Surface Water Monitoring 2024

DRINKING WATER AMBIENT MONITORING PROGRAM

9/5/2025

Surface Water Monitoring 2024

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Background

The Drinking Water Ambient Monitoring Program (DWAMP) surface water monitoring initiative aims to characterize the ambient and seasonal water quality conditions of surface water bodies that supply drinking water. Seasonal sampling was conducted three times a year to measure water chemistry parameters (phosphorous, nitrate, chloride, and total suspended solids (TSS)) and water quality indicators (temperature, specific conductivity (SPC), dissolved oxygen (DO), pH, oxidation reduction potential (ORP), turbidity, and phycocyanin (PC)).

These water chemistry parameters were selected because they are effective indicators of surface water quality and commonly found in impaired waters requiring Total Maximum Daily Load (TMDL) standard development. The TMDL is a calculation of the maximum amount of a pollutant allowed by the Environmental Protection Agency (EPA) to enter a waterbody to assure the waterbody will continue to meet water quality standards.[1]

In addition, a subset of surface water sources were sampled for the following cyanotoxins: microcystin, anatoxin-a, cylindrospermopsin, and saxitoxin. These toxins are produced by harmful algal blooms (HABs), which can contaminate drinking water sources and pose a risk to human health.

Because these samples were taken from public access points on the water bodies, the public water systems (PWSs) were included in communications for awareness only. These efforts were not used for or required for compliance with the Safe Drinking Water Act.

Contaminant information

Chloride

Chloride is an ion that is naturally occurring and can also be introduced to water from deicing, water softening, and other anthropogenic (human-made) causes. High concentrations of chloride can be toxic for birds, plants, and aquatic life and cause drinking water to taste salty.[2] The EPA has established a secondary maximum contaminant level (SMCL) for chloride of 250 mg/L. A secondary drinking water standard is a non-enforceable guideline that regulates a contaminant causing cosmetic or aesthetic effects in drinking water but does not pose a risk to human health.

Total suspended solids

TSS is the total volume of organic and inorganic solids present in water. Elevated TSS is associated with lower water clarity and higher turbidity, which can impede the growth of

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[1] MPCA. (n.d.). *Total maximum daily load (TMDL) projects*. Retrieved from Minnesota Pollution Control Agency: https://www.pca.state.mn.us/business-with-us/total-maximum-daily-load-tmdl-projects

[2] MPCA. (n.d.). *Chloride*. Retrieved from Minnesota Pollution Control Agency: https://www.pca.state.mn.us/pollutants-and-contaminants/chloride

beneficial aquatic plants and impair the vision of fish. In-stream erosion or runoff from the surrounding land surface are sources of sediment which may increase TSS in a water body, and this sediment may carry nutrients, pesticides, and other contaminants.[3]

Nitrate

Nitrate is a nutrient with both natural and anthropogenic sources. It may be elevated in agricultural runoff after application of fertilizer. In drinking water, high nitrate can have negative impacts to human health; the most well-documented is the potential to cause methemoglobinemia (also known as blue baby syndrome).[4] The EPA enforces a maximum contaminant level (MCL) of 10 mg/L for nitrate in drinking water. MCLs are established through a scientific process that evaluates the health impacts of the contaminant and the technology and cost required for prevention and/or treatment. They are legally enforceable standards that apply to PWSs.

Phosphorous

Phosphorous is a nutrient with natural and anthropogenic sources. Like nitrate, it may be elevated in agricultural runoff after application of fertilizer. Phosphorous in drinking water does not typically present a risk to human health. However, elevated phosphorous in surface water fuels HABs, which may produce harmful cyanotoxins and undesirable taste and odor compounds.[5] Thus, the EPA recommends phosphorous not exceed 0.1 mg/L in streams which do not empty into reservoirs, 0.05 mg/L in streams discharging into reservoirs, and 0.025 mg/L in reservoirs.

Cyanotoxins

Cyanotoxins are a group of toxic compounds produced by naturally occurring cyanobacteria. When conditions are right for a HAB, cyanobacteria can produce rapidly and release cyanotoxins at levels that are harmful to human health.[6] HAB occurrence is correlated to multiple environmental factors, including temperature, nutrient availability, and flow conditions. For this reason, they are transitory in nature and can be difficult to predict. Cyanotoxin contamination, in turn, may also be transitory, although some toxins can persist in

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[3] MPCA. (n.d.). *Sediment*. Retrieved from Minnesota Pollution Control Agency: https://www.pca.state.mn.us/pollutants-and-contaminants/sediment

[4] MDH. (2025). *Nitrate in Drinking Water*. Retrieved from Minnesota Department of Health: https://www.health.state.mn.us/communities/environment/water/contaminants/nitrate.html

[5] MPCA. (n.d.). *Phosphorus*. Retrieved from Minnesota Pollution Control Agency: https://www.pca.state.mn.us/pollutants-and-contaminants/phosphorus

[6] MPCA. (n.d.). Blue-green algae and harmful algal blooms. Retrieved from Minnesota Pollution Control Agency: https://www.pca.state.mn.us/air-water-land-climate/blue-green-algae-and-harmful-algal-blooms

the environment after a bloom has died.[7] Microcystin[8,9] is the most frequently detected cyanotoxin in Minnesota waters, but anatoxin-a,[10] cylindrospermopsin[11], and saxitoxin[12] have also been found.

Cyanotoxins are associated with various human health effects, including vomiting, diarrhea, cough, sore throat, and headaches. Several instances of livestock and dog deaths as well as human illnesses have been recorded in Minnesota following cyanotoxin exposure during HAB events. In rare circumstances, cyanotoxin exposure can be fatal to humans.

While there are no federal drinking water standards in place for any of these four toxins, the EPA has published 10-day Health Advisory values (HAs) for microcystin and cylindrospermopsin. HAs identify the concentration of a contaminant in drinking water at which adverse health effects and/or aesthetic effects are not anticipated to occur over specific exposure durations. The most conservative HAs, intended to be protective of infants and toddlers, are 0.3 µg/L for total microcystin and 1.6 µg/L for cylindrospermopsin. MDH has also developed a Health Based Value (HBV) of 0.1 µg/L for microcystin-LR in drinking water. An HBV is the concentration of a chemical (or a mixture of chemicals) that is likely to pose little or no risk to human health. Because microcystin-LR is the most toxic form of microcystin, guidelines for total microcystin and microcystin-LR are often used interchangeably.

Health risk data for saxitoxin and anatoxin-a in drinking water are limited. For anatoxin-a, MDH recommends a Risk Assessment Advice value (RAA) of 0.1 µg/L. RAA is technical guidance concerning exposures and risks to human health. For acute exposure to saxitoxin, the World Health Organization recommends a guidance value of 3.0 µg/L.

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[7] EPA. (2014). Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems. United States Environmental Protection Agency, Office of Water. Retrieved from https://www.epa.gov/sites/default/files/2014-08/documents/cyanobacteria_factsheet.pdf

[8] MDH. (2015). *MIcrocystin-LR in Drinking Water.* Retrieved from Minnesota Department of Health: https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/mclrinfo.pdff

[9] Heiskary, S., Lindon, M., & Anderson, J. (2014). Summary of microcystin concentrations in Minnesota lakes. *Lake and Reservoir Management, 30*(3), 268-272.

[10] MDH. (2016). *Anatoxin-a and Drinking Water.* Retrieved from Minnesota Department of Health: https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/anatoxininfo.pdf

[11] Heathcote, A. (2022). *Determining Risk of Toxic Alga in Minnesota Lakes.* Retrieved from Legislative-Citizen Commission on Minnesota Resources (LCCMR): https://www.lccmr.mn.gov/projects/2018/finals/2018_06f.pdf

[12] Heiskary, S., & Lindon, M. (2007). *Microcystin Levels in Eutrophic South Central Minnesota Lakes.* Minnesota Lake Water Quality Assessment, Minnesota Pollution Control Agency. Retrieved from https://www.pca.state.mn.us/sites/default/files/wq-lar3-11.pdf

Phycocyanin, a blue-green pigment found in cyanotoxin-producing cyanobacteria, is frequently used as a proxy indicator for cyanobacterial blooms. Phycocyanin is positively correlated with cyanobacteria mass, and a bloom may be observed at levels greater than 0.0030 mg/L.[13]

Methods

Site selection

All surface water bodies that serve as partial or primary sources of drinking water for municipal PWSs were sampled for general chemistry parameters. Sampling was conducted from the nearest public water access or park to the city's drinking water intake (see Table 1 and Figure 1). When no nearby access point was available, the city was contacted for permission to sample from their property.

Additionally, seven sources serving six PWSs were selected for cyanobacteria and cyanotoxin sampling: Budd Lake (Fairmont), Wright Lake (Fergus Falls), Mississippi River (Minneapolis), Minnesota River (Mankato), Blue Earth River (Mankato), Burntside Lake (Ely), and Lake Superior (Duluth). These samples were collected from the same location as the general chemistry samples.

Table 1. Surface Water Source Sampling Locations

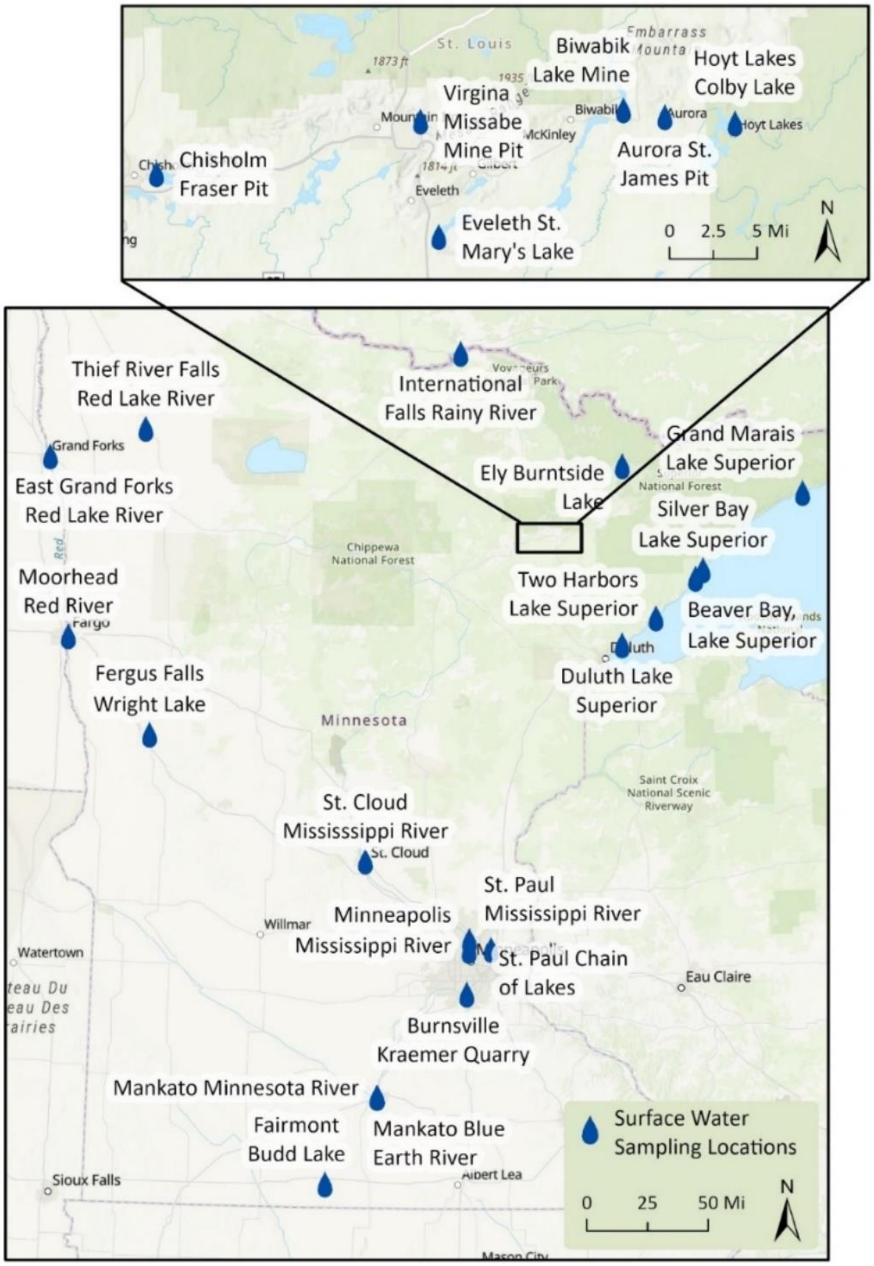
Public Water System	Water Body	Sampling Location	Cyanotoxins Sampled?
Aurora	St. James Pit	St. James Pit PWA	No
Beaver Bay	Lake Superior	Near Beaver Bay pumphouse	No
Biwabik	Lake Mine	Sabin (Embarrass Mine) PWA	No
Burnsville	Kraemer Quarry	Kraemer Quarry near intake	No
Chisholm	Fraser Pit	Chisholm private access near intake	No
Duluth	Lake Superior	Beach just north of Lakewood Station	Yes
East Grand Forks	Red Lake River	Bob Zavoral Memorial Boat Ramp	No
Ely	Burntside Lake	Ely private access behind pumphouse	Yes
Eveleth	St. Mary's Lake	Off road across Eveleth Veterans Park	No
Fairmont	Budd Lake	Steve Pierce Memorial Park	Yes
Fergus Falls	Wright Lake	Fergus Falls private access near intake	Yes
Grand Marais	Lake Superior	Near Grand Marais pumphouse	No

[13] Ahn, C.-Y., Joung, S.-H., Yoon, S.-K., & Oh, H.-M. (2007). Alternative Alert System for Cyanobacterial Bloom, Using Phycocyanin as a Level Determinant. *Journal of Microbiology, 45*(2), 98-104.

Public Water System	Water Body	Sampling Location	Cyanotoxins Sampled?
Hoyt Lakes	Colby Lake	Water access behind treatment plant	No
International Falls	Rainy River	Ray Jans Sportfishing Pier	No
Mankato	Blue Earth River	Sibley Park	Yes
Mankato	Minnesota River	Land of Memories Park	Yes
Minneapolis	Mississippi River	North Mississippi Regional Park	Yes
Moorhead	Red River	Off River Drive S	No
Saint Cloud	Mississippi River	Off Fifth Ave N in Hester Park	No
Saint Paul Regional Water Services	Chain of Lakes	Off Sucker Lake Rd	No
Saint Paul Regional Water Services	Mississippi River	River Park	No
Silver Bay	Lake Superior	Silver Bay private access near pumphouse	No
Thief River Falls	Red Lake River	Mill Yard Park upstream of dam	No
Two Harbors	Lake Superior	South end of Lakeview Park	No
Virginia	Missabe Mine Pit	Minorca Mine private dock*	No

*Samples collected from Missabe Mine Pit in the Spring were taken at the Virginia drinking water intake.

Figure 1: Sampling Locations of Surface Water Bodies that Source Public Drinking Water for Communities in Minnesota



Communications

All PWS operators were notified of the sampling efforts for both the general water chemistry parameters as well as the cyanotoxin investigation. Since samples were collected from public access points on the water bodies in most cases, these communications were for awareness only.

Results from the cyanotoxin samples were sent to the respective PWSs for general awareness, and the DWAMP team offered additional follow-up sampling at the intake and entry points of the systems. Only one system opted to have additional samples taken at the treatment plant, and the results were below the relevant health-based guidance values. Results from analysis of general water chemistry parameters were also available to system operators upon request.

Sampling

Sampling at each site was conducted in the spring, summer, and fall of 2024 to capture seasonal variation in general chemistry parameters. Grab samples of phosphorous, nitrate, chloride, and TSS were collected from shore or a dock as close to the PWS intake as possible using an extendable sampling rod. Water quality indicators were measured *in situ* using a multiparameter sonde equipped to measure temperature, SPC, pH, ORP, turbidity, DO, and PC. Data from the sonde were recorded every 3 minutes for 15 minutes before collecting grab samples. General chemistry samples were collected, preserved, and analyzed in accordance with the EPA-approved standard methods listed in Table 2.

In July, cyanobacteria and cyanotoxin samples were collected at a selection of surface water sampling locations. A duplicate set of samples was collected at the Minneapolis Mississippi River sampling location. Cyanobacteria samples were preserved in the field with aqueous glutaraldehyde and assayed using a Yokogawa Fluid Imaging Technologies FlowCam Cyano. Cyanotoxin samples were collected and preserved following guidelines recommended by Eurofins Abraxis and assayed using ELISA Plates (Table 2).

All grab samples were kept on ice until lab drop-off and analyzed by the Minnesota Department of Health Public Health Laboratory.

Table 2: Sample Collection and Analysis Methods

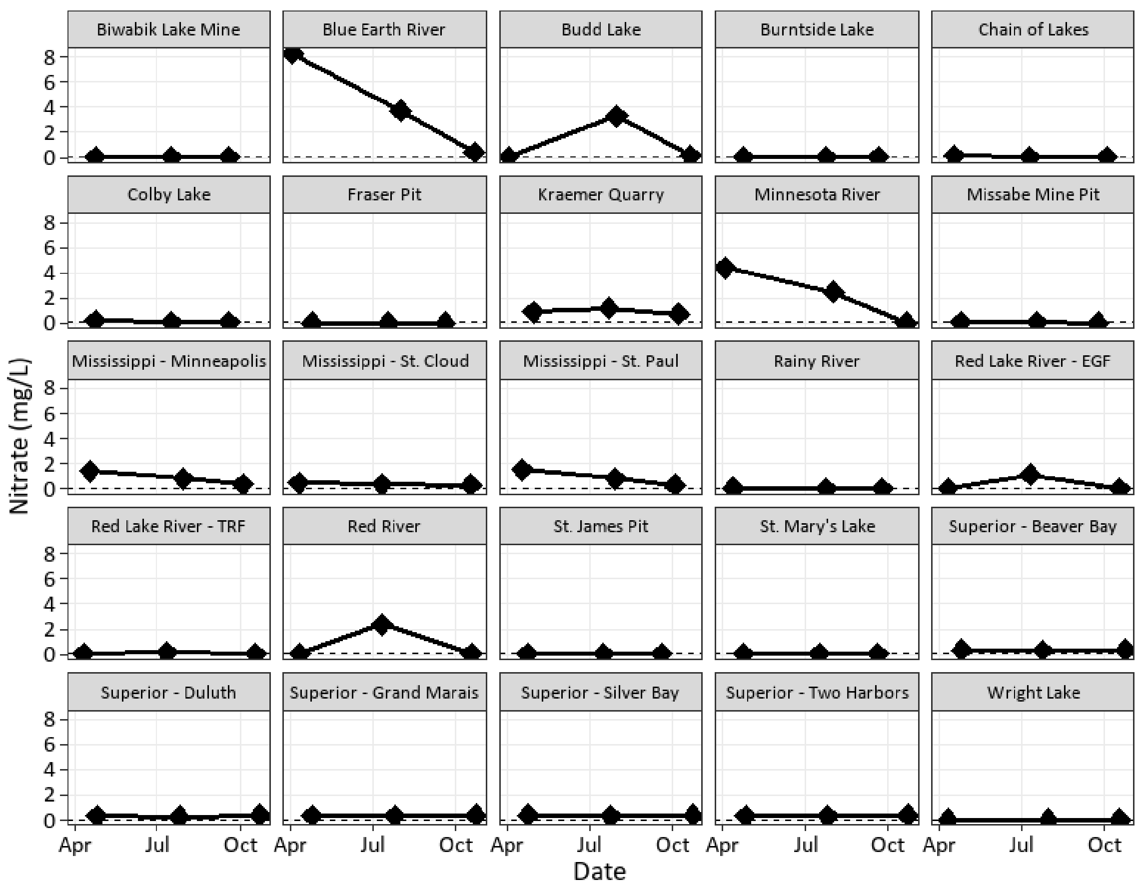
Analyte	Method
Total Phosphorous	EPA 365.1
Nitrite + Nitrate Nitrogen	EPA 353.2
Chloride	EPA 300.1
Total Suspended Solids	SM 2540 D, 2011
Anatoxin-a	Abraxis 520060
Cylindrospermopsin and Microcystins	Abraxis 522011
Saxitoxin	Abraxis 52255B

Results

Nitrate

There were no nitrate detections above the MCL of 10 mg/L, and nitrate in most of the analyzed samples was below 2.5 mg/L. Nitrate concentrations were highest in the Blue Earth and Minnesota Rivers in Mankato, and also decreased sharply between spring and fall (Figure 1). In the Blue Earth River, nitrate fell from over 8 mg/L in the spring to less than 1 mg/L in the fall. In the Minnesota River, nitrates decreased from over 4 mg/L in the spring to below detection in the fall. In the Mississippi River, nitrates remained below 2 mg/L throughout the year, decreasing slightly between April and October. As nitrate concentrations are typically correlated to flow rate in Minnesota, this seasonal variability in river nitrate is expected.[14] In the lake sources, nitrates remained low throughout the year, with most measurements sitting right above or below the detection limit. The highest concentration among lakes was recorded in Fairmont (Budd Lake) in July.

Figure 2: Concentration of Nitrate + Nitrite Nitrogen in Surface Drinking Water Sources in Minnesota in 2025



EGF: East Grand Forks; TRF: Thief River Falls. The dashed line at y = 0.05 on each plot denotes the reporting limit for nitrate. The data shown in this figure is included in Table A1.

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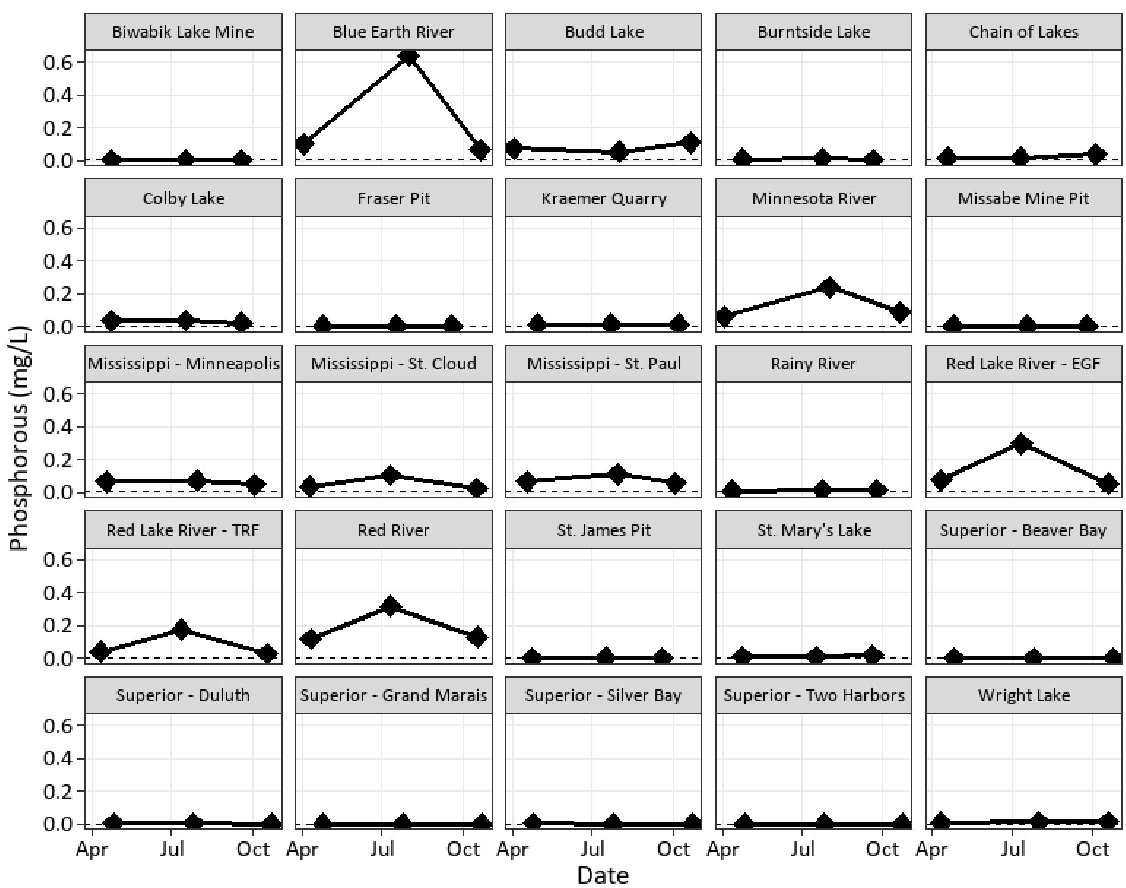
[14] MPCA. (2020). *5-year Progress Report on Minnesota's Nutrient Reduction Strategy.* Executive Summary, Minnesota Pollution Control Agency. Retrieved from https://www.pca.state.mn.us/sites/default/files/wq-s1-84b.pdf

Phosphorous

Phosphorous concentrations peaked during the summer at each river source. In July, phosphorous in the river sources (mean= 0.218 mg/L) was an order of magnitude higher than Phosphorous in the pit, quarry, and natural lakes (mean= 0.0156 mg/L). Phosphorous was particularly high in the Blue Earth, Minnesota, Red Lake, and Red Rivers, where land is predominately used for crop cultivation. Phosphorous in all river sources increased in July, which followed a period of heavy rainfall and flooding throughout much of Minnesota in the early summer. Like nitrate, phosphorous concentrations typically increase in Minnesota rivers during periods of high flow. A similar pattern was not observed in the lakes – phosphorous in these sources remained relatively low and steady throughout the year. Phosphorous was particularly low along Lake Superior’s North Shore, with a maximum concentration of 0.008 mg/L as measured near Duluth’s intake in April, and most samples measuring around or below the detection limit.

Figure 3: Concentration of Phosphorous in Surface Drinking Water Sources in Minnesota in 2025

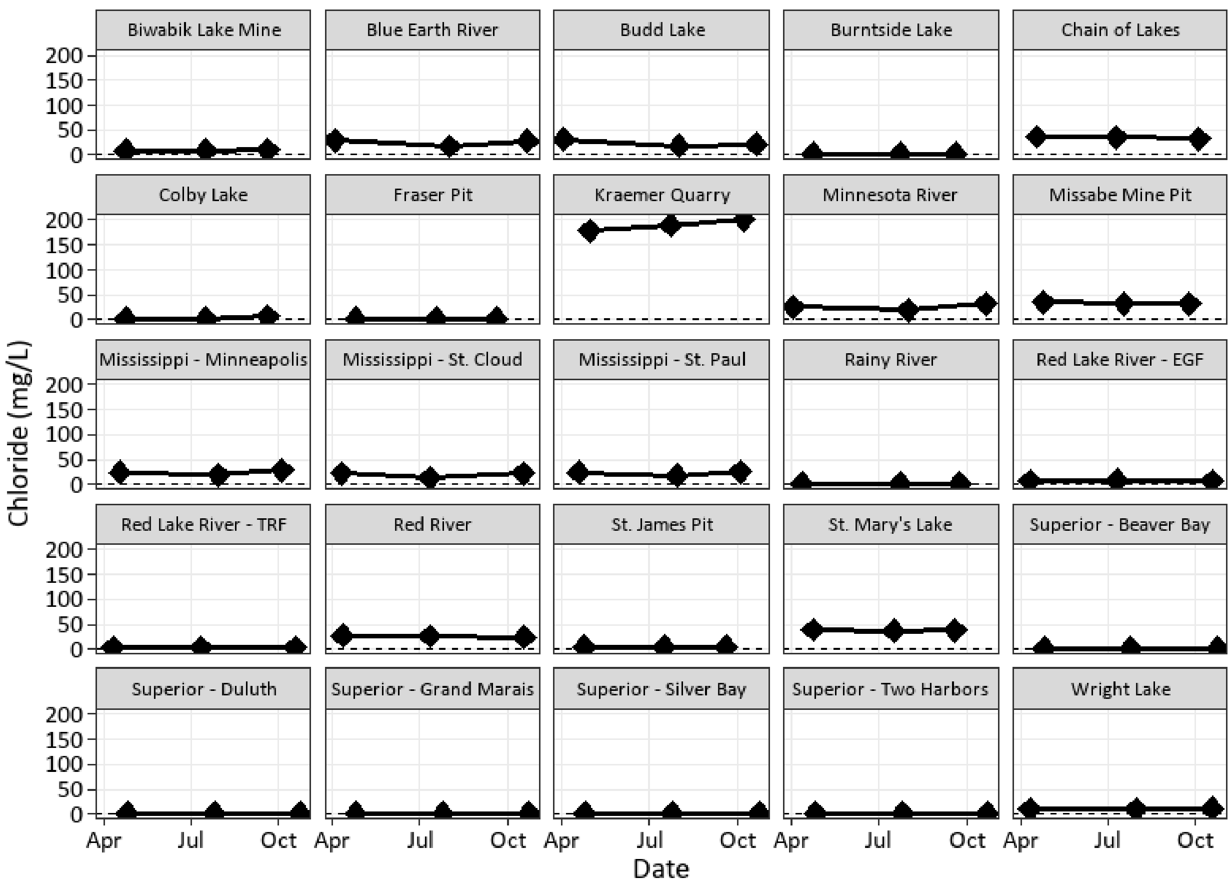


EGF: East Grand Forks; TRF: Thief River Falls. The dashed line at y = 0.003 on each plot denotes the reporting limit for phosphorous. The data shown in this figure is included in Table A2.

Chloride

Chloride was highest in the pit and quarry lakes (mean = 47.8 mg/L), particularly in Burnsville's water source (mean= 189.7 mg/L), which is surrounded by an active limestone quarry. Generally, chloride concentrations did not change much throughout the year. The exceptions were the Mississippi, Minnesota, and Blue Earth Rivers, where chloride concentrations dipped in the summer and increased again in the fall, possibly due to dilution by the storms and flooding experienced by the southern half of the state between June and July.

Figure 4: Concentration of Chloride in Surface Drinking Water Sources in Minnesota in 2025



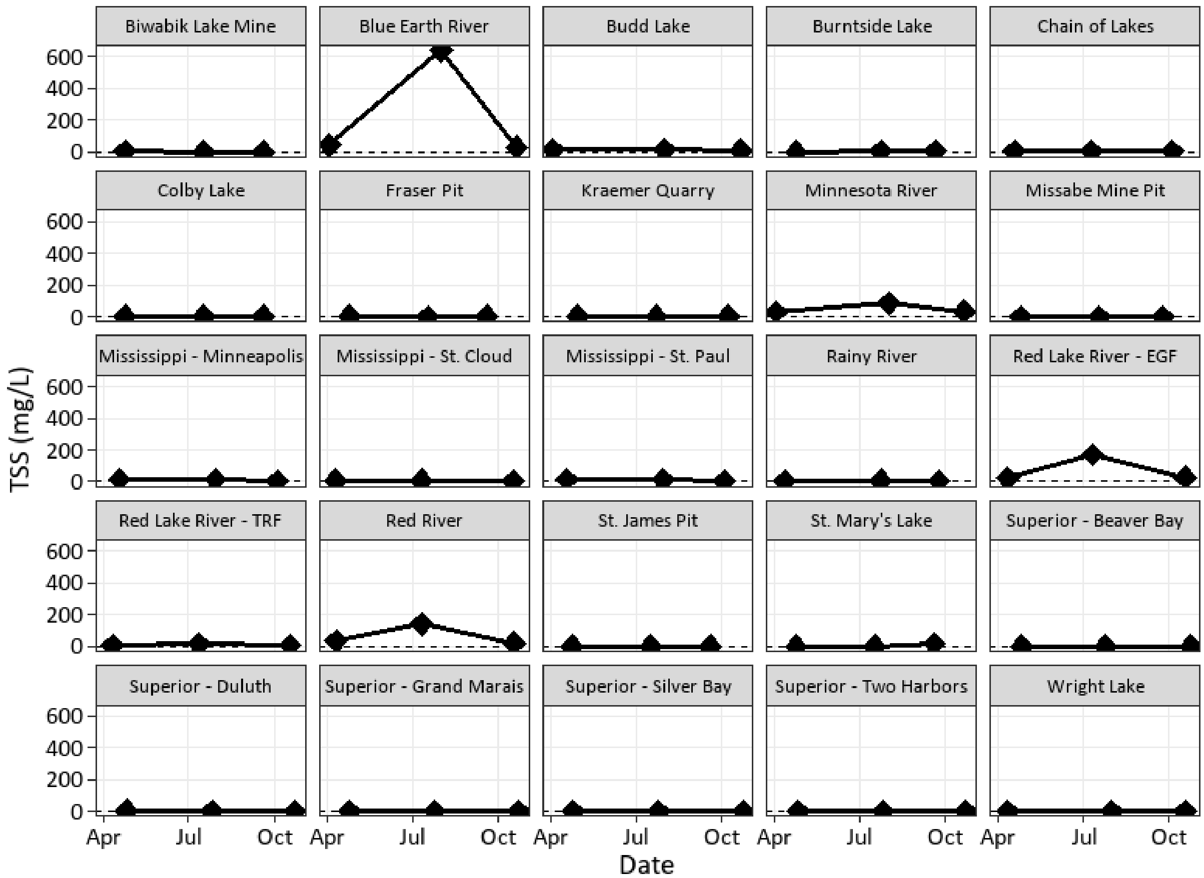
EGF: East Grand Forks; TRF: Thief River Falls. The dashed line at y = 0.5 on each plot denotes the reporting limit for chloride. The data shown in this figure is included in Table A3.

Total suspended solids

In most river sources, TSS was highest during the summer sampling when flood conditions produced high, fast-moving waters. This was especially true for the Blue Earth, Minnesota, Red Lake, and Red Rivers, where there have been historical impairments within the watershed for

TSS and turbidity.[15] In these rivers, TSS followed the same trend as phosphorous. TSS levels in the lake sources were comparably low.

Figure 5: Concentration of Total Suspended Solids at Surface Drinking Water Sources in Minnesota in 2025



EGF: East Grand Forks; TRF: Thief River Falls. The dashed line at y = 1 on each plot denotes the reporting limit for TSS. The data shown in this figure is included in Table A4.

Cyanotoxins

Several taxa of cyanobacteria were found at each of the seven locations chosen for cyanobacteria and cyanotoxin sampling. However, only Budd Lake had a total cyanobacteria volume above the detection limit (204 mm^3/L).

One or more cyanotoxins were detected at four of the sampling locations. Anatoxin-a detections in Burntside Lake (0.18 µg/L), Mississippi River (0.44 µg/L), and Blue Earth River (3.90

[15] MPCA. (n.d.). *Minnesota's impaired waters list*. Retrieved from Minnesota Pollution Control Agency: https://www.pca.state.mn.us/air-water-land-climate/minnesotas-impaired-waters-list

µg/L) and an occurrence of microcystin in Budd Lake (0.57 µg/L) were all above guidance values. Saxitoxin was also detected in the Blue Earth River, although the concentration (0.02 ug/L) was just above the detection limit. Anatoxin-a concentration in the duplicate sample collected from the Mississippi River was 0.29 µg/L.

Sonde measurements of phycocyanin were lower than 3 µg/L throughout the year, indicating that none of the surface water sources experienced a cyanobacteria bloom concurrent with sampling.

Summary and discussion of results

Overall, nitrate, phosphorous, and TSS in the river samples were elevated following periods of heavy rain, while chloride concentrations remained mostly stable throughout the year. However, it’s important to note that because these contaminant concentrations are grab samples, they are not flow-weighted, which indicates a higher chloride, nutrient, and sediment load overall during heavy precipitation and flood conditions. In the lakes, chloride, nitrate, phosphorous, and TSS concentrations remained mostly stable throughout the year, except for Budd Lake, where nitrate peaked in July. This spike in nitrate concurred with elevated microcystin and cyanobacteria biomass in Budd Lake. Continued monitoring of nutrients, cyanobacteria, and cyanotoxins is necessary to explore this relationship further.

Because cyanobacteria biomass and cyanotoxin concentrations can vary spatially across a water body, these data are not necessarily predictive of which cyanotoxins may be present in public drinking water. PWSs typically draw water further from shore and deeper in the water column than what was accessible for DWAMP staff at the time of sampling. Furthermore, PWSs using surface water sources may already have treatment in place that is effective at removing cyanotoxins and cyanobacteria in their finished water. Thus, coordinating with PWSs to conduct additional sampling, in both raw source water and finished drinking water, is necessary to assess the health risk cyanotoxins pose in public drinking water. Additionally, the transitory nature of HABs and cyanotoxins in surface water and relationship to climatic factors warrants more frequent and longer-term sampling, particularly during the growing season.

Future implications

In 2025, cyanotoxin monitoring will be expanded to include more frequent sampling at the intake of several PWSs around the state that source their drinking water from surface water bodies and will include monitoring of treated water. Seasonal water chemistry sampling will continue at all surface water sources throughout the year.

General chemistry and cyanotoxin data will be compiled in reports on an annual basis. Every five years, these reports will be expanded to include a more robust analysis of interannual trends.

Appendix

Table A1: Nitrate in Surface Drinking Water Sources

Source	Spring Result (mg/L)	Summer Result (mg/L)	Fall Result (mg/L)
Biwabik Lake Mine	<	<	<
Budd Lake	0.05	3.3	0.15
Burntside Lake	<	<	<
Chain of Lakes	0.14	<	0.06
Colby Lake	0.21	0.11	0.11
Fraser Pit	<	<	<
Kraemer Quarry	0.89	1.2	0.74
Missabe Mine Pit*	0.09	0.06	<
St. James Pit	<	<	<
St. Mary's Lake	0.06	<	<
Superior - Beaver Bay	0.36	0.31	0.36
Superior - Duluth	0.31	0.29	0.37
Superior - Grand Marais	0.35	0.31	0.36
Superior - Silver Bay	0.37	0.31	0.36
Superior - Two Harbors	0.34	0.31	0.36
Wright Lake	<	<	<
Blue Earth River	8.3	3.7	0.42
Minnesota River	4.4	2.5	<
Mississippi - Minneapolis	1.4	0.83	0.36
Mississippi - St. Cloud	0.47	0.34	0.3
Mississippi - St. Paul	1.5	0.83	0.31
Rainy River	0.06	<	<
Red Lake River – East Grand Forks	<	1.1	<
Red Lake River – Thief River Falls	<	0.15	<
Red River	<	2.4	<

< denotes samples with nitrate below the reporting limit, which is 0.05 mg/L.

*Samples collected from Missabe Mine Pit in the Spring were taken at the Virginia drinking water intake as surface water access was not possible.

Table A2: Phosphorus in Surface Drinking Water Sources

Source	Spring Result (mg/L)	Summer Result (mg/L)	Fall Result (mg/L)
Biwabik Lake Mine	0.005	0.003	ND
Budd Lake	0.075	0.053	0.11
Burntside Lake	0.008	0.011	0.005
Chain of Lakes	0.018	0.018	0.04
Colby Lake	0.034	0.037	0.023

Source	Spring Result (mg/L)	Summer Result (mg/L)	Fall Result (mg/L)
Fraser Pit	0.003	0.004	0.003
Kraemer Quarry	0.015	0.014	0.014
Missabe Mine Pit*	0.004	0.003	0.004
St. James Pit	<	0.004	<
St. Mary's Lake	0.009	0.01	0.017
Superior - Beaver Bay	0.003	<	<
Superior - Duluth	0.008	0.006	<
Superior - Grand Marais	<	0.003	<
Superior - Silver Bay	0.006	0.003	<
Superior - Two Harbors	<	0.003	<
Wright Lake	0.012	0.015	0.016
Blue Earth River	0.099	0.639	0.066
Minnesota River	0.061	0.238	0.088
Mississippi - Minneapolis	0.065	0.07	0.048
Mississippi - St. Cloud	0.037	0.105	0.024
Mississippi - St. Paul	0.067	0.109	0.057
Rainy River	0.01	0.015	0.016
Red Lake River – East Grand Forks	0.076	0.296	0.052
Red Lake River – Thief River Falls	0.041	0.174	0.03
Red River	0.119	0.315	0.129

< denotes samples with a phosphorous concentration below the reporting limit, which is 0.003 mg/L.

*Samples collected from Missabe Mine Pit in the Spring were taken at the Virginia drinking water intake as surface water access was not possible.

Table A3: Chloride in Surface Drinking Water Sources

Source	Spring Result (mg/L)	Summer Result (mg/L)	Fall Result (mg/L)
Biwabik Lake Mine	9.38	9.28	9.5
Budd Lake	31	18.4	21.3
Burntside Lake	2.5	2.49	2.45
Chain of Lakes	36.2	36.1	33
Colby Lake	1.64	2.83	6.55
Fraser Pit	2.12	1.92	1.89
Kraemer Quarry	178	190	201
Missabe Mine Pit	35*	32.3	32.1
St. James Pit	5.2	5.03	4.86
St. Mary's Lake	39.2	36.7	37.9
Superior - Beaver Bay	1.65	1.65	1.63
Superior - Duluth	2.24	2.27	1.68
Superior - Grand Marais	1.65	1.58	1.63

Source	Spring Result (mg/L)	Summer Result (mg/L)	Fall Result (mg/L)
Superior - Silver Bay	1.65	1.62	1.62
Superior - Two Harbors	1.79	1.68	1.61
Wright Lake	10.1	10.3	11.5
Blue Earth River	29.6	17.4	28.3
Minnesota River	25.5	19.5	32.9
Mississippi - Minneapolis	24.6	18.9	28.7
Mississippi - St. Cloud	22.6	13.3	23
Mississippi - St. Paul	24.9	18.2	25.6
Rainy River	2.15	1.6	1.61
Red Lake River – East Grand Forks	6.43	7.99	7.17
Red Lake River – Thief River Falls	4.05	4.44	3.85
Red River	27.3	26.6	24.4

*Samples collected from Missabe Mine Pit in the Spring were taken at the Virginia drinking water intake as surface water access was not possible.

Table A4: Total Suspended Solids in Surface Drinking Water Sources

Source	Spring Result (mg/L)	Summer Result (mg/L)	Fall Result (mg/L)
Biwabik Lake Mine	2.4	1.2	<
Budd Lake	15	13	8.4
Burntside Lake	<	2	1.6
Chain of Lakes	1.6	1.6	2.8
Colby Lake	3.2	1.6	2
Fraser Pit	1.2	<	2
Kraemer Quarry	3.6	1.6	1.6
Missabe Mine Pit	<*	<	<
St. James Pit	<	1.2	<
St. Mary's Lake	2.4	2.4	16
Superior - Beaver Bay	<	<	<
Superior - Duluth	2.4	1.6	<
Superior - Grand Marais	<	<	<
Superior - Silver Bay	<	<	<
Superior - Two Harbors	<	<	<
Wright Lake	1.6	1.2	1.2
Blue Earth River	42	640	29
Minnesota River	30	85	34
Mississippi - Minneapolis	14	10	2.8
Mississippi - St. Cloud	5.6	8.4	3.2
Mississippi - St. Paul	13	10	2.4
Rainy River	2	8.4	2.8

Source	Spring Result (mg/L)	Summer Result (mg/L)	Fall Result (mg/L)
Red Lake River – East Grand Forks	22	170	26
Red Lake River – Thief River Falls	6.4	16	7.2
Red River	33	140	22

< denotes samples with TSS below the reporting limit, which is 1 mg/L.

*Samples collected from Missabe Mine Pit in the Spring were taken at the Virginia drinking water intake as surface water access was not possible.

Table A5: Cyanotoxins and Cyanobacteria in Drinking Water Sources

Source	Anatoxin-a (µg/L)	Microcystin (µg/L)	Saxitoxin (µg/L)	Total Cyanobacteria (mm3/L)
Lake Superior - Duluth	<	<	<	<
Burntside Lake	0.18	<	<	<
Mississippi River - Minneapolis	0.44	<	<	<
Budd Lake	<	0.57	<	204
Wright Lake	<	<	<	<
Blue Earth River	3.90	<	0.02	<
Minnesota River	<	<	<	<

< denotes samples with concentrations below the reporting limits. Cylindrospermopsin was not detected in any samples.