Water quality

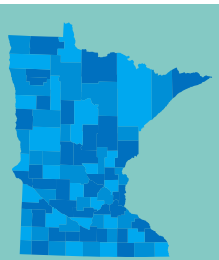
November 2021

2022 Minnesota Water Quality:

Report to Congress of the United States

Clean Water Act Section 305(b) Abbreviated Narrative Report
Water Years 2020 – 2021

MINNESOTA POLLUTION CONTROL AGENCY



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Foreword

2022 Integrated Report

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

Water years 2020 – 2021

Beginning in 2004, the Minnesota Pollution Control Agency began providing the Water Quality Integrated Report to the U.S. Environmental Protection Agency. This report is intended to combine the requirements of the Clean Water Act Sections 305(b) and 303(d) through the following format by a biennial abbreviated narrative report.

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Acronyms

ATTAINS	Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System
AUID	Assessment Unit Identification
BEACH	Beaches Environmental Assessment and Coastal Health
BMPs	Best Management Practices
BWSR	Minnesota Board of Water and Soil Resources
CECs	Contaminants of Emerging Concern
CWA	Federal Clean Water Act
CWF	Clean Water Fund
CWLA	Clean Water Legacy Act
E. coli	*Escherichia coli*
EAC	Endocrine Active Compound
EPA	United States Environmental Protection Agency
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
LGU	Local Governmental Unit
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MGS	Minnesota Geological Survey
mg/L	Milligram per liter
MDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollution Discharge Elimination System
NPS	Nonpoint Source
PCB	Polychlorinated Biphenyl
PFAS	Per- and polyfluoroalkyl substances
TALU	Tiered aquatic life use
TCMA	Twin Cities Metropolitan Area
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WLA	Waste Load Allocations
WCA	Minnesota Wetland Conservation Act
WQ	Water Quality
WQS	Water Quality Standards(s)

Part A. Introduction and executive summary

The Minnesota Pollution Control Agency (MPCA) surface and groundwater monitoring activities provide critical information to support our mission of helping Minnesotans protect the environment. To prevent and address problems, decision-makers need good information about the status of the resources, potential and actual threats, options for addressing the threats, and data on how effective management actions have been. The MPCA primarily follows a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. Some monitoring – namely monitoring of toxic parameters – continues to occur on a statewide basis. Assessment of those parameters is done statewide every 2 years, to reflect the monitoring design.

Sections 305(b) and 303(d) of the Federal Clean Water Act (CWA) call for states to report on their waters to help measure progress toward the national goals of fishable and swimmable waters. Data analyses determine the extent that all waters are attaining water quality standards, identify impaired waters and the need to be added to the 303(d) List, and identify waters attaining standards that can be removed from the List. Note that Minnesota's 303(d) List is included in a larger document called the Impaired Waters List, and will be referred to as such.

Results of 305(b) water quality assessments are submitted to US EPA and can be viewed at https://mywaterway.epa.gov/state/MN/water-quality-overview. Please note that the summary tables that appeared in previous versions of this report are now found at this website.

Water body specific information is readily available on the MPCA website: https://webapp.pca.state.mn.us/surface-water/search.

Point of contact: Miranda Nichols at 651-757-2416 or miranda.nichols@state.mn.us.

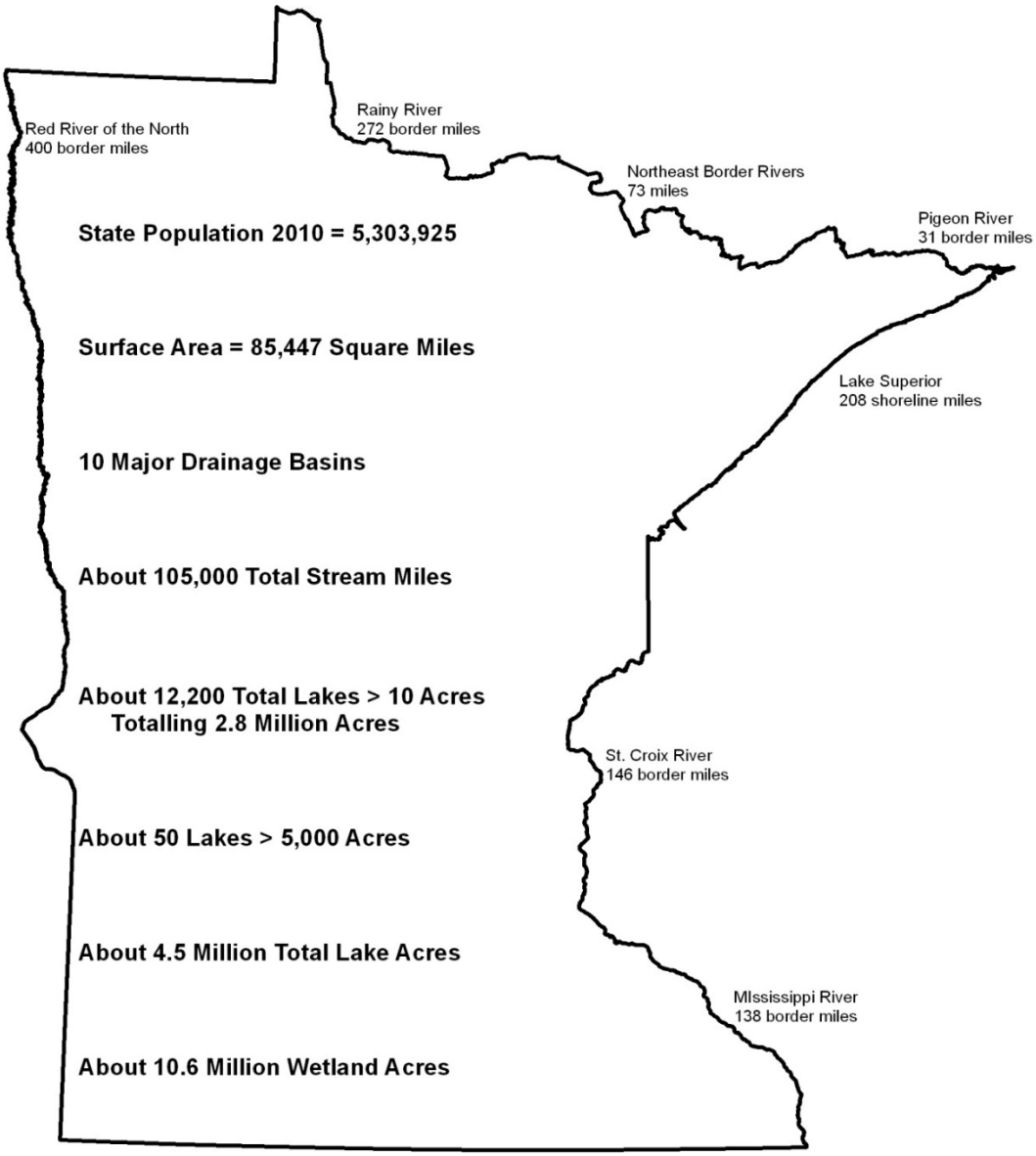
Part B. Background information

B.1. Total waters

B.1.1. State background information

The estimates of background information (in Figure 1) for water bodies were developed from 1:24,000 scale National Hydrography Dataset, with the exception of the estimate for wetland acres. The total lake acres' estimate includes the Minnesota portion of border lakes and Lake Superior. Wetland acres' estimates were obtained from the National Wetland Inventory dataset, which is not derived from 1:24,000 source data; rather it was interpreted from aerial imagery at a resolution that makes it appropriate for use at 1:24,000 or smaller.

Figure 1. Minnesota background information and border waters



B.1.2. Watershed approach

Minnesota's Clean Water Legacy Act (CWLA) provides a policy framework and resources to state and local governments to accelerate efforts to monitor, assess, and restore impaired waters, and to protect unimpaired waters. The MPCA primarily follows a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. Some monitoring – namely monitoring of toxic parameters – continues to occur on a statewide basis. Assessment of those parameters is done statewide every 2 years, to reflect the monitoring design.

The watershed approach provides a unifying focus on the water resource as the starting point for water quality (WQ) assessment, planning, and results measures. It provides a predictable schedule to monitor all of the state's major watersheds while accomplishing the following:

- Provides advance notice to interested stakeholders, local governments, and volunteers participating in monitoring plans.
- Allows local groups to conduct monitoring efforts in conjunction with or in-between agency monitoring efforts.
- Informs stakeholders when Total Maximum Daily Load (TMDL) study or protection strategy work will begin in their area.
- Insures that comprehensive information on the status of WQ and WQ management efforts is collected, evaluated, and provided to state and local partners at least once each decade.

This approach may be modified to meet local conditions, based on factors such as watershed size, landscape diversity and geographic complexity (e.g., Twin Cities Metro Area).

For more detail on MPCA's watershed approach, including the 10-year Intensive Watershed Monitoring Schedule, see the Watershed Approach webpage at: https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality.

Point of contact: Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

B.2. Water program areas

B.2.1. Wastewater overview

The overall goal of the wastewater programs, to assure that discharge of treated wastewater to surface waters and groundwater, is protective of public health and the environment. To meet these overall goals, the MPCA and its partners conduct technical assistance, develop rules and policy, permitting, land application approvals, limits determination, environmental reviews, technical reviews, compliance and enforcement, financial assistance, training, certification and licensing. The MPCA conducts this work with partners that include the municipal wastewater, water treatment, industrial wastewater and industrial stormwater facilities; local units of government (LGU), U.S. Environmental Protection Agency (EPA), other funding agencies and pumpers, installers, and inspectors of individual sewage treatment systems. For more see https://www.pca.state.mn.us/water/wastewater.

B.2.1.1. TMDLs

The MPCA continues to complete TMDL projects containing wastewater Waste Load Allocations (WLAs) assigned to industrial and municipal dischargers. The agency ensures that water quality based effluent limits included in National Pollutant Discharge Elimination System (NPDES) permits are consistent with EPA approved TMDL WLAs. Multiple individual TMDLs are frequently associated with each TMDL project. The list of TMDL projects can be found here: https://www.pca.state.mn.us/water/total-maximum-daily-load-tmdl-projects.

B.2.1.2. Permitting

MPCA water quality permits establish specific limits and requirements to protect Minnesota's surface and groundwater quality. Permits are regularly reviewed and updated as they expire, allowing the MPCA to incorporate new information about the impacts of pollutants to the environment in subsequent permits. Permits are enforced through a combination of self-reporting (reports to the MPCA, U.S. EPA, or both) and compliance monitoring. More information is at https://www.pca.state.mn.us/water/introduction-wastewater-permits.

The MPCA continues to evaluate and develop process improvement projects to meet the statutory goal of reissuing permits within 150 days of permit application receipt. The trend continues to show permit timeliness meeting the goals for 90% of permit actions.

B.2.1.3. Pretreatment

Pretreatment is the treatment of wastewater by commercial facilities and other non-domestic wastewater sources to remove harmful pollutants before the wastewater is discharged to a municipal sewer system. The Code of Federal Regulation in title 40 Part 403 defines implementation of pretreatment programs and describes the responsibility of the EPA, states, public treatment facilities, and industrial users in protecting infrastructure, workers, and the environment. The communities approved to implement pretreatment programs issue industrial user permits, conduct inspections of industrial and commercial sources, sample industrial discharges, and enforce regulations.

The MPCA maintains routine program oversight, including review of annual reports, annual inspections of the delegated publicly owned treatment plants, and three audits. The Agency also supports enforcement and annual report reviews. More information is found at https://www.pca.state.mn.us/water/wastewater-pretreatment.

B.2.1.4. Financial assistance program and policy development/implementation

The MPCA prepares the Project Priority List to determine funding priorities for Clean Water State Revolving Fund Loans and Point Source Implementation Grants.

Minnesota's State Revolving Fund is managed by the Minnesota Public Facilities Authority, a board of six state commissioners from the departments of Employment and Economic Development, Finance, Health, Agriculture, Transportation and the MPCA. The Public Facilities Authority and MPCA staff jointly administer the wastewater components of the State Revolving Fund. The PFA is responsible for the financial elements of the program, while the MPCA is responsible for its environmental and technical components. Details on the Clean Water Revolving Fund and Project Priority Lists are at https://www.pca.state.mn.us/water/wastewater-financial-assistance.

B.2.1.5. Training and certification

In Minnesota, wastewater treatment operators must be certified in order to operate and maintain a wastewater treatment facility. The MPCA administers the certification program and provides workshops and conferences: https://www.pca.state.mn.us/water/wastewater-operators-training-and-certification.

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B.2.2. Nonpoint source pollution control

B.2.2.1. Statewide Watershed Approach

Several state agencies are involved in carrying out Minnesota’s multiple programs addressing nonpoint source (NPS) pollution based on statewide watershed approach (https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality). The MPCA is responsible for monitoring and assessment, completing TMDLs and developing Watershed

Restoration and Protection Strategies (WRAPS); the Board of Water and Soil Resources (BWSR) prepares and posts protection actions based on available WRAPS, TMDL implementation plans, and local water plans on its website: http://www.bwsr.state.mn.us/planning/1W1P/index.html. The resulting One Watershed One Plan is a criteria-based, systematic process to prioritize Minnesota Clean Water Fund (https://www.legacy.mn.gov/clean-water-fund) nonpoint source implementation investments.

WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point sources, and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. Reports include an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

The implementation strategies, including associated scales of adoption and timelines, are based on what is likely needed to meet the water quality goals for restoration and protection. The strategies are the result of previous watershed reports completed in the watershed approach context, watershed modeling efforts, and professional judgment based on what is currently known and they should be considered approximate. Also, many strategies are predicated on building social readiness and sufficient resource support including needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

Point of contact: Celine Lyman at 651-757-2541 or celine.lyman@state.mn.us.

B.2.2.2. Nonpoint source management

The Minnesota Nonpoint Source Management Program Plan (Plan) focuses on addressing nonpoint source (NPS) pollution, including phosphorus, nitrogen, sediment, bacteria and other contaminants. This Plan is required by the Federal CWA, Section 319(b) to describe a management program for NPS pollution. The purpose of the Plan is two-fold:

1. Ensure compliance with Section 319 requirements of the Federal CWA for providing a long-term programmatic direction of Minnesota's overall approach to addressing NPS pollution.
2. Provide a "one-stop" resource to understand the state's multiple efforts, overall goals and programs, and connections among them for addressing this pollution source.

There are numerous funding sources for NPS pollution implementation for landowners, producers, and LGUs from local, state, federal, and private sources. Minnesota's Plan highlights some important state and federal agencies' grants and other programs for funding water quality improvement projects. The website for Minnesota's Plan is: https://www.pca.state.mn.us/water/minnesota-nonpoint-source-management-program-plan.

Point of contact: Cynthia Osborn at 651-757-2099 or cynthia.osborn@state.mn.us.

B.2.2.4. Federal Clean Water Act - Section 319

Section 319 of the CWA requires each state to assess NPSs of pollution within its boundaries. State investigations must identify NPSs of pollution that contribute to WQ problems, as well as waters or stream segments unlikely to meet Water Quality Standards (WQS) without additional NPS controls. State management programs must:

- Run for a specific number of years.
- Identify the NPS controls necessary.
- Specify the programs that will apply the controls.
- Certify that the state has adequate authority to implement these measures.

- Identify all sources of funding for these programs.
- Establish a schedule for implementation.

Section 319 NPS funds are made available to assist LGUs and organizations in Minnesota to implement NPS measures that reduce water pollution to lakes, rivers, wetlands and groundwater resources.

In almost every chapter of Minnesota's management plan, education is recognized as an important means for effecting change with respect to NPS water pollution problems. MPCA awarded $2.5 million in the federal fiscal year 2019 funding round for projects that will reduce nonpoint source pollution in Minnesota's lakes, rivers, and streams. Details are found here: https://www.pca.state.mn.us/water/clean-water-partnership-and-section-319-programs.

Point of contact: Cynthia Osborn at 651-757-2099 or cynthia.osborn@state.mn.us.

B.2.2.5. Clean Water Partnership

The MPCA provides additional financial and technical assistance to local government and other water resource managers to address nonpoint-source water pollution through the state Clean Water Partnership. Clean Water Partnership funds will be used for development or implementation projects that protect water bodies currently meeting Minnesota's water quality standards. Details are found here: https://www.pca.state.mn.us/water/clean-water-partnership-and-section-319-programs.

Point of contact: Cynthia Osborn at 651-757-2099 or cynthia.osborn@state.mn.us.

B.2.2.5. Civic engagement

Since watershed protection and restoration depends largely on changing the behaviors of citizens who live on the land, it will require a real commitment at the community level to address problems in our lakes and streams. Watershed assessment and planning must be much more inclusive, with the public playing a much more active role, beginning early in the planning process. Citizens must be involved in framing the problem, developing solutions and taking responsibility for implementation. See more information at: https://www.pca.state.mn.us/water/civic-engagement-watershed-projects.

Point of contact: Celine Lyman at 651-757-2541 or celine.lyman@state.mn.us.

B.2.3. Stormwater program

Section 402 of the CWA established the NPDES permit program to specifically control the discharge of pollutants from point source dischargers to waters of the United States. A 1987 amendment to the CWA required stormwater discharges from municipal, construction, and industrial sources to be permitted under the NPDES permit program. The amendment was to be implemented in two phases, Phase I in the early 1990s and Phase II in March 2003.

Extensive information on MPCA's stormwater programs is available at: https://www.pca.state.mn.us/water/stormwater

B.2.3.1. Municipal stormwater

A municipal separate storm sewer system (MS4) is a conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains, etc.) that is also:

- Owned or operated by a public entity (which can include cities, townships, counties, military bases, hospitals, prison complexes, highway departments, universities, sewer districts, etc.).
- Designed or used for collecting or conveying stormwater.
- Not a combined sewer.

- Not part of a publicly owned treatment works.

MS4s in Minnesota must satisfy the requirements of the MS4 general permit if they are located in an urbanized area and used by a population of 1,000 or more or owned by a municipality with a population of 10,000 or more, or a population of at least 5,000 and the system discharges to specially classified bodies of water.

The MPCA issued the original small MS4 General Permit in June of 2002. The MS4 general permit is issued for five years, after which it must be reissued. As part of the reissuance, MPCA staff consult with permittees and stakeholders and solicit public comment to look for ways to improve and revise the permit. The last permit issued was in 2020; see https://www.pca.state.mn.us/water/2020-ms4-general-permit.

The MPCA is managing competing demands for staff resources associated with priority projects. These priorities continue to evolve and require stormwater staff resources. These priorities include project management and the ongoing *Stormwater Manual* update effort (https://www.pca.state.mn.us/water/minnesotas-stormwater-manual).

Additional information on Minnesota's Municipal Stormwater Program can be found at https://www.pca.state.mn.us/water/municipal-stormwater-ms4.

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B.2.3.2. Construction stormwater

The Phase I rules regulated large construction activities that disturb five or more acres of land. The Phase II rules required small construction activities disturbing one to five acres, including construction that is part of a common plan of development or sale disturbing one acre or more, to have NPDES permit coverage.

In August 2013, the MPCA reissued the construction Stormwater General Permit to comply with the EPA final rule on *Effluent Guidelines for Discharges from Construction and Development Sites* (December 2009). In addition, the revised permit requires electronic applications and one-inch volume control from new impervious surfaces. With the new volume control requirement, the MPCA will have a concerted effort to ensure the resulting green infrastructure (mostly infiltration basins) will be designed, built, and operated correctly. This will be done through education, compliance/enforcement, and partnering with local governments. Additional information on Minnesota's Construction Stormwater Program can be found at https://www.pca.state.mn.us/water/construction-stormwater.

Point of contact: Rachel Parlin at 651-757-2118 or rachel.parlin@state.mn.us.

B.2.3.3. Industrial stormwater

Industrial Stormwater General Permit (Permit) are reissued every five years. At this time the Permit is effective through April 1, 2025. The timelines of current and post Permits are found at https://www.pca.state.mn.us/water/industrial-stormwater-permit-development-and-program-history. The Permit regulates dozens sectors of industrial activity and required all Permittees to sample their stormwater runoff and send the results to the MPCA. Sampling requirements continue to be a key indicator for Permittees successes and deficiencies; it is a feedback loop to alert permittees if their chosen stormwater management practices are working or not. Sampling requirements started over for all Permittees, regardless of their outcomes of sampling results during past permit cycles. Beginning July 2015 for renewing Permittees (and next full calendar quarter for new applicants), Permittees are required to sample their stormwater discharges for a minimum of four quarters. Over time, the Industrial Stormwater Program has shifted focus from education/outreach and local partner development, to responding to sampling results and compliance/enforcement strategies. The Industrial

Stormwater Program continues to collaborate with the University of Minnesota to provide training on permit requirements. Staff are also working more closely with industrial and municipal permit writers to ensure appropriate stormwater language is being written into their individual permits. The Industrial Stormwater Program's website is updated at least monthly with frequently-asked-questions, steps to compliance, quarterly newsletters, and more: https://www.pca.state.mn.us/water/industrial-stormwater.

Point of contact: Mary West at 651-757- 2818 or mary.west@state.mn.us.

B.2.3.4. Stormwater rules

Minnesota state stormwater rules, Minn. R. ch. 7090 (https://www.revisor.mn.gov/rules/?id=7090), were enacted in 2005, combining the Phase I and Phase II rules in one place. Information on rulemaking is found at https://www.pca.state.mn.us/water/stormwater-program-rulemaking.

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B.3. Cost-benefit analysis

Underlying the nation's water pollution control efforts is the assumption that the overall cost of those efforts, while considerable, is outweighed by the resulting benefit.

Cost-benefit analysis (CBA) is an attempt to make this assumption explicit and testable. However, estimating the benefits associated with environmental programs (and, to an extent, even the costs) is challenging. While the influence of environmental factors on market prices and the positive value that people place on environmental improvements is at this point fairly well established, it remains extremely difficult to estimate environmental values with precision. As a result, environmental policy decisions continue to be made through the political process, rather than through the strict application of a quantitative CBA, which would be incomplete and of debatable accuracy.

Nevertheless, the underlying purpose of CBA – the assurance that the public's dollars are well spent – lies at the heart of the MPCA's considerable efforts at cost control and program effectiveness. In a time of decreased funding countered by increased demand for environmental services, the MPCA has done a great deal to ensure that its programs are directed towards the most important environmental problems and that those programs are conducted as cost-effectively as possible. Ongoing process-improvement efforts addressing the efficiency of various agency programs, and reports on stressors to Minnesota's aquatic ecosystems, such as *Stressors Candidates Causes—Stressors to biological communities in Minnesota's river and streams*,[*] used by the MPCA to help prioritize the environmental problems currently faced by Minnesota, are only two examples of this continuing effort.

A partial accounting – partly quantitative, partly descriptive – of some of the costs and benefits associated with Minnesota's water quality program is given below.

B.3.1 Costs

The primary water quality programs at the state level are those of the MPCA, Minnesota Department of Natural Resources (MDNR), Minnesota Department of Agriculture (MDA), Minnesota Department of Health (MDH) and BWSR. Including local assistance, the WQ budget of the MPCA is approximately $108

[*] *MPCA, 2019. Stressors Candidate Causes. Retrieved from: https://www.pca.state.mn.us/sites/default/files/wq-ws1-27.pdf*

million per year[†] and of BWSR approximately $74 million per year.[‡] Other costs are incurred at the local level in the regulation of land use, feedlots, and on-site sewage disposal systems. It should be noted also that other environmental programs, such as air quality, solid waste, hazardous waste, and agricultural pesticide regulation have direct effects on the quality of the state's surface and groundwater. The MPCA, which has primary jurisdiction for the first three of these, has an overall budget of approximately $400 million per year.

Regarding the actual implementation of point source water pollution controls, more than $5 billion[§] in federal, state, and local funds have been spent since the enactment of the CWA for the construction of municipal wastewater treatment facilities in the state, including the separation of combined sewers. The estimated infrastructure investment needs and annual operating costs for water treatment statewide is $4.12 billion over the next five years.[**] Note, however, that municipal facilities treat industrial as well as municipal wastes and that industrial contributions represent a significant portion of the above figures.

In addition to government agency costs, some regulated parties might incur costs in order to adhere to permitting restrictions, such as permit application fees, changes in management practices, investment in water treatment technology, and other costs. Depending on market conditions, firms might incur costs from reducing production and thus become less competitive, and the economy could experience indirect effects to employment.

The overall costs of NPS water pollution control implementation, are more diffuse and more difficult to calculate than those for point source programs. Due to changing economic circumstances, such as crop prices, it is not possible to estimate the indirect costs of best management practices (BMPs) to control runoff statewide. For example, reduced crop production owing to buffer strips is a considerable cost[††], but the economic impact varies by soil quality, type of crop, and many other factors.

One proxy for the cost of non-point pollution abatement is the amount of state funding dedicated towards watershed conservation projects. Between 2009 and 2019, $40.2 million was awarded by the MPCA to fund watershed load reduction projects.[‡‡] Based on past estimates for restoration and current impairments, approximately $2 billion to $9 billion will be needed to restore Minnesota waters on the current 303(d)[§§] list that are impaired by NPSs.

B.3.2. Benefits

While it is difficult to fully account for all costs of the CWA in Minnesota, the true measurement of benefits is subject to even higher uncertainty. Theoretical models for translating WQ improvement into economically measured benefits have been applied in numerous contexts in the United States and in Minnesota, but no attempts have been made to do this for the state as a whole.

[†] MMB. 2019. 2020 – 21 Governor's Budget – Pollution Control Agency: https://mn.gov/mmb-stat/documents/budget/2020-21-biennial-budget-books/governors-recommendations-february/pollution-control-agency.pdf

[‡] *BWSR, Biennium budget, FY 2022-23.*

[§] Minnesota Public Facilities Authority, 2020 Annual Report: https://mn.gov/deed/assets/pfa-annual-report_tcm1045-290187.pdf

[**] MPCA, 2020. Future wastewater infrastructure needs and capital costs Fiscal Year 2020 Biennial Survey of Wastewater Collection and Treatment: https://www.lrl.mn.gov/docs/2020/mandated/200064.pdf

[††] Srinivas, R., Drewitz, M., & Magner, J. (2020). Evaluating watershed-based optimized decision support framework for conservation practice placement in Plum Creek Minnesota. Journal of Hydrology, 124573.

[‡‡] MPCA, 2019. Watershed Achievements Report 2019. Retrieved from: https://www.pca.state.mn.us/sites/default/files/wq-cwp8-23.pdf

[§§] MPCA Impaired Waters Viewer: https://www.pca.state.mn.us/water/impaired-waters-viewer-iwav

Water quality is an ecosystem service, or benefit from nature essential to human well-being (MA, 2005).[***] A 2015 study performed an economic valuation of the ecosystem services of the St. Louis Watershed,[†††] which valued the water resources of the St. Louis Watershed at $2 to $5 billion per year. Though the resulting estimate describes the total annual flow of ecosystem goods and services rather than the benefit caused by improvements in water quality, it is an important starting point to conceptualize the economic benefits the water resources of Minnesota offer continually to the economic health of the state.

The MPCA has also made progress towards its turbidity reduction goals for the Minnesota River and the southern basin of the Mississippi River by identifying sediment sources and designing an action plan including a sediment reduction strategy[‡‡‡] with a goal of 50% reduction of sediment loads by 2030. In conjunction with the sediment TMDL for Lake Pepin, a full cost accounting study estimated that a 50% reduction in sediment and phosphorus loading could lead to net zero economic loss to society when balancing reductions in agricultural production with the increased provision of ecosystem services, including carbon sequestration, recreational hunting, flood prevention, and biodiversity existence value. The results suggest that the most cost-efficient strategy to reduce sediment and phosphorus loading is to convert conventional crop production to forest or to crop production using half as much phosphorus fertilizer.[§§§]

For point source programs, even if dollar figures are not readily available, benefits can be illustrated in descriptive terms. Significant improvements in state water quality have occurred over the past several decades, especially since the passage of the CWA. While only 20% of the state's sewered population was served by facilities capable of at least secondary treatment in 1952, fully 99.9% are so served at present. In a similar vein, rates of regulatory compliance for municipal and industrial facilities are at a high level, with 99% of permittees meeting their effluent limits. As a result of the MPCA's efforts, phosphorus loads from wastewater treatment plants have decreased by 55% since 2006.

As a result of both point source and NPS programs, water quality improvements in the state have been significant. Over the past decade, more stations in the state's long-term river monitoring network show a decrease in total phosphorus and total suspended solids (TSS) concentrations than those that show an increase (29% versus 5% for total phosphorus; 15% versus 8% for TSS). However, nitrate concentrations increased at 51% of stations and only decreased at 2%.[****]

Numerous site-specific projects have already resulted in remarkable improvements in water quality. For example, due to decades of remediation efforts, the St. Louis River Area of Concern is on track to be delisted from its nine beneficial use impairments by 2025. Among many noticeable achievements, the first evidence of sturgeon population recovery occurred in 2011, when four young sturgeons were collected. Since 1978, at least $420 million dollars[††††] has been invested in this area of concern for infrastructure updates, restoration, and remediation of historic industrial contaminants. The restoration of the St. Louis River is essential for protecting the ever-growing tourism industry in Duluth, for which water resources and natural scenery are major assets. Duluth tourism tax revenues have nearly doubled

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[***] Millennium Ecosystem Assessment, 2005. Ecosystems and human well-being. Retrieved from: http://www.millenniumassessment.org/documents/document.356.aspx.pdf

[†††] Fletcher, A., Christin, Z. 2015. The Value of Nature's Benefits in the St. Louis River Watershed. Earth Economics, Tacoma, WA.

[‡‡‡] Sediment Reduction Strategy for the Minnesota River Basin and South Metro Mississippi River: https://www.pca.state.mn.us/sites/default/files/wq-iw4-02.pdf

[§§§] Dalzell, B., Pennington, D., Polasky, S., Mulla, D., Taff, S., and Nelson, E. 2012. Lake Pepin Watershed Full Cost Accounting Project. Retrieved from: https://www.pca.state.mn.us/sites/default/files/wq-iw9-01n.pdf

[****] Clean Water Fund Performance Report: https://www.legacy.mn.gov/2020-clean-water-fund-performance-report

[††††] St. Louis River Area of Concern, 2019 Remedial Action Plan, Retrieved from https://www.pca.state.mn.us/sites/default/files/wq-ws1-31.pdf

since 2010 to more than $12 million in 2019,[‡‡‡‡] and current revenues have recovered past pre-pandemic levels.[§§§§]

Indicative of both the value of clean water and the success of Minnesota's clean water programs is the large total revenue of the state's tourism industry, which generated approximately $16.6 billion in 2019 with a growth of 23.5% between 2012 and 2019.[*****] More than $3 billion comes from expenditures related to fishing and wildlife viewing alone, according to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Minnesota's water resources are a considerable attraction for this economically important industry and provide habitat for wildlife that also attract tourists.[†††††]

Similarly, a study by Bemidji State University on the economic value of Minnesota lakes found a strong relationship between water clarity and lake property values, with an increase of one meter in water clarity associated with additional total property value of tens or even hundreds of millions of dollars for given individual lakes.[‡‡‡‡‡] The results of this study, along with numerous similar studies across the United States, emphasize that individuals express a preference for high water quality in the real estate market, and gain a direct economic benefit from improved water resources.

In addition to the tourism and property values benefits of clean water, numerous studies have demonstrated that clean water provides many other environmental services, all of which have significant economic value. These services include safe drinking water, agricultural uses (irrigation and raising livestock), commercial fishing, use in manufacturing, use in mining, use in electrical power generation, navigation, and hydropower. The protection of water quality also plays an important role in mitigating the damages associated with floods, human health risks from accidental ingestion or contact with water, and reduced treatment or other damages downstream. In addition, Minnesotans receive non-market benefits from experiencing positive aesthetic properties of clean water bodies, knowing that pristine ecosystems are kept intact, and protecting surface waters' assimilative capacity for the use of future generations.

While the economic value of all the services provided by maintaining clean surface waters and groundwater in Minnesota have not been estimated, numerous studies have shown that clean water is essential to the U.S. economy, that the economic value of clean water is significant, and that the benefits of having clean water generally outweigh the costs of maintaining clean water.

While CBA can be used to evaluate the overall benefit of clean water, it can also be used to evaluate the water quality impact of a specific project/policy. Water quality contributes to several other ecosystem services, such as water quantity, water purification, navigation, drinking water, recreation, and wildlife habitat (Keeler et al., 2012).[§§§§§] A specific project or policy that improves water quality, also sustains

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[‡‡‡‡] *Galioto, Katie. (2020, February 5). Duluth rakes in record $12.4M in tourism revenue. Star Tribune. Retrieved from: https://www.startribune.com/duluth-rakes-in-record-12-4m-in-annual-tourism-revenue/567602662/*

[§§§§] *Johnson, Brooks. (2021, October 5). Star Tribune. Retrieved from: https://www.startribune.com/duluth-tourism-rebound-the-recovery-year-we-needed/600103997/*

[*****] *Explore Minnesota. 2020 Annual Report. Tourism and Minnesota's Economy. Retrieved from www.exploreminnesota.com https://mn.gov/tourism-industry/assets/AnnualReport_2020_tcm1135-485394.pdf*

[†††††] *USFWS, 2018. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Minnesota. Retrieved from: https://www.census.gov/prod/2013pubs/fhw11-mn.pdf*

[‡‡‡‡‡] *Krysel, C., Boyer, E. M., Parson, C., & Welle, P. (2003). Lakeshore property values and water quality: Evidence from property sales in the Mississippi Headwaters Region. Submitted to the Legislative Commission on Minnesota Resources by the Mississippi Headwaters Board and Bemidji State University. Retrieved from: http://www.friendscvsf.org/bsu_study.pdf*

[§§§§§] *Keeler, B. L., Polasky, S., Brauman, K. A., Johnson, K. A., Finlay, J. C., O'Neill, A., ... & Dalzell, B. (2012). Linking water quality and well-being for improved assessment and valuation of ecosystem services. Proceedings of the National Academy of Sciences, 109(45), 18619-18624.Retrieved from: https://www.pnas.org/content/109/45/18619*

these valuable ecosystem services for use by current and future generations. Therefore, any change in water quality or related ecosystem service in response to a given policy or project, also provides a measure of the benefits from the policy/project. Ecosystem services are typically not marketable and have public-good features that make them difficult to quantify and evaluate in monetary terms. However, valuation of ecosystem services is an active research area in economics and several methods are available including theoretical, empirical, and spatially explicit methods such as Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST), by the Natural Capital project,[******] that may be appropriate for a given ecosystem service or a particular valuation scenario. For example, a meta-analysis approach found that the average willingness to pay (WTP) per household in Iowa for a 25% improvement in water quality was $138 (Ge et al., 2013).[††††††] Another study used a combination of econometric modeling and InVEST to examine tradeoffs between private and social benefits when implementing alternative land use-land management (LULM) policies to improve water quality and other ecosystem services in the agriculturally dominated Seven Mile Creek watershed in south central Minnesota, and found that meeting stringent water quality goals is possible without incurring losses to society, if the resulting social benefits were incorporated within private returns to farmers (Pennington et al., 2017).[‡‡‡‡‡‡]

An accounting of some of the key results regarding the MPCA's environmental programs can be found at https://www.pca.state.mn.us/about-mpca/dashboard-environmental-and-performance-measures.

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B.4. Special state concerns and recommendations

Over the past several years, the MPCA has invested significant resources to investigate and evaluate other contaminants now known to be widely present in the environment that are not included in regular monitoring activities. These contaminants are often referred to as contaminants of emerging concern (CECs) and include pharmaceuticals, household and industrial-use products; endocrine active compounds (EACs); brominated flame retardants; and per- and polyfluoroalkyl substances (PFAS). The work done by the MPCA and others is important to inform lawmakers, regulators, the public and industry about the presence and extent of these contaminants in Minnesota's waters, and to evaluate when and how to address the contaminants through agency protection programs. The following paragraphs provide an overview of recent MPCA activities and other developments related to CECs.

B.4.1. Pharmaceuticals, household and industrial-use products

The MPCA has been collaborating on an ongoing basis with researchers from the U.S. Geological Survey (USGS) to monitor the presence of pharmaceuticals, personal care products, and other wastewater-associated chemicals in Minnesota's groundwater, lakes, and flowing waters. In general, these studies show that industrial and household-use compounds and pharmaceuticals are present in streams, groundwater, wastewater, and landfill effluents. Steroidal hormones, prescription and non-prescription

[******] *InVEST. Natural Capital Project. Retrieved from: https://naturalcapitalproject.stanford.edu/software/invest*
[††††††] *Ge, J., Kling, C. L., & Herriges, J. A. (2013). How much is clean water worth? Valuing water quality improvement using a meta analysis. Retrieved from: https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1050&context=econ_las_workingpapers*
[‡‡‡‡‡‡] *Pennington, D. N., Dalzell, B., Nelson, E., Mulla, D., Taff, S., Hawthorne, P., & Polasky, S. (2017). Cost-effective land use planning: Optimizing land use and land management patterns to maximize social benefits. Ecological Economics, 139, 75-90. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0921800916310813?casa_token=wE7GI7RWN8AAAAAA:O-SXvOctrfqhBr2YuK_-SrpXGFp1BtprSPh8wc3RXyjPOBh_mEWC7-eJ2oAbw-45oeOU6F-5ouBX*

drugs, insect repellent, detergents and detergent degradates, and plasticizers are widespread at low concentrations in Minnesota's rivers, lakes, and streams. The chemicals are typically found downstream of sources such as wastewater treatment plants. However, they are also present in more remote surface water where sources of these chemicals are not clear. Two large monitoring campaigns in conjunction with EPA's National Aquatic Resource Survey – one of 150 river and stream locations and one that included a random selection of 50 lakes - revealed that these chemicals are surprisingly widespread in Minnesota's ambient surface water. The results of many of these studies can be found in reports located at https://www.pca.state.mn.us/water/endocrine-active-compounds.

B.4.2. Other contaminants of concern in Minnesota's environment

Over the past ten years, the MPCA has invested significant resources to investigate and evaluate other contaminants known or suspected to be widely present in the environment that are not included in regular monitoring activities. These contaminants are often referred to as contaminants of emerging concern (CECs) and include pharmaceuticals, household and industrial-use products; endocrine active compounds (EACs); brominated and orthophosphate flame retardants; iodinated disinfection by-products, and per- and polyfluoroalkyl substances (PFAS).

This work done by the MPCA and others is important in several ways: first, it informs lawmakers, regulators, the public and industry about the presence and extent of these contaminants in Minnesota's environment; second, local, collected-in-Minnesota samples of water, sediment and/or other media are tested using new and developing gene-based techniques to assess the potential impacts of these less understood chemicals on aquatic life; and finally, it provides a developing foundation to evaluate if, when and how to address emerging contaminants through agency protection programs.

The following paragraphs provide an overview of ongoing MPCA activities and other developments related to CECs.

B.4.2.1. Pharmaceuticals, household and industrial-use products

The MPCA has been monitoring the presence of pharmaceuticals, personal care products, and other anthropogenic chemicals in Minnesota's lakes, rivers and streams since 2010 via statewide monitoring campaigns that are conducted at five year intervals in conjunction with EPA's National Aquatic Resource Surveys. These investigations have clearly demonstrated that pharmaceuticals and personal care products (PPCPs) such as antibiotics and antidepressants, the pesticide DEET, alkylphenols, and the disinfectant triclosan are widespread in Minnesota's surface waters. Many of these chemicals are endocrine active, mimicking naturally occurring hormones. Concern is continuing over the effect these chemicals may have on fish and wildlife and human health at very low concentrations.

Also in 2010, the MPCA began collecting groundwater samples from its Ambient Groundwater Monitoring Network for analysis of the same set of emerging contaminants (pharmaceuticals, household and industrial-use products). Initially, the key objective of the groundwater monitoring was to determine the magnitude of contamination; subsequently, the sampling has focused on areas with a high relative potential for groundwater contamination. This work generally shows that fewer contaminants of emerging concern are detected in groundwater compared to surface water, and that the concentrations of the contaminants in groundwater tend to be lower than in surface water.

The results from the 2010 survey along with more information about PPCPs and EACs are available here: https://www.pca.state.mn.us/sites/default/files/wq-cm4-03.pdf. The MPCA is continuing to monitor Minnesota's surface and groundwater for EACs and other emerging contaminants.

B.4.2.2. Endocrine active chemicals (EACs)

The potential harm caused to aquatic life through exposure to EACs, including causing adverse behavioral and physiologic effects such as impairment of the reproductive system or disruption of an organism's growth and development driven significant research worldwide.

MPCA scientists, building on the results from the monitoring work described above and other studies of EACs and emerging contaminants, have conducted a number of investigations in collaboration with researchers at the USGS, St. Cloud State University, the University of Minnesota, the University of St. Thomas, and other organizations to further investigate the significance, sources, and occurrence of EACs. Many of these studies have included an analysis of how fish are impacted by EACs or have included some component of study looking at genetic changes in organisms exposed to EACs.

These studies show that sources of emerging contaminants to the environment include wastewater, stormwater, and landfill effluents, and that detectable concentrations of some of these contaminants are present in precipitation. This last finding helps explain why contaminants of emerging concern are found not just downstream of populated areas; they are also found as in pristine lakes in remote areas of the state, such as the Boundary Waters Canoe Area (BWCA).

The results of many of these studies can be found in reports located at https://www.pca.state.mn.us/water/endocrine-active-compounds.

B.4.2.3. Other emerging contaminants

New contaminants of emerging concern continue to be identified on an on-going basis. One is the broad category of microplastics, for which there is substantial worldwide interest and concern; however, there is still relatively limited information regarding what aspects of microplastics contamination present the most concern. MPCA is staying abreast of developments regarding microplastics and actively working to evaluate different monitoring and analysis techniques, since no standardized method has yet been developed.

Another newly identified emerging contaminant is 6PPD-quinone (6PPD-Q), a breakdown product from the anti-oxidants used in automobile tires. This chemical was recently identified as the toxic chemical responsible for die-offs of certain salmon during spawning in the Pacific Northwest. There is concern about similar toxicity in the Great Lakes and the Atlantic, and about how 6PPD-Q may affect other species. Again, MPCA scientists are staying on top of the information that is coming available and will consider further action, such as monitoring, when circumstances (i.e. methods, funds, staffing) permit.

The MPCA will continue monitoring for EACs and other emerging contaminants in Minnesota surface waters in conjunction with statewide and nationally based probabilistic surveys. MPCA also conducts additional research to expand our understanding of the occurrence of these emerging contaminants and their potential to negatively impact aquatic life.

B.4.3. Per- and polyfluoroalkyl substances (PFAS)

Per- and polyfluoroalkyl substances, commonly known as PFAS, are manmade chemicals used to manufacture products that are heat and stain resistant and repel water. PFAS are widespread and persistent in the environment and they have been found in animals and people all over the globe. There is evidence that exposure to PFAS can lead to adverse human health effects. The MPCA provides extensive information on its website: https://www.pca.state.mn.us/waste/pfas-pollution.

The most recent update to the state's work on PFAS is the release of Minnesota's PFAS Blueprint, summarized at https://www.pca.state.mn.us/waste/minnesotas-pfas-blueprint. The Minnesota PFAS Blueprint (full report at https://www.pca.state.mn.us/sites/default/files/p-gen1-22.pdf) identifies short-

and long-term opportunities, as well as legislative actions, to manage PFAS in our environment and protect families and communities. Over the coming months and years, state agencies will further develop these strategies and engage Minnesotans on how best to implement them. Future needs and opportunities are complex and resource-intensive. State agencies and community partners will need to work together to undertake projects that most strategically advance the collective goal to protect human health and the environment from the impacts of PFAS.

The MPCA will continue to evaluate conditions in PFAS-affected waters to determine if further regulatory or prevention activity is needed to assure that these waters fully support their beneficial uses.

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Part C. Monitoring and assessment strategy

C.1. Monitoring strategy

C.1.1 Minnesota's water quality monitoring strategy

The Minnesota's Water Quality Monitoring Strategy, 2021-2031, describes elements of the state's surface water and groundwater monitoring programs. The Monitoring Strategy satisfies the EPA monitoring program strategy requirement and serves as the guide to MPCA monitoring programs.

Minnesota's Water Quality Monitoring Strategy is available at: https://www.pca.state.mn.us/water/water-quality-monitoring-strategy.

Point of contact: Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

C.1.2. Condition monitoring strategy: Watershed approach

In recent years, the MPCA has organized components of stream and lake condition monitoring into the watershed framework at the major watershed level. An average of 8 to 10 watersheds are intensively monitored annually and assessed in a yearly rotation expected to complete a statewide assessment every 10 years. This approach coordinates with the Minnesota's impaired waters program, local groups, and citizens by laying out future work and impairment listings well in advance. For a full discussion of the benefits and components of the watershed approach, refer to the Watershed Approach webpage (https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality).

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C.1.3. Stressor identification strategy

Minnesota addresses impaired biota by examining the interactions of numerous physical, chemical, and biological processes that define community composition. Biological impairments can be driven by natural or unnatural changes to one or many components of these systems. Biological impairments differ from some traditional WQ impairments in that the impaired biotic communities are indicators of disturbance rather than causes of disturbance.

Biological impairments are commonly caused by stressors that are not considered conventional pollutants within our WQ rules. These include stressors such as degraded habitat or altered hydrology. Minnesota utilizes the process of stressor identification developed by the EPA to identify the dominant stressors.

The process of stressor identification draws upon a broad variety of disciplines such as aquatic ecology, biology, geology, geomorphology, statistics, chemistry, environmental risk assessment, and toxicology. Information and reports can be found at https://www.pca.state.mn.us/water/your-stream-stressed.

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C.1.4. Effectiveness monitoring strategy

Much like problem investigation monitoring, the state's effectiveness monitoring strategy relies on monitoring activities by a variety of parties. For individual projects, a variety of groups (regulated parties, local implementers, agency contractors, other organizations and the MPCA) can be involved in conducting effectiveness monitoring to evaluate specific management practices in a project area. With

the MPCA's adoption of the watershed approach (https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality), the condition monitoring conducted in the first round of the 10-year cycle becomes dual purpose monitoring in subsequent cycles, since at this point the WRAPS has been developed and implementation is underway. As a result, the second round of monitoring can serve as a measure of the effectiveness of the implemented practices from the previous cycle.

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C.1.5. Surface water monitoring purposes, designs and indicators

The MPCA's current Condition, Problem Investigation and Effectiveness Monitoring activities are described in detail in Section 2.2 of the Minnesota's Water Quality Monitoring Strategy, 2021-2031. The information provided includes monitoring activity start date, purpose, and description, including the type of monitoring design that is used to meet the specific monitoring purpose, and indicators.

Minnesota's Water Quality Monitoring Strategy is available at:
https://www.pca.state.mn.us/water/water-quality-monitoring-strategy.

Point of contact: Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

C.1.6. Drinking water assessments

The MPCA does not assess groundwater (Class 1A) for potential impairment of the drinking water use. However, the MPCA is assessing Class 1B and Class 1C listed surface waters for potential impairment by nitrate nitrogen. This step was taken in recognition of the trend of increasing nitrate concentrations in Minnesota streams and the public health and economic impact arising from elevated nitrate concentration in drinking water (a particular concern in southeast Minnesota's karst region, where many Class 1B and 1C waters are located). More information about the assessment of Class 1B and 1C waters for nitrate nitrogen is available in Section VI., Part D, of the *2022 Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* available here: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

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C.1.7. Source water

The Minnesota Department of Health (MDH) is the lead agency in Minnesota working on source water protection with the EPA. For groundwater-based public water supplies, source water protection is the state's wellhead protection program. For surface water supplies, source water assessment is being approached in various ways, depending on the size and circumstances of each source water and watershed. Where possible, these assessments and MPCA's Watershed Assessment Teams (WAT) are being coordinated.

In the past, the MPCA has worked closely with the MDH on source water protection, through a Memorandum of Agreement. As part of this effort, the MPCA provides data on potential contaminant sources in source water protection areas and provides technical assistance to the MDH, and public water suppliers on managing contaminant sources. The MDH and the MPCA continue to coordinate on special projects that involve both source water protection, and basin and watershed management. The MDH can now electronically access some of the MPCA's electronic databases to obtain information on potential contaminant sources, and the MPCA is continuing to work on the expansion of data access. The MPCA also has a representative on the MDH Ad Hoc Committee on Source Water Protection for Surface Water Systems.

For more on source water protection go to https://www.health.state.mn.us/communities/environment/water/swp/index.htm.

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C.2. Assessment methodology

Minnesota's water quality assessment methodology is fully documented in the *MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* posted at https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

C.3. Assessment results

The fulfill CWA Section 305(b) requirements, Minnesota's water quality assessment results are reported to EPA's ATTAINS database on a biennial cycle. The results of the last cycle Minnesota reported can be viewed on EPA's website, https://mywaterway.epa.gov/, and MPCA's website, https://webapp.pca.state.mn.us/surface-water/search.

C.3.1. Impaired Waters List

The fulfill CWA Section 303(d) requirements, Minnesota's list of impaired waters in need of TMDLs are submitted to EPA on a biennial cycle. The most recent impaired waters list can be found on the MPCA website at: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

C.3.2. Total maximum daily loads and impaired waters

For each pollutant that causes a water body to fail to meet applicable WQSs, the CWA requires the states to conduct a study called a TMDL study.

A TMDL study determines the assimilative capacity of a water body and identifies both point and NPSs of each pollutant that violates standards. Water quality sampling and computer modeling determine how much each pollutant source is contributing to the problem. An allocation process involving stakeholders determines how much each source must reduce its contribution to assure the standards are again met.

An impaired water body may have several TMDL studies, each one determining reductions for a different pollutant. After a TMDL study is written, a detailed implementation plan is developed to meet the TMDL's pollutant load allocation and achieve the needed reductions to restore WQ. Depending on the severity and scale of the impairment, restoration may require many years and millions of dollars.

The MPCA's progress on TMDLs is updated frequently here: https://www.pca.state.mn.us/water/tmdl-status.

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C.3.2.1. Strategies the MPCA employs in the impaired waters restoration process

C.3.2.1.1. State funding

Minnesota voters approved the Clean Water, Land and Legacy Amendment in 2008, which increased the sales and use tax rate by three-eighths of 1% on taxable sales starting July 1, 2009 through 2034. Approximately 33% of those funds are dedicated to the Clean Water Fund (CWF). The CWF appropriations for all fiscal years (found at https://www.legacy.mn.gov/clean-water-fund-interagency-fact-sheets). The MPCA is using these funds to meet the requirements of the federal CWA and the state

CWLA which focuses on existing restoration and protection programs. These funds should enable us to keep on track with state goals. More information on current funding can be found on the following websites:

- CWA: https://www.epa.gov/laws-regulations/summary-clean-water-act
- CWLA: https://www.revisor.mn.gov/statutes/?id=114D
- CWF: http://www.legacy.leg.mn/funds/clean-water-fund

Minnesota state agencies, local government, and nonprofit organizations are spending CWFs on hundreds of projects to protect and restore the state's surface water, groundwater, and drinking water. Project categories include water-quality monitoring and assessment, watershed restoration and protection strategies, protection and restoration implementation activities, and drinking water protection activities.

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C.3.2.1.2. Partnering with local government

Cities, counties, soil and water conservation districts, and watershed management organizations play a large and growing role in NPS pollution abatement across the state. The MPCA is ultimately responsible for completing and submitting TMDLs to the EPA. However, these stakeholders play a critical role in the development and implementation of TMDLs, therefore, the first priority is to use ready and qualified local government and watershed organizations with jurisdiction in the impaired watershed to develop TMDLs to lead a project. These entities need to have the expertise to do the work, especially for monitoring, land use inventory, choosing reduction scenarios, developing implementation plans and public outreach.

Locally-driven projects are most likely to succeed in achieving WQ goals because communities often best understand the sources of WQ problems and effective solutions to those problems. Through grant contracts with the MPCA, local governments and watershed organizations are leading over three-fourths of Minnesota's TMDL projects. The remaining projects, particularly the most complex ones, will often be led by MPCA or other state agencies. The MPCA provides oversight, technical assistance, and training to ensure regulatory and scientific requirements are met.

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C.3.2.1.3. Working with private consultants

The MPCA and local government often employ private consultants to perform specific steps of TMDL studies where needed and where they will be most effective. Consultants are helpful in supplementing MPCA and local staff resources, particularly for technical work. In many cases, consultants assist with data collection, modeling and development of draft reports.

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C.3.2.1.4. Strategies to increase the effectiveness and efficiency of total maximum daily load development and implementation

Watershed Restoration and Protection Strategies (WRAPS)

The WRAPS report summarizes current water quality conditions from the technical data; identifies the stressors and sources; and lists impaired water bodies with associated TMDLs, as well as water bodies needing protection. In the WRAPS, the critical section is the strategies table, where each impairment/protection need is assigned a list of strategies or types of conservation practices that will effectively address the problem. Similar information is shared with EPA in the annual Environmental

Performance Partnership Agreement reporting cycle. Progress is reported at https://www.pca.state.mn.us/water/watershed-restoration-and-protection-strategy-status.

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One Watershed One Plan (1W1P)

The purpose of the One Watershed, One Plan program is to develop comprehensive watershed management plans, as described in Minnesota Statute 103B.801 (https://www.revisor.mn.gov/statutes/cite/103B.801) that:

- Align local water planning purposes and procedures under this chapter and chapters 103C and 103D on watershed boundaries to create a systematic, watershed-wide, science-based approach to watershed management.
- Acknowledge and build off existing local government structure, water plan services, and local capacity.
- Incorporate and make use of data and information, including watershed restoration and protection strategies under section 114D.26.
- Solicit input and engage experts from agencies, citizens, and stakeholder groups; focus on implementation of prioritized and targeted actions capable of achieving measurable progress.
- Serve as a substitute for a comprehensive plan, local water management plan, or watershed management plan developed or amended, approved, and adopted, according to chapter 103B, 103C or 103D.

Progress on 1W1P development and approval is found at https://bwsr.state.mn.us/one-watershed-one-plan-participating-watersheds.

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C.3.2.1.5. Goal setting and performance measurement

Clean Water Fund Performance Reports on progress protecting and restoring waters are produced every two years: https://www.legacy.mn.gov/funds/clean-water-fund/clean-water-fund-performance-reports.

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C.4. Wetlands update

At over 10 million acres, Minnesota's wetland resource is large and diverse. There are also important regional wetland quantity and quality differences in the state. These regional differences require consideration in developing the state's regulatory and monitoring practices. The MPCA is committed to monitoring the wide variety of wetlands throughout Minnesota through probabilistic surveys.

C.4.1. Wetland regulatory program

The Minnesota Wetland Conservation Act (WCA) continues to be the principle wetland protection and regulatory program in Minnesota. Central to the WCA is the enactment of state policy to achieve a 'no net loss' and to increase the "quantity, quality and biological diversity of wetlands in the state" (Minn. Stat. § 103A.201). Several non-wetland specific regulatory programs including the 404/401 certification permit program, the MNDNR Public Waters Permit Program and the NPDES Permit Program (including stormwater) align with the WCA and the Federal Food Security Act "Swampbuster", to provide broad oversight of most types of direct and indirect physical alteration to Minnesota wetlands.

Minnesota actively implements Section 401 of the federal CWA (401 certification) based on state water quality standards (Minn. R. ch. 7050), including the wetland WQ standards. Many, though not all, of the Section 401 certification actions, in Minnesota, involve wetland waters.

Figure 2 illustrates the number of MPCA individual Section 401 certifications by industry category for fiscal year 2019. Infrastructure projects, such as road construction, trails, airports, pipelines, waste management, and stormwater and power lines represent the most common project type affecting wetlands. These data generally do not include agricultural land improvement projects. Figure 3 presents the number of statewide Section 401 WQ certifications by the type of determination action; certify, deny and wave. During this time period the MPCA issued slightly more waivers than certifications. The MPCA recognizes that 401 WQ Certification as an important regulatory tool which has contributed measurable protection to Minnesota's valuable wetlands and watersheds.

Figure 2. Minnesota Section 401 water quality certifications by category for federal fiscal year 2020

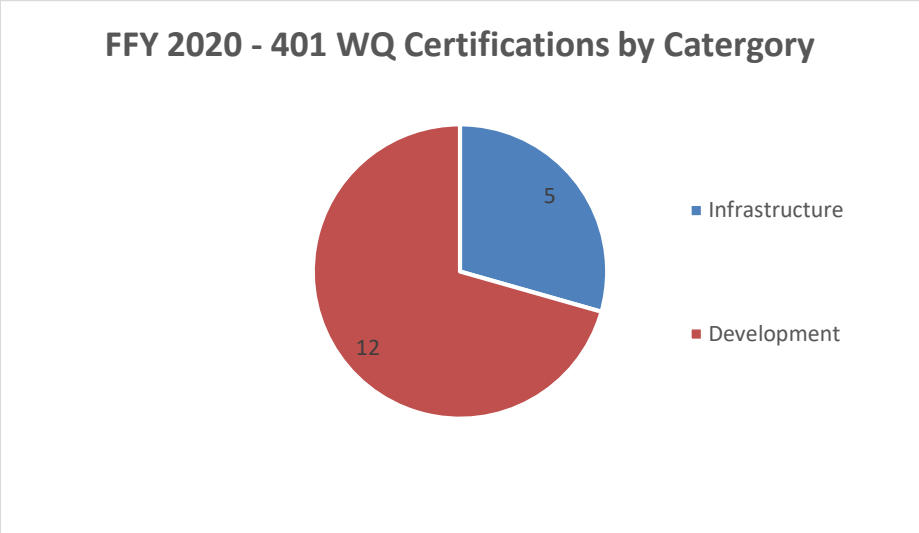
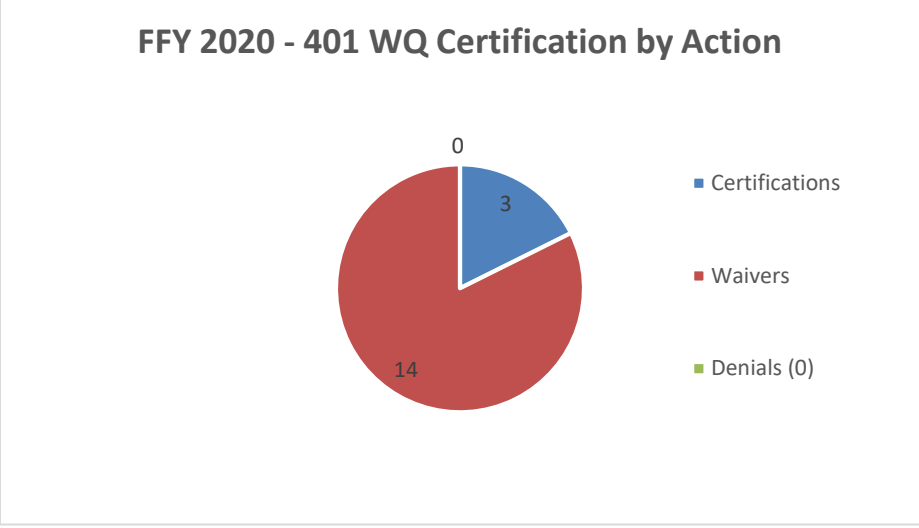


Figure 3. Minnesota Section 401 water quality certification by action federal fiscal year 2020



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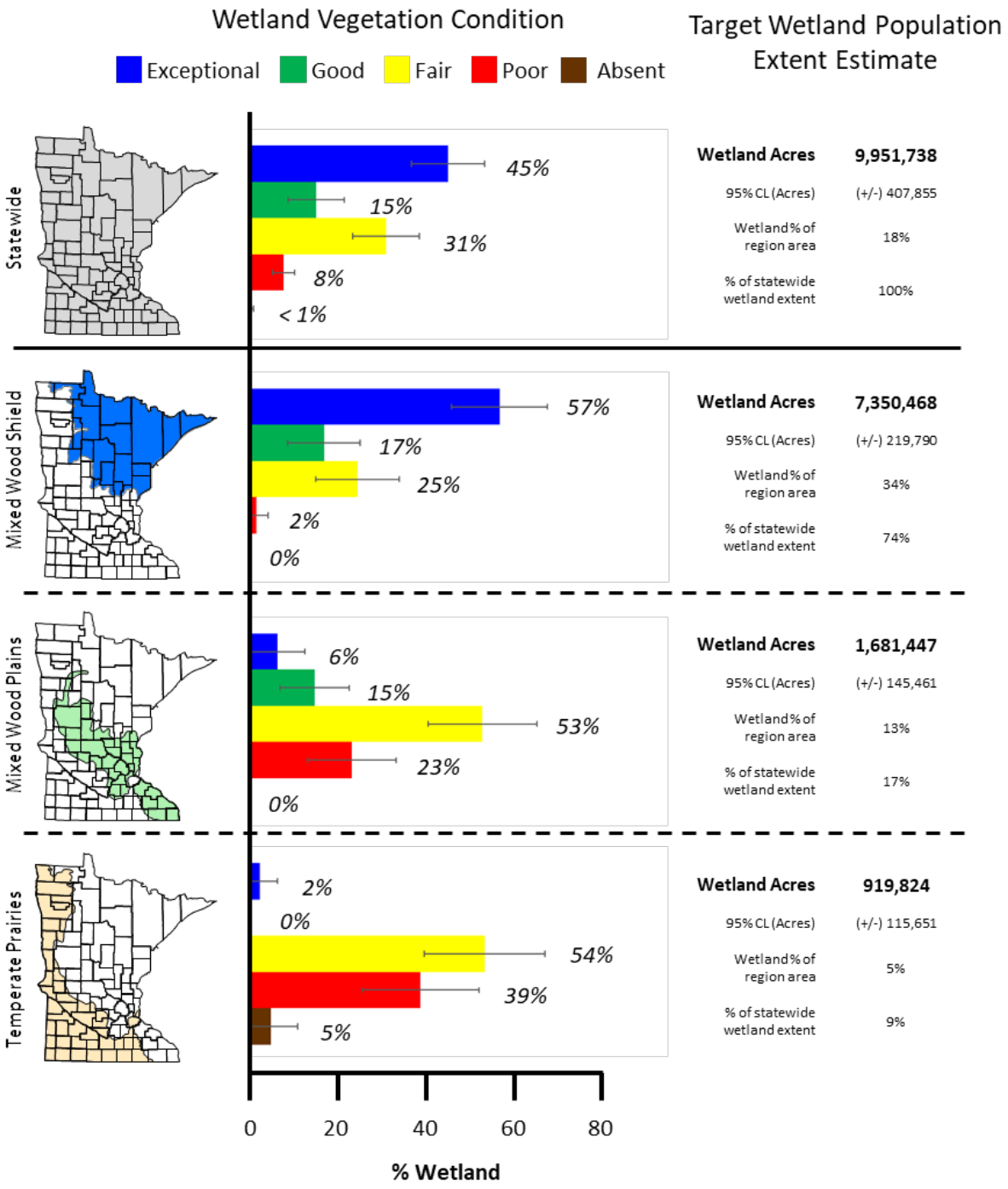
C.4.2 Wetland monitoring and assessment.

The MPCA is the lead agency for wetland quality monitoring in the state. The primary indicators are biological indices based on vegetation (applicable to all wetland types in the state) and macro-invertebrate (applicable only in depressional wetlands that typically have some open water) communities. A limited number of vegetation and macro-invertebrate depressional wetland assessments have been made; however, given the size and diversity of the resource and that wetlands are often restored as a means to improve stream and quality, it was decided that monitoring overall wetland quality and trends through broad surveys is of greater priority than individual wetland assessment.

Beginning in 2011, the MPCA has worked in conjunction with EPA on the National Wetland Condition Assessment in Minnesota. Statewide and regional intensification surveys have been completed in 2011/12 and 2016 to provide wetland vegetation quality status and trends information. Overall, Minnesota's wetland vegetation quality is high; however, condition varies widely in different parts of the state (Figure 4). Wetland vegetation is predominately in exceptional/good quality in the northern part of the state (where most of Minnesota's wetlands occur) and predominately in fair/poor quality in the remainder of the state. The MPCA is continuing this survey on the 5-year National Wetland Condition Assessment schedule and began the next iteration in 2021.

In addition, the MPCA conducts an independent survey of depressional wetland quality. These wetlands occur in a distinct basin, have marsh type vegetation, and typically some open water. Depressional wetlands make up a small (6% of the statewide wetland extent over an estimated 160,000 wetland basins) but iconic part of Minnesota's wetland resource. Three depressional wetland survey iterations have been completed (2007-09, 2012, and 2017) in the Mixed Wood Plains and Temperate Prairies ecoregions—where deperessional wetlands are more common. No significant wetland quality changes in have been detected over the survey iterations. The MPCA anticipates continuing the depressional wetland survey in 2023.

Figure 4. 2016 wetland vegetation condition category proportion and extent estimates statewide and by ecoregion.



Point of contacts: Michael Bourdaghs at 651-757-2239 or michael.bourdaghs@state.mn.us; John Genet at 651-757-2386 or john.genet@state.mn.us.

C.5. Trends analysis

C.5.1. Water quality trends for Minnesota rivers and streams

The Watershed Pollutant Load Monitoring Network, which consists of permanent flow and chemistry monitoring sites on a basin, major watershed, and subwatershed scale. A number of the load monitoring sites are located at former Minnesota Milestones sites. The load monitoring stations will be used to provide information about long-term water quality trends in Minnesota rivers. Information about the Watershed Pollutant Load Monitoring Network is available at: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring-network.

Point of contact: James Jahnz at 651-757-2214 or james.jahnz@state.mn.us.

Trend analysis of stream water clarity data has also recently been done using all stream and river transparency measurements available at the MPCA, including those collected by volunteers through the Citizen Stream Monitoring Program. Table 15 shows the most recent trends from 2018. See for https://www.pca.state.mn.us/water/transparency-trends methodology and a detailed statewide map of stream trends.

Table 1. Trends in Minnesota stream water clarity

Stream trend	Streams with this trend in 2018
Degrading	243 (34%)
Improving	232 (32%)
No trend	210 (29%)
No change	38 (5%)
Too clear to run a test	514
Insufficient data	2526
Stream stations with data	3762
Stream stations with enough data to run a test	722

Points of contact:

- Lake Monitoring Program at clmp.pca@state.mn.us
- Stream Monitoring Program at csmp.pca@state.mn.us

C.5.2 Biology

Every five years the MPCA conducts a statewide probabilistic survey of rivers and streams in Minnesota to evaluate biological condition. The latest iteration of this survey was completed in 2015, the results of which are presented here. Each site sampled was evaluated using an IBI based on fish community and aquatic invertebrate community attributes, independently. These IBI scores were compared to thresholds unique to each stream class that are based on characteristics of the sampling location including region (e.g., northern vs. southern), drainage area, and gradient (found at https://www.revisor.mn.gov/rules/7050.0222/). There are nine fish and nine invertebrate IBI classes used by the MPCA to assess the aquatic life designated use of rivers and streams. Within five of the fish IBI classes and four of the invertebrate IBI classes there are distinct thresholds for general and modified (i.e., channelized) aquatic life use streams. These thresholds, along with those for exceptional use streams (not used in this analysis), represent criteria for use in a tiered aquatic life use (TALU) framework that was adopted into water quality standards in November 2017. Therefore, the IBI results

from each survey site were compared to the appropriate threshold in relation to stream classification and channel condition, providing an approximation of its aquatic life use support status.

Figure 5. Estimated percent of stream miles that meet (i.e., Yes) invertebrate IBI TALU criteria

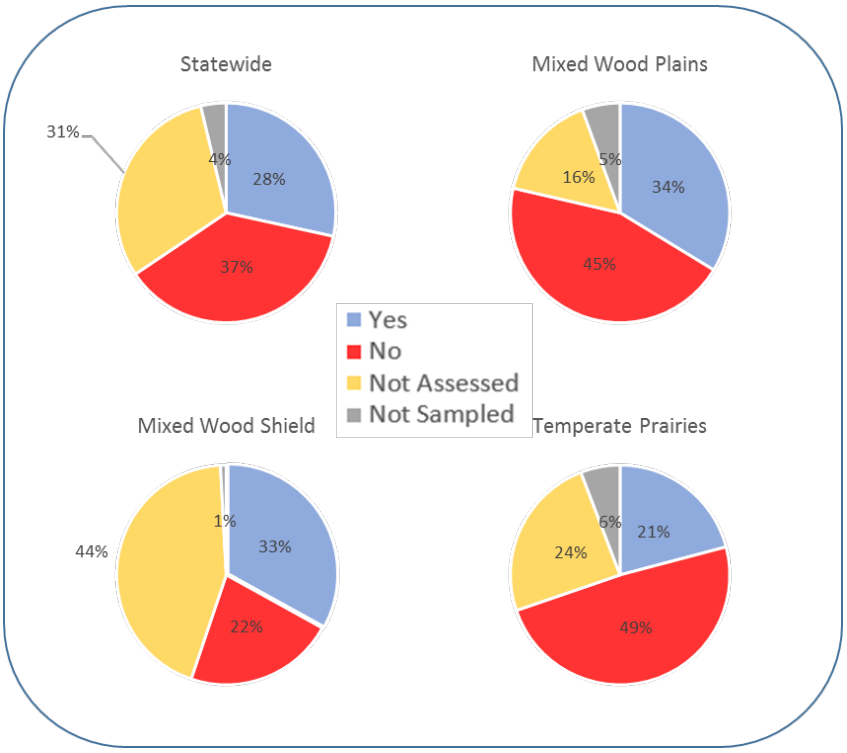
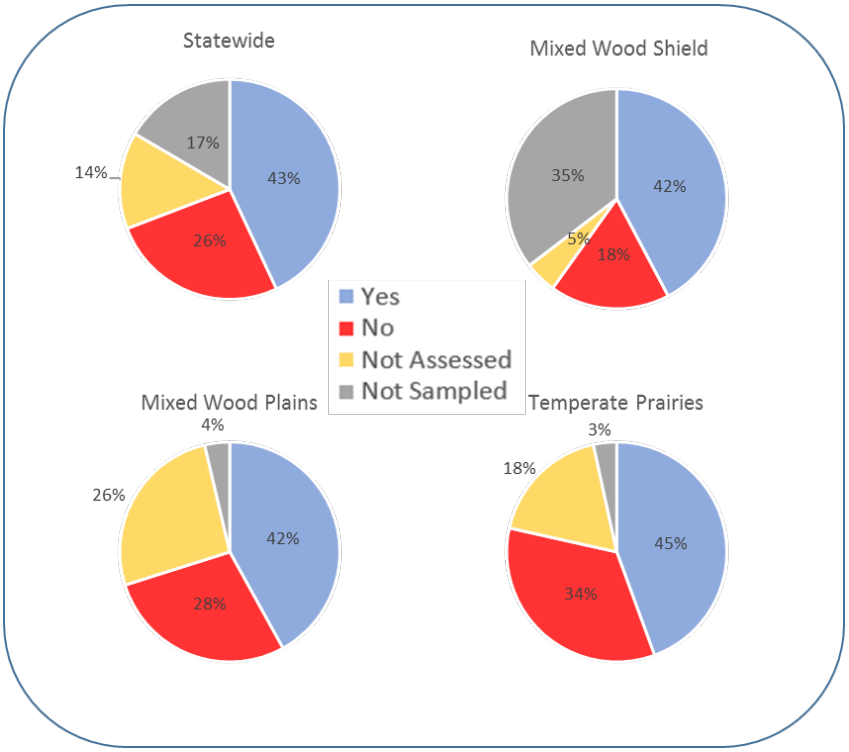
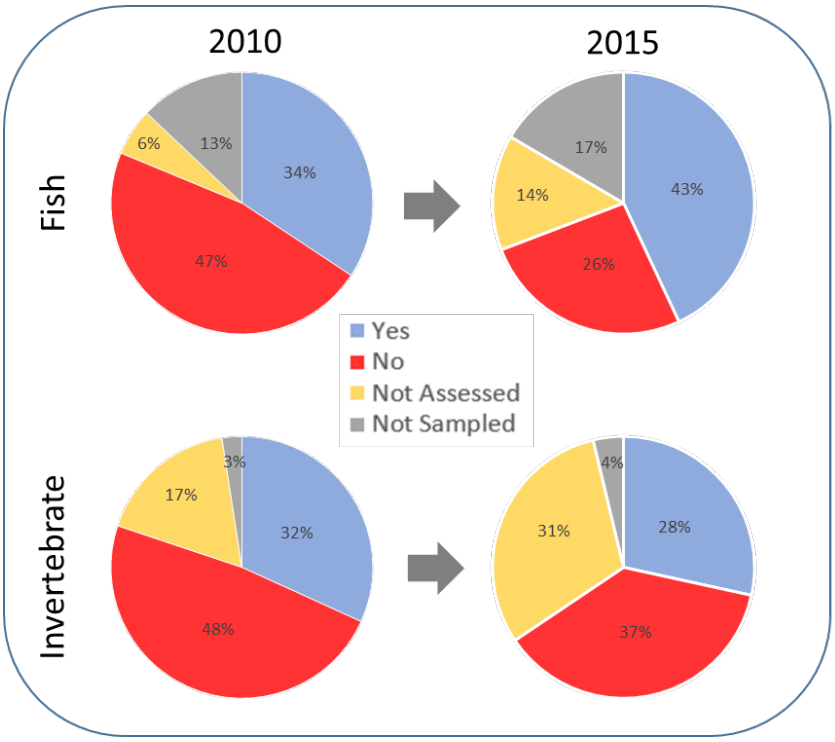


Figure 6. Estimated percent of stream miles that meet (i.e., Yes) fish IBI TALU criteria



The 2015 results indicate that about 43% of the stream miles statewide support aquatic life (general or modified) based on fish IBI results, and 28% support aquatic life based on invertebrate IBI results. These percentages shown in Figures 9 and 10 also demonstrate some ecoregion dissimilarity; for example, the percentage of streams supporting invertebrate aquatic life criteria (i.e., Yes) in the Temperate Prairie region is less than the corresponding statewide estimate while the Mixed Wood Plains and Mixed Wood Shield both exceed the statewide estimate. Estimates of the percentage of stream miles in Minnesota supporting aquatic life use did not change significantly between 2010 and 2015 regardless of the community type used to derive the estimates. Fish IBI results did yield a significant change in the estimated percent of stream miles not supporting aquatic life, decreasing by ~20% in the 5-year period (Figure 7). However, this decrease was partially due to increases in the percentage of not sampled and not assessed stream miles. Therefore, it is premature to draw conclusions at this early stage of the long-term status and trends monitoring program. Future iterations of the survey will provide a clearer picture of aquatic life condition trends in Minnesota resulting from the implementation of watershed restoration and protection strategies.

Figure 7. Comparison of 2010 and 2015 statewide condition estimates based on fish and aquatic invertebrate IBI results



C.5.3. Water quality trends for Minnesota lakes

Trend analysis of stream water clarity data has also recently been done using all stream and river transparency measurements available at the MPCA, including those collected by volunteers through the Citizen Stream Monitoring Program. Table 14 shows the most recent trends from 2018. See for https://www.pca.state.mn.us/water/transparency-trends methodology and a detailed statewide map of stream trends.

Table 2. 2018 Lake transparency trend assessment

Lake trend	Lakes with this trend
Degrading	187 (11%)
Improving	482 (29%)
No trend	788 (48%)
No change	189 (11%)
Insufficient data	3150
Lakes with data	4796
Lakes with a trend	1646

In addition, the Sentinel Lakes Monitoring Program, a component of Sustaining Lakes in a Changing Environment, which is a long-term collaborative monitoring effort, led by the MDNR, involves long-term monitoring of water chemistry, fisheries, habitat and other factors. The MPCA is a partner in the effort with the primary focus on collection and assessment of water quality data for these lakes. More information about the Sentinel Lakes Monitoring Program is available here: https://www.pca.state.mn.us/water/sentinel-lakes.

Probabilistic (or random) surveys have become an important tool for monitoring the condition of Minnesota's water resources. These surveys provide data sets that yield statistically sound, unbiased estimates of the condition of the state's water bodies, and are very helpful in determining trends in water resource condition over time. Reports developed from Minnesota's participation in the 2007 and 2012 National Lakes Assessment may be found here https://www.pca.state.mn.us/water/national-lakes-assessment-project-nlap.

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C.5.3.1 National Lakes Assessment Survey

Minnesota's participation in the EPA's National Lake Assessment involved a collaborative approach with other agencies. A total of 1,000 lakes were included in the national survey. Minnesota drew 42 lakes as a part of the initial draw for this statistically-based national survey effort and added 8 lakes to allow for state-based assessment. All 50 lakes received the national level of assessment and contributed to both the state-based and national assessments. In addition, 100 lakes were added from EPA's randomized list of lakes to allow for ecoregion-based assessments (50 per major ecoregion) in Minnesota. Additional details may be found at https://www.pca.state.mn.us/water/national-lakes-assessment.

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While the data collected are not sufficient for broad, state-scale, assessment of temporal trends, they are valuable for assessing spatial trends (patterns) and provide valuable insight on a variety of lake management issues. Further details may be found at https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring-network.

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Part D. Groundwater monitoring and assessment

The state agencies work together to provide a coordinated approach to groundwater monitoring and protection in Minnesota.

D.1. Minnesota's groundwater resources

Minnesota's groundwater is contained within 14 principal aquifers that are composed of unconsolidated sand deposits and a series of bedrock units. The uppermost aquifers in the state are sand and gravel aquifers that are generally of glacial origin. Twelve bedrock aquifers, which generally are composed of sedimentary rocks, underlie the sand and gravel aquifers.

The sand and gravel aquifers are important sources of water supply throughout the state. These aquifers occur throughout Minnesota but are concentrated in the central and western parts. These aquifers primarily were formed by materials deposited during a period of continental glaciation, which occurred about 10,000 to 350,000 years ago. The sand and gravel aquifers are found near the land surface or buried within more impermeable materials. The surficial sand and gravel aquifers are most prevalent in the central part of the state. The buried sand and gravel aquifers occur in areas with thick glacial deposits where multiple glaciations occurred. The sand and gravel aquifers yield moderate to good amounts of water in the central and western parts of the state; elsewhere the yields from these aquifers are limited. For example, northeastern Minnesota has a relatively thin covering of glacial materials overlying crystalline bedrock.

The Prairie du Chien-Jordan, Tunnel City/Wonewoc, and Mount Simon Hinckley are the three main bedrock aquifers used for water supply in Minnesota. These aquifers are composed of limestone, dolostone, and sandstones that generally were deposited when seas covered Minnesota about 500 million years ago. The Prairie du Chien-Jordan is the uppermost of these three aquifers and is highly developed in the Twin Cities Metropolitan Area (TCMA). The Tunnel City/Wonewoc aquifer underlies the Prairie du Chien-Jordan and is an important source of water supply in parts of southeastern Minnesota where the Prairie du Chien-Jordan aquifer is either near the land surface or not present. The Mount Simon/Hinckley aquifer underlies all of southeastern Minnesota and extends as far north as the city of Duluth, Minnesota. Groundwater withdrawals from the Mount Simon/Hinckley aquifer increase substantially north of the TCMA.

Groundwater resources are limited in southwestern and northeastern Minnesota. Surficial sand and gravel aquifers that yield moderate amounts of water are the main groundwater resources in southwestern Minnesota. In this part of the state, the sand and gravel aquifers often are located near streams. Northeastern Minnesota has the most limited groundwater resources in the state because this area is composed of very old crystalline rocks with a thin veneer of glacial materials that yield little water.

D.2. Groundwater protection programs

Minnesota's groundwater protection programs primarily are shared among four state agencies—the MPCA, MDA, MDH, and MDNR (Table 15), with regional coordination in the TCMA by the Metropolitan Council. The MPCA's programs focus on protecting the state's groundwater from non-agricultural chemical contamination. The MDA's programs protect the groundwater from agricultural chemicals. The MDH is charged with protecting the state's drinking water supplies from groundwater contamination. The MDNR's manage groundwater quantity by regulating water allocation and withdrawals.

The MPCA administers regulatory and monitoring programs that protect the groundwater from contamination by non-agricultural chemicals. The agency's regulatory programs identify, regulate, and remediate spills of non-agricultural contaminants. These include the state's Brownsfields, Emergency Response, Landfills/Dumps, Petroleum Remediation, Resource Conservation and Recovery Act Corrective Action, Superfund, Voluntary Investigation and Cleanup, Subsurface Sewage Treatment System, Feedlot, and Stormwater programs. The MPCA also maintains an ambient groundwater monitoring network to determine the presence and distribution of non-agricultural chemicals and identify any trends. This monitoring also includes an "early warning network" of shallow monitoring wells. The main goal of the "early warning network" is to identify trends in groundwater quality early, so BMPs to reduce contamination can be put in place rather than more-costly remediation.

The MDH administers several programs that protect the public's health from waterborne contaminants. The agency administers the state's Well Management Program that regulates the construction of new wells and the proper sealing of unused ones. The agency also administers the state's Drinking Water and Source Water Protection programs and develops human health-based guidance for groundwater.

The MDA is the lead state agency for regulating pesticides and fertilizers in the state and administers programs, which protect the groundwater from agricultural chemical contamination. The MDA approves new pesticide products for use in the state in cooperation with the EPA. The MDA also monitors the groundwater to determine that pesticides are used properly and do not have a harmful impact on the state's groundwater. The MDA also takes enforcement actions when improper disposal or application of pesticides is found. The MDA also develops BMPs for pesticide use and regulates the sale, use, and disposal of pesticides.

The MDNR administers programs related to groundwater appropriations. The agency permits groundwater withdrawals, performs aquifer vulnerability assessments, resolves water use conflicts, and monitors groundwater levels across the state.

Table 3. Summary of Minnesota groundwater protection programs

Programs or Activities	Check (✓)	Implementation Status	Responsible State Agency
Active Sara Title III Program	✓	Established	MPCA, MN Dept. of Public Safety
Ambient groundwater monitoring system	✓	Continuing Effort	MPCA, MDA
Aquifer vulnerability assessment	✓	Continuing Effort	MNDNR
Aquifer mapping	✓	Continuing Effort	MGS
Aquifer characterization	✓	Continuing Effort	MPCA, MDA, MNDNR, MGS
Comprehensive data management system	✓	Continuing Effort	MPCA, MDA, MNDNR, MDA, MGS
Consolidated cleanup standards	✓	Continuing Effort	MPCA, MDH
Groundwater Best Management Practices	✓	Continuing Effort	MPCA, MDA
Groundwater legislation	✓	Continuing Effort	All agencies
Groundwater classification	✓	Established	MPCA
Groundwater quality standards	✓	Continuing Effort	MDH, MPCA, MDA
Interagency coordination for groundwater protection initiatives	✓	Established	All agencies
Nonpoint source controls	✓	Established	MPCA, MDA
Pesticide State Management Plan	✓	Established	MDA
Resource Conservation and Recovery Act Primacy	✓	Established	MPCA
Source Water Assessment Program	✓	Continuing Effort	MDH
State Property Clean-up Programs	✓	Established	MPCA, MDA
Susceptibility assessment for drinking water/wellhead protection	✓	Established	MDH
State septic system regulations	✓	Established	MPCA
Underground storage tank installation requirements	✓	Established	MPCA
Underground Storage Tank Remediation Fund	✓	Established	MPCA/Dept. of Commerce
Underground Injection Control Program	✓	Established	MDH
Underground Storage Tank Permit Program	✓	Established	MPCA
Well abandonment regulations	✓	Established	MDH
Wellhead Protection Program (EPA-approved)	✓	Established	MDH
Well Installation Regulations	✓	Established	MDH

D.3. Groundwater monitoring programs

Four state agencies jointly conduct groundwater quantity and quality monitoring in Minnesota. The MDNR maintains the state's groundwater level monitoring network (quantity). The MPCA, MDA, and MDH jointly conduct groundwater quality monitoring based on their individual state and federal authorities and requirements. The MPCA monitors non-agricultural chemicals, and the MDA monitors agricultural chemicals such as pesticides and fertilizers. The MDH monitors the groundwater used by the public to ensure any chemicals are below concentrations that present a threat to human health. Further information on this multi-agency approach to groundwater monitoring is contained in Minnesota's Water-Quality Monitoring Strategy document (Minnesota Pollution Control Agency 2011).

Several state agencies have integrated the storage of their groundwater data into a shared data management system. The MPCA, MDA, and MDNR all store the water quality data collected by their groundwater condition monitoring networks in a data management system maintained by the MPCA. These advances in data management have facilitated the analysis and interpretation of groundwater data collected across state agencies.

D.4. MPCA's monitoring and assessment strategy

The MPCA's monitoring and assessment strategy continues to focus on aquifers that are vulnerable to human contamination and underlie the urban and undeveloped parts of Minnesota. The MPCA's ambient groundwater network currently focuses on the surficial sand and gravel and the Prairie du Chien-Jordan aquifers. Water samples generally were collected annually to determine concentrations of over 100 chemicals, including nitrate, chloride, trace elements, and volatile organic compounds (VOCs).

D.5. MDA's monitoring and assessment strategy

The MDA continues to monitor the State's groundwater to provide information about the impacts from the routine application of agricultural chemicals. The primary focus of this monitoring is to assess the presence and distribution of pesticides in the groundwater (Minnesota Department of Agriculture 2019). The network typically monitors the upper part of the sand and gravel aquifers and consists of about 230 monitoring wells. About 165 of these locations are located in central Minnesota. The remaining sites (approximately 45 monitoring wells, 12 domestic water supply wells, and 13 springs) are located in agricultural areas in other parts of the state. Domestic wells and springs are sampled in southeastern part of the state in lieu of monitoring wells since springs integrate water-quality conditions in karstic areas and domestic wells are a good alternative in places where monitoring wells are expensive to install. Additional information about the program can be found at the MDA's website here: http://www.mda.state.mn.us/monitoring.

From 2013-2019, the MDA conducted the Township Testing Program to determine current nitrate-nitrogen concentrations in private wells on a township scale. For this project, the MDA identified townships for nitrate sampling throughout the state that were vulnerable to groundwater contamination and had significant row crop production. From 2014-2019, the MDA conducted a similar program, called the Private Well Pesticide Project, to evaluate the occurrence and distribution of pesticides in private drinking water wells where nitrate was detected as part of the Township Testing Program. As of February 2021, 32,217 private drinking water wells in 344 townships were sampled for the Township Testing Program, and about 5,700 wells were tested for the Private Well Pesticide Project from 2014-2021. Additional information concerning these programs can be found at the MDA's website

here: http://www.mda.state.mn.us/townshiptesting and https://www.mda.state.mn.us/pesticide-fertilizer/private-well-pesticide-sampling-project.

D.6. MDH's monitoring and assessment strategy

The MDH continues to monitor the condition of the state's public water supplies, which often utilize groundwater. The MDH samples the state's finished drinking water in cooperation with the public water supply systems to determine whether contaminant concentrations meet Safe Drinking Water Act regulations. Private drinking water wells are not assessed as part of this effort; however, the MDH reviews nitrate, arsenic, and coliform bacteria data collected by well drillers from newly installed drinking water wells to determine the potability of the water. The MDH also conducts investigative monitoring to assist the public water suppliers in locating wells in aquifers with lower concentrations of arsenic, radionuclides, and nitrate. In addition, the MDH measures the tritium values in some wells to identify locations with recently recharged groundwater which are very susceptible to contamination. The MDH also administers the state's wellhead protection program to protect the groundwater from contamination.

D.7. MDNR's monitoring and assessment strategy

The MDNR continues to maintain a groundwater level monitoring network across the state. The MDNR uses the collected data to assess groundwater resources, determine long term trends in water levels, interpret impacts of pumping and climate, plan for water conservation, and evaluate water conflicts. Water level readings are measured on an approximately monthly schedule in cooperation with soil and water conservation districts or other LGUs.

D.8. Minnesota's groundwater quality

The MPCA's 2019 condition monitoring report integrated data on nitrate, chloride, trace elements, VOCs, poly- and perfluoroalkyl substances (PFAS), and other contaminants of emerging concern (CECs) like medicines in the groundwater (Kroening and Vaughan 2019). This information was collected by several state agencies and national monitoring efforts. The monitoring data from the 2019 report indicated high nitrate concentrations were primarily an issue in the groundwater beneath agricultural parts of Minnesota. In these areas, 49% of the tested shallow monitoring wells had nitrate concentrations exceeding the standard set for drinking water (10 mg/L as nitrogen). The MDA's Township Testing Program identified where domestic water supplies in agricultural areas were most impacted by high nitrate concentrations, which was defined as at least 10% of the tested wells having concentrations of 10 mg/L or greater. The majority of these townships were in southeastern Minnesota, often in places where the shallow groundwater was naturally vulnerable to contamination from the land surface. The MPCA's monitoring data showed that chloride was primarily a concern in the groundwater underlying urban areas. The greatest chloride concentrations generally occurred in the TCMA, where most of the wells with concentrations exceeding the secondary maximum contaminant level of 250 mg/L were located. The MPCA continued to determine long-term temporal trends in nitrate and chloride concentrations in the groundwater. The analyses in the 2019 report evaluated trends using data from 2005-2017. Statistical testing found that chloride concentrations increased in 40 percent of the tested wells. The majority of the wells with upward chloride trends were installed in bedrock aquifers in the TCMA or southeastern Minnesota; some of these wells were as deep as 340 feet. This result suggests some of the chloride used in the State is beginning to seep downward into the groundwater used for

drinking. In contrast, statistical testing found no consistent temporal trends in nitrate concentrations at the statewide or watershed scale or in any particular land use setting.

The MPCA has collected samples annually from selected wells in its condition monitoring network for analysis of over 100 CECs since 2009 and periodically samples the network for PFAS. Detections of both of these suites of chemicals in the ambient groundwater were associated with urban land use. PFAS sampling conducted in 2013 (Kroening 2017) found that one or two PFAS typically were detected in the ambient groundwater underlying urban areas, but these chemicals usually were not detected in the groundwater underlying forested, undeveloped areas. This result suggested that most of the PFAS measured in the ambient groundwater originated from chemicals being disposed to the land surface rather than regional atmospheric deposition. Perfluorobutanoic acid (PFBA) was the most commonly detected PFAS in the ambient groundwater, being found in almost 70% of the sampled wells. The most commonly detected CECs in the groundwater were the antibiotic sulfamethoxazole, the flame retardant tris (1,3-dichloro-2-propyl) phosphate, the x-ray contrast agent iopamidol, and the non-anionic surface mixture branch p-nonylphenols. These chemicals all are known to be widely used, resistant to degradation, and persistent in the environment.

D.9. Groundwater contamination sources

Monitoring of Minnesota's groundwater has identified contamination from non-point sources from agricultural fertilizers and pesticides, urban runoff, manure applications, septic systems, road salt and stormwater infiltration, in many vulnerable aquifers (Minnesota Pollution Control Agency and Minnesota Department of Agriculture 2015). The most common contaminants detected include nitrate, pesticides, and road salt in urban areas. In addition, CECs that are not commonly monitored or regulated are being identified at low concentrations in groundwater. These include antibiotics, fire retardants, detergents, and plasticizers and includes endocrine active chemicals.

Sources of groundwater contamination in Minnesota were listed in appendix A of the Environmental Quality Board's 2015 water policy report (Minnesota Pollution Control Agency and Minnesota Department of Agriculture 2015). Most nitrate enters the groundwater from anthropogenic sources such as animal manure, fertilizers used on agricultural crops, failing subsurface sewage treatment systems, fertilizers used at residences and commercially, and nitrous oxides from the combustion of coal and gas. Pavement deicing chemicals and water softeners were identified as the primary sources of chloride to groundwater. The disposal of fluorochemical manufacturing wastes prior to the advent of modern solid and hazardous waste laws and regulations caused the most well-known PFAS contamination in Minnesota's groundwater. In contrast, naturally-occurring soil and rock are the main sources of arsenic in the state's well water.

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D.10. Groundwater literature cited

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Part E. Public participation

In general, public participation is critical throughout Minnesota's TMDL process. Minnesota expects advisory groups to be involved from the earliest stages of the project. At a minimum, the EPA requires that the public must be given an opportunity to review and comment on TMDLs before they are formally submitted to EPA for approval. Every TMDL is formally public-noticed in Minnesota with a minimum 30-day comment period.

In addition, the MPCA has a comprehensive effort underway to build civic engagement into watershed projects. The MPCA is trying to build greater civic engagement in watershed planning by encouraging more citizens to become leaders for change in their communities and holding individuals personally responsible for making needed changes that could reduce water pollution. The MPCA is engaged in several activities to promote civic engagement in watershed plans and has developed several civic engagement products and services for use by local partners and citizens. See more information at: https://www.pca.state.mn.us/water/civic-engagement-watershed-projects.

Finally, in addition to the TMDL development, the MPCA has an active public participation process during the development of biennial updates to the 303(d) List, including public meetings throughout the state on the draft List and a 60-day public comment period.

The draft 2022 303(d) Impaired Waters List was placed on the MPCA website in November 2021. The public was informed by a statewide MPCA press release and emails to individuals and groups on the MPCA 303(d) distribution list. A 60-day public comment period followed with multiple meetings scheduled for the public to attend.

Minnesota's Impaired Waters List, the comments received during the public comment period, and the MPCA's responses to comments are available on the MPCA website at: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

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