2024 CLEAN WATER FUND PERFORMANCE

February 2024

More information about the measures summarized in this publication can be found on the Minnesota's Legacy website at www.legacy.leg.mn/funds/clean-water-fund.

Project Team

Reid Christianson (MDA)
Bill Dunn (MPCA)
Annie Felix-Gerth (BWSR)
Marco Graziani (MPCA)
Mary Juhl (BWSR)
Steve Kloiber (DNR)
Kim Laing (MPCA)
David L. Miller (MPCA)
Alycia Overbo (MDH)
Gabriel Posteuca (MPCA)
Paul Putzier (DNR)
Lanya Ross (MCES)
Jen Schaust (MDA)
Udai Singh (BWSR)
Azra Thakur (MDH)
Brad Wozney (BWSR)

Clean Water Fund Interagency Coordination Team

Tannie Eshenaur (MDH)
Andrea Fish (BWSR)
Jeff Freeman (PFA)
John Jaschke (BWSR)
Peder Kjeseth (MDA)
Jason Moeckel (DNR)
Sam Paske (MCES)
Richard Jess (DNR)
Glenn Skuta (MPCA)
Judy Sventek (MCES)
Margaret Wagner (MDA)

Designers

Vicki Heagerty (MDA)
Kabao Her (MDA)

This can be made available in other formats, including Braille, large type, computer disk or audio tape, upon request.

Minnesota Board of Soil and Water Resources (BWSR)
Minnesota Department of Natural Resources (DNR)
Minnesota Department of Agriculture (MDA)
Minnesota Pollution Control Agency (MPCA)
Minnesota Department of Health (MDH)
Minnesota Public Facilities Authority (PFA)

CLEAN WATER FUND PERFORMANCE

INTRODUCTION

Water is part of our Minnesota identity. Minnesota is known as the Land of 10,000 Lakes, is home to Lake Superior, features many streams and wetlands, and has extensive regional aquifers. Minnesotans value their drinking water, lakes, streams, and groundwater highly, and showed their commitment when they supported the Clean Water, Land and Legacy Amendment in 2008. The Clean Water Fund enables protection of our pristine waters, the restoration of our degraded waters, and the protection of our groundwater and drinking water sources.

The Clean Water Fund enhances our water programs and accelerates our progress in meeting clean water goals. Between 2010 and 2023, Minnesota's Clean Water Fund:

- Awarded more than 4,271 grants to protect and restore Minnesota's water resources.
- Delisted 81 lakes and streams from Minnesota's impaired waters list due to restoration activities.
- Led to many more lakes having improving water quality trends than declining trends and maintained the quality of unimpaired waters.
- Issued more than 2,253 loans to landowners to prevent nonpoint source water pollution or solve existing water quality problems.
- Secured more than 941 easements that will permanently protect approximately 31,164 acres along riparian corridors and within wellhead protection areas, of which 23,830 acres were supported by Clean Water Funds.
- Repaired 881 subsurface sewage treatment systems that posed an imminent threat to human health.
- Upgraded 52 municipal wastewater treatment facilities, which reduced phosphorus discharges by over 316,000 pounds per year.
- Developed plans for nearly 800 out of the approximately 970 community water systems in Minnesota to protect their drinking water sources and awarded approximately 1,300 grants supporting local source water protection actions.

- Engaged 84,000 visitors in the We Are Water MN exhibit at 30 sites statewide since 2016. Of those surveyed in 2022, 88% indicated an increased awareness of threats to our water resources.
- Incentivized the replacement and assessment of water-using devices with nearly 15,000 water-efficient alternatives through city and township programs, when implemented save an estimated 204 million gallons of water each year.
- Offered free nitrate testing to over 90,000 well owners in areas vulnerable to nitrate contamination and 32,000 of those well owners ultimately participated in the program.
- Certified nearly 1,000,000 acres of Minnesota farmland across more than 1,400 farms through the state's Agricultural Water Quality Certification Program.
- Added pesticide water quality monitoring for approximately 140 additional pesticide compounds in vulnerable groundwater and surface water resources statewide.
- Cooperated with tribal governments on monitoring and assessment programs, strategy development for meeting water quality standards, detection of unregulated contaminants, and comprehensive planning.
- Supported statewide testing for PFAS in drinking water, which covered over 99% of Minnesotans that drink water from a community water system.

The Clean Water Fund leverages investments and partnerships at state, regional, and local levels to maximize their impacts. The Clean Water Fund is often the funding source for science, planning, and public engagement that leads to larger investment from other sources. In fiscal years 2010-2023, each dollar in Clean Water Fund spending leveraged another $1.06 in additional funding. In addition, the Clean Water Fund supports programs that provide multiple benefits other than just water quality, such as improved habitat, reduced financial risk for farmers, climate resiliency, greater household affordability for drinking water and sewage treatment, flood reduction, and more.

In 2023, Minnesota completed a major milestone with the completion of the final Watershed Restoration and Protection Strategy (WRAPS) for all 80 watersheds. The WRAPS resembles a "to-do list" or blueprint for activities that must happen for waters in a major watershed to meet water quality standards. The state continues to scale up its program for Groundwater Restoration and Protection Strategies (GRAPS). These strategies form a "to-do" list for each watershed to use to meet water quality standards over time. Clean Water Fund initiatives have helped characterize our groundwater resources that allowed for sound science-based policy and regulation during recent droughts. Finally, the Fund recently supported pilot projects to two groups of rural counties to offer free private well testing, one for nitrate and one for arsenic, and options for alternative water for income-qualified households. These pilots form the basis for the state's upcoming response to recent federal requirements to support drinking water needs for private well users with high nitrate levels in southeastern Minnesota.

As Minnesota looks back at the progress in water protection over the last two years, and looks ahead to current and future challenges, we also celebrate the landmark legislation that supports our work with the 50th anniversaries of the passage of the Clean Water Act and Safe Drinking Water Act. This historic legislation is a cornerstone of our work, and through the collaborative and collective actions under the Clean Water Fund, Minnesotans are working to ensure water is safe and healthy for future generations.

Minnesota's Clean Water mission and goals

The Clean Water Council developed the mission, goals, and objectives with stakeholder involvement in an effort to align activities implemented with Clean Water Fund dollars to the Clean Water Legacy Act. For the 2020 Performance Report and subsequent reports, we began to better align measures with the mission, goals, and objectives the Clean Water Council developed (shown below).

Mission

Protect and restore Minnesota's waters for generations to come.

Goals and objectives

Drinking water is safe for everyone, everywhere in Minnesota

- Protect public water supplies
- Ensure private well users have safe water

Groundwater is clean and available

- Improve and protect groundwater quality
- Ensure sustainable long-term trends in aquifer levels
- Avoid adverse impacts to surface water features due to groundwater use

Surface waters are swimmable and fishable

- Prevent and reduce pollution of surface waters
- Maintain and improve the health of aquatic ecosystems
- Protect and restore hydrologic systems

Minnesotans value water and take actions to sustain and protect it

- Build capacity of local communities to protect and sustain water resources
- Encourage systems and approaches that support, protect, and improve water
- Provide education and outreach to inform Minnesotans' water choices
- Encourage citizen and community engagement on water issues

About this report

This report provides a high-level overview of Minnesota's performance so far in restoring and protecting the quality of the state's surface water, groundwater and drinking water resources using Clean Water Fund dollars. Published every two years, the report highlights:

- **Action measures** to track where agency and partner activities are occurring with Clean Water Fund dollars to protect surface, groundwater, and drinking water, including how effectively agencies are completing the work to achieve clean water goals.
- **Investment measures** to track where Clean Water Fund money is spent and how spending patterns are changing, including tracking where other funds are leveraged to extend the work done to meet clean water goals.
- **Outcome measures** to track progress on improving the quality of our surface, groundwater, and drinking water.

The report is not a complete assessment of all work achieved with Clean Water Legacy funds, either at the state or local level, but shows key activities that represent the overall Clean Water Fund investment. All of the water agencies have other performance measures, but the measures included in this report are chosen to represent progress over the 25 years of the amendment and concerns known to be of public interest.

Report organization

Measure profiles provide a snapshot of how Clean Water Fund dollars are being spent and what progress has been made. These profiles are organized into three sections: investment measures, surface water quality measures, and drinking and groundwater protection measures. The report displays how spending and progress are occurring across Minnesota, to the extent that statewide data are available. Each measure profile includes the following:

The measures used in this report are designed to remain constant over time to make it easy to identify where change is occurring. However, at times, measures may need to be modified as our scientific knowledge expands and new, more effective approaches are developed. The procedures used to produce the measures in this report and how they have changed over time, are documented in a separate metadata document available on the Legacy website.

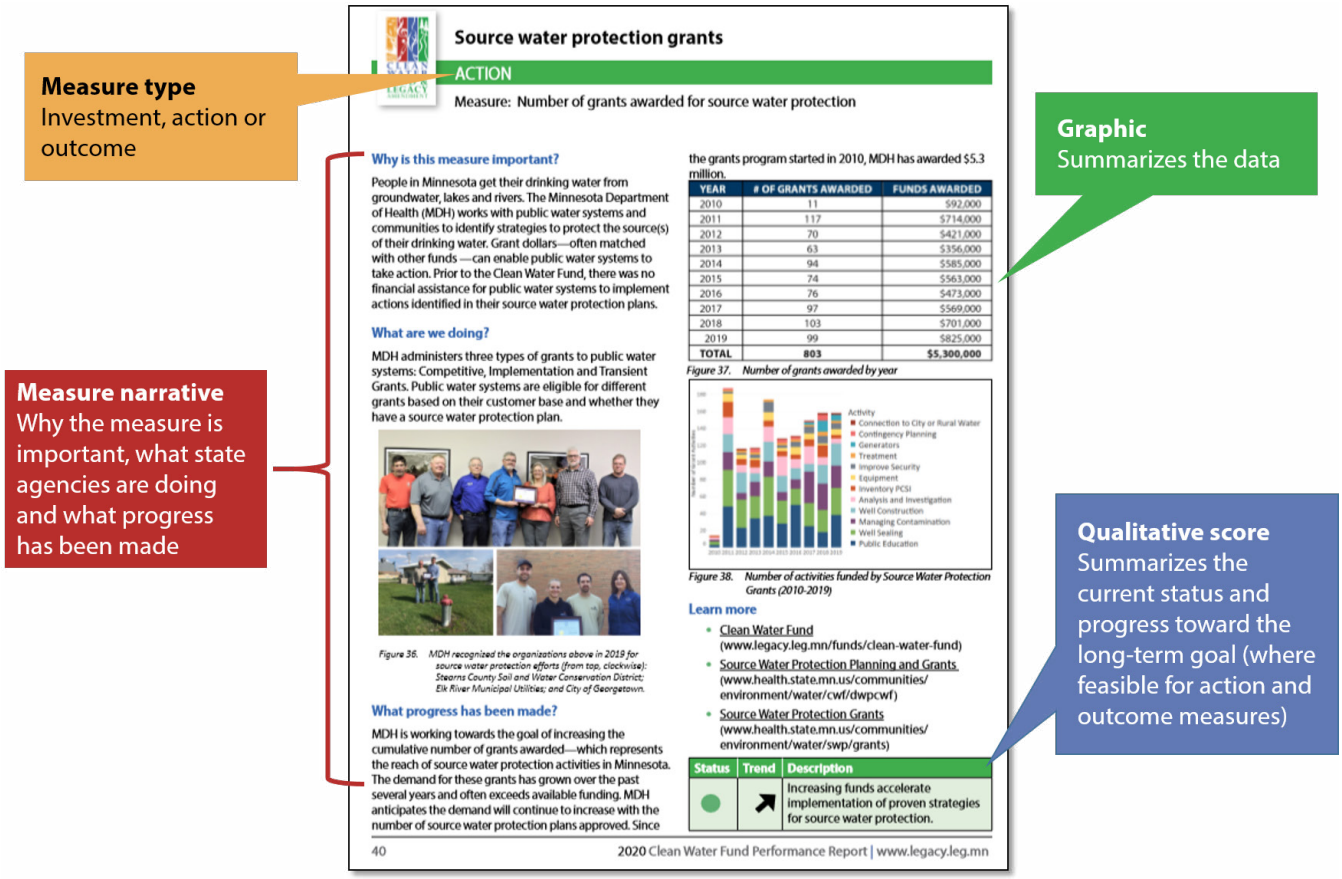


Figure 1. Each measure profile includes measure type, measure narrative, a graphic, and a qualitative score.

2024 CLEAN WATER FUND REPORT CARD

Minnesotans care deeply about the state's natural resources and cultural heritage. In 2008, we voted to increase our sales tax and pass the Clean Water, Land and Legacy Amendment, providing 25 years of constitutionally dedicated funding for clean water, habitat, parks and trails, and the arts.

The following report card highlights work done using Clean Water, Land and Legacy Amendment dollars for Minnesota's many water resources. The Report Card tracks a suite of performance measures that are described in the full report that follows. It provides a qualitative assessment of how well actions are being implemented and what outcomes are being achieved.

Measures are scored according to their status as of the end of fiscal year 2023 (FY23) and for their trend over time. Scores were developed using data-informed professional judgment of agency technical staff and managers. The legend shows the symbols used to describe how measures were scored.

Action Status Legend

SYMBOL	MEANING
●	We are making good progress/ meeting the target
▲	We anticipate difficulty; it is too early to assess; or there is too much variability across regions to assess
■	Progress is slow/we are not meeting the target; or the activity or target is not commensurate with the scope of the problems

Outcome Status Legend

SYMBOL	MEANING
●	Water quality is high – we are on track to meet long-term water resource needs and citizen expectations
▲	Water quality needs improvement or it is too early to assess – it is unclear if we will meet long-term water resource needs and citizen expectations; and/or water quality varies greatly between regions
■	Water quality is under intense pressure – long-term water resource needs and/ or citizen expectations exceed current efforts to meet them

Trend Legend

SYMBOL	MEANING
↗	Improving trend
→	No change
↘	Declining trend
NEI	Not enough information to determine trend at this time

Investment Measures

	MEASURE	STATUS	TREND	DESCRIPTION
INVESTMENT	Total Clean Water Fund dollars appropriated by activity	$1.8B has been appropriated to the Clean Water Fund from FY10-25, ranging from $157M in FY10-11 to $318M in FY24-25.	FY16-17: $228M FY18-19: $212M FY20-21: $261M FY22-23: $257M FY24-25: $318M	For FY10-25, all 80 watersheds benefited from Clean Water Fund supported activities. Implementation activities comprise the largest portion of spending in watersheds statewide.
	Total Clean Water Fund dollars per watershed or statewide by activity	All watersheds in the state are benefiting from local and statewide projects.		For FY10-25, all 80 watersheds benefited from Clean Water Fund supported activities. Implementation activities comprise the largest portion of spending in watersheds statewide.
	Total Clean Water Fund dollars awarded in grants and contracts to non-state agency partners	$777M was awarded in grants and contracts to non-state agency partners in FY10-23.		About 84% of grant and contract awards are for implementation activities; 43% of total FY10-21 appropriations were awarded to non-state agency partners.
	Total dollars leveraged by Clean Water Fund	$630M was leveraged by Clean Water Funds in FY10-23, or $1.06 for every implementation dollar invested.		Required Clean Water match funds were exceeded.

Surface Water Measures

ACTION

MEASURE	STATUS	TREND	DESCRIPTION
Percent of monitoring addressing state & local needs.	▲	➡	Nearly 40% of watersheds met goals for addressing state and local needs for monitoring. Ongoing program development is aimed to ensure local needs are identified for monitoring.
Local partner participation in monitoring efforts.	●	➡	As of 2023, all programs are meeting participatory goals.
Number of nonpoint source best management practices implemented with Clean Water Funding and estimated pollutant load reductions.	■	↗	Although funding has increased and there is a continued increase in practices and projects being implemented, the total request for projects has remained significantly greater than available funds.
Number of municipal point source construction projects implemented with Clean Water Funding and estimated pollutant load reductions.	●	➡	Pace of awards is linked to permit cycles, compliance schedules, and available Clean Water Funds. Applications exceed currently available funds even after significant infusion of bond funds over the past several cycles.

OUTCOME

MEASURE	STATUS	TREND	DESCRIPTION
Rate of impairment/unimpairment of surface water statewide and by watershed: Stream aquatic life.	▲	NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Rate of impairment/unimpairment of surface water statewide and by watershed: Stream swimming	▲	NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Rate of impairment/unimpairment of surface water statewide and by watershed: Lake swimming	▲	NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Changes over time in key water quality parameters for lakes and streams: Lake clarity	▲	NEI	Water quality varies greatly by region. There are more improving trends for lake clarity than there are declining trends. 60% of lakes with data, are either no trend or no change.
Changes over time in key water quality parameters for lakes and streams: Sediment in large rivers.	▲	NEI	Water quality varies greatly by region. Over 50% of streams have no trend detected. There are more improving trends than declining trends in total suspended solids concentrations.
Changes over time in key water quality parameters for lakes and streams: Nitrate in large rivers.	▲	NEI	Water quality varies greatly by region. Over 50% of streams have no trend detected. Concentrations of nitrate are increasing in some major rivers
Changes over time in key water quality parameters for lakes and streams: Phosphorus in large rivers.	▲	NEI	Water quality varies greatly by region. Over 50% of streams have no trend detected. There are more improving trends than declining trends in phosphorus concentrations.
Changes over time in key water quality parameters for lakes and streams: Pesticides in streams.	▲	NEI	Detections in streams vary greatly as a result of hydrologic and agronomic conditions; exceedances of pesticide water quality standards are rare. Some “surface water pesticides of concern” are showing increasing detection frequency and concentrations.
Changes over time in key water quality parameters for lakes and streams: Pesticides in lakes.	▲	➡	Monitoring has indicated stable pesticide concentrations in lakes, and nearly all detections are low relative to water quality reference values. Pesticide detection frequency and concentrations in lakes are lower compared to streams.
Changes over time in key water quality parameters for lakes and streams: Chloride in streams and rivers.	▲	↘	Concentrations are increasing in almost all metro area rivers and streams.
Number of previous impairments now meeting water quality standards due to corrective actions.	■	➡	Although funding has increased and there is a continued increase in practices and projects being implemented, the total request for projects has remained significantly greater than available funds.
Mercury in fish.	▲	➡	Mercury in game fish is not yet responding to decreases in local mercury emissions, although these reductions likely have prevented a steeper upward trend. Global emissions have increased. The time lag between emission reductions and response is likely several decades. It is too soon to see a measurable response in fish mercury levels. Long-term and consistent monitoring is necessary to track changes in fish tissue.
Mercury emissions.	▲	↗	Significant progress has been made reducing mercury emissions from power plants. Emissions from mercury use in various products saw a decrease in emissions for the 2022 emission inventory, continuing a general downward trend since 2014. Conversely, emission from the mining sector have remained relatively steady since 2017 with a notable decline in 2020 of about 150 pounds as a result of an overall production decrease across the industry due to the COVID-19 pandemic. To meet Minnesota’s 2025 emissions goal, significant reduction of mercury emission from the mining sector and further reduction of mercury use in various products will be necessary.
Municipal wastewater phosphorus discharge trend.	●	↗	Significant phosphorus load reductions have been achieved through regulatory policy, infrastructure investments, improved technology, and optimization of operations.

Drinking water and groundwater measures

ACTION

MEASURE	STATUS	TREND	DESCRIPTION
Number of community water supplies assisted with developing source water protection plans.	●	↗	On track to meet goal of protecting all vulnerable systems under Source Water Protection Plans by 2020.
Number of grants awarded for source water protection.	●	↗	Increasing funds accelerate implementation of proven strategies for source water protection.
Number of local government partners participating in groundwater nitrate-nitrogen monitoring and reduction activities.	●	↗	New partnerships continue to be established for nitrate-nitrogen monitoring and reduction activities.
Number of new health-based guidance values for contaminants of emerging concern.	●	→	Completed 1 re-evaluation and 1 full evaluation, updated water guidance for 2 CECs, established a partnership with EPA to create a contaminant screening tool, provide technical assistance to understand and use water guidance values, authored 3 scientific publications.
Number of counties completing a county geologic atlas for groundwater sustainability.	●	↗	County atlases (including the geologic & groundwater atlases) are being completed at the planned rate, and counties continue to step up to participate. With continued and consistent funding, completion of geologic atlases for all counties is expected around 2035, and completion of groundwater atlases for all counties around 2040.
Number of long-term groundwater monitoring network wells.	■	↗	Many areas of the state still lack important groundwater information. Long-term ramp up in monitoring accelerated by Clean Water Fund investments is filling gaps.
Number of unused groundwater wells sealed.	●	→	The legislative appropriation for this initiative is completed, but other Clean Water Fund programs continue to fund and promote well sealing.
Land use in Drinking Water Supply Management Areas.	●	→	There is increasing research, engagement and activity to protect vulnerable areas in DWSMAs.

OUTCOME

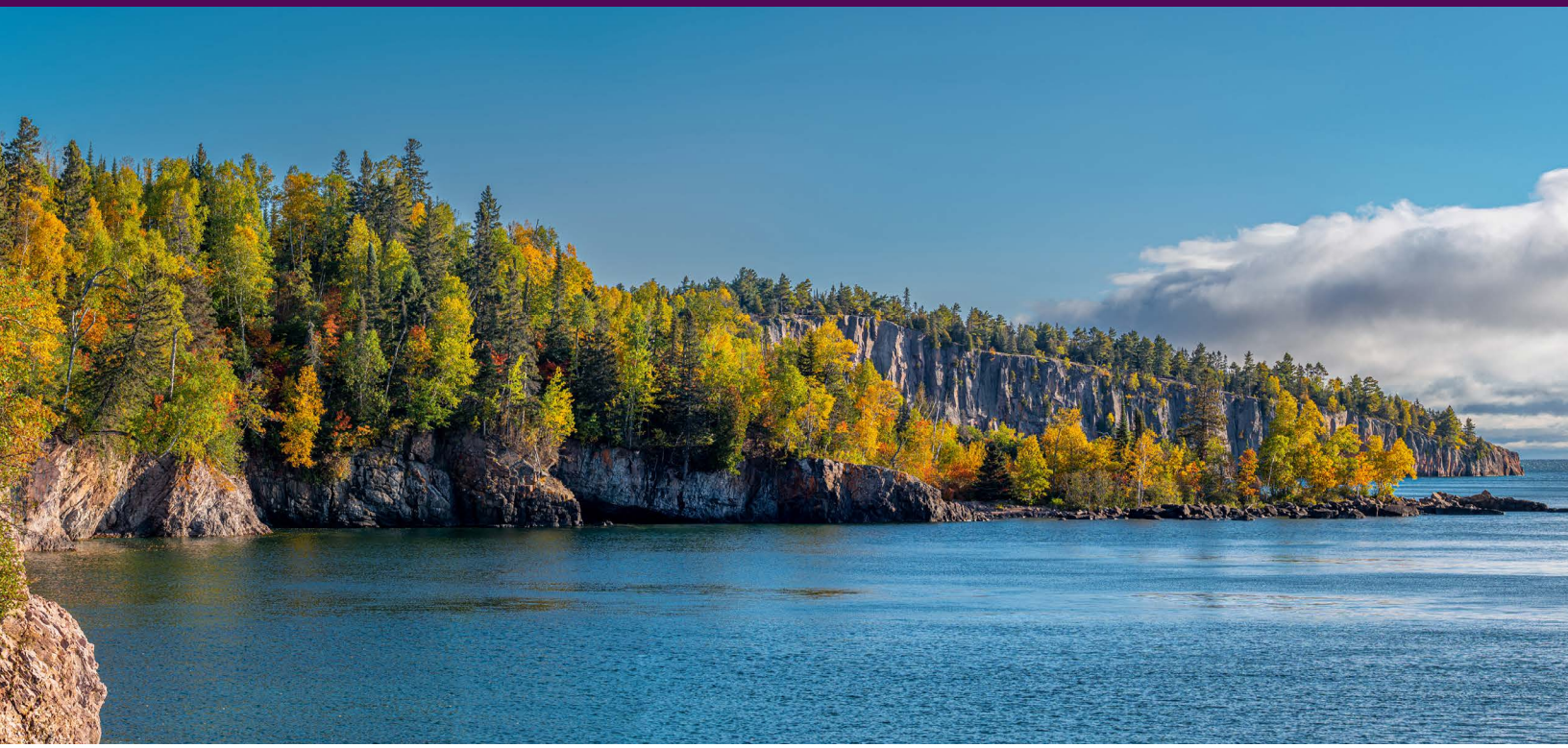
MEASURE	STATUS	TREND	DESCRIPTION
Changes over time in pesticides, nitrate-nitrogen, and other key water quality parameters in groundwater: Pesticides.	▲	→	Variable trends for five common pesticides indicate a mixed signal. Low levels are frequently detected in vulnerable groundwater.
Changes over time in pesticides, nitrate-nitrogen, and other key water quality parameters in groundwater: Nitrate-nitrogen statewide.	▲	NEI	Nitrate contamination is a significant concern in vulnerable groundwater areas (the southeast, Central Sands, and southwest). In some agricultural areas, drinking water supplies are not vulnerable to surficial contamination and most wells have low levels of nitrate-nitrogen.
Changes over time in pesticides, nitrate-nitrogen, and other water quality parameters in groundwater: Nitrate-nitrogen southwest region.	■	NEI	In areas where groundwater is vulnerable, nitrate levels can be high. Of the 21 vulnerable townships tested in southwest Minnesota (2013-2019), 100% of them were determined to have 10% or more of the wells over the nitrate-nitrogen 10 mg/L standard.
Changes over time in pesticides, nitrate-nitrogen, and ther key water quality parameters in groundwater: Nitrate-nitrogen Central Sands.	■	→	Trend data from the Central Sands Private Well Network shows a slight downward trend in the 90th percentile . However, township testing data show a high level of nitrate in some vulnerable areas in the Central Sands.
Changes over time in pesticides, nitrate-nitrogen, and other key water quality parameters in groundwater: Nitrate-nitrogen southeast region.	■	→	Trend data from the Southeast Minnesota Volunteer Nitrate Monitoring Network shows a slight downward trend in the median value. However, Township Testing data show a high level of nitrate in some vulnerable areas in southeast Minnesota.
Changes over time in source water quality used for community water supplies.	●	↗	Current risk management approaches for unregulated contaminants are more proactive and collaborative than the project-based approach of the past.
Nitrate concentrations in newly constructed wells.	▲	→	Since 1992, there has been a general increase in the percent of new wells that have nitrate levels above the drinking water standard.
Arsenic concentrations in newly constructed wells.	▲	→	The percentage of wells with arsenic above the drinking water standard has remained steady over the past 10 years. Evaluation of ways to reduce this percentage is ongoing and may take years before significant progress is made.
Changes over time in groundwater levels.	▲	↗	Most observation wells show no signficant change or an upward trend; many areas of the state lack important groundwater information while some areas experience declines.
Changes over time in total and per capita water use.	▲	↗	There has been a slight improvement in water efficiency in recent years, although continued tracking is needed to determine the amount of impact from annual difference in weather versus changes in management.

Social Measures and External Drivers

DRIVERS

MEASURE	STATUS	TREND	DESCRIPTION
Social Measure- Building local capacity to support and engage in water restoration and protection.	▲	NEI	State agencies are using the Social Measures Monitoring System to integrate social science into some of Clean Water Fund projects. The most evaluated project is We Are Water MN.
External drivers- Important land use, population, and climate trends.	▲	→	The external drivers identified continue to alter land-water interactions across Minnesota, impacting how Clean Water Funds need to be invested.

INVESTMENT MEASURES



INVESTMENT MEASURES

Total dollars appropriated

INVESTMENT

Measure: Total Clean Water Fund dollars appropriated by activity

Why is this measure important?

This measure illustrates the overall amount of Clean Water Funds allocated in a particular biennium and provides a breakdown of that funding in specific categories to demonstrate spending over time. It is the first of four financial measures, providing context for the others. It is the primary investment that enables resources to be spent on the actions that will ultimately help achieve outcomes.

What are we doing?

State agencies, local government and nonprofit organizations are spending Clean Water Funds 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, drinking water protection activities, and applied research.

What progress has been made?

Voter approval of the Clean Water, Land and Legacy Amendment increased the sales and use tax rate by three-eighths of one percent on taxable sales, starting July 1, 2009 through 2034. Of those funds, 33 percent were dedicated to the Clean Water Fund.

Over $1.8 billion has been appropriated since the inception of the Clean Water Fund. Figure 2 shows the dollars appropriated by biennium for all funding source categories. Appropriation levels will vary by biennium due to changes in sales tax revenue. Figure 3 shows the appropriations organized by specific categories.

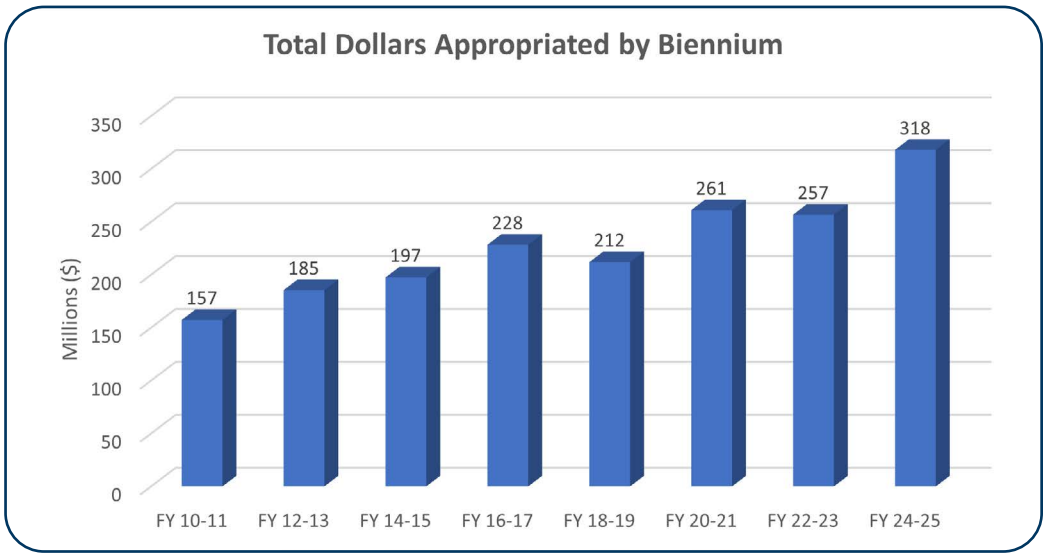


Figure 2. Total dollars appropriated by biennium

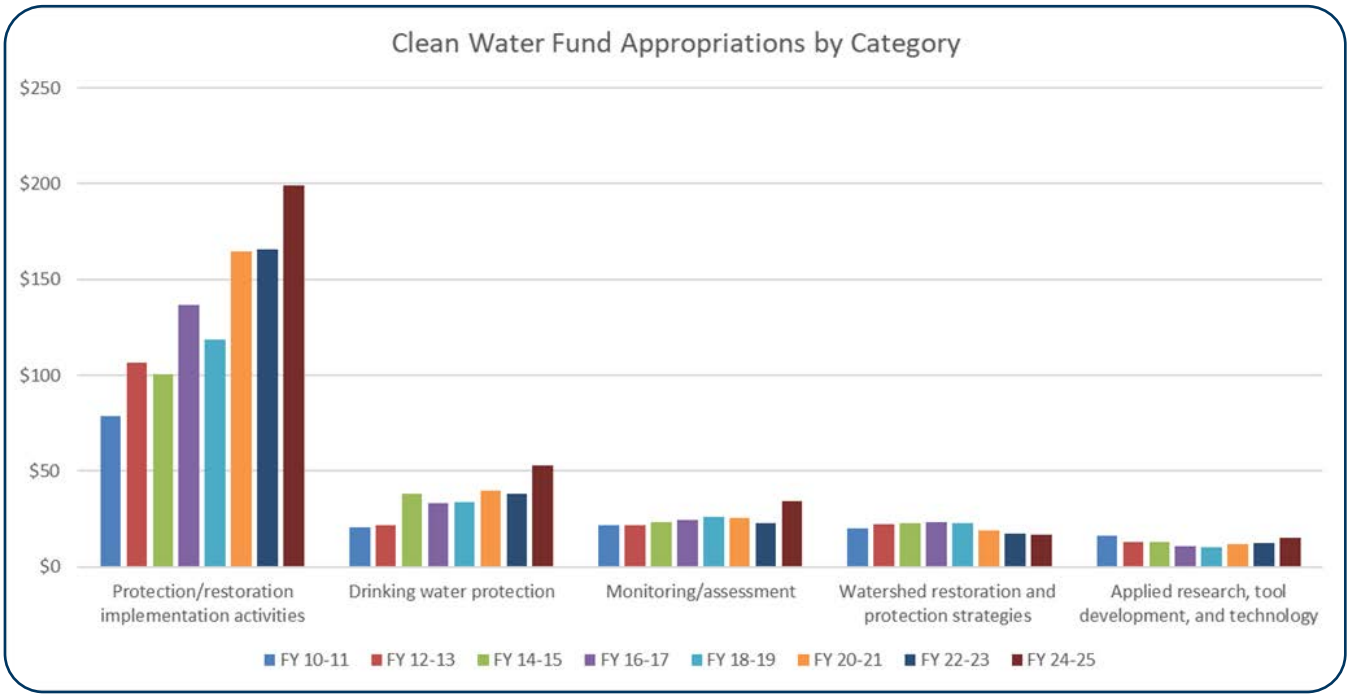


Figure 3. Clean Water Fund appropriations by category

Total dollars invested by watershed or statewide

INVESTMENT

Measure: Total dollars invested per watershed or statewide for monitoring/assessment, watershed restoration/protection strategies, protection/restoration implementation activities, and drinking water protection.

Why is this measure important?

Many Minnesotans want to know how much money from the Clean Water Fund is being invested in their backyard. There is also Clean Water Fund work that has a statewide benefit. This measure tracks Clean Water Fund investments in each major watershed in the state, as well as investments on statewide activities that benefit all watersheds. It shows how the funds are being allocated geographically to support specific activities in four major activity categories:

- Water quality monitoring/assessment
- Watershed restoration/protection strategy development
- Restoration/protection implementation activities
- Drinking water protection

What are we doing?

Thousands of Clean Water Fund-supported projects led largely by local governments are completed and underway across the state. Funded activities include:

- Implementation of practices to clean up wastewater, stormwater, and agricultural runoff
- Regular testing, assessment, and modeling of water quality in lakes and rivers to help gauge the effectiveness of clean water practices
- Strategy development and targeting of practices to guide effective watershed restoration and protection, as well as protection of drinking water and groundwater

State agencies provide technical assistance and administrative oversight for all these activities. They include: Minnesota Board of Water and Soil Resources, Department of Natural Resources, Department of Agriculture, Department of Health, Metropolitan Council, Pollution Control Agency, and Public Facilities Authority.

What progress has been made?

A total of $641 million in completed projects has been expended for all categories of funding tied directly to specific watersheds and $357 million connects back to statewide and regional efforts as a whole, for a total of $998 million for this measure.

Spending varies among the watersheds, depending on the resources of concern, watershed size and complexity, and the technical and administrative capacities of partners in the watershed.

For Fiscal Years 2010-2023, Clean Water Fund allocations to surface water and drinking water projects are benefiting all 80 watersheds in Minnesota. As noted above, these activities are being implemented by local partners as well as state agencies.

Of the four activity categories, funding for implementation activities comprised the largest portion of spending statewide. However, the costs of implementation can vary significantly by watershed, depending on the type of projects and the problems being addressed.

Learn more

Find information on activities funded by the Clean Water Fund at: www.legacy.leg.mn/funds/clean-water-fund

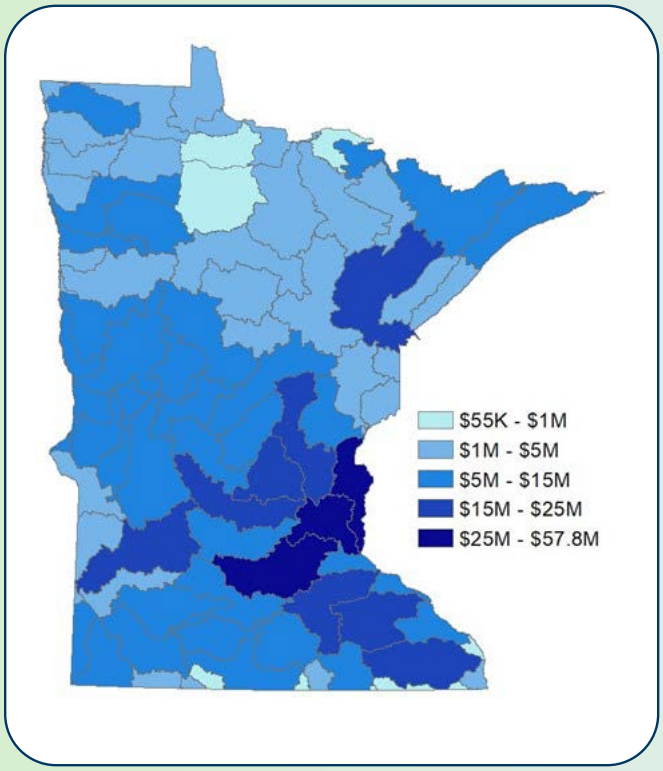


Figure 4. Combined funding for water quality monitoring, watershed restoration and protection strategies (WRAPS) development, implementation, and drinking water protection

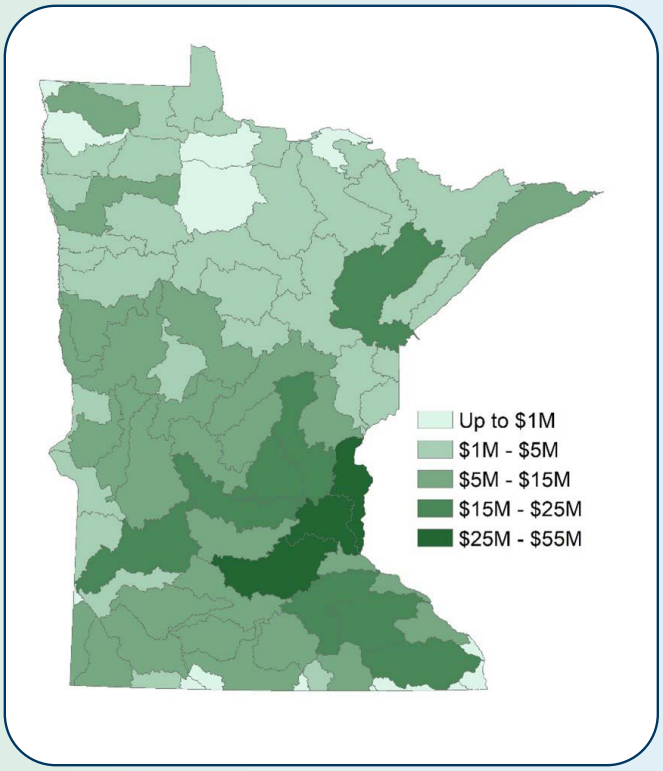


Figure 5. Funding for implementation and drinking water protection actions only

FY10-23 Clean Water Fund Dollars by Watershed

Figure 4 includes all reported financial information by major watershed for the following actions: water quality monitoring, watershed restoration and protection strategies (WRAPs) development, implementation, and drinking water protection. As illustrated in Figure 5, the majority of the funds are going towards implementation activities, which has been increasing over time.

Figure 5 shows a subset of the financial information that includes only implementation and drinking water protection actions. These maps represent projects and supporting activities that have been completed to date, as there are several active grants and contracts with prior appropriations which results are not represented in Figures 4 and 5. Smaller amounts of funds have been expended in some northern Minnesota watersheds where there is significant amount of protected public lands with relatively good water quality. Also, a few watersheds in northwestern Minnesota and along the Iowa border are very small in size and as an artifact of the mapping process appear to have received less funds, but are similar in funds per unit area with adjoining watersheds.

Total dollars awarded

INVESTMENT

Measure: Total Clean Water Fund dollars awarded in grants and contracts to non-state agency partners.

Why is this measure important?

This measure tracks the amount of Clean Water Funds awarded in grants and contracts to external, non-state agency partners to conduct a wide range of clean water activities. The measure provides context on funding distribution between state, federal and local agencies to perform Clean Water Fund-supported work.

What are we doing?

Thousands of Clean Water Fund-supported projects, led largely by local government units, are underway and being implemented across the state. Non-state agency partners include cities, counties, soil and water conservation districts, watershed management organizations, federal agencies, universities, nonprofit organizations, and private consulting firms working with local and state agencies.

Funded activities include implementation of practices to clean up wastewater, stormwater and agricultural runoff. They also include testing water quality to determine the health of lakes and rivers, strategy development to guide effective watershed restoration and protection, and implementation of source water protection plans for drinking water. Groundwater monitoring is also funded through Clean Water Fund dollars and is used to ensure drinking water and groundwater protection.

For all actions taken by local government units and other partners, state agencies provide monitoring activities, development of watershed protection and restoration strategies, as well as technical assistance and administrative oversight. The agencies include Minnesota Board of Water and Soil Resources, Department of Natural Resources, Department of Agriculture, Department of Health, Metropolitan Council, Pollution Control Agency, and Public Facilities Authority.

What progress has been made?

As shown in Figure 6, a total of $777 million in Clean Water Funds were awarded to non-state agency partners from Fiscal Year 2010-23, with the largest share of that going to protection and restoration implementation activities. This represents nearly 43 percent of the total $1.8 billion in Clean Water Fund appropriations for those years.

The balance of remaining appropriations is largely used by state agencies to provide statewide monitoring, watershed protection and restoration strategy development, technical assistance, conservation easements with private landowners, and oversight on Clean Water Fund-supported projects.

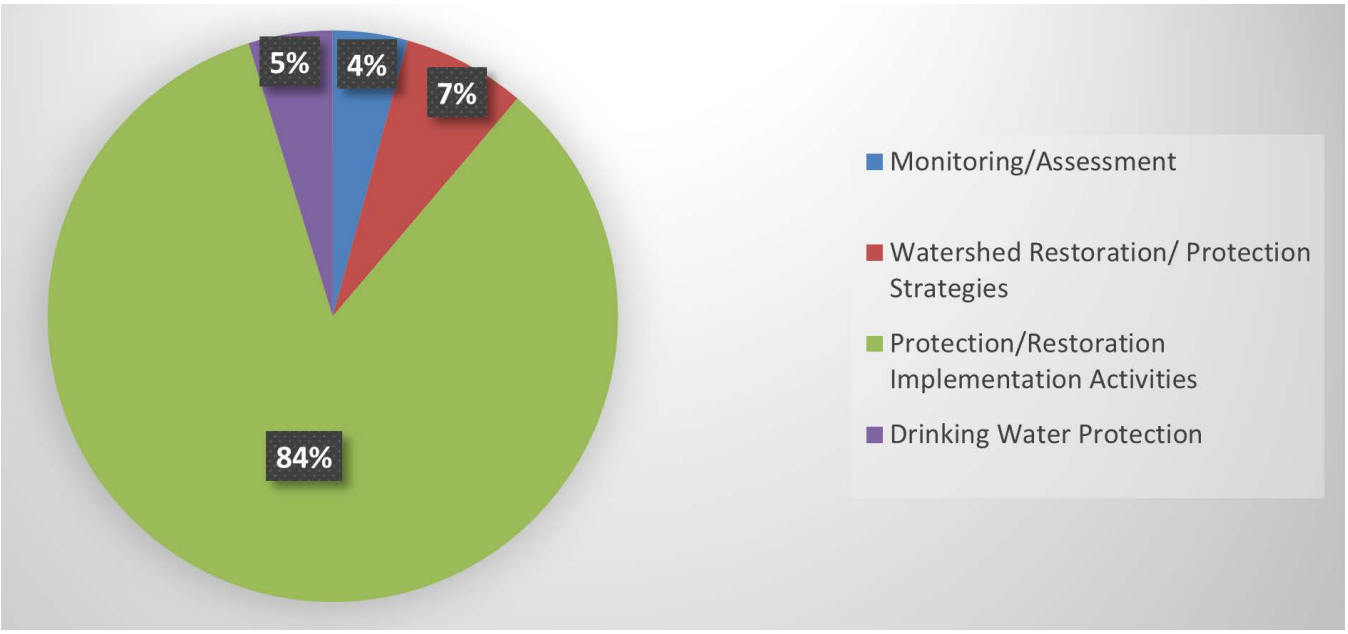


Figure 6. The percentage of total grant and contract awards ($777 million) in FY10-23 for each major Clean Water Fund-supported activity. Allocations to implementation activities are expected to stay steady or grow in future years as more projects move from strategy development to implementation.

Learn more

Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund.

STATUS	DESCRIPTION
$777M was awarded in grants and contracts to non-state agency partners in FY10-23.	About 84 percent ($653 million) of grant and contract awards are for implementation activities; 43 percent of the total $1.8 billion in Clean Water Fund appropriations were awarded to non-state agency partners (FY10-23).

Dollars leveraged

INVESTMENT

Measure: Total dollars leveraged by Clean Water Fund implementation activities.

Why is this measure important?

This measure describes how many total dollars supplement the Clean Water Fund dollars invested in projects in a given year. Throughout Minnesota, the demand for funding to protect and restore the water resources far exceeds the available state dollars. The ability to use Clean Water Fund dollars to leverage local and other funds means millions more dollars are available – increasing the number of projects that are implemented and making projects more cost effective for communities.

What are we doing?

Clean Water Fund grant programs fund actions to prevent polluted runoff from fields, streets, lawns, roofs and other similar sources. They also fund improvements to municipal wastewater and stormwater treatment. Partnerships between state agencies, various local units of government, and the federal government are critical to implement these water quality improvement activities.

What progress has been made?

During Fiscal Years 2022 and 2023, more than $125 million in state grants and loans was awarded to local governments (watershed management organizations, SWCDs, counties, etc.) for projects to reduce runoff from agricultural fields, streets, lawns and other similar sources. Local match and leveraged federal funds increased the project dollars available by $73 million.

During Fiscal Years 2022 and 2023, more than $20 million in state grants was awarded to improve municipal treatment facilities and to help small communities invest in new infrastructure. Local match and other funding sources increased the project dollars by $64.6 million.

As a result, during FY10-23, more than $630 million dollars was leveraged by Clean Water Fund, or $1.06 for every implementation dollar invested (Figure 7).

As shown in Figure 6, total dollars leveraged has remained relatively flat from FY10-17 compared to the increase of Clean Water Fund implementation funds. This is in part because BWSR has provided additional clarification to grantees on match requirements and tracking, which has resulted in more moderate amounts of leveraged funds being reported over time.

Note: In FY 18-19, changes to the Public Facility Authority grant programs resulted in a significant increase in leveraged funds for the biennium. For FY20-21, the MDA updated their formula for calculating leverage from the AgBMP Loan and the Forever Green Initiatives that more accurately calculated leveraged funds.

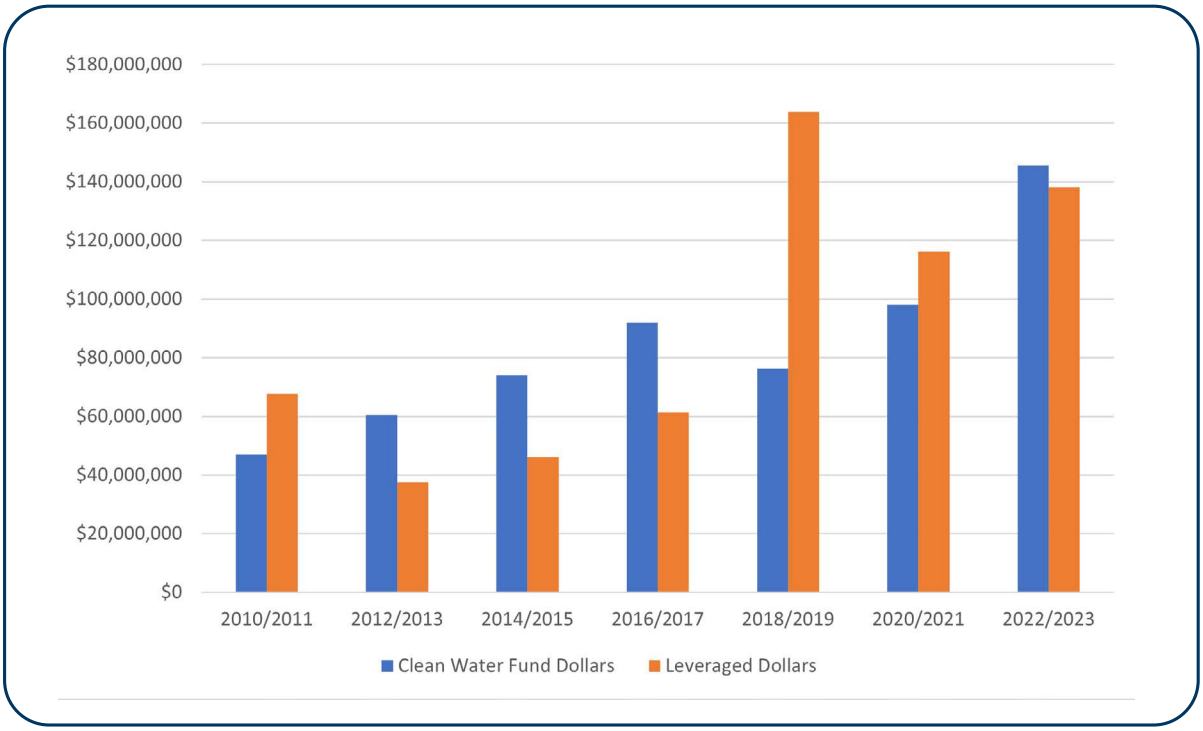


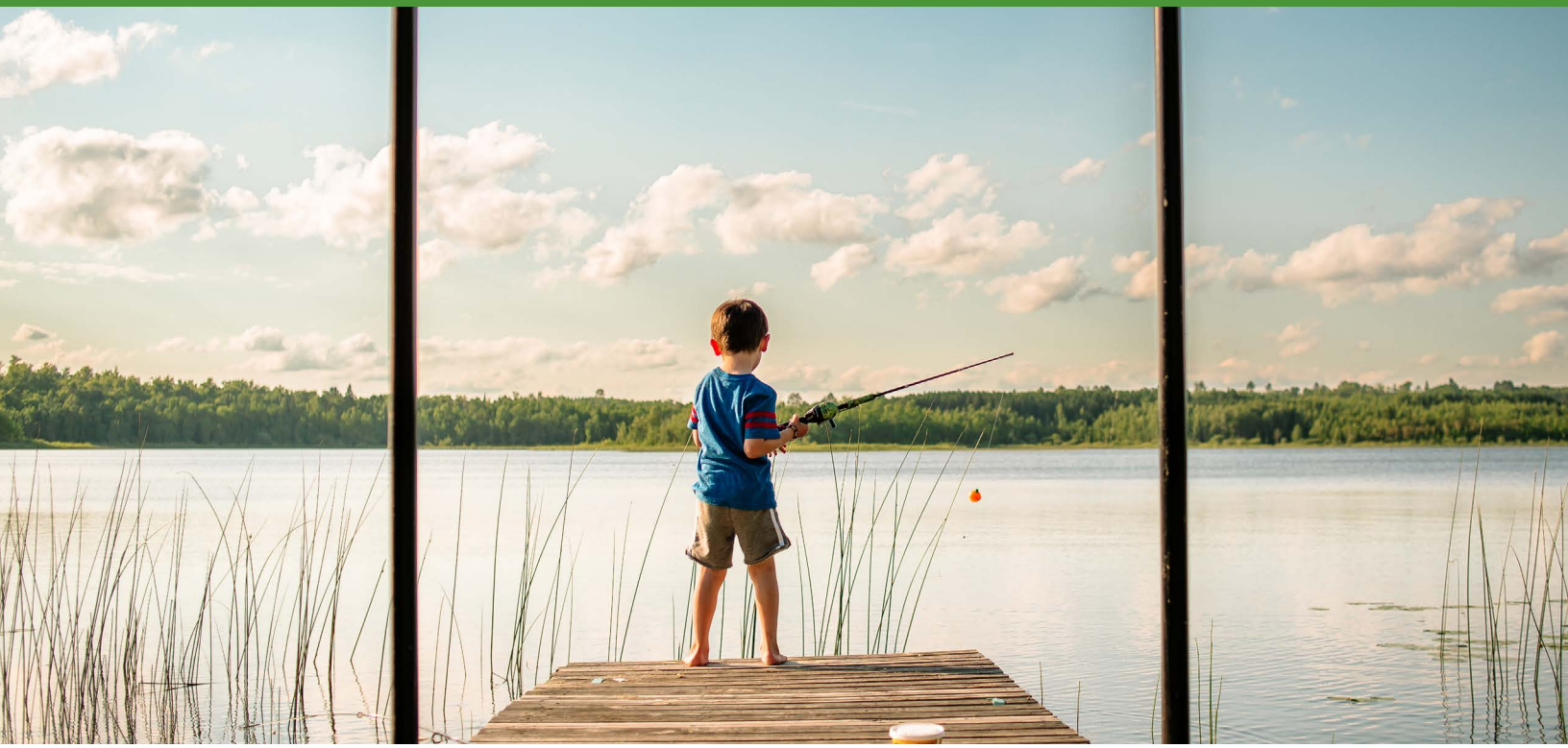
Figure 7. Total dollars leveraged by Clean Water Fund

Learn more

Clean Water Fund www.legacy.leg.mn/funds/clean-water-fund.

STATUS	DESCRIPTION
FY10-23, more than $630 million dollars was leveraged by Clean Water Fund, or $1.06 for every implementation dollar invested.	Required Clean Water match funds were exceeded.

SURFACE WATER QUALITY MEASURES



Major watersheds monitored

ACTION

Measure: Percent of monitoring addressing state and local needs through surface water monitoring requests.

Why is this measure important?

Minnesotans want to know that their investments in water quality are making a difference. With the Clean Water Fund, Minnesota now has a comprehensive baseline assessment of conditions across the state. Similar to an annual visit to the doctor, this monitoring shows where work to protect or return the watersheds to healthy conditions is required. In Minnesota, the monitoring has shown that more restoration is necessary in the south and west, and more protection of resources in the north and east.

This data is essential to help develop local plans for targeted implementation activities and with time, will measure resulting changes in water quality. By returning to these watersheds to monitor after ten years, the Minnesota Pollution Control Agency (MPCA) can do a checkup and determine if the targeted implementation is resulting in changes in water quality. Without continued monitoring, there is no way to see if the rivers and lakes are meeting the goal of fishable and swimmable waters.

Figure 8. The MPCA and partner organizations evaluate water conditions, establish improvement goals and priorities, and take actions designed to restore or protect water quality on a 10-year cycle.

What are we doing?

The first round of watershed monitoring and assessment is complete. This provides the baseline for determining where waters need protection and restoration. The Watershed Restoration and Protection Strategy (WRAPS) document takes the monitoring data and turns it into the specific local strategies needed on the ground to protect and restore waters. This then feeds into local water planning and One Watershed One Plan (1W1P) to target local implementation activities in order to see improvement in water quality.

The MPCA is returning to watersheds to complete the second round of watershed-based lake and stream monitoring, which includes biological, fish contaminant, water quality, and pollutant load sampling. This monitoring is essential to measure progress in restoring and protecting lakes and streams. Additionally, the monitoring will fill gaps to guide local planning and implementation efforts and track long-term changes in water quality and biological communities over time.

As the MPCA returns to watersheds, the Agency has reduced essential core monitoring to provide monitoring capacity for other needs, such as to support permitting decisions, to address a local monitoring need, or address a gap identified in the WRAPS or 1W1P. MPCA has implemented this modified approach to planning and monitoring in watersheds for the next ten years of watershed monitoring around the state.

What progress has been made?

MPCA has developed a process to solicit other surface water monitoring requests and has worked with partners to determine monitoring needs in these watersheds. The process has been implemented in 44 watershed and adaptations have been made as the process matures. Requests vary across the state due to the unique aspects of each watershed and the needs of each watershed. For example, some watersheds are small or have few to no lakes and there are a few additional local requests. Others are very large, with extensive stream and lake networks and there are many additional local requests. In some, Agency proposed sites meet the needs and there are no additional local requests.

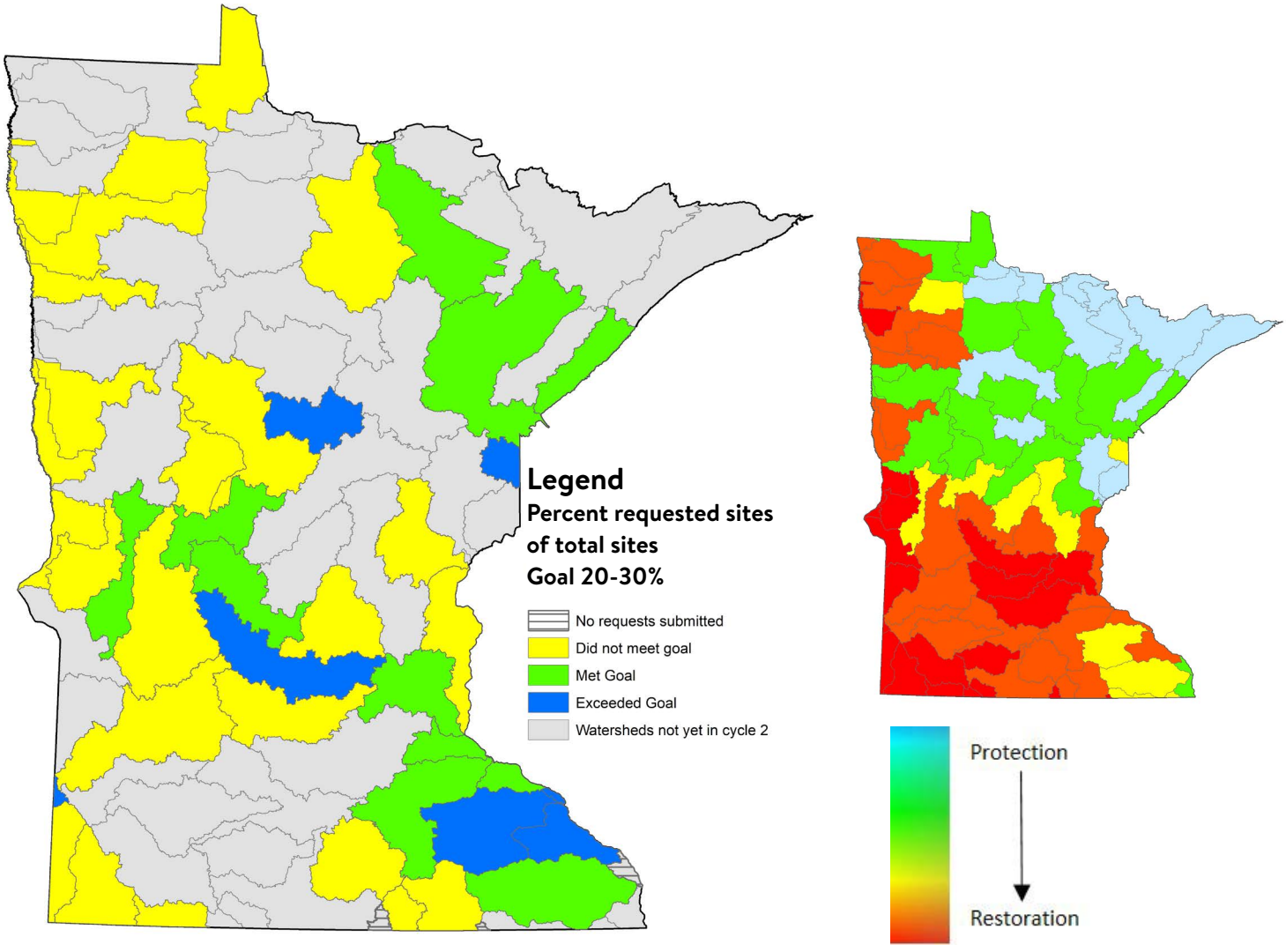


Figure 9. The entire state has completed baseline monitoring (inset map). The percentage of requested and approved surface water monitoring request sites relative to the total number of sites per monitoring year is shown on the larger map. Goal is to have 20-30% identified needs addressed through monitoring.

Learn more

- Find more information about this measure and its data at: www.legacy.leg.mn/funds/clean-water-fund.
- Find your watershed at: www.pca.state.mn.us/business-with-us/watershed-information
- Learn when the MPCA will be intensively monitoring your watershed: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/watershed-approach/index.html

STATUS	TREND	DESCRIPTION
		Nearly 40% of watersheds met goals for addressing state and local needs for monitoring. Ongoing program development is aimed to ensure local needs are identified for monitoring.

Watersheds monitored by local partners

ACTION

Measure: Local partner participation in monitoring efforts

Why is this measure important?

Clean Water Fund dollars enable intensive sampling and assessment of lakes and streams in all 80 major watersheds. This allows for better protection of Minnesota's clean waters and restoration of the polluted ones. As noted in statute, one of the purposes of the Clean Water Fund is to provide "…grants, loans, and technical assistance to public agencies and others testing waters…" This measure shows the participation of local partners, citizen volunteers, and students across Minnesota.

The Minnesota Pollution Control Agency (MPCA) alone cannot complete all of the monitoring necessary to comprehensively assess the waters in the state. Local partner participation is crucial to meet water monitoring strategy goals and to build a base of engaged participants for restoration and protection activities that follow the monitoring and assessment of waters.

What are we doing?

MPCA works with local organizations across the state to build capacity for monitoring efforts. Each year, MPCA prioritizes certain lake, river, and stream sites and works with local partners to award contracts to cover the costs of staff, training, equipment, and lab analysis of condition monitoring.

In this way, MPCA is ensuring that the most current and comprehensive dataset is available for assessment and for the development of protection and restoration strategies. By bolstering local capacity, expertise, and equipment inventory, these partners become well suited to carry out future monitoring efforts, such as subwatershed pollutant load monitoring to aid in restoration and protection strategies.

In addition, MPCA supports a volunteer water monitoring program for stream and lake clarity. Over 1,300 volunteers participate annually; the data supports assessment and trend development work and provides an engaged citizenry for environmental protection and restoration.

Clean Water Fund dollars also support a large environmental education effort in the Red River Basin through the Red River Watershed Management Board. This work exposes hundreds of students to local waterways, provides watershed training to teachers, curriculum development for elementary students, and engages students in biological and continuous monitoring.

What progress has been made?

MPCA has been able to maintain its goal of a minimum of 75 percent of the stream sites offered being picked up by local partners. The MPCA has seen a decline in the participation with lake monitoring through the SWAG program. This has been attributed to a lack of staff capacity at the local level to undertake the tasks associated with lake monitoring.

Figure 10. Local partners play a crucial role in assessing the health of lakes and streams in Minnesota. Lew Overhaug (Winona County) and Joe Coleman (MN Conservation Corp) collect profile measurements on Lake Winona. Image by Megan Kabele. Bethany Chaplin with the Crow Wing SWCD fills a sample bottle after collecting water from the Gull River. Image by Alicia Lang.

During 2022 and 2023, MPCA awarded 26 new SWAG contracts for monitoring activities across the state. The WPLMN monitoring program amended 16 contracts executed in the previous biennium for work through 2022 and 2024. Local partners who received contracts include a Tribal Bands, a Regional Policy Making Council, counties, educational institutions, joint powers, watershed districts, a non-profit, and soil and water conservation districts.

In the Red River Basin, the Red River Basin River Watch program continues to engage local students through programs like River of Dreams (ROD) and Red River Explorers Paddling Program. Measurable outcomes for both programs are detailed below.

ROD

- Delivery of classroom resources including books, art supplies, and canoes
- Completion of 44 classroom sessions
- Completion of 44 field sessions
- Web design and ROD database with canoe tracking information

Paddle Trips

- Completed six kayak and seven canoe ecological river excursions with 532 participants.
- Completed four observational reports.

Additional activities completed through the Red River Basin River Watch program include macroinvertebrate monitoring and Stem assistance.

In the Minnesota River Basin, the Minnesota River Basin River Watch Program was implemented in 2022 and 2023. During the 2022-2023 school year the Minnesota River Watch program worked both in the field and in the classroom with nearly 3,300 students from 22 high schools, 2 middle schools, and 10 elementary schools. Activities within the Minnesota River Basin are detailed below.

- Water quality monitoring using professional state-of-the-art electronic field meters along with collection of water and macroinvertebrate samples.
- River of Dreams workshops and day camps for elementary and middle school students.
- Student-led educational Community River Walks along the floodplain of the Minnesota River.

Volunteers through the Volunteer Water Monitoring Program provide data on over 1,500 lake and stream locations across Minnesota. These long-term networks have allowed the state to track trends and assess water quality.

Minnesotans benefit from many other local and volunteer monitoring efforts across the state. This interest in water resources has provided information to inform local action and engagement.

Learn more

- Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund
- Find out when the MPCA will be intensively monitoring your watershed: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/watershed-approach/index.html
- Surface Water Assessment Grants: Surface Water Assessment Grants | Minnesota Pollution Control Agency (state.mn.us)
- Watershed Pollutant Load Monitoring Network: Watershed pollutant load monitoring | Minnesota Pollution Control Agency (state.mn.us)

STATUS	TREND	DESCRIPTION
		As of 2023; all programs are meeting participatory goals.

Nonpoint source BMP implementation

ACTION

Measure: Number of nonpoint source best management practices implemented with Clean Water funding and estimated pollutant load reductions.

Why is this measure important?

Minnesotans want their water resources protected and restored. Unfortunately, it can take many years for pollution control practices to result in clean water, particularly at the scale outlined in the Clean Water Road map. This measure helps us monitor progress toward the long-term goal of clean water by tracking the actions of people and organizations to implement best management practices, in cities and on the farm. This measure also tracks the estimated amount of pollution those management and conservation practices are expected to reduce.

What are we doing?

The Board of Water and Soil Resources (BWSR) is the primary state agency responsible for nonpoint source implementation and operates in partnership with local partners. Local governments—cities, watershed districts, counties, and soil and water conservation districts— are leading both cleanup and protection efforts across the state. They are working directly with communities, individual landowners, and various non-profit organizations to implement best management practices. These practices include reducing polluted runoff from city streets, agricultural fields, and feedlots; stabilizing stream channels; and upgrading septic systems. See BWSR Clean Water Fund Stories site for more information [https://bwsr.state.mn.us/your-clean-water-funds-work-0].

The Minnesota Agricultural Water Quality Certification Program (MAWQCP) is a statewide voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our water. The MAWQCP brings together producers with local soil and water conservation district staff and agronomy professionals to address the risks to water quality based on a whole-farm assessment. Farmers and landowners who implement and maintain approved farm management practices are certified and in turn obtain regulatory certainty for a period of ten years. Certified producers may use their status to promote their business as protective of water quality, and producers interested in becoming certified also receive priority status for technical and financial assistance. Importantly, independent analysis from Minnesota State Agricultural Centers of Excellence shows MAWQCP-certified farms also average 20% higher net profit than non-certified farms.

Table 1. FY10-23 BWSR Grant Funded Project Outcomes

Major Basin	Number of Mapped BMPs	Sediment Reduction (T/yr)	Phosphorus Reduction (Lbs/yr)
Minnesota	5,320	77,613	99,421
Upper Mississippi	5,953	130,762	54,371
Missouri	682	17,706	14,767
Rainy River	103	1,103	1,435
Red River	6,348	111,287	89,596
St. Croix	948	27,569	15,488
Lower Mississippi	2,926	43,121	57,355
Lake Superior	155	2,653	2,512
TOTALS:	**22,435**	**411,814**	**334,944**

The MAWQCP has awarded more than 560 supplemental grants directly to producers to implement conservation practices, totaling over $2.2 million. An additional $16 million in federal funding has been leveraged for conservation implementation grants through the USDA NRCS Regional Conservation Partnership Program (RCPP).

- 983,942 acres and 1,347 farms have been Water Quality Certified through the MAWQCP. These certifications have added more than 2,640 new conservation practices to the landscape.

In total, more than 22,435 best management and conservation practices have been installed through BWSR grant programs, resulting in a reduction of about 334,944 pounds of phosphorus and 411,814 tons of sediment across the state.

What progress has been made?

With funding from the Clean Water Fund, the implementation of practices to improve and protect Minnesota's water resources has accelerated, as has the completion of Total Maximum Daily Load (TMDL) and Watershed Restoration and Protection Strategy (WRAPS) assessments that outline water quality needs. However, funding is not keeping pace with demand.

From 2010 to 2023 the Clean Water Fund has:

- Funded more than 4,271 grants to protect and restore Minnesota water resources.
- Issued more than 2,253 loans to prevent nonpoint source water pollution or solve existing water quality problems.
- Secured more than 941 easements that will permanently protect approximately 31,164 acres along riparian corridors and within well head protection areas, of which 23,830 acres were supported by Clean Water Funds.
- Repaired 881 imminent health threat subsurface sewage treatment systems.

Learn more

- Clean Water Fund **www.legacy.leg.mn/funds/clean-water-fund**
- BWSR Clean Water Fund Stories **bwsr.state.mn.us/clean-water-fund-stories**
- Agriculture Best Management Practices (BMP) Loan Program **www.mda.state.mn.us/agbmploan**
- Minnesota Agricultural Water Quality Certification Program **www.MyLandMyLegacy.com**
- Best management practices map **https://public.tableau.com/app/profile/mpca.data.services/viz/CWAA-Bestmanagementpracticesbywatershed/Bestmangementpracticesbywatershed**

STATUS	TREND	DESCRIPTION
■	↗	Although funding has increased and there is a continued increase in practices and projects being implemented, the total request for projects has remained significantly greater than available funds.

Connection with Minnesota's Clean Water Roadmap

Goals: An 8 percent increase in the percentage of lakes with good water quality, and a 7 percent increase in the percentage of rivers and streams with healthy fish communities.

This measure will support the Roadmap goals by tracking reductions in phosphorus and sediment as a result of implementation activities. State-funded nonpoint implementation projects and associated pollutant reductions are tracked and will be analyzed on the major river basin.

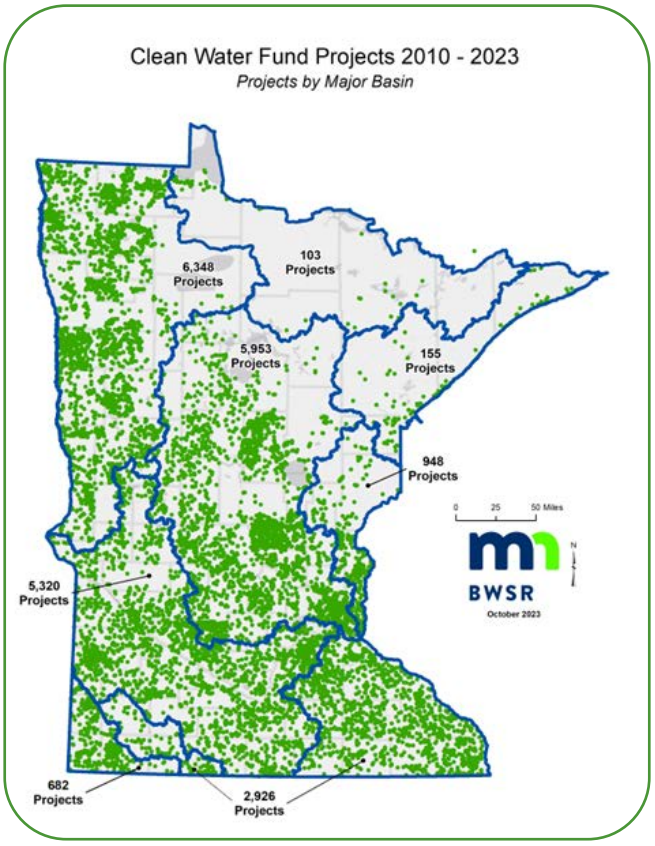


Figure 11. Clean Water Fund projects 2010-2023 (projects by major basin)

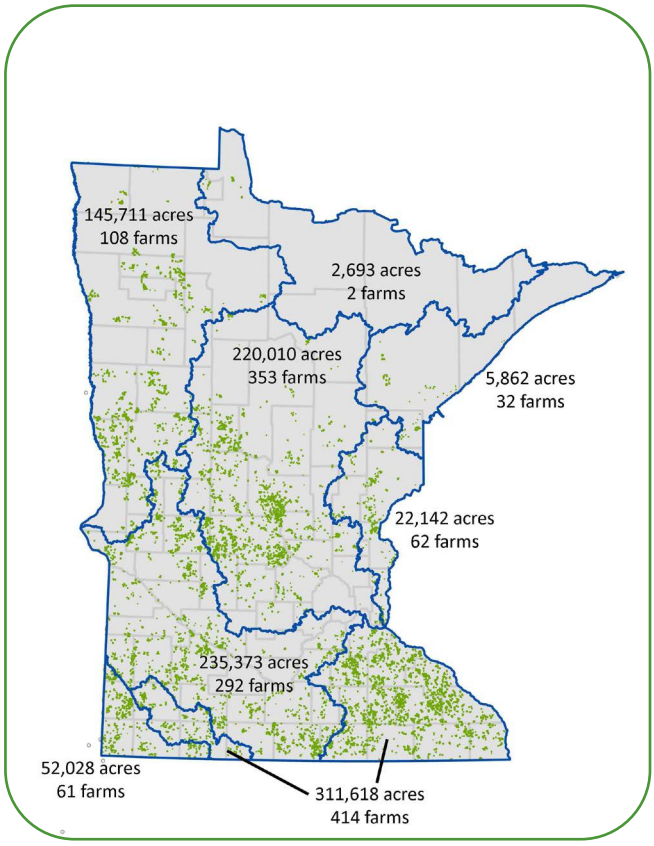


Figure 12. Minnesota Agricultural Water Quality Certification Program certified farms & acres, FY14-23.

Municipal infrastructure project implementation

ACTION

Measure: Number of municipal point source construction projects implemented with Clean Water funding and estimated pollutant load reductions

Why is this measure important?

Municipalities across Minnesota are required to upgrade treatment facilities, increase treatment of stormwater runoff, and replace failing septics in order to protect or restore our state's waters. These construction projects help meet required wasteload reductions through implementation of Total Maximum Daily Loads (TMDLs), phosphorus discharge limits and Water Quality Based Effluent Limits (WQBEL). These reductions are in addition to the major water quality benefits already achieved by municipalities through ongoing investments to replace aging wastewater infrastructure.

What are we doing?

Cities are required to implement upgrades to their wastewater and stormwater infrastructure to meet tighter discharge standards and specific water quality protection and restoration goals. Small unsewered communities are required to fix noncomplying individual sewage treatment systems or install community systems when new individual systems are not feasible. The Minnesota Public Facilities Authority (PFA) and the Minnesota Pollution Control Agency (MPCA) jointly administer programs that provide grants and loans from Clean Water Funds to help municipalities pay for these infrastructure improvements.

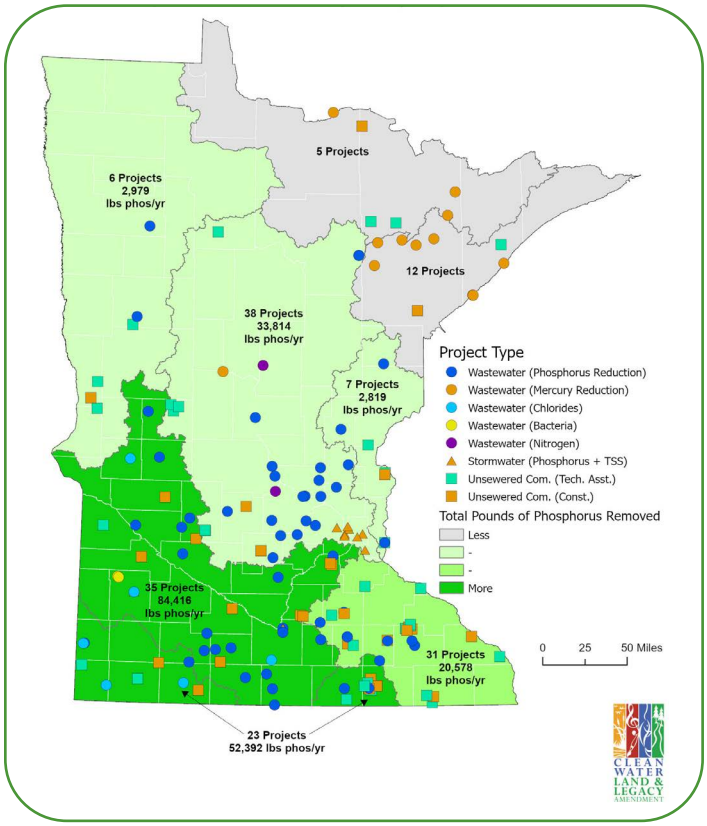


Figure 13. Municipal infrastructure projects by major basin, 2010-2023

What progress has been made?

Since 2010, Clean Water Fund dollars have helped 157 projects that implement wastewater and stormwater improvements, including:

- 57 wastewater construction projects to reduce phosphorus discharges to 1 milligram per liter or less, resulting in an estimated total phosphorus reduction of 190,194 pounds per year.
- 12 wastewater construction projects to reduce mercury discharges, resulting in an estimated total reduction of 5,372 milligrams per year.
- 2 wastewater construction projects that will provide treatment to reduce subsurface nitrogen discharges, resulting in an estimated total reduction of 5,818 pounds per year.
- 6 construction projects to reduce chloride discharge, resulting in an estimated total chloride reduction of 27,751 pounds per year.
- 10 stormwater construction projects that will provide treatment to reduce phosphorus discharges by an estimated 1,528 pounds per year and also result in reducing total suspended solids of 97,949 pounds per year.
- 39 small community technical assistance projects to help small unsewered communities evaluate treatment alternatives to address serious water quality and public health problems from non-complying septic systems.
- 33 wastewater construction projects to help small unsewered communities solve their wastewater problems by connecting to existing municipal systems or building their own treatment systems such as community cluster mound systems, resulting in estimated annual reductions in phosphorus of 5,277 pounds and nitrogen of 2,681 lbs. Over 1,000 non-compliant systems have been fixed so far.

Clean Water Funds are targeted to high priority projects based on the MPCA's Project Priority List which ranks projects based on water quality impacts and public health factors. Projects are designed to achieve specific effluent limits and wasteload reductions, and discharges are monitored to verify compliance.

The majority of projects to date have focused on reducing phosphorus discharges from wastewater treatment facilities.

Phosphorus is a nutrient which, when present in excessive amounts, is responsible for water quality impairments due to excess algal growth. River nutrient standards are being implemented across the state and Clean Water Funds are vital in helping to finance the required treatment upgrades. Continued appropriations will be needed to meet the increasing municipal demand for funding to improve treatment facilities across Minnesota.

For information on activities funded by the Clean Water Fund visit:

- www.legacy.leg.mn/funds/clean-water-fund
- Minnesota Public Facilities Authority (PFA): www.mn.gov/deed/pfa
- Minnesota Pollution Control Agency (MPCA): https://public.tableau.com/app/profile/mpca.data.services/viz/CWAA-Wastewaterloadingbyfacility/Wastewaterpollutantloading

STATUS	TREND	DESCRIPTION
		Pace of awards is linked to permit cycles, compliance schedules and available Clean Water Funds. Applications exceeds currently available funds even after significant infusion of bond funds over the past several cycles.

SURFACE WATER QUALITY MEASURES

Surface water health

OUTCOME

Measure: Rate of impairment/unimpairment of surface water statewide and by watershed

Why is this measure important?

Many Minnesotans want to know if they can swim and fish in their favorite lake or stream. Before the Clean Water Fund, few lakes and streams had enough water quality information to determine if Minnesota's water goals were being met. In order to determine a waterbody's health, state agencies need basic water quality information that is obtained through monitoring. Without this basic information, work to develop strategies to reverse water pollution and to protect high quality lakes and streams would be delayed.

What are we doing?

Clean Water Funding significantly increased water monitoring and assessment activities. In 2008, the MPCA implemented the Watershed Approach. This is a 10-year cycle where approximately eight of Minnesota's 80 major watersheds are intensively monitored each year for stream and lake water chemistry and biology. These data from monitoring activities are then assessed to determine if goals to protect recreational activities such as fishing and swimming, as well as to safeguard fish and aquatic ecosystems, are being met. By considering all lake and stream data for a given watershed at one time, a complete picture of the watershed's overall health develops. State agency and local partners are working together to conduct the intensive monitoring, assess the resulting monitoring information, to develop restoration and protection plans, and assess progress towards water quality goals.

What progress has been made?

As of January 2024, all 80 watersheds have been assessed, and a quarter of the watersheds have had a second update. As monitoring and assessment continues across the state, the new focus is on measuring progress. The assessment results are located on the MPCA's Minnesota Watershed web page at www.pca.state.mn.us/business-with-us/watershed-information

Figure 14. MPCA staff sample streams and lakes across Minnesota to determine if recreation and aquatic life are supported.

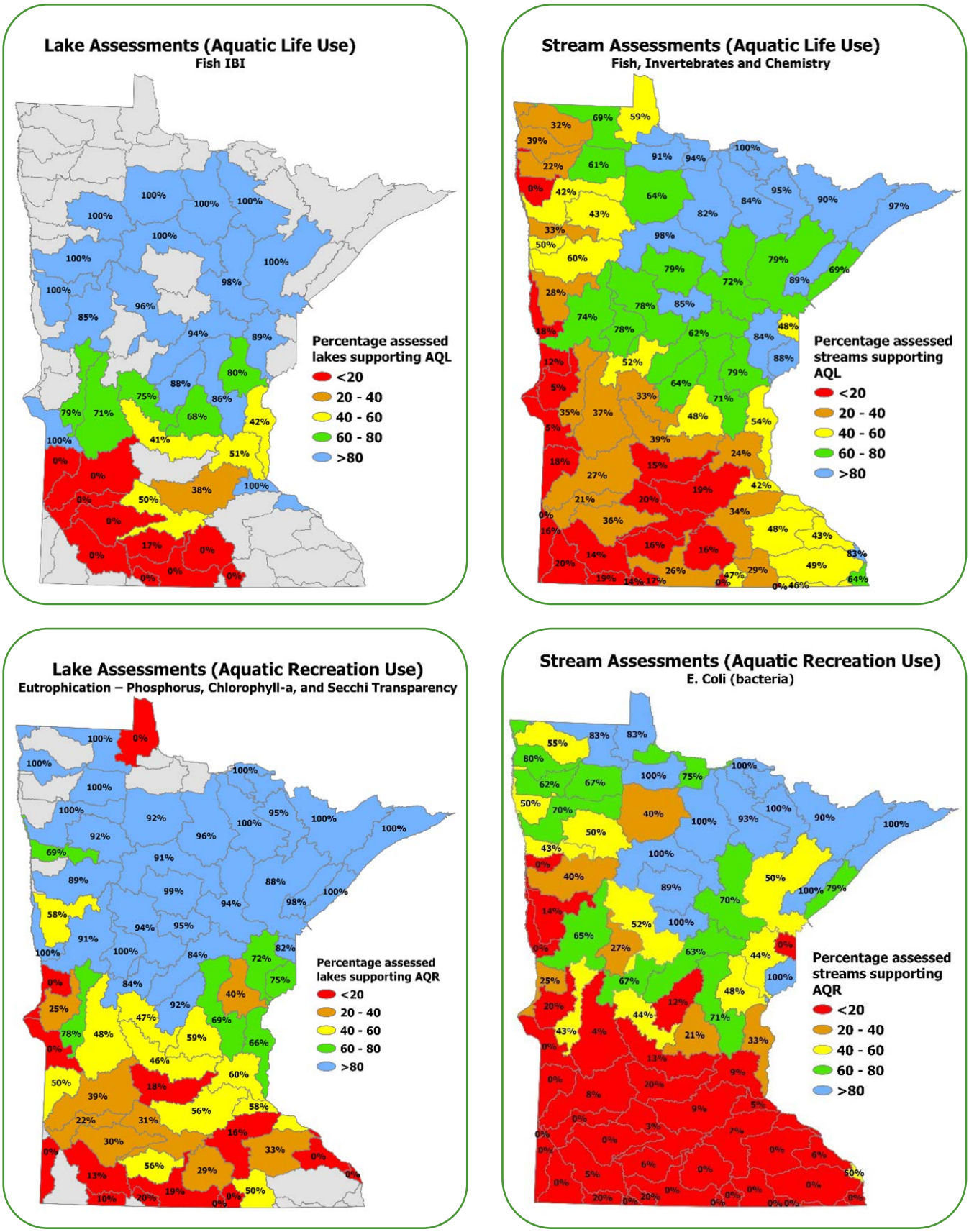


Figure 15. Streams are monitored for water chemistry, fish, and aquatic insects to determine if a stream has healthy aquatic ecosystems. Water monitoring information is also evaluated to determine if lakes and streams are suitable for swimming and other water recreation, and to determine whether consumption of fish should be limited.

Minnesota is working to increase the number of lakes meeting acceptable recreation values and the number of rivers and streams meeting their potential for a healthy fish community by 8% and 7% respectively. These goals were developed as a part of the Clean Water Fund Roadmap. This projects the estimated improvement anticipated with the funding made available for targeted implementation over the course of the Clean Water Fund.

While monitoring alone does not yield changes in environmental condition, it does provide the information necessary to target protection and restoration activities in the watershed. It also allows for progress to be measured, as practices are implemented (improvements) or as more land is developed (degradation).

Learn more

- Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund.
- Find water quality assessment results for specific lakes and streams at https://public.tableau.com/views/WaterQualityAssessmentResultsDataViewer/Designatedusetable?:language=en-US&:display_count=n&:origin=viz_share_link
- Visit www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/watershed-approach/index.html to find out when your watershed will be monitored.

STATUS	TREND	DESCRIPTION
Stream Aquatic Life 	**NEI**	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Stream Swimming 	**NEI**	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Lake Swimming 	**NEI**	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.

Lake and stream water quality

OUTCOME

Measure: Changes over time in key water quality parameters for lakes and streams.

Why is this measure important?

Water quality in a lake or stream can change depending on a variety of factors ranging from rain quantity or temperature to runoff from agricultural areas, parking lots, roads and lawns. Because of factors like these, waters must be sampled for many years to detect water quality trends. Information gathered over the years is valuable because it gives insights into general water quality patterns and trends across the state. This helps determine where to target restoration and protection efforts and the effectiveness of current activities to restore polluted waters and protect those that have good water quality.

What are we doing?

Federal, state and local organizations have been monitoring Minnesota's lake and stream water quality for decades. Data were collected statewide, and the results of this work were widely reported to support various program goals. Taken together, Minnesota's water quality data paint a picture of general condition and changes in Minnesota's lakes and streams.

This measure tracks those water quality factors that tend to be the largest sources or indicators of pollution. Some of these parameters include:

Lakes

- Total phosphorus
- Chlorophyll-a (algae pigment)
- Secchi (transparency)
- Pesticides

Phosphorus, chlorophyll-a, and Secchi combined indicate whether lake water quality is good for recreation, such as swimming and wading. Pesticides can affect the survival rate of fish, insects, and their food sources.

Rivers and streams

- Total phosphorus
- Nitrate
- Total suspended solids (sediment)
- Chloride
- Fish and invertebrates (aquatic insects)
- Pesticides

Phosphorus, nitrate, suspended solids, chloride, and pesticides in high concentrations affect the survival rate of fish, and their food source, aquatic insects. All of these parameters combined measure the ability of the stream to support healthy fish populations and aquatic ecosystems.

Pesticides

The pesticide data will focus on the five pesticides designated as "surface water pesticides of concern" by the Minnesota Department of Agriculture (MDA), including the herbicides acetochlor and atrazine, and the insecticides chlorpyrifos, clothianidin and imidacloprid. Clothianidin and imidacloprid are neonicotinoid insecticides that were designated as "surface water pesticides of concern" in 2020. The MDA analyzed for 185 different pesticide compounds in 2022, with many compounds not detected at all and others detected infrequently.

Acetochlor, atrazine, and chlorpyrifos have MPCA water quality standards available. Currently, there is one river with an acetochlor impairment, and one lake and 12 rivers with a chlorpyrifos impairment. There are currently no atrazine impairments. The MPCA does not have water quality standards available for

clothianidin and imidacloprid. To screen detections for these compounds, the MDA used the USEPA chronic aquatic invertebrate benchmarks. MPCA water quality standards are required for the determination of impaired waters.

In addition to analyzing data from existing sites, state and local partners are expanding the monitoring network to provide information in new areas or places facing new threats.

What progress has been made?

Expansion of the monitoring network is critical to evaluating water quality trends in the state of Minnesota. The following activities are key highlights:

- The Minnesota Pollution Control Agency's (MPCA) Watershed Pollutant Load Monitoring Network began in 2008 to understand long-term trends in water quality concentration and load around the state and currently includes 199 sites (see Flow corrected trends maps in Figures 17-19).
- Trend information is available in an interactive form and for download at: https://public.tableau.com/app/profile/mpca.data.services/viz/Long-termStreamTrends/Pollutantconcentrations

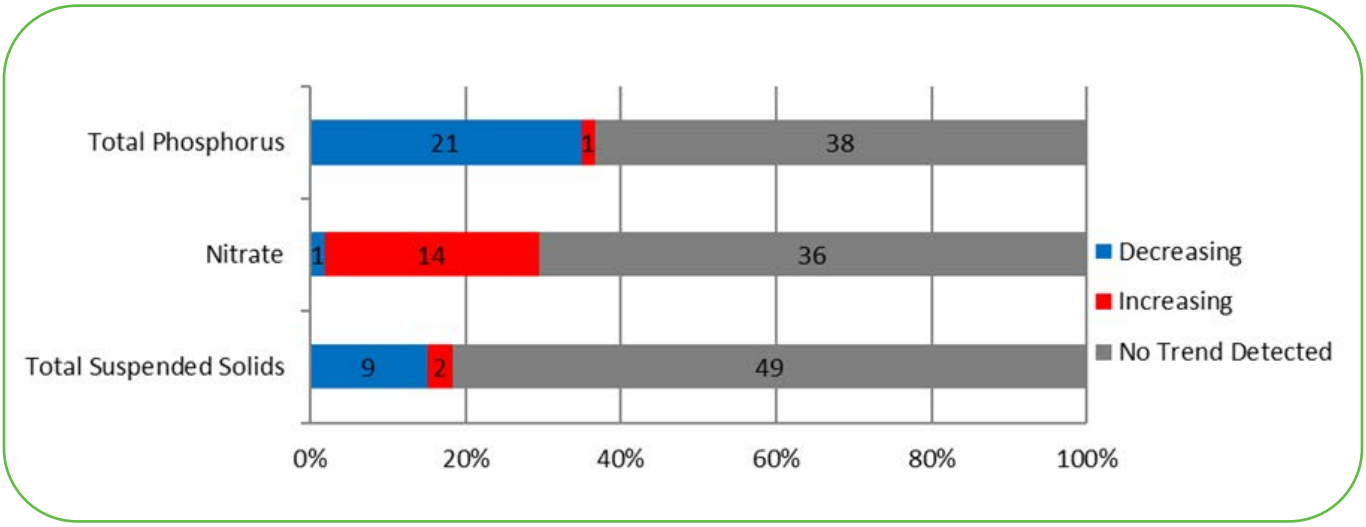


Figure 16. Where approximately ten years of streamflow and water quality data are available, phosphorus and total suspended solids concentrations in Minnesota's larger rivers are generally decreasing or staying the same, while nitrate concentrations are staying the same or increasing.

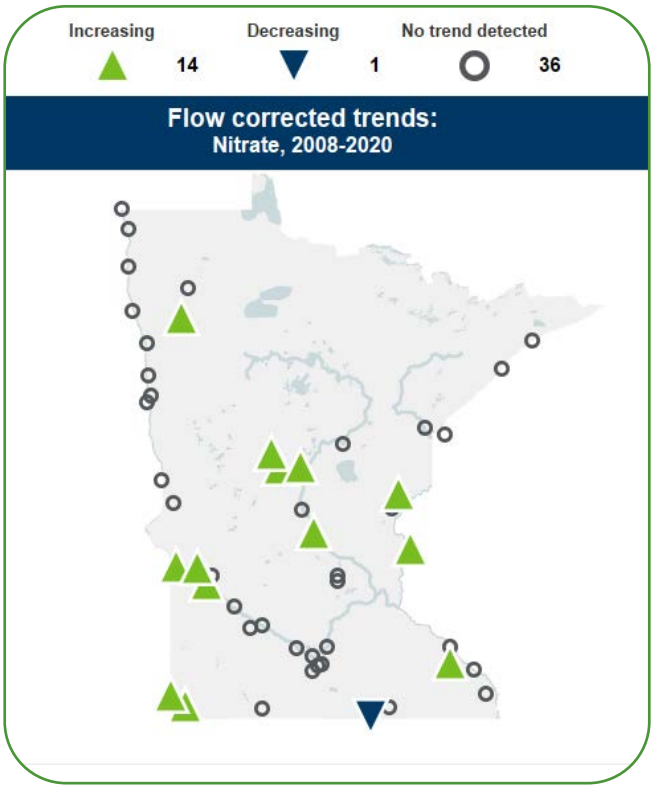


Figure 17. Nitrate trends are generally showing no trend or increasing throughout the state.

Figure 18. Phosphorus trends are generally decreasing across the state, especially in central and southern Minnesota.

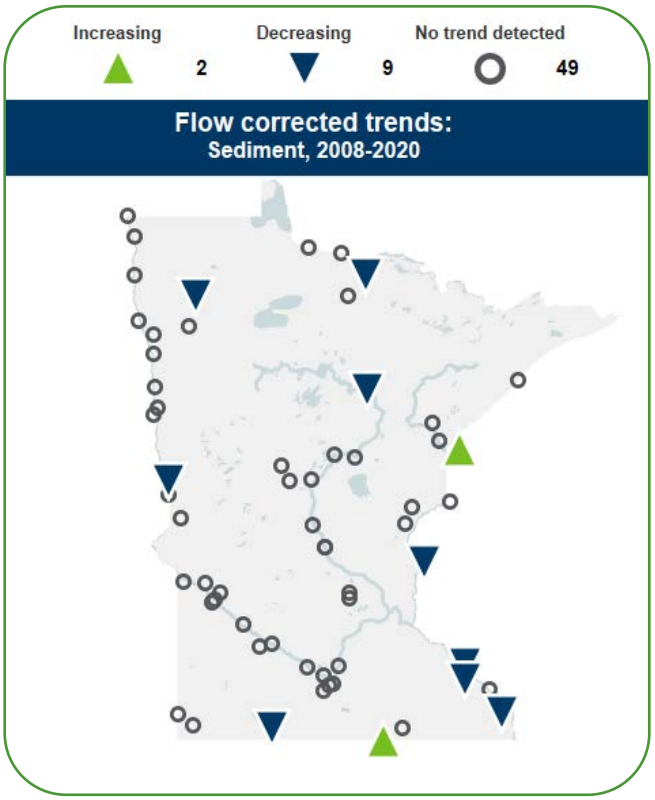
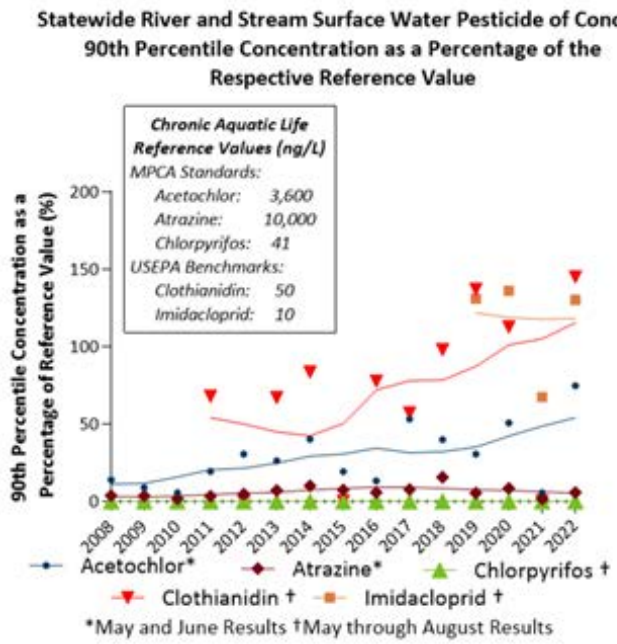


Figure 19. Where there are trends detected, the total suspended solids concentration trends across the state are generally decreasing.

The Minnesota Department of Agriculture conducts pesticide monitoring at approximately 60 agricultural and urban river and stream sites each year. Although low levels of select pesticides, and associated breakdown products, are detected frequently in some waterbodies, an exceedance of a water quality standard is rare.



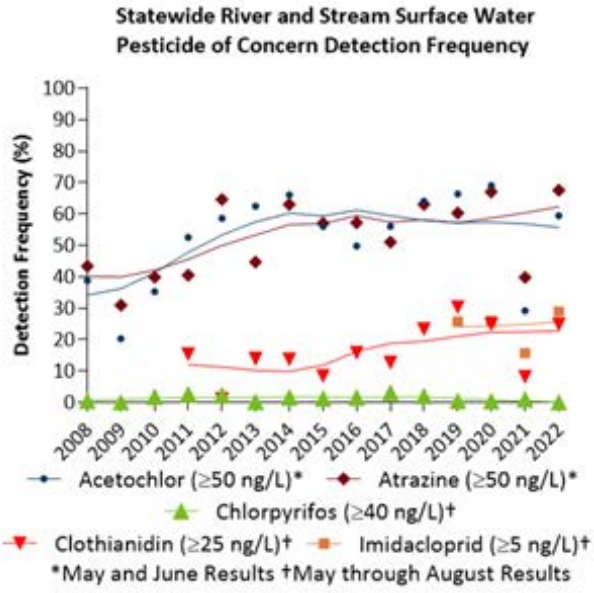


Figure 20 (left graph). Long-term pesticide monitoring is needed to assess concentrations relative to water quality reference values due to variability in climate, pesticide use, and agronomic factors. The MDA is presenting the 90th percentile concentration as a percentage of the applicable MPCA standard or USEPA benchmark to allow for comparison amongst each "surface water pesticide of concern". Clothianidin and imidacloprid have the highest 90th percentile concentration relative to the reference value of all pesticides monitored in rivers. In recent years, the acetochlor 90th percentile concentration has been above 50% of the standard. Chlorpyrifos detection frequency is low (below 5%) however, all chlorpyrifos detections approach or exceed the water quality standard. Most atrazine detections are well below their water quality standard.

Figure 21 (right graph). Long-term pesticide monitoring has allowed the MDA to assess detection frequency trends over time. The two herbicides, acetochlor and atrazine, have been detected more frequently than the three insecticide "surface water pesticides of concern".

Long-term pesticide monitoring is needed to assess concentrations relative to water quality reference values due to variability in climate, pesticide use, and agronomic factors. The MDA is presenting the 90th percentile concentration as a percentage of the applicable MPCA standard or USEPA benchmark to allow for comparison amongst each "surface water pesticide of concern". The 90th percentile concentrations of clothianidin and imidacloprid are greater than their USEPA benchmark. In recent years, the acetochlor 90th percentile concentration has been above 50% of the standard. The 90th percentile concentration of atrazine and chlorpyrifos are low relative to their appliable MPCA standards. Long-term pesticide monitoring has allowed the MDA to assess detection frequency trends over time. The two herbicides, acetochlor and atrazine, have been detected more frequently than the three insecticide "surface water pesticides of concern".

- Metropolitan Council monitors and analyzes water quality within the 7-county metropolitan area on lakes, river segments and area streams. In 2021 the Council completed an assessment of chloride in metro area streams, examining concentrations, loads, and long-term trends.

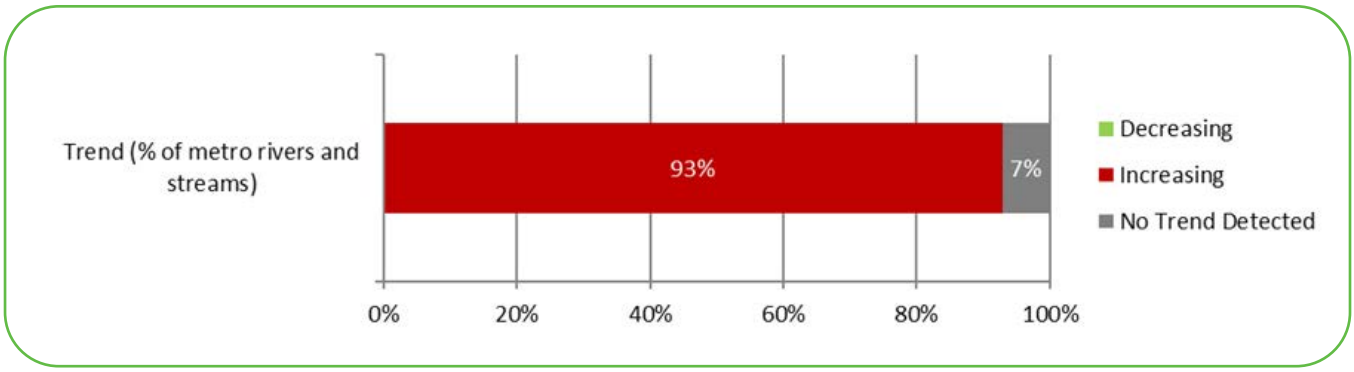


Figure 22. Among 28 rivers and streams in the Twin Cities metro area, including the Mississippi, Minnesota, and St. Croix Rivers, almost all are seeing a long-term increasing concentration trend in chloride.

- Participants in the Volunteer Water Monitoring Program have collected lake and stream water clarity information for decades. This program is vital in gathering data for long-term trend analyses.

differences in water quality trends when comparing the long-term trend (more than 20 years) against the short-term trend (five to 15 years) for a given lake or stream.

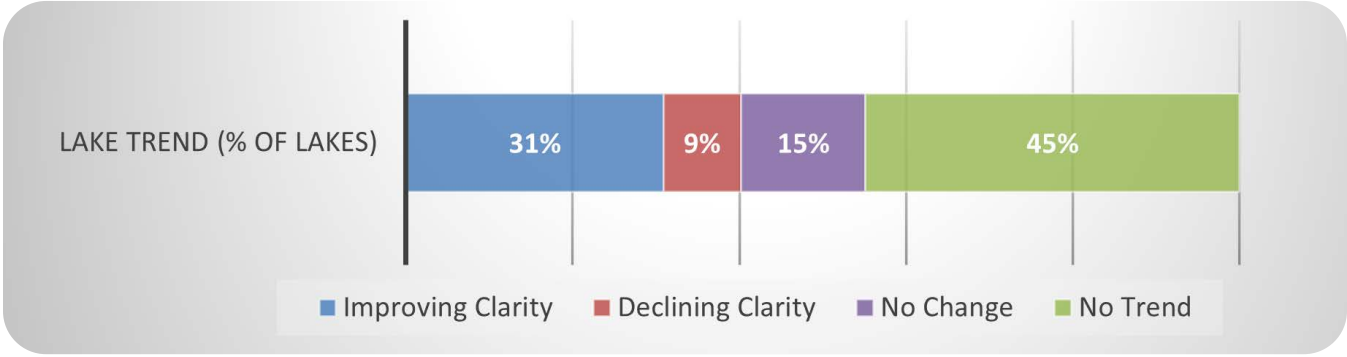


Figure 23. Trends in lake water clarity between 1973 and 2022. While water clarity, in general, is poorer in southern Minnesota, increasing and decreasing lake clarity trends are fairly evenly scattered through north and south-central Minnesota.

- All of the watersheds have been comprehensively monitored, providing baseline data for assessments and a starting point for future trends. The second 10-year rotation of watershed monitoring began in 2018 and will provide information to measure progress.
- The MPCA participates in the National Aquatic Resources Surveys for lakes, including a partnership with MDA for pesticide work, and conducted state probabilistic surveys for streams, rivers, and wetlands, providing baseline information.

Though it is tempting to make sweeping statements, most often the story is a complicated mix of seeing improvements in some aspects of water quality. and declines in others. There can also be striking

Learn more

The MPCA has a rich array of graphics that can be produced for multiple combinations of waterbody types, pollutants/parameters, and monitoring approaches to provide a comprehensive picture of the state of Minnesota's water resources. See www.legacy.mn.gov/clean-water-fund.

STATUS	TREND	DESCRIPTION
Lake Clarity 	**NEI**	Water quality varies greatly by region. There are more improving trends for lake clarity than there are declining trends. 60% of lakes with data, are either no trend or no change.
Sediment in Large Rivers 	**NEI**	Water quality varies greatly by region. Over 50% of streams have no trend detected. There are more improving trends than declining trends in total suspended solids concentrations.
Nitrate in Large Rivers 	**NEI**	Water quality varies greatly by region. Over 50% of streams have no trend detected. Concentrations of nitrate are increasing in some major rivers.
Phosphorus in Large Rivers 	**NEI**	Water quality varies greatly by region. Over 50% of streams have no trend detected. There are more improving trends than declining trends in phosphorus concentrations.
Pesticides in Streams 	**NEI**	Detections in streams vary greatly as a result of hydrologic and agronomic conditions; exceedances of pesticide water quality standards are rare. Some “surface water pesticides of concern” are showing increasing detection frequency and concentrations while others are showing stable detection frequency and concentrations.
Pesticides in Lakes 		Monitoring has indicated stable pesticide concentrations in lakes, and nearly all detections are low relative to water quality reference values. Pesticide detection frequency and concentrations in lakes are lower compared to streams.
Chloride in rivers and streams 		Concentrations are increasing in almost all metro area rivers and streams.

Waters restored

OUTCOME

Measure: Number of previous impairments now meeting water-quality standards due to restoration activities.

Why is this measure important?

This measure tracks how actions taken on the ground lead to successful restoration of impaired waters. "Impaired waters" are lakes, streams, or rivers that fail to meet water quality standards due to one or more pollutants such as nutrients, bacteria, mercury, and sediment. High levels of pollution in impaired waters can be unsafe for public health, fish and other aquatic life, as well as damaging to recreational opportunities.

Although Minnesota's impaired waters list is growing as the state monitors and assesses more watersheds, so too is the list of waters that are improving. Cleanup efforts can take several years to decades to complete, but there are many examples of impaired waters that have been restored.

What are we doing?

Pollution problems are initially identified through water quality monitoring, followed by studies and plans to determine what restoration activities are needed. Local governments – cities, watershed management organizations (WMO), counties and soil and water conservation districts (SWCDs) – are leading these cleanup efforts, working closely with organizations, landowners and citizens. These actions include upgrading wastewater treatment plants and septic systems; reducing polluted runoff from city streets, agricultural fields and feedlots; and implementing other on-the-ground best management practices (BMPs).

What progress has been made?

Ultimately, the target is to restore all impaired waters in Minnesota. The Minnesota Pollution Control Agency (MPCA) began listing impaired waters in 1992; since 2002, the agency has delisted 81 previously impaired lakes and river segments because they are now meeting water quality standards due to restoration activities.

A recent example is Bone Lake (lake id 82-0054-00) in Washington County, which was determined to be impaired for excess nutrients in 2004. A Total Maximum Daily Load (TMDL) study was developed in 2010 that set a 46% reduction goal for phosphorus needed to reach water quality standards. The Comfort Lake Forest Lake Watershed District took on the task of reducing roughly 820 pounds of phosphorus per year through an approach that included in-lake curly leaf pondweed management, as well many best management practices such as converting row crops to perennials, wetland restoration, carp barriers and carp harvesting, and other agricultural practices. In addition, upstream nutrient reductions from Moody Lake reduced the amount of phosphorus flowing into Bone Lake. Another key component of the project's success included a farmer lead council that assisted in outreach and advisory roles. When the lake was revisited in 2021 for the second cycle of assessments, total phospohorus was meeting standards and subsequently recommended for delisting with the 2024 impaired waters list.

Many other waters are improving

In most cases, the 81 success stories are the result of several years of diligent efforts at the local level both prior to and with Clean Water Funds.

Though not ready for delisting yet, many more lakes and streams are making restoration progress. Statewide, many have realized considerable improvements in recent years from work ranging from restoring wetlands and stabilizing streambanks to addressing septic system and feedlot issues. These actions result in improvements such as greater clarity and reduced algae. Although full restoration of Minnesota's waters will take time, Clean Water Fund investments are helping to accelerate the pace of these activities.

Learn more

- Clean Water Fund www.legacy.leg.mn/funds/ clean-water- fund
- Find your watershed and restoration projects at: Watersheds www.pca.state.mn.us/water/watersheds
- Minnesota's Impaired Waters List www.pca.state.mn.us/water/minnesotas-impaired-waters-list

Figure 24. Bone Lake in Washington County. Photo courtesy of the Comfort Lake-Forest Lake Watershed District.

STATUS	TREND	DESCRIPTION
■	➡	Although funding has increased and there is a continued increase in practices and projects being implemented, the total request for projects has remained significantly greater than available funds.

Mercury trends

OUTCOME

Measure: Trends of mercury in fish and mercury emissions in Minnesota.

Why is this measure important?

Many Minnesota lakes and rivers contain contaminants, primarily mercury, which accumulate in fish and may pose a risk to humans as well as fish-eating wildlife. Because air pollution is the primary source of mercury, reducing mercury in fish requires large reductions in mercury emissions from sources in Minnesota and throughout the world. To evaluate if Minnesota waters are getting cleaner, we can track mercury emission levels over time through periodic emissions inventories and then measure how fish mercury levels respond. Because of the large variation in mercury concentrations from year to year within and among lakes, long-term trends of mercury in fish are necessary to see if pollution control efforts are sufficient.

What are we doing?

The Minnesota Department of Natural Resources (DNR) is leading efforts to track mercury levels in fish. The DNR collects fish from approximately 150 lake and river sites annually throughout Minnesota and prepares samples for testing. Each year, thousands of walleyes, northern pike, panfish, and other species are tested; Clean Water funding has expanded the number of sites tested each year. The Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Health (MDH) select sites, with input from DNR, where samples should be collected; the Department of Agriculture's (MDA) laboratory analyzes the samples.

Decades of monitoring has shown that (1) most fish contain some mercury, (2) the average mercury level generally increases from south to north in Minnesota, and (3) panfish have lower mercury levels than top predator fish. This is the basis for MDH statewide guidelines for eating fish.

MPCA scientists have also evaluated whether the average concentration of mercury in walleyes and northern pike in Minnesota lakes is changing with time. The trend analysis initially focused on 1982 to the present and has been reported on in previous versions of the Clean Water Fund Performance Report. However, a re-examination of the data showed that fish sampling efforts prior to 1990 were concentrated on lakes in northern Minnesota, a region where mercury concentrations are generally higher than the state average (see #2 above), and that a long-term trend analysis could be biased if the pre-1990 samples were included. As a result, MPCA scientists are now only using walleye and northern pike collected since 1990 to determine how mercury concentrations in lakes are changing over time.

What progress has been made?

Figure 25 shows the current fish-mercury trend. Data from lakes starting with 1990 as the baseline year show an upward trend in average mercury concentration. The increase, 0.33% per year on average, is small but statistically significant from zero slope. Minnesota's water standard for mercury in edible fish tissue – 200 parts per billion (ppb) – is shown for reference on the figure, because it is the threshold above which lakes and streams are impaired. The standard protects humans for consumption of one meal per week of fish caught in Minnesota.

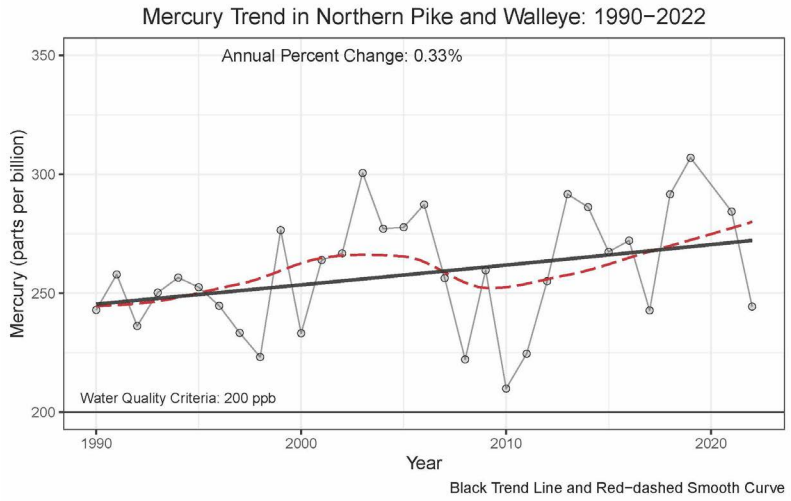


Figure 25. The current mercury in fish tissue trend from 1990 to 2022. The trend analysis focuses on Northern Pike and Walleye fish species. Lakes with at least five Northern Pike or Walleye were selected for mercury in fish tissue analysis. Trends are not evaluated for rivers because of the uncertainty of specific sample collection locations from year to year. The results of the analysis starting with 1990 as the baseline year show an upward trend in average mercury concentration. The increase of 0.33% (0.0033) per year on average, is small but statistically significant from the zero slope. Minnesota's water standard for mercury in edible fish tissue – 200 parts per billion (ppb) – is shown for reference in the figure, because it is the threshold above which lakes and streams are designated as impaired.

The fish-mercury trend is not tracking the trend in mercury emissions. Although there have been substantial decreases in mercury emissions in Minnesota (see below), the United States, and Europe, the estimated global mercury emissions between 2010 and 2015 increased 22 percent. Many monitoring studies have reported increasing mercury levels in fish and wildlife, especially at higher latitudes. It has been most commonly attributed to climatic changes in temperature and precipitation leading to increasing availability of mercury to food webs.

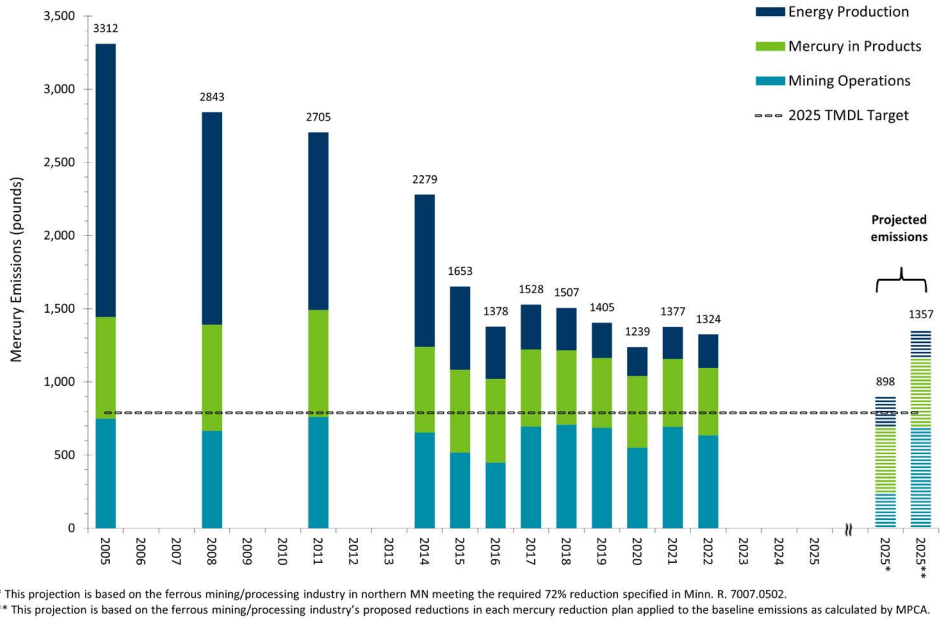


Figure 26. Mercury emissions from Minnesota sources; 2025 emission projections are based on measured and calculated inventories in previous years and the emission estimates contained in the mercury reduction plans submitted by the ferrous mining/processing facilities in northern Minnesota.

To achieve the necessary reductions of mercury in the fish, Minnesota's Statewide Mercury TMDL established a goal of a 93 percent reduction in mercury input from all human sources, both those inside and those outside Minnesota borders. Minnesota is implementing the TMDL to achieve the goal within the state by 2025. However, mercury pollution from outside the State still impacts fish and waterbodies in the State and reductions outside of Minnesota remain important. While the baseline year for Minnesota's Statewide Mercury TMDL is 1990, the year 2005 is used as the baseline year in the Implementation Plan for the TMDL. In order to apply Minnesota's reduction goals to national and regional emissions, the MPCA used 2005 as a baseline in its calculation due to the poorer quality and availability of emissions data for 1990. Within the TMDL implementation plan the final goal of 789 pounds is a 76% reduction from the 2005 baseline. There is also an interim 2018 goal of 1,464 pounds, a 56% (average) reduction from the 2005 baseline. These percentages (56% and 76% respectively) were applied to the 2005 regional and national emissions estimates to develop comparable regional and national "goals". Minnesota met our 2018 reduction goals, but more work is needed to meet the 2025 goal. Regional/national mercury emission reductions have also surpassed the interim 2018 goal and nearly meet the 2025 goal already. Regionally, meaning the States of Minnesota, Michigan, Wisconsin, North Dakota, South Dakota, and Iowa, there has been a 75% reduction from the 2005 baseline (22,170 pounds in 2005 compared to 5,619 pounds in 2020). Nationally, there has been a 71% reduction from the 2005 baseline (225,491 pounds in 2005 compared to 64,451 pounds in 2020).

The Minamata Convention, entered into force in July 2017, provides the foundation for mercury emissions reductions globally. Rapid economic growth in Asia and India since 1990 has contributed to increased global emissions of mercury, despite mercury emissions in North America and Europe being cut in half since 1990. The United Nations Environment Program is negotiating reductions among all countries of the world through the Minamata Convention. Minnesota is doing its part and has taken significant steps towards achieving the identified mercury air emission reductions. Since 1990, removing mercury from latex paint, requiring mercury controls on municipal waste combustors, banning small onsite incinerators, mercury in batteries, and disposal of mercury-containing products has reduced mercury emissions in Minnesota by more than 85 percent.

To reach the 93 percent reduction goal, air emissions of mercury from all sources in Minnesota must be reduced to 789 pounds per year (Figure 26).

Learn more

- Mercury research and reduction initiative: www.pca.state.mn.us/water/plan-reduce-mercury-releases-2025
- Fish Consumption Advice: www.health.state.mn.us/fish (MDH) www.dnr.state.mn.us/lakefind/index.html (DNR)
- United Nations Global Mercury Assessment: www.unenvironment.org/explore-topics/chemicals-waste/what-we-do/mercury/global-mercury-assessment

STATUS	TREND	DESCRIPTION
Mercury in Fish 		Mercury in game fish is not yet responding to decreases in local mercury emissions, although these reductions likely have prevented a steeper upward trend. Global emissions have increased. The time lag between emission reductions and response is likely several decades. It is too soon to see a measurable response in fish mercury levels. Long-term and consistent monitoring is necessary to track changes in fish tissue.
Mercury Emissions 		Significant progress has been made reducing mercury emissions from power plants. Emissions from mercury use in various products saw a decrease in emissions for the 2022 emission inventory, continuing a general downward trend since 2014 Conversely, emission from the mining sector have remained relatively steady since 2017 with a notable decline in 2020 of about 150 pounds as a result of an overall production decrease across the industry due to the COVID-19 pandemic. To meet Minnesota's 2025 emissions goal, significant reduction of mercury emission from the mining sector and further reduction of mercury use in various products will be necessary.

Municipal wastewater phosphorus trend

OUTCOME

Measure: Municipal wastewater phosphorus discharge trend.

Why is this measure important?

Phosphorus continues to be a significant challenge for meeting Minnesota's water quality goals. This measure shows trends in the amount of phosphorus being discharged from municipal wastewater treatment facilities. These regulated entities provide treatment for contaminated water from homes, businesses and industries. Wastewater treatment facilities are required to remove phosphorus and many other pollutants to levels that protect water quality.

What are we doing?

Regulatory policies implemented over the past 20 years (Figure 27) have resulted in the reduction of phosphorus discharged by wastewater treatment facilities. The treatment plant improvements needed to achieve these reductions are expensive, particularly for smaller cities. Clean Water Funds have helped cities make the required infrastructure investments to meet phosphorus wasteload reductions mandated through the implementation of Total Maximum Daily Loads (TMDLs) and Water Quality Based Effluent Limits.

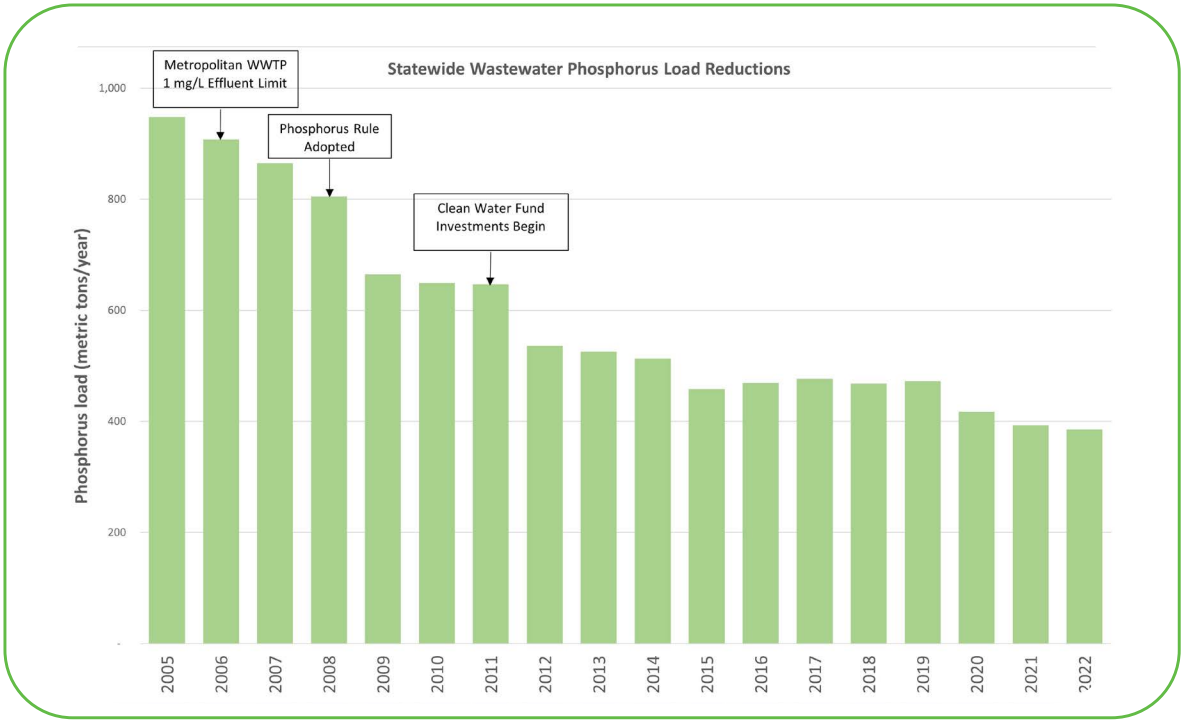


Figure 27. Reported statewide effluent phosphorus loads from wastewater sources since the year 2005. The reductions in phosphorus discharged to Minnesota waters reflect the cumulative effect of permitting policies, implementation of TMDLs, Clean Water Fund investments, and local efforts and investments for the protection and restoration of Minnesota's water resources.

Since 2010, almost $58 million in Clean Water Fund grants have helped finance 52 municipal wastewater treatment upgrades to meet required phosphorus reductions. These grants leveraged an additional $139 million in other funding for these infrastructure improvements. The availability of these Clean Water Fund grants help cities implement these treatment improvements on an expedited time schedule.

What progress has been made?

Over the past 10 years, municipal wastewater phosphorus discharges statewide have been reduced by 58 percent compared to the projected effluent loads that would have resulted from previous permitting policies. Overall, these combined efforts have led to a steady decline of phosphorus pollution and major improvements in water quality. Continued implementation of river nutrient standards is expected to result in further reductions in wastewater phosphorus loads in coming years.

Fifty-two of CWF awards have funded upgrades, consolidation projects or unsewered area connections affecting 50 wastewater treatment facilities. Figure 28 shows cumulative effluent phosphorus loads discharged by those 50 WWTFs. The blue columns represent phosphorus discharged by that select group of facilities in the years before the first CWF projects came online. The green columns represent phosphorus discharged by that select group of facilities in the years after the first CWF project came online. The dotted lines represent the median cumulative effluent phosphorus load discharged by these facilities during those two respective time periods. The gap between the two dotted lines represents a cumulative effluent phosphorus reduction of 316,474 lbs per year.

In total, eighty-nine Clean Water Fund phosphorus reduction awards since 2010 have facilitated wastewater treatment facility upgrades, unsewered area improvements and municipal wastewater consolidation projects.

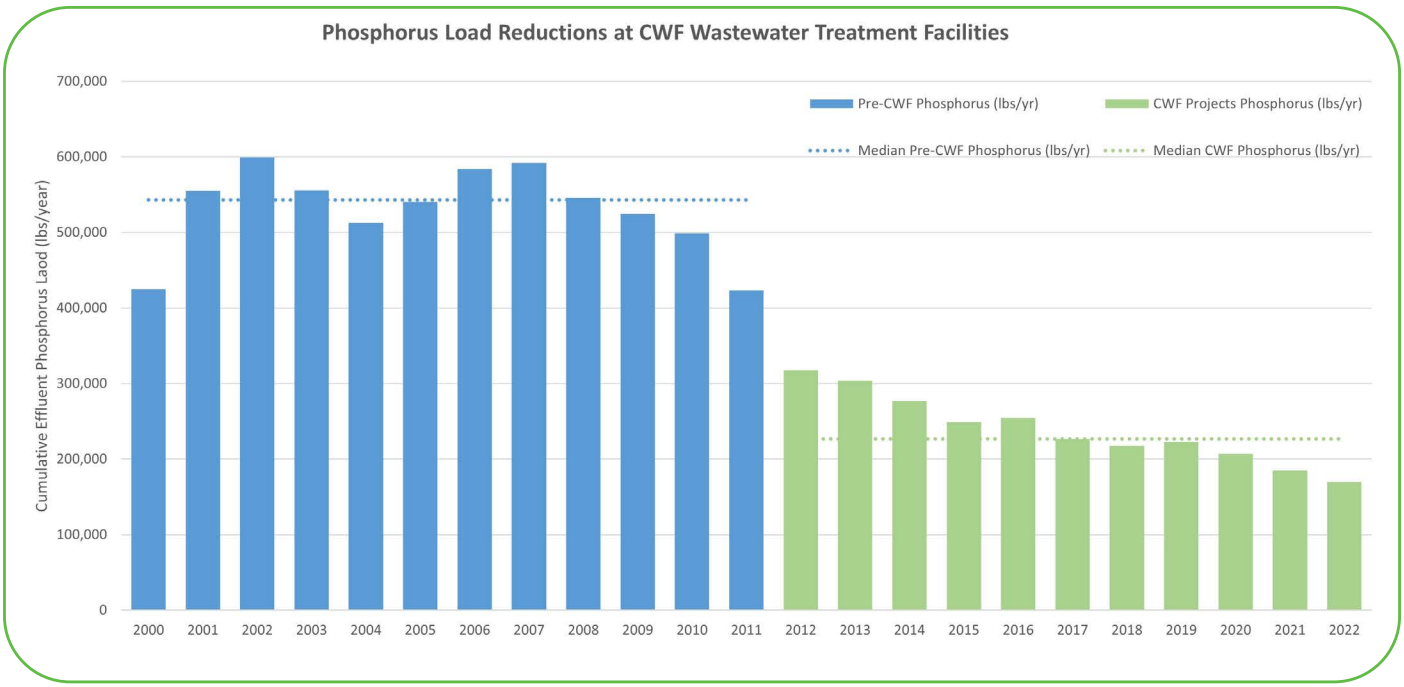


Figure 28. Phosphorus load reductions at Clean Water Funded wastewater treatment facilities.

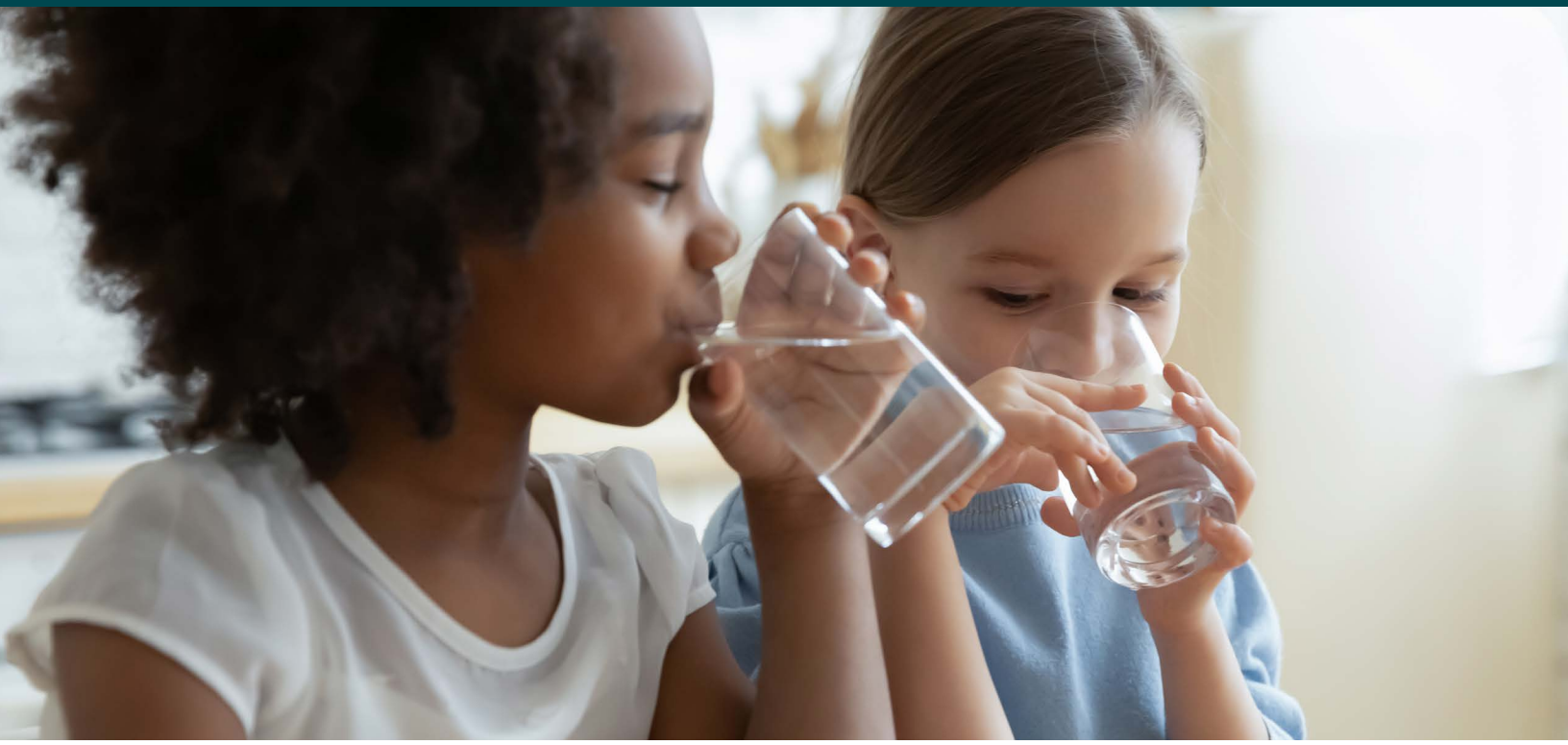
Learn more

For information on activities funded by the Clean Water Fund visit:

- www.legacy.leg.mn/funds/clean-water-fund
- Minnesota Public Facilities Authority (PFA): www.mn.gov/deed/pfa
- Minnesota Pollution Control Agency (MPCA): www.pca.state.mn.us

STATUS	TREND	DESCRIPTION
		Significant phosphorus load reductions have been achieved through regulatory policy, infrastructure investments, improved technology, and optimization of operations.

DRINKING WATER AND GROUNDWATER MEASURES



DRINKING WATER AND GROUNDWATER MEASURES

Source water protection plans and implementation

ACTION

Measure: Number of community water supplies assisted with developing source water protection plans

Why is this measure important?

People in Minnesota obtain drinking water from groundwater, lakes, and rivers. The Minnesota Department of Health (MDH) works with public water systems and communities to protect the sources of their drinking water. Some examples of threats to drinking water sources include unused wells, urban pollutants, agricultural nutrients, storage tanks, lawn nutrients and chemicals, hazardous waste, and uncontrolled land development. Source water protection is important because it:

- Protects human health
- Keeps costs down—pollution prevention is often less expensive than remediation and treatment
- Ensures sustainable water supplies for future generationsat are we doing?

MDH requires source water protection planning for all community and noncommunity water systems that use groundwater, although the level of engagement varies based on their population. Additionally, some systems that use surface water have voluntarily developed Source Water Protection Plans. MDH is expanding the surface water program to provide more support to those systems.

Source Water Protection Plans identify the land area that supplies water, assess the vulnerability of that area to contamination, and identify actions to reduce the risk of threats. Protection areas, also known as drinking water supply management areas, cover approximately 1.2 million acres or 2 percent of the state's total land area. Within the protection areas, approximately 473,000 acres are vulnerable (at higher risk for contamination).

What progress has been made?

The program has delineated Drinking Water Supply Management Areas for all 500 community water systems in the state with vulnerable wells and is in the process of delineating areas for remaining non-vulnerable systems. An approved Drinking Water Supply Management Area is the first step on the ladder of progressive steps a system can take to protect the land area that supplies water to its source.

The Source Water Protection Program has several targets through 2034:

- Conduct ongoing source water protection planning and implementation for the state's 500 vulnerable community water systems;
- Complete first-generation Source Water Protection Plans for the remaining 420 community water systems by 2025;
- Complete revised Source Water Assessments for all 23 surface water systems by 2025;
- Complete source water intake protection planning by 2027; and
- Complete pilot source water protection planning for 10 non-community water systems with at-risk populations by 2027.

Progress towards these strategic goals can be seen in figure 29. The Source Water Protection Program has long been engaged in planning for vulnerable and nonvulnerable community water systems using groundwater. Surface water planning is a newer effort and the program is gaining momentum.

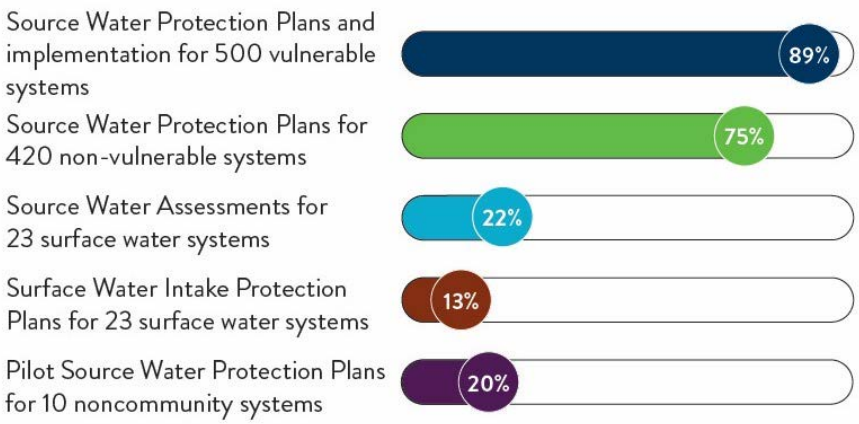


Figure 29. Progress on source water protecetion planning goals.

Learn more

Source Water Protection: www.health.state.mn.us/communities/environment/water/swp/index.htm

Status	Trend	Description
●	↗	On track to meet planning goals for groundwater and surface water systems

DRINKING WATER AND GROUNDWATER MEASURES

Source water protection grants

ACTION

Measure: Number of grants awarded for source water protection

Why is this measure important?

People in Minnesota get their drinking water from groundwater, lakes, and rivers. The Minnesota Department of Health (MDH) works with public water systems and communities to identify strategies to protect the source(s) of their drinking water. Grant dollars – often matched with other funds – can enable public water systems to take action. Prior to the Clean Water Fund, there was no financial assistance for public water systems to implement actions identified in their Source Water Protection Plans.

What progress has been made?

MDH continues to work towards its goal of meeting community demand for Source Water Protection Grants. The demand for these grants has grown over the past several years and often exceeds available funding. MDH has leveraged other resources to meet increasing community demand for grants. MDH anticipates the demand will continue to increase with the number of Source Water Protection Plans approved. Since the grants program started in 2010, MDH has awarded $9.1 million.

MDH recognized the community of Pipestone for its efforts to protect its source of drinking water with a Source Water Protection Award.

Table 2. Number of Grants Awarded by Year

Year	Number of Grants Awarded	Funds Awarded
2010	11	$92,000
2011	117	$714,000
2012	70	$421,000
2013	63	$356,000
2014	94	$585,000
2015	74	$563,000
2016	76	$473,000
2017	97	$569,000
2018	103	$701,000
2019	99	$825,000
2020	108	$754,000
2021	112	$902,000
2022	118	$973,000
2023	144	$1,188,000
TOTAL	**1,286**	**$9.1 million**

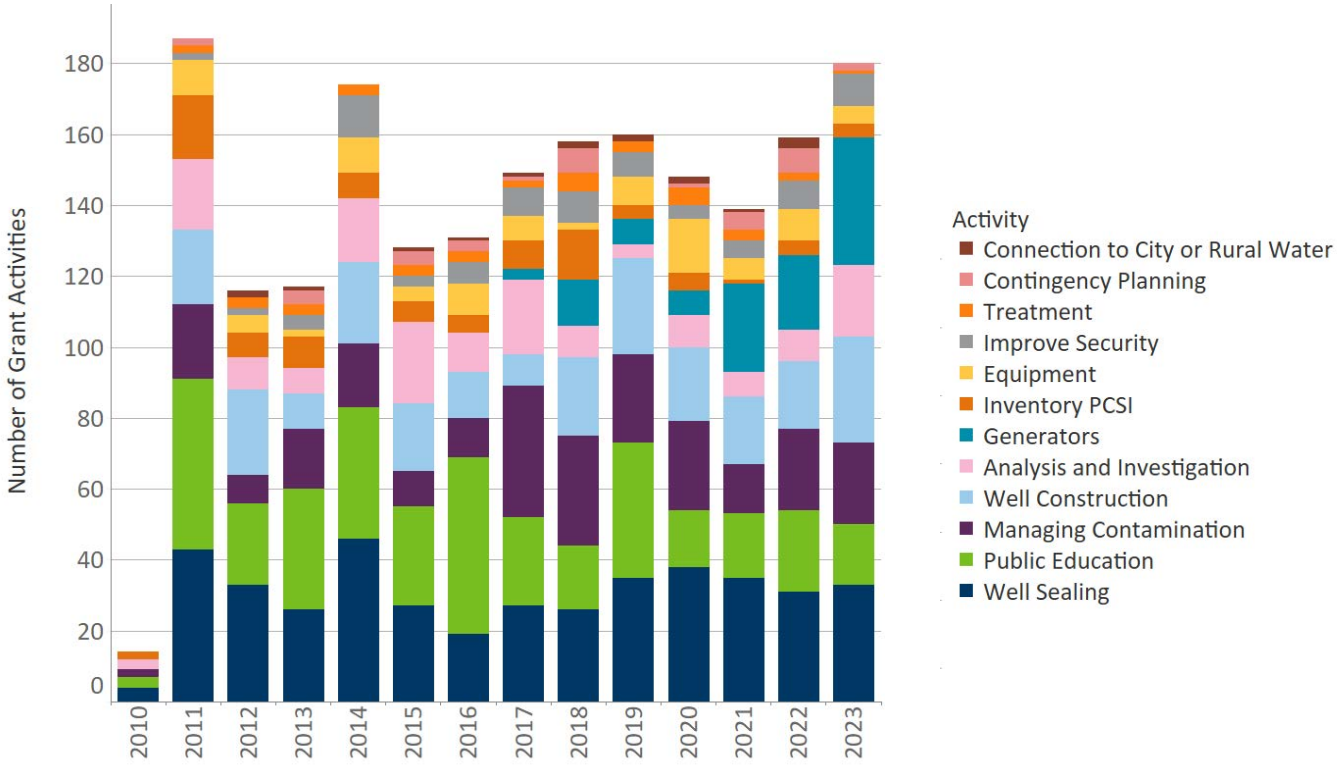


Figure 30. Number of Activities Funded by Source Water Protection Grants (2010–2023).

Source Water Protection Grants may have more than one activity so the total number of grant activities may exceed the number of grants for a given year.

What are we doing?

MDH administers three types of grants to public water systems: Competitive, Implementation, and Transient Grants. Public water systems are eligible for different grants based on their customer base and whether they have a Source Water Protection Plan.

Learn more

- About source water protection grants at www.health.state.mn.us/communities/environment/water/cwf/dwpcwf.html
- Grant information for applicants at www.health.state.mn.us/communities/environment/water/swp/grants.html

Status	Trend	Description
●	↗	Leveraging resources helps to meet increasing demand for grants and to accelerate implementation of source water protection activities.

DRINKING WATER AND GROUNDWATER MEASURES

Nitrate monitoring and reduction by local partners

ACTION

Measure: Number of local government partners participating in Clean Water Fund supported groundwater nitrate-nitrogen monitoring and reduction activitie

Why is this measure important?

Nitrate is one of the most common pollutants in Minnesota's groundwater. In some sensitive areas of the state, a high number of private wells have elevated nitrate levels.

Nitrate comes from many sources, including fertilizers, manure, septic systems, landfills, and natural decomposition of organic matter. Nitrate-nitrogen occurs naturally in groundwater at levels typically in the range of 0 to 3 milligrams per liter (mg/L). Human activities can raise the level of nitrate in groundwater. The drinking water standard for nitrate-nitrogen is a concentration of 10 mg/L. Nitrate-nitrogen above this level can have negative effects on human health, especially infants under the age of six months.

Groundwater is most vulnerable to nitrate contamination in the Central and Southeast regions of Minnesota. Areas in central Minnesota are vulnerable because of widespread sandy soil. Southeastern Minnesota is vulnerable because of shallow bedrock, sinkholes, and underground caves (referred to as karst geology). Also, certain types of wells — shallow wells, hand-dug wells, tile wells, and improperly grouted wells —are vulnerable to nitrate contamination.

Minnesota's Clean Water Fund is being used for activities that help identify the severity and magnitude of nitrate contamination. Funds are also used to evaluate and implement practices at the local level to reduce nitrate in groundwater. State agencies work closely with many partners on nitrate monitoring and reduction activities. Building and maintaining these partnerships is essential to effectively address groundwater concerns.

What are we doing?

The Minnesota Department of Agriculture (MDA) focuses its work in areas where there is elevated nitrate-nitrogen in groundwater. The MDA has worked with more than 50 local partners on nitrate monitoring and reduction projects, a total of 36 in the last two years. In general, the MDA provides technical support, and the local partners provide coordination and contribute knowledge, skills, and expertise about local conditions and issues.

The goal of our partnerships is to increase knowledge and awareness about nitrate issues and foster a greater willingness by farmers to adopt and maintain best management practices to reduce nitrate leaching loss from cropland. These partnerships continue to grow and offer new opportunities to further the work addressing nitrate in groundwater.

This profile focuses on four current activities —the progress of implementing the Groundwater Protection Rule, private well testing, research and demonstration at the Rosholt Farm, and a local partnership.

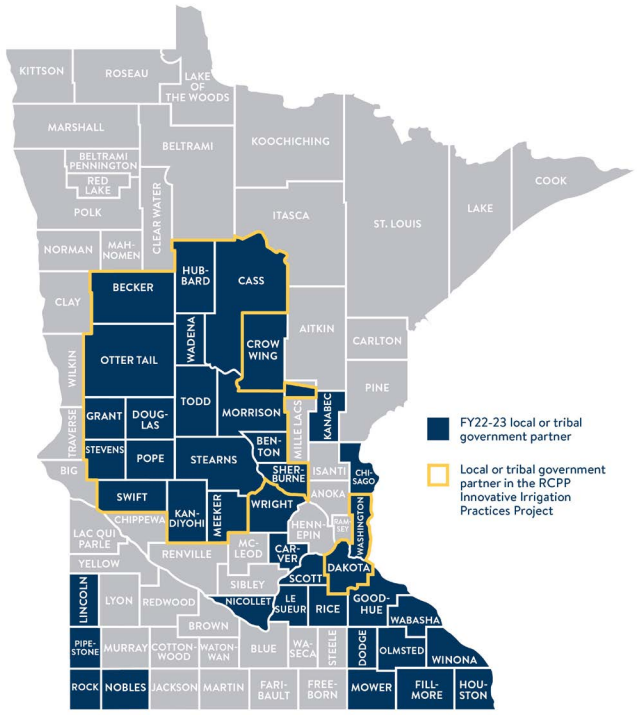


Figure 31. Local and tribal partners the MDA worked with to address nitrate in groundwater in 2022-2023.

Groundwater Protection Rule

The Groundwater Protection Rule (GPR), effective in 2019, minimizes potential sources of nitrate pollution to the state's groundwater and protects our drinking water. The rule restricts the application of nitrogen fertilizer in the fall and on frozen soils in areas vulnerable to contamination, and it outlines steps to reduce the severity of the problem in areas where nitrate in public water supply wells is already elevated.

In areas where Drinking Water Supply Management Areas (DWSMA) have elevated nitrate the MDA is working with local partners to form local advisory teams with farmers, agronomists, and other community members. The teams are involved in reviewing and advising the MDA on appropriate farm management practices to reduce nitrate leaching losses in the DWSMA.

Long-term Private Well Monitoring Networks

The MDA is working with two volunteer long-term private well monitoring networks to determine the trend of nitrate levels in regional drinking water over time. The networks were established in the Southeast and West Central ("Central Sands"), regions of the state where groundwater is most vulnerable.

This work is done in partnership with local governments and individual private well owners. A total of 23 counties are included in the networks (9 in Southeast, 14 in Central Sands). Selection of individual wells was random, and each participant is encouraged to submit a water sample each year. Participants receive a sample kit from a certified lab with instructions on how to collect and submit the sample. Sampling began in 2006 in the Southeast network, and 2011 in the Central Sands network.

Rosholt Farm

The MDA partners with the Pope Soil and Water Conservation District (SWCD) and University of Minnesota (U of M) to support on-farm research, educational outreach, and increase adoption of nitrogen fertilizer best management practices (BMPs) in the Central Sands region of Minnesota.

The Rosholt Farm is dedicated to agricultural research and education that addresses regional issues and agricultural practices that are typical in the area. The farm's coarse-textured soils and need for supplemental irrigation typifies the crop production system in this area. The Pope SWCD owns the farm and coordinates day-to-day activities, weekly sampling and analysis of water samples, crop and soil moisture monitoring, and management of the irrigation system.

There are currently two studies at the Rosholt Farm supported by Clean Water Funds:

Nitrogen, Cover Crop, and Water Quality Research
led by Dr. Fabian Fernandez, U of M

Variable Irrigation and Nitrogen Research
led by Dr. Vasu Sharma, U of M

Local partnership with Dakota County SWCD

The MDA began working with Dakota County SWCD on the Nitrogen Fertilizer Management Plan in 2017. Initial work focused on coordination of the local advisory team (LAT) for the Groundwater Protection Rule, but tasks have evolved over the years to include irrigation water management and best management practices for reducing nitrate in groundwater. The MDA has provided funding for Dakota County SWCD staff to assist with the implementation of the Groundwater Protection Rule, including promoting the use of best management practices and alternative management practices to reduce nitrate leaching.

What progress has been made?

Groundwater Protection Rule

There are currently 17 active local advisory teams in DWMAs where nitrate-nitrogen exceeds 8.0 mg/L in the community water supply wells. In consultation with the local advisory teams, the MDA has approved a list of nitrogen fertilizer best management practices (BMPs) and alternative management tools (AMTs) to protect groundwater in three of the DWSMAs. These practices will need to be adopted on at least 80% of cropland within the DWSMA. The MDA works closely with local partners to raise awareness about required practices and encourage adoption of BMPs. The MDA will conduct a follow-up survey in no less than three growing seasons and if practices are not adopted the DWSMA could move to a regulatory phase under the Groundwater Protection Rule.

Long-term Private Well Monitoring Networks

Although there can be variability in the sampled population and nitrate-nitrogen concentration in individual wells from year to year, on a regional scale most wells have water that is below the health risk limit of 10 mg/L. In 2022, 282 private wells were tested in the Central Sands network, 90.4% of the results were less than 3 mg/L, 7.4% were between 3 and less than 10 mg/L, and 2.1% were greater than 10 mg/L. In the Southeast network, 376 private wells

were sampled, 69.4% were less than 3 mg/L, 22.3% were between 3 and less than 10 mg/L, and 8.2% were greater than 10 mg/L. Results are shared directly with well owners and summarized in a regional report.

Rosholt Farm-Nitrogen and Water Quality

Rosholt Farm in Pope County is a local "educational hub" for providing technical information to area farmers, crop advisors, and agronomists about nitrogen BMPs, new fertilizer recommendations, irrigation frequency and timing, cover crop management, emerging crop production technologies, and their water quality impacts. To quantify nitrogen balances and losses, the research has been expanded to include the collection of greenhouse gas emissions from the soil for different treatments including cover crops and fertilizer treatments. Data from this research is used in the process to revise and update nitrogen fertilizer best management practices by the U of M Extension.

In 2022 and 2023, the Pope SWCD hosted four annual events (two field days and two workshops) reaching more than 200 participants, including farmers, crop advisers, and other local government partners.

Working Together to Deliver Technical and Financial Assistance

The partnership with Dakota County SWCD has built capacity to incentivize practices to protect groundwater and surface water in the area. The highlights listed below will be ongoing in the next biennium.

Cover crop and harvestable cover incentives programs: Discussions related to nitrate and drinking water led to the development of local policy for an incentive program for practices that reduce nitrate in groundwater. Dakota County SWCD leverages local, state, and federal funding to provide incentive payments to landowners and operators.

Working with the MDA and sharing information with farmers: Funding has allowed staff the time to coordinate and participate on the LAT in the Hastings DWSMA. It has also allowed staff to stay up-to-date on the Groundwater Protection Rule (GPR). SWCD staff serve as a local point of contact for questions related to the GPR, nutrient management, and groundwater issues.

Work on the RCPP grant: SWCD staff in 20 SWCDs, including the Dakota County SWCD, and staff from other partner groups helped the MDA secure $3,510,000 through the USDA Regional Conservation Partnership Program (RCPP) for irrigation practices that reduce water use and nitrate leaching. Partners are using their local relationships to help recruit interested landowners and implement these practices.

Figure 32. Dakota County SWCD and MDA staff installing an ag weather station. Access to current weather is critical for growers to efficiently schedule irrigation and reduce nitrate leaching.

> *"Dakota County SWCD is glad to have these new partnerships as we move forward to address nitrate in groundwater and work towards innovative solutions. We have a new level of understanding in the complexity of groundwater issues. We're excited about new programs for farmers and the conversations we're having about continuous living cover and alternative crops. We're adding to our traditional conservation practices to protect both surface water and groundwater."*
>
> *– Ashley Gallagher*
> *Senior Resource Conservationist*

Learn more

Clean Water Fund
www.legacy.leg.mn/funds/clean-water-fund

Township Testing Program
www.mda.state.mn.us/townshiptesting

Water Quality and Irrigation Research at Rosholt Farm
www.mda.state.mn.us/rosholtfarm

Local Weather Data and Irrigation Scheduler
www.mda.state.mn.us/ag-weather-irrigation-management-resources

Nutrient Management Initiative
www.mda.state.mn.us/nmi

Irrigation Partnerships to Protect Groundwater (RCPP Project)

agcentric.org/rcpp-precision-irrigation

Status	Trend	Description
		New local partnerships continue to be established for nitrate-nitrogen monitoring and reduction activities.

DRINKING WATER AND GROUNDWATER MEASURES

Contaminants of emerging concern

ACTION

Measure: Number of new health-based water guidance values and advance methodology for contaminants of emerging concern

Why is this measure important?

Water is especially susceptible to contamination from human activities. Whether it is household products, personal care products, pharmaceuticals washed down the drain, or chemicals released to the environment through manufacturing, contaminants are found across Minnesota. Monitoring of water sources finds contaminants from products or sources we never suspected in places we never expected, like our lakes, rivers, groundwater, and drinking water.

Contaminants of emerging concern (CECs) are chemicals released into the environment, often from consumer products and personal care products, that may not have been previously assessed for risk to human health. Understanding the risk from these types of chemicals when they are present in Minnesota's waters is critical to preventing health effects in people and for removing contamination from the environment. The CEC Initiative staff in the Health Risk Assessment Unit at the Minnesota Department of Health study CECs in water and develop risk assessments and health-based water guidance values. These values aid state agencies in their work to protect and maintain clean water for all Minnesotans, and to provide context for private well owners and the general public for CEC exposures through water. Very few states have similar programs.

The development of water guidance values represents a meaningful indicator of public health protection. Hundreds of CECs have been found in Minnesota waters. The vast majority of these CECs have no health-based water guidance values to understand any health risks associated with exposures to these compounds. Without this toxicological and risk assessment information, Minnesotans may not be informed of these new risks.

The need for new guidance is enormous and ongoing as there are tens of thousands of chemicals in commerce and the vast majority have little or no toxicology information publicly available. These chemicals find their way into Minnesota waters and are more frequently being detected there, in part because new analytical capabilities can measure them at very low concentrations. Historically, approximately 70% of all health-based guidance values developed by the CEC Initiative lack federal water guidance values.

What are we doing?

Chemical nominations are accepted on an ongoing basis from agency staff and the general public. The nominations are evaluated to determine which chemicals pose the largest threat to Minnesotans based on both toxicological and exposure concerns.

Staff toxicologists and exposure scientists research nominated chemicals with a goal to develop CEC health-based water guidance. Staff calculate levels of a chemical in water that does not pose a risk to human health, even for sensitive populations such as fetuses, infants, pregnant women, and children. We are enhancing the chemical review process to include concerns about health equity and environmental justice to ensure that the guidance is protective of all populations in Minnesota.

What progress has been made?

The CEC initiative focused on per- and polyfluoroalkyl substances (PFAS) family chemicals during the 2022-2023 Fiscal Years (FY22-23). PFAS are a family of human-made chemicals that have been widely used for decades and do not breakdown in the environment. The CEC initiative is a nationally respected leader in the

development of the first health-based guidance values for PFAS in the nation due to their historical use in Minnesota.

In addition to developing guidance for PFAS family chemicals, the CEC initiative provides toxicological and risk assessment support for communities, private well owners, MDH and other state agencies, and the general public affected by water contamination. The CEC initiative also regularly presents their work at scientific meetings across the country and participates in CEC-related state and federal workgroups.

The CEC team pioneered important developments for PFAS risk assessment, contributing to scientific knowledge production through their authorship in the following publications:

- Bogdan AR, Fossen Johnson S, Goeden H. Estimation of Serum PFOA Concentrations from Drinking and Non-Drinking Water Exposures. Environ Health Perspect. 2023 Jun;131(6):67701.
- Post GB, Birnbaum LS, DeWitt JC, Goeden H, Heiger-Bernays WJ, Schlezinger JJ. Letter to the editors regarding "The conundrum of the PFOA human half-life, an international collaboration". Regul Toxicol Pharmacol. 2022 Oct;134:105240.
- Isaacs KK, Wall JT, Paul Friedman K, Franzosa JA, Goeden H, Williams AJ, Dionisio KL, Lambert JC, Linnenbrink M, Singh A, Wambaugh JF, Bogdan AR, Greene C. Screening for drinking water contaminants of concern using an automated exposure-focused workflow. J Expo Sci Environ Epidemiol. 2023 May 17.

From the CEC Initiative's inception through the FY22-23 biennium, 224 contaminants were nominated for review, of which 165 were screened for toxicity and exposure information. Some nominated contaminants were ineligible for CEC review, typically because the nomination did not identify a specific contaminant or because a different program within the unit reviewed it. In the last biennium, MDH screened 38 new or re-nominated contaminants. MDH also reviewed the updated EPA water intake rates for CECs, and updated TDCPP and venlafaxine (these updates did not result in changes to their health-based guidance values)

MDH completed a full review of PFHxA and a re-evaluation of PFBS during FY22-23. In addition to this, the CEC team began re-evaluations of PFOS and PFOA. Re-evaluations for PFOA and PFOS were developed using newly-available human health data from epidemiological studies, making them more similar to full reviews than simpler re-evaluations. Evaluating human epidemiological studies for the PFOA and PFOS re-evaluations this way has been time-intensive, as past guidance values were developed using animal data. Re-evaluating existing health-based guidance ensures Minnesota guidance is up to date with the latest risk assessment methodology and includes the most recent available scientific data.

Table 3. MDH health-based guidance values for contaminants in FY22-23
(micrograms per liter (µg/L) in water)

Contaminant	MDH Guidance
PFHxA *PFAS family*	0.2 (noncancer)
PFBS *PFAS family*	0.1 (noncancer)

The CEC team also regularly provides expert technical assistance to risk managers to aid in proper application of health-based guidance values in their work and to the general public to support safer and better choices for chemical use and disposal. During the FY 22-23 biennium, the CEC team completed more than 40 expert technical assists for external partners including presentations, emails, phone conversations, and technical documents.

A major obstacle in developing full chemical reviews each biennium is lack of publicly available toxicity information. The CEC Initiative is meeting this obstacle head on by partnering with U.S. Environmental Protection Agency (EPA) scientists. We are working to identify and develop new tools and nontraditional sources of data to identify and screen chemicals for both toxicity and exposure risk. This is a multi-year project focusing on emerging contaminants that lack data typically used in standard risk assessments. This partnership has already created an automated workflow to perform exposure screenings much faster than can be done manually, which resulted in a scientific publication.

One accomplishment of the CEC Initiative in the last biennium was to partner with other programs within the Environmental Health (EH) Division at MDH to help better understand and communicate health risk from elevated levels of chemicals in Minnesota drinking water, especially for formula-fed infants.

Learn more

Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund.

MDH Contaminants of Emerging Concern (CEC) program information: www.health.state.mn.us/cec.

Status	Trend	Description
		Completed 1 re-evaluation and 1 full evaluation, updated water guidance for 2 CECs, established a partnership with EPA to create a contaminant screening tool, provide technical assistance to understand and use water guidance values, authored 3 scientific publications

DRINKING WATER AND GROUNDWATER MEASURES

County geologic atlases

ACTION

Measure: Number of counties completing a county geologic atlas for groundwater sustainability

Why is this measure important?

Approximately 75% of Minnesotans get their water for drinking and other needs from groundwater. A stable, long-term and reliable source of high quality groundwater is an economic benefit to communities. County Atlases provide detailed information about an area's geology and groundwater that helps communities find reliable water sources and manage them to maintain availability and quality for generations. Without informed water supply planning, groundwater pumping or land-use changes could impact public water quality and availability and degrade surface waters (wetlands, lakes, rivers and unique resources, such as trout streams and fens).

The County Atlases are routinely used to make informed decisions related to water, natural resources and land-use planning. Typical applications include:

- long-term water supply planning and well construction design
- wellhead protection planning
- groundwater modeling
- identification of valuable natural resources and planning for their use and protection
- planning for landfills, septic systems, industrial sites and feedlots
- emergency response to contaminant releases
- research and community education

When completed, the County Atlases are an economic benefit for a county and communities within the county. This measure tracks the extent to which county atlases are available in Minnesota.

What are we doing?

The Minnesota Geological Survey (MGS) and the Department of Natural Resources (DNR) prepare the County Atlases to convey valuable geologic and groundwater information and interpretations to private organizations, agriculture, industry, academia, citizens and government units at all levels, particularly to local governments. The County Atlases provide "information infrastructure". MGS focuses on the county geology, and DNR focuses on county groundwater resources.

The Clean Water Fund supports enhanced research to improve the quality of county atlases and to accelerate their completion. Local participation is a primary factor in determining which counties are chosen for this work, while groundwater sensitivity, water demand and the size of the population served are also considerations. The counties are asked to provide in-kind services in support of the atlas.

What progress has been made?

In total, MGS County Geologic Atlases are complete or underway for 77 counties and Groundwater Atlases are complete or underway for 46 counties.

The completion of special high-quality drilling and coring to obtain detailed geologic information was most recently supported in Lake of the Woods, Waseca, Faribault, and Ramsey counties (FY23).

The long-term goal is to complete an atlas (both geologic and groundwater) for every county in Minnesota. Approximately four atlases are being completed each year. The Clean Water Fund supports expanded data collection for atlases, such as the use of sophisticated geological coring.

DNR County Groundwater Atlas staff used Clean Water support to conduct specialty groundwater dye tracing in collaboration with the Minnesota Department of Health, Olmsted County, and the University of Minnesota. Work

was completed in support of a Groundwater Protection and Restoration Grant (Grant Agreement 193947) at Bear Spring in Olmsted County, with final project deliverables expected June 2024. Groundwater Atlas staff also completed final reporting in support of a Minnesota Department of Health pathogen study to identify sources of biological contaminants in water-supply wells.

Clean Water Funds also supported analysis for an ultra-low tritium pilot project to determine the value of using ultra-low tritium analysis instead of enriched tritium analysis for future groundwater residence time projects.

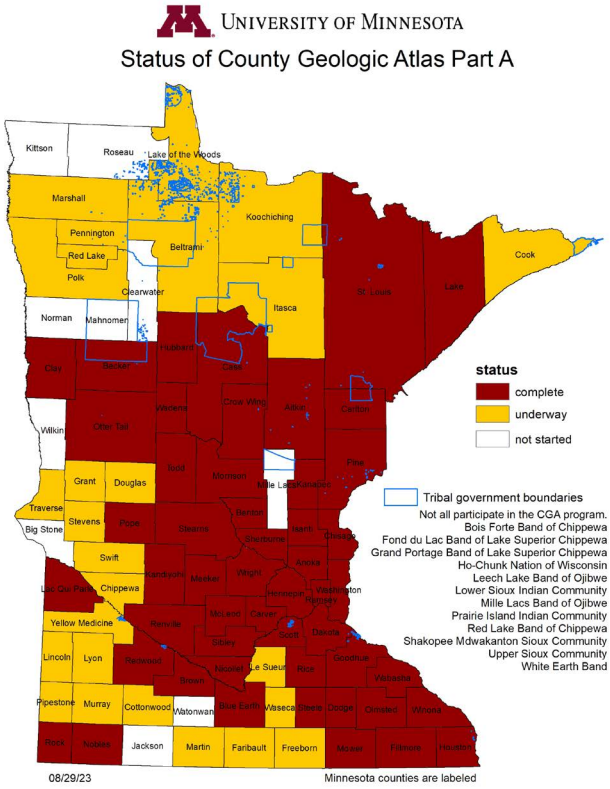


Figure 32. Map of Minnesota counties showing the status of progress on county geologic atlases (used with permission from the Minnesota Geological Survey).

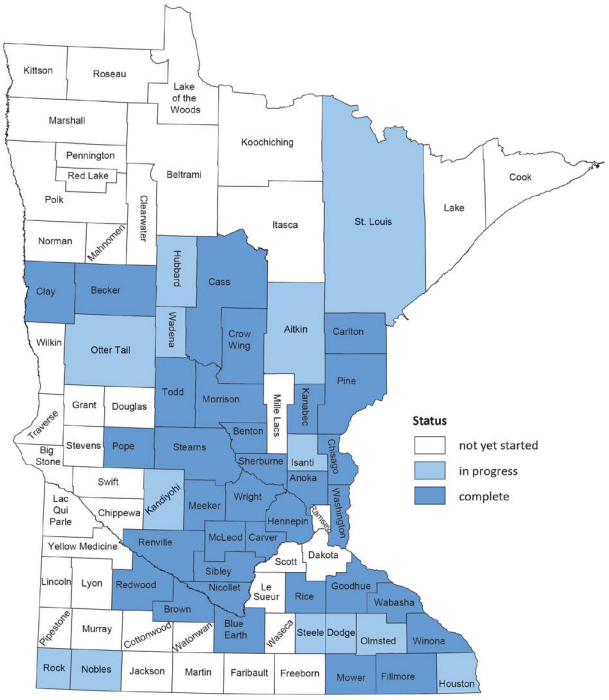


Figure 33. Map of Minnesota counties showing the status of progress on county groundwater atlases.

Status	Trend	Description
●	↗	County atlases (including the geologic & groundwater atlases) are being completed at the planned rate, and counties continue to step up to participate. With continued and consistent funding, completion of geologic atlases for all counties is expected around 2035, and completion of groundwater atlases for all counties around 2040.

DRINKING WATER AND GROUNDWATER MEASURES

Long-term monitoring network wells

ACTION

Measure: Number of long-term groundwater monitoring network wells in Minnesota

Why is this measure important?

About 75 percent of Minnesota's drinking water comes from groundwater, which is pumped from the state's many and varied aquifers. Groundwater also supports agriculture, industry, and natural resources that define Minnesota's quality of life. Minnesota is relying more and more on groundwater to meet its growing needs, but many parts of the state lack basic information about the availability and quality of groundwater.

Since it is underground, people can't see groundwater to observe its condition. Monitoring wells provide a "window" into aquifers, providing a way to see groundwater levels and measure water quality. This information is essential to better inform investments in water supply infrastructure and efforts to protect public health and natural resources.

To provide a safe and reliable drinking water supply at the lowest cost, well drillers and well owners should know the depth of the closest safe-quality groundwater. They should also know how much groundwater levels and quality fluctuate during wet and dry seasons, to ensure that pumps in wells don't go dry and to understand potential health risks. Groundwater monitoring information is also important for protecting wetlands, developing Total Maximum Daily Loads (TMDLs) for streams, and for preventing the migration of contamination plumes.

This measure tracks the number of wells used for long- term monitoring of groundwater conditions. Well installation, water quality sampling, and water level measurement are coordinated among state agencies, and wells are used for multiple purposes whenever feasible. Other monitoring wells exist, but they are used for short-term contamination or remediation events.

What are we doing?

While Minnesota's groundwater monitoring network is still inadequate for understanding groundwater conditions in portions of the state, it is improving. Clean Water Fund investments accelerate efforts to fill gaps in understanding aquifer conditions across the state, and improve local capacity to improve private and public drinking water supply infrastructure development.

The Minnesota Department of Natural Resources manages a statewide network of water level observation wells, in partnership with Soil and Water Conservation Districts and various volunteers. Data from these wells are used to determine long-term trends, interpret impacts of pumping and climate, plan for water conservation, and otherwise manage the water resource. DNR monitors aquifer levels in 1,234 wells with an ultimate goal of 1,500 total wells monitored. The Minnesota Pollution Control Agency manages a statewide network of about 262 groundwater quality monitoring wells to determine whether non-agricultural pollutants are present and to track trends in pollutant concentrations. These wells are primarily installed in urban aquifers that are most susceptible to pollution from human activities. Water samples are collected annually to determine the concentrations of more than 100 regulated and unregulated chemicals, including nitrate, chloride, and volatile organic compounds. The agency is still adding wells to the network, which will have about 275 wells when complete.

The Minnesota Department of Agriculture (MDA) manages a network of about 141 groundwater quality monitoring wells across the state, primarily in agricultural areas, with the purpose of determining the impacts of pesticides and fertilizers on vulnerable groundwater. Additionally, the MDA network also includes 13 domestic wells and 13 springs, not illustrated

on the map. The MDA added an additional 25 monitoring wells between 2020 and 2022 for the purpose of monitoring nitrate in Drinking Water Supply Management Areas with high nitrate concentrations.

What progress has been made?

The current statewide groundwater monitoring network includes approximately 1,583 monitoring wells. The ultimate goal is a network of approximately 2,000 state-owned and managed long-term groundwater monitoring wells.

The DNR continues to increase the number of wells that are installed for determining water levels. While the MDA has added wells to determine the impacts of pesticides and fertilizers on vulnerable groundwater.

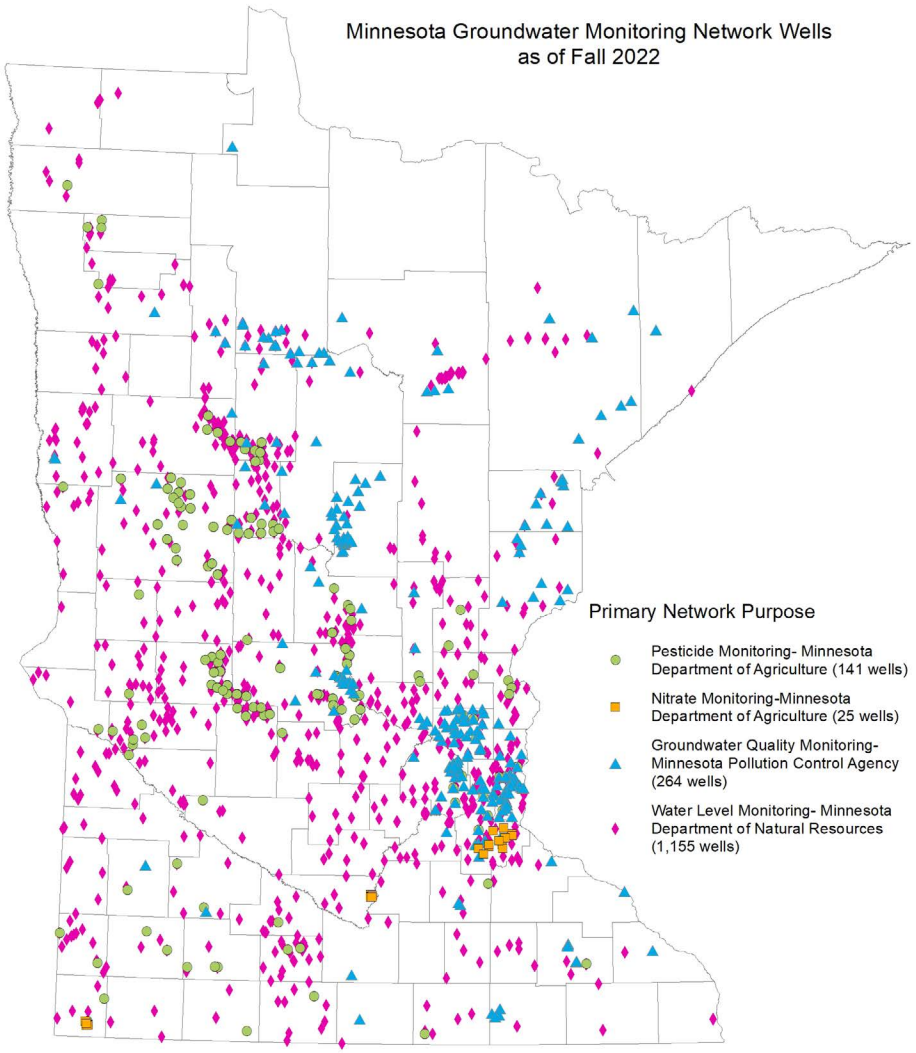


Figure 34. Map showing Minnesota groundwater monitoring network wells as of October 2023.

Status	Trend	Description
■	↗	Many areas of the state still lack important groundwater information. Long-term ramp up in monitoring accelerated by Clean Water Fund investments is filling gaps.

DRINKING WATER AND GROUNDWATER MEASURES

Unused groundwater wells sealed

ACTION

Measure: Number of unused groundwater wells sealed

Why is this measure important?

Unused wells that are not properly sealed can be a source of groundwater contamination, potentially affecting nearby drinking water wells. They may threaten water quality in municipal wells, private business wells, and residential wells. Groundwater is the main source of drinking water for three out of four Minnesotans.

A well may be taken out of service for a variety ofreasons:

- It no longer operates properly or provides enough water;
- It became contaminated; or
- It was replaced by extension of public water supplies.

A well may be "lost" or abandoned when:

- New buildings or additions are constructed;
- Property changes hands; or
- When use of the land changes, such as from agricultural to industrial or residential.

The layers of rock and soil that lie between an aquifer and the land surface or between aquifers typically act as natural barriers against the spread of contamination. However, an unused, unsealed well can provide an open pathway between the surface and an aquifer or between a shallow aquifer and a deeper aquifer. This open pathway allows surface water runoff, contaminated water, and improperly disposed waste to reach an aquifer.

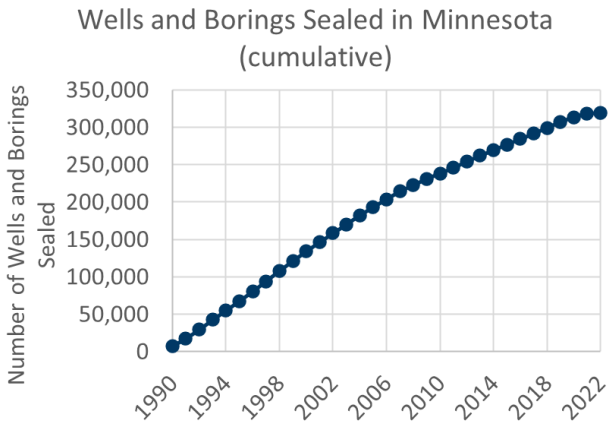


Figure 35. Wells and borings sealed in Minnesota (cumulative)

What are we doing?

Clean Water Funds provided an incentive for sealing unused wells. Funds for sealing private wells were made available as part of the Board of Water and Soil Resources (BWSR) Clean Water Fund Competitive Grant program for FYs 2012, 2014, 2017, 2019, and 2021. These funds were awarded to local governments, who could provide a 1:1 matching grant to well owners to seal their unused wells. Priority was given to sealing: wells in areas near public water supply wells; large diameter, multi-aquifer wells; and wells in areas with known groundwater contamination.

Clean Water Funds were made available through the Minnesota Department of Health to seal unused public water supply wells for FYs 2013, 2015, 2016, and 2018. These wells tend to be larger and deeper than private wells and can be much more expensive to seal. They also pose a significant threat to public water supplies because they are typically near active public water supply wells.

What progress has been made?

A total of 95 unused public water supply wells and 1,370 private wells were sealed with Clean Water Funds since 2010.

Forty-three different public water supply owners were awarded funds across Minnesota. Thirty-four local governments were awarded funds through BWSR's Competitive Grant program.

Although this initiative is completed, well sealing activities are also funded through Source Water Protection Grants.

Ultimately, the goal is to seal all unused wells in Minnesota to protect public health and groundwater resources.

Unused wells continue to be identified on a regular basis through property transfers and other activities. While Minnesota has sealed over 315,000 wells since 1990, continued effort is needed to address the estimated 250,000 to 500,000 unused unsealed wells remaining.

Learn more:

Find information on this measure at Sealing of Wells and Borings (www.health.state.mn.us/communities/environment/water/wells/sealing).

Status	Trend	Description
		The legislative appropriation for this initiative is completed, but other Clean Water Fund programs continue to fund and promote well sealing.

DRINKING WATER AND GROUNDWATER MEASURES

Land use in Drinking Water Supply Management Areas

ACTION

Measure: Land use changes over time in Drinking Water Supply Management Areas

Why is this measure important?

In many parts of Minnesota, public water systems can pump and deliver water to households with minimal treatment. However, activities or features on the land can affect the quality of drinking water sources. Certain land uses, such as forested land or wetlands, are more protective of water quality than others.

Protection of drinking water sources is particularly important within Drinking Water Supply Management Areas (DWSMAs), areas that contribute groundwater used for drinking water. There are approximately 1.2 million acres of land in DWSMAs in Minnesota, and about 40% (487,600 acres) is vulnerable to contamination. The total number of vulnerable acres changes over time as community DWSMAs are delineated and amended.

Land use within DWSMAs is a useful indicator to assess risks to drinking water sources and their level of protection. Yet MDH and public water systems have limited ability to influence land use in DWSMAs, since much of the land within DWSMAs is privately owned and outside of municipal jurisdiction.

MDH has a long-term goal to promote land use that is beneficial to water quality in DWSMAs. This measure reports on the amount of land in protective land use in DWSMAs.

What are we doing?

MDH works with communities, public water systems, and other state and local partners to promote land use that is mutually beneficial. MDH helps communities identify vulnerable areas within their DWSMAs and plan and implement activities that prevent contamination. Strategic partnerships with other stakeholders in DWSMAs, such as private landowners, can also create opportunities to protect drinking water sources.

The Source Water Protection program at MDH has created a framework defining four levels of protection: 1) Delineating a DWSMA; 2) Preparing a SWP Plan; 3) Implementing the Plan; and 4) Securing long-term protection of the DWSMA. Most public water systems progress through these levels sequentially. By encouraging protective land use in DWSMAs, MDH and public water systems can prevent or mitigate contamination of drinking water sources.

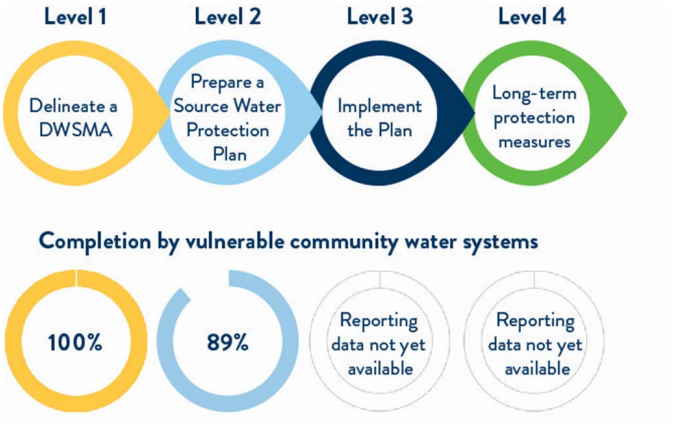


Figure 36. Levels of protection and completion by vulnerable community water systems.

What progress has been made?

MDH provides direct programmatic support to communities through Levels 1 and 2 of the framework but relies on communities and partners to implement Level 3 and 4 activities. MDH is currently able to report on Levels 1 and 2 and is developing metrics and processes to track systems' and partners' progress through Levels 3 and 4.

MDH is assessing available data sources to measure and evaluate long-term protection of the vulnerable areas within DWSMAs. MDH will work with state and local partners to create the tools and plan needed to advance

this initiative. These resources will allow MDH, public water systems, and other stakeholders to identify and prioritize appropriate protection measures for the diverse DWSMAs in the state, and measure progress accordingly.

Existing land use across vulnerable DWSMAs provides a glimpse of the opportunities and challenges associated with achieving long-term protection measures for these areas. Approximately 29% of land in DWSMAs statewide has protective use that benefits water quality (i.e., lands that are forested or used for low impact agriculture like pasture and hay production). Planning and implementing land use changes with decision-makers is a locally led process that takes time. MDH seeks to work with local decision makers as well as state and regional partners to tailor implementation towards protective activities that are appropriate based on the land uses in a DWSMA. For example, in rural areas where DWSMA acres are dominated by agricultural lands, partners at the federal Natural Resource Conservation Service (NRCS) and at MDA seek to incentivize practices that are protective of water quality.

Table 4. Examples of partner interventions and land uses to protect drinking water.

Partner interventions to protect drinking water	Total acres in vulnerable acres (N=487,600)
MDA Water Quality Certification Program	(Analysis pending)
Groundwater protection practices enrolled in NRCS	34,100
Conservation easements	6,200
Existing land uses that are generally protective of drinking water	
Publicly owned forested lands	6,200
Privately owned forested lands	52,400
Publicly owned land in Twin Cities Metropolitan Area	18,700

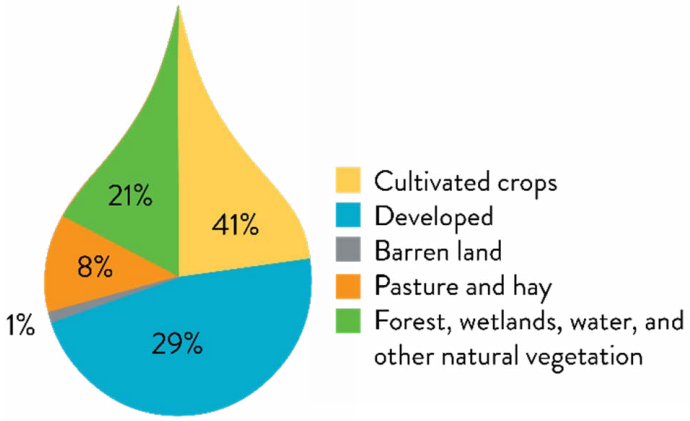


Figure 37. Land use in vulnerable DWSMAs.

What are the challenges and limitations?

A challenge in tracking changes in land use over time is the availability of data. Statewide data on land use is available through the National Land Cover Database (NLCD). These data show generalized land uses such as forestry, wetlands, agriculture, and urban development. These land use categories are an insufficient indicator for drinking water protection since they do not account for the array of best management practices (BMPs), activities, and programs that safeguard drinking water sources. For example, conservation practices can mitigate contamination in agricultural areas but may not change land use classification in the NLCD. This is also true for stormwater BMPs that can reduce contamination from runoff in urban areas. Additionally, updated NLCD data is typically released every five years.

This measure is expected to change over time as partnerships are made and different sources of data become available. While MDH is working with partners to develop reporting metrics, a recommendation is to support policy initiatives among Minnesota Executive Branch agencies and their partners to share data on land use protections in DWSMAs. Making these data available would help local implementers plan activities to protect Minnesota drinking water now and in the future.

Learn more

Protecting vulnerable drinking water sources (www.health.state.mn.us/communities/environment/water/cwf/protecting.html)

Status	Trend	Description
●	→	There is increasing research, engagement, and activity to target and protect vulnerable areas in DWSMAs.

DRINKING WATER AND GROUNDWATER MEASURES

Groundwater quality

OUTCOME

Measure: Changes over time in pesticides, nitrate-nitrogen, and other key water quality parameters in groundwater

Why is this measure important?

Chemicals are commonly used to control pests, support food production, manage lawns, protect human health, and keep our roadways free of ice and snow. People also use many chemicals for cleaning clothes, maintaining cars and homes, and improving lives.

Unfortunately, the benefits of pesticides, fertilizers, and other chemicals are balanced against potential impacts to the state's sensitive groundwater resources. It is only with highly detailed and sophisticated monitoring that the impacts of chemical use to groundwater resources can be understood and managed.

What are we doing?

The Minnesota Department of Agriculture (MDA) samples groundwater wells in urban and agricultural settings. The MDA water samples are analyzed for many pesticides (185 in 2022) as well as nitrate. Results are used as feedback in the fertilizer and pesticide management process and are reported to farmers and the general public. The MDA and advisory committees use monitoring results to inform management decisions.

The Minnesota Pollution Control Agency (MPCA) samples a network of wells, primarily in urban settings, that measure ambient (or background) conditions for a large number of non-agricultural chemicals, including nitrate, chloride, volatile organic compounds, and emerging contaminants. The network is focused on two aquifers that are especially vulnerable to man-made contamination — the sand and gravel and Prairie du Chien-Jordan aquifers.

The Minnesota Department of Health (MDH) has many roles in protecting groundwater from contamination. The MDH's primary roles include ensuring wells are properly constructed and sealed, monitoring drinking water to ensure the state's public water systems meet federal and state guidelines, monitoring for emerging contaminants, evaluating contaminated sites to ascertain what chemicals are present, and determine whether exposure to those chemicals may pose risks to human health.

What progress has been made?

The MDA began its monitoring program in 1985 and currently samples more than 167 monitoring wells, naturally occurring springs, and private drinking water wells throughout the state. Pesticide concentrations in groundwater rarely exceed drinking water standards in monitoring wells or private drinking water wells. Five pesticides have been detected frequently enough to be placed in the "common detection" category: acetochlor, alachlor, atrazine, metolachlor, and metribuzin. These pesticides are being tracked and best management practices are promoted to minimize environmental impacts.

The MDA's groundwater monitoring program was not designed to determine nitrate concentration status and trends in drinking water. Nitrate concentrations in the very shallow, highly sensitive groundwater monitoring wells sampled adjacent to agricultural fields in this program frequently exceed health risk levels. However, this is not the situation with every well or all the regions monitored. The MDA's groundwater monitoring program was designed as an early detection system. To more accurately determine nitrate trends across the state, the MDA relies on regional and township monitoring programs.

In 2008, the Southeast Minnesota Water Resources Board and the MPCA, MDA and MDH established the Southeast Minnesota Volunteer Nitrate Monitoring Network. This region was selected because of its sensitive and complex geology. This network of 675

private drinking water wells, representing nine counties and several aquifers, was designed to provide nitrate concentration data. Through 2022, 6,913 samples have been analyzed for nitrate, and an average of 9.3% of the wells exceeded the drinking water standard of 10 milligrams per liter (mg/L). The percentage of wells exceeding the drinking water standard for each sampling round ranged between 7.5% and 14.6%. This work continues as an ongoing effort.

In 2011, homeowners in 14 counties in central Minnesota (an area of the state with sandy soil that is vulnerable to nitrate contamination) participated in a monitoring project, and a subset of these wells has been sampled annually since that time. Through 2022, 4,652 samples have been collected as part of the annual monitoring, and an average of 2.9% of wells have water with a nitrate concentration equal to or greater than the drinking water standard of 10 mg/L. There is a slight downward trend in the 90th percentile of this network.

In 2013, the MDA began sampling private wells on a township scale as part of the Township Testing Program. Through 2020, the MDA has sampled private wells in 344 townships in 50 counties in cooperation with local partners. The goal of the project is to sample wells throughout the state in areas where groundwater is most vulnerable to contamination. Through 2020 about 32,217 wells have been sampled, and 9.1% of the wells have nitrate exceeding the drinking water standard, although this percentage can be much higher in some townships.

The Private Well Pesticide Sampling (PWPS) Project is a follow-up program to the Township Testing Program. The primary goal of the PWPS Project is to provide information to homeowners and the general public about the presence of pesticides in private drinking water wells. Homeowners who had nitrate detections in their wells as part of the Township Testing Program may have had their wells sampled for nitrate and pesticides as part of the PWPS Project Phase 1 (2014 – 2020), when about 6,350 wells in 50 counties were sampled. Concentrations were generally low and were typically below drinking water standards. However, 3% of the 1,841 wells that were sampled during Phase 1 were found to have a pesticide concentration above the human health reference value for total cyanazine. Cyanazine is a corn herbicide that has not been registered for use in Minnesota since 2002, cyanazine degradates were not able to be added to the analytical list until 2019. In the summer of 2021, the MDA began revisiting counties sampled prior to 2019, through targeted sampling based upon previous results, to evaluate private drinking water wells in these areas for atrazine and cyanazine degradates as part of Phase 2. Of the 1,095 wells that were sampled between 2021-2022 during Phase 2, it was found that 62 wells had a concentration that exceeded the health reference value for total cyanazine.

The MPCA continues to track chloride concentration trends in groundwater. The agency's continued commitment to annual monitoring has increased its ability to determine whether groundwater quality has changed. The number of wells that have enough data to determine trends in the MPCA's monitoring network increased from 35 in 2011 to 120 in 2022. Analysis of data from 2012-2022 continued to show that chloride contamination is seeping into the aquifers used for drinking water. Chloride concentrations increased in 23% of the sampled water wells. Most of the water wells with upward trends were located in the Twin Cities metropolitan area.

In addition to ensuring state and federal standards for drinking water are met, the MDH has led various efforts to characterize emerging contaminants and PFAS in public drinking water, including the Unregulated Contaminants Monitoring Project (UCMP) and the Statewide PFAS Monitoring Project. 95% of community water systems have been sampled for PFAS, covering 99% of Minnesotans that receive drinking water from a community water system. The MDH is working towards establishing permanent program capacity to sample for contaminants of emerging concern and other chemicals in public and private drinking water on an annual basis through the Drinking Water Ambient Monitoring Program (DWAMP). Water quality data collected through these various monitoring efforts will be used to characterize aquifer systems and vulnerable drinking water sources.

Groundwater Human Health Reference Values

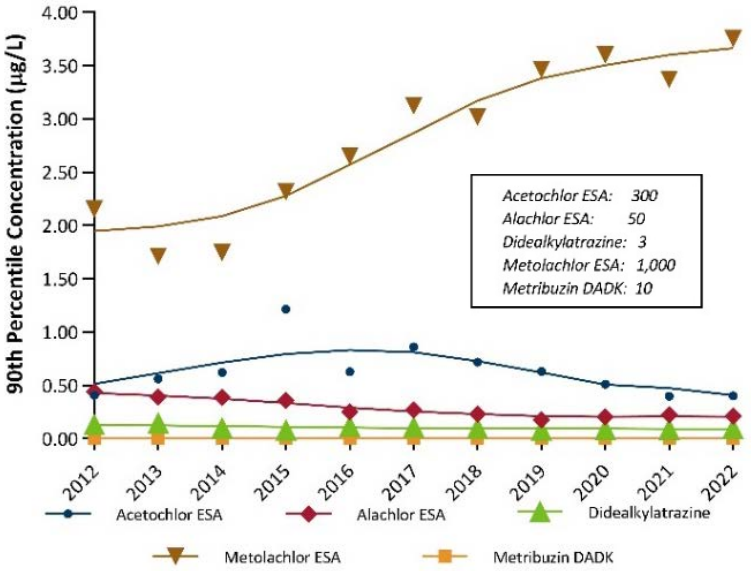


Figure 38. Statewide groundwater common detection pesticides degradates 90th percentile concentration.

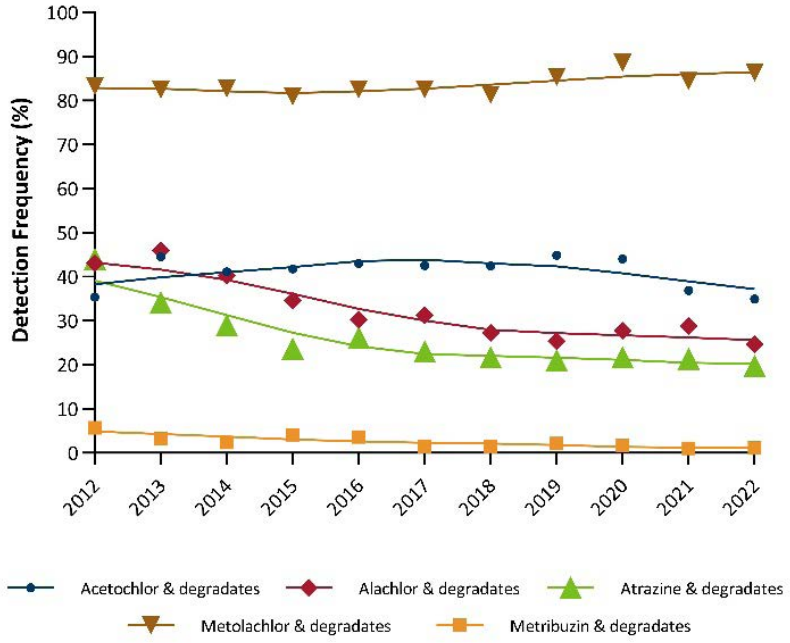


Figure 39. Statewide groundwater common detection pesticides and degradates detection frequency.

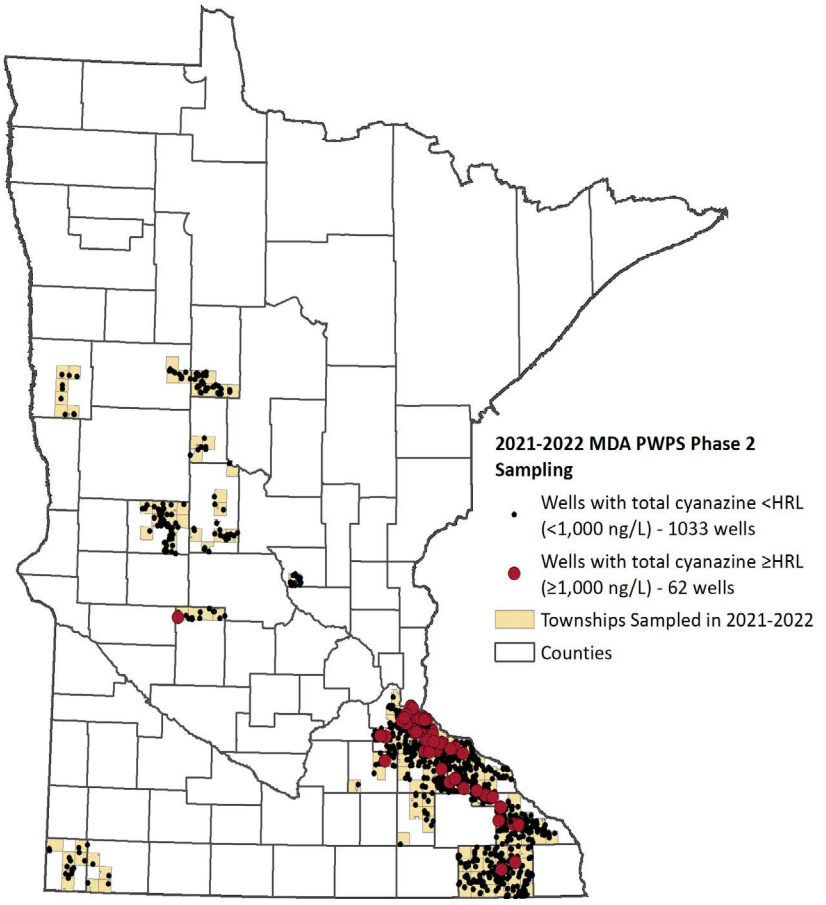


Figure 40. Private Well Pesticide Sampling (PWPS) Project Phase 2 results (2021-2022).

Learn More

Clean Water Fund
www.legacy.leg.mn/funds/clean-water-fund

The MDA Pesticide Monitoring Programs
www.mda.state.mn.us/environment-sustainability/ water-monitoring-programs

Southeast Minnesota Volunteer Nitrate Monitoring Network www.mda.state.mn.us/southeast- minnesota-volunteer-nitate-monitoring-network

Central Sands Private Well Network
www.mda. state.mn.us/central-sands-private-well-network

Township Testing Program
www.mda.state.mn.us/township-testing-program

The MDA groundwater data through the Water Quality Portal www.waterqualitydata.us

Private Well Pesticide Sampling Project
www.mda.state.mn.us/pesticide-fertilizer/private-well-pesticide-sampling-project

PFAS Testing of Public Water Systems at MDH
www.health.state.mn.us/communities/environment/water/pfas.html

Status	Trend	Description
▲ Pesticides	→	Variable trends for five common pesticides indicate a mixed signal. Low levels are frequently detected in vulnerable groundwater.
▲ Nitrate-nitrogen statewide	NEI	Nitrate contamination is a significant concern in vulnerable groundwater areas (the southeast, Central Sands, and southwest). In some agricultural areas, drinking water supplies are not vulnerable to surficial contamination and most wells have low levels of nitrate-nitrogen.
■ Nitrate-nitrogen southwest region	NEI	In areas where groundwater is vulnerable, nitrate levels can be high. Of the 21 vulnerable townships tested in southwest Minnesota (2013-2019), 100% of them were determined to have 10% or more of the wells over the nitrate-nitrogen 10 mg/L standard.
■ Nitrate-nitrogen Central Sands	→	Trend data from the Central Sands Private Well Network shows a slight downward trend in the 90th percentile. However, Township Testing data show a high level of nitrate in some vulnerable areas in the Central Sands.
■ Nitrate-nitrogen southeast region	→	Trend data from the Southeast Minnesota Volunteer Nitrate Monitoring Network shows a slight downward trend in the median value. However, Township Testing data show a high level of nitrate in some vulnerable areas in southeast Minnesota.

DRINKING WATER AND GROUNDWATER MEASURES

Source water quality for community water systems

OUTCOME

Measure: Changes over time in source water quality used for community water systems

Why is this measure important?

Minnesotans use both surface water and groundwater as drinking water sources. When untreated source water does not meet the standards of the Safe Drinking

Water Act (SDWA), community water systems (CWSs) add treatment to make the water safe to drink.

Testing the source water before it goes through a treatment process is one measure of our efforts to protect drinking water at the source, whether it's surface water or groundwater. Understanding source water quality and chemistry also improves our understanding of groundwater aquifers, variables that might affect the treatment process, and the pollutants that can contaminate source water.

What are we doing?

Minnesota Department of Health (MDH) has several projects to supplement routine SDWA monitoring that are supported by Clean Water Fund. Under the federal SDWA, EPA establishes drinking water quality standards. These are called Maximum Contaminant Levels (MCLs). MCLs are enforceable limits for water delivered by public water systems. EPA has established MCLs for approximately 100 contaminants.

Thousands of other chemicals are used in our modern, industrial world. Some end up in the environment and in drinking water sources. Contaminants that do not have MCLs are unregulated contaminants. There are no enforceable standards for unregulated contaminants under the SDWA. Many of these unregulated contaminants have not been evaluated for the risks they pose to human health or the environment. MDH has several programs and activities to support partners with risk management for unregulated contaminants. These include the Contaminants of Emerging Concern (CEC) Framework, which provides guidance on CEC detections in drinking water, as well as the CEC Initiative, which investigates the health risks of CECs in water.

Unregulated Contaminant Monitoring Project

The Unregulated Contaminant Monitoring Project began in 2019 and tested for CECs in drinking water sources across the state.

This project helped us understand where unregulated contaminants occur and at what levels. We also learned how treatment affects some CECs detected in source water. The project was funded by the Environment and Natural Resources Trust Fund (ENRTF) and supported by Clean Water Fund.

Approximately 100 CWSs participated in this project. MDH selected a set of CECs to sample for based on detection in previous studies and public health interest. MDH sampled for perfluoroalkyl substances (PFAS), pharmaceuticals, wastewater indicators, benzotriazoles, and pesticides.

What progress has been made?

MDH completed the Unregulated Contaminant Monitoring Project in 2022. The samples were analyzed for over 500 distinct CECs across different contaminant classes. The majority of CECs were not detected.

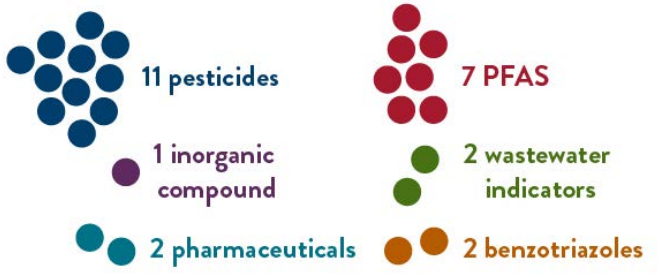


Figure 41. Contaminants detected in at least 20% of samples.

Contaminants detected in at least 20% of samples

The ten most frequently detected contaminants in the project included a wastewater indicator, a pharmaceutical, an inorganic compound, pesticides, PFAS, and a benzotriazole. Benzotriazoles are chemicals used in a wide variety of industrial, commercial, and consumer products. Most detects were at very low levels.

Ten most frequently detected CECs

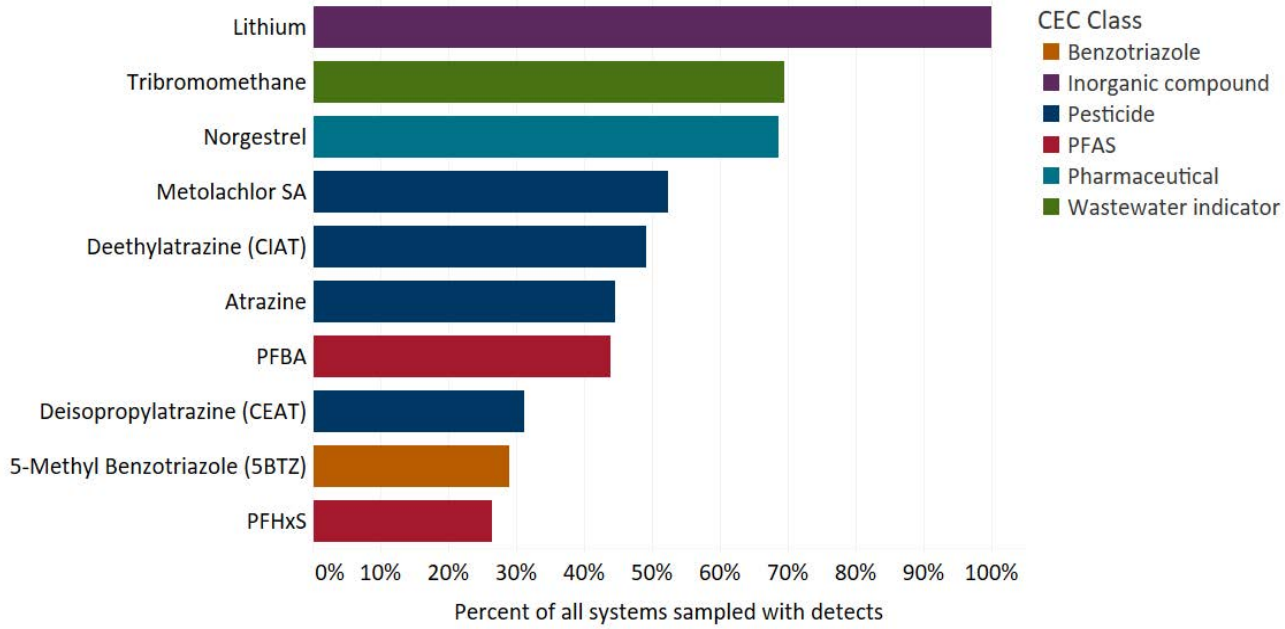


Figure 42. Contaminants detected in community water systems.

Statewide PFAS Monitoring Project

MDH also undertook a project to test for PFAS, or "forever chemicals," in community water systems across the state. The goal of this project was to evaluate whether Minnesotans are exposed to PFAS at levels above guidance values in drinking water. Sampling results are available on the MDH Interactive Dashboard for PFAS Testing in Drinking Water (www.health.state.mn.us/communities/environment/water/pfasmap.html).

Drinking Water Ambient Monitoring Program

MDH is creating a new program to advance scientific study of contaminants in drinking water sources. The Drinking Water Ambient Monitoring Program will proactively test for CECs and other priority contaminants in drinking water sources such as aquifers, lakes, and rivers. The Drinking Water Ambient Monitoring Program builds upon MDH's past CEC monitoring and is administered through the Source Water Protection Program.

The monitoring program will have overarching goals to:

1. Proactively test drinking water sources for CECs and other contaminants of public health interest.
2. Evaluate data to assess potential public health risks and coordinate with partners to limit exposures to acute and chronic contaminants from drinking water.
3. Identify monitoring priorities for drinking water sources following consistent processes that can be flexible in responding to emerging threats but prioritize public health needs.

Information about CEC detections in drinking water sources will help inform MDH priorities for: future drinking water monitoring; development of health-based guidance; risk management; and management of aquifers at a watershed-scale for Drinking Water Supply Management Areas and private well users.

Additionally, data from this program will be used to assess water quality concerns at an aquifer or watershed scale, rather than a system-by-system approach. Regional analyses of water quality data can yield tools

and information that better help water resource professionals manage drinking water quality for public water system customers and private well users.

The Drinking Water Ambient Monitoring Program will coordinate with other state agency programs on CECs in water resources to best target, prioritize, and maximize its efforts.

Learn more

Visit the MDH website for the data summary report and additional information: Unregulated Contaminants Monitoring Project (www.health.state.mn.us/communities/environment/water/unregcontam.html)

Status	Trend	Description
		Current risk management approaches for unregulated contaminants are more proactive and collaborative than the project-based approach of the past.

DRINKING WATER AND GROUNDWATER MEASURES

Nitrate and arsenic concentrations in new wells

OUTCOME

Measure: Nitrate and arsenic concentrations in newly constructed wells

Why is this measure important?

Groundwater is the main source of drinking water for three out of four Minnesotans. About one in five Minnesotans (1.2 million people) get their drinking water from a private well. Both arsenic and nitrate are found in Minnesota groundwater at levels that can cause short-term and long-term health effects.

Consuming water high in nitrate can affect how blood carries oxygen and can cause a condition called methemoglobinemia (also known as blue baby syndrome). This condition can result in serious illness or death. Bottle-fed babies under six months old are at the highest risk of getting methemoglobinemia. Drinking water with arsenic in it over many years can increase the risk of cancer and other serious health effects.

Nitrate is a naturally occurring compound made of nitrogen and oxygen. Natural levels of nitrate in Minnesota groundwater are usually below 3 milligrams per liter milligrams (mg/L). Levels of nitrate greater than 3 mg/L are associated with human-made sources of nitrate. Sources include fertilizers, animal wastes, and human sewage. These sources can contaminate the groundwater. Shallow wells in areas with sandy soils or karst geology are more vulnerable to nitrate. Improper well construction or a damaged well can also allow nitrate to reach otherwise protected groundwater sources.

Arsenic occurs naturally in rocks and soil across Minnesota and can dissolve into groundwater. The way glaciers moved across Minnesota affects where arsenic is found in sediment and groundwater. Because of the complex nature of arsenic occurrence, it is very difficult, and in some cases impossible, to avoid arsenic when constructing a new well.

Radium is a naturally occurring radionuclide in rocks and soil that can get into groundwater. Radium is found in public water supply wells, commonly in the Mount Simon and Jordan aquifers. The drinking water standard for Radium is 5 pCi/L. Radium in well water puts private well users in contact with low doses of radiation that can lead to a higher cancer risk over many years.

What are we doing?

Nitrate

Current laws require that wells are located and constructed in a way that provides a sanitary source of drinking water and protects groundwater quality. In addition, Minnesota Department of Health (MDH), Minnesota Department of Agriculture (MDA), and other partner agencies help well owners and farmers properly manage nitrate sources (such as fertilizers and septic systems) to help reduce input of nitrate into groundwater. Each time a new well is drilled, nitrate levels (along with arsenic and coliform bacteria) are measured to verify that the water is safe to use. If nitrate levels are higher than the drinking water standard of 10 mg/L, MDH informs the well owner of options to reduce their risk. MDA and local governments occasionally offer clinics for residents to have their well water tested for nitrate.

With Clean Water Funds, the MDA Township Testing Program tests for nitrate in townships that have vulnerable geology and a large percentage of row crop agriculture. The results of this testing will guide efforts to reduce nitrate in groundwater through the Nitrogen Fertilizer Management Plan. Other activities funded by the Clean Water Fund, including the Agriculture Water Quality Certification Program, nutrient management assistance and funding for cover crops, and other best management practices reduce input of nitrate to groundwater.

Arsenic

If arsenic is detected in the initial water sample after a well is constructed, MDH informs the well owner of options to reduce their risk. Clean Water Funds made it possible for MDH to collaborate with the U.S. Geological Survey (USGS) to better understand the occurrence and distribution of arsenic in groundwater. The project helps identify the best approach for collecting the initial well water sample to get an accurate measure of long-term arsenic concentrations. Understanding how the arsenic concentration changes over time helps homeowners plan water treatment options.

Radium

MDH is working on a final report and developing guidance on how to protect homeowner health from radiation exposure.

Education and outreach

MDH is also using Clean Water Funds to improve education and outreach to private well owners. The goal is to increase private well testing and help private well owners take action to reduce their exposure to unsafe levels of contaminants, such as arsenic and nitrate.

What progress has been made?

Nitrate

The goal is that all new wells have nitrate levels below 3 mg/L. About 3% of new wells in Minnesota have nitrate levels above level of 3 mg/L and below the drinking water standard of 10 mg/L. About 1% of new wells have a nitrate level above the drinking water standard. However, the MDA Township Testing Program, which tests wells that are vulnerable to groundwater contamination, found a much higher percentage of wells in the central and southeastern regions of the state that have elevated levels of nitrate. The townships tested had a high percentage of land in row crop agriculture and the geology in these regions make it easier for nitrate to travel into groundwater.

The low statewide percentages of new wells with nitrate show that the well code is effective in reducing nitrate contamination risks for most wells. However, it is important that the owners of wells with elevated nitrate take actions to reduce their risk. Because concentrations of nitrate can change over time, well owners should periodically test their water, even if their water had a low level of nitrate initially. There are also many older wells that may have never been tested.

As shown below, there has been a general upward trend in the percent of new wells with nitrate levels higher than the drinking water standard over the past 18 years.

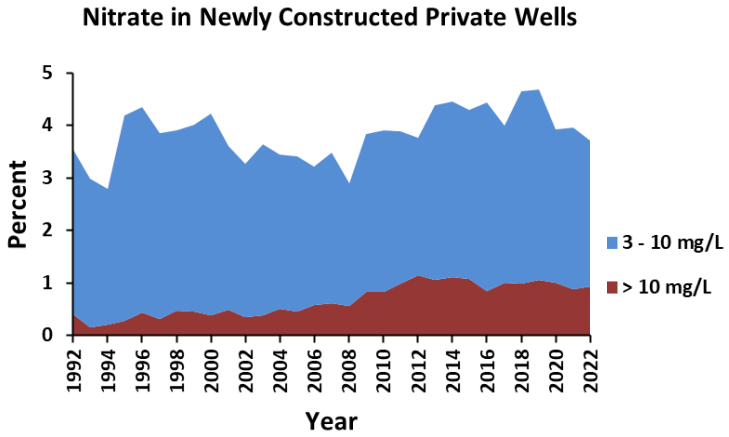


Figure 43. Nitrate concentrations in new drinking water wells.

It is not clear if there is a relationship between this trend and actual nitrate levels in groundwater since new well construction is not uniformly distributed across the state and the number of new wells is not consistent from year to year. This measure cannot tell us the specific causes of nitrate contamination. However, through Clean Water Fund activities that address and manage nitrate sources, nitrate concentrations in groundwater across the state should eventually decline. This measure should reflect that decline.

Arsenic

The goal for this measure is to reduce the percentage of new wells exceeding the drinking water standard for arsenic by 50%. Fifty one percent of new wells in Minnesota drilled since 2008 have arsenic. About 11% of new wells have arsenic levels above 10 micrograms per liter (µg/L)—the drinking water standard for community

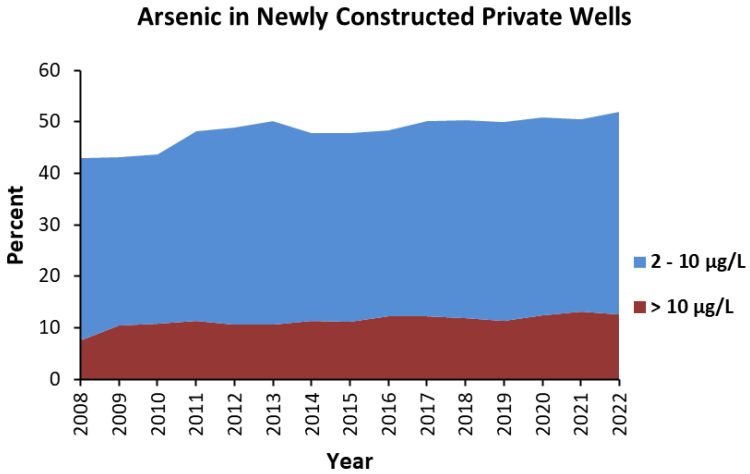


Figure 44. Arsenic concentrations in new drinking water wells.

water systems.

In 2014, MDH and USGS started collaborating to better understand the occurrence and distribution of arsenic in groundwater. No activities to date have had a direct influence on reducing the percentage of new wells with arsenic. As we learn more about arsenic in groundwater, MDH will develop guidance for well contractors to reduce the likelihood that arsenic is in a new well.

Radium

In 2018-2021, MDH sampled 97 wells for gross alpha, an indicator of naturally-occurring radiation, at five sites across southeastern and central Minnesota. Wells that had some level of gross alpha were resampled for combined radium 226/228. Of the 48 resampled wells, 25% had elevated combined radium 226/228 above the drinking water standard of 5 pCi/L.

Learn more

About this measure and data: Clean Water Fund (www.legacy.mn.gov/clean-water-fund).

Nitrate in Drinking Water (www.health.state.mn.us/nitrate)

Arsenic in Drinking Water (www.health.state.mn.us/communities/environment/water/contaminants/arsenic)

Status	Trend	Description
Nitrate ▲	→	Since 1992, there has been a general increase in the percent of new wells that have nitrate levels above the drinking water standard.
Arsenic ▲	→	The percentage of wells with arsenic above the drinking water standard has remained steady over the past 10 years. Evaluation of ways to reduce this percentage is ongoing and may take years before significant progress is made.

DRINKING WATER AND GROUNDWATER MEASURES

Groundwater levels

OUTCOME

Measure: Changes over time in groundwater levels

Why is this measure important?

Approximately three out of every four Minnesotans rely on groundwater for their drinking water. Minnesota's numerous aquifers also support agriculture, industry, and the natural resources (streams, wetlands, and lakes) that define Minnesota's quality of life. While the state's reliance on groundwater increases, many areas of the state lack basic information about the availability of groundwater.

This information supports the evaluation of water supply planning efforts to protect natural resources, prevent well interference, and sustain drinking water sources for future generations.

Groundwater levels are affected by both nature and man-made stresses. Climate change is affecting precipitation patterns, tiling and development modify local recharge and runoff, while pumping wells can impact the flow of groundwater. Changes in groundwater levels cause changes in the streams, fens and wetlands, springs, and lakes connected to them. Wells are also affected. When groundwater levels decline, well interferences may occur causing local water supply emergencies and costing private and public well owners money.

Decisions about water supply development and appropriation, watershed management, and land use are made daily. The success of management decisions relies in part on understanding how weather and man-made stresses impact groundwater levels on both a seasonal and long-term basis.

What are we doing?

To monitor this "hidden" resource the Minnesota Department of Natural Resources (DNR) manages a statewide network of groundwater-level observation wells. Traditionally water levels were measured monthly by Soil and Water Conservation Districts and other volunteers, however this network is being converted to continuous monitoring using automated sensors that measure levels every hour and then store the data until retrieved by staff, Figure 45 illustrates the difference between manual readings and continuous monitoring). The statewide network of groundwater level

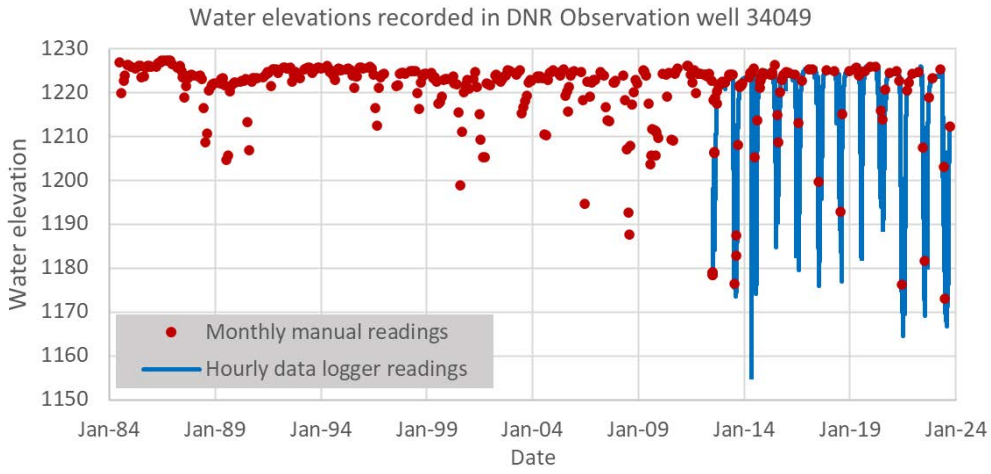


Figure 45: Hydrograph illustrating monthly manual readings versus hourly data logger readings. Note data logger consistently captures lower levels during summer months.

observation wells provides information about seasonal water level fluctuations and long-term water level changes (Figure 45). Data from these wells are used to determine long-term trends, interpret impacts of pumping and climate, plan for water conservation, and manage the water resource. The water level data are available online and are used by hydrologists and water managers evaluate water supply questions at local and regional scales.

Data are insufficient to assess Minnesota's groundwater conditions in portions of the state, but the number of monitoring wells is being expanded to enhance our ability to detect trends. Since 2022, through a combination of Clean Water Funds and other state and federal sources, an additional 140 wells have been added to the network bringing the total wells in the DNR network to 1,234.

What progress has been made?

To evaluate progress, the DNR compiled water level data from observation wells with sufficient measurements in at least 15 out of each 20-year period. An analysis is then completed that uses the annual minimum water level, i.e., the lowest water level recorded for the year in an observation well, for determining trends. The latest analysis, covering the period from 2003-2022, includes 328 DNR monitored wells. This year's analysis incorporates water level data from an additional 76 wells that are monitored by permittees, bringing the total wells included in the analysis to 404 statewide. The wells monitored by permittees are usually installed in close proximity to their active production wells. While DNR observation wells are designed to monitor "back-ground" water levels, the data collected by permittees allow DNR hydrologists to compare both the local and regional aquifer response to high volume pumping. Incorporating these permittee wells into the analysis broadened the geographic coverage and allows monitoring of aquifers pumped by high-capacity users. Statewide, 93% of the 404 observation wells exhibited upward or no clear trend while only 7% showed a downward trend (Figure 46).

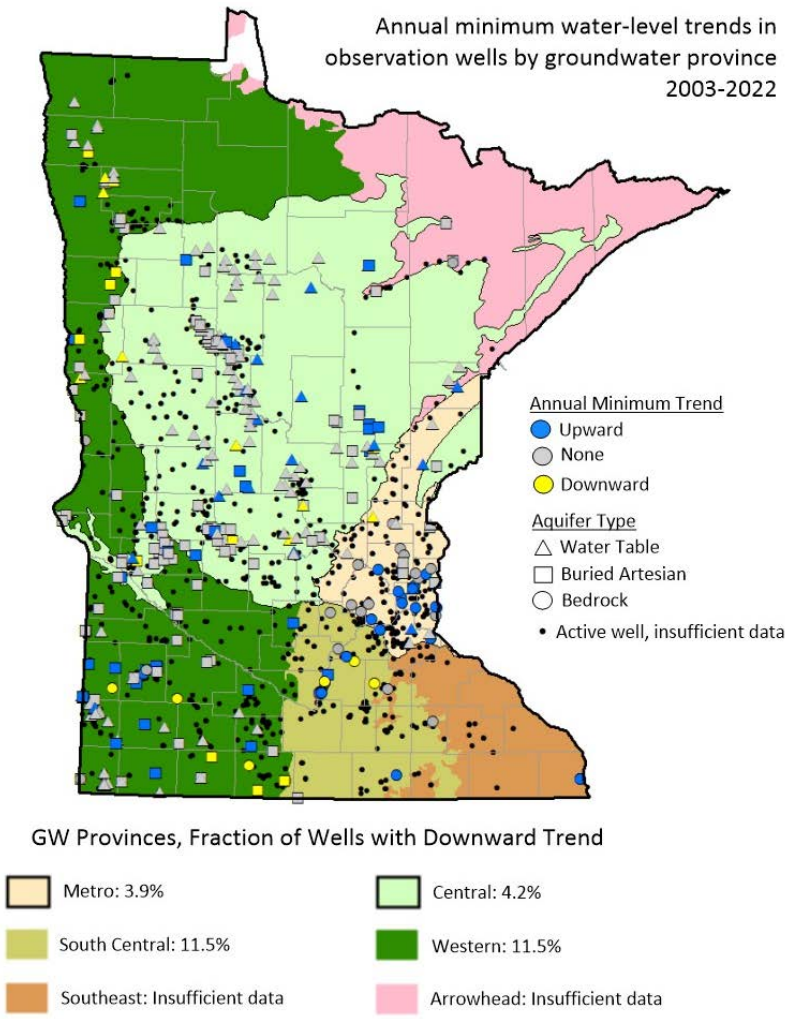


Figure 46. Water level trends in DNR and permittee observation wells for the period 2003-2022.

This analysis has now been completed four times and cover the following periods: 1993-2012, 1997-2016, 2000-2019 and 2003-2022. A comparison of the four periods offers a view of how groundwater trends have changed over time. The original analysis, completed for the period from 1993- 2012, indicated that statewide, water levels in 63% of the 295 wells selected for analysis showed rising or no clear trend, while 37% indicated a downward trend. Analysis of water levels from 1997-2016 showed water levels in 81% of the 341 sampled observation wells showing no clear or an upward trend, while 19% exhibited a downward trend. The 2000-2019 analysis showed a continuing improvement with 94% of the 310 wells showing rising or no trends and only 6% of the wells with a downward trend. This year's analysis (2003-2022) showed 93% of the 404 sampled wells continued to trend upward or show no clear trend. Table 5 highlights the trends calculated for both Statewide and by Groundwater Province during the four periods of analysis. Generally, water level trends have been rising statewide, resulting in a significant drop in the percentage of wells showing a downward trend. Downward trends can result from a variety of factors. Analysis periods that start during years of high-water levels or

Table 5. Comparison of water level trend data by analysis period and location. Arrowhead and Southeast Provinces not displayed due to insufficient data.

Period (dates) of analysis	Number of wells with 20 year record included in the analysis	Statewide percent of wells with upward or no clear trend	Metro province percent of wells with upward or no clear trend	Central province percent of wells with upward or no clear trend	Western province percent of wells with upward or no clear trend	South-Central province percent of wells upward or no clear trend
1993-2012	295	63%	44%	66%	76%	Insufficient data
1997-2016	341	81%	73%	86%	74%	Insufficient data
2000-2019	310	94%	100%	97%	83%	Insufficient data
2003-2022	404	93%	96%	96%	88%	88%

periods that incorporate drier climate conditions in the later years of the analysis period will likely exhibit downward trends. An increase in groundwater use, a drop in surface water levels, and land use changes may all result in downward trends.

Year over year the majority of the wells exhibit no clear trend, however with the analysis now in its fourth iteration it is possible to look back at the earlier analyses and compare the past trends of the current 28 wells with downward trending water levels. While 10 of the wells are new to the "downward" trend, 18 of the wells have exhibited downward trends one, two or three times in the past. DNR hydrologists have identified probable causes for the downward trends in several wells located in the northwest part of the state and are working with local partners to address the trend. DNR staff will be investigating the source of the water level declines in those wells with multiple years of downward trends.

Groundwater-level information is becoming better integrated into water supply planning, which supports work to reduce the environmental, economic, and public-health risks created by unsustainable aquifer decline. In the Twin Cities metropolitan area, regional planning policies are being revised to address declining aquifer levels.

Statewide, the DNR has established Groundwater Management Areas (GWMAs) where additional planning and monitoring is needed to ensure that growing water demands do not cause unsustainable seasonal or long-term groundwater declines. Clear standards for sustainability of aquifers and the surface water features they support are being established and implemented in the near future. The emerging GWMA program is creating new partnerships between DNR, Pollution Control Agency, Department of Health, Department of Agriculture, Board of Water and Soil Resources, Metropolitan Council, and many local stakeholders.

Statewide, the DNR has established Groundwater Management Areas (GWMAs) where additional planning and monitoring is needed to ensure that growing water demands do not cause unsustainable seasonal or long-term groundwater declines. Clear standards for sustainability of aquifers and the surface water features they support are being established and implemented in the near future. The emerging GWMA program is creating new partnerships between DNR, Pollution Control Agency, Department of Health, Department of Agriculture, Board of Water and Soil Resources, Metropolitan Council, and many local stakeholders.

Status	Trend	Description
▲	→	Most observations wells with a sufficient period of record show no significant change or an upward trend.

DRINKING WATER AND GROUNDWATER MEASURES

Water efficiency

OUTCOME

Measure: Changes in total and per capita water use

Why is this measure important?

This measure describes how much water (groundwater and surface water) is used in Minnesota – as an annual statewide total and per person. As Minnesotans, we get much more from our water than drinking and washing. Water also helps to provide power, irrigate crops, run industrial processes, service health care facilities, and support our state's rich natural environment. And every drop of water that people move from one place to another for a variety of uses comes with a cost—such as the energy to move it, the infrastructure to treat it, and the impact to the source from which it was taken. Being good stewards means getting the most value out of the water we use, taking care not to waste it, and putting it back into the environment sustainably.

What are we doing?

The Minnesota Department of Natural Resources (DNR) is responsible for managing water withdrawal (appropriation) permits in Minnesota. Current laws require those who use large amounts of water to take practical actions to use water efficiently. Various water efficiency targets have been established since the Clean Water, Land and Legacy Amendment was passed. The following metrics and results are from the DNR Water Conservation Reporting System for public water suppliers statewide. To ensure meaningful trend analysis, the DNR uses a "Gold Club" of 132 utilities (out of 342 utilities serving over 1,000 people) that have reported reasonable data through the Water Conservation Reporting System each year:

- In 2022, for the Gold Club utilities, unaccounted for water loss was 10%, compared to 9% in 2020.
- In 2022, 87% of the cities reporting reasonable information met the goal of residential water use less than 75 gallons per capita daily (GPCD). For Gold Club utilities, 90% met the goal in 2020 and 88% met the goal in 2022.
- The statewide aggregate GPCD was 56. For the Gold Club utilities, GPCD was 54 in both 2020 and 2022.
- In 2022, 70.6% of all utilities reporting reasonable data met the goal of maximum daily use being less than 2.6 times that of average daily use. 77% of Gold Club utilities met this goal, compared to 78% in 2020.

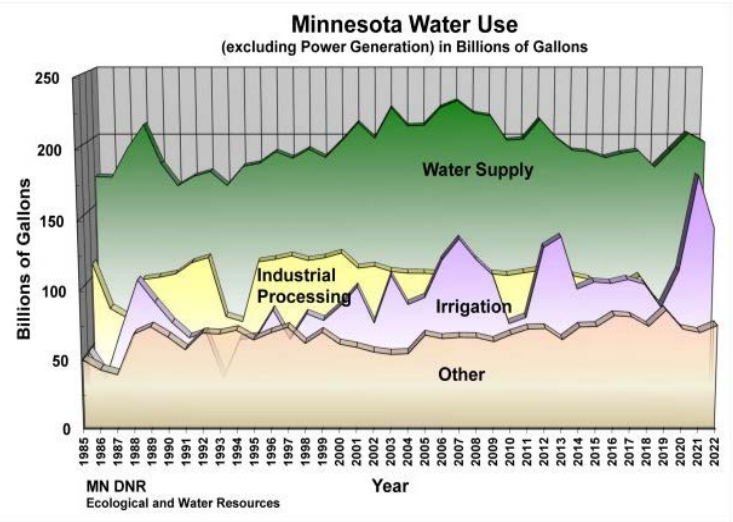


Figure 47. Minnesota water use in billions of gallons per year, excluding power generation.

In the Twin Cities metropolitan area, the Metropolitan Council (Met Council) has identified a regional target for total per person water use of 90 gallons/day, on average, for community water systems. The DNR, the Minnesota Department of Agriculture (MDA), the University of Minnesota (U of M), and the Met Council are using the Clean Water Fund to accelerate the implementation of water efficiency measures and progress toward these goals.

Examples:

- U of M Technical Assistance Program Water Conservation Program
- U of M Extension Turfgrass Science Program
- Freshwater Society Water Stewards Program (with resources for water conservation)
- Met Council Water Efficiency Grant Program

What progress has been made?

Between 2010 and 2022, while population increased, total water use has decreased by approximately 22%. This is likely due to a combination of factors including more efficient appliances and technology for commercial processes as well as suppliers' focus on leak detection and maintenance.

Table 6. Total Minnesota water use from 2010-2022

Year	Total MN Water Use (gallons per day)	Total MN Population	Gallons per person per day
2010	3,704,591,268	5,303,925	69.8
2012	3,682,228,800	5,368,972	68.5
2014	3,474,456,459	5,453,218	63.7
2016	3,372,221,158	5,528,630	60.9
2018	3,178,799,171	5,629,416	56.4
2019	2,904,713,342	5,680,337	51.1
2020	2,776,064,658	5,706,494	48.7
2022	2,902,092,877	5,801,769	50.0

Learn more:

Clean Water Fund (www.legacy.leg.mn/funds/clean-water-fund)

Minnesota Water Use Data (www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html)

Great Lakes Compact (www.dnr.state.mn.us/waters/watermgmt_section/great_lakes_compact/index.html)

Irrigation Outreach & On-Farm Nitrogen Management in Central Minnesota (www.mda.state.mn.us/ag-weather-irrigation-management-resources)

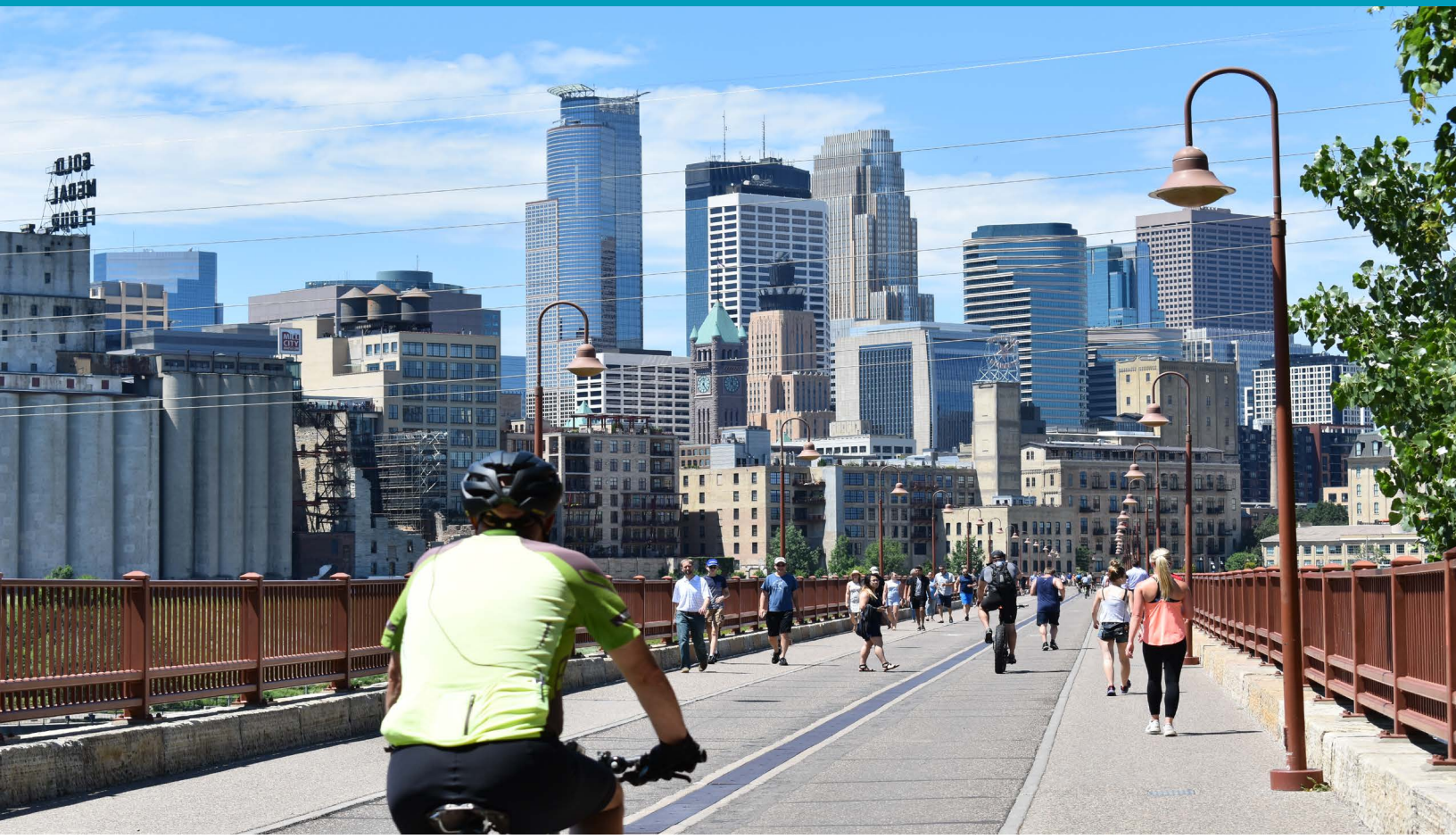
Freshwater Society Water Stewards Program (https://freshwater.org/minnesota-water-stewards/)

U of M Technical Assistance Program Water Conservation (www.mntap.umn.edu/focusareas/water/conservation/)

Met Council Water Efficiency Grant Program (metrocouncil.org/Wastewater-Water/Funding-Finance/Available-Funding-Grants.aspx)

Status	Trend	Description
▲	→	There has been a general trend of improving water use efficiency from 2010 through 2022. Continued tracking is needed to assess the relative contributions of weather patterns versus changes in management.

SOCIAL MEASURES AND EXTERNAL DRIVERS



SOCIAL MEASURES AND EXTERNAL DRIVERS

Social Measures

Building local capacity to support and engage in water restoration and protection

What are social measures?

Social measures track how Clean Water Fund investments affect people and communities, specifically their ability to support and engage in local projects. Tracking social measures provides valuable information about how well education, outreach, and civic engagement strategies are working.

Social measures are a way of integrating social science into Clean Water activities. They can help answer questions about what motivates people and communities to take positive actions as well as the barriers and constraints that prevent or limit action. Understanding and measuring these factors helps state agencies and their partners be more strategic when engaging and partnering with the public to address water quality and quantity, and evaluating the success of those efforts. Previous reports (2016, 2018, and 2020) provide a description of the Social Measures Monitoring System (SMMS) and how state agencies have worked together to pilot the application of this framework to Clean Water Fund projects. For this report we have highlighted We Are Water MN.

Below is a graphic that illustrates the four main components of social measures — individual, relational, organizational, and programmatic capacity.

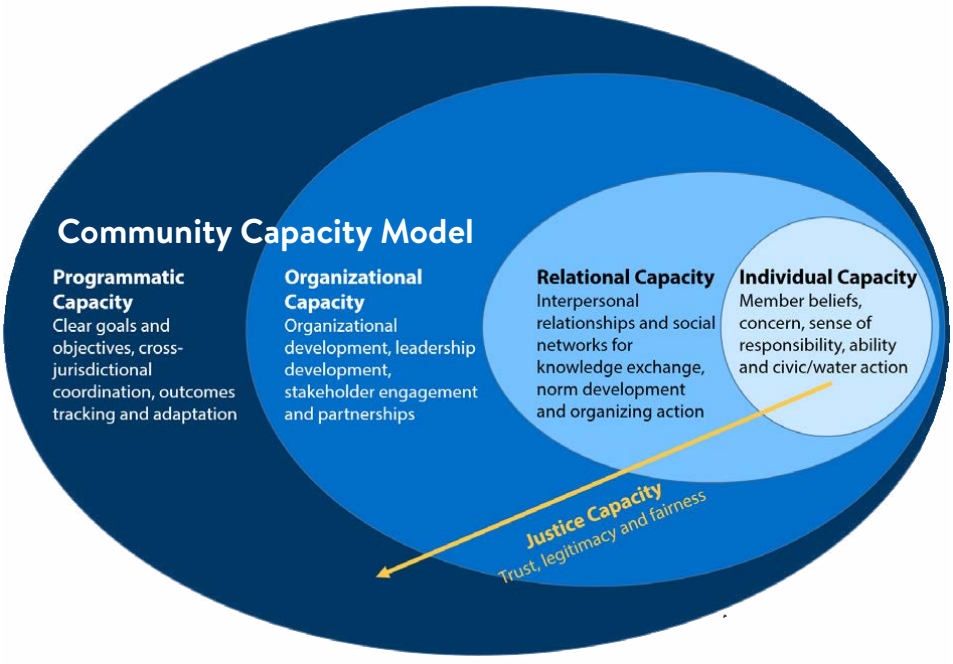


Figure 48. Four main components of social measures: Individual, relational, organizational, and programmatic capacity

We Are Water MN is the Clean Water Fund's only dedicated community capacity-building program. Communities are also connecting to protect water resources and plan for the future through local water management plans and the One Watershed, One Plan process. The Clean Water Council's vision is to increase the number of Minnesotans who understand their own role in achieving and maintaining healthy lakes, rivers, and wetlands and act accordingly. Early engagement provides opportunity to influence policy decisions, implementation plans, and increase ownership, or buy-in to actions needed to meet water quality goals.

We Are Water MN

Why is this measure important?

We Are Water MN is dedicated to building community capacity. It builds individual and relational capacity for participation in clean water through education and network building at the local level.

The program is built upon the theory that building community capacity to protect water requires building relationships between community members, organizations, and sectors. We Are Water MN achieves these goals through three key activities:

- Building a network of partnerships
- Hosting a traveling exhibit
- Designing public events

The program is a partnership of the Minnesota Humanities Center, Minnesota Pollution Control Agency, Minnesota Historical Society, University of Minnesota Extension, and the Minnesota Departments of Agriculture, Board of Water and Soil Resources, Health, and Natural Resources. It is hosted by local organizations that participate in 6-12 months of support and planning before the traveling exhibit arrives in their location.

We Are Water MN began in 2016 and uses the Minnesota Humanities Center's (MHC's) equity-based approach to community engagement, the Absent Narratives Approach™, that increases partnerships with communities and fosters equitable practices within systems. Practicing the Absent Narratives Approach™ as a framework for building relationships leads to the outcomes for water protection and restoration described in the Social Measures Monitoring System (SMMS), such as:

- Positive interpersonal relationships within communities that promote information exchange, build trust, foster shared identity, and promote common awareness, concern, and sense of responsibility for water.
- Networks that can promote positive social norms and share a vision for and participate in water stewardship.
- An increased and broadened community awareness of local water issues because visitors to the exhibit and public programming come from more diverse backgrounds than one host organization could convene on its own.

What are we doing?

In 2022, the state partners worked with five local organizations, located in diverse regions of the state:

- Winona: City of Winona
- Lake Pepin: Lake Pepin Legacy Alliance
- Alexandria: Legacy of the Lakes Museum
- Fergus Falls: Otter Tail County
- Hastings: Dakota County

What progress is being made?

There has been consistent delivery and statewide reach with this capacity building and water education program.

Host communities – Building relational capacity

While in the program, the host organizations focus on developing their own local networks. The program encourages them to connect with organizations outside their existing partnerships and with individuals or organizations representing traditionally absent narratives. A robust network of over 100 partnerships were engaged in 2022, 63% of which were new partnerships.

"I think we created a lot of really deep and meaningful partnerships and have continued on with the partnerships we have." – Legacy of the Lakes, Alexandria host site

Together, these local networks design a minimum of four public events that build people's relationship with and responsibilities to water. In 2022, there were 69 events, an average of nearly 14 events per host site.

The relationships formed through We Are Water MN provide opportunity for future work.

"I had never worked with the Hastings Environmental Protectors. They're awesome, and now I know about them and can go to them for a future partnership. Our collective awareness of each other's connections has grown tremendously." – Dakota County

Visitors – Building individual capacity

More than 28,000 visitors attended the exhibit in 2022. In addition, 4,600 attended one of the 69 host site events. Visitors to the exhibit are asked to complete a survey describing how their awareness of water issues changed after viewing the exhibit and their willingness to adopt pro-environmental behaviors. For both questions, visitors could select all responses that applied to them.

Overall, the traveling exhibit provides a way to engage visitors and increase knowledge and awareness about

local water resources. Survey results indicate that the vast majority of visitors learned something new and reported they are going to take action for water resources.

We Are Water MN Survey Results

Awareness of water issues response options	% of respondents
I learned something new about our water resources	78%
I increased awareness regarding threats to our water resources	88%
I was exposed to a perspective different from my own regarding water resources	85%

Willingness to adopt pro-environmental behaviors	% of respondents
I will change how I personally use water	80%
I will share what I learned with others	77%
I will get involved with local organizations working to protect water resources	47%

Figure 50. Most of those surveyed at the exhibit report they've learned something new and will act for water resources. Visitors are encouraged to write their action on a water drop and post it in the exhibit.

We Are Water MN 2016-2022

Since 2016, We Are Water MN has visited 25 communities, involved 554 community organizations, reached 84,000 visitors, and strengthened 8 state agencies' relationships with each other and their ability to do meaningful community engagement.

Figure 49. We Are Water MN host locations, 2016-2022

Status	Trend	Description
▲	→	State agencies are using the Social Measures Monitoring System to integrate social science into some of Clean Water Fund projects. The most evaluated project is We Are Water MN.

SOCIAL MEASURES AND EXTERNAL DRIVERS

External Drivers

Important land use, population, and climate trends

The trends outlined in this section represent important land use, population, and climate-related changes that may influence the quality and quantity of water in Minnesota's lakes, rivers, wetlands, and aquifers. Because these factors are changing in ways that may impact our ability to achieve our Clean Water goals, they are referred to as external drivers. The external drivers highlighted in this report track changes occurring within Minnesota as a result of regional, national, or even international activities. The broad scale at which these external drivers operate means that they cannot be solely managed through the Clean Water planning process, yet they can have a significant impact on the quality and quantity of Minnesota's water resources.

External driver categories

Climatic changes:

- Average Minnesota temperature
- Average Minnesota precipitation

Demographic changes:

- Population size and proportion in urban/suburban counties

Land use changes:

- Agricultural land use
- Impervious surface urban/suburban communities
- Wetland coverage

Understanding how external drivers are changing over time provides important context for many of the Clean Water outcome measures highlighted in this report because those trends may increase or hamper Minnesota's ability to achieve its Clean Water goals. Tracking external drivers can also provide important information to help enhance the effectiveness of protection and restoration actions that are implemented.

By understanding how Minnesota's landscape and climate are changing, Clean Water partners can fine-tune where money is invested and what actions are taken to enhance successful outcomes (see figure below). Tracking external drivers will help Clean Water partners adapt their actions over time, enhancing water quality and drinking water outcomes.

It is important to note that the relationship between the external driver and the water quality or drinking water outcome of interest is often complex and may vary from location to location. Just because one of the external driver categories highlighted in this section increases over time does not mean that water resource quality will decline. For example, increased adoption of best management practices or other actions by state and local governments may more than offset the change.

Of the many categories of external drivers that could be highlighted, this section focuses on a few selected land use, population, and climate changes. The specific trends represented on the following pages were chosen because they represent major external driver categories and are reliably and routinely updated at a statewide scale.

Figure 52. Expected relationships of external drivers to investments, actions, and outcomes.

Climate

Changing hydro-climatic patterns

Minnesota's climate exhibits large season-to-season, and year-to-year variations that influence the condition of the state's water resources, as well as the strategies that Minnesotans will need to employ to achieve restoration and protection goals. The amount and timing of precipitation influences how much water soaks into the ground —changing whether it can be taken up by plants, replenish soil and groundwater resources, or runs off directly into the nearby lakes, rivers and wetlands.

Precipitation patterns also control water demand for outdoor uses such as agricultural and residential irrigation. Likewise, Minnesota's temperature patterns affect the length of Minnesota's winter - controlling the period when lakes and streams are covered by ice, the length of the summer growing season, how warm surface waters become, as well as many of the chemical, physical, and biological processes that shape how the state's aquatic resources behave.

Minnesota is becoming both wetter and wetter, even when accounting for the dry early 2020s and for cool years in 2019 and 2022. The top ten combined wettest and warmest years between 1895 and 2022 all occurred since 1998. (See "wet-warm graph")

Average annual precipitation has increased at a rate of 0.28 inches per decade, or by a total of 3.6 inches since 1895. Part of this increase was the natural rebound expected after the major drought episode of the 1920s and 1930s, when annual precipitation decreased to the lowest levels on record. However, in the past few decades, precipitation has continued increasing beyond what would be expected from typical wet/dry variations. The period from the 1990s through the 2010s was the most consistently wet period on record, and the 2010s finished as Minnesota's wettest decade back to the 1890s. (see "P_trends_2023")

The wetter conditions have coincided with increases in heavy and extreme precipitation. The Minnesota State Climatology Office has noted that from 1990 to 2022, days with one, two, and three inches of precipitation were 18%, 30%, and 60% more common, respectively, than in the entire record up to that point.

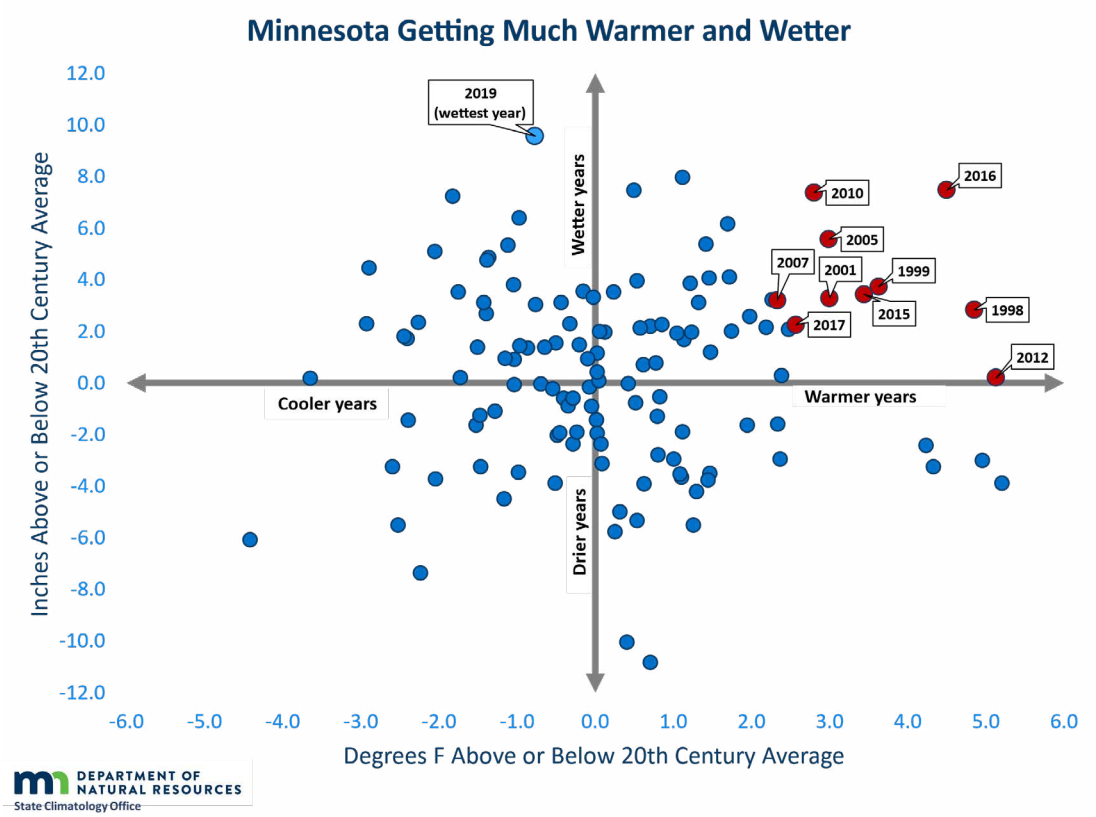


Figure 53. Combined temperature and precipitation departures from 20th century averages for Minnesota for all years, 1895-2022, highlighting the 10 combined warmest and wettest years on record, all of which occurred since 1998.

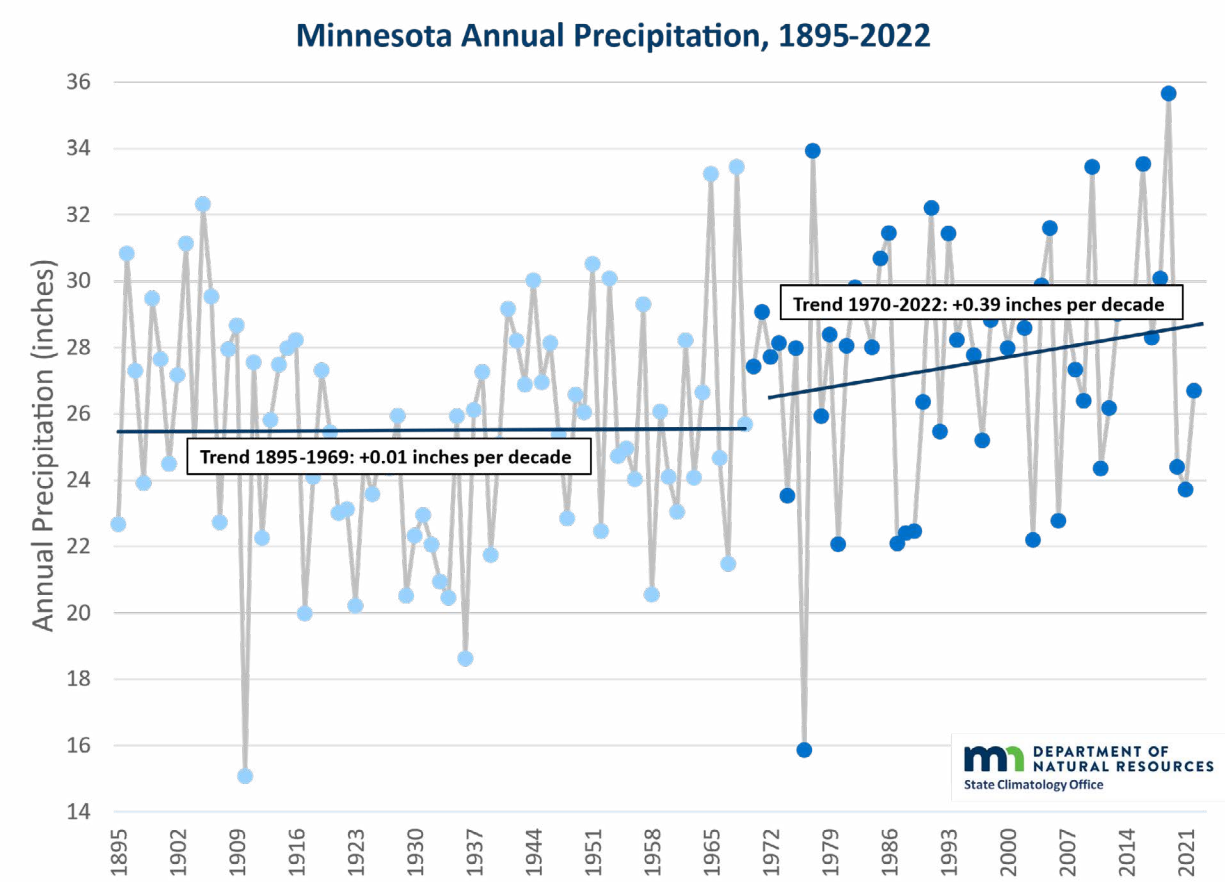


Figure 54. Minnesota annual precipitation, 1895-2022, showing no trend from 1895 through 1969, and a trend towards overall precipitation increase from 1970-2022.

In the early 2020s, steep declines in warm-season precipitation (May through September) led to three distinct major drought episodes covering all or part of Minnesota. These dry periods represent short-term variations that have not changed the trends towards increased precipitation. In fact, cool-season precipitation (October - April) has continued increasing during this time, with record-breaking winter and spring precipitation in northern Minnesota during 2022 leading to historic flooding on the Rainy River. The drought episodes have been substantial, but near-record wetness during the cool season has made the early 2020s the "wettest dry period" on record in Minnesota.

Minnesota has warmed by approximately 3° F since the beginning of statewide records in 1895, but warming rates have increased sharply in the past several decades. For instance, Minnesota's average annual temperature increased at a rate of + 0.15° F per decade from 1895 through 1969, but has tripled from 1970 through 2022, to a rate of 0.46° F per decade. (see "T_trends_2023")

This sharp uptick in warming since 1970 has been driven by milder winters, fewer cold weather extremes and higher daily minimum temperatures. Average daily low temperatures have increased 68% faster than average daily high temperature since 1970, while winter has warmed 42% faster than fall, four times faster than summer, and 6-7 times faster than spring. Warming rates in all seasons have been faster in northern Minnesota than southern Minnesota. (see "MN_T_change_thru_Aug_23")

Although summertime daily high temperatures have been the slowest to respond to changing climate conditions in Minnesota, they now exhibit some long-term increases (warming) in northern and central Minnesota, but not yet in southern Minnesota.

In 2018, the Minnesota Department of Natural Resources created a climate trend analysis tool that allows resource managers and planners to examine these statewide climatic changes in more detail, both seasonally and geographically. In 2021, a new version of the tool was updated to include the use of future climate projections. Using these tools can

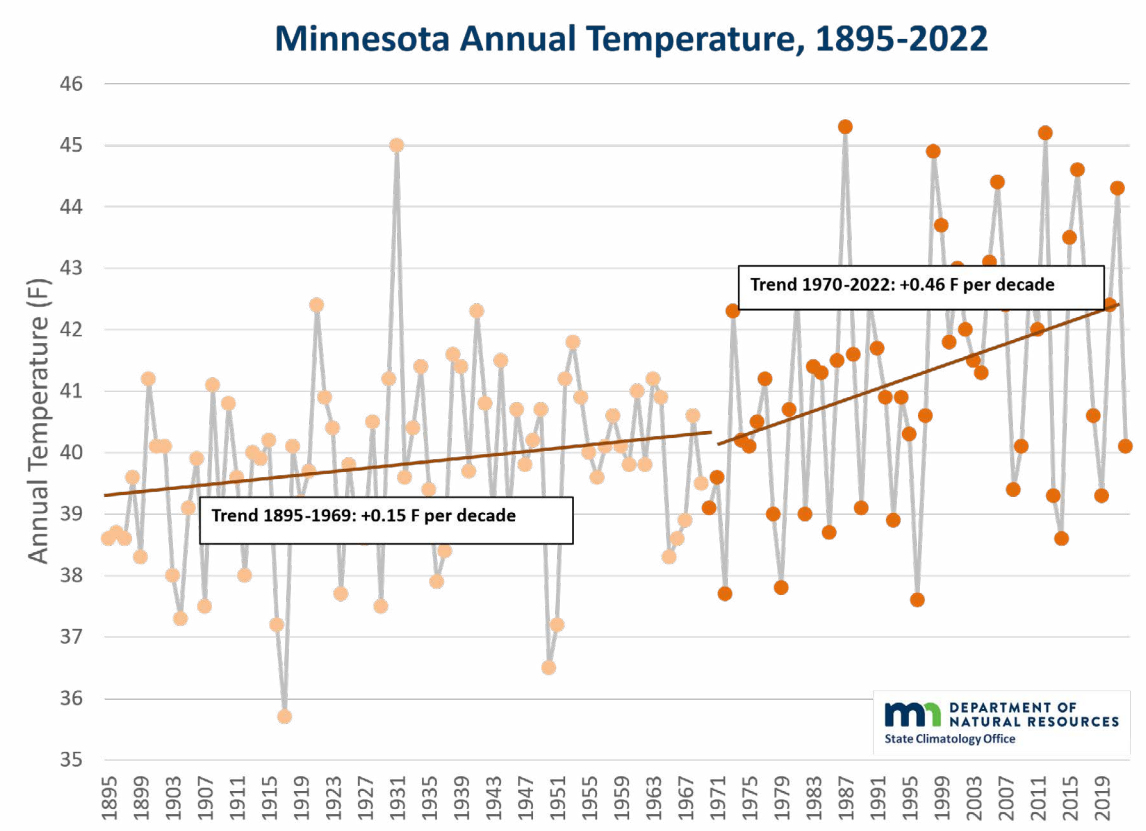


Figure 55. Graph of Minnesota annual temperature, 1895-2022, showing a slight increasing trend from 1895 through 1969, and a strong increasing trend from 1970-2022.

help inform the development of protection and restoration strategies, and the selection of implementation projects to anticipate changes in climatic patterns. The new tool, the Minnesota Climate Explorer, is available at: arcgis.dnr.state.mn.us/climateexplorer/main/historical, and the previous tool, Minnesota Climate Trends, is still available at arcgis.dnr.state.mn.us/ewr/climatetrends.

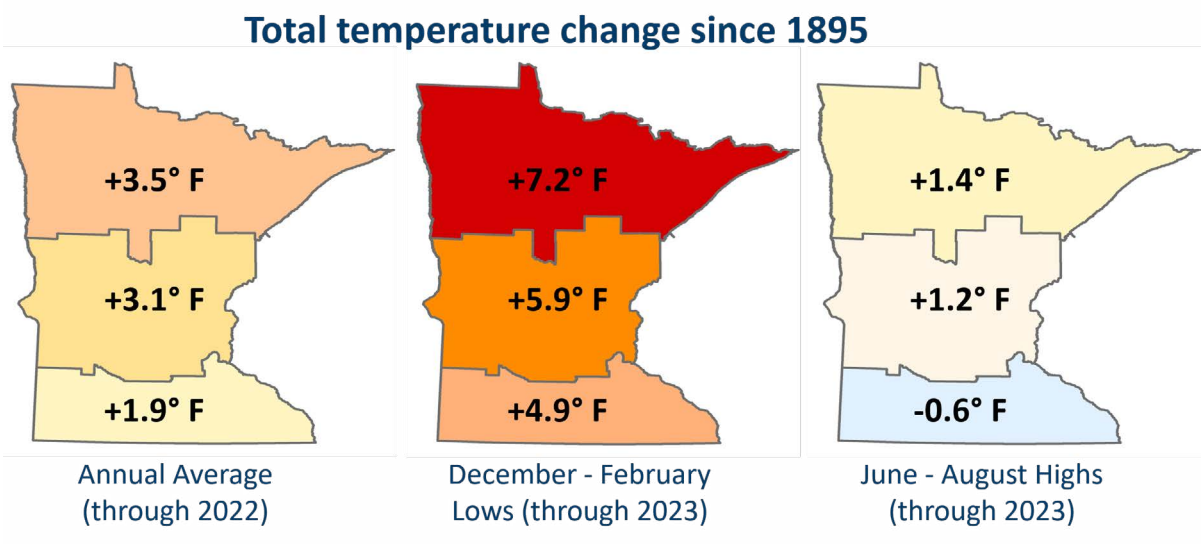


Figure 56. Maps showing total temperature change in Minnesota since 1895 for the annual average (left), average of winter daily lows (middle), and average of summer daily highs (right)

Demographic (Population)

Demographic changes

The size and makeup of Minnesota's population can stress water resource quality in terms of demand for water and how those uses impact the quality and quantity of water that is returned to the environment. As shown in Figure 57, Minnesota's population has increased steadily since 1950, and nearly all of that growth can be attributed to urban or suburban counties. This shift reflects more impervious surface that has the potential to impact surface water quality and quantity, increased water demand and associated impacts to groundwater and surface water supplies and an expanded volume of treated wastewater being discharged back into the environment. As Minnesota's population continues to increase, so too will the demands placed on the state's water resources. These changes may require modifications to current water quality actions and strategies.

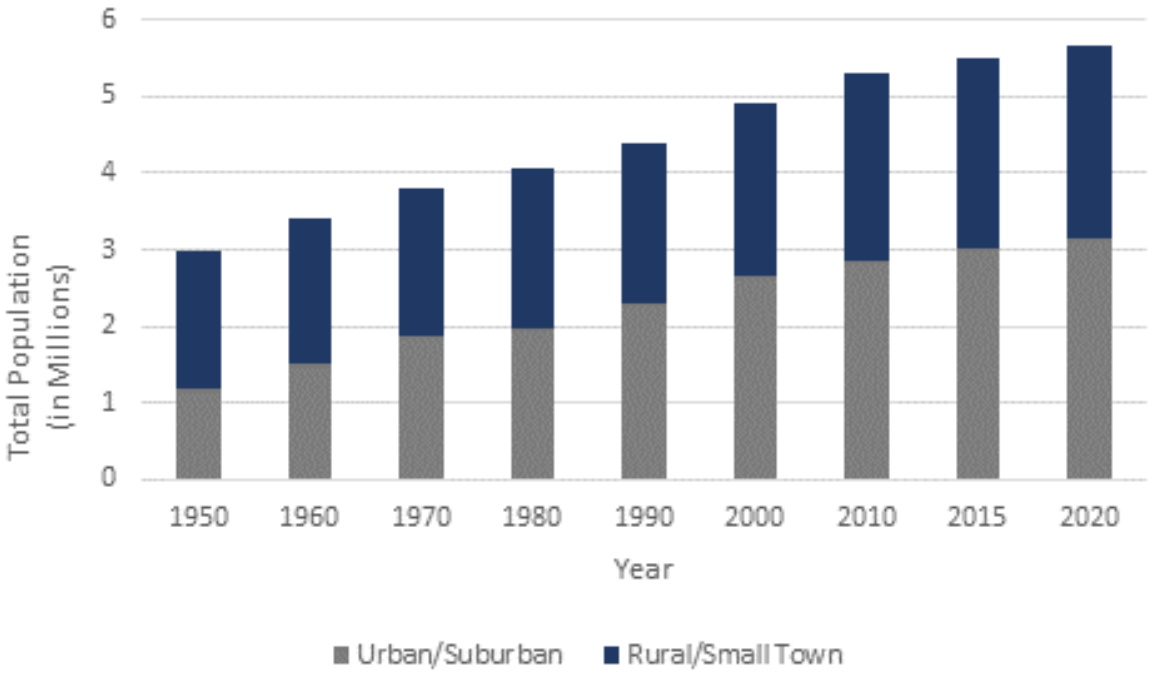


Figure 57. Changes in Minnesota's urban/suburban and rural population from 1950 through 2020.

Land Use: Agricultural Land Use

Though the total area of agricultural land use in Minnesota has remained relatively constant over time, the crops grown (land cover) have undergone a significant transformation. There have been major shifts in land cover in Minnesota over the last 100 years (Figure 58). The number of acres planted in small grains or hay has declined and been replaced by increases in corn and soybean acreage. The roughly nine million acres where agricultural land use has changed represents about 16% of the state. These cropping changes have altered the time of year and extent to which the land is covered by a growing crop. This impacts soil erosion, fertilizer use, nutrient uptake, and soil moisture. These crop cover changes may increase nutrient and sediment discharge to surface waters and leaching into groundwater.

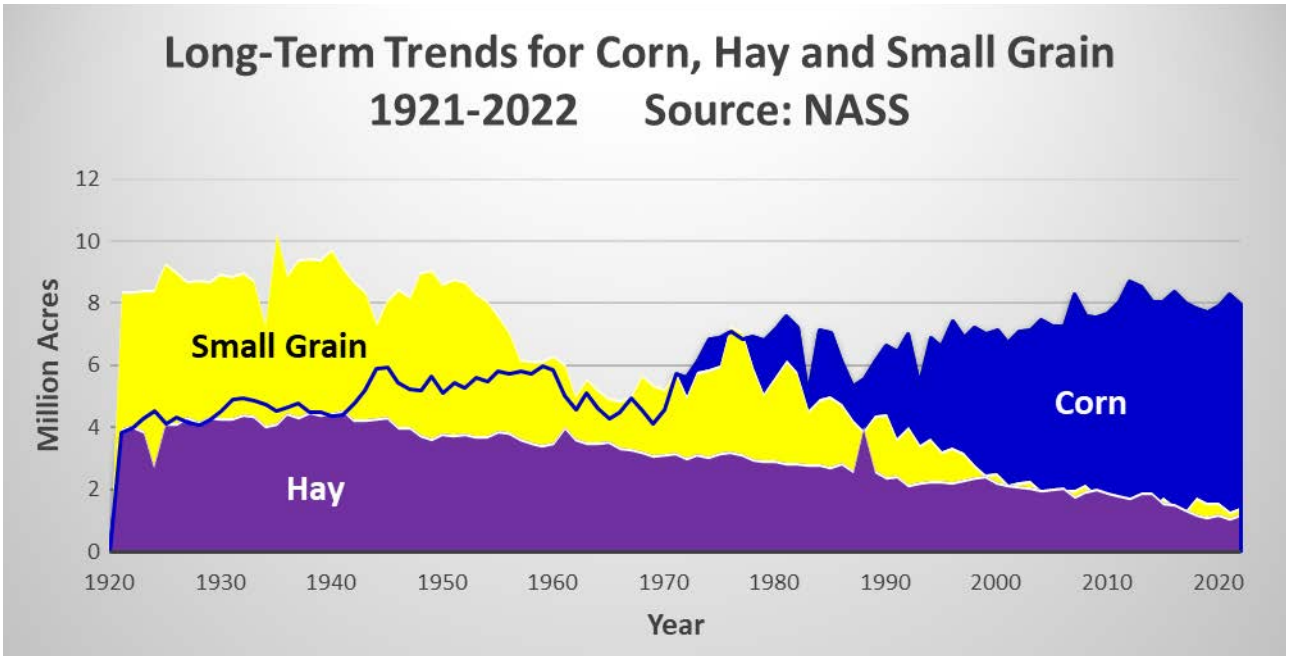


Figure 58. Long-term trends for corn, hay, and small grain (1921-2022) – Source NASS

Land Use – Wetlands

Change in wetland acreage

Wetlands are critical to Minnesota's water quality because they provide water storage, hold back runoff and reduce the intensity of flood peaks, reduce the concentration of various pollutants in runoff water, and contribute to groundwater recharge. The abundance of wetlands has changed significantly in many parts of Minnesota. Since the 1800s, it has been estimated that about half of the state's wetlands have been lost. In many parts of southern Minnesota, well over 90% of the original wetlands have been drained. Because of the benefits associated with wetlands, Minnesota adopted a "no net loss" of wetland policy in 1991, and in 2006 initiated a rigorous, long-term monitoring programs to track changes in wetland quality (MPCA) and quantity (DNR) over time. Between 2006 and 2008, the DNR's monitoring effort assessed wetland and deepwater area in 4,990 plots across Minnesota to serve as a baseline. Those same plots are reassessed every three years to track changes in wetland and deepwater area. In 2017, the program reduced the number of plots to 3,750. Data have been collected through 2023 and analyzed through 2020. Because these plots are a random sample of the state, they allow us to estimate statewide values, but note that we have not conducted a complete inventory of the state's wetlands for these data.

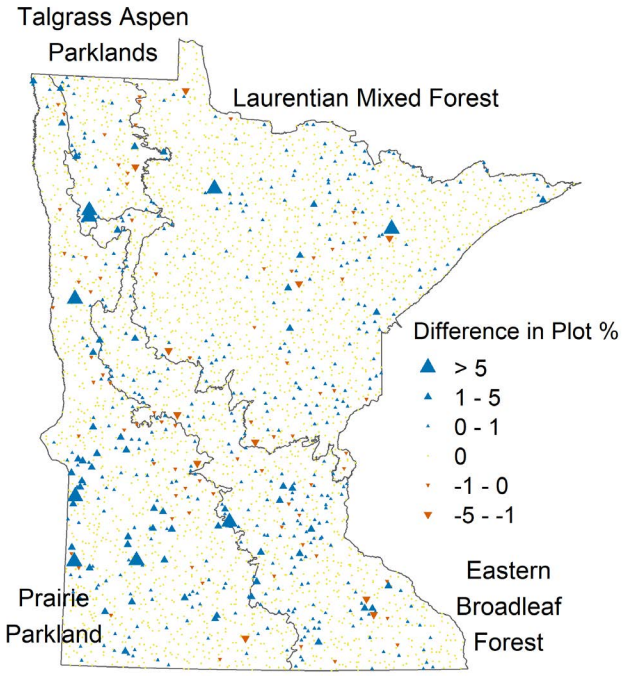


Figure 59: Change in wetland and deepwater area to or from upland and artificially flooded wetland between the baseline and 2020, displayed as the difference in percent plot area (final percent - initial percent). The ecological provinces, as defined by MN DNR's ecological land classification system, are outlined and labelled.

Minnesota had the following estimated changes in statewide wetland/deepwater between 2006 and 2020:

- A gain of 50,737 acres, which is a 0.39% increase from baseline acreage,
- A loss of 7,348 acres, which is a 0.06% decrease from baseline acreage, and
- A net change of 43,389 acres, which is a 0.33% increase from baseline acreage.

The most recent monitoring cycle (2018-2020) captured the greatest gains and smallest losses in wetland area so far in the monitoring program.

In spite of nominally achieving the state's no-net loss goal with respect to wetland quantity, the data suggest important reasons to be concerned about the state of wetlands in Minnesota.

- Much of the observed gains have been unconsolidated bottom type wetlands (ponds) that typically have limited wildlife habitat value.
- Large areas of wetlands have been converted between different types between 2006 and 2020, including approximately 89,632 acres of forested wetlands statewide that have become emergent wetland, and approximately 23,298 acres of emergent wetlands statewide that have become cultivated wetland. While these changes are not considered a loss of wetland area; they undoubtedly represent a loss of wetland function.

Restoring wetlands may be an important practice in Minnesota to slow down runoff and trap pollutants before they reach downstream lakes and streams. Results from the wetland tracking effort described above suggest that historical patterns of outright wetland loss may be leveling off, but there is a need to focus on restoring and maintaining wetland functional quality.

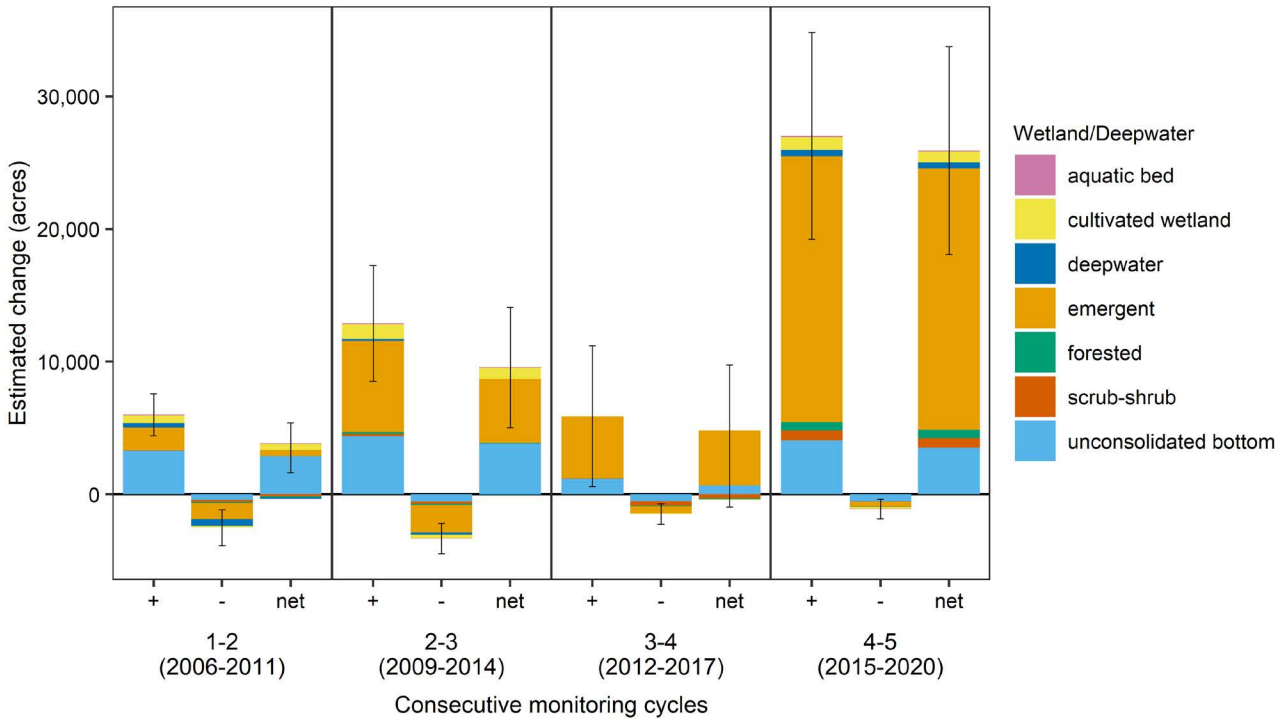


Figure 60: Change in wetland area between consecutive monitoring cycles, estimated for the entire state of Minnesota, color-coded by wetland class/deepwater.

Status	Trend	Description
▲	➡	External drivers interact in a complex manner impacting how Clean Water Funds need to be invested.