Figure III-5. Swimming Use Support for Small and Large Lakes by Number of Assessed Lakes

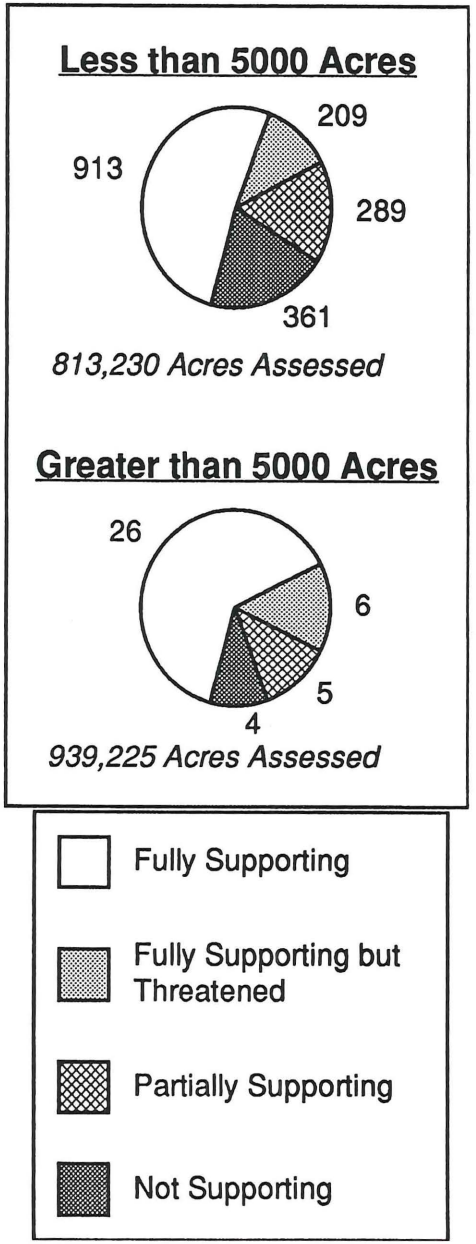


Table III-6. Overall Use Support Summary for Lakes

Degree of Use Support	Assessment Basis Evaluated	Monitored	Total Assessed
Fully Supporting	449 ,655	654,514	1,104,169
F/S but Threatened	37,935	250,883	288,818
Partially Supporting	45,392	109,751	155,143
Not Supporting	52,279	150,796	203,075
TOTAL	585,261	1,165,944	1,751,205

Table III-7. Total Lake Acres Not Fully Supporting Uses Listed by Source Categories

SOURCE CATEGORY	CONTRIBUTION TO IMPAIRMENT Major	Minor
Municipal Point Sources		94,822
Nonpoint Sources-unspecified	263,396	94,822

Assessments show a majority of the lake acres (62 percent) fully supporting swimmable use, and 17 percent fully supporting but threatened for swimmable use. The remaining lake acres either partially support or do not support swimmable use.

For small lakes (those with surface areas less than 5,000 acres) a total of 814,931 acres were assessed for swimmable use. This included a total of 1,772 lakes, or about 15 percent of the state's small lakes. Of these 580,851 acres (1,123 lakes) were monitored. In the 1992 Water Quality report 792,994 acres (representing 1,713 lakes) were assessed.

For large lakes (those with surface areas greater than 5,000 acres) a total of 936,274 acres were assessed for swimmable use. This included 41 lakes (about 66 percent) of the large lakes. Of these, 585,093 acres (32 lakes) were monitored. This compares to 933,604 acres (40 lakes) assessed in 1992.

Figure III-5 shows the relative distribution of use support for small and large lakes. Based on number of lakes, 63 percent of the large lakes fully supported swimmable use while about 12 percent did not. For small lakes, 51 percent fully supported swimmable use, while 20 percent did not.

Trophic Status and Swimmable Use Support by Ecoregion

The distribution by ecoregion of the trophic status of Minnesota lakes, by the number of assessed lakes, is shown in Figure III-6. Of the total number of assessed lakes, 48 percent would be considered oligotrophic or mesotrophic.

Use of an ecoregion framework facilitates the examination of spatial trends in trophic status and swimmable use support in lakes. It is useful for relating lake resource conditions in each region to the morphometric and watershed constraints which could affect the ability of those lakes to support swimmable use. It would also make it simpler to assess the relative importance of point source and NPS pollution in each region. Table III-8 shows the distribution of assessed lakes by ecoregion.

Ninety-nine percent of the lakes assessed as fully supporting swimmable use are located in either the Northern Lakes and Forests or North Central Hardwood Forest ecoregion. Ninety-seven percent of the lakes assessed as supporting but threatened, and 86 percent of the lakes assessed as partially supporting are located in these two regions. Lakes assessed as not supporting swimmable use are found in every ecoregion, with a majority (65 percent) in the North Central Hardwood Forest ecoregion. Figure III-7 provides a breakdown of use support in the assessed lakes by ecoregion. A lake is considered "impaired" if it does not support or partially supports swimmable use.

Twenty percent (193 lakes) of the assessed lakes in the Northern Lakes and Forests ecoregion were impaired. Five percent of these lakes have received at some time a point source discharge. Nonpoint sources account for the remainder of the impairment.

Fifty-two percent (362 lakes) of the assessed lakes in the North Central Hardwood Forests ecoregion were impaired. In this ecoregion, 15 percent of lakes have received point source discharge, and NPS pollution accounts for the remainder of impairment.

Eighty-three percent (74 lakes) of the lakes assessed in the Western Corn Belt Plains ecoregion were impaired. This is due in large part to the shallow depth of the lakes and the impacts of agricultural NPS pollution. Of the lakes considered to be impaired, 18 percent have received a point source discharge at some time.

In the Northern Glaciated Plains ecoregion a majority of the lakes (80 percent) are assessed as impaired. This is due primarily to shallowness of the lakes together with the high level of nutrients received by the lakes through agricultural runoff.

No culturally acidified lakes have yet been identified in Minnesota. The MPCA has assessed 1,113 lakes for acid sensitivity, and of the 200 assessed lakes considered threatened by acidic deposition 95 percent are located in the Northern Lakes and Forests ecoregion. Acid sensitive lakes are located in the northeastern portion of this ecoregion, where there is very thin topsoil over granitic bedrock formations. Other acid sensitive lakes are located in this ecoregion in moraine areas.

Table III-7 summarizes the sources of nonsupport identified for Minnesota lakes. Sources are listed for lake acres that are not supporting swimmable use. The table reflects a relatively larger impact on lakes from NPSs than from point sources.

Pollutants Causing Nonsupport

The major pollutants causing nonsupport of swimmable use were studied. The parameters chosen as pollution indicators were pH and nutrients (e.g., total phosphorus and nitrite-nitrate).

Figure III-6. Trophic Status of Lakes by Number of Lakes per Ecoregion

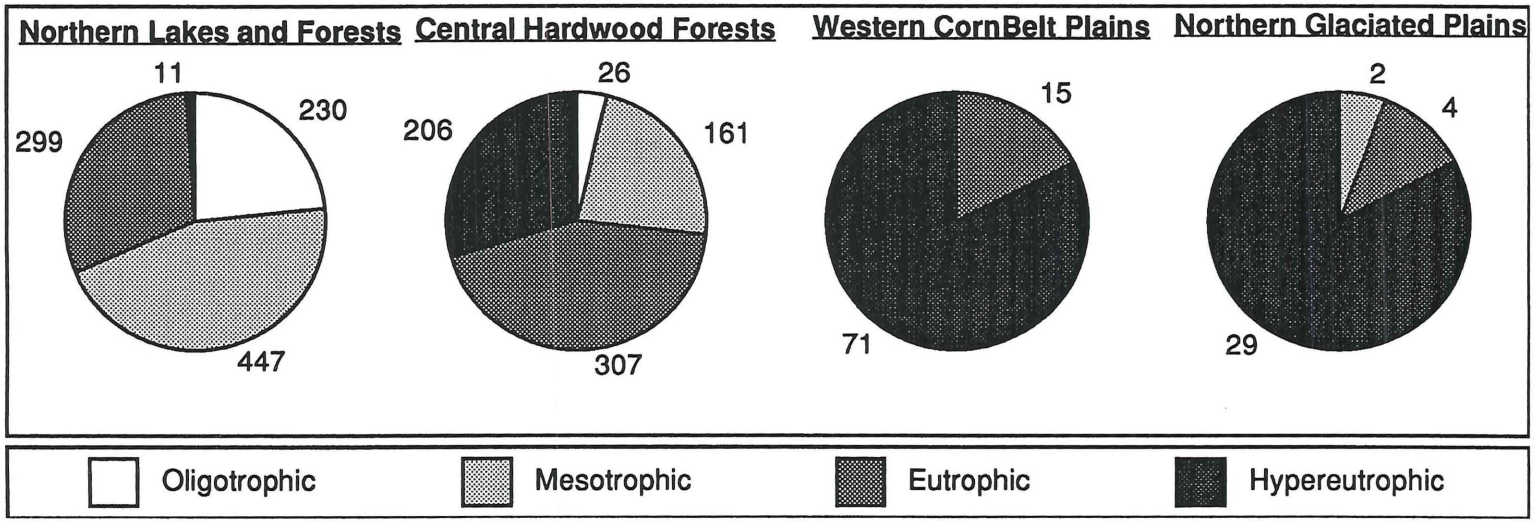
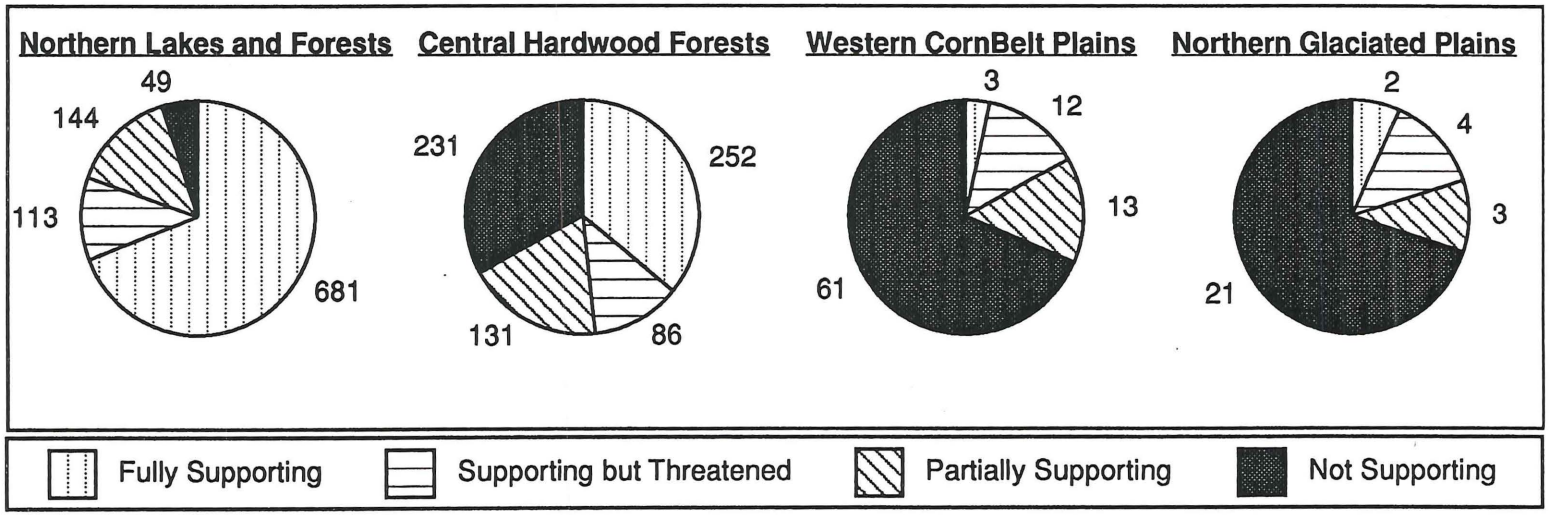


Figure III-7. Swimming Use Support of Lakes by Number of Lakes per Ecoregion



Measures such as chlorophyll-a and transparency can be related to nutrient levels in lakes. Based on monitored and evaluated data, nutrients are the primary pollutant found to be causing nonsupport in lakes with phosphorus being the most significant. Since agricultural and urban runoffs are the most significant source of nutrients in Minnesota's lakes it appears that NPS agricultural and urban storm water pollution should be the primary area of concern.

Trophic Status and Use Support

The following summarizes trophic status (see Figure III-6) and use support (see Figure III-7) for each ecoregion.

The Northern Lakes and Forests ecoregion contains approximately 5,558 lakes or about 46 percent of Minnesota's lakes. These lakes are generally small and deep. For the assessed lakes, surface areas are typically 100 to 550 acres, while maximum depths are typically between 20 to 60 feet.

The trophic status of lakes in this region range from oligotrophic to hypereutrophic. A majority (80 percent) of the assessed lakes in this region fully support swimmable use and five percent do not support swimmable use. Those not fully supporting tend to be shallower (mean maximum depth = 25 feet) than the norm (mean = 32 feet) for this region. Lakes that fully support swimmable use tend to be deeper than the norm for this region (mean maximum depth = 52 feet).

The North Central Hardwood Forests ecoregion contains approximately 4,765 lakes or about 40 percent of Minnesota's lakes. In terms of physical morphometry these lakes are quite similar to those of the Northern Lakes and Forests ecoregion.

A wide variation in trophic status is evident in the lakes of this region, which range from oligotrophic to hypereutrophic. Typically lakes in this ecoregion can be characterized as eutrophic in nature (44 percent). The remainder are evenly divided between mesotrophic and hypereutrophic (Figure III-6). Those lakes not supporting swimmable use tend to be shallower (mean maximum depth = 27 feet) than the norm for this region (mean = 31 feet). Lakes with maximum depths less than 30 feet typically do not remain thermally stratified during the summer. Internal loading from sediments in these lakes may be a significant source of phosphorus, in addition to the watershed sources.

The Western Corn Belt Plains ecoregion contains approximately 577 lakes, or about five percent of Minnesota's lakes. In general, these lakes are quite shallow and have larger surface areas than the lakes in the Northern Lakes and Forests and North Central Hardwood Forests ecoregions. Typically, surface areas are between 250 to 1,000 acres and maximum depths are between 5 and 20 feet.

All assessed lakes in this region are either eutrophic or hypereutrophic with about 17 percent of the lakes in this region fully supporting swimmable use (Figure III-7). The lakes supporting swimmable use tend to be slightly deeper (mean maximum depth = 15 feet) than the norm (mean = 10 feet) for this region.

The Northern Glaciated Plains ecoregion contains approximately 855 lakes, or about seven percent of Minnesota's lakes. Lakes in this region are all quite shallow and rather large. Based on assessed lakes, surface areas are typically 250 to 900 acres and maximum depths are typically 6 to12 feet.

The lakes in this region are very fertile, based on their phosphorus concentrations, and a majority (83 percent) are considered hypereutrophic. Two lakes in this ecoregion were assessed as fully supporting swimmable use based on Secchi transparency data. Those lakes are deeper than the norm for the Northern Glaciated Plains.

Table III-8. Distribution of Assessed Lakes and Acres by Ecoregion

Number of Lakes Assessed (by Ecoregion)	Total Lakes	1994 # assessed	1992 # assessed	1994 acres assessed	1992 acres assessed	1994 # monitored	1992 # monitored
Northern Lakes and Forests	5,558	987	960	1,226,890	1,213,592	532	496
Central Hardwood Forests	4,765	700	674	388,499	380,260	534	473
Western CornBelt Plains	577	89	84	61,332	82	64	47
Northern Glaciated Plains	855	30	33	48,425	661	26	27

Causes of Nonsupport of Uses

Both the quantity and quality of the runoff from a lake's watershed, along with the physical characteristics of the lake, determine the quality of the lake water. Runoff from cultivated and urban areas will usually carry more nutrients and sediments to lakes than the runoff from forested or wetland areas. The mean depth (or maximum depth) together with the surface area of a lake provide an indication of the lake's ability to assimilate nutrients and sediments coming from the watershed. It also determines the likelihood of internal sources of nutrients contributing to the production of algae and rooted vegetation. Thus as total phosphorus concentrations in the lake increase, lake eutrophication tends to increase. This impact of increased nutrient levels, along with NPSs, will contribute to lake impairment or nonsupport.

A listing of assessments for lakes is in Appendix Three. The list is organized by watershed or USGS hydrologic unit code. The ecoregion, swimmable use support and trophic status are listed for each lake.

Lake Programs and Support Activities

Monitoring of lake water quality is a very important component of any program to protect or improve water quality. When more information is available on the status of lakes, the state will be better able to develop programs to protect and improve the condition of lakes. The state's ability to track changes or trends in water quality is directly tied to statewide lake monitoring programs. Funding under the Lake Water Quality Assessment Grant under CWA Section 314(a) has helped to improve the database.

Since the 1992 Water Quality report, improvement has been made in total number of assessed acres (and numbers) of lakes. In this assessment, 1,813 lakes and 1,751,205 acres have been assessed for support of swimmable use. This is an increase of 60 lakes and 26,348 acres over the previous assessment. Data in Table III-8 show the increase in monitored lakes by ecoregion. The number of monitored lakes increased in most regions. The increase in numbers of lakes was not as great as in previous assessments because monitoring emphasis was on sampling of ecoregion reference lakes and lakes exhibiting trends, which are lakes already in the database.

Improvements in the data base can be attributed to the three lake monitoring programs discussed in Part III, Chapter One: the CLMP, LAP, and MPCA's ecoregion reference lake monitoring. Ecoregion reference lake monitoring has resulted in a comprehensive database for each region. These data were used to develop phosphorus criteria for each ecoregion.

These phosphorus criteria have been used to: (1) prioritize and select projects to be funded through Minnesota's NPS and CWP programs, and the federally funded section 314 Clean Lakes Program; (2) aid resource managers in developing water quality management plans; (3) as an educational tool for communicating what can reasonably be expected in terms of lake quality; (4) as a guide for enforcement decisions; (5) as a guide for interpreting nondegradation requirements, and for assessing swimming use support by ecoregion.

In 1993, a comprehensive analysis of lake water quality trends based on Secchi transparency data was conducted. Secchi transparency was selected as the variable for assessing temporal trends in lake trophic state. Most of this data was collected by citizen volunteers through Minnesota's CLMP program. The results of this analysis are included in a report entitled, "Lake Water Quality Trends in Minnesota."

As in the 1992 Water Quality report, lakes with eight years or more of CLMP data have been assessed for trends. On the basis of published work, it appears that eight to ten years of data are required to produce a Secchi disk transparency database sufficient to detect (at some point in the future) a ten percent degradation in clarity.

The 1993 assessment for transparency trends included data from 161 lakes. This represents eight percent of the overall 1,813 lakes included in this report. A nonparametric statistical test was used to determine trends in transparency over time. A ten percent level was used as the basis for identifying significant trends. Thirteen lakes were considered to have a significant decline in transparency and 44 lakes were considered to have a significant increase in transparency over time. About half of the remaining lakes had nonsignificant declines and the other half had nonsignificant increases in transparency.

No strong regional patterns were found in this data. However, 11 of 13 lakes posting a significant decline in transparency were located in the North Central Hardwood Forests ecoregion. This ecoregion includes the majority of the state's population and the lakes receive much usage. More citizen complaints regarding lake water quality arise from this ecoregion than any other in Minnesota. Individual case studies were conducted on 37 lakes. These case studies are an attempt to corroborate the transparency trends with additional trophic status, user perception, watershed and modeling information.

Some of the lakes showing significant trends were selected for more intensive monitoring of chemical, physical and biological characteristics in order to better evaluate the trends suggested by the Secchi transparencies. This analysis is an ongoing part of the 314(a) Lake Water Quality Assessment Grant activities.

Chapter Five: Great Lakes Assessment

Background

Lake Superior, the largest of the Great Lakes, contains ten percent of the world's supply of freshwater. Minnesota's North Shore of the lake covers 272 miles of the 2,961 miles of total shoreline. Lake Superior is known for its beautiful, rugged coastline, its clear, deep waters and its colorful regional history. This Great Lake is also a valuable economic resource. Tourism in the four Minnesota counties bordering Lake Superior support more than 10,000 jobs for the region, with salaries and wages totaling $193 million. Tourists spend an estimated $500 million per year in these counties.

The State of Minnesota recognizes that protecting the ecological health of the lake is critical for maintaining its value as an economic and environmental resource. Regulatory programs have succeeded in decreasing pollutants that cause the type of pollution that people can see and smell. On the other hand, the more subtle form of pollution in Lake Superior, by chemicals that are long lasting and toxic, is an ongoing problem. The State of Minnesota is committed to a variety of programs for reducing the impact of toxics on Lake Superior.

Binational Program to Restore and Protect the Lake Superior Basin

In September 1991, the governments surrounding Lake Superior took a challenge from the IJC to set aside Lake Superior as a zero discharge demonstration area. The goal, as identified in the agreement signed by Minnesota's Governor and others, is to achieve zero discharge and zero emission of certain persistent bioaccumulative chemicals that may affect the ecosystem of the Lake Superior basin. The governments identified three strategies for achieving zero discharge. They are pollution prevention (altering a process so hazardous chemicals are not used or produced), special designations (similar to the ORVW designation Minnesota already has for the North Shore) and traditional controls and regulations. The nine zero discharge chemicals identified in the binational program include chlordane, DDT, dieldrin, dioxin, hexachlorobenzene, mercury, octachlorostyrene, PCBs and toxaphene.

With help from partners in other states and stakeholders from across the basin, the MPCA has been involved in a variety of activities to plan and implement the binational program. Following are some of the projects in which the MPCA has been involved:

Lakewide Management Plan (LaMP)

Ontario, Minnesota, Wisconsin, Michigan, Environment Canada and USEPA have drafted Stage I of the LaMP for Lake Superior. Although the Great Lakes Water Quality Agreement requires a LaMP for each of the Great Lakes, the Lake Superior LaMP is influenced by the binational program and its goal of zero discharge. The current draft characterizes the lake and the major discharges. It also identifies the chemicals that are causing use impairment. Besides the nine zero discharge chemicals, the LaMP documents impairments or criteria exceedances due to alpha-BHC, heptachlor epoxide, polyaromatic hydrocarbons, aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel and zinc. The next version will include air emission point sources and minor discharges. Copies of the LaMP are available from the MPCA or USEPA.

St. Louis River Remedial Action Plan

There are eight Areas of Concern (AOC) on Lake Superior that have been identified by the IJC under the 1987 amendments to the Great Lakes Water Quality Agreement. Minnesota and Wisconsin share responsibility for one of these AOCs, which is on the lower St. Louis River. The two states jointly submitted Stage I or the problem definition phase of the St. Louis River RAP to the IJC for review at a public meeting in March 1993. The IJC reviewers and commissioners in attendance at the evaluation noted that the St. Louis River RAP represented one of the best Stage I plans reviewed to date. With the problems identified in Stage I, the next step is to develop an action plan. To accomplish this in Stage II, the committees have formed four work groups. These groups are in the process of developing recommendations that will detail which actions will be necessary to restore impaired beneficial uses. Forty-four Stage II recommendations have been developed to date. A 40 member Citizen Advisory Committee meets regularly to assist in determining priorities for action. One of the recent recommendations asks the US Coast Guard to monitor wastewater treatment systems in ships to ensure that such systems are in compliance with federal standards and to prohibit discharges of improperly treated wastes to Duluth-Superior Harbor and Lake Superior.

Minnesota and Wisconsin Storm Water Project

The MPCA is cooperating on a storm water project sponsored by the WDNR. As part of the project, the cities of Hibbing, Virginia, Cloquet and Duluth will develop storm water runoff plans. The purpose of the project is to reduce flow and solids, thereby reducing toxics and the nutrients entering the St. Louis River.

Monitoring

Lake Superior Fish: As part of the Binational Program, the MPCA has contracted with the USFWS to collect Lake Superior fish for baseline contaminant analysis. Minnesota Pollution Control Agency staff previously assembled existing fish data from all parties for the LaMP.

St. Louis River Sediment Assessment (Tier 2): The MPCA is characterizing contaminants in lower St. Louis River sediments. The characterization study will be followed by development of a remediation plan.

St. Louis River Load Study: This study will quantify both the concentration of toxics and the flow of the river, making it possible to estimate the mass of toxics delivered into the St. Louis River AOC and out to Lake Superior by this river, its largest US tributary.

Pollution Prevention Strategy for Lake Superior

This document was produced by the three Lake Superior states (Minnesota, Wisconsin and Michigan) and USEPA. It recommends 12 pollution prevention strategies for eliminating discharges and emissions of the nine chemicals in the Lake Superior basin. Copies of the report are available from the MPCA.

VSQG Survey

The MPCA surveyed small businesses in the basin. Of the 1,131 Very Small Quantity Generators (VSQG) now known to exist in the Minnesota portion of the basin, half of them were identified in this one survey. Besides being made aware of their status as VSQGs, the businesses were told how and where they could safely dispose of their hazardous wastes.

Agricultural Clean Sweep

The MDA did an agricultural clean sweep for banned pesticides in the Lake Superior basin. The collection netted 4,800 pounds of banned pesticides in one sweep, including 1,200 pounds of DDT. More agricultural clean sweeps are needed in the entire basin. In most cases, a second sweep will collect at least as much as the first.

New Grants

The MPCA and its partners in the other states have received funding for a series of grants aimed at reducing persistent toxics, especially mercury, in the Lake Superior basin. In the future, some of the activities we will see in the Minnesota portion of the basin include awareness campaigns and hazardous waste collections, mercury sampling at emission sources and mentoring of smaller communities by the Western Lake Superior Sanitary District (WLSSD).

Lake Superior Partnership

The MPCA, WLSSD and other area dischargers are participating in a pilot multimedia inspection program (see box on Page III-21). Typically, these regulatory activities have been split by MPCA organizational divisions of water quality, air quality, solid waste and hazardous waste.

Great Lakes Water Quality Initiative

As one of eight Great Lake states, Minnesota participated in the development of the Water Quality Guidance for the Great Lakes System of the Great Lakes Initiative (GLI). The GLI, mandated by amendments to the CWA, is a joint USEPA and state effort. The GLI has a threefold goal: 1) to establish uniform water quality criteria for all waters in the Great Lakes basin, 2) to implement procedures to set effluent limits for dischargers in the basin, and 3) to set antidegradation policies for waters in the basin.

The GLI water quality criteria will protect aquatic life, human health and wildlife from the harmful effects of pollutants. The implementation and antidegradation provisions will translate the criteria into effluent limits that will go into discharge permits. Many aspects of the proposed GLI procedures are similar to what Minnesota already has in its water quality rules. However, pollutants that have bioaccumulation factors greater than 1,000 (called Bioaccumulative Chemicals of Concern (BCC)) will be treated more stringently than nonbioaccumulative pollutants under the GLI. Dischargers will have to meet chronic criteria for BCCs in their effluent ten years after the GLI goes into effect under the current proposal. Also, the GLI antidegradation policies for BCCs will be more stringent than for non-BCCs.

The USEPA is reviewing the many comments received on the proposed GLI and plans to issue a final GLI regulation in March 1995. Great Lake states will then have two years to adopt the GLI into their own rules.

Assessment of Use Support

The Minnesota portion of Lake Superior has fish consumption advisories due to high levels of mercury and PCBs in fish (see Public Health section). In addition to PCBs, the draft LaMP notes that concentrations of mercury, dioxin and toxaphene exceed the fish consumption criteria in the open waters of Lake Superior. (Note: the LaMP does not discriminate between Canadian and US waters or each state's portion of the lake.) Until atmospheric deposition of these chemicals can be controlled, it is unlikely the advisories will be significantly altered.

Lake Superior Partnership

The MPCA, Western Lake Superior Sanitary District (WLSSD) and the facilities that discharge to WLSSD are all participating in this unique partnership. This Lake Superior Partnership is the effort by the agency, the major treatment plant in the Minnesota portion of the basin and pretreatment dischargers to work together to discuss pollution prevention, pretreatment, permit and enforcement activities and cross media contamination. Previously, the agency dealt with these facilities according to individual program permits. For example, air quality and water quality program inspectors would not be familiar with each others' permit conditions.

One special characteristic of the partnership are the 17 pilot multimedia inspections. These permittees discuss their facility with the environmental inspectors prior to inspection. The actual multimedia inspection involves inspectors from each of the MPCA's program areas. The completed inspections have both shortcomings and advantages which are summarized as follows:

- Businesses found it helpful and efficient to have all the inspectors see their facilities at the same time. For example, without multimedia inspections, an inspector from one program might make a recommendation that would cause the facility to be out of compliance with another program.
- The agency found that multimedia inspections consume quite a bit of time because of the coordination needed for all the inspectors' reports.
- Programs that use unannounced inspections found shortcomings in the advance notice of multimedia inspections.
- The partners found they had a greater understanding of the capabilities and limitations of the other partners.
- Some problems were found with multimedia inspections that would not have been found without them. For example two facilities were found with unpermitted solid waste facilities.

The future of the Lake Superior Partnership is currently being decided. The partners have again assembled since the 17 inspections are complete. Their goal is to keep some of the most useful characteristics of the partnership, especially the foundation of good communication between the partners.

Chapter Six: Wetlands Water Quality Assessment

Background

Minnesota has made several advances in wetland protection and management during 1992 and 1993 including promulgation of two regulatory measures for the protection of wetlands. They include:

1) The administrative rules adopted by the Minnesota BWSR in accordance with the WCA of 1991; and

2) The development of wetland water quality standards, which will be effective in April 1994.

Both these measures provide increased protection of wetlands, which are a key component of water resources in Minnesota.

WCA Implementation

The Board of Water and Soil Resources (BWSR) completed Minnesota Rules ch, 8420 which regulate the implementation of the WCA of 1991 by Local Government Units (LGU). Local government units include cities, counties, townships, soil and water conservation districts and watershed management agencies. The rule which took effect January 1, 1994 requires the LGU to regulate drain and fill activities in all wetlands that are not included as *public waters wetlands*. *Public waters wetlands* are the wetlands listed on the Protected Waters Inventory regulated by the MDNR under Minnesota Statute 103G. Under the WCA, certain wetland types, sizes and activities are exempted from regulation by the LGU. Regulations implementing the WCA provide authority to the LGU to grant one or more of 25 exemptions for certain project types. These exemptions principally apply to proposed land use activities on smaller less inundated wetlands. The LGU's are required to confirm to BWSR their acceptance of the responsibilities to administer requirements of the WCA and to indicate their jurisdictional area.

One of the strengths of local government regulation is their relative closeness to the wetland resource and their ability to integrate mandated wetland protection efforts with the local zoning and planning responsibilities. Another anticipated advantage to LGU administration of these wetland protection measures will be effective follow up monitoring and enforcement of conditions included in wetland replacement plans.

A challenge to this newly implemented local regulation will be for BWSR to coordinate the many officials in all cities, townships, counties, SWCDs and watershed management organizations that seek approval to implement this program within their jurisdiction. Training, program interpretation and application and consistency in wetland delineation will also be a major challenge.

Wetland Water Quality Standards and Authorities

Following USEPA guidance the MPCA recently developed narrative water quality standards for wetlands, as part of several revisions to Minnesota Rules ch. 7050. Following solicitation of outside opinion, a 30 day public notice period of the proposed rule, six administrative hearings and two appearances before the MPCA Citizens Board, Minnesota adopted the final rule on January 25, 1994. The following are the amendments pertaining to wetlands that were added to Minnesota Rules ch. 7050 during the 1993 triennial review of water quality standards:

1) Define wetlands in the water quality standards.
2) Assign water use classifications for wetlands.
3) Adopt narrative nondegradation standards to protect wetlands from harmful or otherwise objectionable conditions resulting from human activities.
4) Apply nondegradation standards to wetlands through wetland mitigation sequencing (avoid, minimize and mitigate).

Minnesota Rules ch. 7050 defines wetlands as: "those areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Constructed wetlands designed for wastewater treatment are not waters of the state. Wetlands must include the following attributes:

1) A predominance of hydric soils.
2) Inundated or saturated by surface water or ground water at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in a saturated soil condition.
3) Under normal circumstances support a prevalence of such vegetation."

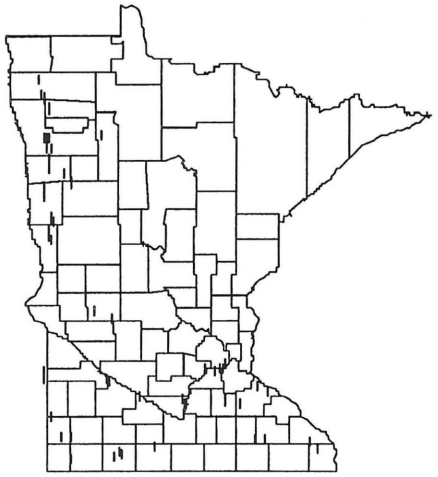
Wetlands have been assigned the following designated uses in the water quality standards: Class 2D wetland waters are protected in support of aquatic life and recreational uses. Dissolved oxygen levels in backgrounds less than 5.0 mg/l daily minimum must be maintained at background, pH and temperature must be maintained at background levels. Class 3D wetland waters are protected in support of industrial uses. Chlorides,

hardness and pH must be maintained at background levels. Class 4C wetland waters are protected for irrigation use and for uses of wildlife, livestock, erosion control, ground water recharge, low flow augmentation, storm water retention and stream sedimentation. In protecting these uses, pH must be maintained at background levels and settleable solids must not accumulate in amounts that result in a loss of use. Class 5 wetland waters are protected in support of aesthetic enjoyment and navigation. For protecting these uses, pH and hydrogen sulfide must both be maintained at background levels.

Through application of these narrative wetland standards, degradation of wetlands from permitted activities will not be allowed. To avoid this degradation associated with permitted activities, these activities are required to be avoided, minimized and in addition any unavoidable physical alterations must be adequately compensated by the replacement of the wetland acreage to satisfy the No-Net Loss Policy of the state. Physical alterations of wetlands would include activities resulting in loss of designated uses associated with filling, draining, excavating or inundating wetlands. Restoration of drained or degraded wetlands would not be considered a physical alteration.

Minnesota recognizes certain significant waters as ORVWs. In some instances wetlands are included in this designation. For example, a wetland is designated as an ORVW when located in a Scientific and Natural Area as designated by the MDNR. In addition, calcareous fens are listed as ORVWs because of their unique floral and faunal communities and their relative sensitivity to impact including hydrologic changes. Calcareous fens are identified and located by the MDNR (see Figure III-8). During each triennial revision of the water quality standards newly identified calcareous fens are considered for listing as ORVWs in state water quality rules.

Figure III-8. Location of 75 Calcareous Fens Listed as Outstanding Resource Value Waters in Minnesota Rules



Prior to this standards revision, state statutes included all waters, including wetlands, as "waters of the state." Therefore, wetland waters were already protected by the water quality standards. The standards developed are more appropriate to the wetlands resource and clarified the application of nondegredation policy to wetlands. The inclusion of a specific definition of wetlands as part of the revised standards was also requested by USEPA.

Another tool used to protect wetlands is Minnesota Executive Order 91-3. This Executive Order mandates that all state agencies protect, enhance and restore Minnesota's wetlands to the fullest extent of their authority. The Executive Order also established a strict policy of No-Net Loss of wetlands in the state that applies to projects under state agency jurisdiction. The revised water quality standards comply with this directive from the Governor and the MPCA continues to operate under that executive directive.

Figure III-9. Water Quality Measurements of 30 Reference Wetlands for Total Suspended Solids (in mg/L) and Turbidity in ntu Units

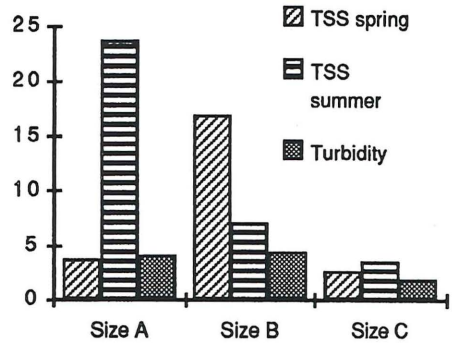
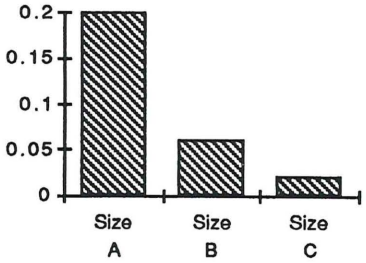


Figure III-10. Summer Values of Orthophosphate (in mg/L) for 30 Reference Wetlands



In Figures II-9 and III-10, 30 reference wetlands are grouped into three size classes:

Size A: 1.8 - 2.0 acres,
Size B: 2.1 - 3.5 acres, and
Size C: 3.6 - 34 acres.

Permit Simplification Activities

In Minnesota there are multiple levels of government involved in regulating activities in wetlands. The LGU administers provisions of the state WCA and the MDNR regulates wetlands designated as Public Waters Wetlands. The USCOE administers provisions of the CWA Section 404 program for all waters of the United States and Section 401 Water Quality Certification is provided by the MPCA.

State agencies including the BWSR, MDNR, MDOT, and MPCA, and federal agencies including the USCOE, USFWS, USEPA (Region 5) and the SCS are working together in an ongoing task force to resolve issues of wetland regulation in Minnesota. These agencies drafted a Memorandum of Understanding (MOU) that states the intent of the agencies to continue cooperation in simplifying wetland permitting activities. As a result of this cooperation the agencies requiring applications for permitting or approval of wetland activities have developed a single joint notification and application form. An applicant may fill out an application document and mail copies to the five agencies listed on the form. This satisfies initial application requirements in a single action. The USCOE has issued a public notice for a General Permit that will provide 404 permit approval for certain activities when they are approved by the LGU under the WCA.

Nationwide Permit Negotiations

Nationwide permits are issued by the USCOE under the CWA Section 404 program. The MPCA certified some of the nationwide permits with conditions, and denied certification for some of the nationwide permits due to water quality concerns. The USCOE and the MPCA negotiated acceptable Regional Conditions and Certification Conditions for the various certified permits. Conditions were applied to nationwide permit number 26, the most commonly used nationwide permit in Minnesota, 1) limiting its application to projects impacting less than three acres of wetland, 2) limiting its application to projects that do not impact ORVW, and 3) requiring notification of the MPCA, the MDNR, the Minnesota Office of Historical Preservation, the USFWS and the USEPA when the proposed project impacts 0.5 acres or more of wetland.

Storm Water Impact to Wetlands

Nonpoint source runoff and point source storm water significantly increase pollutant loadings to surface and ground waters. As these problem sources continue to be studied, different elements of the runoff flow characteristics and pollutant loads associated with them are correlated with the varying landscapes in Minnesota. Agricultural, forested, industrial, commercial areas and urban runoff all pose different challenges to provide either source reduction or BMPs to reduce water quality degradation caused by runoff in these areas. A common water quality BMP in many of these land use situations involves natural wetland basins in the watershed. Natural wetland basins provide water quality benefits to the watershed and the protection and restoration of wetlands for water quality improvement is a frequently used BMP.

Storm water management and the associated impact to wetlands in the urban area are among issues currently being explored by a federal, state and local agency task group. The MPCA promotes construction of storm water retention or treatment ponds in developing areas and the preservation of natural wetland basins as part of wetland protection efforts. Construction of storm water ponds and the preservation of natural wetland basins is sometimes difficult to achieve in developing areas where other incentives may be pushing for maximizing land development. The task group on Urban Storm Water has a mission to develop design criteria and wetland impact policy for storm water management and treatment and offer this information through publication and conferences to the many local, state and federal government agencies that regulate activities involving storm water and wetlands impacts.

Surface water planning is a component of local government, while the permitting for the draining or filling of wetlands associated with the implementation of these plans may involve state and federal authorities. Therefore, development of design criteria for storm water management systems is needed to achieve the desired treatment goals of all interests. Development of a policy for implementation of these design criteria is needed to ensure consistent wetland protection at all levels of government, thereby reducing the potential for government gridlock over projects where responsibilities may overlap.

Representing a predominantly agricultural area of the state, the Minnesota River basin study documented the importance of wetlands with relation to peak flow, sedimentation and chemical pollutants in tributaries and the main river stem. The study should lay a foundation for developing BMPs, wetland protection and wetland restoration techniques to achieve much needed water quality improvements in the watershed.

Comprehensive Wetland Planning

Beginning in July of 1993, Minnesota began a statewide comprehensive wetland conservation planning effort. The MDNR is facilitating this ongoing effort to coordinate existing local, state and federal wetland programs resulting in more effective management of wetland resources. As part of this planning effort, overall statewide wetland goals will be articulated and guidance will be developed for linking these goals with local decision makers. Participants in the planning process include representatives from: state asso-

ciations of cities, counties, watershed districts and SWCDs; state agencies including MDA, BWSR, DNR, MPCA and MDOT; federal agencies including the USCOE, USFWS, SCS, and Federal Highway Administration. The planning process will establish clear objectives for the state's wetland resources for the future, integrating existing regulatory and nonregulatory wetlands programs at all levels of government and identify new programs and strategies required to achieve the plan's objectives.

Basin Planning Initiative

The MPCA is developing a basin planning and management approach and at the same time is moving toward more quantitative and criteria based decision making. In making this shift the MPCA recognizes that there is only minimal existing water quality monitoring information available for wetlands. Therefore, one of the principal needs is to provide consistent monitoring methodologies for wetlands. Efforts are being formulated by the MPCA for initial water quality monitoring of wetlands in priority watersheds of selected basins. One benefit of this effort is to develop a multiple tiered approach for assessing designated uses of the wetland as part of these monitoring efforts. This multiple tiered assessment methodology would include working with local government units and citizens.

The Reference Wetlands Project

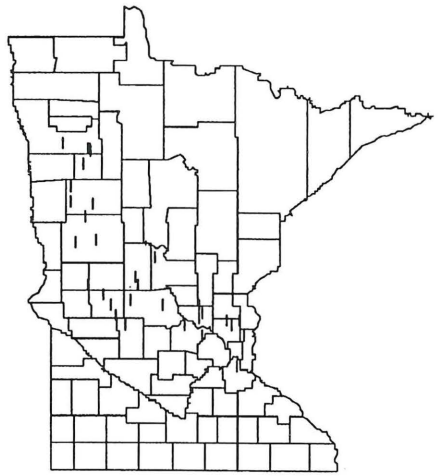
The MPCA has undertaken a reference wetland project to develop the basis for assessing the biological and chemical health of wetlands in Minnesota. The project, originally funded by the Legislative Commission on Minnesota Resources through the Environmental Trust Fund, is currently funded by USEPA through the Office of Research and Development. Biological assessment is important because changes in species composition can reflect pollution or habitat alteration. In addition, biological communities are a key to understanding whether restored wetlands can achieve a condition comparable to natural wetlands. This requires knowledge of reference wetlands that have had minimal disturbance.

Thirty-five isolated or depressional wetlands including three impact sites were selected in seventeen counties in the North Central Hardwood Forest Ecoregion in Minnesota (Figure III-11). These reference wetlands are located largely on public lands managed by Macalester College, the Nature Conservancy, MDNR Heritage Program, MDNR Wildlife, St. John's University, University of Minnesota and the USFWS (WPA's). Invertebrate communities were the main focus of study, but vegetation, amphibians, land cover around the wetlands, water and sediment chemistry were also analyzed.

Wetland water quality is surprisingly high with very clear water, low TSS (Figure III-9) and low orthophosphate (Figure III-10). Turbidity in the reference wetlands is in the range of the clearwater lakes of Northern Minnesota. In summer, water in the smaller sites becomes more chemically concentrated as they dry down. Sites less than two acres had higher TSS and orthophosphate in the summer than in the spring, while larger sites tended to have low TSS and lower phosphate in summer (Figures III-9 and III-10). Where conductivity, a measure of overall ionic concentration, is higher, there are greater numbers of some invertebrates in the wetlands.

Biologically the reference wetlands are very diverse. Invertebrates that act as predators in wetlands include many taxa or kinds of beetles, bugs, dragonflies and damselflies. These feed on a diverse array of herbivorous taxa, like the chironomids or midges, mayflies and caddisflies and crustaceans such as clam-shrimp and scuds. Nesting waterfowl and young ducklings are dependant on the rich invertebrate food source in wetlands. One small reference wetland had over 1,000 clam shrimp per sample, 23 taxa of beetles and five species of young frogs. This productive but temporary wetland was dry by July. A significant relationship exists between the size of the wetlands and the amount of frog reproduction, with smaller sites having more tadpoles per sample than larger wetlands.

Figure III-11. Location of 35 Reference Wetlands in the North Central Hardwood Forest Ecoregion



Present work involves determining 'guilds' or groups of taxa that indicate the condition of the habitat. There are some significant relationships between crustaceans, mayflies and damselflies to some water quality indicators. The diversity of the sedge family may be another useful indicator. A variety of indicators of wetland health including not just invertebrates, but vegetation diversity and the densities of amphibians is being evaluated. This will lead toward the multimetric or several parameter approaches advocated by USEPA for biological criteria.

Wetland Monitoring and Restoration Activities

The MPCA Duluth Regional Office began an effort in 1993 using volunteers to monitor breeding vocalizations of local frog populations in the riverine wetland areas along the St. Louis River. Each of the observation sites was visited three times from April through July. The data presented in Table III-9 shows that frog species vary greatly in their distribution. This difference may be due in part to site conditions and relative sensitivity of the various frog species to pollution related impacts. Similar efforts in other parts of the state including the Twin Cities Metropolitan area will over time provide valuable information about wetland health based on amphibian information. Table III-9 shows the frequency that each species was heard at 50 wetland sites in the first year of the St. Louis River survey. The value reflects the number of sites at which a species' breeding call was heard as a percentage of the 50 sites at which volunteers listened for calls.

Three sites reported hearing what was identified as a pickerel frog. This data is not included in the table because this identification was not confirmed and the sites are out of the normal range of the pickerel frog.

Though there is limited accounting of the status and trends of wetland resource condition in the state, several resource agencies have contributed to the restoration of the wetland resource base in Minnesota. Table III-10 shows approximate totals of restored wetland acres in three regions of Minnesota, as recorded by the USFWS and the SCS during 1992 and 1993. The majority of these restorations involved depressional or riverine wetlands concentrated in the prairie pothole region of the state. It should be noted that these figures of restored wetland acres represent best estimates of projects completed and/or under contract by the respective agencies.

Table III-9. Frequency of Frog Occurrence

Wood Frog	54%	American Toad	30%	Number of samples = 50,
Chorus Frog	40%	Gray Treefrog	44%	Data collected during the
Spring Peeper	80%	Mink Frog	4%	1993 St. Louis River
Leopard Frog	14%	Green Frog	12%	Vocalization Survey

Table III-10. Restored Wetland Acres by Region in Minnesota during 1992 and 1993 (Courtesy of the USFWS and the SCS)

Region	1992 Acres	1993 Acres
Prairie Pothole Region	3,370	3,276
Central Hardwood Forest Transition Region	896	583
Northeast Forest Region	31	15

The BWSR restored 210 wetland acres statewide in 1992 and 349 acres as part of the first of two application cycles in 1993. The MDNR cooperated in many of these restorations and conducted some of their own restoration projects. Many private organizations and interests were involved in restoring these wetland acres, and have conducted wetland restorations without direct assistance from federal agencies. It is extremely difficult to establish the total number of restored wetland acreage in Minnesota because of the large number of agencies and private groups or interests that cooperate in many wetland restoration projects. In the future, it is expected that tracking of wetland restoration projects will improve with the advance of GIS data, technology and techniques.

Minnesota recently completed the digitization of the USFWS National Wetland Inventory. This database is now undergoing field testing. Application databases are currently in development at the MDNR in cooperation with the state Land Management Information Center.

Future Activities and Needs

Minnesota is striving to integrate wetland resource planning activities into the basin planning and management initiative. Key elements to this task include the geographic targeting and prioritizing of wetland resources to manage more effectively priority wetlands on a watershed basis. In the future, wetland monitoring and assessment information will be used to make resource management decisions. It is also recognized that improvements need to be made in linking wetland protection goals to other surface and ground water protection efforts.

Chapter Seven: Public Health/Aquatic Life

Introduction

Fish are a vital part of life in Minnesota. They are an important economic resource for the commercial and recreational fishing industries, and they are an attractive recreational resource for tourists visiting Minnesota year round. Fish are also a significant part of the diet of many fish eating birds and mammals including humans. It is a great concern then, that some waterways in the state are contaminated with chemicals such as mercury and PCBs that are persistent in the environment and accumulate in fish tissue. These chemicals may be detrimental to fish and toxic to wildlife and humans when ingested in significant amounts.

Minnesota agencies survey lakes and stream reaches for contamination of fish tissue with mercury and PCBs. The MDH issues an annual fish consumption advisory for specific waterbodies based on the concentrations of these chemicals in skin-on filets. The advisory lists each individual lake or stream sampled and the consumption advice for each size class of each species sampled. This chapter reviews the methodology and monitoring programs used to determine the fish consumption advice. It also classifies each waterbody according to the most restrictive consumption advisory issued for that waterbody and summarizes this information for small and large lakes, Lake Superior and rivers that have been sampled in Minnesota.

It is difficult to determine an "average" amount of contamination due to species and size dependant factors. This chapter makes use of the classification of a waterbody by its most restrictive consumption advice to characterize the fish consumption use support of each waterbody, and as a representation of the overall fish consumption use support in Minnesota waters. This is a very conservative method for the following four reasons:

1) The fish contaminant data used previously for assessment were collected primarily for the issuance of fish consumption advisories, and were not meant to be an overall representation of Minnesota waters. Fish are generally collected from waters that have a history of contamination, are near suspected sources, have characteristics similar to contaminated waters or are heavily fished.

2) This chapter does not take into account the less restrictive consumption advice and categorizes each waterbody by the single most restrictive advice issued rather than the average or most common advice for the waterbody. Because of this weighting of the worst case fish sample which may not be typical of other fish or the most often caught fish in the waterbody, this summary is not an accurate representation of the overall fish consumption use support for a waterbody.

3) This assessment does not take into account the variability in contaminant levels due to fish size. Larger, older fish have longer exposures to contaminants and generally have higher levels of contamination. Therefore, waterbodies with a high proportion of large fish sampled may be placed in a more restrictive category than waterbodies with a high proportion of small fish sampled.

4) In addition, this assessment does not distinguish between locations with different levels of sampling effort. For example, large lakes larger than 5,000 acres are not sampled as intensively as small lakes (smaller than 5,000 acres) due to logistical difficulties in obtaining samples.

In summary, the nonrandom nature of the sampling and the focus on potentially impacted areas for site selection mean that the usage of the results of fish tissue monitoring should be solely for determining the annual fish consumption advisory, and not as an overall representation of fish contaminant levels in Minnesota. In addition, this report classifies a waterbody by its most restrictive consumption advice, even if it is not representative of the consumption advice for other fish in that waterbody. The information in this chapter is thus intended to reflect fish advisories and cannot be used to represent overall use support.

Methods

The MDH issues a fish consumption advisory each spring that is based on the levels of mercury or PCBs in fish collected from Minnesota lakes and streams. The MDH bases the consumption advisory for mercury contaminated fish on the risk of neurological damage due to mercury consumption. The consumption advisory for PCB contaminated fish is based on fetal and infant development risks associated with PCB consumption. The consumption advice used for this report is intended for the general, annual fish consumer. Advice for women of childbearing age, pregnant or nursing women and young children is more restrictive, and people interested in this information as well as the less restrictive advice for the seasonal, vacationing fish consumer should consult the annual MDH fish consumption advisory. Table III-11 shows the total mercury and total PCB concentrations that trigger the four levels of fish consumption advice.

The fish tissue data collected for the advisory, along with WDNR fish tissue data from Minnesota-Wisconsin border waters, were used for the summary of fish consumption advisories in this report. Currently, the MDNR collects fish from approximately 100 sites each year, 90 percent of which are lakes and ten percent are rivers. Approximately 80 percent of these sites are new, and 20 percent are retests. Fish are collected to represent predator, pan and rough fish. All samples are analyzed for mercury, approximately 40 percent of the samples are analyzed for PCBs, and only a few select samples are analyzed for other contaminants such as dioxin, metals and pesticides.

Sites are chosen using recommendations from MDNR area managers and state and federal agencies based on suspected impacted areas, high fishery usage, lack of current data or special studies. The remaining sites are chosen randomly. Because of the overall nonrandom nature of site selection, it is likely that impacted waters are overrepresented, and data in this summary should be viewed with this in mind.

Minnesota agencies have collected fish tissue data for over 25 years. Due to changes in analytical methods and environmental concentrations over this time, not all fish tissue data is representative of current contaminant levels. Because of this, the following data restrictions are used. For rivers, only PCB and mercury data collected in 1982 or later was used for this report. For lakes, PCB data from 1982 to the present and mercury data from 1977 to the present are used for this report. Data collected between 1987 and 1992 are considered monitored data and are given preference over older data. If there is no monitored data for a given waterbody, data collected between 1982 (mercury in rivers and PCBs in lakes and rivers) or 1977 (mercury in lakes) and 1987 are used. This older data is considered evaluated data.

Lake Results

A total of 491 lakes representing 2,347,981 acres have been sampled for PCBs or mercury in fish since 1977. These lakes represent 4.1 percent of the total 11,842 lakes in Minnesota and 71 percent of total lake acres. Table III-12 shows the total number of lake acres and river miles assessed in Minnesota and those having a consumption advisory for at least one fish species and size class. This shows total river miles and lake acres sampled for mercury or PCBs in fish, and those having a one meal per week, one meal per month or do not eat consumption advisory for at least one size class of a species.

Approximately 99 percent of all Minnesota lakes are less that 5,000 acres. Large and small lakes will be discussed separately to avoid overrepresenting the large lakes.

Small Lakes (less than 5,000 acres)

Out of the 491 lakes sampled for fish contaminants, 453 lakes (92 percent) are less than 5,000 acres in size. These lakes represent 3.8 percent of all Minnesota lakes and 11 percent of the total Minnesota lake acres. Of the 453 small lakes sampled for fish contaminants, 27 lakes (5.3 percent of sampled lake acres) had contaminant levels in all fish samples that allowed unlimited consumption of all sizes of all species sampled in the waterbody (Figure III-12). Two hundred and fifty five lakes or 57 percent of all lake acres sampled had at least one fish sample with a mercury or PCB concentration that placed that size of that species in the one meal per week advisory category. A one meal per month advisory for at least one size of a species is found on 166 lakes which represent 36.3 percent of the lake acres sampled. Only five lakes (less than one percent of lake acres) had a fish sample with contaminant levels that placed it in the do not eat category. These lakes included two lakes in the Twin Cities area and one in Rochester that had

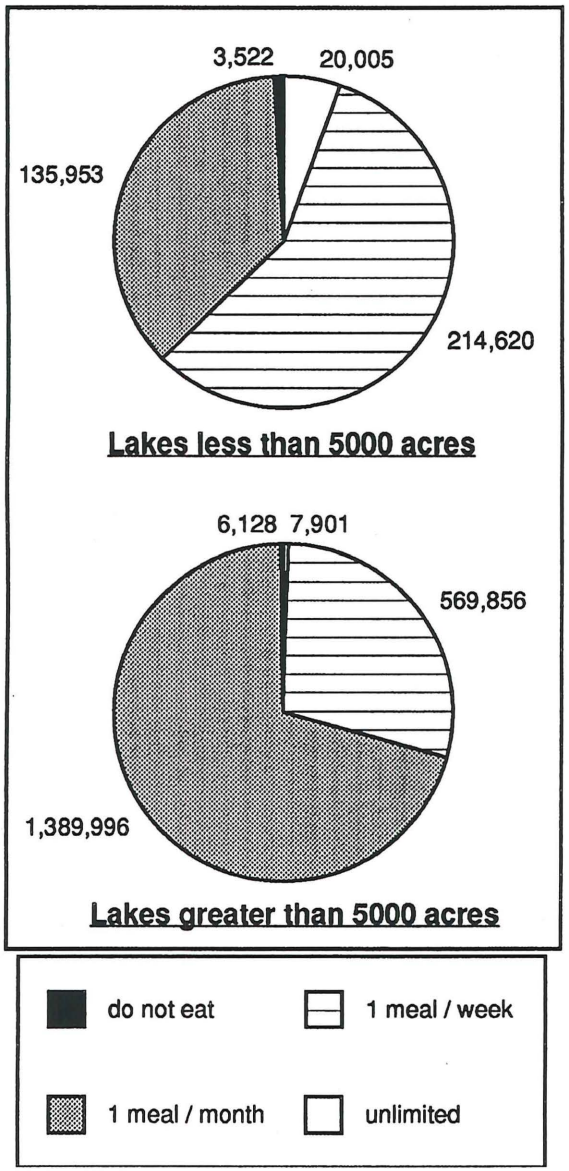
Table III-11. Concentrations (in micrograms per gram wet weight) Used in Fish Consumption Advisories

Consumption Advice	Total Mercury	Total PCB
Unlimited	< 0.16	< 0.025
1 meal/week	0.16-0.65	0.025-0.10
1 meal/month	0.66-2.8	0.11-0.47
Do not eat	> 2.8	> 0.47

Table III-12. Total Waterbody Sizes with Consumption Advisory

Waterbody Type	Size Assessed	Size With an Advisory
Rivers (miles)	2,044	1,858
Total lakes (acres)	2,347,981	2,320,075
Lakes < 5000 acres	374,100	354,095
Lakes > 5000 acres	1,973,881	1,965,980
Great Lakes (miles)	272	272

Figure III-12. Most Restrictive Advice of All Species or Sizes of Fish on a Given Lake. Shown is the Total of Assessed Acres in Each Consumption Category



fish tissue PCB levels greater than 0.47 micrograms per gram and two lakes in Northeast Minnesota that had fish tissue mercury concentrations above 2.81 micrograms per gram.

Large Lakes (greater than 5,000 acres)

Out of the 491 lakes that have been sampled for fish contaminants, 38 lakes (7.7 percent) are over 5,000 acres, and they represent 60 percent of total lake acres. One of these lakes had fish contaminant levels low enough to allow unlimited consumption of all sizes of all species that were sampled. A one meal per week consumption advisory was issued for 19 large lakes (29 percent of the lake acres sampled). Seventeen large lakes were classified as having at least one sample with contaminant levels that placed it in the one meal per month category. These 17 lakes account for 70 percent of the large lake acres that have been sampled since 1977. Only one large lake had a fish sample (collected in 1984) with a contaminant level that placed it in the do not eat category, and it accounted for less than one percent of the large lake acres that were sampled. This lake was in the Twin Cities metro area and had a fish tissue PCB concentration greater than 0.47 micrograms per gram. The information on large lakes is summarized in Figure III-12. This pie chart shows the percentage of sampled lake acres at each fish consumption advisory level for small and large lakes. Lakes are categorized according to the most restrictive consumption advice issued for any size class or species of fish sampled in the waterbody.

Lake Superior

Five locations on the Minnesota shoreline of Lake Superior have been sampled for fish contaminants. These stations are considered to represent the entire 272 miles of shoreline. The bioaccumulation of PCBs in Lake Superior fish continues to be the primary cause for the issuance of consumption advisories in this lake. All stations had at least one fish sample with a PCB concentration high enough to place it in the do not eat category. Siscowet and lake trout were found to have the highest PCB concentrations.

Rivers

Fish from 219 river locations, representing 2,044 miles of Minnesota rivers have been sampled for fish contaminants since 1982. While these miles account for only 2.2 percent of the total 91,944 miles of rivers in Minnesota, they are likely to account for a higher percentage of the river miles that are managed for fish. The same caveat regarding interpretation of the lake categorization applies to rivers. The selection of sampling sites is at least partially nonrandom with a focus on potentially contaminated sites, and a stretch of river is classified by the most contaminated sample found even if no contaminants are detected in other fish from the same river stretch.

Of the 2,044 river miles that have been sampled for fish contaminants, 187 miles (9.1 percent of river miles sampled) were classified as having unlimited fish consumption (i.e. no fish sample had contaminant levels of concern). A one meal per week consumption advisory was issued for at least one fish type on 734 miles of Minnesota rivers (36 percent of river miles sampled). Six hundred and fifty-five river miles (32 percent) had a fish sample that was placed in the one meal per month category, and 468 miles (23 percent) were found to have at least one fish sample with a do not eat consumption advisory. All of the do not eat advisories issued for river segments in Minnesota are due to elevated PCB concentrations in fish tissue.

Figure III-13 summarizes the fish consumption advice for rivers that have been sampled for mercury or PCBs in fish tissue. This pie chart shows the distribution of river miles for each fish consumption advisory category.

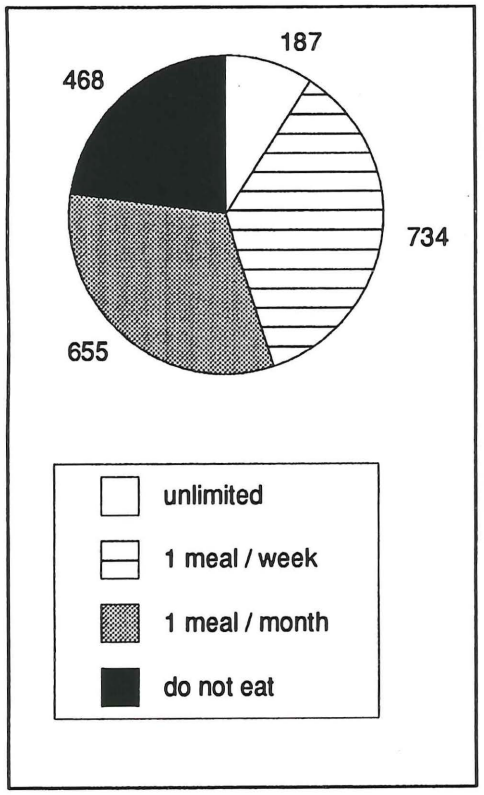
Fish Kills

The MDNR maintains a log of recorded fish kills that have occurred in Minnesota waterbodies. Table III-13 contains the recorded kills that were known to be pollution related during this current reporting period.

Table III-13. Pollution-caused Fish Kills in Minnesota, October 1991 to October 1993

Name of Waterbody	Date	Source of Pollutants	Fish Killed
Lura Lake, Blue Earth County	4-29-92	3500 lb. spill of anhydrous ammonia.	3,054 (crappies, carp, bullheads).
Schwerin Creek, Mower County	4-9-93	250-300 gallons of weed killer (Prowl).	996 (estimated, mostly minnows).

Figure III-13. River Miles Distribution Among Categories of Fish Consumption Advice; 2,044 Total River Miles Assessed



PART IV: GROUND WATER QUALITY

Chapter One: Ground Water Protection

Introduction

More than 200 billion gallons per year or over 500 million gallons of ground water per day are used for residential and industrial purposes in Minnesota. Seventy-five percent of Minnesotans rely on clean ground water for drinking and domestic uses. Minnesota industries, which include mining, paper production, irrigating crops, food processing and power generating, depend on ground water. During 1992-1993 approximately 26,000 new private drinking water wells and 59 municipal wells were drilled. These new wells, in addition to the approximately 400,000 currently active wells, pull ground water from Minnesota's 14 aquifers, which are water bearing geologic units.

Ground Water Protection Activities

Many aquifers in Minnesota yield large volumes of good quality water. Increased concerns about public health and the environment have led Minnesota to put a high priority on maintaining the viability of our ground water resources. The following examples indicate the strong commitment to ground water protection.

Ground Water Protection Act

In addition to the federal laws, Minnesota passed a Ground Water Protection Act (GWPA) in 1989. The GWPA added to an existing state framework for ground water protection. The law also states that ground water quality should be maintained so that it is continually free of human induced pollutants. The GWPA continues to fund projects such as ground water monitoring and data management, increased control of pesticides and fertilizers, agricultural chemical cleanups and local water plans. The GWPA is currently under review and may be strengthened by the Legislative Water Commission.

Comprehensive State Ground Water Protection Program

The MPCA compiled an assessment of Minnesota's ground water protection activities needed to meet the goals of the USEPA Comprehensive State Ground Water Protection Programs (CSGWPP) initiative. Initially, a framework was compiled to define the elements that direct the state's long-term ground water protection efforts. This framework is based on previously written water plans and ground water protection objectives. The current step is the state assessment, a document that compares the state framework to current ground water protection and management programs, to determine gaps in authorities and/or programs. The next steps are to identify priorities and a timeline for implementation.

Wellhead Protection

Wellhead protection (WHP) is a federal and state requirement for public water supply wells. The goal of WHP is to prevent contaminants from entering public water supplies by delineating protected areas around well fields. Within these WHP zones, specific land uses or industries that may contribute to ground water contamination will be managed. The MDH is preparing rules and guidance for communities to use in developing a WHP strategy. Plans include a model WHP ordinance, training and information sessions to water supply staff and data management assistance. The final WHP program will be submitted to USEPA for approval. Eight communities, listed below, are currently active in the WHP process. In January 1994, the MDH, the MPCA and the MDA adopted a Memorandum of Agreement providing for increased cooperation in identifying and addressing potential sources of contamination in WHP areas.

Minnesota's Pilot WHP Communities

Clear Lake	Perham
Edgerton	Renville
Maple Grove	Rochester
Moorhead	St. Peter

Local Water Management Plans

Local Water Management Plans are long-range plans formulated by individual counties to evaluate water quality and quantity and, where necessary, improve management practices to protect their resources. Almost all of Minnesota's counties have written water plans and are working on implementing the goals each has outlined. Local water management and implementation grants are available from the Minnesota BWSR to assist counties with implementing their plans.

Well Construction Code

The MDH adopted an updated version of rules as of May 1993 to improve how wells and borings are drilled and sealed when no longer in use. The new rules make wells less likely to become a pathway for contaminants to enter ground water. Also, attention was given to the grout material of new wells, sealing requirements for

Table IV-1. Minnesota State Agencies and Programs in Ground Water Management

Office of Strategic and Long-Range Planning, Land Management Information Center
- Staff for Environmental Quality Board
- Environmental Policy Planning
- Land Management Information System
- Ground Water Data Clearinghouse
- Systems for Water Information Management (SWIM)
- Data Compatibility Standards

Environmental Quality Board
- Water Resources Committee
- Interagency Water Policy Development
- State Water Plan and Priorities
- Water Monitoring Plan
- Water Information and Education Plan
- Water Research Needs
- Quality & Quantity Trends Report (biennial)
- Enforcement of Data Compatibility Standards

Department of Natural Resources
- Water Appropriation Permits
- Ground Water Sensitive Areas - Criteria and Mapping
- County Geologic Atlases and Regional Hydrogeologic Assessments (with Minnesota Geological Survey)
- MDNR and US Geological Survey Cooperative Programs
- Ground Water Investigations
- Hydrologic Data Collection and Analysis

Board of Water and Soil Resources
- Local Water Resource Protection Grants
- Local Water Resource Plan Review and Approval
- Erosion Control and Water Quality Grants
- RIM Reserve Program
- Well Sealing Grants
- Oversight of Soil and Water Conservation Districts and Watershed Districts

Pollution Control Agency
- Ground Water Monitoring and Assessment
- Ground Water Data Management
- Water Quality Standards
- Pollution Discharge Permits
- Nonpoint Pollution Programs
- Clean Water Partnership Grants
- Agricultural Waste Systems
- Solid and Hazardous Waste Management
- Tanks and Spills Program
- Contaminated Site Response/State Superfund

Department of Agriculture
- Agricultural Best Management Practices Development
- Fertilizer Regulation
- Water Monitoring for Pesticides and Fertilizer
- Pesticide Use Survey
- Pesticide Registration, Application and Certification
- Incident Response and Cleanup
- Waste Pesticide Collection
- Superfund for Agricultural Chemicals
- Sustainable Agriculture and Integrated Pest Management

Department of Health
- Well Management
- Wellhead Protection
- Public Water Supply Program
- Health Risk Limits
- Community Health Services Grants

Department of Education
- Environmental Education Advisory Board
- Office of Environmental Education (jointly by the Departments of Education and Natural Resources)

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abandoned wells, allowances for at-grade finishing of wells that must be placed in high traffic areas, and revised and newly-defined separation distance requirements for new wells from sources of contamination such as petroleum tanks and lines, animal yards, and on-site sewage treatment systems.

Pesticide Management

The lead agency for agricultural activities is the MDA. The MDA supports managed usage of pesticides by registering the users and distributors of pesticides, and by educating and certifying pesticide applicators. Recently, the MDA has begun developing a Pesticide Management Plan that includes education for the general public on pesticide-related issues and implementing the use of BMPs. The MDA has an active ground water monitoring program that will be discussed in more detail in Part IV, Chapter Two.

State Agency Ground Water Management Responsibilities

Minnesotans recognize their reliance on ground water for many daily uses and have a strong interest in protecting the resource. This involves planning regional water needs, water availability and monitoring ground water quality, as well as regulating and remediating problems when necessary. These functions are taken on by many state agencies and local programs (see Table IV-1).

Ground Water Monitoring Efforts

Clean Water Partnership

The CWP was created by the Legislature in 1987 to provide local units of government with resources to protect and improve lakes, streams, and ground water that may be impacted by land-use related pollution. There are two components of the CWP. The first phase involves collecting information on the specific area for a diagnostic study. If the diagnostic evaluation indicates that protective action is needed in the study area, funding for a second phase RAP may be implemented.

Minnesota Department of Agriculture's Ground Water Monitoring Program

The MDA's Ground Water Monitoring Program evaluates the impact of agricultural chemicals on the environment by focusing on a specific region or geologic unit, to determine if an area or a particular landform is susceptible to pesticide contamination. The 1993 report (Haugan, 1993) on the Des Moines Lobe Altamont Association Till Plain Well Network (Southwestern Minnesota) demonstrated that the area is minimally sensitive to pesticide research on the Carbonate Bedrock Wells Network (Southeastern Minnesota), the Sand Plains Wells Network (Central Minnesota) and Reconnaissance Wells Network (statewide).

Geologic Atlases and Regional Studies

Since 1982 the MDNR in conjunction with the Minnesota Geologic Survey, has been conducting in-depth mapping of specific counties and regions.

The results of this research are the County Geologic Atlases, and Regional Hydrogeologic Assessments, which contain detailed maps of an area's surficial geology, bedrock geology, and hydrogeologic systems.

Table IV-2. Results of Sampling for Nitrates

CWP Ground Water Protection Project	Number of Wells Sampled	Nitrates Detections >1/10 RAL	Nitrate Exceeding RAL
Beardsley	27	48%	33%
Brown/Nicollet	58	83%	47%
Clear Lake	46	61%	33%
Coon Creek	21	24%	5%
Maple Grove	20	15%	0%
Moorhead	11	63%	0%
Olmsted County	93	1%	1%
Pineland	34	65%	41%

Table IV-3. Results of Sampling for Volatile Organic Compounds

CWP Ground Water Protection Project	Number of Wells Sampled	Volatile Organic Compounds Detections	Volatile Organic Compounds Exceedances
Maple Grove	6	0%	0%
Moorhead	35	0%	0%
Olmsted County	88	10%	0%

Table IV-4. Results of Sampling for Trace Metals

CWP Ground Water Protection Project	Number of Wells Sampled	Metal %>1/10 of the RAL	Metal Exceedances
Maple Grove	20	0%	0%
Moorhead	35	31%	0%
Olmsted County	91	0%	0%

Table IV-5. Results of Sampling for Pesticides

CWP Ground Water Protection Project	Number of Wells Sampled	Pesticide Detections	Pesticide Exceedances
Brown/Nicollet	40	5%	3%
Clear Lake	12	42%	0%
Moorhead	23	0%	0%
Olmsted County	93	2%	0%

Table IV-6. Source of Contaminants in Ground Water

Sources	Inorganic Substance	Organic Substance	Radio-Nuclide	Biological
Agricultural Land Use				
Animal feedlots and waste storage and application*	X	X		X
Fertilizer application	X	X		
Irrigation and Chemigation	X	X		
Pesticide application				
Industrial/Commercial Land Use				
Hazardous materials use, storage and handling	X	X		X
Hazardous waste disposal	X	X	Possible Minor	
Mining wastes	X	X		
Salvage and junk yards	Possible	X		
Municipal Land Uses				
Incinerator ash	X	X		
Public service and maintenance facilities*	X	X		
Road salt, storage and use of	X	X		X
Sewage and industrial effluent	X	X		X
Sewage sludge	X	X		X
Sewer (sanitary) leakage	X	X		X
Solid waste landfills	X	X		
Urban runoff	X	X		
Other Sources				
Accidental spills*	X	X	Possible Minor	X
Cemeteries*		X		
Infiltration of polluted precipitation and surface water	X	X		X
Injection wells	X	X	X	X
Military facilities	X	X	X	X
On-site sewage treatment systems (individual)	X	X		
Well construction and abandonment				X

* Indicates the source of pollution may be a "point source", depending on the use or facility and current federal and state regulations. Table reproduced from Guidebook for Local GW Protection (1993) with permission from MDNR, Division of Waters.

Statewide Ground Water Quality Monitoring

The MPCA's Ground Water Monitoring and Assessment Program (GWMAP) is a comprehensive statewide ground water monitoring program. GWMAP collects statistically valid samples from Minnesota's 14 principal aquifers, using a stratified random network of primarily domestic wells that meet certain construction and hydrogeologic criteria. The samples are analyzed for 43 inorganic parameters and 68 volatile organic compounds (VOC) (see Appendix Six). This information is then used to evaluate regional water quality, to identify spatial variability in aquifers, and in some cases, to identify particular areas of concern that may require more in-depth water quality analysis. This data is used by local governments, state agencies, residents in the area of study, and others interested in baseline ground water quality information.

The GWMAP data is collected using reliable and consistent methodologies for field and laboratory procedures. Quality assurance and quality control checks are performed regularly and most parameters are analyzed for the lowest detection limits available. Where possible, the GWMAP team samples in conjunction with the counties or other local organizations in the sampling area. This allows local governments to meet their ground water information needs, while benefiting from shared monitoring costs and shared data. The GWMAP also cooperates with other state agencies. The GWMAP has collected samples to be analyzed for the MDA's Pesticide and Nutrient Monitoring Program, and has coordinated its sampling with concurrent Regional Hydrogeologic Assessments by the MDNR. If additional funds are made available for GWMAP, an additional component will be added to the program for intensive time trend analyses of ground water quality to be conducted in sensitive geologic or high growth areas of the state.

In 1992, 158 wells in southeastern Minnesota were sampled. During 1993, 206 wells in south-central and southwestern Minnesota were sampled. Because of the widespread coverage of samples from various aquifers, the data allows for a general characterization of the aquifer water quality, and can highlight land use activities that may impact ground water quality. The GWMAP is currently preparing a report which will discuss this data. Well owners have been notified of their sample results and, where appropriate, advised of potential health or aesthetic concerns with their water supply.

Public Water Supply compliance monitoring data collected by the MDH is on file with the USEPA and was not included in this report.

Substances of Concern

In the results of the ground water quality studies mentioned above, the following parameters were highlighted as of potential concern in Minnesota. Table IV-6 indicates the sources of contaminants.

Nitrates

Nitrates may be the most widespread pollutant in Minnesota's ground water. Nitrates are very mobile in water and can enter ground water from many sources, including yard and crop fertilizers, areas of concentrated animal wastes, septic systems, and surface water that has been exposed to these sources. During 1992-1993, 62 percent of the wells sampled by GWMAP detected nitrates, and seven percent exceeded the MDH Health Risk Limit (HRL) of ten mg/l. Elevated nitrates can have adverse health impacts on infants, children and pregnant women and can necessitate the use of filtration systems, bottled water, or drilling new wells. See Table IV-2 for CWP data.

Volatile Organic Compounds

Volatile Organic Compounds often indicate industrial or other human induced pollution problems. Larger examples of these problems are the MDH-designated well construction advisory areas and drinking water advisory areas, where known industrial sites or landfills have leaked VOC's into the ground water. These are discussed in more detail later in Part IV of this report. In the 356 randomly chosen wells sampled in 1992-1993 by GWMAP for VOC's, 41 wells indicated VOC's were present at low levels, with only two wells having a VOC that exceeded the Recommended Allowable Limit (RAL). See Table IV-3 for CWP data.

Pesticides

Ground water contamination from pesticides can result from agricultural applications especially if used intensively in geologically sensitive areas. Moreover, pesticide contamination of soils and ground water is often a result of spills or improper disposal of unused pesticides or pesticide containers. The MDA routinely monitors ground water in specific areas to study pesticide contamination, and they investigate and clean up agricultural chemical spills and contaminated sites. See Table IV-5 for CWP data. The MDA also retrieves and properly disposes of outdated pesticides that contain arsenic. This and other programs, such as those instituted by pesticide manufacturers, that collect used pesticide containers for safe disposal, help reduce ground water contamination.

Arsenic

Arsenic occurs naturally in some Minnesota geologic formations and is commonly found in ground water, sometimes in significant quantities. Currently, there is controversy about the toxicological effects of low or moderate levels of arsenic in

drinking water if consumed over time. The MDH currently has no HRL for arsenic, but is developing guidance which suggests that levels as low as three parts per billion may carry some risk.

Iron and Manganese

Minnesota ground water commonly contains naturally occurring elevated levels of iron and manganese. Iron rich water causes no adverse health affects, however it can cause an unpleasant taste, odor and appearance of water. Also, 'iron bacteria,' a microorganism that feeds on iron, can be a source of unsatisfactory water quality by contributing to the disagreeable taste of the water, staining clothing and can cause problems by clogging well pumps and screens. Filtration and treatment devices exist to alleviate these problems.

Manganese is also a common problem in Minnesota and often causes problems similar to those of iron in well water. Although manganese has a HRL of 100 parts per million, this level is commonly exceeded in Minnesota's ground water. Manganese's negative aesthetic effects are treatable with filtration or softening devices.

Discussion of Major Contaminant Sources

Table IV-7 indicates the major potential sources of groundwater contamination. One of the primary regulatory agencies for protection of ground water quality in Minnesota is the MPCA. The MPCA maintains information on various types of regulated facilities, including one large database of potential pollution sites grouped in categories such as solid waste landfills, Superfund sites, hazardous waste generators, and other pollution sites. The information from this database has been compiled into regional maps illustrating site location and the site category (see Figures IV-1 thru 6, showing MPCA Regions 1 thru 6).

Table IV-7. Potential Sources of Ground Water Contamination

Potential Source	Number of Known Facilities
Septic Tanks*	approximately 500,000
Permitted Municipal Landfills	40 active
On-site Industrial Landfills	20 active
Other Permitted Landfills	142 active
Closed Landfills, of all types	192
Historical "Open Dumps"	1,800
Scrapyards	525
Class V Injection Wells	at least 100,000*
State Superfund Sites	184
Federal Superfund Sites	41
Permitted Hazardous Waste Facilities	38
Voluntary Investigation Cleanup	342
Total Leaky Petroleum Tank Sites Reported	6,813
Total Leaky Petroleum Tank Sites Cleaned Up	3,230
Total Spills Reported	18,563
Land Application of Wastes/Sludge	not compiled
Road Salting	191,303 tons/year
Feedlots*	approximately 50,000

*No complete survey of injection wells, septic systems, or feedlots exists.

Superfund

These six maps show the location of 184 State Superfund sites in Minnesota. These include some of the sites in the Comprehensive Environmental Response, Compensation, and Liability Information System Act (CERCLIS) database as well as all the federal superfund sites on the Permanent List of Priorities. During 1992 -1993, 13 sites have been cleaned up and removed from the state Superfund list. Fewer sites are being added in recent years because of changes within the Superfund program, including the creation of the Voluntary Investigation and Cleanup (VIC) program. The VIC program allows willing owners or responsible parties of contaminated sites to clean up their property more expediently and with fewer legal costs than the traditional Superfund program. Minnesota currently has 342 sites involved in the VIC program, with more than 50 cleanups completed. One hundred eighty-six sites were added in 1992 and 1993.

A modification in the Superfund program that is still being sought in the 1994 Legislative session involves removing the state's solid waste landfills from the Superfund program by creating a separate fund for landfill sites. By reducing legal fees, a new program could reduce cleanup costs and could facilitate the cleanup process. "A separate landfill program would relieve fiscal

pressure on the Fund, cut the cost of cleaning up landfills from an estimated $800 million to $250-450 million, eliminate huge lawsuits, and eliminate the current burden on [surrounding] communities..." (MPCA,1994). More modifications are in store for Superfund as the federal program is reauthorized beginning in 1994.

Landfills

Minnesota contains 202 active permitted landfills, only 40 of which dispose of mixed municipal solid waste. Although landfills can contribute to ground water degradation, recent landfill designs are better at protecting ground water. The improved leachate and gas collection and disposal systems, caps, and liners for landfills demonstrate an improvement in environmental protection. Because of the increased public awareness about potential contamination problems and the activities of other pollution prevention programs such as household hazardous waste programs or pesticide container recycling programs, landfills now receive fewer hazardous items. However, as landfills continue to fill up and close, other waste management options continue to increase; these include waste to energy facilities, increased recycling, and composting. Several studies conducted by the MPCA on the solid waste stream have recommended innovative ways to make waste reduction cost effective and feasible.

The Minnesota state legislature granted the MPCA $2.2 million over two years (FY93-FY94) to investigate the environmental and human health impacts of the state's many closed or closing sanitary landfills. Since these older landfills may not have many of the current safeguards for protecting ground water, they require additional attention. The funding is being used to survey landfill conditions, for monitoring ground water, and to make recommendations on improvements or remediation, if necessary. At the end of 1994, MPCA staff will present a report to the state legislature summarizing its survey of the state's closed landfills.

Tanks

Tanks and associated fuel piping are some of the most numerous points of potential ground water contaminants. Tanks most commonly contain gas or fuel oil for homes, industrial complexes, farms or schools. For safety reasons, many tanks are located below ground, where leakage can occur without being immediately apparent. However, improved education of tank owners, increased monitoring and financial compensation from Petrofund for leaky tanks has reduced the risks of undetected contamination and has expedited the cleanup process. During 1992 and 1993, a total of 2,079 leaky tanks were reported, and during the same period of time 1,799 leaky tank sites were cleaned up.

Spills

Petroleum and chemical spills and other environmental emergencies must be reported to the MPCA. The company responsible for the spill is directed to the proper method of cleanup and debris disposal in order to minimize any contamination to surface or ground water. If the responsible person does not act quickly or adequately, the spill staff can activate state contractors to do the cleanup using Superfund or Petrofund dollars. During the past two years 3,131 incidents were reported via the spills line. For 169 incidents an emergency was declared and state contractors mobilized. The remainder were cleaned up by the spiller under state oversight or no further cleanup was necessary. The spills program is increasing its emphasis on spill prevention and response preparedness to lessen reliance on cleanup.

Land Use

Many land uses can have significant impacts on ground water quality. Both rural and urban areas contain many potential contamination sources that only in recent years are being identified as such. A few examples include fertilizer or pesticide applications to farm fields, lawns or golf courses; feedlots; road salt runoff; and septic systems. Minnesota is an active agricultural state and has many areas where sandy soils or shallow fractured bedrock make ground water susceptible to the potential contaminants associated with animal and crop production. Contaminants can enter ground water from applications of agricultural chemicals or waste, and they can reach deeper ground water from improperly sealed or abandoned wells.

Septic Systems

In Minnesota, there are an estimated 500,000 housing units, or 27 percent of the total, that are not connected to a public sewer. An estimated 70 percent of these housing units have systems that are not in compliance with the current state guidelines. Septic systems are especially common in rural or other nonsewered areas. When septic systems are not designed, constructed or maintained properly, they can contaminate drinking water sources by contributing bacteria, viruses and nitrogen to ground water. Contamination can also occur if household hazardous wastes are disposed of in a septic system. Minnesota shoreland regulations currently require counties and cities to bring all septic systems near the shorelines of lakes, streams or other water bodies, up to current standards of design and maintenance.

Class V Injection Wells

A septic system at a nonresidential site, such as a car wash or auto repair shop, is considered a Class V injection well. Commercial and industrial wastewater can cause significant soil and ground water contamination. Because on-site sewage treatment systems are not designed for the disposal of industrial and commercial waste, regulators recommend that industrial wastewater generators hook up to municipal sewer systems. The discharged water can then be treated at wastewater treatment plants. However, other options do exist such as setting up holding tanks, filtering and reusing the waste water, or designing a specific system for a particular industry that meets regulations. No specific inventory of injection wells has been conducted; however, it was estimated that there are over 100,000 injection wells in Minnesota, the vast majority of which are septic systems receiving wastes other than domestic waste water. In spite of increased public education efforts by the MPCA, many industrial pollutants are still entering ground water through on-site sewage treatment systems.

Well and Drinking Water Advisory Areas

Well Advisories apply to specific areas with known ground water contamination problems that have, or may have, risks to human or environmental health. In these areas, the MDH imposes more stringent regulations for construction or reconstruction and sealing wells. The six Well Advisory areas in Minnesota are listed in Table IV-8.

In areas where ground water contamination may have affected drinking water wells, the MDH can issue a Health and Drinking Water Advisory, so that citizens in an affected area are told not to consume well water. There are two specific areas around the Kummer Landfill and around Long Prairie where this has occurred (see Table IV-9). In addition to these area advisories, approximately 320 wells statewide have demonstrated unhealthy levels of contamination since 1989 and residents have been asked to find an alternate source of drinking water.

Table IV-8. Well Advisory Areas

Well Advisory Area	County	Type of Contamination
Baytown/West Lakeland/Bayport	Washington	VOC's
Pine Bend Landfill	Dakota	VOC's
Lakeland/Lakeland Shores	Washington	Petroleum
Lehillier	Blue Earth	VOC's
Washington County Landfill	Washington	VOC's

Table IV-9. Health and Drinking Advisory Areas

Health and Drinking Advisory Area	County	Type of Contamination
Long Prairie	Todd	tetrachloroethylene
Individual Wells	Statewide	Various

Figure IV-1. Location of Potential Ground Water Sources, Northeast Region

POTENTIAL GROUND WATER POLLUTION SOURCES
North East Region

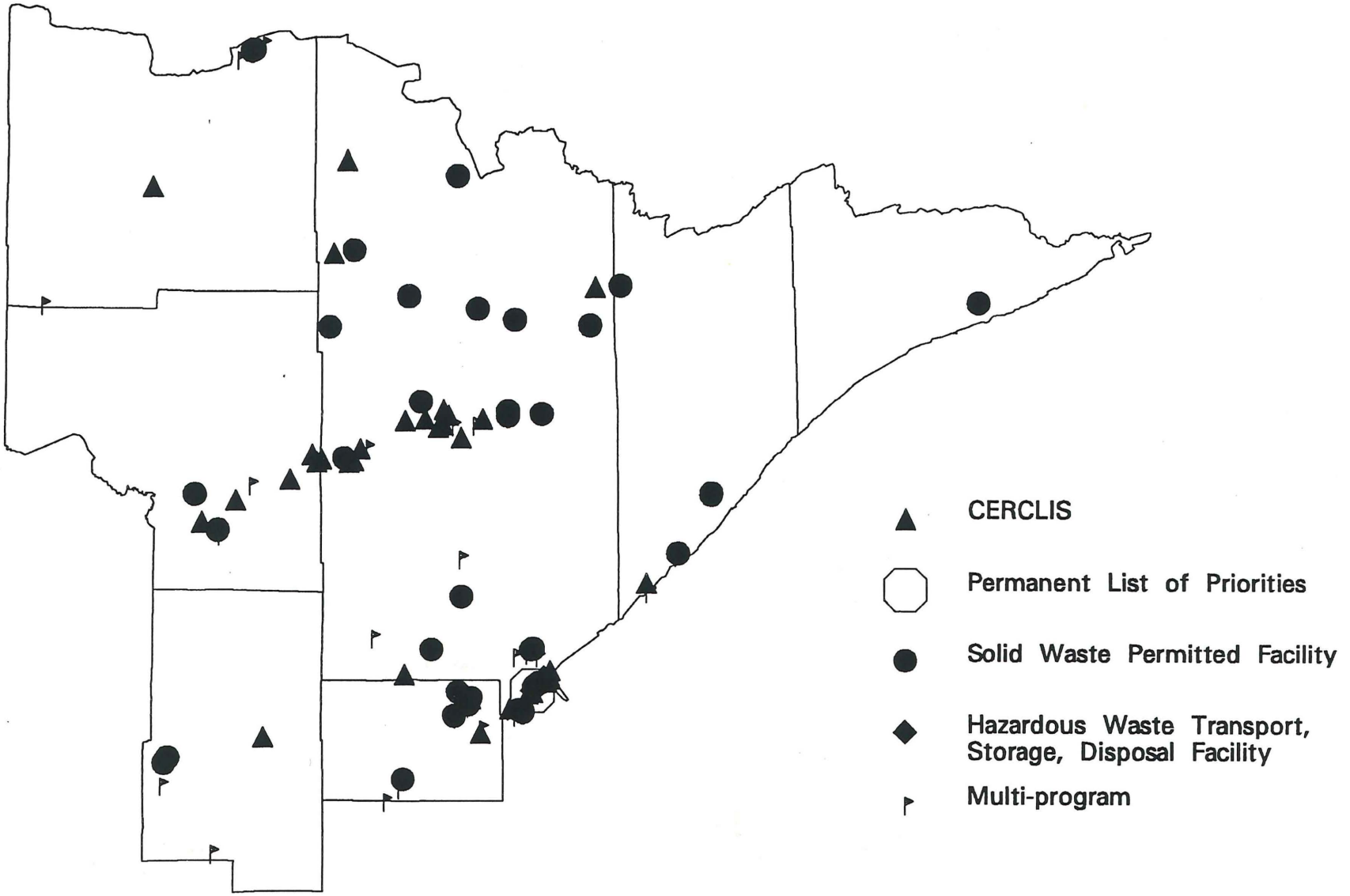
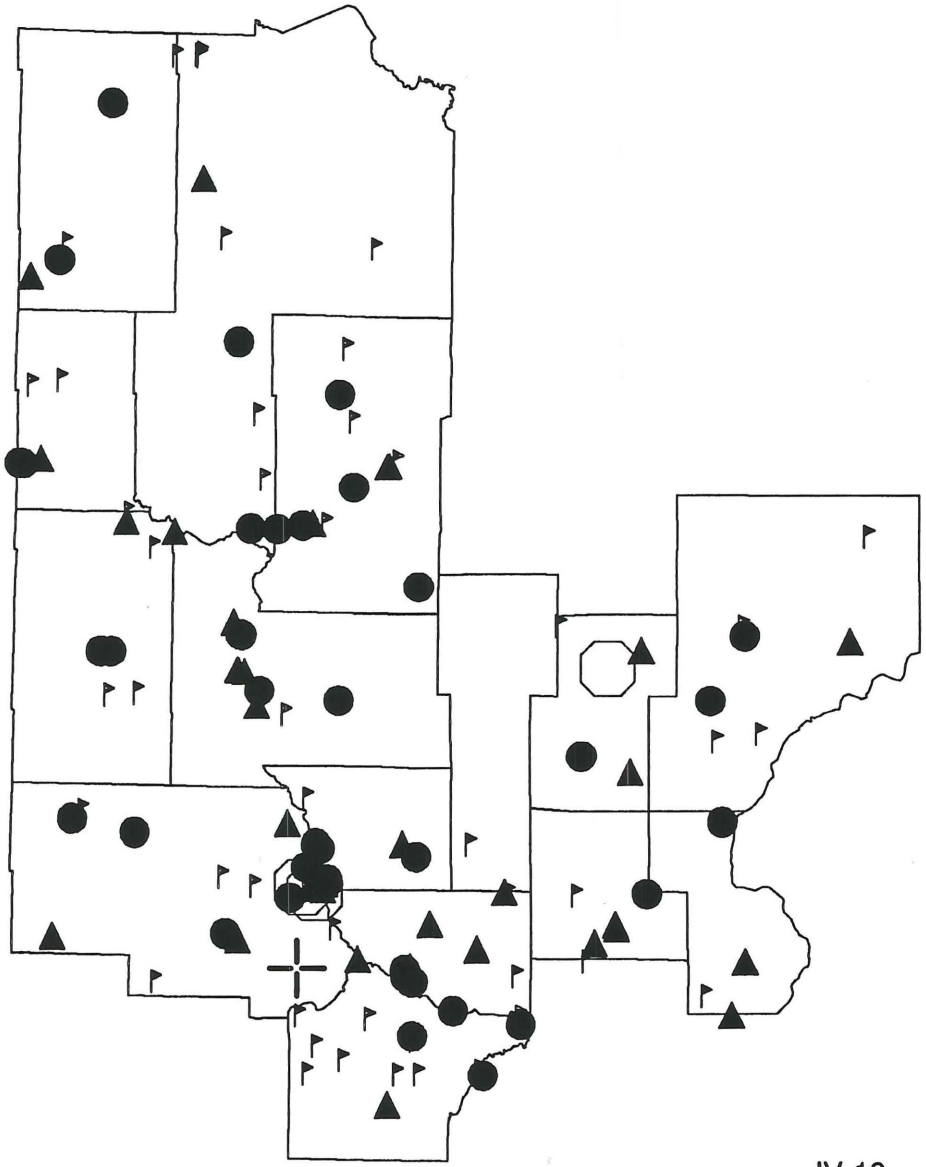


Figure IV-2. Location of Potential Ground Water Sources, East Central Region

POTENTIAL GROUND WATER POLLUTION SOURCES

East Central Region



CERCLIS

Permanent List of Priorities

Solid Waste Permitted Facility

Multi-program Site

Figure IV-3. Location of Potential Ground Water Sources, Northwestern Region

POTENTIAL GROUND WATER POLLUTION SOURCES

Northwestern Region

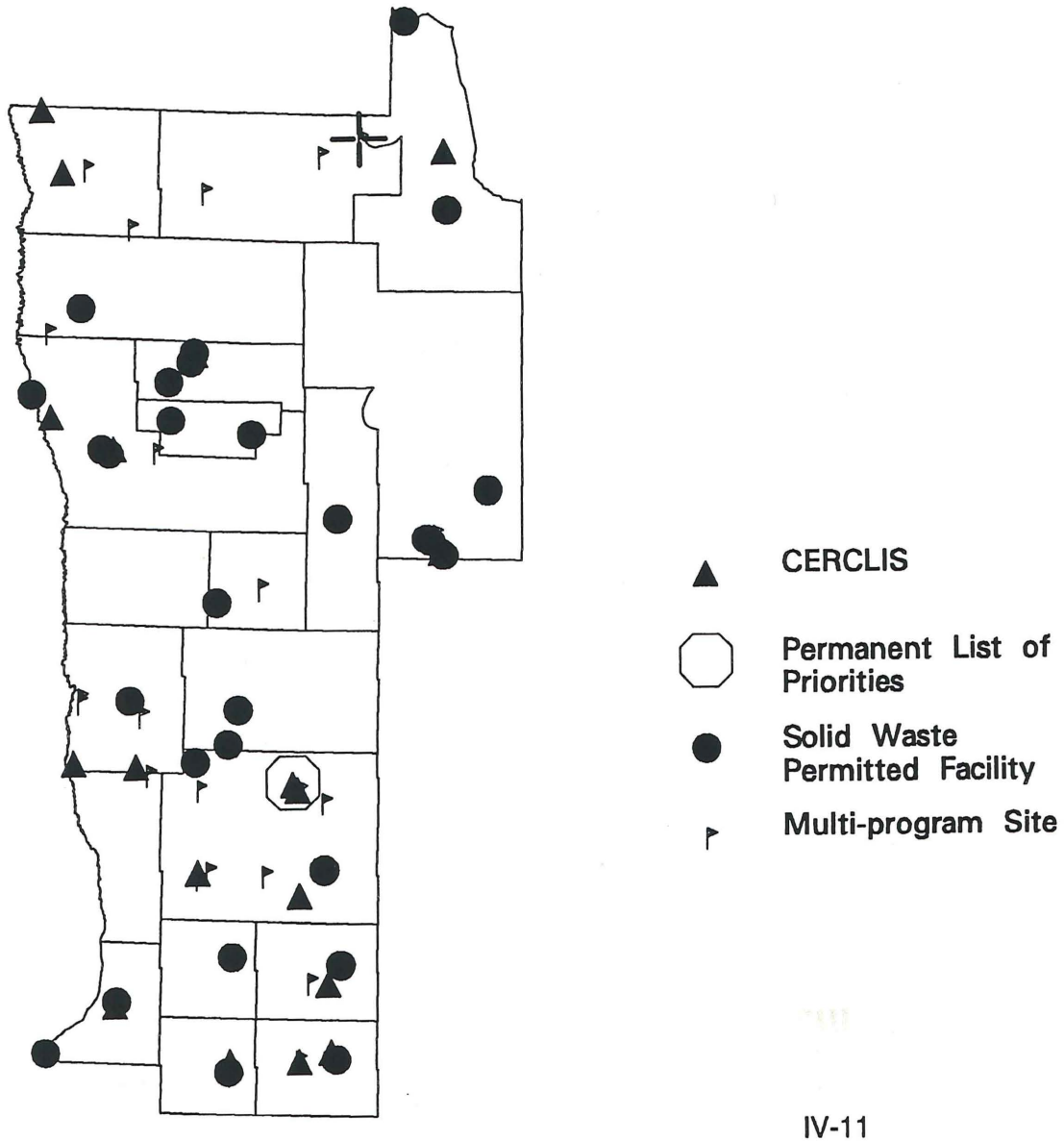
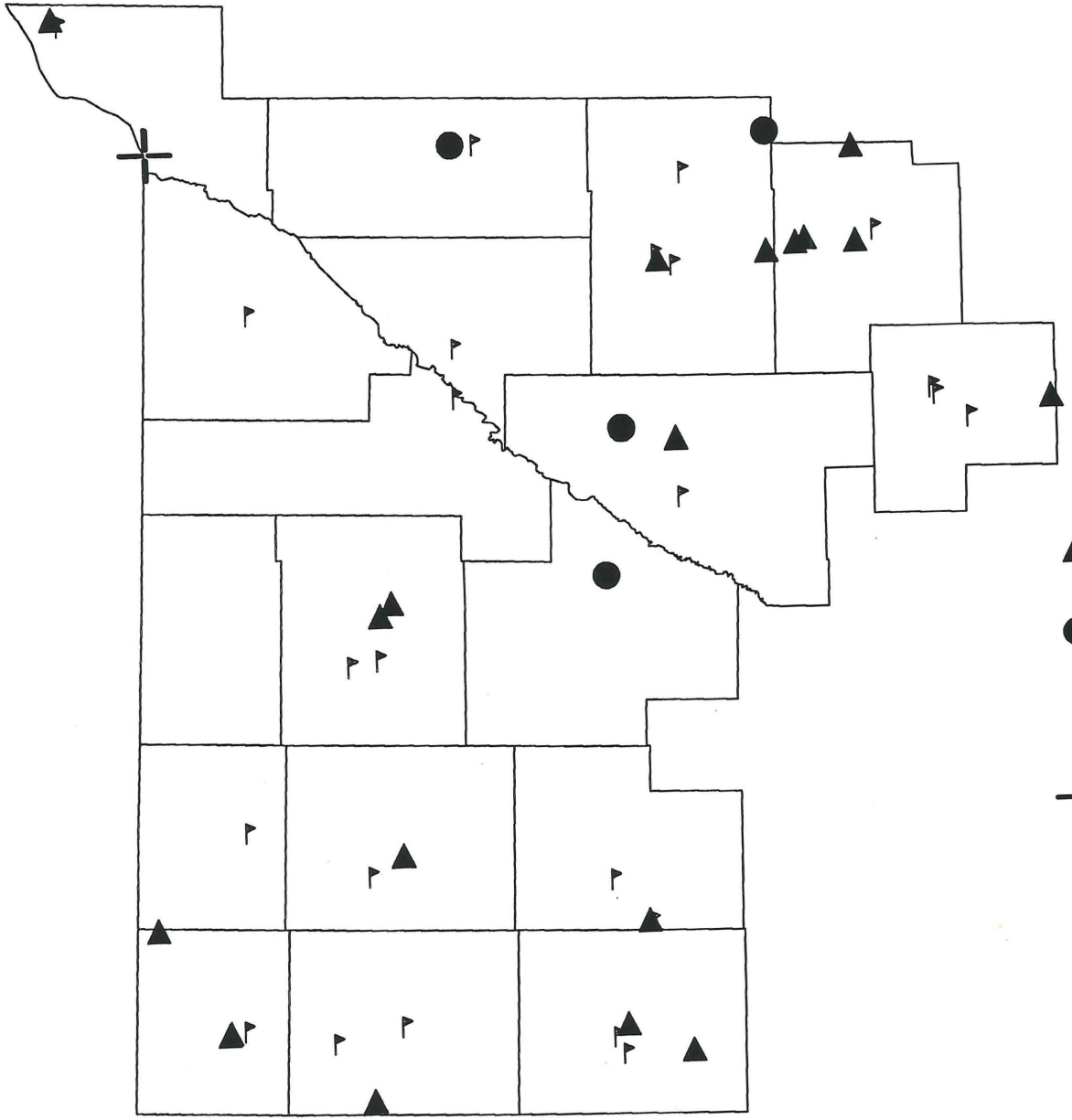


Figure IV-4. Location of Potential Ground Water Sources, Southwestern Region

POTENTIAL GROUND WATER POLLUTION SOURCES

Southwestern Region



CERCLIS

Solid Waste Permitted Facility

Multi-program Site

Voluntary Investigation and Cleanup

Figure IV-5. Location of Potential Ground Water Sources, Southcentral Region

POTENTIAL GROUND WATER POLLUTION SOURCES

Southcentral Region

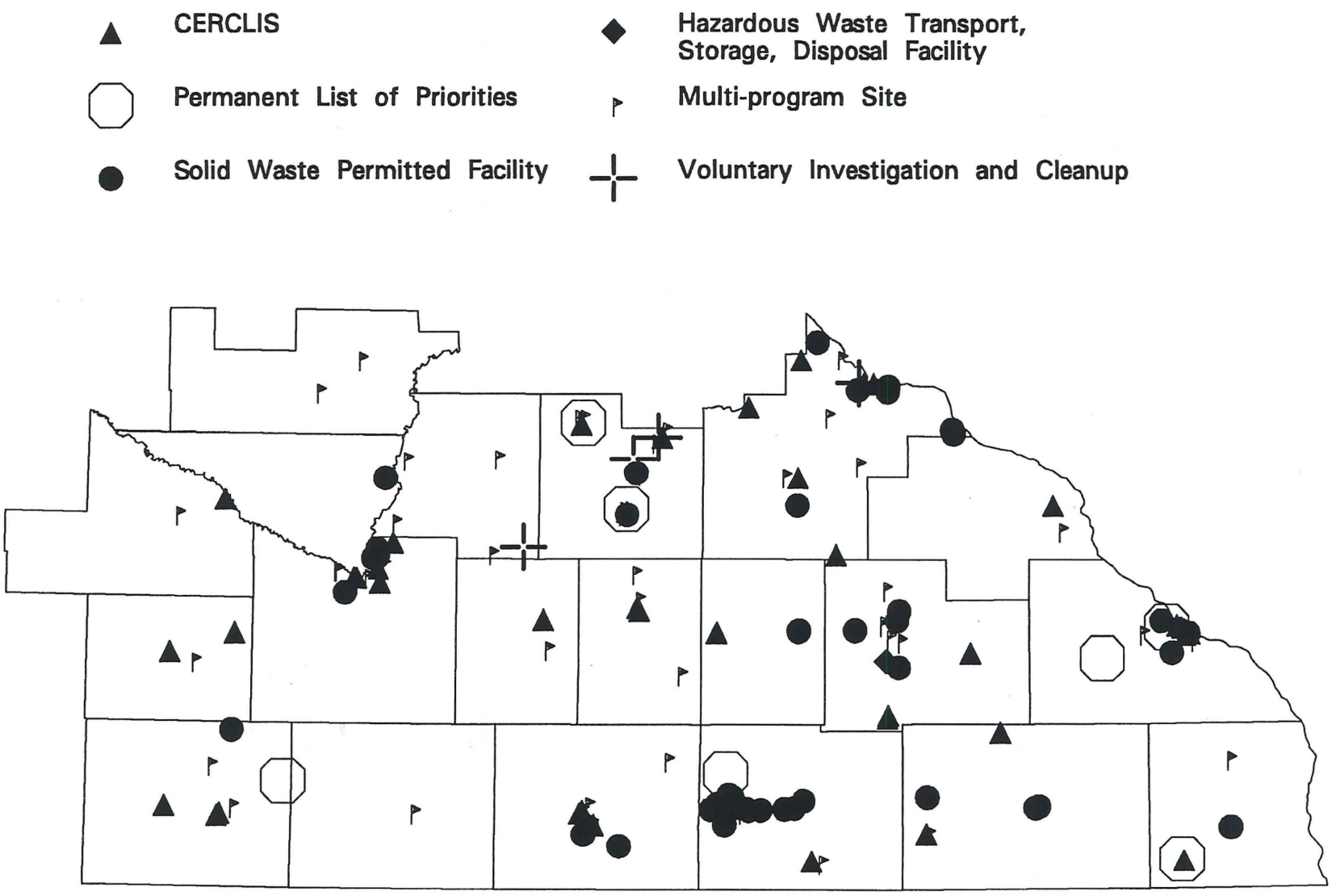
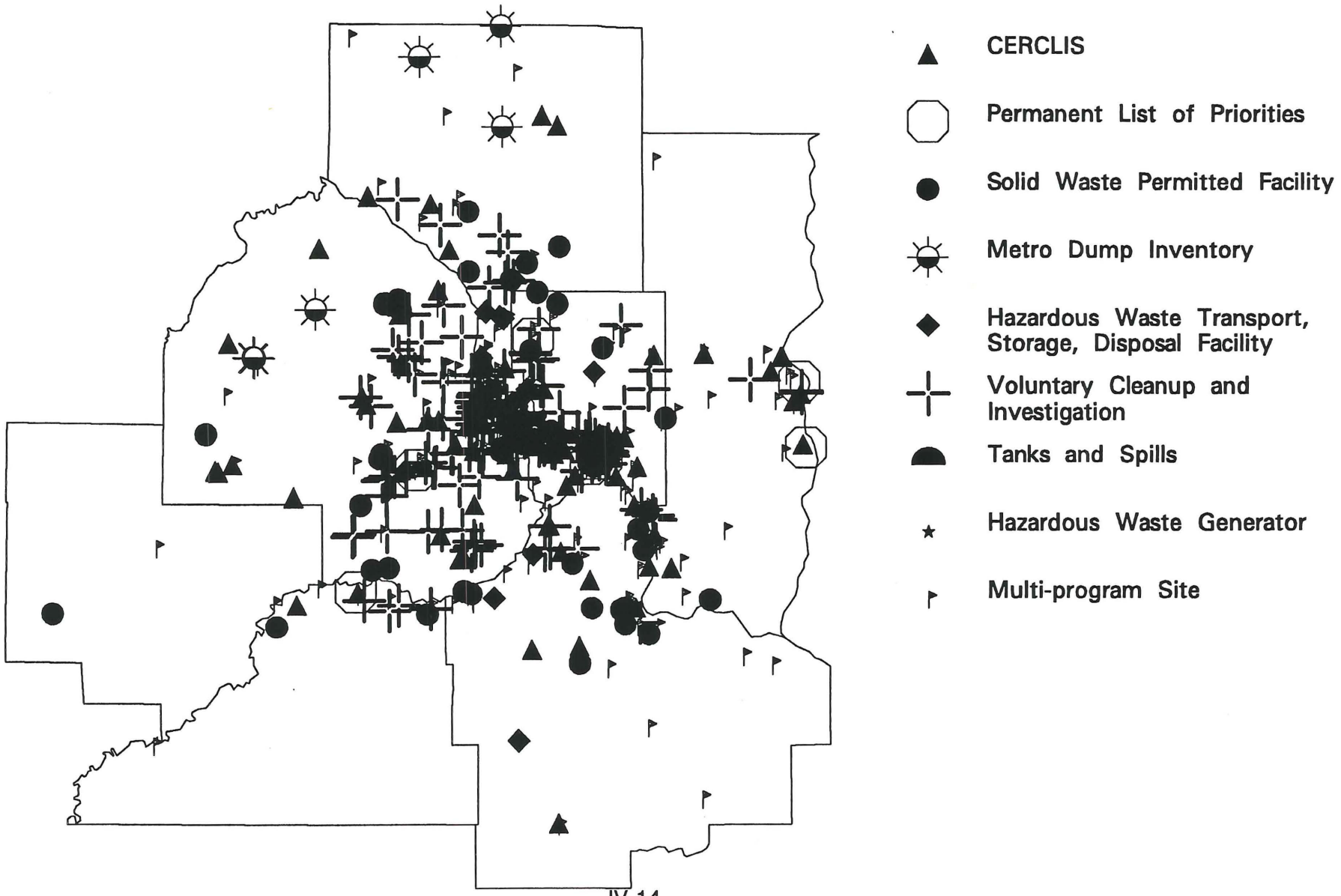


Figure IV-6. Location of Potential Ground Water Sources, Twin Cities Region

POTENTIAL GROUND WATER POLLUTION SOURCES

Twin Cities Region



PART V: WATER POLLUTION CONTROL PROGRAM

Chapter One: Point Source Pollution Control Program

Municipal Section

Three compliance units make up part of the Municipal Section of the Water Quality Division. These units are responsible for issuing, tracking and regulating the wastewater treatment facilities in accordance with the requirements described in the NPDES and State Disposal System (SDS) permits issued to the facilities. Each of the compliance units contain staff responsible for engineering and technical review, permit reissuance on a five-year cycle, financial assistance, and, when needed, land application of sludge, hydrogeologic review, and compliance and enforcement activities. This allows for easy communication between the involved staff, timely resolution of compliance problems, and a thorough understanding of all of the issues surrounding each of the of the 54 major (greater than one million gallons per day of effluent) and 675 minor wastewater treatment facilities around Minnesota.

Presently, each of the three compliance units focus on two of the six regions of the state. This regionalization concept could work very well as the Water Division moves into Basin Management.

Permits specify required effluent limits, which are established to protect all beneficial uses in the receiving water. If the stream flow in the receiving water may be inadequate to assimilate the effluent from the discharger, an intensive survey is done, as described in Part III, Chapter One, Surface Water Monitoring Program. Data from these surveys are used to determine appropriate effluent limits. Table V-1 lists river segments for which intensive surveys have been done in the last ten years and actions have been taken to ensure attainment of water quality standards, and thus, protection of beneficial uses.

In November 1993, the MPCA negotiated and reissued an important NPDES Permit for the largest advanced wastewater treatment facility on the Mississippi River, the Metropolitan Wastewater Treatment Facility in St. Paul. The "Metro" plant treats approximately 240 million gallons per day on average. The reissued permit calls for extensive sampling and monitoring along the river focusing on point and NPSs of phosphorus. In particular, it requires assessment of future facility treatment options.

The associated MOU between the involved parties includes an agreement to continue NPS work in the Minnesota and Mississippi Rivers. The MOU provides $12.35 million for addressing NPS pollution problems.

The municipal section also has an Operators Training Unit (OTU). The OTU staff are responsible not only for training and certifying wastewater treatment facility operators around the state, but are often the operator's "first call for help" when problems or questions arise. They are also available for on-site assistance if needed by cities.

Industrial Section

The 27 major and 573 minor industrial dischargers are regulated by the staff of the industrial section. The industrial section's compliance units provide engineering review, technical assistance, hydrogeological review, permit issuance and compliance and enforcement determination.

A few areas of the industrial section's work are addressed in Chapter Three: Special Concerns and Recommendations. These include the Storm Water Program and airport deicing chemicals.

Compliance/Enforcement Strategy

Careful and timely compliance determination is an essential element of the MPCA mission and philosophy. Enforcement staff reviews and evaluates data generated from various sources including Discharge Monitoring Reports, permittee correspondence, compliance schedules, inspections and reports.

Effluent and reporting violations are circulated on a monthly basis for all major and minor facilities that may require a response from the enforcement individual assigned the facility. Often, reporting violations and complaints trigger a follow-up inspection. The MPCA staff investigates these complaints and referrals from citizens, regional offices and other government agencies. Typically, violations of state and federal environmental rules and regulations become known through violator self-reporting, complaint investigations or routine inspections.

Table V-1. River Segments with Intensive Surveys Performed and Action Taken

Reach	Reach Name	Actions Taken	Date
04010201-531* - downstream sites	Elbow Creek	Eveleth facility rehabilitated	November 1993
04010201-631* - downstream sites	Elbow Creek	Eveleth facility rehabilitated	November 1993
07010103-219 - downstream sites	Welcome Creek	Keewatin facility upgrade	September 1989
07010104-027	Little Elk River	Randall facility upgrade	February 1992
07010107-107 - downstream sites	Union Creek	Wadena facility upgrade	February 1991
07010201-017 - downstream sites	South Two River	Holdingford facility upgrade	December 1990
07010202-102 - downstream sites	Sauk River	Melrose facility upgrade (phosphorus)	July 1990
07010202-106 - downstream sites	Sauk River	Melrose facility upgrade	July 1990
07010202-206 - downstream sites	Sauk River	Melrose facility upgrade	July 1990
07010205-106 - downstream sites	S. Fork Crow River	Hutchinson facility upgrade	June 1988
07020003-013	Lazarus Creek	Canby new facility	June 1991
07020003-115	Canby Creek	Canby new facility	June 1991
07020004-310	Lateral L.	Echo new facility	May 1993
07020008-208	Pell Creek	Walnut Grove facility upgrade	October 1993
07020008-308	Unnamed ditch	Walnut Grove facility upgrade	October 1993
07020009-010 - data before 1/89	Center Creek	United Foods eliminates storm sewer connections	January 1989
07020010-109 - downstream sites	St. James Creek	St. James facility upgrade	August 1991
07020011-102 - downstream sites	JD #49 (Prov. Ck.)	Amboy facility upgrade	November 1989
07020011-202 - downstream sites	JD #49	Amboy facility upgrade	November 1989
07020012-009 - downstream sites	High Island Creek	Arlington facility upgrade	January 1990
07020012-124 - downstream sites	E. Branch Raven Stream	New Prague facility upgrade	August 1989
07020012-224 - downstream sites	Trib. to E. Br. Raven Strm.	New Prague facility upgrade	August 1989
07030005-435	Trib. to Sunrise River	Lindstrom/Chisago new facility, discharge moved	July 1988
07040002-021 - downstream sites	Straight River	Owatonna facility upgrade	June 1988
07040008-344	Trib. to Wisel Creek	Canton facility/significant progress towards compliance	
07080201-023 - downstream sites	East Fork Cedar River	Hayfield facility upgrade, discharge moved	September 1989
07100003-021 - downstream sites	East Fork Des Moines R.	Ceylon constructed stabilization ponds	November 1988
07100003-221	JD #26	Ceylon constructed stabilization ponds	November 1988
09020302-130 - downstream sites	Coburn Creek	Blackduck went to spray irrigation	October 1988
09020305-112 - downstream sites	Lost River	Oklee constructed stabilization ponds	August 1992
10170204-021000 - downstream sites*	Norwegian Creek	Ellsworth new facility	December 1991

Table V-1 (continued).

Reach	Reach Name	Actions Taken	Date
07010207-111	Bogus Brook	Bock administrative order-sewer use ordinance	September 1991
07010207-211	Bogus Brook	Bock administrative order-sewer use ordinance	September 1991
07020001-028	Little Minnesota River	Browns Valley went to spray irrigation	November 1989
07020005-001	Chippewa River	Montevideo permit reissued with ammonia limits	April 1993
07020006-106	Redwood River	Marshall permit reissued with ammonia limits	1992
07020012-101	Minnesota River	MWCC/Blue Lake upgrade MWCC/Seneca upgrade MSP Int'l Airport permit issued	June 1991 July 1991 1993
07080201-122	Roberts Creek	Brownsdale stabilization ponds under construction	1993
07100001-101	W. Fork Des Moines R.	Windom facility upgrade planned	1995
10170203-132	Split Rock Creek	Jasper facility plan completed	1993

Since 1989, the Division has also expanded its enforcement tools to include issuance of an Administrative Penalty Order. This addition has assisted in improving the compliance rate. Enforcement staff are also assigned to civil and criminal violations of water quality standards.

Although MPCA staff takes the lead in enforcement actions, the Minnesota Attorney General's Office staff provides critical advice in the investigative process and reviews proposed escalated actions and documents. The point source program of the Water Quality Division continues to focus on the resource - improving water quality in the State of Minnesota. Many of the operations in the point source program will be undergoing some changes as the division moves toward better and more efficient compliance and enforcement under the basin planning approach. This will be a difficult time of transition. However, the benefits, including a greater ability to focus on environmental results, will provide even greater opportunities for success.

Chapter Two: Nonpoint Source Pollution Control Program

Introduction

Minnesota is fortunate not only with the sheer abundance of waterbodies but also the number of pristine waterbodies remaining. The existence of pristine waterbodies emphasizes the importance of a protection component in water quality plans, but it does not mask the fact that already far too many of the state's water resources have been significantly degraded.

Most of the pollution originating from point sources (municipal and industrial facilities discharging to a state water) has been controlled, yet the pollutants entering surface waters in runoff and seepage from land areas, particularly in highly agricultural regions, continue to degrade water quality. This NPS type of water quality degradation, which originates from human land use activities, is the major reason causing a number of Minnesota's surface and ground waters are to not be clean enough for recreation or drinking water use.

The abundance of waterbodies in the state prohibits the kind of extensive monitoring necessary for quantitatively measuring the level of water quality impairment across the state, or determining the land use activities contributing to impairment. A more qualitative method of data collection, a survey of local resource managers, has been administered biennially since 1987 as a supplement to the quantitative monitoring data. With these data limitations in mind, the following generalizations can be made:

- Nonpoint source is a significant contributor to the degradation of 95 percent of the state's river miles assessed as impaired and 94 percent of the state's lake acres assessed as impaired.
- Based on the survey responses identifying threats or impairments, feedlots (total confinement) contribute to the degradation of 2,844 river miles (62 percent of the river miles); animal holding areas contribute to 3,863 river miles (85 percent); urban storm sewers contribute to 2,828 river miles (62 percent); urban surface runoff contributes to 2,979 river miles (65 percent); on-site wastewater systems contribute to 3,555 river miles (78 percent); and removal of riparian vegetation contributes to 2,116 river miles (46 percent). A given river segment is most often impacted by multiple sources.
- Based on the survey information, feedlots (total confinement) contribute to the degradation of 177,834 lake acres; animal holding areas to 222,568 lake acres; urban storm sewers to 260,404 lake acres; urban surface runoff to 253,747 lake acres; on-site wastewater systems to 530,293 lake acres; and riparian vegetation removal to 124,419 lake acres.

The state's efforts to restore these resources center around the concept of a "resource management system," whereby a set of BMPs appropriate to the site-specific concerns within a watershed unit are selected and applied on a watershed basis.

Nonpoint Source Management Program

Minnesota has historically demonstrated a strong commitment to protecting and improving water quality through NPS abatement. Over the past six years, this commitment has received increasing attention, expressed in terms of both increased financial support and a redirected focus of many statewide programs. The increased focus on NPS in Minnesota has led to a comprehensive revision of the state's NPS Management Program, which was originally developed in 1988 to satisfy requirements under Section 319 of the CWA.

Revision of the 1988 NPS Management Program was initiated in 1993 with the establishment of 14 subcommittees, each of which was comprised of a mix of state, federal and local resource managers. Committees were charged with developing a four year applied strategy for one of the issues significant to NPS management in Minnesota. Strategies were developed for each of the following issues:

- Education and Information.
- Monitoring and Assessment.
- Particular water resources, including wetlands, ground water, rivers/streams and lakes.
- Agricultural Pesticides.
- Agricultural Erosion.
- Silviculture.
- Urban Runoff.
- Contaminated Sediments.
- Feedlots.
- Nutrient Management.
- Mining.
- On-site wastewater systems.
- BMPs.
- Watershed programs and prioritization.

Development of these strategies has involved extensive interagency participation and is scheduled to go through a public review process in the summer of 1994.

The overall program plan resulting from this effort is comprehensive and identifies the priority goals and objectives in NPS management over the next four years. Although many of the action

steps designed to meet these goals are contingent upon future funding levels, several action steps identified as priorities are currently being initiated and are summarized below.

Statewide Information And Education Program

One of the first strategies to be developed for the NPS Management Program revision was the Information and Education (I & E) strategy. In 1992, the Minnesota Office of Strategic and Long-Term Planning, together with the MPCA, initiated a process to address the NPS informational and educational needs of the adult population on a statewide basis. In addition to using an interagency steering committee for strategy development, the state held a series of focus group sessions throughout the state in an effort to achieve a high level of regional input.

The steering committee, together with the focus groups, identified five factors contributing to NPS problems that an I & E strategy could effectively address. These contributing factors include:

- Misperceptions and inadequate knowledge about NPS pollution issues.
- Disincentives and lack of motivation to change approaches and behavior.
- Lack of access to existing information and resources.
- Exclusion of NPS pollution issues from decision-makers' priority lists.
- Lack of mechanisms and structure for coordinating NPS pollution information and education efforts in the state.

With the above factors forming the conceptual foundation of the strategy, a set of goals, objectives and action steps were developed, along with a four year implementation schedule. As a first step in implementing the objectives, a comprehensive inventory has been prepared and distributed to local governments.

Raising awareness through information alone, however, was not considered sufficient to motivate the support necessary for action. It is much easier to build public consensus for action when people feel they are protecting a particular water resource. Local coalitions and participatory processes were therefore considered vital in preparation of the I & E strategy, and the next step in implementing the strategy is to dedicate a two-year position toward achieving these important local connections. The position, a mobility assignment of a Minnesota Extension Service employee to MPCA, has received Section 319 funding support and will begin in spring 1994. The programmatic framework established by this position will allow the objectives and milestones of the I & E strategy to be accomplished over the next four years.

Prioritization of Watersheds for NPS Management

Minnesota currently targets watersheds for NPS controls through the CWP program administered by the MPCA. The program, established in 1987, relies upon local units of government to prioritize the watersheds within their region and subsequently submit proposals to MPCA for a watershed project. MPCA and an interagency task force called the Project Coordination Team ranks the projects based on an approved set of ranking criteria. The highest ranked projects are then eligible for financial and technical assistance from the state. CWP projects involve the following:

- Completing a comprehensive diagnostic study of a waterbody and its watershed by identifying the pollutants that cause a reduction of water quality and the origin of the pollutants,
- Developing an implementation plan that identifies the BMPs needed to restore and protect water quality, and
- Implementing the BMPs.

There is tremendous interest and demand for participation in this program, with 38 Phase I Diagnostic Studies Implementation and 11 Phase II Implementation Projects selected out of 144 applications to date. The chosen projects represent more than ten million dollars of state and local efforts in lake, stream, ground water and wetland activities across the state.

While CWP is acknowledged as an extremely successful NPS watershed program, the interagency teams currently working on Management Program revision have identified a need to prioritize watersheds on a statewide basis for NPS activities. The primary purpose of this prioritization effort is to provide local project sponsors and state and federal agencies a statewide pool of priority watersheds to serve as an initial screening tool for selecting watershed remediation projects, for focusing local planning efforts and for identifying monitoring and diagnostic needs.

Examples of ways in which programs or activities could benefit from this prioritization effort include the following:

- Providing a candidate pool for CWP project selection and for projects under the state revolving loan program.
- Providing US Department of Agriculture with the state's list of ranked waterbodies to factor into selection of water quality initiative projects.
- Providing a candidate pool for selection of 319 watershed grants.

• Establishing a systematic procedure for linking local priorities with state priorities.
• Providing the state with a process that could serve to address anticipated requirements stemming from CWA reauthorization.

A subcommittee of the NPS interagency team, the Project Coordination Team, has been formed to develop the prioritization process over the next year.

Improving NPS Assessment Process

In updating the management program, one of the most frequently noted problems is the inadequate database used for NPS assessment work. Due to the sheer number of water resources in Minnesota, (See Minnesota Background, Part II), obtaining the traditional type of quantitative monitoring information on a meaningful scale has not been possible. In order to address this lack of available monitoring information, a survey of local resource managers was developed in 1987 with the intent of drawing upon the expertise and knowledge of those resource managers who work within particular water resources on a daily basis. The biennial survey requests information on the observed impairment status (whether it is threatened or impaired), the particular pollutant causing the impairment, the land use activity associated with the impairment and the estimated extent of impairment in river miles or lake acres.

While the NPS survey of local resource managers has provided the state with valuable assessment information, it has many limitations. There is widespread consensus among the state agencies and within the MPCA that one of the first priorities the state should undertake is improvement of this survey. The interagency Project Coordination Team, along with a MPCA task force, have developed a number of recommendations to improve the survey process. The improvements, scheduled for implementation in 1995, focus on developing a process that achieves a higher level of local consensus as well as on improving the survey methods and questions. Improvement of the NPS survey is an important first step to implement the prioritization process summarized above.

Forestry BMP Auditing Process

Forestry BMPs serve as the cornerstone for Minnesota's forestry water quality protection program. As part of the implementation program, a pilot field audit process was initiated in 1991 to evaluate BMP compliance on state, county, federal, private industrial (PI), and nonindustrial private (NIPF) lands. The forestry community recognized that the ability to demonstrate compliance on all land ownerships was essential if the BMP process was to be credible.

The field audits were conducted by interdisciplinary teams composed of representatives from state and federal agencies, county land departments, forest industry, the public and conservation organizations. Efforts were made to ensure that each team incorporated expertise in road engineering, soil science, hydrology, fisheries and forest management. Forty-eight sites were evaluated in 1991. For 1992, approximately 115 sites have been field reviewed, and the results will be summarized and published over the next few months. The audit forms used to rate individual sites contained 96 specific BMPs. Each site was rated for the applicability of the specific BMPs (yes or no), whether the applicable BMPs were applied correctly (five-point scale), and the effectiveness of the BMP application (six-point scale).

The field audits from the first year suggest a relatively high degree of conformance with BMPs for state (80 percent), county (90 percent), federal (87 percent), and PI (88 percent) forest lands. A lower level of compliance was found for NIPF lands (71 percent). Where departures from BMP requirements were found, the majority were minor in nature. Application of filter strip BMPs averaged 88 percent statewide, with highest compliance found for northeastern Minnesota (96 percent) and lowest compliance for southeastern Minnesota (76 percent). The steep terrain in southeastern Minnesota required wider filter strips than were generally needed for northeastern sites. This increased the probability of an infraction occurring since filter strips occupied a greater portion of a site.

Statewide, the audits consistently found that the majority of all departures from BMP requirements were associated with forest roads and skid trails. Most of these departures were for practices that influenced the volume, velocity or direction of flow (e.g., proper culvert installation, property water bar installation, use of lead off ditches).

Minnesota's forestry BMPs were effective in minimizing sediment movement. Adequate protection to the water resources was found 99 percent of the time where BMPs were properly applied. The magnitude of the impairment to water quality increased with the extent to which the BMP requirements were compromised.

Chapter Three: Special State Concerns

Deicing

The MPCA staff has issued a water quality NPDES/SDS permit for discharges from the Minneapolis - St. Paul International Airport. Over the course of permit reissuance activities, data collected on the effluent from the Metropolitan Airports Commission (MAC) facility indicated that the discharge has a high organic content.

It is believed that the heavy organic loading from deicing and anti-icing chemicals used at the airport creates DO depletions and violations of the Minnesota River's DO water quality standard. This situation is most serious under conditions of low flow in the river and ice coverage.

The permit has a two-year time frame with expiration set for the fall of 1995. Mass discharge limitations are proposed for the five-day carbonaceous biochemical oxygen demand (CBOD5). The CBOD5 limit for the first year is set at an annual maximum mass of 1200 short tons. This value corresponds to a 50 percent reduction in the discharge of deicing material from reported levels discharged during the 1992-1993 deicing season. The CBOD5 limit for the second year is set at an annual maximum mass of 900 short tons. This value corresponds to an additional 25 percent reduction in the discharge of deicing material from the permitted levels established for the discharge during the 1993-1994 deicing season. These mass limit calculations were based on the work that was documented in the Minneapolis - St. Paul International Airport Phase I/II storm water investigation report dated June 1993.

The special conditions of the draft permit can be divided into several categories which include:

- Chemical use and spill reporting including urea, glycol, other deicing chemicals, fuel products and sand.
- System evaluations for the treatment facilities currently on site.
- Plan development and implementation for short-term reductions in pollutant releases for the 1993 and 1994 deicing season.
- Activities for glycol recycling including request for proposals, pilot testing and other reporting requirements.
- Plan development for long-term reductions in pollutants releases which is required to be submitted by December 1, 1994.
- Monitoring and control plans which will be required for all activities included in both the short-term and long-term plans and activities.

The intent of the planning required for long-term reductions in pollutant releases, to meet effluent limits, is to protect the water quality standards in the receiving waters. In order to evaluate appropriate alternatives, target values were established in this permit based upon the wasteload allocation work previously accomplished on the Minnesota River. In addition to the special conditions, end-of-pipe effluent monitoring will be required for all discharges from this facility for parameters that may be present.

Feedlots

The MPCA is responsible for administration of regulations related to pollution caused by animal feeding operations (feedlots) in Minnesota, as put forth in Minnesota Rules Chapter 7020 and the federal NPDES program. Issues related to feedlots and the animal production industry have received much attention in Minnesota recently. Concerns over surface and ground water impairment due to various NPS pollutants, including animal confinement and manure storage facilities, criminal enforcement of some flagrant feedlot pollution problems, as well as concerns over odors produced by large livestock and poultry confinement and manure storage areas have resulted in considerable press coverage and public interest in these issues.

Animal manure when properly used as fertilizer is a useful resource. It contains valuable nutrients such as nitrogen, phosphorus and potassium. However when animal manure is improperly stored, handled or disposed of and allowed to leach or run off into surface or ground waters it can create serious water pollution hazards.

Calculations, based on 1988 Minnesota agricultural statistics, indicate that livestock and poultry in the state produce an amount of animal waste that would exceed the amount of human waste produced by a population of over 40 million people. Minnesota has a human population of approximately 4.3 million people; we used as a factor of comparison the typical BOD of the wastes produced. This figure does not include manure produced by turkeys or

horses. Most of this waste is land applied. However, if even a small percentage of the manure runs off fields and feedlots, this can lead to a significant water quality problem.

The most recent comprehensive survey of animal confinement facilities conducted in Minnesota, a Section 208 study for USEPA in 1978, estimates that up to 15 percent of the existing facilities could pose some hazard to water quality. A new inventory of facilities has been discussed in order to assess the current extent of this water quality hazard posed by these facilities, but no funding has been secured for this much needed project.

Surface water effects from these facilities include nutrient enrichment and eutrophication leading to surface water degradation, addition of compounds potentially toxic to aquatic organisms or which deplete oxygen in surface waters. Manure solids and soils disturbed by animal traffic on open lots may increase sediment loadings in surface waters. Ground water concerns include potential human and animal health effects from nitrates and pathogens.

A recent study prepared by the Minnesota Nitrogen Task Force, funded by the Minnesota State Legislature, indicates that Minnesota farmers are generally doing a good job of managing nutrients applied in commercial fertilizers. Inputs of nutrients from other sources such as manure are not often being credited accurately.

The Minnesota NPS Management Plan describes the requirements for an effective system to address pollution related to feedlots as follows: For the feedlot permit program to be effective, it requires not only good county-state cooperation, but also close coordination between other state and federal agencies involved in feedlot pollution control. The Agricultural Stabilization and Conservation Service (ASCS), SCS, BWSR, MDA, MDNR, Minnesota Extension Service and MPCA are working closely to coordinate their animal waste control programs so that federal and state cost-share funds, technical assistance programs, and the state permit program will work together efficiently. The ASCS and BWSR each has cost-share programs to provide incentives to install pollution control equipment for animal waste management. An effort is being made to develop a State Revolving Fund to provide low interest loans for feedlot pollution structures and equipment. The SCS and SWCD provide technical assistance. The MPCA permit program acts as a catalyst to bring farmers into these programs by adding a regulatory incentive.

Individual Sewage Treatment Systems

Twenty-seven percent or 491,925 of the housing units in Minnesota are not connected to a public sewer (unsewered). These figures reflect a 22 percent increase in the number of unsewered housing units between the 1980 and the 1990 census. (A 13 percent increase in the total number of housing units occurred during this time period.)

An informal survey of county planning and zoning administrators done by the MPCA indicated that 70 percent or approximately 344,348 housing units have systems that are failing to provide adequate treatment or do not meet minimum state design and treatment standards. Systems not properly treating sewage are described as "nonconforming" in Minnesota Rules Chapter 7080 (Individual Sewage Treatment System (ISTS) Standards). Nonconforming systems are classified as:

1) Failing systems having a surface discharge or backup.
2) Cesspools, drywells, leaching pits or seepage pits.
3) Systems with inadequate depth of soil above limiting soil characteristics (such as bedrock or a seasonally high water table).
4) Systems not installed according to all applicable local standards adopted and in effect at the time of the installation.

Nonconforming systems discharge raw or inadequately treated sewage to surface and ground waters, which can result in serious health and environmental consequences. The effluent (discharge) from an ISTS septic tank contains solids, BOD,chemical oxygen demand, phosphorus, nitrogen, chloride, bacteria, pathogens, viruses and organic chemicals. Effluent can also contain VOCs and other pollutants, which often get flushed down the drain. If wastes are not adequately treated, diseases can be transmitted and ground and surface waters can be contaminated.

The MPCA reviews plans and specifications and issues permits for systems that receive flows greater than 10,000 gallons per day. In addition, the MPCA administers a grant program that provides financial assistance to municipalities for system upgrades and provides workshops with the University of Minnesota to train professionals in proper siting, design, construction and maintenance of ISTS's.

Storm Water Program

The storm water permit originated from the 1987 CWA. The program is part of the NPDES permit regulations, and the MPCA is authorized by the USEPA to administer all NPDES programs in Minnesota.

In 1990, USEPA developed regulations to specify program applicability and permit application requirements for individuals required to apply for storm water permit coverage. Those required to apply for permit coverage fall into three groups:

- Industrial activities.
- Construction activities over five acres.
- Municipalities with over 100,000 individuals.

MPCA Program

The primary focus of a permit issued under the federal storm water regulations is pollution prevention and the implementation of BMPs. Due to the broad audience covered under the program, MPCA elected to use a policy of general permit coverage for all required industrial and construction activities.

Upon reviewing the federal regulations, clearly thousands of industrial and construction activities would be required to apply for an NPDES storm water permit. A wide variety of activities (manufacturing, mining, transportation, construction, etc.) were required to apply for permit coverage. To prioritize the implementation process, the program was divided into two parts, an industrial component and a construction component. The industrial component was developed and implemented first because it would involve the largest number of individuals.

General Permit for Industrial Activities

The industrial component established three specific goals:

- Issue a general permit by October 1, 1992, which required the development and implementation of a storm water pollution prevention plan.
- Market the program and solicit permit applications.
- Provide all permittees with coverage by the end of 1992.

All three goals were achieved. The general permit began in January 1992. This process included extensive review of the permit and program policies by a wide variety of groups. The general permit for industrial activities received public notice in August 1992 and the permit was finalized on September 30, 1992. The primary requirement of the permit is the development and implementation of a pollution prevention plan that utilizes BMPs for each covered facility.

During the summer and fall of 1992, the storm water program staff solicited permit applications from over 16,000 potential applicants. The MPCA received over 14,000 permit applications by the October 1, 1992, deadline. To date, the MPCA has received over 21,000 permit applications. Coverage was issued to the first group of 1,600 required permittees on November 2, 1992. Permit applications are reviewed within one week of receipt. To date, approximately 2,500 permittees have been issued coverage under the general permit.

General Permit for Construction Activities

The construction component of the program focused on two goals, timely permit coverage and development and implementation of short and long term sediment and erosion control.

Development of the general permit for construction activities was initiated during January 1993. A thorough process of extensive review by interested and affected groups was conducted prior to permit issuance. The permit was public noticed in August 1993 and finalized on September 3, 1993. Full implementation will begin in January 1994.

Approximately 200-500 construction activities will be required to obtain permit coverage each year. Construction activities are inherently intermittent so the permit allows for coverage that coincides with the duration of the activity. One of the key elements of the new permit is the co-permittee status of the owner and contractor, making both responsible for the implementation of BMPs that eliminate or minimize polluted site runoff. Implementation of the permit will take place during the winter of 1993-1994 and will begin with educational meetings, prior to an extensive education and marketing effort.

Municipal Permits

Current storm water regulations require municipalities with over 100,000 individuals to apply for individual NPDES permits, so that Minneapolis and St. Paul are required to apply for permit coverage. The primary focus of the municipal permits will be pollution prevention and BMPs such as increased street sweeping and storm sewer inlet stenciling. Minneapolis and St. Paul have submitted permit applications and both permits are currently under development.

Future Direction

The storm water program has been successfully developed and implemented in Minnesota. In the near future, the industrial side of the program will concentrate on education, compliance and program marketing. The construction side will concentrate on initial implementation and education. Additional changes will take place to follow USEPA requirements and due to learning from interaction with the affected parties.

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Recommendations

Minnesota is rich in water resources that are vital to the state's economy and quality of life. With substantial support from the USEPA through the CWA of 1972, Minnesota has significantly reduced point source pollution.

The state must continue to control the remaining point sources while aggressively addressing NPSs of pollution, toxics, habitat destruction and wetlands protection. These new problems require new approaches. Today, the focus must be on the water resource and all factors that threaten or impair its uses.

In protecting water quality it is essential to recognize the interrelationships between lakes, streams, ground and surface waters, between water quality and quantity, and other related resources. To address NPSs, the cooperation of federal, state and local governments and the active participation of individual citizens and public organizations is needed.

The MPCA is now undertaking an integrated water resource planning approach called basin management. To further this process, the following steps are recommended:

⇒ Continue to develop and implement basin planning and management.

⇒ Plan in advance the purposes of monitoring and specify the uses for the data collected.

⇒ Implement recommendations from the monitoring and assessment strategy in each basin monitoring plan, including use of longitudinal surveys, reference site biological monitoring, random site monitoring for valid generalizations of the basin, and long-term routine monitoring sites for trends.

⇒ Report different use supports (using appropriate assessment methods) for separate parts of a waterbody.

⇒ Identify discrepancies among assessment methods (e.g. chemical and biological results, etc.) and maintain this data in the Waterbody System.

⇒ Develop an effective process for identifying high priority waterbodies in a basin.

⇒ Adopt the "plan-implement-evaluate" cycle for all water quality activities.

⇒ Coordinate monitoring and assessment among local, state and federal agencies, including participation in the Interagency Task Force on Monitoring and coordination with USGS on NAWQA studies in Minnesota.

⇒ Maintain the interagency water monitoring committee, created to develop a monitoring strategy for the Section 319 NPS Management Plan, and continue the involvement of local, state and federal agencies.

⇒ Expand cooperative monitoring with other state and local agencies.

⇒ Develop water quality assessments using all credible sources of information and the judgments of local resource managers.

⇒ Improve water quality assessments in each basin using the pilot assessment methods developed for the Minnesota River basin.

⇒ Focus on actual use impacts on waterbodies by using all credible sources of information in a "weight-of-evidence" approach.

⇒ Develop assessments that incorporate magnitude, duration and spatial extent of pollution as well as frequency of violations.

⇒ Review assessment data for adequacy, relevance and validity.

⇒ Categorize assessments that serve distinct purposes (e.g. identify areas violating standards; provide information about fish consumption; identify areas not impaired but use is "threatened," etc.).

By using these approaches it is possible to make assessments of water quality that are accurate, meaningful, and potentially useful in management, prioritization, and planning. Minnesota will continue to improve the focus and coordination of its assessment work to support the national water quality assessment process and to provide the best information to managers, professionals and the public in regard to the quality of the waters of the state and the progress of Minnesota's water quality programs.