Nine Mile Creek Watershed District

Summary of 2023 Water Monitoring Program

Prepared for
Nine Mile Creek Watershed District

August 2024

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August 2024

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1 Introduction

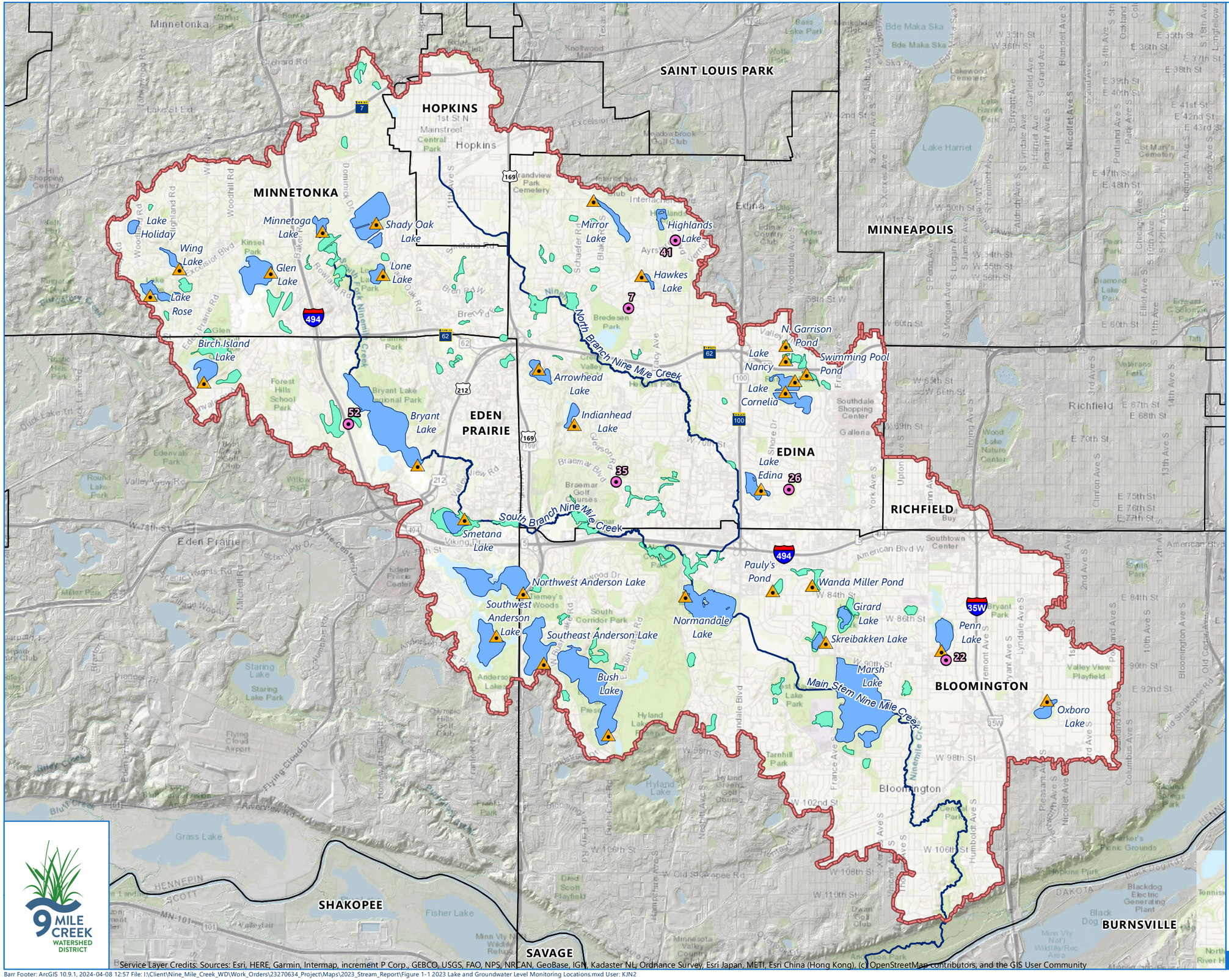
Monitoring of waterbodies in the Nine Mile Creek watershed is essential to developing an understanding of past and present conditions within the watershed and determining the need for action by the Nine Mile Creek Watershed District (District) or other entities. The District annually implements a lake, groundwater, and stream monitoring program designed to establish baseline conditions, track changes, inform additional studies (e.g., feasibility studies, water quality studies), and measure the effectiveness of past and/or ongoing improvement projects. The following report summarizes the lake, groundwater, and stream monitoring data collected by the District in 2023.

The District has been collecting lake levels and groundwater levels since 1960 and 1962, respectively. This information has been used to monitor fluctuations in lake and groundwater levels, helping to understand the connections between groundwater and surface water throughout the watershed and providing important information during times of flooding and drought. In 2023, the District collected monthly levels at 29 lakes and six groundwater monitoring wells. Figure 1-1 shows the lake level and groundwater monitoring locations.

The District has been conducting its water quality monitoring program since the late-1960s. Protecting and enhancing the surface water quality of Nine Mile Creek and the lakes within the watershed has been an important goal of the District for many decades. To help accomplish this goal, the District operates an extensive lake and stream management program. Generally, the program includes:

- Data collection (monitoring)
- Assessment (e.g., studies)
- Implementation of projects and programs

The District's 2023 water quality monitoring program included monitoring five lakes (Bush, Cornelia, Edina, Minnetoga, and Normandale), and Nine Mile Creek (Figure 1-2).



Level Monitoring Location

Active Groundwater Observation Wells

Nine Mile Creek

Lakes

Public Water Wetland

District Hydrologic Boundary

Municipal Boundaries

0 1 2

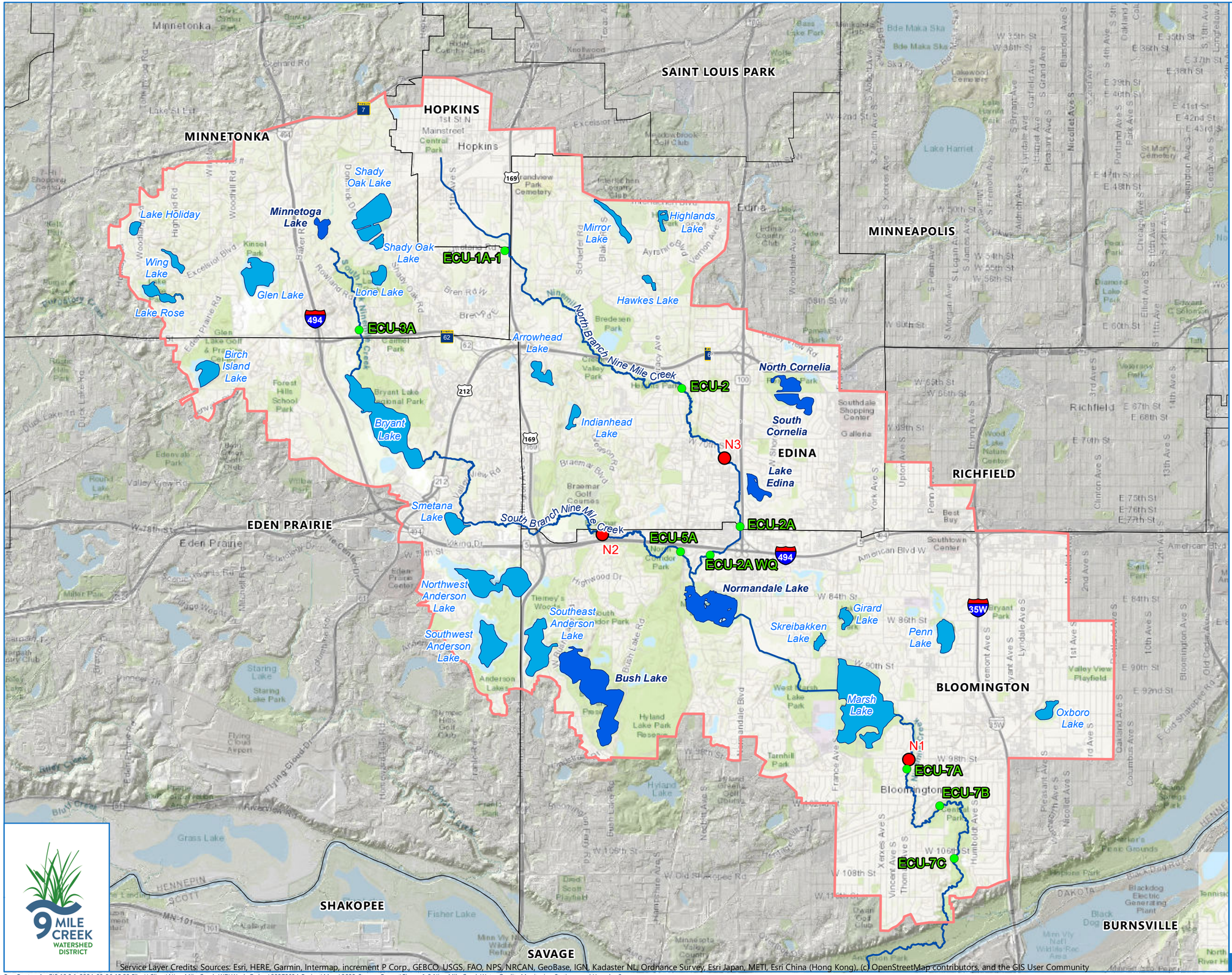
Miles

2023 LAKE AND GROUNDWATER LEVEL MONITORING LOCATIONS

Nine Mile Creek Watershed District

Hennepin County, Minnesota

Figure 1-1



WOMP (Watershed Outlet Monitoring Point) Stream Monitoring Station

Stream Monitoring Locations

Lake

Monitored Lake

Nine Mile Creek

District Legal Boundary

Municipal Boundaries

0 1 2

Miles

2023 LAKE AND STREAM MONITORING LOCATIONS
Nine Mile Creek Watershed District
Hennepin County, Minnesota

Figure 1-2

Barr Footer: ArcGIS 10.8.1, 2024-03-26 15:29 File: I:\Client\Nine_Mile_Creek_WD\Work_Orders\23270634_Project\Maps\2023_Stream_Report\Figure 1-2 Nine Mile Creek Water Quality Monitoring Stations.mxd User: kac2

2 Lake Water Quality Monitoring Overview

The Nine Mile Creek Watershed District monitors the water quality of its lakes on a rotating basis. Lakes monitored in a given year are selected to track water quality conditions, to gather additional information needed for consideration of potential management activities, to prepare for proposed projects, and/or to measure the effectiveness of past or ongoing improvement projects.

The District's full lake monitoring program typically consists of the following monitoring:

- water quality monitoring on six occasions (ice-out and five events during June through September)
- analysis of zooplankton on five occasions (June through September)
- analysis of phytoplankton on five occasions (June through September)
- aquatic plant (macrophyte) surveys during June and August.

In some cases, the District opts to collect a more limited dataset for a given lake, based on specific data needs and budget considerations. Table 2-1 summarizes the lake monitoring completed by the District in 2023. The water quality monitoring generally includes the following parameters: total phosphorus (TP), soluble reactive phosphorus (ortho phosphate), total nitrogen, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, pH, chlorophyll *a*, chloride, dissolved oxygen, Secchi disc, temperature, specific conductance, and turbidity.

Table 2-1 Summary of 2023 Lake Monitoring by the Nine Mile Creek Watershed District

Lake	Water Quality Monitoring	Phytoplankton	Aquatic Plant Surveys
Bush	X		
Cornelia (North and South)	X	X	(1)
Edina	X		
Minnetoga	X		(1)
Normandale	X	X	(2)

(1) Point intercept aquatic plant surveys conducted.
(2) Point intercept aquatic plant surveys and biomass surveys conducted.

Results of the District's 2023 lake monitoring are summarized in detail by lake in Sections 3 through Section 7. A summary of the 2023 monitoring results and recommendations for each lake can be found in subsections "Conclusions and Recommendations."

3 Bush Lake

Bush Lake (Figure 3-1), located in Bloomington, is a deep lake with a surface area of 188 acres, a maximum depth of 35 feet, and an estimated mean depth of 9.8 feet. The lake has a littoral zone (shallow area where plants grow) of 114 acres which is about 66 percent of the lake's surface area.

Bush Lake was a landlocked lake until a pumped outlet to the Southeast Anderson Lake was constructed in 2000 to manage water levels. The pump is programmed to turn on when the lake reaches a level of 833.5 mean sea level (M.S.L) and continue pumping until the lake reaches a level of 833 M.S.L.

In 2023, the Nine Mile Creek Watershed District monitored Bush Lake for:

- Water chemistry- total phosphorus (TP), soluble reactive phosphorus (orthophosphate), total nitrogen, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, chlorophyll *a*, and chloride.
- Water field measurements- dissolved oxygen, pH, temperature, specific conductance, turbidity, and Secchi disc.

Water quality monitoring data are summarized in Appendix A. Monitoring results are discussed in the following paragraphs and compared with historical data.

Figure 3-1 Bush Lake on July 10, 2023

3.1 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

Figure 3-2 shows the 2023 summer average (June through September) conditions for total phosphorus, chlorophyll *a*, and Secchi disc transparency data collected in the epilimnion (surface), in comparison with monitoring results from past years. The lake's 2023 summer average total phosphorus concentration of 13 µg/L, chlorophyll *a* concentration of 3.2 µg/L, and Secchi disc transparency of 3.6 meters met the Minnesota State water quality standards for lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Minnesota State water quality standards for deep lakes in the North Central Hardwood Forest Ecoregion are ≤40 µg/L, ≤14 µg/L, and ≥1.4 meter for total phosphorus, chlorophyll *a* and Secchi depth, respectively.

The historical water quality data presented in Figure 3-2 comes from several sources, including Nine Mile Creek Watershed District (1983, 1986, 1988, 1991, 1995, 2000, 2006, 2010, 2014, 2018, 2022, and 2023), the Limnological Research Center, the Citizen Lake Monitoring Program, Metropolitan Council, and the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP). During the monitored years, summer average total phosphorus and Secchi disc depth met the Minnesota State standards. In all monitored years besides 2001, the summer average chlorophyll *a* concentration met the Minnesota State standard.

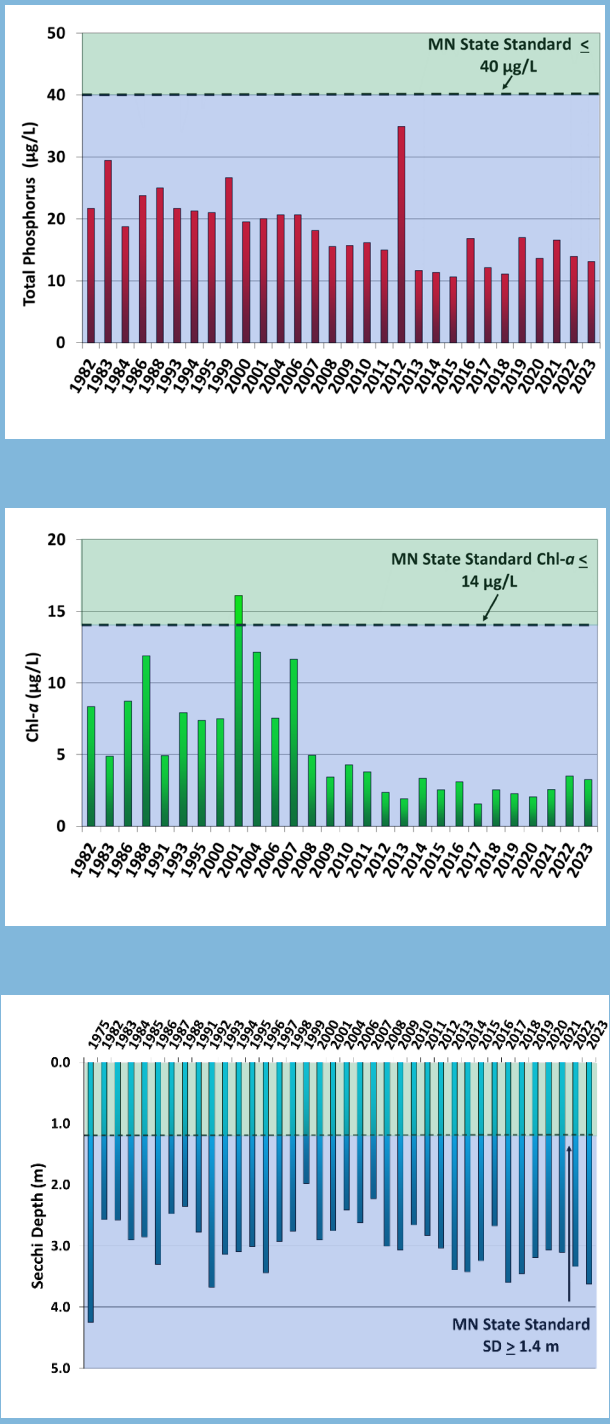


Figure 3-2 Bush Lake historical summer average values
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

3.2 Chlorides

Chloride concentrations were measured in 2010, 2014, 2018, 2022, and 2023 generally between April and September. Figure 3-3 shows the observed 2023 chloride concentrations, in comparison with historical observations. In 2010, 2022, and 2023, chloride concentrations were monitored in both the epilimnion (lake surface) and hypolimnion (lake bottom). Monitoring results showed that the chloride concentrations did not vary notably between the epilimnion and hypolimnion. Chloride concentrations increased in 2022 compared with past years and again increased in 2023. 2022 chloride concentrations in the epilimnion ranged from 55 to 64 mg/L compared with concentrations ranging from 44 to 58 mg/L in the epilimnion for monitored years between 2010 and 2018. 2023 chloride concentrations in the epilimnion ranged from 63 to 74 mg/L.

Because high concentrations of chloride can harm fish and plant life, the Minnesota Pollution Control Agency (MPCA) has established acute and chronic exposure chloride standards. A lake is considered impaired if two or more exceedances of chronic criterion (230 mg/L or less) occur within a three-year period or one exceedance of acute criterion (860 mg/L) is measured. All Bush Lake chloride measurements to date were well below the acute and chronic MPCA criteria. The 2023 data are summarized in Appendix A.

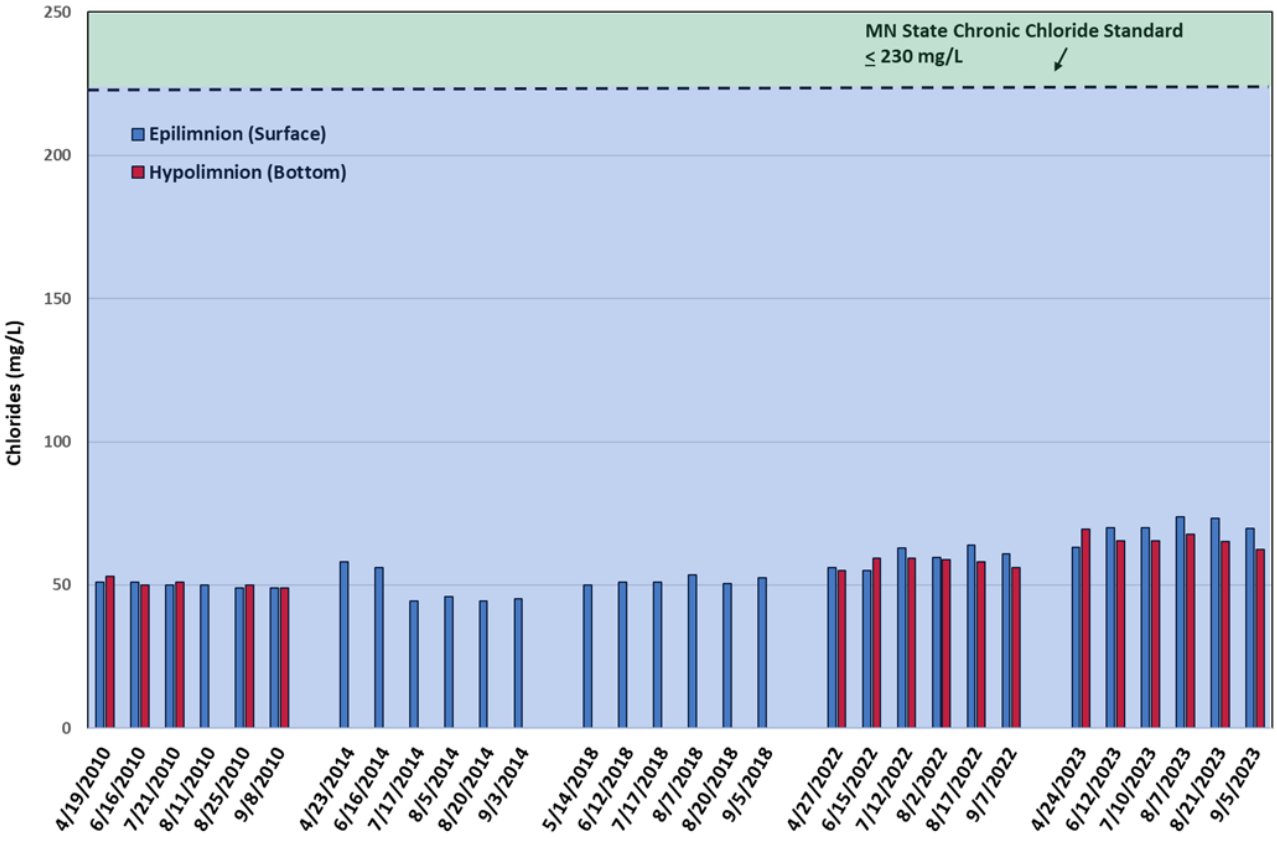


Figure 3-3 Bush Lake historical chloride concentration

3.3 Conclusions and Recommendations

Bush Lake water quality was excellent in 2023. Monitoring results indicate Bush Lake met the Minnesota State lake eutrophication water quality standards for total phosphorus, chlorophyll *a*, and Secchi disc depth as well as the MPCA acute and chronic exposure chloride criteria.

Aquatic invasive species (AIS) management projects were completed by the United States Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) during 2004 through 2007. During this period, the lake was annually treated with two herbicides, 2,4-D to control Eurasian watermilfoil (EWM) and endothall, to control curly-leaf pondweed (CLP).

Beyond the District's stormwater management rules for land development and re-development activities, no large-scale watershed or in-lake management projects have been implemented by the District since the USACE project was completed in 2007. The District is planning to conduct a water quality study of Bush Lake in 2025 to evaluate overall lake health and identify protection opportunities for the lake and its watershed.

Continuation of periodic water quality and biological monitoring is recommended to assess the condition of the lake's water quality and biological community and identify trends.

4 Lake Cornelia

Lake Cornelia (Figure 4-1) is located in the north central portion of Edina. Lake Cornelia is comprised of two basins, north and south. The two basins are connected by a small equalizing culvert under 66th Street (invert elevation of 859.0 MSL) on the south side of the north basin. Ultimately the water levels in the north basin are controlled by the outlet structure at the south basin. The outflow from the south basin discharges over a 14-foot long weir structure with a control elevation of 859.1 MSL. Discharges from Lake Cornelia - South Basin are conveyed to Lake Edina through an extensive storm sewer network.

The Minnesota Department of Natural Resources stocks the lake annually with bluegills for its Fishing in the Neighborhood Program.

In 2023, the Nine Mile Creek Watershed District monitored Lake Cornelia (North and South Basins) for:

- Water chemistry- total phosphorus (TP), soluble reactive phosphorus (ortho phosphate), total nitrogen, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, chlorophyll *a*, and chloride.
- Water field measurements- dissolved oxygen, pH, temperature, specific conductance, turbidity, and Secchi disc.
- Phytoplankton (microscopic plants).
- Macrophytes (aquatic plants).

Water quality monitoring results are summarized in Appendix A, phytoplankton results in Appendix B, and macrophyte monitoring maps in Appendix C. Monitoring results are discussed in the following paragraphs and compared with historical data.

Figure 4-1 Lake Cornelia – North Basin (left) and South Basin (right) on July 21, 2023

4.1 Lake Cornelia – North Basin

Lake Cornelia – North Basin (Figure 4-1) has a water surface area of approximately 20 acres, a maximum depth of 3.7 feet, and a mean depth of approximately 2.3 feet. The lake is shallow enough for aquatic plants to grow over the entire lake. It is a polymictic lake, mixing many times per year. The lake is currently on the MPCA's impaired waters list for excess nutrients (since 2008).

4.1.1 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2023, Lake Cornelia – North Basin water quality was poor. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 145 µg/L and 109 µg/L, respectively (Figure 4-2). The lake's 2023 summer average Secchi disc transparency was 0.3 meters (Figure 4-2). The summer averages for all three parameters failed to meet the Minnesota water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion in 2023 which are ≤60 µg/L, ≤20 µg/L, and ≥1 meter for total phosphorus, chlorophyll *a*, and Secchi disc transparency, respectively.

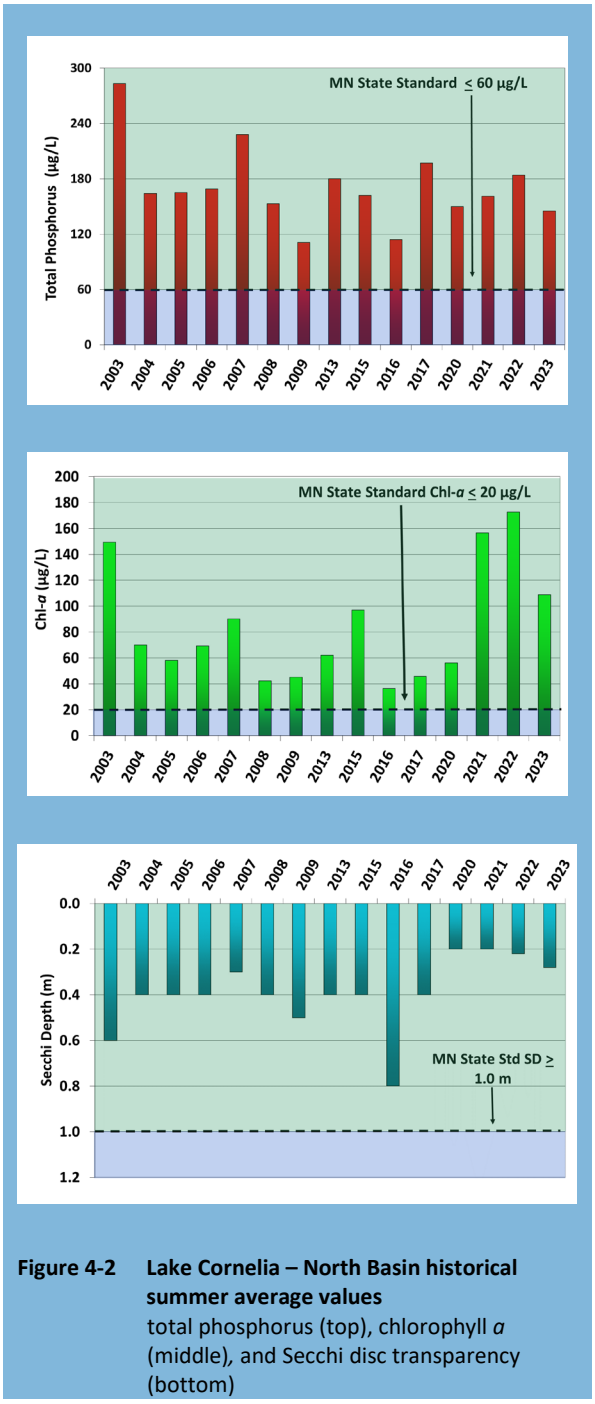


Figure 4-2 Lake Cornelia – North Basin historical summer average values
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc transparency (bottom)

Water quality data have been collected from Lake Cornelia – North Basin by Nine Mile Creek Watershed District (NMCWD) during 2004, 2008, 2013, 2015-2017, and 2020-2023 and by the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) during 2003, 2005-2009. Poor water quality has been observed in the lake during the entire period of record. All summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency values failed to meet the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion (Figure 4-2).

4.1.2 Chlorides

Chloride concentrations were measured in 2013, 2015-2017, and 2020-2023 generally between April and September. The observed chloride concentrations from 2013 through 2023 are summarized in Figure 4-3. Because high concentrations of chloride can harm fish and plant life, MPCA has established acute and chronic exposure chloride standards. A lake is considered impaired if two or more exceedances of chronic criterion (230 mg/L or less) occur within a three-year period or one exceedance of acute criterion (860 mg/L) is measured. All measurements were below the acute criterion. During 2013 through 2020, chloride measurements were above the chronic criterion in April/May, but all other measurements met the chronic criterion. In 2021, chloride measurements during April through August were above the chronic criterion. In 2022, chloride measurements during April and early August were above the chronic criterion. All 2023 chloride measurements were above the chronic criterion. The higher than usual chloride concentrations throughout the summers of 2021 through 2023 were likely due to the dry climatic conditions and resulting lack of flushing. 2023 data are summarized in Appendix A.

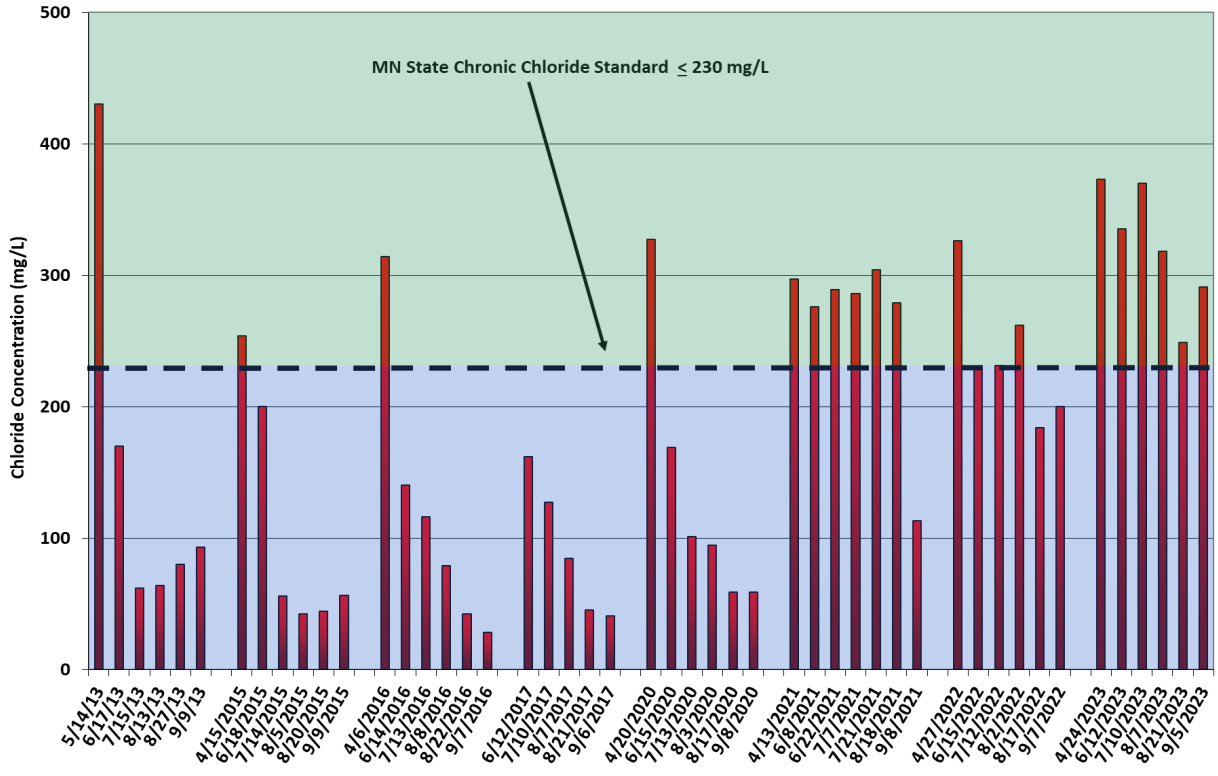


Figure 4-3 Lake Cornelia – North Basin historical chloride concentrations

4.1.3 Aquatic Plants

A healthy aquatic plant community is an essential part of lakes and provides many important benefits such as nutrient assimilation, sediment stabilization, and habitat for fish. Eutrophication may have detrimental effects on a lake, including reductions in the quantity and diversity of aquatic plants. The ability to assess the biological condition of a lake plant community is a valuable tool in the conservation of Minnesota's lakes. With this objective in mind, the Minnesota Department of Natural Resources (MNDNR) developed a Lake Plant Eutrophication Index of Biological Integrity (IBI) to measure the response of a lake plant community to eutrophication. The Plant IBI can provide important context to understanding information about water quality, shoreline health, and the fish community.

The MNDNR Lake Plant Eutrophication IBI includes two metrics: (1) the number of species in a lake; and (2) the "quality" of the species, as measured by the floristic quality index (FQI). The MNDNR has determined a threshold for each metric. Lakes that score below the thresholds contain degraded plant communities and are likely stressed from anthropogenic eutrophication.

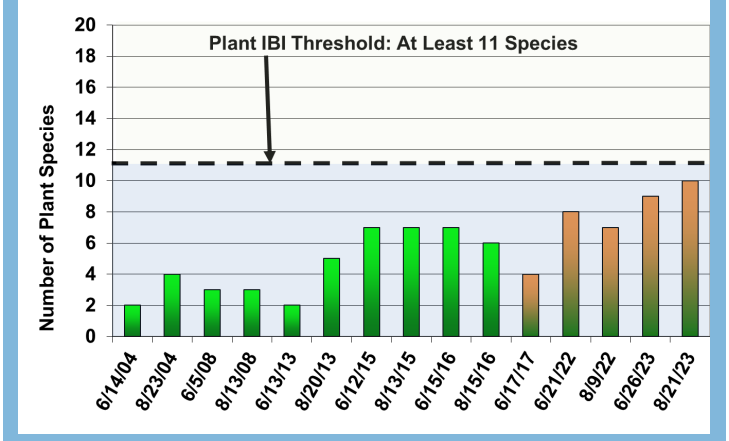


Figure 4-4.A

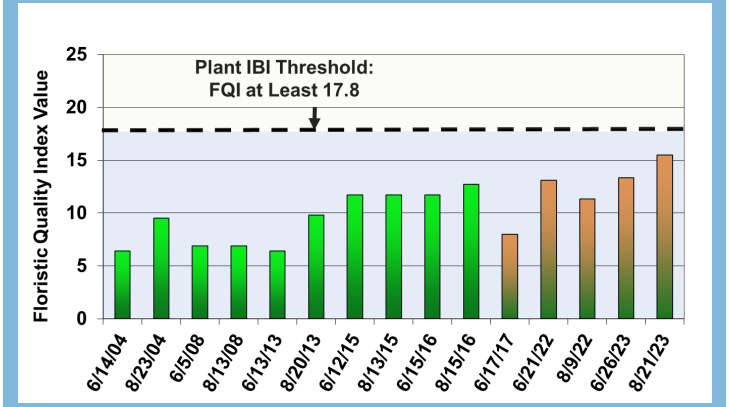


Figure 4-4.B

Figure 4-4 Lake Cornelia – North Basin Plant Index of Biotic Integrity (IBI)
Values compared with plant IBI thresholds (MNDNR): Number of Plant Species (top) and Floristic Quality Index (FQI) (bottom). Note: orange bars indicate period following significant infestation of curly-leaf pondweed and completion of spring herbicide treatments (2017-2021) to reduce curly-leaf prevalence.

The District conducted point intercept plant surveys of Lake Cornelia – North Basin in June and August of 2023. Maps showing survey results are included in Appendix C. Plant survey data from 2004 through 2023 were assessed to track changes in plant IBI scores. Figure 4-4 shows the number of species and FQI scores in Lake Cornelia – North Basin for that period compared to the MNDNR Plant IBI thresholds. In 2023, both the number of species in the lake and FQI values failed to meet the MNDNR Plant IBI thresholds.

- **Number of species:** A shallow lake (maximum depth 15 feet) fails to meet the MNDNR Plant IBI threshold when it has fewer than 11 species. During the period examined, the number of species in Lake Cornelia – North Basin ranged from 2 to 10 and failed to meet the MNDNR Plant IBI

threshold during the entire period (Figure 4-4.A). However, the number of species observed in 2023 (9-10) was higher than the number of species observed in previous years (2-8).

- **FQI values (quality of species):** The MNDNR Plant IBI threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values in Lake Cornelia – North Basin ranged from 6.4 to 15.5, failing to meet the MNDNR Plant IBI threshold during this entire period (Figure 4-4.B). However, the FQI values observed in 2023 (13.3-15.5) were higher than the values observed in previous years (6.4-13.1).

The City of Edina annually conducted spring herbicide treatments in Lake Cornelia – North Basin from 2017 to 2021 to reduce the presence of curly-leaf pondweed, an invasive aquatic plant that typically dies off in mid-summer, releasing phosphorus into the lake. Annual pre-treatment plant surveys conducted during the spring of 2017 to 2023 documented CLP locations and its frequency of occurrence in the lake. The herbicide treatments during 2017 to 2021 reduced curly-leaf pondweed frequency of occurrence in the lake from 100 percent of sample locations in the spring of 2017 to 8 percent of sample locations in the spring of 2022 (Figure 4-5). The Lake Cornelia – North Basin was not treated with herbicide in 2022. At the time of the pre-treatment survey in May 2023, CLP frequency of occurrence was 10 percent of the sampling locations and the lake was not treated with herbicide.

Plant surveys completed by the District during June and August 2023 documented a rapid increase in CLP from 10 percent in May to 63 percent in June and 73 percent in August (Figure 4-5). The data suggest that CLP turions germinated later than expected or growth from seeds occurred in 2023.

Significant frequency changes in plant species between 2022 and 2023 were documented by a Chi squared analysis using point intercept plant survey data collected from the lake by the Nine Mile Creek Watershed District on June 21, 2022 and June 26, 2023 and on August 9, 2022 and August 21, 2023 (Figure 4-6). Only species collected on the rake were included in the Chi squared analysis. Visually observed species not collected on the rake were excluded from the analysis.

The following aquatic invasive species (AIS) significantly changed in frequency between 2022 and 2023 (Figure 4-6):

- CLP (*Potamogeton crispus*) increased in frequency from 8 percent in June 2022 to 63 percent in June 2023
- CLP (*Potamogeton crispus*) increased in frequency from 6 percent in August 2022 to 73 percent in August 2023

The following native species significantly changed in frequency between 2022 and 2023 (Figure 4-6):

- Coontail (*Ceratophyllum demersum*) increased in frequency from 2 percent in August 2022 to 15 percent in August 2023
- Leafy pondweed (*Potamogeton foliosus*) increased in frequency from 8 percent in August 2022 to 25 percent in August 2023

Three native species were not observed in 2022, but were observed in 2023 (large duckweed, *Spirodela polyrhiza*, long-leaf pondweed, *Potamogeton nodosus*, and common watermeal, *Wolffia columbiana*) (Figure 4-6). However, these changes were not statistically significant.

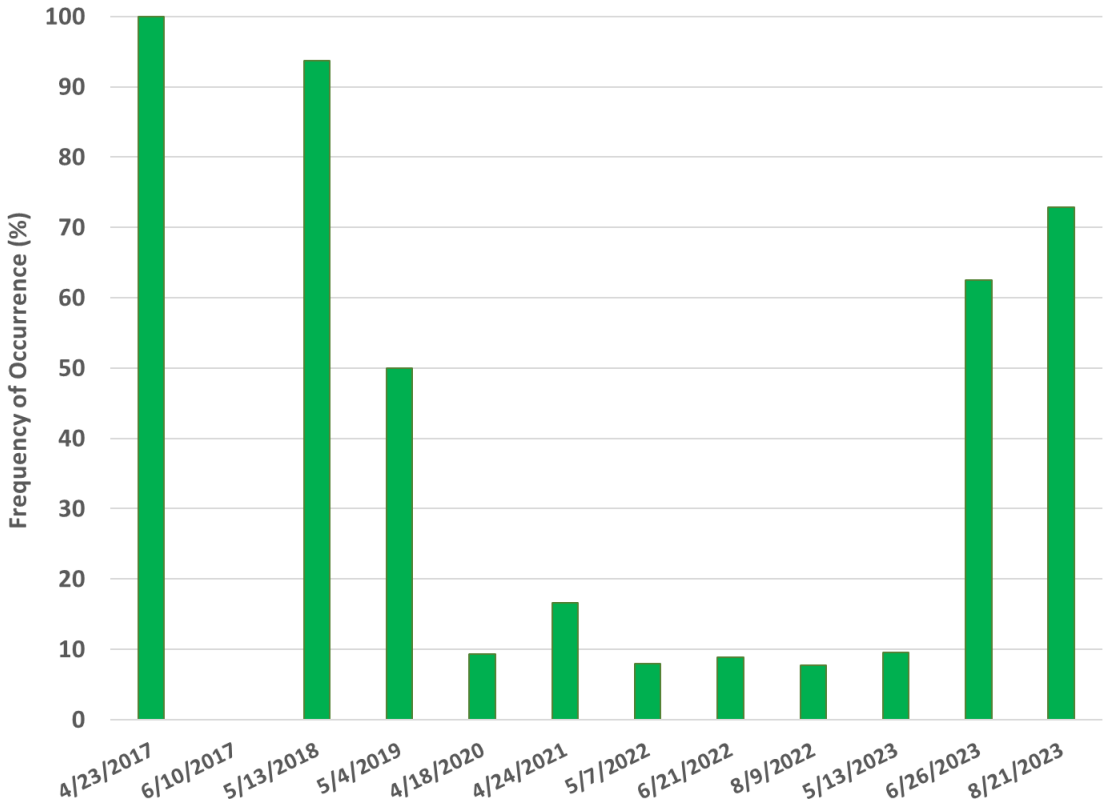


Figure 4-5 **April 2017 through May 2022, and May 2023 Lake Cornelia-North Basin curly-leaf pondweed data collected and provided by the City of Edina; June and August 2022, and June and August 2023 data collected by the Nine Mile Creek Watershed District**

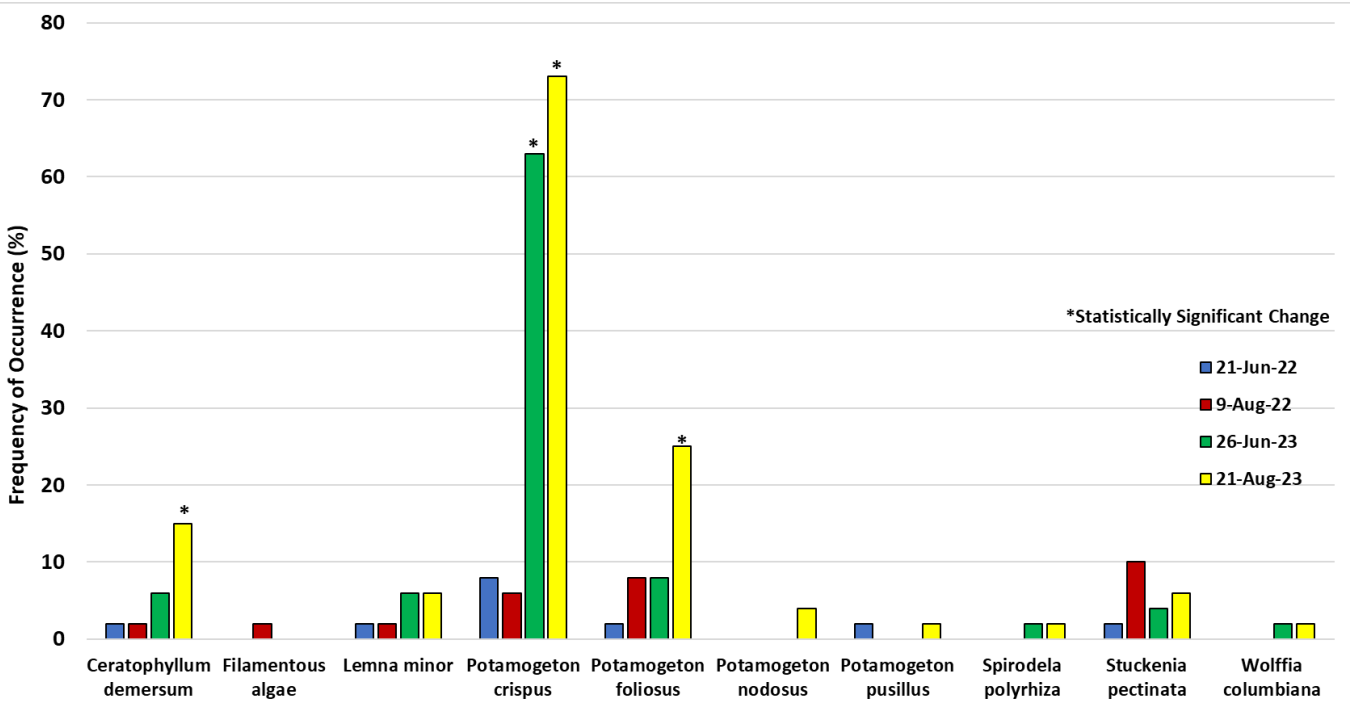


Figure 4-6 2022-2023 Lake Cornelia – North Basin frequency of occurrence and significant change between years

Four aquatic invasive species were found in Lake Cornelia – North Basin in 2023:

- **Curly-leaf pondweed (CLP) (*Potamogeton crispus*)** – CLP was collected on the rake at 30 locations (63 percent) and visually observed at an additional 7 locations in June (Figure 4-6). In August, CLP was collected on the rake at 35 locations (73 percent) and visually observed at an additional 5 locations (Appendix D). On a scale of 1 (low) to 3 (high), the average rake density was 2 during both June and August (Appendix D).
- **Hybrid Eurasian watermilfoil** – Observed in one location in mid-October along the north-central shoreline.
- **Purple loosestrife (*Lythrum salicaria*)** – Observed at one location along the eastern shore in June and August. Most purple loosestrife plants showed mild to moderate damage from *Galerucella*, the purple loosestrife eating beetle. The beetles control purple loosestrife plants by eating the plants. Because they are expected to control the purple loosestrife in the lake, no additional management is needed.
- **Reed canary grass (*Phalaris arundinaceae*)** – Observed at one location along the eastern shore in June and August.
- **Hybrid cattail (*Typha X glauca*)** – Dominant along the shore of the north basin during June and August.

4.1.4 Phytoplankton

Phytoplankton, also called algae, are microscopic aquatic plants naturally present in lakes. Phytoplankton derive energy from the sun through photosynthesis and provide food for several types of aquatic organisms, including zooplankton, which are in turn eaten by fish. An inadequate phytoplankton population limits a lake's zooplankton population, and indirectly limits fish production in a lake. Excess phytoplankton can reduce water clarity.

The phytoplankton community in Lake Cornelia – North Basin was monitored in 2023, including identification and enumeration of the phytoplankton species to help evaluate water quality and the quality of food available to zooplankton (microscopic animals). The phytoplankton monitoring also included blue-green algae, which is actually a type of bacteria called cyanobacteria. This type of bacteria thrives in warm, nutrient-rich water and can grow rapidly under certain conditions, causing "blooms." Blue-green algae can produce algal toxins, which can be harmful to humans or other animals. Blue-green algae are also a poor quality food for zooplankton; they can be toxic to zooplankton and may not be assimilated if ingested.

Figure 4-7 summarizes the number and major groups of phytoplankton observed in Lake Cornelia – North Basin for monitored years. Green algae, diatoms, and cryptomonads were present throughout the monitored period and provided a good quality food source for the zooplankton community. Blue-green algae numbers were higher during 2020 through 2023 than previous years, with the highest observed counts to date in 2021.

In 2023, severe blue-green algal blooms were observed in the lake during the late July through September sample events. Blue-green algae numbers during this period ranged from approximately 126,000 units per milliliter in late August to approximately 269,000 units per milliliter in early August, well above the WHO threshold of 100,000 per milliliter for a moderate probability of adverse health effects to recreational users (Figure 4-8). Although there can be many causes of blue-green algal blooms, the high total phosphorus concentrations and hot, dry summer conditions likely contributed to the growth and persistence of the blue-green algal population throughout the summer months.

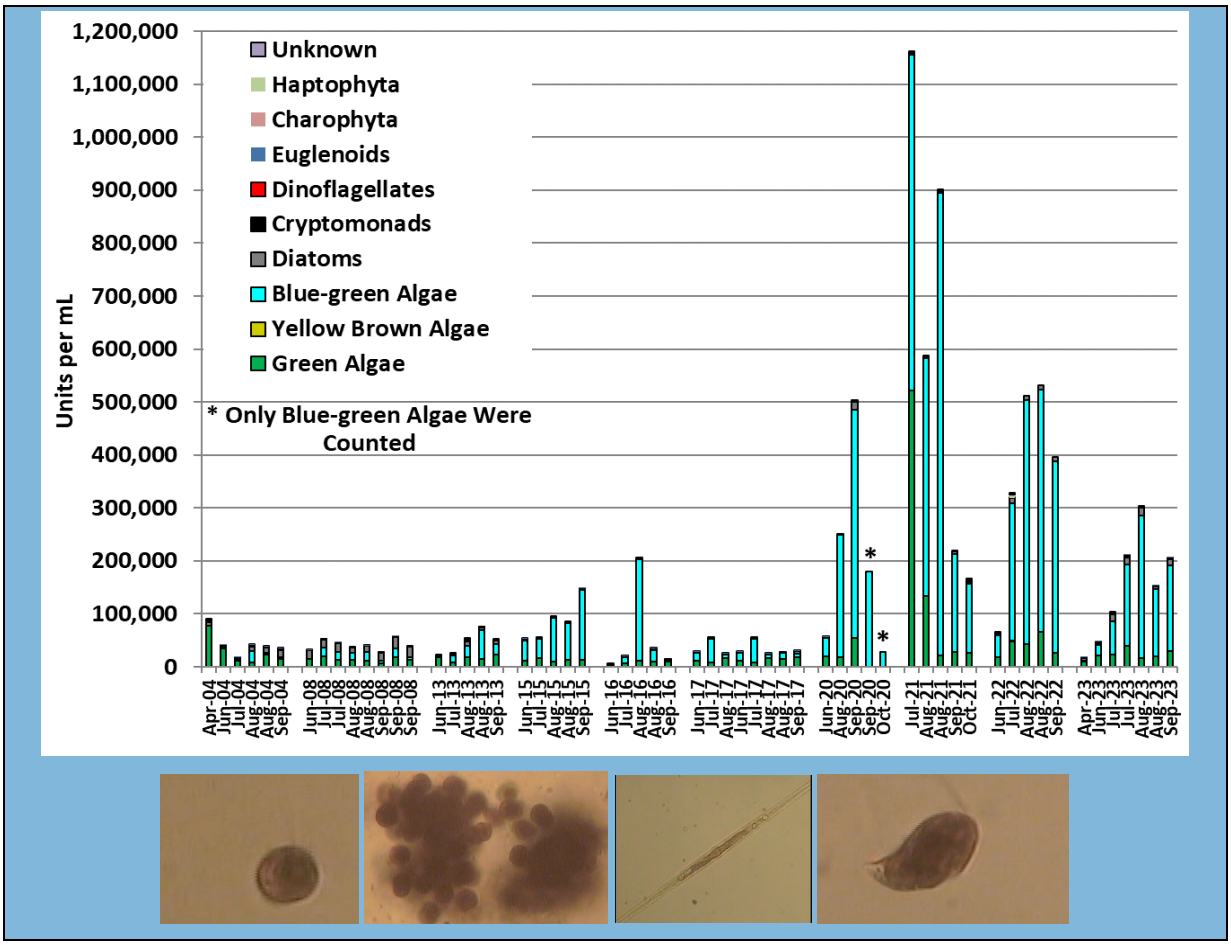


Figure 4-7 Lake Cornelia – North Basin phytoplankton

Top, Lake Cornelia – North Basin 2004, 2008, 2013, 2015-2017, and 2020-2023 phytoplankton numbers and bottom, microscopic pictures of phytoplankton species found in the lake, from left to right, *Chlamydomonas globosa* (green algae), *Microcystis aeruginosa* (blue-green algae), *Synedra ulna* (diatom), and *Cryptomonas erosa* (cryptomonad)

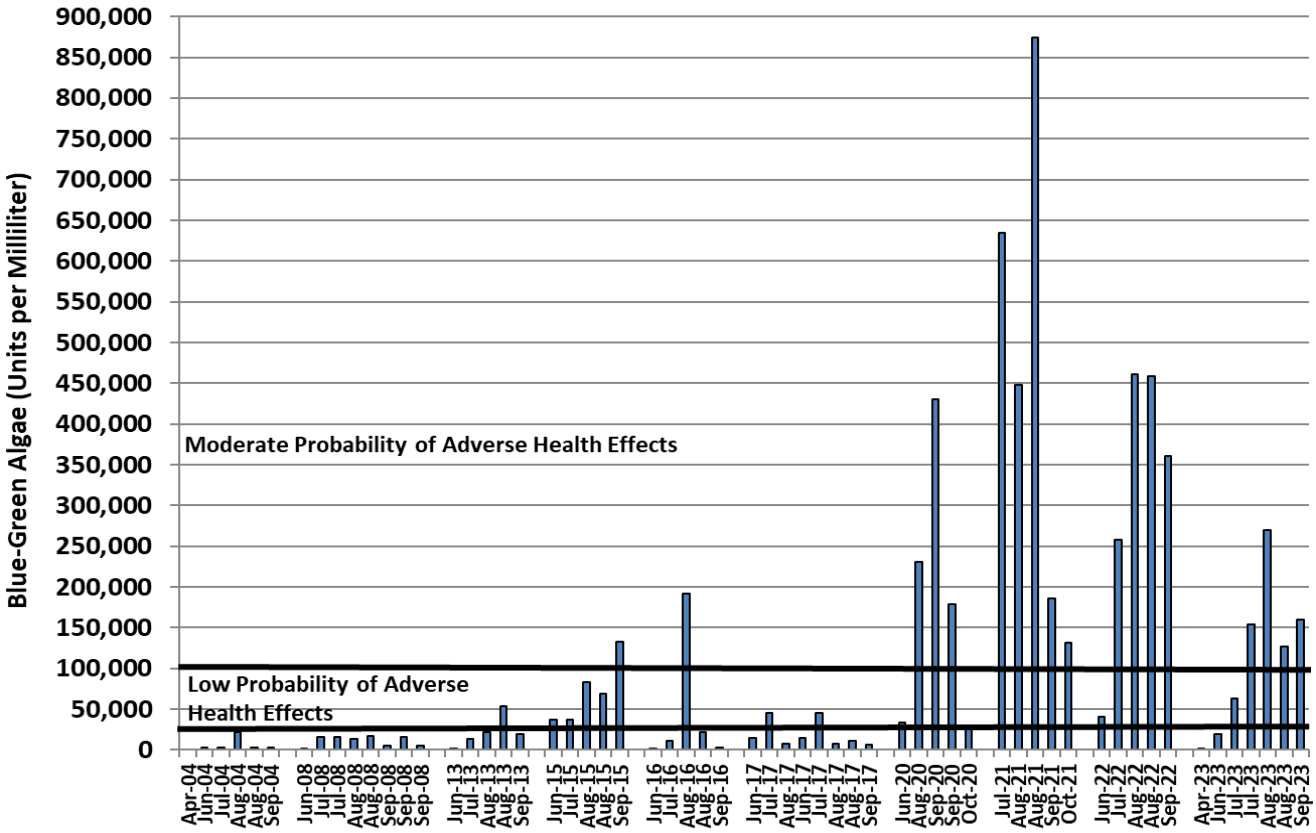


Figure 4-8 Lake Cornelia – North Basin blue-green algae compared with World Health Organization (WHO) thresholds for adverse health effects to recreational users

The Lake Cornelia phytoplankton community during 2013 – 2018 and 2022 - 2023 was impacted by algaecide treatments. The City of Edina started treating Lake Cornelia with copper sulfate to control algal populations in 2013. Table 4-1 shows the approximate dates of the algal treatment efforts based on past records.

Table 4-1 Lake Cornelia North Basin Algaecide Treatment Record

Algaecide Treatment Record – North Basin	
July 19, 2013	August 9, 2017
August 21, 2013	September 7, 2017
June 18, 2014	July 11, 2018
July 25, 2014	June 29, 2022
August 18, 2015	June 12, 2023
August 3, 2016	August 28, 2023

4.1.5 Conclusions and Recommendations

Water quality of Lake Cornelia – North Basin was poor in 2023. The lake failed to meet Minnesota State eutrophication water quality standards for shallow lakes in 2023 due to excess phosphorus and algae in the lake and poor water clarity. Chloride concentrations in Lake Cornelia – North Basin also exceeded the MPCA chronic criteria during all 2023 monitoring events between April and September.

In 2023, severe blue-green algal blooms were observed in the lake during the late July through September monitoring events, with blue-green counts well above the World Health Organization (WHO) threshold of 100,000 per milliliter for a moderate probability of adverse health effects to recreational users. Although there can be many causes of blue-green algal blooms, the high total phosphorus concentrations and the hot, dry summer conditions likely contributed to the growth and persistence of the blue-green algal population throughout the summer months.

Both the number of aquatic plant species in the lake and FQI values in 2023 failed to meet the MNDNR Plant IBI thresholds of 11 and 17.8, respectively. However, both the number of species observed (9-10) and the FQI values (13.3-15.5) were higher than in previous years.

The City of Edina annually conducted spring herbicide treatments from 2017 to 2021 within the North Basin to reduce the presence of curly-leaf pondweed, an invasive aquatic plant that typically dies off in mid-summer, releasing phosphorus into the lake. The treatments successfully reduced the curly-leaf pondweed extent to 8 percent in May 2022 and 9 percent in June 2022 compared with a lake-wide dense growth in 2017. However, curly-leaf pondweed extent rapidly increased in 2023, with the data suggesting that turions germinated later than expected or growth from seeds occurred. CLP increased from 10 percent in May to 63 percent in June and 73 percent in August.

The District completed a water quality study of Lake Cornelia and Lake Edina in July of 2019 to identify water quality improvement measures for both lakes. The study concluded that the poor water quality in Lake Cornelia is primarily due to excess phosphorus, which fuels algal production and decreases water clarity. The recommended management strategy to improve water quality in Lake Cornelia was to reduce watershed and internal phosphorus loading to the lake by implementing several management practices.

An alum treatment was conducted by the District in spring of 2020 to reduce the release of phosphorus from lake bottom sediments. Sediment cores collected from the lake in 2021 indicated that the alum treatment successfully converted iron-bound phosphorus into aluminum bound phosphorus. Iron-bound phosphorus is the sediment fraction that is responsible for internal phosphorus loading when oxygen is low, whereas aluminum bound phosphorus is stable under low oxygen conditions and does not cause internal loading. However, the core data also showed that organically bound phosphorus is still high in North and South Cornelia. Hence, internal phosphorus loading may still be occurring (although at a lower rate) because of organically bound phosphorus decay in lake bottom sediments.

In summer 2022, the District completed construction of a stormwater filtration system in Rosland Park to reduce the amount of watershed phosphorus reaching Lake Cornelia during storm events as well as removing phosphorus from Lake Cornelia during dry periods. The innovative upflow filtration system

includes three parallel filtration chambers to test the effectiveness of different filtration media in removing dissolved phosphorus. In 2024, the City of Edina and NMCWD will continue to optimize the functionality of the filtration system.

The water quality study completed by the District also identified goldfish and carp at biovolumes large enough to warrant further assessment as these rough fish species can have negative effects on lake water quality. The *Goldfish Population and Management Feasibility Study in the Lake Cornelia System* was completed by WSB from 2021 – 2022 to determine the environmental conditions that drive goldfish movements to upstream waterbodies, assess the goldfish population, and to test multiple goldfish removal/management methods. The study concluded that goldfish are likely spawning within their resident lakes near cattails and bullrush fringes rather than in upstream waterbodies and determined that small-mesh baited box nets were effective at removing goldfish. Following these conclusions, goldfish removal efforts were expanded in 2023 where four box net traps were deployed and lifted on 12 occasions. In 2023, in total, 1,829 pounds or approximately 42,133 individual goldfish were removed from the North Basin. The District plans to continue box netting efforts in 2024.

Continuation of water quality and biological monitoring is recommended to assess the condition of the lake's water quality and biological community, evaluate impacts of the management activities, and identify trends.

4.2 Lake Cornelia – South Basin

Lake Cornelia – South Basin has a water surface area of approximately 32 acres, a maximum depth of 5.4 feet, and a mean depth of 3.6 feet at a normal surface elevation of 859.1 MSL. The water level in the lake is controlled by the elevation of the weir structure at the south side of the lake. The lake is shallow enough for aquatic plants to grow over the entire lake bed. It is a polymictic lake, mixing many times per year. The lake is currently on the MPCA's impaired waters list for excess nutrients (since 2018).

4.2.1 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2023, Lake Cornelia – South Basin water quality was poor (Figure 4-9). The lake's summer average total phosphorus and chlorophyll *a* concentrations were 74 µg/L and 89 µg/L, respectively. The lake's summer average Secchi disc transparency was 0.3 meters. The summer averages for all three parameters failed to meet the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion in 2023 which are ≤ 60 µg/L, ≤ 20 µg/L, and ≥ 1 meter for total phosphorus, chlorophyll *a*, and Secchi disc transparency, respectively.

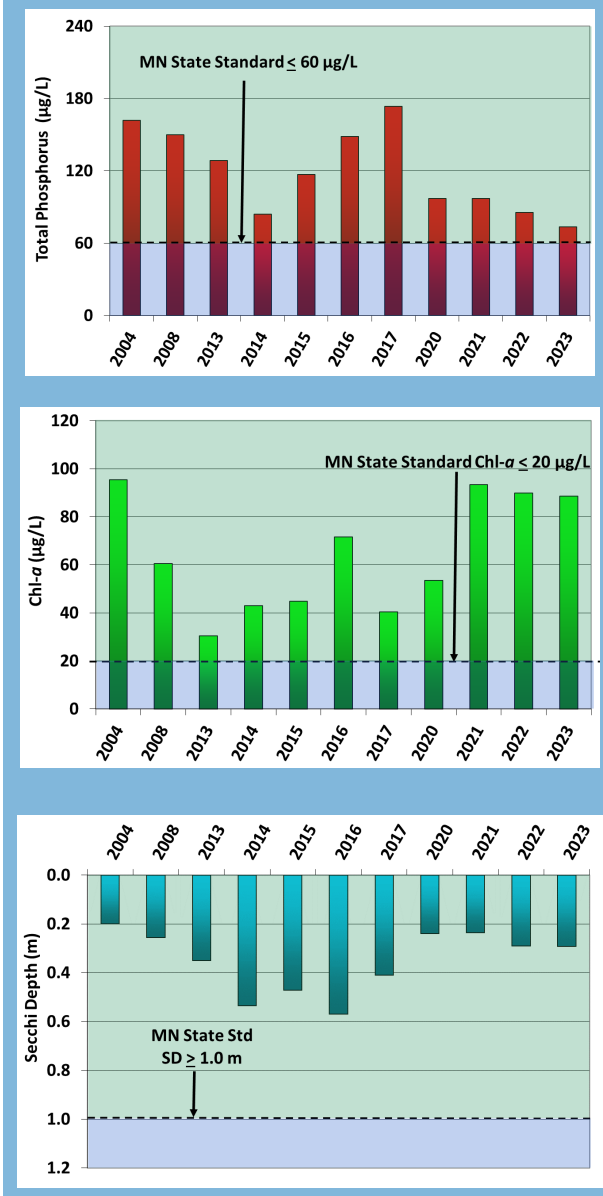


Figure 4-9 **Lake Cornelia – South Basin historical summer average values**
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

Water quality data were collected from Lake Cornelia – South Basin by Nine Mile Creek Watershed District (NMCWD) during 2004, 2008, 2013, 2015-2017, and 2020-2023 and by the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) during 2013-2015. All summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency depths failed to meet the Minnesota State eutrophication water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion (Figure 4-9). Summer average total phosphorus concentrations have been lower following the spring 2020 alum treatment. The lake's 2023 summer average total phosphorus concentration (74 µg/L) was lower than summer average concentrations measured in all previous

monitored years since 2004 (84-162 µg/L). The 2023 summer average chlorophyll *a* concentration and Secchi disc transparency were within the range observed in previous years.

4.2.2 Chlorides

Chloride concentrations were measured in 2013, 2015-2017, and 2020-2023 generally between April and September. The observed chloride concentrations from 2013 to 2023 are summarized in Figure 4-10**.** Because high concentrations of chloride can harm fish and plant life, MPCA has established acute and chronic exposure chloride standards. A lake is considered impaired if two or more exceedances of chronic criterion (230 mg/L or less) occur within a three-year period or one exceedance of acute criterion (860 mg/L) is measured. All 2023 measurements were below the acute criterion but exceeded the chronic criterion. Chloride concentrations in 2023 were the highest observed in the monitoring record starting in 2013. The higher than usual chloride concentrations in the summer of 2023 were likely due to the dry climatic conditions and resulting lack of flushing. 2023 data are summarized in Appendix A.

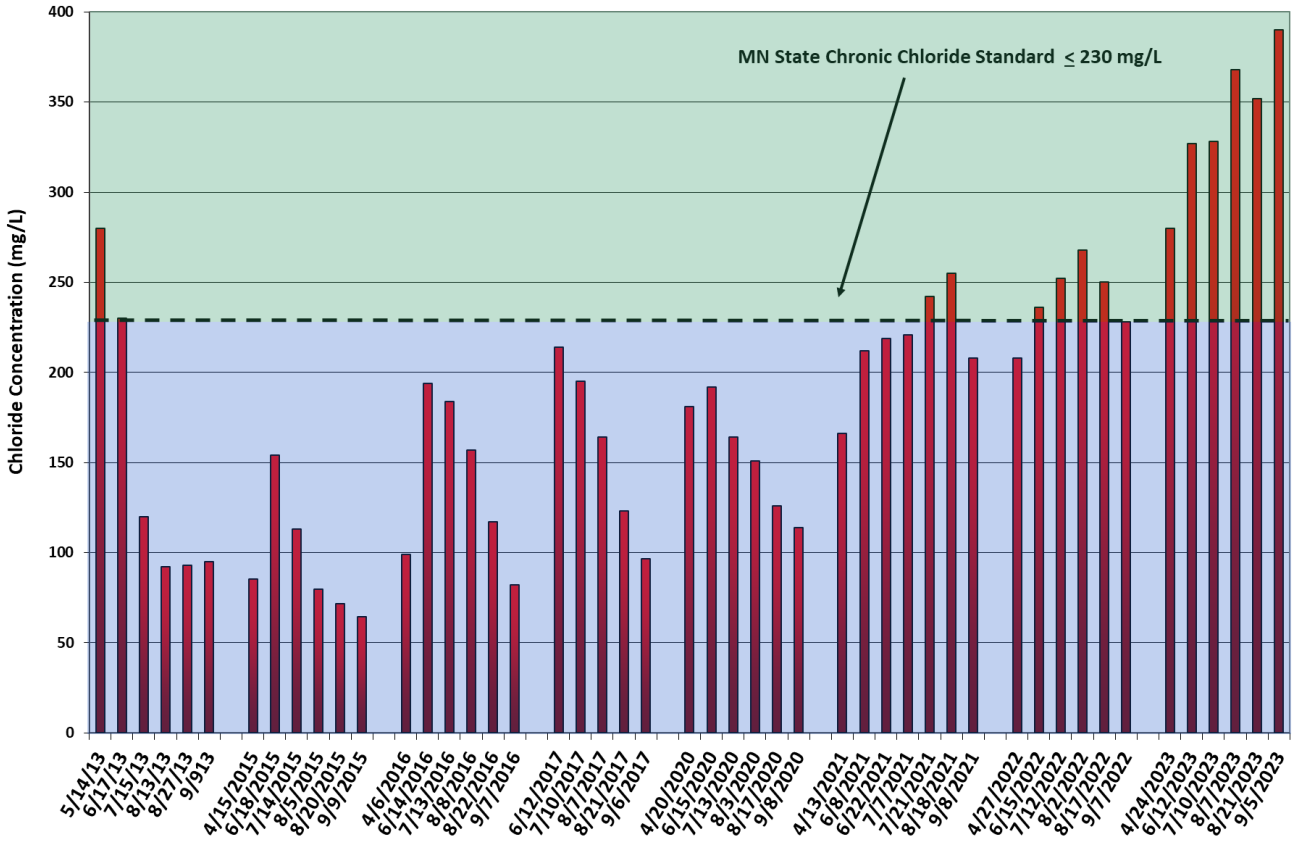


Figure 4-10 Lake Cornelia – South Basin historical chloride concentrations

4.2.3 Aquatic Plants

A healthy aquatic plant community is an essential part of lakes and provides many important benefits such as nutrient assimilation, sediment stabilization, and habitat for fish. Eutrophication may have detrimental effects on a lake, including reductions in the quantity and diversity of aquatic plants. The ability to assess the biological condition of a lake plant community is a valuable tool in the conservation of Minnesota's lakes. With this objective in mind, the Minnesota Department of Natural Resources (MNDNR) developed a Lake Plant Eutrophication Index of Biological Integrity (IBI) to measure the response of a lake plant community to eutrophication. The Plant IBI can provide important context to understanding information about water quality, shoreline health, and the fish community.

The MNDNR Lake Plant Eutrophication IBI includes two metrics: (1) the number of species in a lake; and (2) the "quality" of the species, as measured by the floristic quality index (FQI). The MNDNR has determined a threshold for each metric. Lakes that score below the thresholds contain degraded plant communities and are likely stressed from anthropogenic eutrophication.

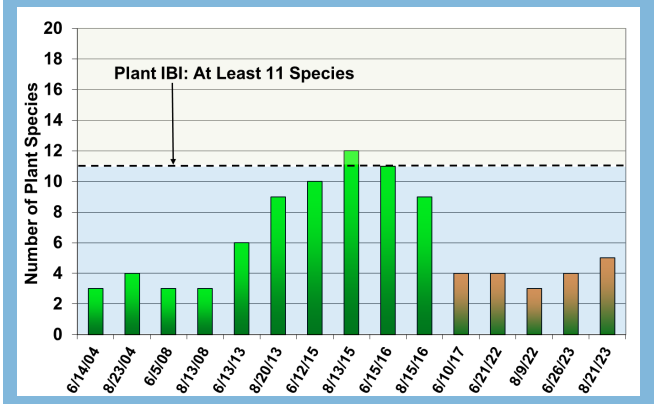


Figure 4-11.A

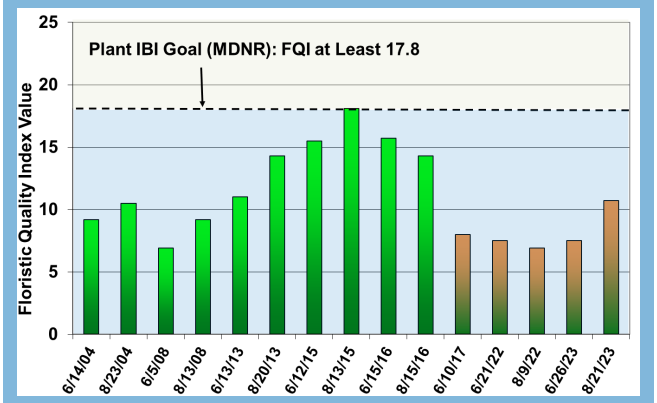


Figure 4-11.B

Figure 4-11 Lake Cornelia – South Basin Plant Index of Biotic Integrity (IBI) Values compared with Plant IBI Thresholds (MNDNR):
Number of plant species (top) and Floristic Quality Index (FQI) (bottom). Note: orange bars indicate period following significant infestation of curly-leaf pondweed and completion of spring herbicide treatments (2017-2022) to reduce curly-leaf prevalence.

The District conducted point intercept plant surveys of Lake Cornelia – South Basin in June and August of 2023. Maps showing survey results are included in Appendix C. Plant survey data from 2004 through 2023 were assessed to track changes in plant IBI scores. Figure 4-11 shows the number of species and FQI scores in Lake Cornelia – South Basin for that period compared to the MNDNR Plant IBI thresholds. Both the number of species in the lake and FQI values failed to meet the MNDNR Plant IBI thresholds in June and August of 2023.

- **Number of species:** A shallow lake (maximum depth 15 feet) fails to meet the MNDNR Plant IBI threshold when it has fewer than 11 species. Between 2004-2023, the number of species observed in Lake Cornelia – South Basin has ranged from 3 to 12, exceeding the MNDNR Plant IBI threshold during August 2015 and June 2016. The City of Edina conducted spring herbicide treatments to reduce CLP in the lake during 2017 to 2022. The first year of herbicide treatment coincided with a decline in the number of species in the lake – from 9 species in August 2016 to 4 species in June

2017. The number of species in the lake has remained low and in 2023 four species were found in June and five species in August.

- **FQI values (quality of species):** The MNDNR Plant IBI threshold for shallow lakes, as measured by FQI, is a minimum value of 17.8. Between 2004-2023, FQI values in Lake Cornelia – South Basin has ranged from 6 to 18, exceeding the MNDNR Plant IBI threshold only in August 2015. The first year of herbicide treatment in 2017 coincided with a decline in FQI in the lake – from 14 in August 2016 to eight in June 2017. The FQI remained low through June 2023 when a value of 8 was measured. FQI increased to 11 in August 2023.

The City of Edina annually conducted spring herbicide treatments in Lake Cornelia – South Basin from 2017 to 2022 to reduce the presence of CLP, an invasive aquatic plant that typically dies off in mid-summer, releasing phosphorus into the lake. Annual pre-treatment plant surveys conducted during the spring of 2017 to 2023 documented CLP locations and its frequency of occurrence in the lake. The herbicide treatments during 2017 to 2022 reduced CLP frequency of occurrence from 100 percent of sample locations in the spring of 2017 to 17 percent of sample locations in the spring of 2022 (Figure 4-12). The Lake Cornelia – South Basin was not treated with herbicide in 2023. At the time of the pre-treatment survey in May 2023, CLP frequency of occurrence was 5 percent and the lake was not treated with herbicide. Plant surveys completed by the District during June and August 2023 documented a rapid increase in CLP from 5 percent in May to 51 percent in June and 75 percent in August (Figure 4-12). The data suggest that CLP turions germinated later than expected or growth from seeds occurred in 2023.

Significant frequency changes in plant species between 2022 and 2023 were documented by a Chi squared analysis using point intercept plant survey data collected from the lake by the Nine Mile Creek Watershed District (Figure 4-13). Data collected on June 21, 2022 were compared with data collected on June 26, 2023 and data collected on August 9, 2022 were compared with data collected on August 21, 2023. Only species collected on the rake were included in the Chi squared analysis. Visually observed species not collected on the rake were excluded from the analysis.

The following aquatic invasive species (AIS) significantly changed in frequency between 2022 and 2023 (Figure 4-13):

- CLP (*Potamogeton crispus*) increased in frequency from 4 percent in June 2022 to 51 percent in June 2023.
- CLP (*Potamogeton crispus*) increased in frequency from 0 percent in August 2022 to 75 percent in August 2023.

The following native species significantly changed in frequency between 2022 and 2023 (Figure 4-13):

- Common waterweed (*Elodea canadensis*) decreased in frequency from 18 percent in June 2022 to 5 percent in June 2023, a significant decline, and then increased in frequency to 16 percent in August 2023, but this increase was not significant.
- Leafy pondweed (*Potamogeton foliosus*) increased in frequency from 0 percent in June and August 2022 to 5 percent in June and 16 percent in August 2023.

Two native species were not observed in 2022, but were observed in 2023 (long-leaf pondweed, *Potamogeton nodosus* and sago pondweed, *Stuckenia pectinata*) (Figure 4-13). However, these changes were not statistically significant.

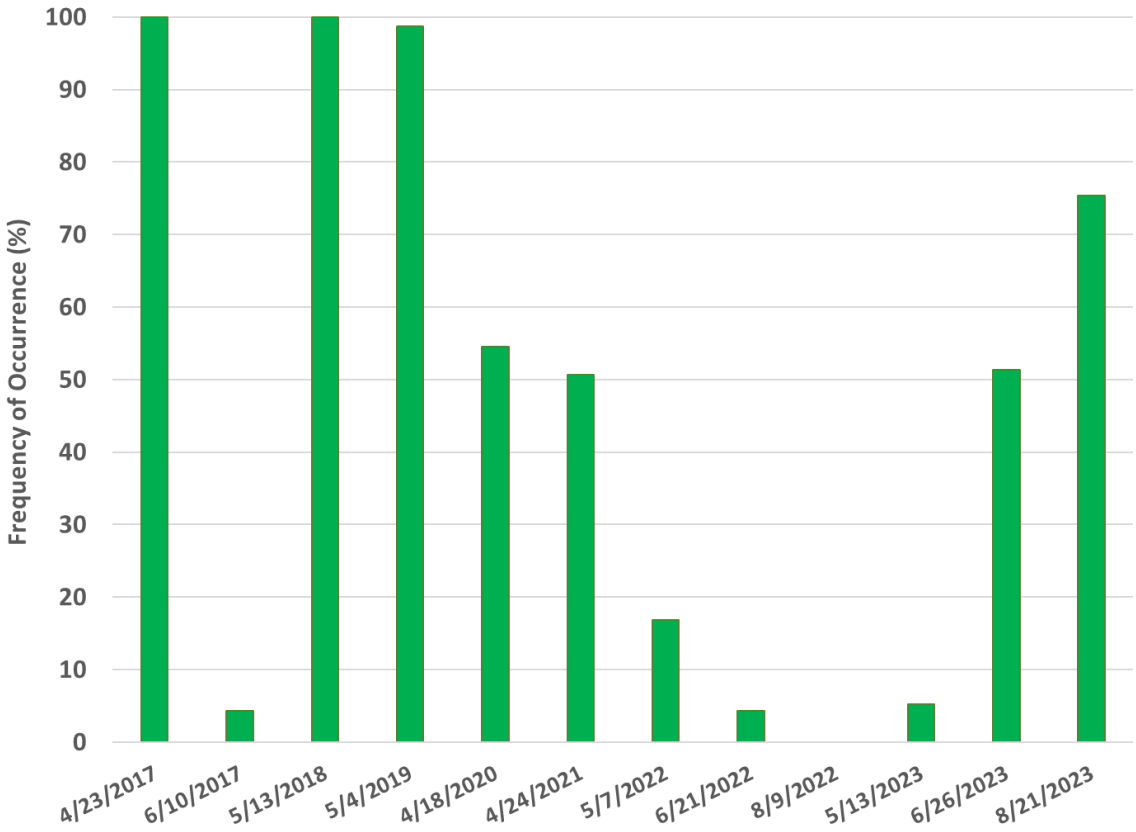


Figure 4-12 2017-2023 Lake Cornelia – South Basin curly-leaf pondweed frequency of occurrence. April 2017 through May 2022 and May 2023 data collected and provided by the City of Edina. Nine Mile Creek Watershed District collected data during June and August in 2022 and 2023.

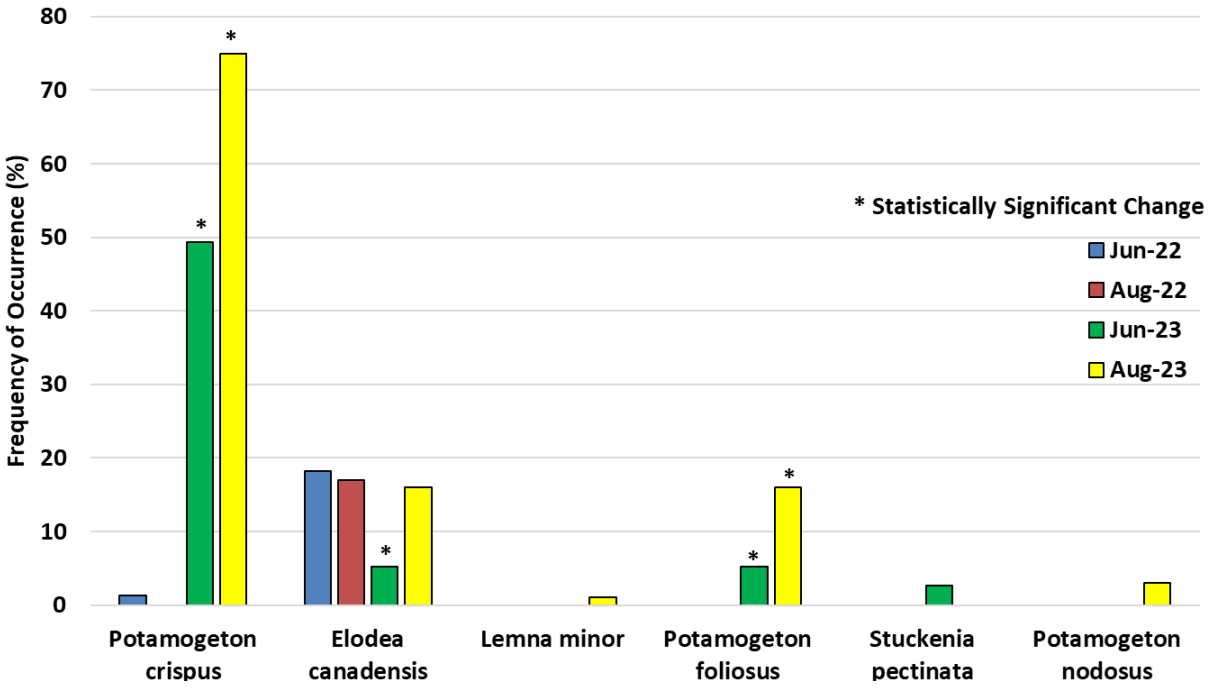


Figure 4-13 2022-2023 Lake Cornelia – South Basin frequency of occurrence and significant change between years

One aquatic invasive species was found in Lake Cornelia – South Basin in 2023:

- **Curly-leaf pondweed (CLP) (*Potamogeton crispus*)** – CLP was collected on the rake at 38 locations (51 percent) and visually observed at an additional 19 locations in June (Figure 4-12). In August, CLP was collected on the rake at 58 locations (75 percent) and visually observed at an additional 8 locations (Appendix D). On a scale of 1 (low) to 3 (high), the average rake density was 1 during June and 2 during August (Appendix D).

4.2.4 Phytoplankton

In 2023, the District monitored the phytoplankton community in June, July, August (twice), and September. Results of the 2023 identification and enumeration of the phytoplankton species can be found in Appendix B.

Figure 4-14 summarizes the number and major groups of phytoplankton observed in Lake Cornelia – South Basin for monitored years. Green algae, diatoms, and cryptomonads were present throughout the monitored period and provided a good quality food source for the zooplankton community. However, the phytoplankton community in Lake Cornelia – South Basin has been generally dominated by blue-green algae throughout the period of record. Blue-green algae can produce algal toxins, which can be harmful to humans or other animals. Blue-green algae are also a poor quality food for zooplankton; they can be toxic to zooplankton and may not be assimilated if ingested. Numbers of blue-green algae generally increased from 2004 through 2021 and remained high in 2022 and 2023.

In 2023, severe blue-green algal blooms were observed in the lake during the July through September sample events (Figure 4-15). Blue-green algae numbers during this period ranged from approximately 102,000 units per milliliter to 259,000 units per milliliter, well above the WHO threshold of 100,000 per milliliter for a moderate probability of adverse health effects to recreational users. Although there can be many causes of blue-green algal blooms, the hot, dry summer conditions likely contributed to the growth and persistence of the blue-green algal population throughout the summer months.

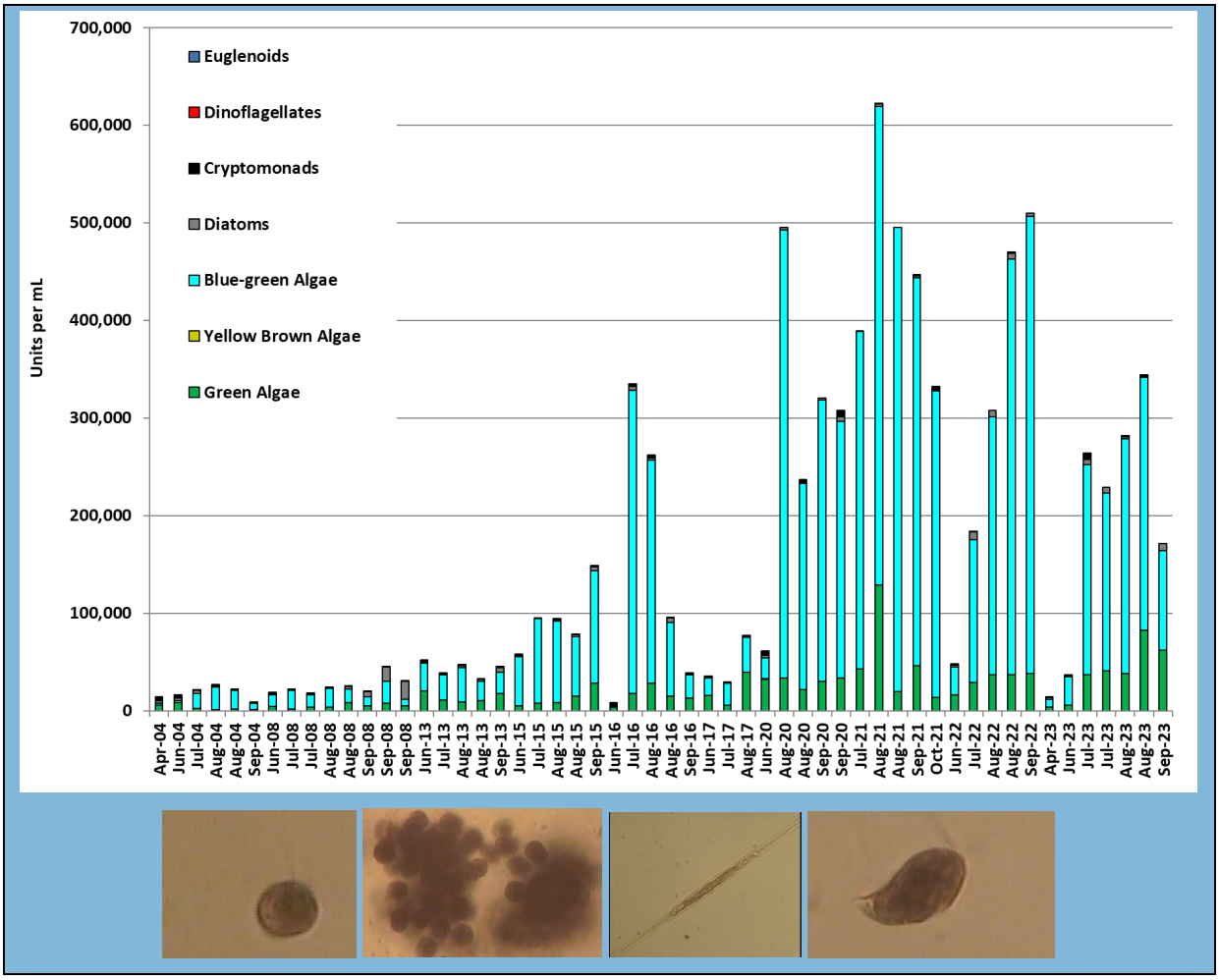


Figure 4-14 Lake Cornelia – South Basin phytoplankton

Top, Lake Cornelia – South Basin 2004, 2008, 2013, 2015-2017, and 2020-2023 phytoplankton numbers and bottom, microscopic pictures of phytoplankton species found in the lake, from left to right, *Chlamydomonas globosa* (green algae), *Microcystis aeruginosa* (blue-green algae), *Synedra ulna* (diatom), and *Cryptomonas erosa* (cryptomonad)

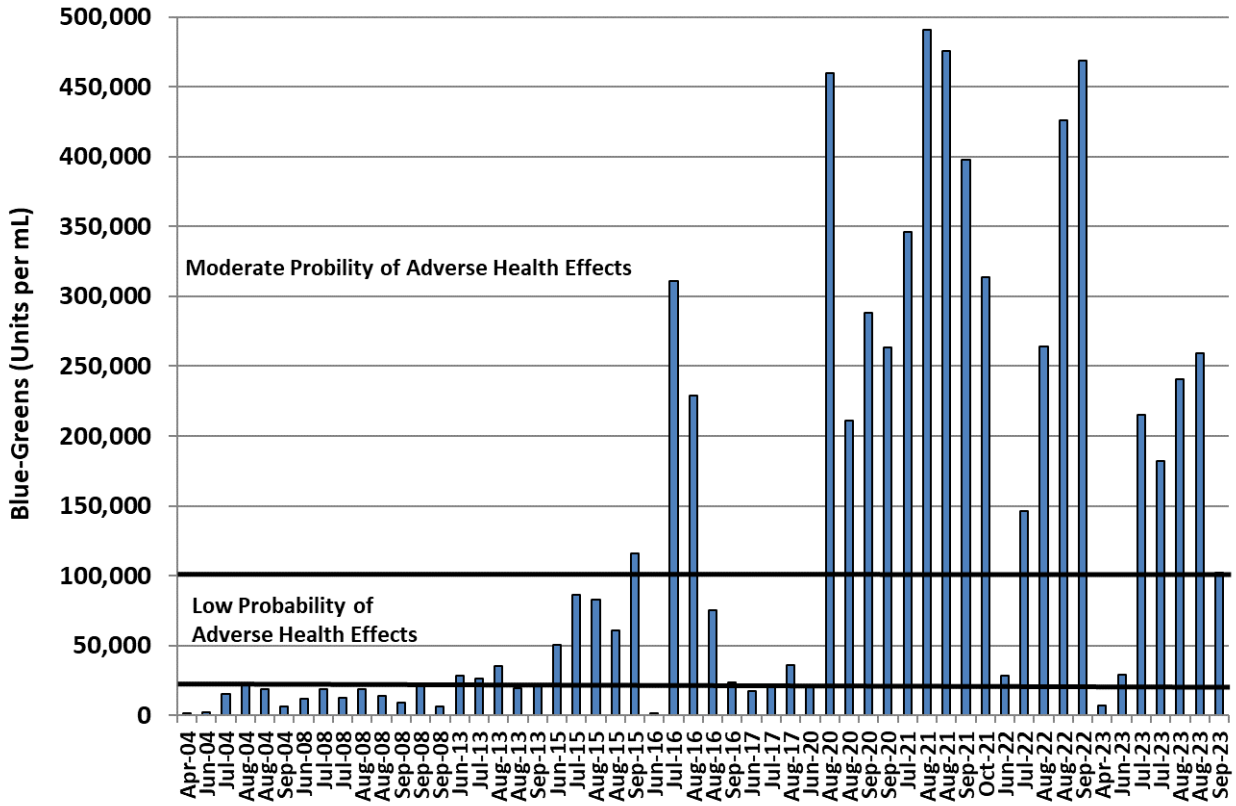


Figure 4-15 Lake Cornelia – South Basin blue-green algae compared with World Health Organization (WHO) thresholds for adverse health effects to recreational users

The Lake Cornelia phytoplankton community during 2013-2018 and 2022-2023 was impacted by algaecide treatments. The City of Edina started treating Lake Cornelia with copper sulfate to control algal populations in 2013. Table 4-2 shows the approximate dates of the algal treatment efforts based on past records.

Table 4-2 Lake Cornelia South Basin Algaecide Treatment Record

Algaecide Treatment Record – South Basin	
July 19, 2013	August 9, 2017
August 21, 2013	September 7, 2017
June 18, 2014	July 11, 2018
July 25, 2014	June 29, 2022
August 18, 2015	June 12, 2023
August 3, 2016	August 28, 2023

4.2.5 Conclusions and Recommendations

Water quality of Lake Cornelia – South Basin was poor in 2023. The lake failed to meet Minnesota State eutrophication water quality standards for shallow lakes in 2023 due to excess phosphorus and algae in the lake and poor water clarity. However, the lake's 2023 summer average total phosphorus concentration (74 µg/L) was lower than summer average concentrations measured in all previous monitored years since 2004. All 2023 chloride concentrations in Lake Cornelia – South Basin exceeded the MPCA chronic criterion and were the highest to date.

In 2023, severe blue-green algal blooms were observed in the lake during the July through September monitoring events, with blue-green numbers well above the World Health Organization (WHO) threshold of 100,000 per milliliter for a moderate probability of adverse health effects. Although there can be many causes of blue-green algal blooms, the hot, dry summer conditions likely contributed to the growth and persistence of the blue-green algal population throughout the summer months.

Both the number of aquatic plant species in the lake and FQI values monitored in 2023 failed to meet the MNDNR Plant IBI thresholds of 11 and 17.8, respectively. Both the number of species observed (4-5) and the FQI values (7.5–10.7) were in a similar range as what was observed in 2017 and 2022.

Annual herbicide treatments by the City of Edina during 2017 through 2022 had significantly reduced curly-leaf pondweed frequency and no herbicide treatment occurred during 2023. However, a rapid increase in CLP during 2023 from 5 percent in May to 51 percent in June and 75 percent in August suggested CLP turions germinated later than expected or growth from seeds occurred.

The District completed a water quality study of Lake Cornelia and Lake Edina in July of 2019 to identify water quality improvement measures for both lakes. The study concluded that the poor water quality in Lake Cornelia is primarily due to excess phosphorus, which fuels algal production and decreases water clarity. The recommended management strategy to improve water quality in Lake Cornelia was to reduce watershed and internal phosphorus loading to the lake by implementing several management practices.

An alum treatment was conducted by the District in spring of 2020 to reduce the release of phosphorus from lake bottom sediments. Sediment cores collected from the lake in 2021 indicated that the alum treatment successfully converted iron-bound phosphorus into aluminum bound phosphorus. Iron-bound phosphorus is the sediment fraction that is responsible for internal phosphorus loading when oxygen is low, whereas aluminum bound phosphorus is stable under low oxygen conditions and does not cause internal loading. However, the core data also showed that organically bound phosphorus is still high in North and South Cornelia. Hence, internal phosphorus loading may still be occurring (although at a lower rate) because of organically bound phosphorus decay in lake bottom sediments.

In fall 2022, the District completed construction of a stormwater filtration system in Rosland Park to reduce the amount of watershed phosphorus reaching Lake Cornelia during storm events as well as removing phosphorus from Lake Cornelia during dry periods. The innovative upflow filtration system includes three parallel filtration chambers to evaluate the effectiveness of different filtration media in

removing dissolved phosphorus. In 2024, the City of Edina and NMCWD will continue to optimize the functionality of the filtration system.

The water quality study completed by the District also identified goldfish and carp at biovolumes large enough to warrant further assessment as these rough fish species can have negative effects on lake water quality. The *Goldfish Population and Management Feasibility Study in the Lake Cornelia System* was completed by WSB from 2021–2022 to determine the environmental conditions that drive goldfish movements to upstream waterbodies, assess the goldfish population, and to test multiple goldfish removal/management methods. The study concluded that goldfish are likely spawning within their resident lakes near cattails and bullrush fringes rather than in upstream waterbodies and determined that small-mesh baited box nets were effective at removing goldfish. Following these conclusions, goldfish removal efforts were expanded in 2023 where four box net traps were deployed and lifted on 12 occasions. In 2023, in total, 1,162 pounds or approximately 12,360 individual goldfish were removed from the South Basin. The District plans to continue box netting efforts in 2024.

Continuation of water quality and biological monitoring is recommended to assess the condition of the lake's water quality and biological community, evaluate impacts of the management activities, and identify trends.

5 Lake Edina

Lake Edina (Figure 5-1) is a small shallow lake located in Edina with a surface area of 24 acres and a maximum depth of approximately 4 feet. The lake is shallow enough for aquatic plants to grow over the entire lake bed. In addition, it is a polymictic lake (mixing many times per year). The lake is currently on the MPCA's impaired waters list for excess nutrients (since 2008).

In 2023, the Nine Mile Creek Watershed District monitored Lake Edina for:

- Water chemistry – total phosphorus (TP), soluble reactive phosphorus (ortho phosphate), total nitrogen, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, chlorophyll *a*, and chloride.
- Water field measurements – dissolved oxygen, pH, temperature, specific conductance, turbidity, and Secchi disc.

Water quality monitoring results are summarized in Appendix A. Monitoring results are discussed in the following paragraphs and compared with historical data.

Figure 5-1 Lake Edina on June 12, 2023

5.1 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

In 2023, Lake Edina water quality was poor. The lake's 2023 summer average total phosphorus concentration of 95 µg/L, summer average chlorophyll *a* concentration of 51 µg/L, and summer average Secchi disc transparency of 0.4 meters failed to meet the Minnesota water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4) (Figure 5-2). It should be noted that the Secchi disc hit the bottom from June through early August due to lower-than-average water levels. Minnesota water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion in 2023 are ≤ 60 µg/L, ≤ 20 µg/L, and ≥ 1 meter, for total phosphorus, chlorophyll *a* and Secchi depth, respectively.

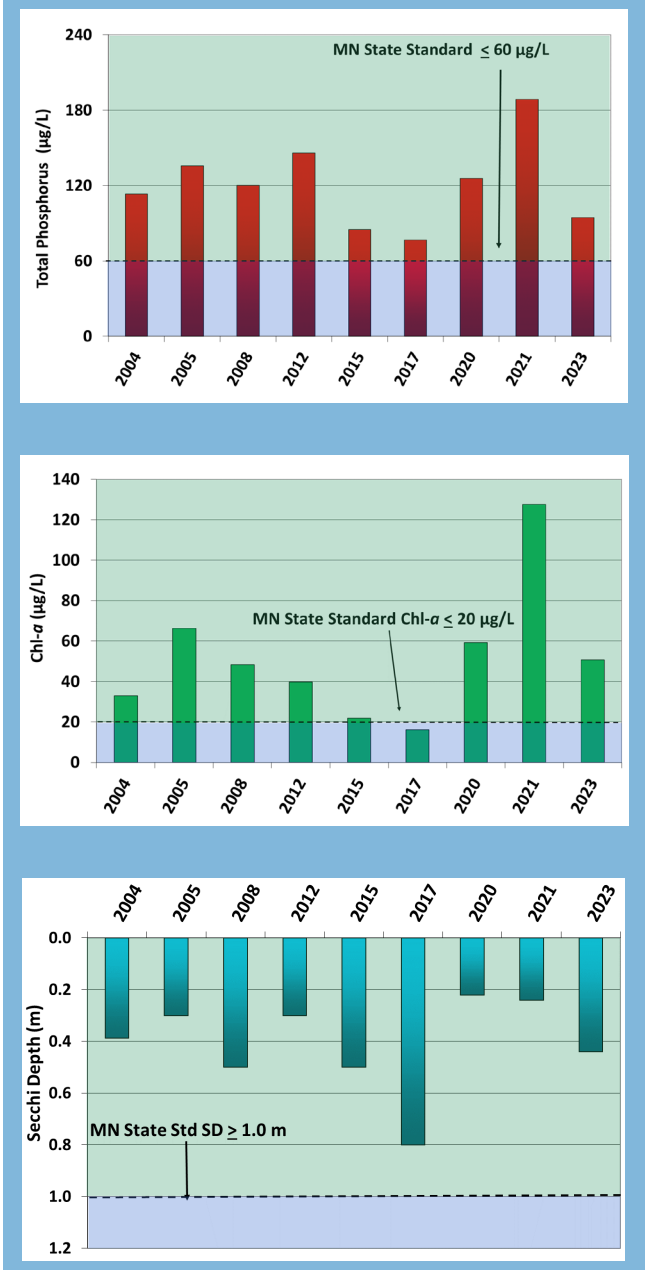


Figure 5-2 **Lake Edina historical summer average values** total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

Historical water quality data have been collected from Lake Edina by NMCWD during 2008, 2012, 2015, 2017, 2020, 2021, and 2023 and by the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) during 2004 and 2005. Between 2004-2023, all observed summer average total phosphorus and Secchi disc transparency values failed to meet the Minnesota State Standards. For chlorophyll *a*, all but the 2017 summer average chlorophyll *a* concentration failed to meet Minnesota State standards for shallow lakes (Figure 5-2). The 2023 summer average total phosphorus and chlorophyll *a* concentrations were lower than values measured in 2020 and 2021 and the 2023 summer average Secchi disc transparency was higher than values measured in 2020 and 2021 (i.e., improved clarity).

5.2 Chlorides

Chloride concentrations were measured in Lake Edina in 2012, 2015, 2017, 2020, 2021, and 2023 generally between April and September. The observed chloride concentrations for years monitored by the District are summarized in Figure 5-3. Because high concentrations of chloride can harm fish and plant life, MPCA has established acute and chronic exposure chloride standards. A lake is considered impaired if two or more exceedances of chronic criterion (230 mg/L or less) occur within a three-year period or one exceedance of acute criterion (860 mg/L) is measured. All chloride measurements were below the acute MPCA criterion. However, the June 2023 value exceeded the chronic MPCA criterion at 276 mg/L and was the highest recorded value to date. 2023 data are summarized in Appendix A.

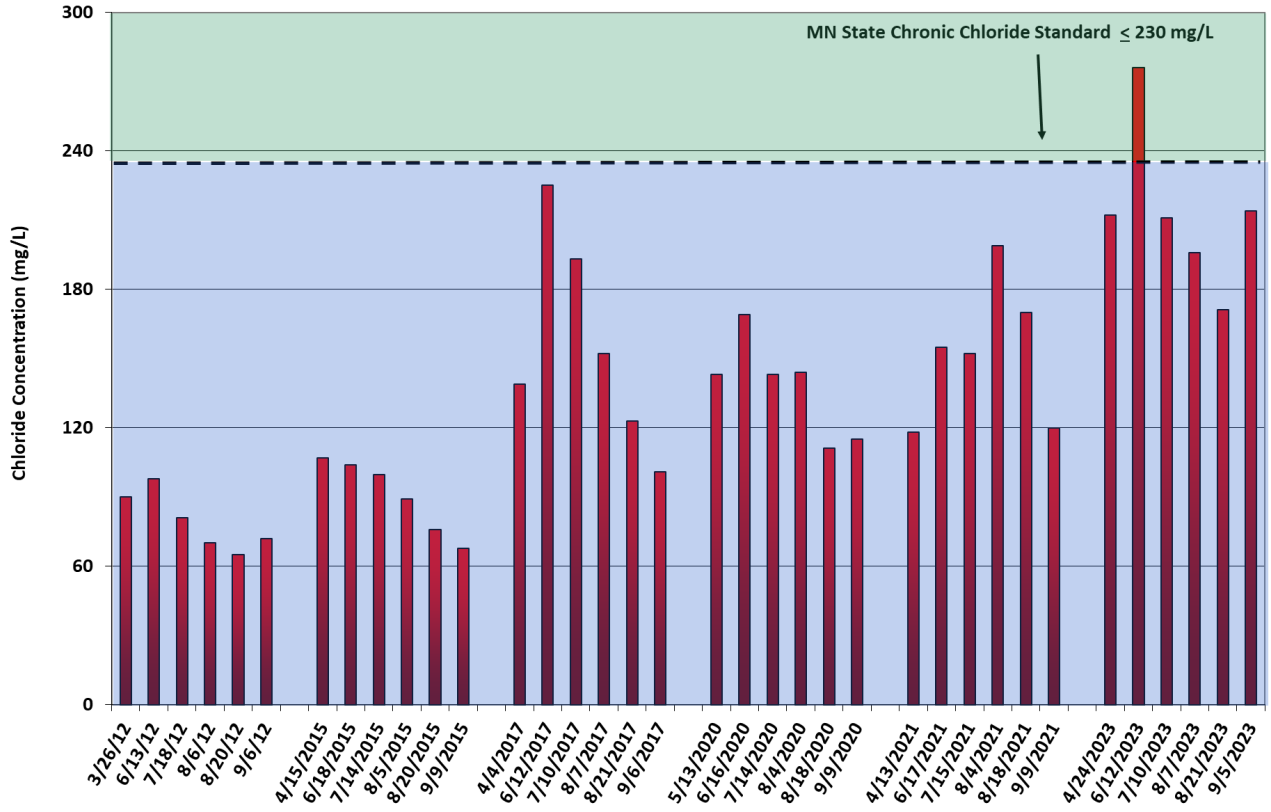


Figure 5-3 Lake Edina historical chloride concentrations

5.3 Conclusions and Recommendations

Water quality of Lake Edina was poor in 2023 due to excess phosphorus and algae in the lake and poor water clarity. Although the 2023 summer average phosphorus and chlorophyll *a* concentrations were lower than 2020 and 2021 values and the 2023 summer average Secchi disc transparency value was higher than 2020 and 2021 values, the lake failed to meet Minnesota State eutrophication water quality standards for shallow lakes. Additionally, monitoring results indicate Lake Edina exceeded the MPCA chronic chloride criterion of 230 mg/L with an observed chloride concentration of 276 mg/L in June 2023.

The District completed a water quality study of Lake Cornelia and Lake Edina in July of 2019 to identify water quality improvement measures for both lakes. The study concluded that the poor water quality in Lake Edina is primarily due to excess phosphorus, which fuels algal production and decreases water clarity. Phosphorus in Lake Edina primarily comes from runoff from the watershed (external sources) and flows from upstream Lake Cornelia. Modeling indicates that during 2017, flows from upstream Lake Cornelia comprised nearly two thirds of the annual phosphorus load to Lake Edina. Because the water quality of Lake Edina is highly influenced by the water quality of Lake Cornelia, a recommended management strategy to improve water quality in Lake Edina is to implement management practices to improve upstream Lake Cornelia. The District and City of Edina have initiated several improvement projects in the Lake Cornelia watershed (see Section 4). The District, in partnership with the City of Edina, also installed a regional infiltration basin (Lynmar Basin) in the Bristol & Mavelle Park within the Lake Edina watershed to reduce pollutants reaching Lake Edina.

Continuation of periodic water quality and biological monitoring is recommended to assess the condition of the lake's water quality and biological community, evaluate impacts of the management activities, and identify trends.

6 Lake Minnetoga

Lake Minnetoga (Figure 6-1) is located in the City of Minnetonka. The lake has a surface area of 15 acres, an approximate maximum depth of 27 feet, and a mean depth of 12.8 feet.

In 2023, the Nine Mile Creek Watershed District monitored Lake Minnetoga for:

- Water chemistry- total phosphorus (TP), soluble reactive phosphorus (ortho phosphate), total nitrogen, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, chlorophyll *a*, and chloride.
- Water field measurements- dissolved oxygen, pH, temperature, specific conductance, turbidity, and Secchi disc.
- Macrophytes (aquatic plants).

Water quality monitoring results are summarized in Appendix A and macrophyte monitoring maps in Appendix D. Monitoring results are discussed in the following paragraphs and compared with historical data.

Figure 6-1 Lake Minnetoga on August 7, 2023

6.1 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

Figure 6-2 shows the 2023 summer average (June through September) conditions for total phosphorus, chlorophyll *a*, and Secchi disc transparency data collected in the epilimnion (surface), in comparison with monitoring results from past years. The lake's 2023 summer average total phosphorus concentration of 25 µg/L, the lake's summer-average chlorophyll *a* concentration of 4.2 µg/L, and the lake's summer average Secchi disc transparency of 2.4 meters met the Minnesota State water quality standards for lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Minnesota State water quality standards for deep lakes in the North Central Hardwood Forest Ecoregion are ≤40 µg/L, ≤14 µg/L, and ≥1.4 meter, for total phosphorus, chlorophyll *a* and Secchi depth, respectively.

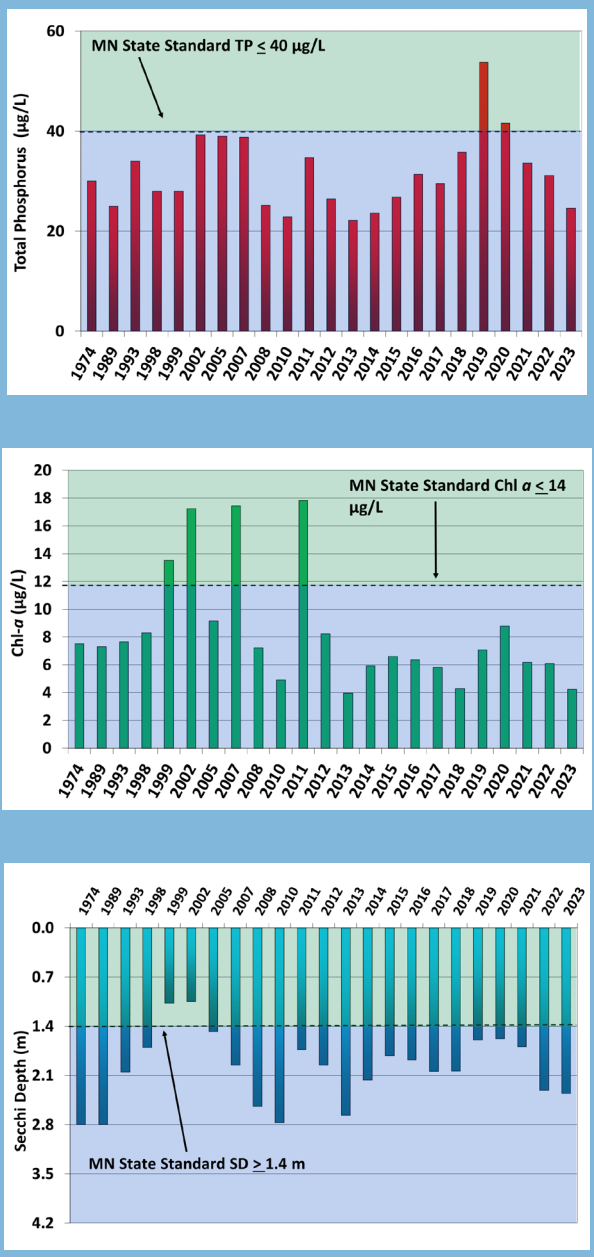


Figure 6-2 Lake Minnetoga historical summer average values
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

The historical water quality data presented in Figure 6-2 comes from several sources, including Nine Mile Creek Watershed District (1974, 1989, 1998, 2007, 2017, and 2023), the City of Minnetonka (1993, 1999, 2002, 2005, 2008, 2011, 2015, 2018, 2019, and 2021), and the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) (2007, 2008, and annually during 2010 through 2023). During the monitored years, summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc depth have generally met the Minnesota State standard. However, the summer average total phosphorus concentrations failed to meet the State standard during 2019 and 2020; the summer average chlorophyll *a* concentrations failed to meet the State standard during 2002, 2007, and 2011; and the summer average Secchi disc transparency failed to meet the State standard during 1999 and 2002.

6.2 Hypolimnion Total Phosphorus Concentrations

Figure 6-3 shows the 2023 summer average (June through September) conditions for total phosphorus, data collected in the epilimnion (surface) and hypolimnion (bottom), in comparison with monitoring results from past years. The lake's 2023 summer average total phosphorus concentration of 25 µg/L in the epilimnion is notably lower than the summer average total phosphorus concentration of 660 µg/L in the hypolimnion. Since 1999, the summer average total phosphorus concentrations in the hypolimnion have been 11 – 38 times higher than the epilimnion. High hypolimnion and low epilimnion total phosphorus concentrations over the summer indicate the following:

1) Notable internal phosphorus loading from lake bottom sediment
2) Strong stratification and reduced lake mixing

Although strong lake stratification during the growing season has resulted in maintaining low phosphorus and chlorophyll *a* concentrations in the epilimnion from May through early September for most monitored years, high chlorophyll *a* concentrations have been consistently observed following spring turnover in April (Figure 6-4). On April 24, 2023, the observed chlorophyll *a* concentration was 267 µg/L, which is approximately 60 times greater than the 2023 summer average of 4.2 µg/L. This higher chlorophyll *a* concentration corresponded to a higher epilimnion total phosphorus concentration of 348 µg/L, which was nearly equal to the concentration monitored in the hypolimnion indicating that the lake had recently turned over and mixed.

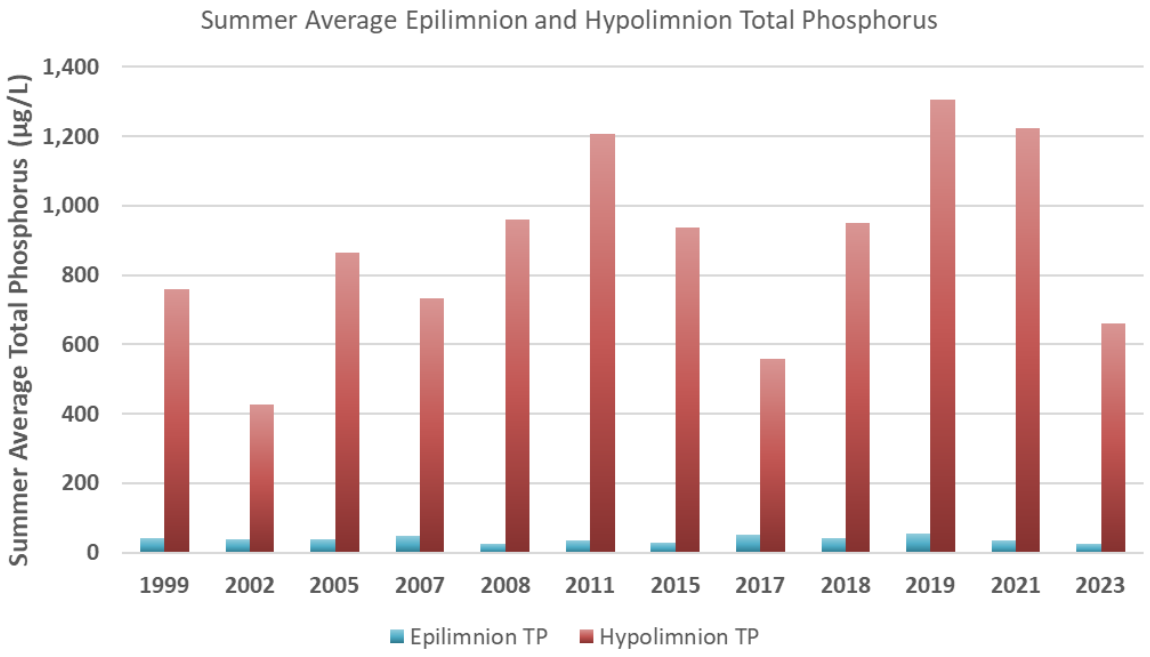


Figure 6-3 Lake Minnetoga historical epilimnion (surface) and hypolimnion (bottom) summer average total phosphorus concentrations

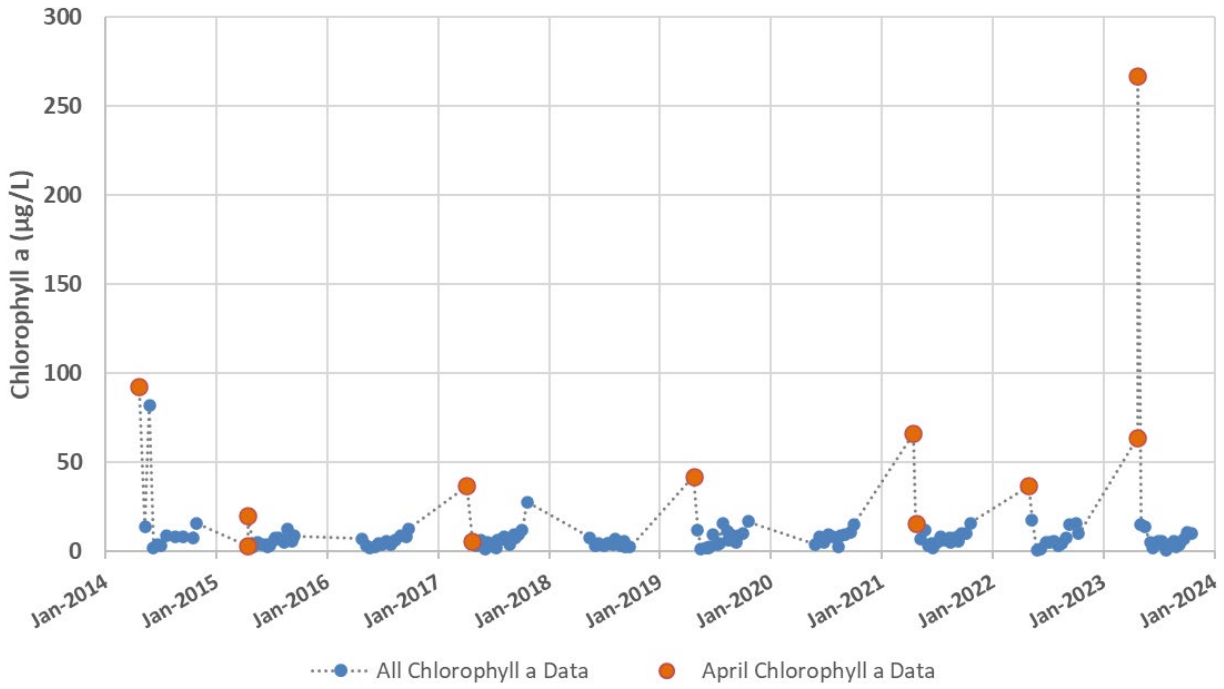


Figure 6-4 Observed chlorophyll *a* monitoring data in April compared to growing season data

6.3 Chlorides

Chloride concentrations were measured in 2017 and 2023 generally between April and September. Figure 6-5 shows the observed 2023 chloride concentrations in comparison with 2017 observations. Chloride concentrations increased in 2023 compared with 2017. 2017 chloride concentrations measured in the lake's epilimnion (surface waters) ranged from 72 to 82 mg/L compared with 2023 concentrations ranging from 140 to 160 mg/L.

Because high concentrations of chloride can harm fish and plant life, the MPCA has established acute and chronic exposure chloride standards. A lake is considered impaired if two or more exceedances of chronic criterion (230 mg/L or less) occur within a three-year period or one exceedance of acute criterion (860 mg/L) is measured. All Lake Minnetoga chloride measurements to date were well below the acute and chronic MPCA criteria. The 2023 data are summarized in Appendix A.

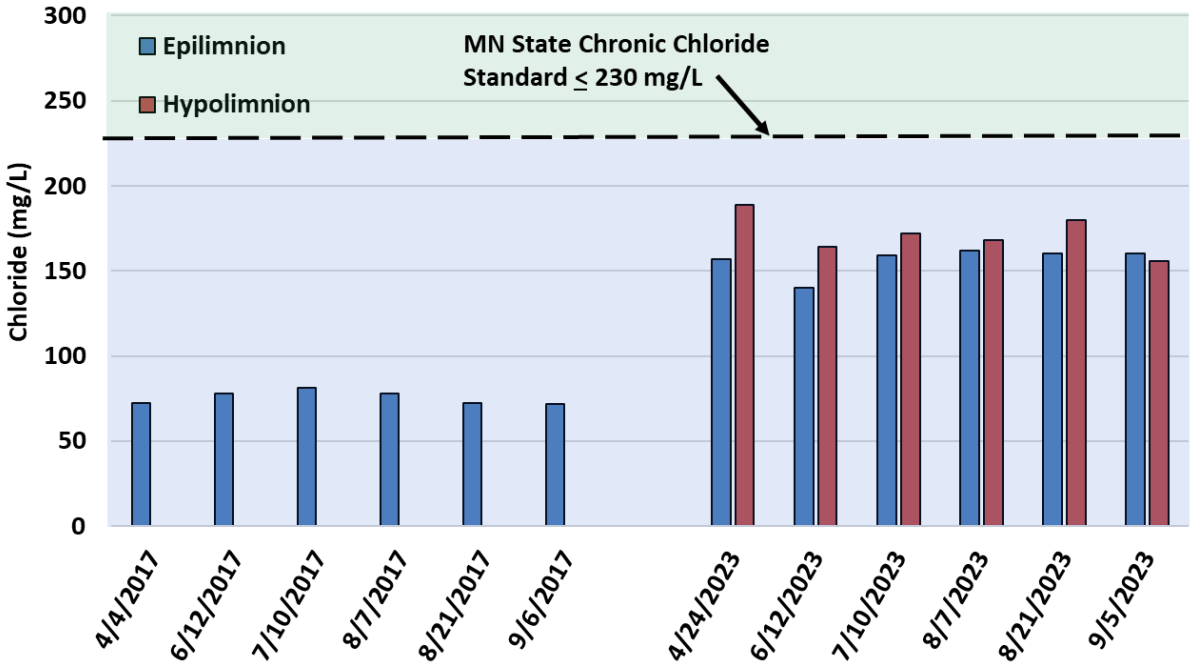


Figure 6-5 Lake Minnetoga historical chloride concentrations

6.4 Aquatic Plants

A healthy aquatic plant community is an essential part of lakes and provides many important benefits such as nutrient assimilation, sediment stabilization, and habitat for fish. Eutrophication may have detrimental effects on a lake, including reductions in the quantity and diversity of aquatic plants. The ability to assess the biological condition of a lake plant community is a valuable tool in the conservation of Minnesota's lakes. With this objective in mind, the Minnesota Department of Natural Resources (MNDNR) developed a Lake Plant Eutrophication Index of Biological Integrity (IBI) to measure the response of a lake plant community to eutrophication. The Plant IBI can provide important context to understanding information about water quality, shoreline health, and the fish community.

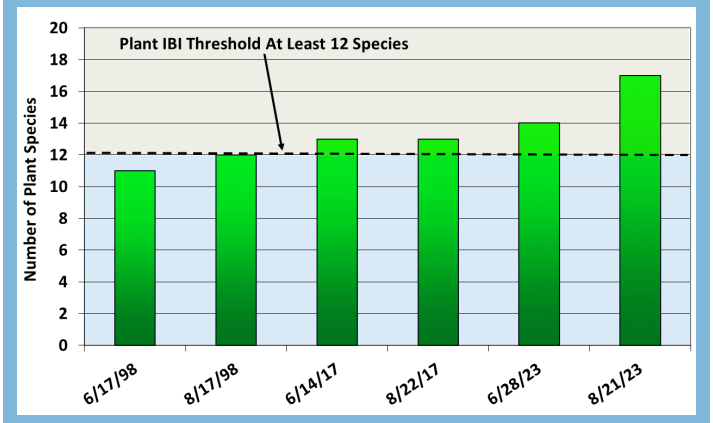


Figure 6-6.A

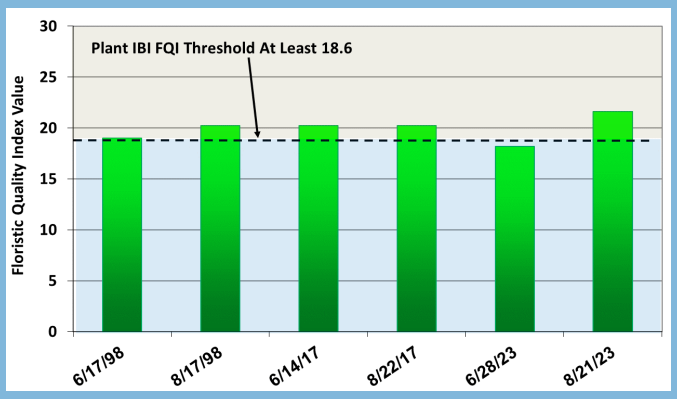


Figure 6-6.B

Figure 6-6 Lake Minnetoga Plant Index of Biotic Integrity (IBI) Values compared with Plant IBI Thresholds (MNDNR)
Number of plant species (top) and Floristic Quality Index (FQI) (bottom).

The MNDNR Lake Plant Eutrophication IBI includes two metrics: (1) the number of species in a lake; and (2) the "quality" of the species, as measured by the floristic quality index (FQI). The MNDNR has determined a threshold for each metric. Lakes that score below the thresholds contain degraded plant communities and are likely stressed from anthropogenic eutrophication.

The District conducted point intercept plant surveys of Lake Minnetoga in June and August of 2023. Maps showing survey results are included in Appendix D. Plant survey data from 1998, 2017, and 2023 were assessed to track changes in plant IBI scores. Figure 6-6 shows the number of species and FQI scores in Lake Minnetoga for that period compared to the MNDNR Plant IBI thresholds. The number of species in the lake met the MNDNR Plant IBI thresholds in June and August of 2023. The FQI met the MNDNR Plant IBI threshold in August of 2023.

- **Number of species:** A deeper lake (maximum depth greater than 15 feet) fails to meet the MNDNR Plant IBI threshold when it has fewer than 12 species. During the period examined, the number of species in Lake Minnetoga ranged from 11 to 17, exceeding the MNDNR Plant IBI

threshold during all but the June 1998 sample event. The number of species in the lake during June and August 2023 was the highest to date at 14 and 17 species, respectively.

- **FQI values (quality of species):** The MNDNR Plant IBI threshold for deeper lakes, as measured by FQI, is a minimum value of 18.6. During the period examined, FQI values in Lake Minnetoga ranged from 18 to 22, exceeding the MNDNR Plant IBI threshold during all but the June 2023 sample date. The August 2023 FQI value (22) was higher than all previous FQI values (18 to 20).

Four aquatic invasive species were found in Lake Minnetoga in 2023.

- **Curly-leaf pondweed (CLP) (*Potamogeton crispus*)** – collected on the rake at 2 locations (4 percent) and visually observed at an additional location in June and collected on the rake at 1 location (2 percent) in August. On a scale of 1 to 3, the average rake density was 1.0 during both June and August.
- **Purple loosestrife (*Lythrum salicaria*)** – plants were scattered around the shoreline in June and August. In June, all plants were covered with *Galerucella* beetles and were barely alive due to damage inflicted by the *Galerucella* beetles. In August, all plants had low to moderate damage from *Galerucella* beetles.
- **Narrow-leaved cattail (Typha angustifolia)** – observed at one location at the southeast corner of the lake in June. In August, narrow-leaved cattail was observed at two locations, one along the northeastern shoreline and one in the bay at the northwest area of the lake.
- **Reed canary grass (Phalaris arundinacea)** – observed at one location along the western shoreline in August.

6.5 Conclusions and Recommendations

Lake Minnetoga epilimnion (surface) water quality was excellent in 2023. Monitoring results indicate Lake Minnetoga met the Minnesota State lake eutrophication water quality standards for total phosphorus, chlorophyll *a*, and Secchi disc depth, as well as the MPCA acute and chronic exposure chloride criteria.

Although epilimnion (surface) total phosphorus concentrations have generally met standards during the summer (June – September) for most of the monitoring record since 1999 (except 2019 and 2020), the summer average total phosphorus concentrations in the hypolimnion (bottom) have been 11–38 times higher than the epilimnion. High hypolimnion and low epilimnion total phosphorus concentrations over the summer indicate notable internal phosphorus loading from lake bottom sediment and strong stratification/reduced lake mixing.

In 2023, the number of aquatic plant species in the lake exceeded the MNDNR Plant IBI thresholds and were more diverse than previous years. The June FQI value of 18 was poorer than the MNDNR Plant IBI threshold of 18.6, but the August value of 22 was better than the MNDNR Plant IBI threshold and higher than all previous FQI values. Four aquatic invasive species (AIS) were observed in Lake Minnetoga in 2022 – CLP, purple loosestrife, narrow-leaved cattail, and reed canary grass.

Continuation of periodic water quality and biological monitoring is recommended to assess the condition of the lake's water quality and biological community and identify trends. As noted above, monitoring data indicate notable internal phosphorus loading from lake bottom sediments in Lake Minnetoga. Strong stratification within the lake during summer months generally prevents mixing and associated introduction of water with higher phosphorus concentrations in the hypolimnion (bottom) to the epilimnion (surface). However, there is potential for the high phosphorus concentrations in the hypolimnion from internal loading to result in higher surface concentrations through periodic mixing and/or diffusion. As identified in the 10-year Water Management Plan, the District plans to conduct a water quality study of Lake Minnetoga in 2026. Given the potential for internal loading to negatively affect surface water quality, the District should consider conducting the water quality study sooner, as feasible.

7 Normandale Lake

Normandale Lake (Figure 7-1 and Figure 7-2) is located in the northwestern portion of Bloomington. Normandale Lake was created as a result of the Mount Normandale Lake flood control project, implemented in the late-1970s. The lake has a water surface area of approximately 116 acres, maximum depth of approximately 9 feet, and a mean depth of 3 feet at the normal water surface elevation of approximately 808 feet MSL. At this elevation, the lake volume is approximately 290 acre-feet. The lake is shallow enough for aquatic plants (i.e., macrophytes) to grow over the entire lake bed.

The water level in Normandale Lake is controlled mainly by the elevation of the outlet structure located at the east side of Normandale Lake and by weather conditions (snowmelt, rainfall, creek flows, and evaporation). The lake, located along Nine Mile Creek, has a large upstream watershed (approximately 30 square miles) and therefore receives a large amount of flow compared to its size. Flows through the lake, and associated pollutant loading, can vary significantly depending on climatic conditions. Water quality conditions in the lake can also vary accordingly.

In 2023, the Nine Mile Creek Watershed District monitored Normandale Lake for:

- Water chemistry - total phosphorus (TP), total dissolved phosphorus, soluble reactive phosphorus (ortho phosphate), total nitrogen, total Kjeldahl nitrogen, ammonia nitrogen, nitrate plus nitrite nitrogen, chlorophyll *a*, and chloride.
- Water field measurements - dissolved oxygen, pH, temperature, specific conductance, turbidity, and Secchi disc.
- Phytoplankton (microscopic plants).
- Macrophytes (aquatic plants).
- Turion survey (survey of curly-leaf pondweed turions in the sediment). Turions are the primary reproductive structures of curly-leaf pondweed.

Water quality monitoring was conducted in two locations: on the east side at the deepest portion of the lake near the outlet (the District's routine monitoring location) and at the inlet of Nine Mile Creek on the northwest side of the lake. Results are summarized in Appendix A. Phytoplankton results, sampled from the District's routine monitoring location on the east side of the lake, are summarized in Appendix B. Macrophyte monitoring maps are provided in Appendix E. Results of the turion survey are provided in Appendix F. Monitoring results are discussed in the following paragraphs.

Figure 7-1 Normandale Lake on June 22, 2023

Figure 7-2 Normandale Lake on July 27, 2023

7.1 Total Phosphorus and Chlorophyll *a* Levels and Water Clarity (Secchi Depth)

Figure 7-3 presents summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency from the lake's routine monitoring location on the east side of the lake. In 2023, the lake's summer average total phosphorus and chlorophyll *a* concentrations of 30 µg/L and 8 µg/L respectively, and the lake's summer average Secchi disc transparency (water clarity) of 2.0 meters met the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050 (Minn. R. Ch. 7050.0222 Subp 4). Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion are ≤60 µg/L, ≤20 µg/L, and ≥1 meter, for total phosphorus, chlorophyll *a* and Secchi depth, respectively.

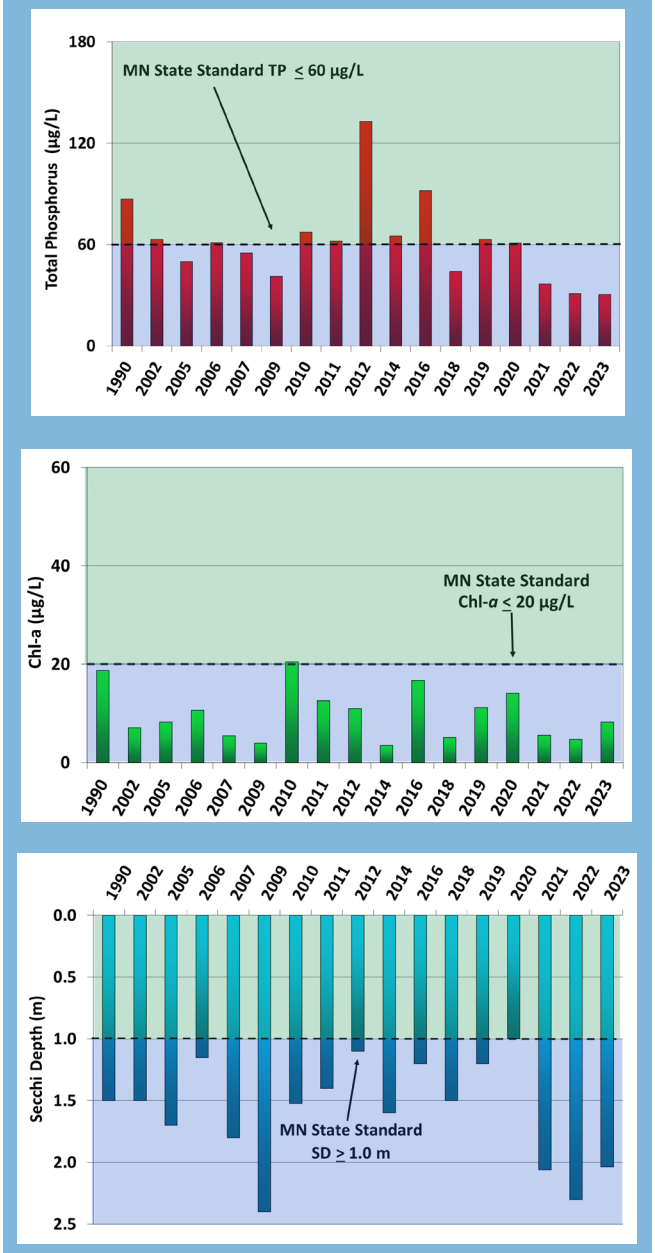


Figure 7-3 Normandale Lake historical summer average values.
Total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

Water quality data were collected from Normandale Lake by Nine Mile Creek Watershed District during 1990, 2002, 2005, 2007, 2010, 2014, 2016, 2018, 2019, 2020, 2021, 2022, and 2023; by the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) during 2006, 2009, 2010, 2011, and 2012; and by the MPCA Citizen Lake Monitoring Program (CLMP) in 2020 – 2023 (Secchi depth). Data from these sources has generally been included in computation of the historic summer average values shown in Figure 7-3, depending on timing of data availability, sampling location, and data quality review.

Comparison of the 2023 data with historical monitoring results indicates the 2023 summer average total phosphorus concentration in Normandale Lake was the lowest on record. The 2023 summer average chlorophyll *a* concentration and Secchi disc depth were within the range of historical data. All observed summer average chlorophyll *a* concentrations and Secchi disc transparencies throughout the period of record have met the respective Minnesota State water quality standards for shallow lakes. Summer

average chlorophyll *a* concentrations have ranged from 4 µg/L to 20 µg/L and summer average Secchi disc transparencies have ranged from 1.0 meter to 2.4 meters. Summer average total phosphorus concentrations have ranged from 30 µg/L to 133 µg/L during the monitored period and have failed to meet the Minnesota State water quality standard of ≤60 µg/L in 2006, 2010-2016, and 2019-2020.

In 2020 through 2023, the District also collected and analyzed monitoring data in the northwest part of the lake near the inlet of Nine Mile Creek. The 2018 Engineer's Report for the Normandale Lake Water Quality Improvement Project concluded that stormwater from the large watershed tributary to Normandale Lake, much of which is untreated prior to reaching Nine Mile Creek, contributes substantial phosphorus loading to the lake. 2020 through 2023 monitoring data indicate that phosphorus concentrations near the inlet of Nine Mile Creek are generally higher than concentrations measured near the lake outlet. As shown in Figure 7-4 comparison of the phosphorus concentrations collected by the District demonstrates that the lake typically removes phosphorus, likely through settling and uptake of nutrients by aquatic plants. Normandale Lake and the 2020-2023 District monitoring locations are shown in Figure 7-5.

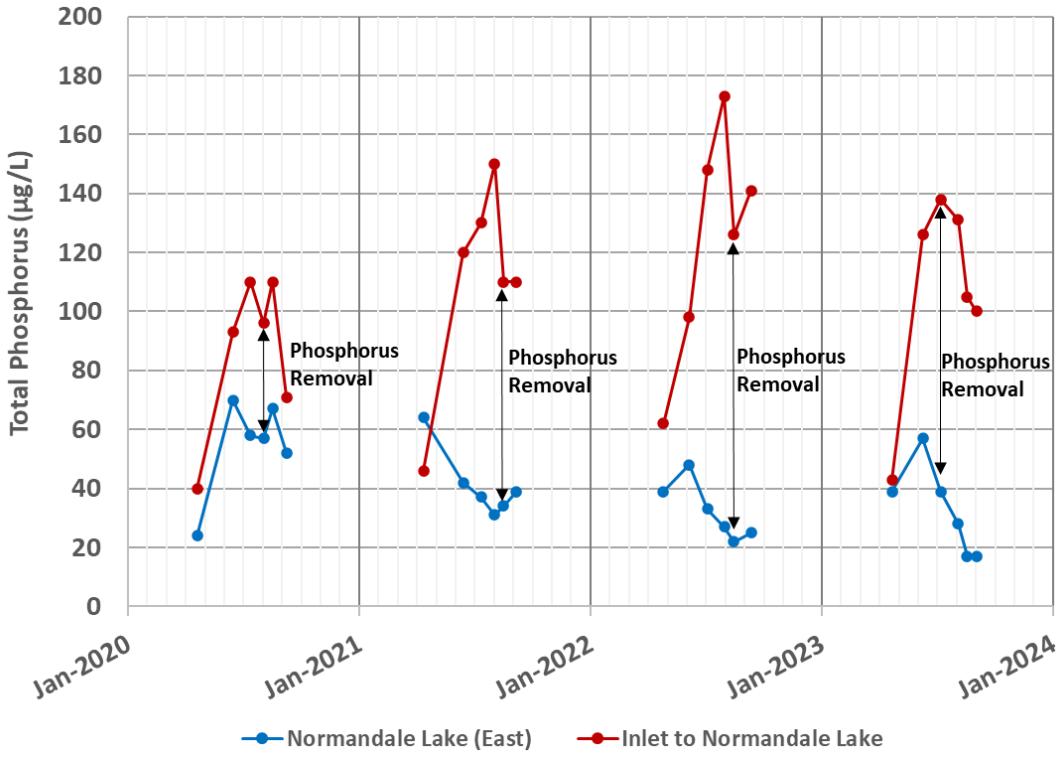


Figure 7-4 2020-2023 Normandale Lake total phosphorus concentrations measured at the lake inlet and on the east side at the deepest portion of the lake near the outlet (District's routine monitoring location)

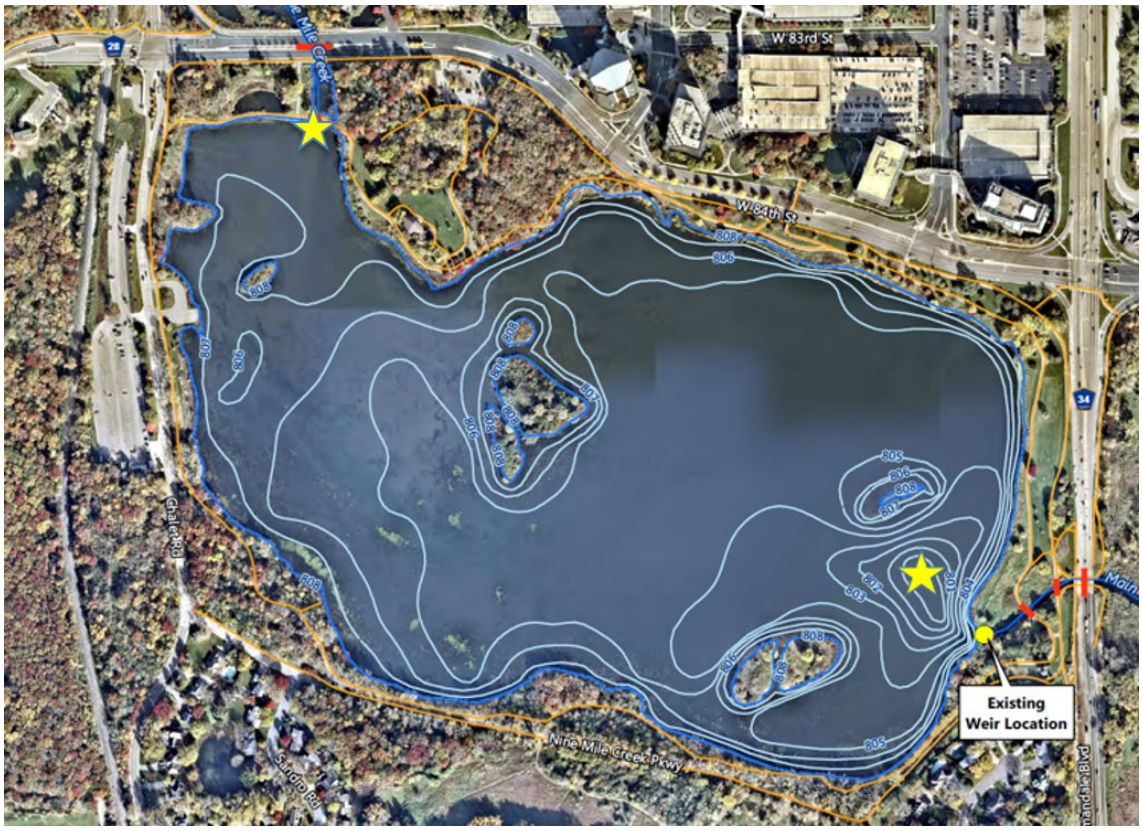


Figure 7-5 Normandale Lake 2020-2023 District sample locations: on the east side at the deepest portion of the lake near the outlet (the District's routine monitoring location) and at the inlet of Nine Mile Creek on the northwest side of the lake

7.2 Nitrogen

While total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency are commonly measured to assess attainment of the eutrophication water quality standards for shallow lakes, it is important to note that nitrogen also plays a significant role in the water quality of Normandale Lake. Algae and aquatic plants require nutrients to grow, including nitrogen and phosphorus. Phosphorus is often the "limiting nutrient" in lakes, meaning that the available quantity of this nutrient is in low proportion to the others and controls the rate at which algae and aquatic plants obtaining nutrients from the water column are produced. However, monitoring data support the conclusion that at varying times throughout the year nitrogen can be the "limiting nutrient," phosphorus and nitrogen can be colimiting, or phosphorus can be the "limiting nutrient" depending on environmental conditions. This conclusion highlights the importance of continued implementation of best management practices in the upstream watershed to minimize the amount of nutrients (both nitrogen and phosphorus) in Nine Mile Creek and education of property owners regarding responsible use of fertilizer on lawns or other turf.

7.3 Chlorides

Chloride concentrations were measured during April/May through September in 2010, 2014, 2016, and 2018-2023. Figure 7-6 summarizes the observed chloride concentrations from 2010 through 2023.

Because high concentrations of chloride can harm fish and plant life, MPCA has established acute and chronic exposure chloride standards. A lake is considered impaired if two or more exceedances of chronic criterion (230 mg/L or less) within a three-year period or one exceedance of acute criterion (860 mg/L) is measured. Observed chloride concentrations were above the MPCA chronic chloride criteria in:

- April 2014
- April 2016
- May and June 2018
- April and June 2021
- July and early August 2022
- June, July, and early August of 2023

All measurements during 2010 through 2023 were below the acute MPCA criterion. 2023 chloride data are summarized in Appendix A.

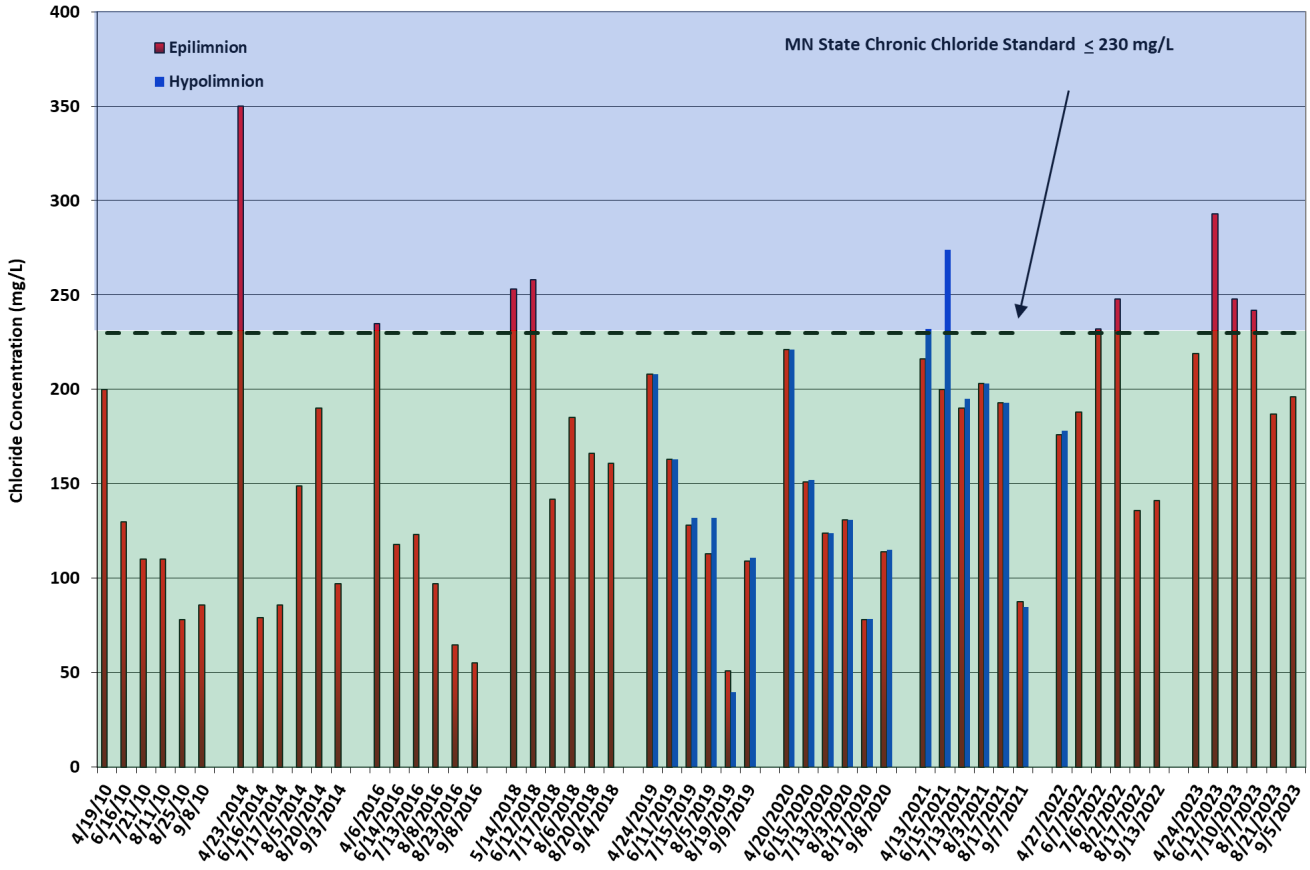


Figure 7-6 Normandale Lake historical chloride concentrations

7.4 Phytoplankton

Phytoplankton, also called algae, are microscopic aquatic plants naturally present in lakes. Phytoplankton derive energy from the sun through photosynthesis and provide food for several types of aquatic organisms, including zooplankton, which are in turn eaten by fish. An inadequate phytoplankton population limits a lake's zooplankton population, and indirectly limits fish production in a lake. Excess phytoplankton can reduce water clarity.

In 2023, the District monitored phytoplankton in Normandale Lake as part of its routine monitoring program. Results of the 2023 identification and enumeration of the phytoplankton species can be found in Appendix B.

Figure 7-7 summarizes the number and major groups of phytoplankton observed in Normandale Lake in monitored years. The observed data indicate that phytoplankton in Normandale Lake have generally been balanced between green algae, cryptomonads, diatoms, and blue-green algae. Green algae, diatoms, and cryptomonads are a good quality food source and contribute towards a healthy zooplankton community. Blue-green algae are a poor-quality food for zooplankton; they can be toxic to zooplankton and may not be assimilated if ingested. Blue-green algae can also produce algal toxins, which can be harmful to humans or other animals.

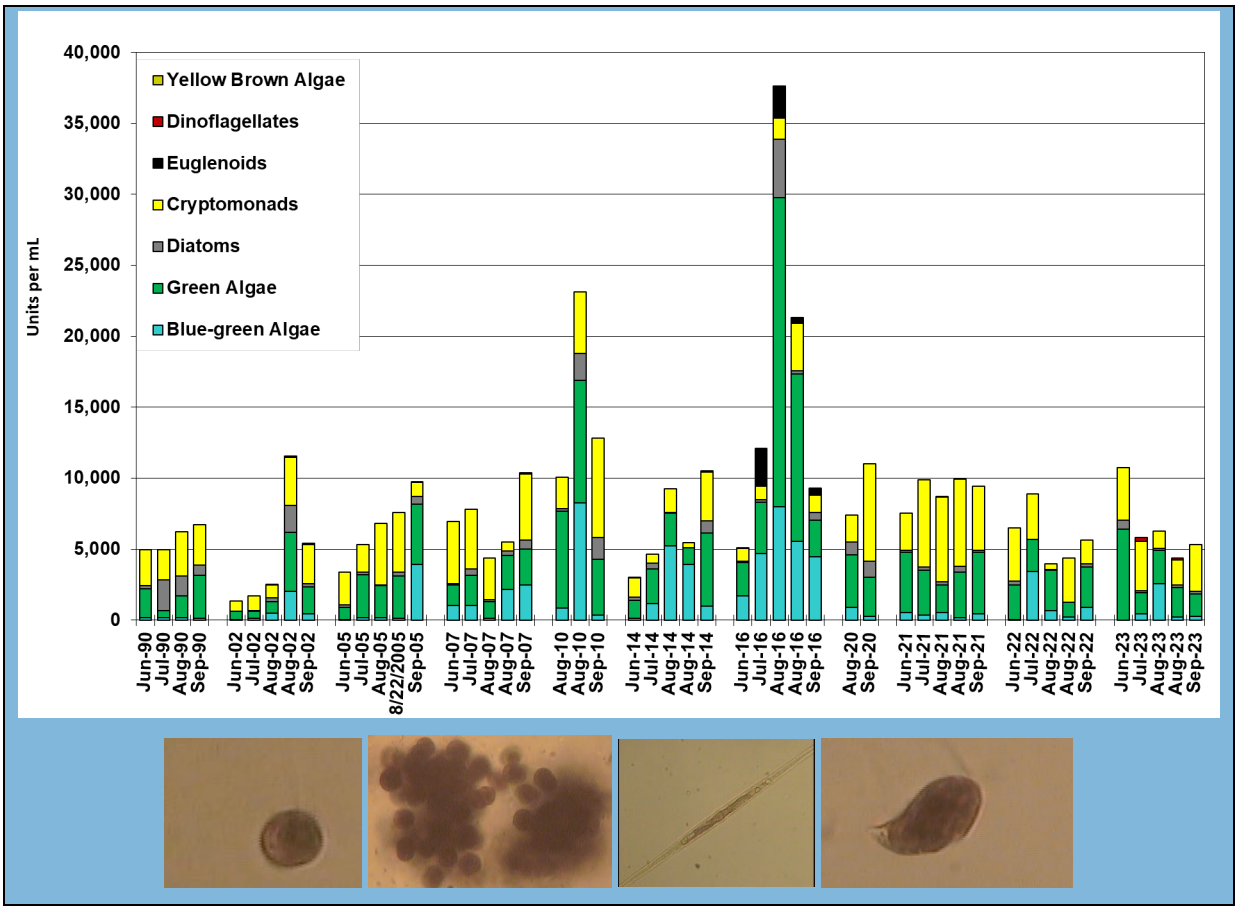


Figure 7-7 Normandale Lake historic summer phytoplankton communities

Top, Normandale Lake 1990, 2002, 2005, 2007, 2010, 2014, 2016, 2020, 2021, 2022, and 2023 summer phytoplankton numbers and bottom, microscopic pictures of phytoplankton species found in the lake, from left to right, *Chlamydomonas globosa* (green algae), *Microcystis aeruginosa* (blue-green algae), *Synedra ulna* (diatom), and *Cryptomonas erosa* (cryptomonad)

Figure 7-8 summarizes the historic blue-green algae numbers at the District's routine monitoring location in Normandale Lake. Comparison of blue-green numbers during the monitored period to the World Health Organization (WHO) guideline thresholds for probability of adverse health effects to recreational users indicates all observed values have been below the threshold for low probability of adverse health effects.

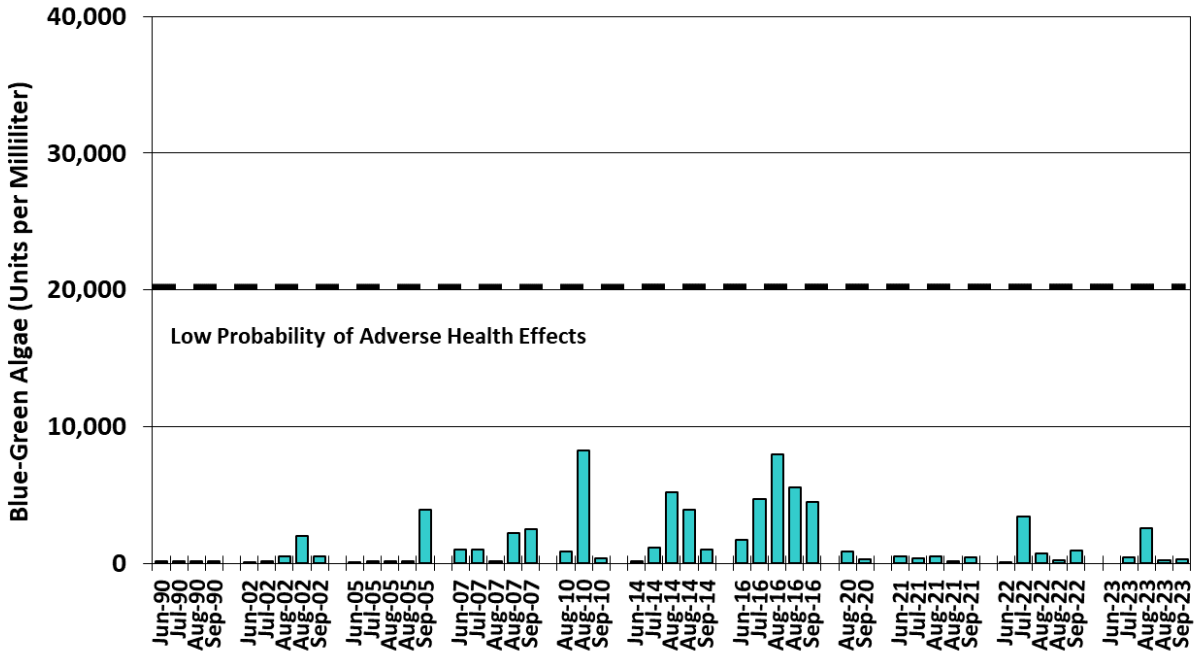


Figure 7-8 Normandale Lake blue-green algae numbers compared with World Health Organization (WHO) thresholds for adverse health effects to recreational users

7.5 Filamentous Algae

Filamentous algae are colonies of microscopic plants in which single cells link together to form long visible chains, threads, or mesh-like filaments and, when nutrient conditions are favorable, form mats that float on the surface of lakes or ponds. Where there is good transparency and where sunlight reaches the bottom, filamentous algae begin their growth on the bottom of waterbodies, attached to bottom sediments or submerged objects. As the algae grow, they produce oxygen that gets trapped in the entangled strands of algae. This trapped oxygen makes the algae buoyant, causing them to rise to the surface where they form floating mats. Disturbance of these algal mats by high wind or heavy rain events may cause them to temporarily sink to the bottom due to the removal of the trapped oxygen bubbles that caused them to be buoyant. This can give a false impression that the growth has "disappeared", only to have the algal mats return to the surface within several days after new oxygen bubbles become trapped in the entangled strands of algae, thus making the mats buoyant once again.

Figure 7-9 summarizes the frequency of filamentous algae in Normandale Lake during plant surveys completed in June and August of years 2016 through 2023. Filamentous algae frequency of occurrence at

sampling points has ranged from 9 percent on August 27, 2016 to 74 percent on June 22, 2022. In 2023, filamentous algae frequency of occurrence at sample points ranged from 26 percent in June to 22 percent in August.

The growth potential of filamentous algae is dependent upon nutrient and light conditions. Nine Mile Creek generally provides a continuous supply of nutrients to fuel the growth of filamentous algae in Normandale Lake and because the lake generally has adequate light, the lake can support the growth of filamentous algae throughout each growing season. Filamentous algae produce reproductive structures that fall to the lake bottom and, when conditions are favorable, the reproductive structures begin a new growth of these algae, sustaining the presence of filamentous algae in the lake. The beginning of the filamentous algae growth season is generally triggered by the warming of the water to a threshold temperature (e.g., 59 to 68° F). The end of their growing season occurs when light, nutrient, or temperature conditions become unfavorable for growth. The most effective long-term management option for filamentous algae is nutrient reduction.

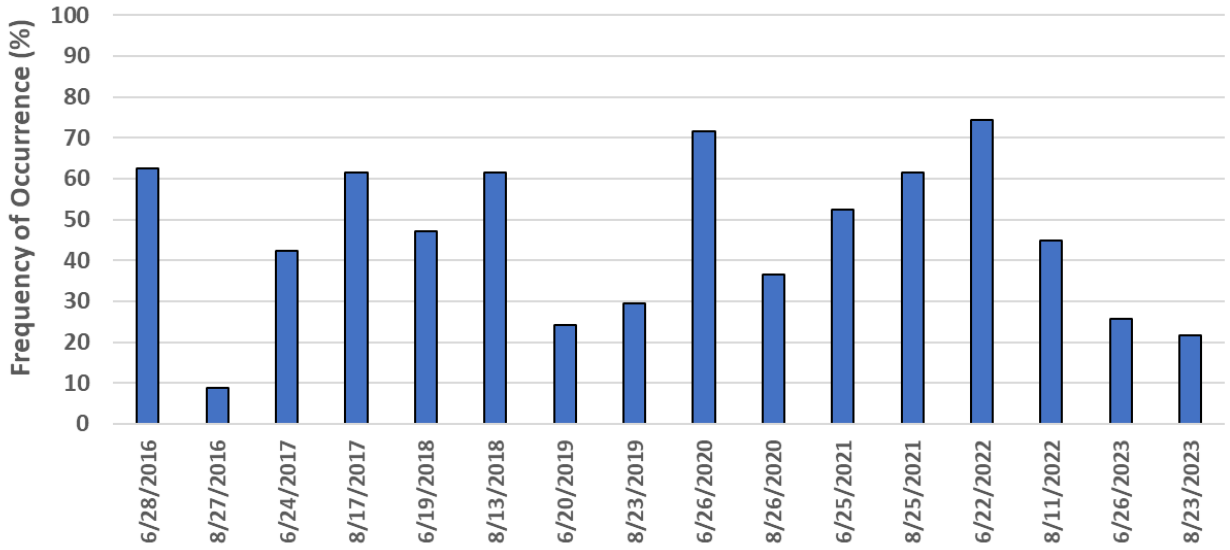


Figure 7-9 Normandale Lake filamentous algae frequency of occurrence

2016- 2023 Normandale Lake filamentous algae frequency of occurrence at the 125 sample locations throughout Normandale Lake

7.6 Aquatic Plants

A healthy aquatic plant community is an essential part of lakes and provides many important benefits such as nutrient assimilation, sediment stabilization, and habitat for fish. Eutrophication may have detrimental effects on a lake, including reductions in the quantity and diversity of aquatic plants. The ability to assess the biological condition of a lake plant community is a valuable tool in the conservation of Minnesota's lakes. With this objective in mind, the MNDNR developed a Lake Plant Eutrophication Index of Biological Integrity (IBI) to measure the response of a lake plant community to eutrophication. The Plant IBI can provide important context to understanding information about water quality, shoreline health, and the fish community.

The MNDNR Lake Plant Eutrophication IBI includes two metrics: (1) the number of species in a lake; and (2) the "quality" of the species, as measured by the floristic quality index (FQI). The MNDNR has determined a threshold for each metric. Lakes that score below the thresholds contain degraded plant communities and are likely stressed from anthropogenic eutrophication.

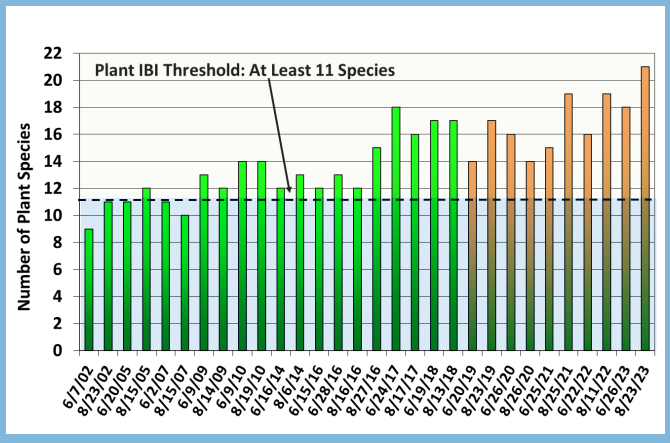


Figure 7-10.A

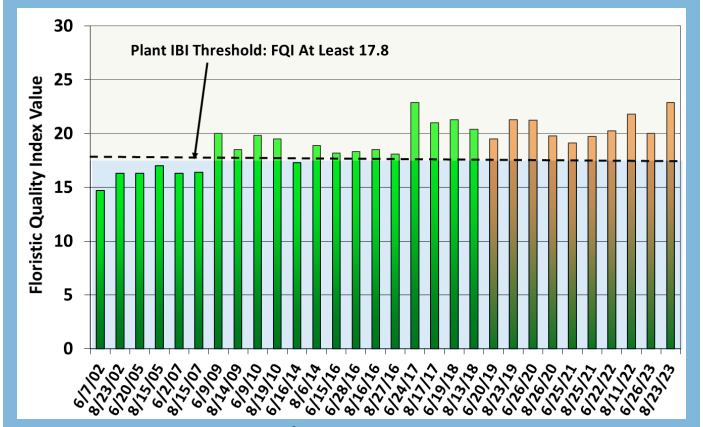


Figure 7-10.B

Figure 7-10 Normandale Lake Plant Index of Biotic Integrity (IBI) values compared with plant IBI thresholds (MNDNR)
Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom)

In 2018, the District began implementation of the Normandale Lake Water Quality Improvement Project, in partnership with the city of Bloomington. A drawdown of the lake was completed in fall of 2018 to expose the lake bed to a winter freeze and freeze out curly-leaf pondweed, an invasive aquatic plant that dies off in late June, releasing phosphorus to the lake as it decays, which can fuel algal growth and degrade lake water quality. In the spring of 2020 through 2023, herbicide treatments were conducted within portions of Normandale Lake and Nine Mile Creek immediately upstream of Normandale Lake using diquat to control curly-leaf pondweed growing in these areas. Comprehensive plant monitoring has occurred since the implementation of the Normandale Lake Water Quality Improvement Project to assess the success of curly-leaf pondweed management and improvements in the diversity and extent of native aquatic plants.

The District conducted point-intercept and biomass aquatic plant surveys of Normandale Lake in June and August of 2023. Results are included in Appendix E. Plant survey data from 2002 through 2023 were assessed to track changes in plant IBI scores. Figure 7-10 shows the Normandale Lake number of species and FQI scores for that period compared to the MNDNR Plant IBI thresholds. The green bars depict data collected before beginning the water quality improvement project in fall of 2018. The orange bars depict data collected after initiation of the water quality treatment project (drawdown in fall of 2018, alum treatment in spring of 2019, and herbicide treatment of curly-leaf pondweed in spring of 2020 through 2023). In 2023, both the number of species in the lake and FQI values were better than the MNDNR Plant IBI thresholds. The highest number of plant species observed to date was in August of 2023.

- **Number of species:** A shallow lake (maximum depth less than 15 feet) fails to meet the MNDNR Plant IBI threshold when it has fewer than 11 species. During the period examined, the number of species in Normandale Lake ranged from 9 to 21. The number of species in the lake has been better than the MNDNR Plant IBI threshold since 2009. Higher numbers of plant species have been observed since August of 2016 and the highest number to date was observed in August of 2023 at 21 species (Figure 7-10A).

- **FQI values (quality of species):** The MNDNR Plant IBI threshold for shallow lakes, as measured by FQI, is a value of 17.8. During the period examined, FQI values ranged from 14.7 to 22.9. FQI scores have been consistently at or better than the MNDNR Plant IBI threshold in monitored years since August 2014 (Figure 7-10B). The highest observed FQI values to date were in June 2016 and August 2023 both at a value of 22.9.

7.6.1 Comparison of Pre- and Post-Project Curly-leaf Pondweed Data

Plant survey data indicate an overall reduction in frequency of curly-leaf pondweed in the lake since implementation of the Normandale Lake Water Quality Improvement Project in 2018 (e.g., drawdown occurred in winter of 2018-2019, herbicide treatments 2020-2023). The frequency of the targeted aquatic invasive species, curly-leaf pondweed, decreased from a range of 47 to 85 percent of sampling locations in June during 2016 through 2018 to a range of 9 to 31 percent of sampling locations in June 2019 through 2023 (Figure 7-11). The observed frequency of curly-leaf pondweed in June 2023 was within the range of frequencies observed in 2019 through 2022.

Plant survey data also indicate an overall reduction in biomass of curly-leaf pondweed in the lake since implementation of the Normandale Lake Water Quality Improvement Project in 2018. The biomass of curly-leaf pondweed, measured as wet weight, decreased from a range of 25 to 230 grams per sample location, on average, in June of 2017 and 2018 to an average of 6 to 20 grams per sample location in June 2019 through 2023 (Figure 7-12). The biomass of curly-leaf pondweed measured as wet weight in June 2023 was within the range of values measured during June 2019 through 2022.

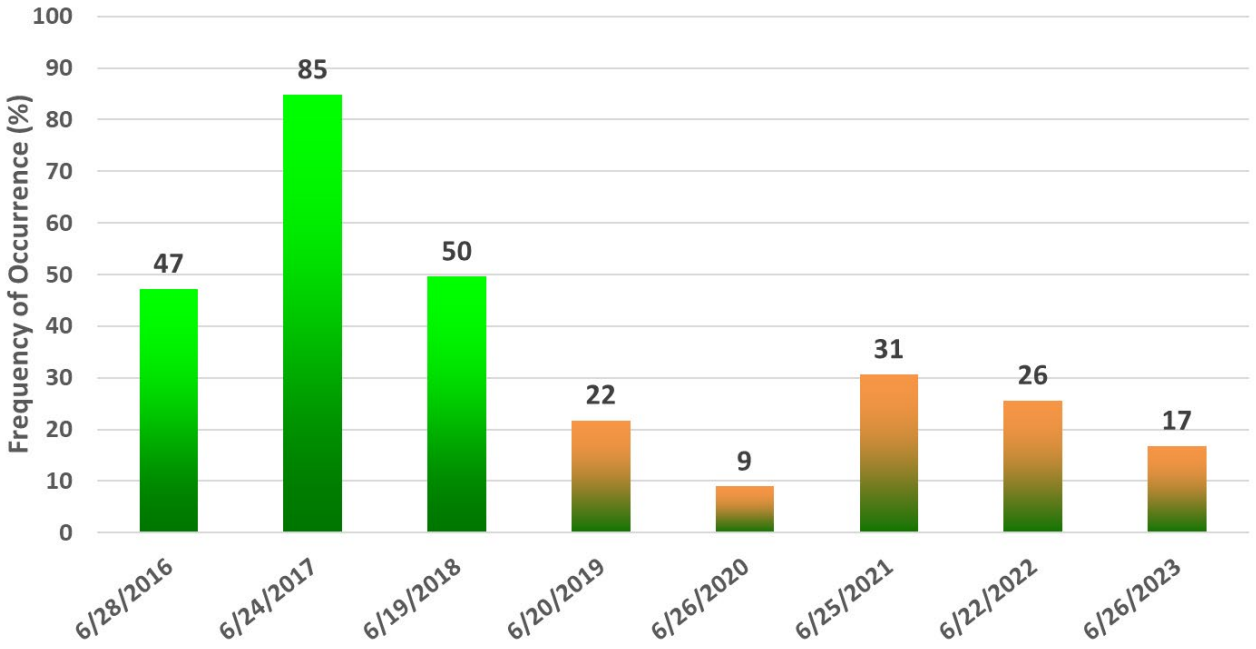


Figure 7-11 **2016-2023 comparison of Normandale Lake curly-leaf pondweed frequency of occurrence in June prior to and after initiation of the water quality improvement project. Note: green bars indicate values prior to water quality improvement project and orange bars indicate values during water quality improvement project (i.e., after drawdown and/or during years in which curly-leaf pondweed was treated with herbicide).**

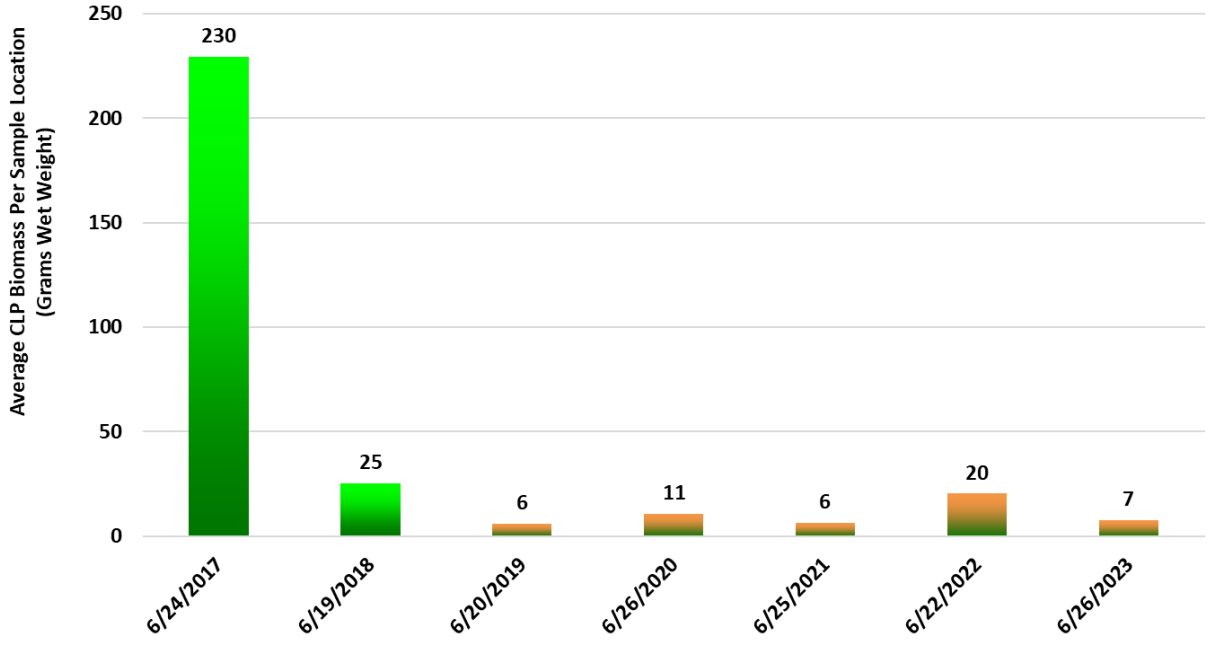


Figure 7-12 **2016-2023 comparison of Normandale Lake curly-leaf pondweed biomass in June prior to and after initiation of the water quality improvement project. Note: green bars indicate values prior to water quality improvement project and orange bars indicate values during water quality improvement project (i.e., after drawdown and/or during years in which curly-leaf pondweed was treated with herbicide).**

7.6.2 Comparison of Pre- and Post-Project Plant Community Data

Overall plant biomass in Normandale Lake, measured as average wet weight of plants per sample point, was assessed before and after the Normandale Lake Water Quality Improvement Project to determine whether the project impacted biomass of the plant community as a whole and/or individual species. Data collected in 2019 were an anomaly related to the lake's response from the lake drawdown. Data collected in 2020 to 2023 show a moderate overall decrease in biomass of the plant community after the project. Total pre-project biomass, measured as wet weight, on average ranged from 876 to 1,401 grams per sample point compared with a total post-project (2020 through 2023) biomass range of 644 to 1,004 grams per sample point (Figure 7-13). 2023 total biomass values, on average, ranged from 644 to 1,004 grams per sample point.

The data in Figure 7-13 also show the dominant species throughout the period of record. In 2023, the three species with the highest average wet weight per sample point – coontail, white water lily, and common waterweed – were generally the three species with the highest average wet weight per sample point prior to the drawdown.

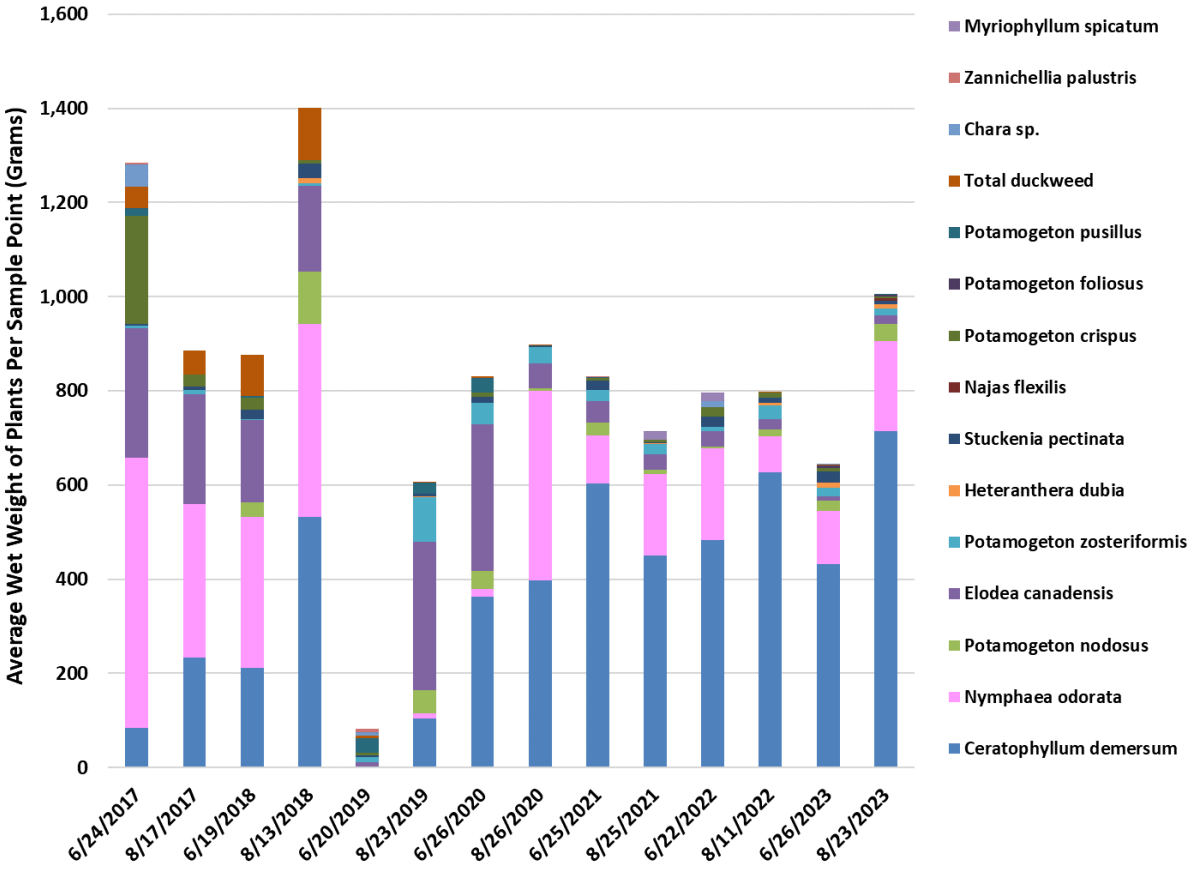


Figure 7-13 2017-2023 comparison of Normandale Lake plant biomass, measured as average wet weight of plants per sample point. The stacked bar graph above shows individual species' wet weights (average per sample point) and the collective total of all species' average wet weights per sample point for each sample event.

The frequency of occurrence of individual species in the plant community was measured in Normandale Lake during 2016 through 2023 to better understand the composition and extent of the plant community prior to the water quality improvement project and help assess impacts of the project which began in fall of 2018. Figure 7-14 compares the frequencies of the ten most commonly occurring species in 2023 with frequencies observed before the water quality improvement project. The most frequently occurring species prior to the drawdown, coontail, was also most frequently occurring species following the drawdown. Flat-stem pondweed, sago pondweed, and long-leaf pondweed increased in frequency after the drawdown. White water lily decreased in frequency after the drawdown, but increased in frequency during 2021 through 2023, exceeding pre-drawdown frequency by August 2023.

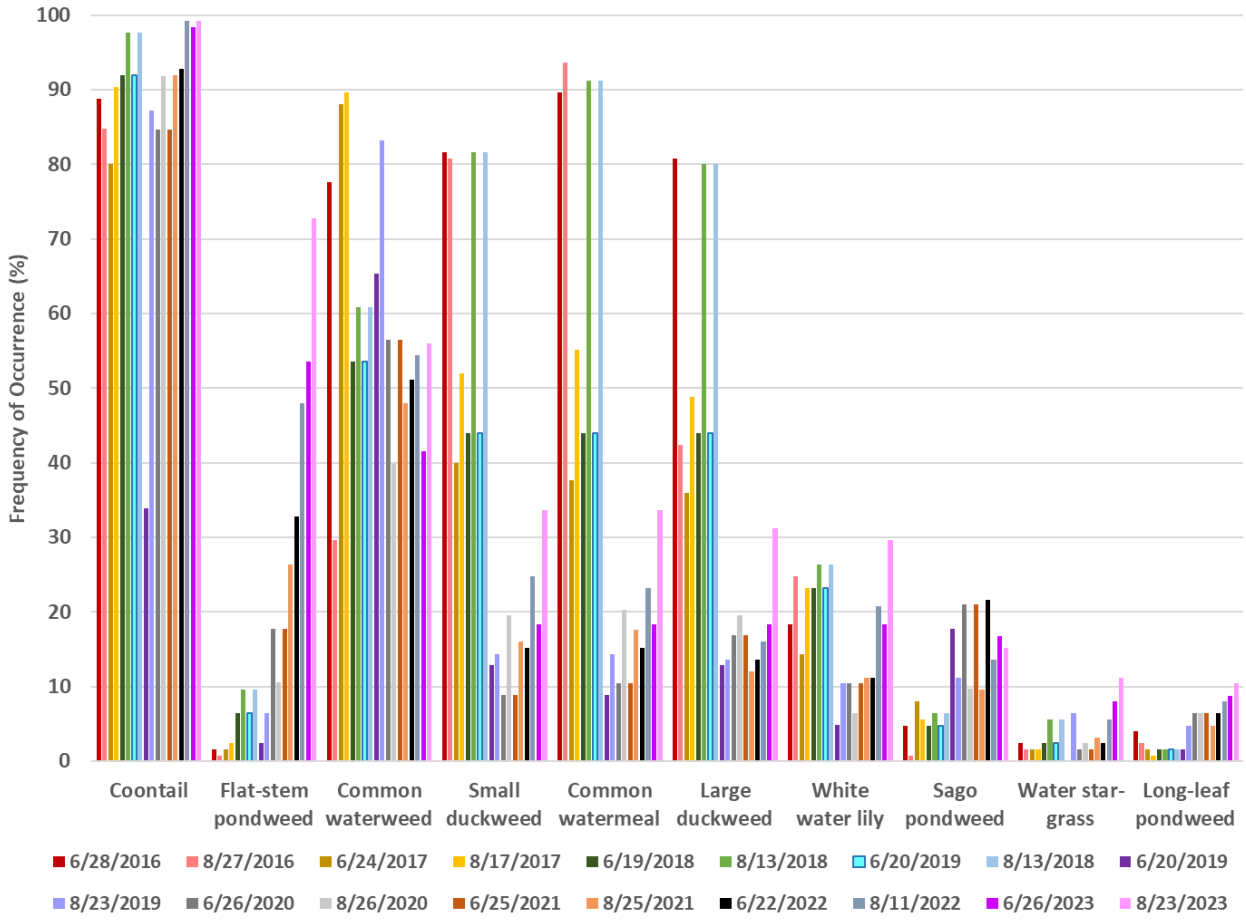


Figure 7-14 **2016-2023 comparison of Normandale Lake frequency of occurrence of individual species. Above graph shows the 2016-2023 frequency of occurrence of the ten individual species occurring most frequently in Normandale Lake in 2023.**

7.6.3 Turion Survey Results

Location and density of curly-leaf pondweed turions in Normandale Lake were assessed following the lake drawdown. Turions are the primary reproductive structures of curly-leaf pondweed and are found in the lake bottom. They are brown, typically half-inch in size, and look like sharp small pinecones (Figure 7-15). The objective of the drawdown was to freeze (or kill) as many turions as possible to reduce future curly-leaf pondweed growth in the lake. Turion surveys were conducted during October 2019 through 2023 to determine where turions were found in the lake, their density, and their size. Results of the turion surveys are provided in Appendix F.

The 2019 survey found some turions remaining in the lake sediment following the drawdown that occurred in the winter of 2018-2019, although generally in low or very low densities. Turions were generally found along the stream channel that remained unfrozen and flowing throughout the winter of the drawdown. A patch of turions was also found in the northeastern portion of the lake.

In 2023, there was no change in the number of sample points in the lake with live turions. In 2022 and 2023, live turions were found at 6 of the 50 sample points (12 percent) compared with 14 to 19 sample points during 2019 through 2021 (28 to 38 percent) (Figure 7-16). A total of 6 live turions were collected from all 50 sample points in 2023 compared with 21 to 36 live turions during 2019 through 2021 and 7 live turions in 2022 (Figure 7-17).

Figure 7-15 A germinating curly-leaf pondweed turion

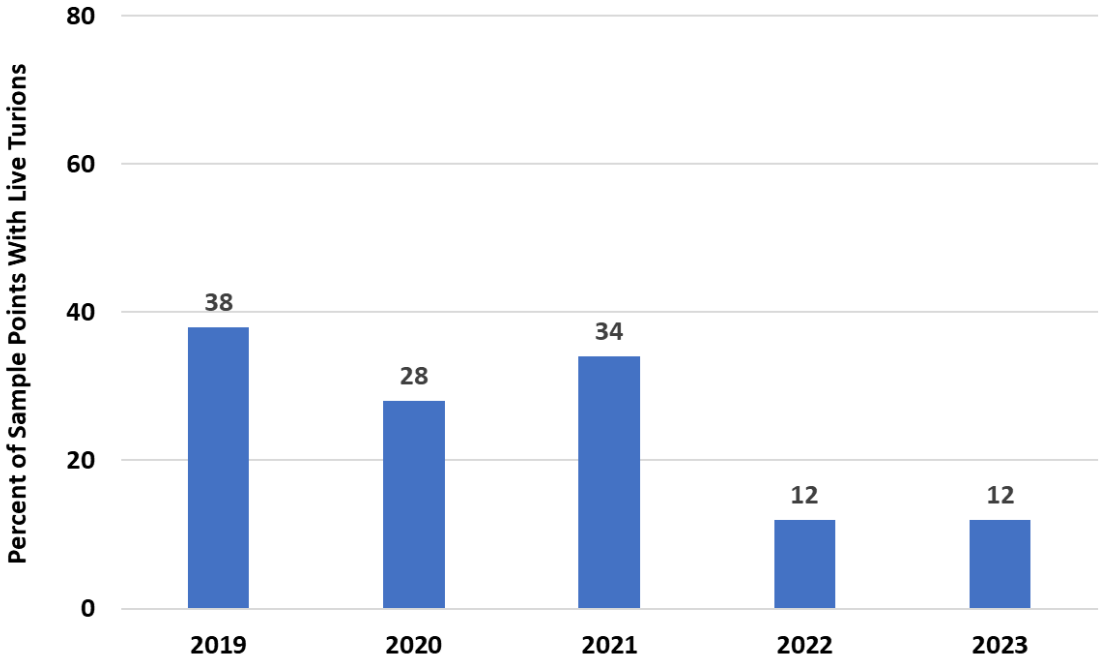


Figure 7-16 Percent of sample points in Normandale Lake with live turions during 2019-2023 survey

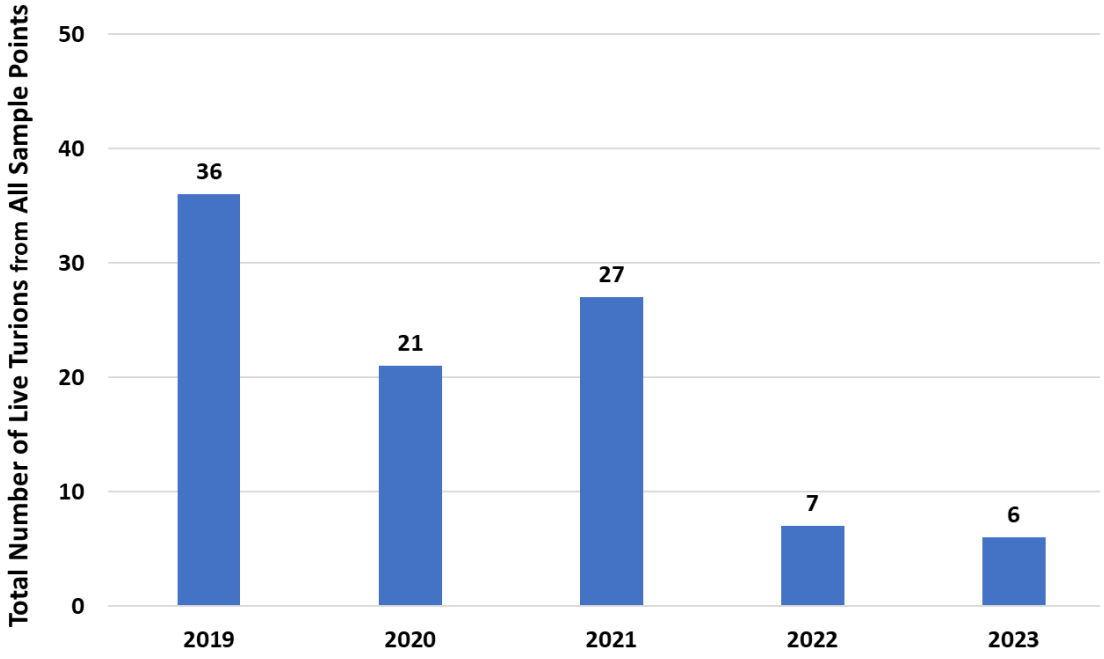


Figure 7-17 Total number of live turions collected from all Normandale sample points in 2019-2023

7.7 Conclusions and Recommendations

In 2018, the District began implementation of a water quality improvement project for Normandale Lake. A drawdown of the lake was completed in fall of 2018 to expose the lake bed to a winter freeze and freeze out curly-leaf pondweed. Curly-leaf pondweed is an invasive aquatic plant that dies off in late June, releasing phosphorus to the lake as it decays. This can fuel algal growth and reduce lake water quality. The lake was treated with alum in spring of 2019 to reduce the release of phosphorus from lake bottom sediments into the water column. In the spring of 2020 through 2023, herbicide treatments were conducted within portions of Normandale Lake and Nine Mile Creek immediately upstream of Normandale Lake using diquat to control curly-leaf pondweed growing in these areas.

Fisheries surveys completed by the District between 2019 and 2021 identified carp at biovolumes large enough to warrant further assessment and management planning as carp can have negative effects on lake water quality. The *Integrated Pest Management Plan (IPM Plan) for Common Carp in Normandale Lake* (updated December 2023) was completed by WSB to review the ecological and hydrological conditions of Normandale Lake and its connected water bodies to develop cost-effective ways to reduce carp populations and limit recruitment. Carp removal efforts occurred in 2021, 2022, and 2023. Carp biomass estimates indicate that carp removal efforts have been successful at reducing the carp population. In 2023, the carp biomass estimate was approximately 160 lbs of carp per acre as compared to 2021 where the carp biomass estimate was approximately 251 lbs of carp per acre. In 2024, the District plans to complete a fisheries population assessment, study the movement of carp into the North and South forks of Nine Mile Creek, and continue removal efforts.

In 2023, the summer average total phosphorus and chlorophyll *a* concentrations and summer average Secchi disc (measure of clarity) in Normandale Lake met the Minnesota State eutrophication criteria for shallow lakes. 2023 monitoring results indicate that chloride concentrations in June, July and early August exceeded the MPCA chronic chloride criterion, but all 2023 chloride concentrations met the MPCA acute chloride criterion.

The phytoplankton communities in Normandale Lake in 2023 were generally dominated by green algae and cryptomonads, with some diatoms and blue-green algae observed. Green algae, diatoms, and cryptomonads are a good quality food source and contribute towards a healthy zooplankton community, whereas blue-green algae are a poor quality food source for zooplankton. The blue-green algae numbers observed at the District's routine monitoring location during 2023 were below the World Health Organization (WHO) guideline threshold for low probability of adverse health effects to recreational users.

A primary objective of the lake drawdown and subsequent herbicide treatments was to reduce the amount of curly-leaf pondweed in Normandale Lake. Aquatic plant surveys conducted in June and August of 2023 indicate the frequency and biomass of curly-leaf pondweed continues to be lower than levels prior to implementation of the Normandale Water Quality Improvement Project.

The lake's plant community in 2023 met the MNDNR Plant IBI thresholds, with the highest number of species to date observed in August of 2023 (21 species). Plant biomass in Normandale Lake was assessed

before and after the water quality improvement project to determine whether the project impacted biomass of the plant community as a whole and/or individual species. Data collected in 2019 were an anomaly related to the lake's response from the lake drawdown. Data collected in 2020 to 2023 show a moderate overall decrease in biomass of the plant community after the project. In 2023, the three species with the highest average wet weight per sample point – coontail, white water lily, and common waterweed – were generally the three species with the highest average wet weight per sample point prior to the drawdown. The frequencies of the ten most commonly occurring species in 2023 were compared with frequencies observed before the water quality improvement project. The comparison indicates the most frequently occurring species before the drawdown, coontail, was the most frequently occurring species after the drawdown.

In 2024, the NMCWD plans to develop a project assessment framework for water quality improvement projects to characterize lake management status and needs following project implementation and identify triggers and timeframes around future monitoring and re-assessment. Normandale Lake will be evaluated as a pilot for the project assessment framework, with anticipated outcomes including recommendations for continuation of water quality and biological monitoring.

8 Nine Mile Creek Stream Monitoring

Because the primary use of Nine Mile Creek is ecological—a place for fish and aquatic life to live—the focus of the Nine Mile Creek monitoring program is evaluation of the stream's fish and aquatic life community as well as the ecosystem components essential for the survival of fish and aquatic life (Figure 8-1). The 2023 Nine Mile Creek monitoring program included:

- March through October monthly measurements of specific conductance, dissolved oxygen, pH, temperature, turbidity, and flow.
- Annual habitat monitoring during summer (i.e., water depth, flow, depth of fine sediment, percent embeddedness, and length of eroded streambank).
- Annual monitoring of the fish community during summer.
- Annual monitoring of the macroinvertebrate community during October.

Figure 8-1 Downstream Main Stem Location ECU-7C (Shorthead Redhorse Fish)
The primary use of Nine Mile Creek is a place for fish and aquatic life to live, such as the shorthead redhorse fish swimming in downstream Main Stem Location ECU-7C, pictured above.

Ten locations were monitored for water quality in 2023, including four locations on the North Fork, three locations on the South Fork, and three locations on the Main Stem. Monitoring locations are listed below and shown on Figure 1-2.

- **ECU-1A-1** is on the North Fork of Nine Mile Creek, west of Highway 169 in Hopkins.
- **ECU-2** is on the North Fork of Nine Mile Creek, east of Cahill Road and north of Brook Drive (Heights Park), approximately mid-way between the Highway 62 crossing upstream and the Highway 100 crossing downstream in Edina.
- **ECU-2AWQ** is on the North Fork of Nine Mile Creek, downstream of Interstate 494 and immediately upstream from 81st Street in Bloomington.
- **N3** is on the North Fork of Nine Mile Creek at Metro Boulevard in Edina. Station N3 is one of NMCWD's automated stream monitoring stations, which were developed in a manner consistent with the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP) stations.
- **ECU-3A** is on the South Fork of Nine Mile Creek, immediately upstream of the Highway 62 crossing and the Bryant Lake Park Reserve and downstream from Bren Road in Minnetonka.

- **ECU-5A** is on the South Fork of Nine Mile Creek, in Corridor Park immediately downstream from Interstate 494 in Bloomington and west of East Bush Lake Road.
- **N2** is on the South Fork of Nine Mile Creek at West 78th Street in Edina. Station N2 is one of NMCWD's automated stream monitoring stations, which were developed in a manner consistent with the Metropolitan Council's WOMP stations.
- **ECU-7A** is on the Main Stem of Nine Mile Creek, downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington. Station 7A is WOMP Station N1.
- **ECU-7B** is on the Main Stem of Nine Mile Creek, downstream of Old Shakopee Road at 103rd Street in Bloomington.
- **ECU-7C** is on the Main Stem of Nine Mile Creek, downstream of 106th Street in Bloomington.

Eight locations were monitored for fish, water depths, and macroinvertebrates. These biological monitoring locations included ECU-1A-1, ECU-2, ECU-3A, ECU-5A, ECU-7A, ECU-7B, and ECU-7C discussed above and ECU-2A located immediately downstream from West 77th Street / West of Highway 100 in Bloomington. The monitoring locations are shown on Figure 1-2.

Data collected during 2023 were evaluated to determine whether:

- Specific conductance, dissolved oxygen, pH, and temperature levels met Minnesota Pollution Control Agency (MPCA) standards published in Minnesota Rule Chapter 7050.
- Flow, water depth, and water quality data were consistent with historical values.
- Fish data met MPCA Fish Index of Biotic Integrity (FIBI) standards published in Minnesota Rule Chapter 7050.
- Macroinvertebrate data met MPCA Macroinvertebrate Index of Biotic Integrity (MIBI) standards published in Minnesota Rule Chapter 7050.

Flow and water quality results are summarized in Appendix G. Water depth data are summarized in Appendix H. Fish and macroinvertebrate results are summarized in Appendix I.

8.1 Nine Mile Creek Water Quality

In 2023, measurements for dissolved oxygen, temperature, specific conductance, pH, turbidity, and discharge occurred monthly during March through October at the 10 sample locations summarized above (Figure 1-2). Minnesota Rule Chapter 7050 specifies standards applicable to Minnesota streams to protect aquatic life. Nine Mile Creek is required to meet the most restrictive water quality standard for Classes 2B, 2C, or 2D; 3A, 3B, 3C, or 3D; 4A, 4B or 4C; and 5 (Minn. R. Pt. 7050.0220, Minn. R. Pt. 7050.0430, and Minn. R. Pt. 7050.0450). The levels of dissolved oxygen, pH, and temperature in Nine Mile were compared to Minnesota State standards for Class 2B streams and specific conductance was compared with the Minnesota State standard for a Class 4A stream because they are the most restrictive water quality standards for these parameters. Overall, 78 percent of the 2023 observed values were within State standards. The Main Stem (81 percent of observed values) met State standards most frequently followed by the North Fork (77 percent of observed values) and South Fork (76 percent of observed values)

(Figure 8-2). All Nine Mile Creek temperature and pH measurements, 86 percent of the dissolved oxygen measurements, and 26 percent of the specific conductance measurements met State standards.

Figure 8-2 Upstream South Fork Location ECU-3A on August 1, 2023

In 2023, 76% of South Fork specific conductance, dissolved oxygen, pH, and temperature values met the MPCA standards.

Figure 8-3 Upstream North Fork Location ECU-1A-1 on August 1, 2023

In 2023, the North Fork met the specific conductance standard less frequently than other locations. Eighty eight percent of specific conductance measurements from upstream North Fork location ECU-1A-1 failed to meet the specific conductance standard.

8.1.1 Specific Conductance

Consistent with previous years, the specific conductance criterion was met less frequently in 2023 than other Minnesota State standards (<1,000 µmhos/cm at 25ºC). Specific conductance is a measure of the conductive ions in water from dissolved and inorganic materials such as alkalis, chlorides, sulfides, and carbonate compounds. High specific conductance measurements in Nine Mile Creek that fail to meet State standards typically result from the discharge of excess chlorides from deicing chemicals (salt) to the creek. Other potential sources include synthetic fertilizers. The MPCA has listed Nine Mile Creek as impaired for chlorides since 2004.

Specific conductance measurements from Nine Mile Creek met the MPCA standard less frequently in 2023 than 2022—26 percent of the specific conductance measurements met the standard in 2023 compared with 62 percent in 2022. As in previous years, the North Fork locations met the State standard for specific conductance less frequently than other sampling locations—16 percent of the North Fork measurements met the specific conductance standard in 2023 compared with 29 percent of South Fork and 39 percent of Main Stem measurements.

Specific conductance measurements from station ECU-1A-1 (North Fork just upstream of Hopkins/Edina boundary, exceeded the water quality criteria during all but the October sampling event in 2023 (Figure 8-3). During the period of record (2009 through 2023), 90 percent of specific conductance measurements at this location have exceeded the Minnesota State standard (Figure 8-4).

In 2023, specific conductance measurements also failed to meet the Minnesota State standard:

- during March through July and September at North Fork location ECU-2 (near Cahill Road and Brook Drive in Edina) (Figure 8-5 and Figure 8-10).
- during March through June and September at North Fork location N3 (at Metro Boulevard in Edina) (Figure 8-6 and Figure 8-7).
- during March through September at North Fork location ECU-2A (downstream of Interstate 494 and immediately upstream from 81st Street in Bloomington) (Figure 8-8 and Figure 8-9).
- during March through September at South Fork location N2 (West 78th Street in Bloomington) (Figure 8-11).
- during March, May, and June at South Fork location ECU-3A (South Fork immediately upstream of the Highway 62 crossing and the Bryant Lake Park Reserve and downstream from Bren Road in Minnetonka).
- during March through September at South Fork location ECU-5A (South Fork in Corridor Park immediately downstream from Interstate 494 in Bloomington and west of East Bush Lake Road) (Figure 8-12.
- during March, May, June, and July at Main Stem location ECU-7A/N1 (Main Stem of Nine Mile Creek, downstream of Marsh Lake immediately downstream of 98th Street in Bloomington) (Figure 8-13).
- during March, May, June, July, and September at Main Stem location ECU-7B (Main Stem of Nine Mile Creek, downstream of Old Shakopee Road at 103rd Street in Bloomington).
- during March, May, June, and July at Main Stem location ECU-7C (Main Stem of Nine Mile Creek, downstream of 106th Street in Bloomington).

During the period of record (1997 through 2023), specific conductance has failed to meet the Minnesota State standard for:

- 46 percent of measurements from North Fork location ECU-2 (Figure 8-5);
- 56 percent of measurements from North Fork location ECU-2A (Figure 8-8);
- 14 percent of measurements from South Fork location ECU-3A;
- 20 percent of measurements from South Fork location ECU-5A;
- 19 percent of measurements from Main Stem location ECU-7A/N1;
- 20 percent of measurements from Main Stem location ECU-7B; and
- 22 percent of measurements from Main Stem location ECU-7C.

During the period of record (2011 through 2023), specific conductance has failed to meet the Minnesota State standard for:

- 59 percent of measurements from North Fork location N3 (Figure 8-6); and
- 30 percent of measurements from South Fork location N2.

The exceedance of the Minnesota State specific conductance standard in Nine Mile Creek in 2023 and throughout the period of record has been unfavorable for the aquatic life in the stream. The *Nine Mile Creek Biological Stressor Identification* prepared for the Minnesota Pollution Control Agency in November 2010 identified excess ionic strength due to chlorides as one of the stressors to the biological community in Nine Mile Creek.

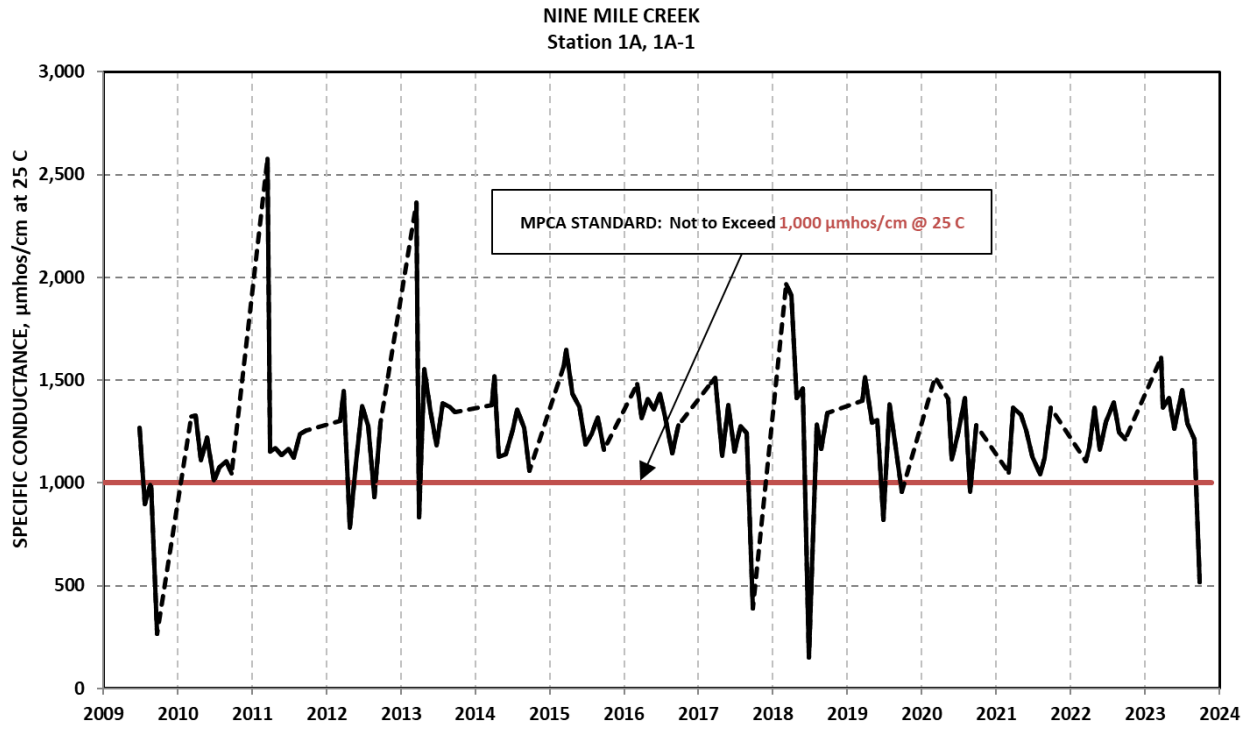


Figure 8-4 **2009-2023 specific conductance measurements from Station ECU-1A-1 (North Fork just upstream of the Hopkins/Edina Boundary) compared with the MPCA standard**

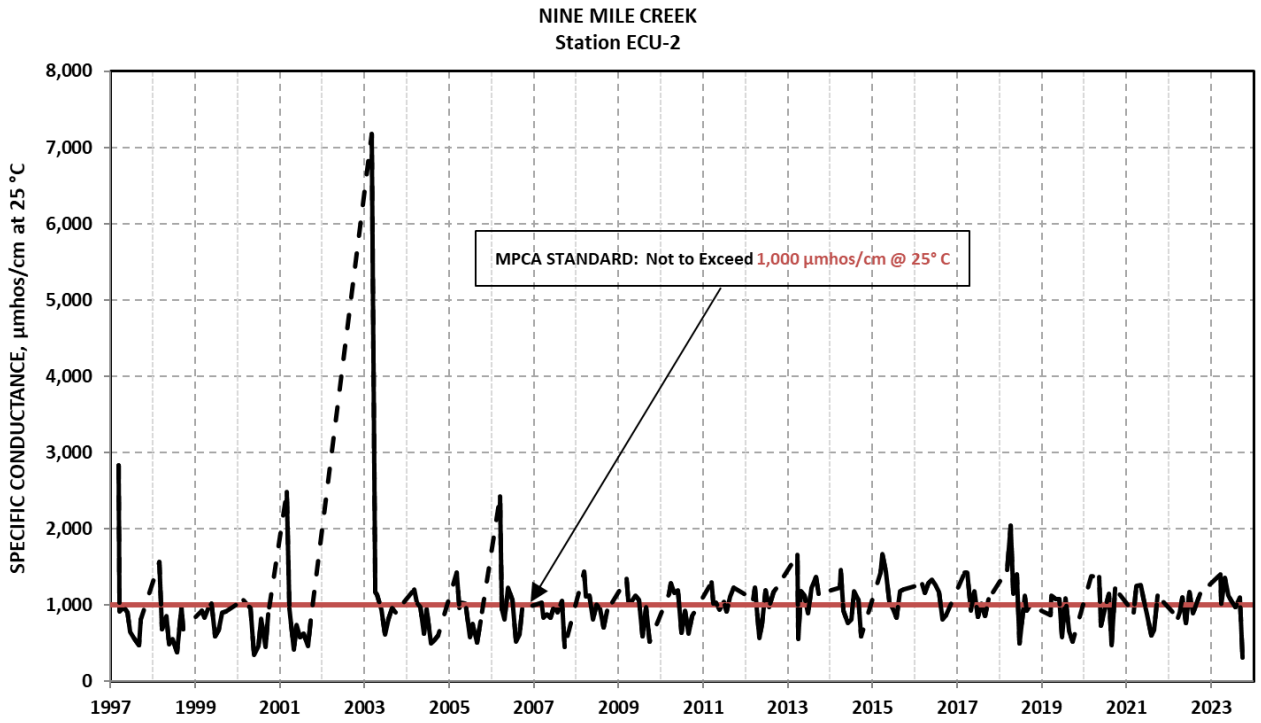


Figure 8-5 **1997-2023 specific conductance measurements from Station ECU-2 (North Fork near Cahill Road and Brook Drive in Edina) compared with the MPCA standard**

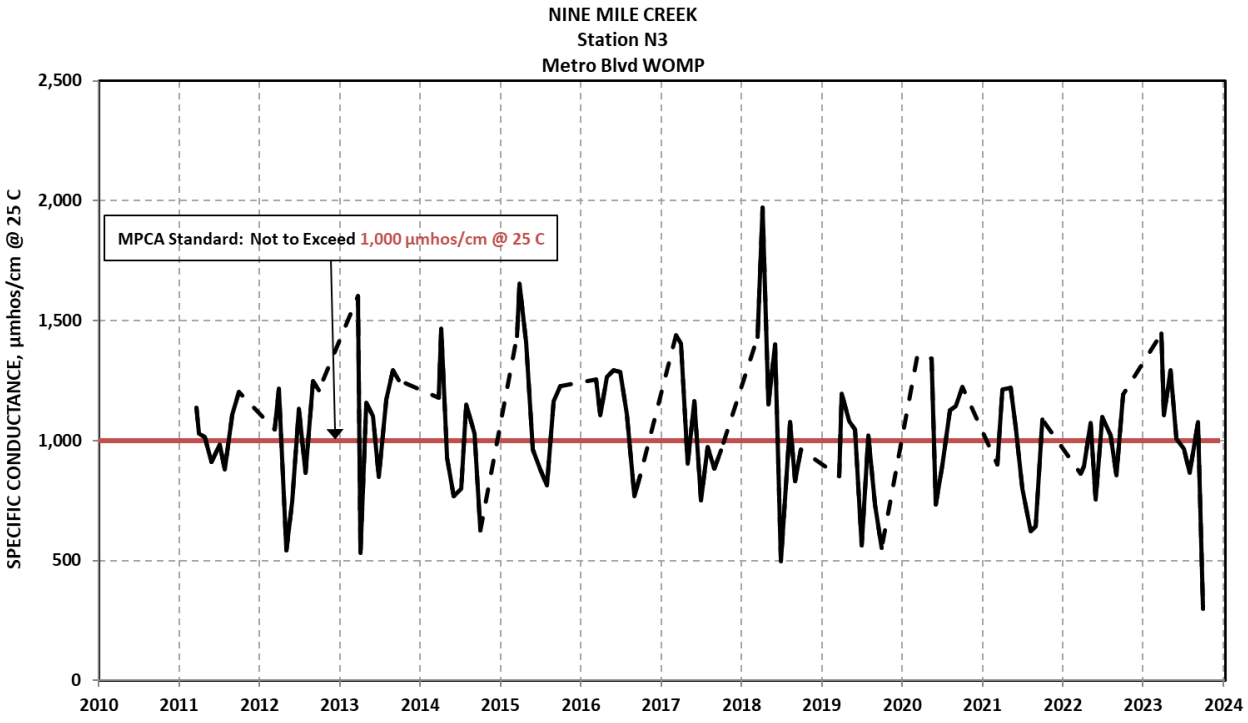


Figure 8-6 **2011-2023 specific conductance measurements from Station N3 (North Fork at Metro Blvd WOMP in Edina) compared with the MPCA standard**

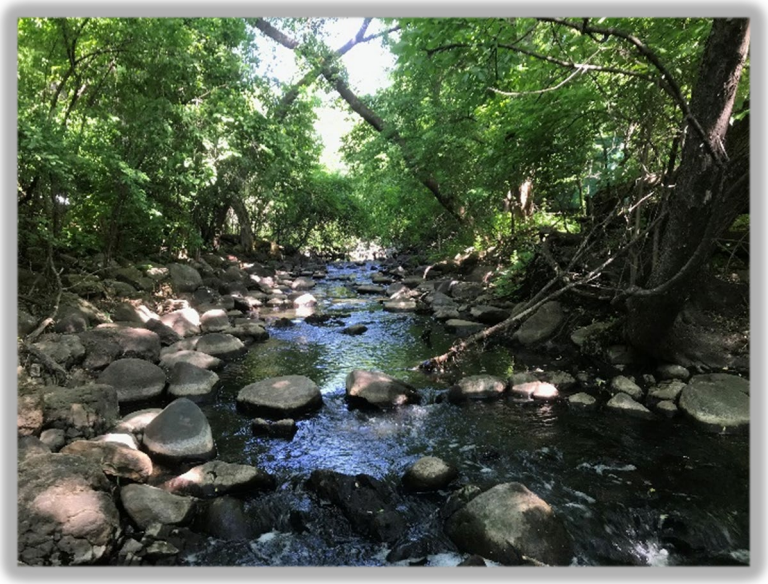


Figure 8-7 North Fork Location N3 on June 1, 2023

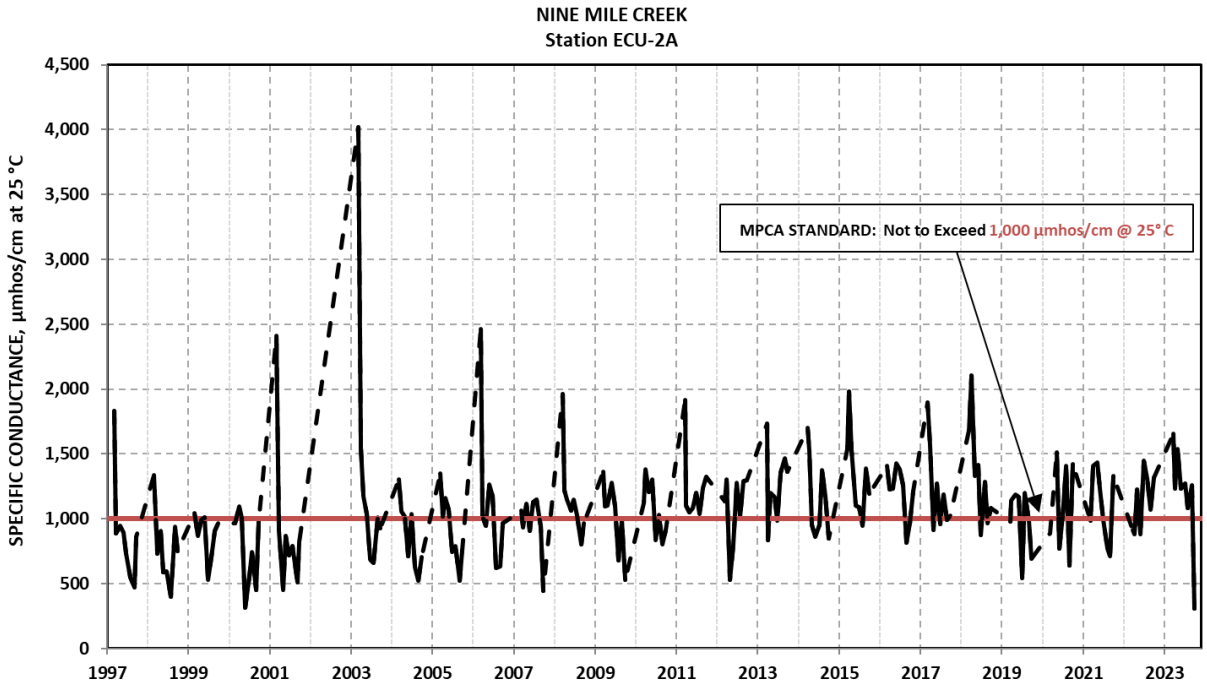


Figure 8-8 1997-2023 specific conductance measurements from Station ECU-2A (North Fork downstream of Interstate 494 and immediately upstream of 81st Street in Bloomington) compared with the MPCA standard

Figure 8-9 North Fork Location ECU-2A on June 1, 2023

8.1.2 Dissolved Oxygen and Stream Flow

Dissolved oxygen measurements observed from Nine Mile Creek in 2023 met the Minnesota State standard (>5 mg/L) with a similar frequency as 2022—86 percent met the State standard in 2023 compared with 87 percent in 2022. In 2023, the South Fork met the State standard for dissolved oxygen less frequently than other sampling locations — 75 percent of the dissolved oxygen measurements from the South Fork were within the State standard criterion in 2023 compared with 91 percent of Main Stem and 94 percent of North Fork measurements.

In 2023, dissolved oxygen levels were below (poorer than) the Minnesota State standard at the following locations:

- ECU-2 (North Fork near Cahill Road and Brook Drive in Edina, Figure 8-10 during June
- N3 (North Fork of Nine Mile Creek at Metro Boulevard in Edina) during June
- N2 (South Fork at West 78th Street in Bloomington, Figure 8-11 during August through October
- ECU-5A (South Fork in Corridor Park immediately downstream from Interstate 494 in Bloomington and west of East Bush Lake Road, Figure 8-12 during June, September, and October
- ECU-7A/N1 (Main Stem of Nine Mile Creek, downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington, Figure 8-13 during June, August, and September

Figure 8-10 North Fork location ECU-2 on June 1, 2023

Figure 8-11 South Fork location N2 on August 1, 2023

Figure 8-12 South Fork location ECU-5A on August 1, 2023

Figure 8-13 Upstream Main Stem location ECU-7A on July 7, 2023

The *Nine Mile Creek Biological Stressor Identification* (2010) concluded the low dissolved oxygen levels in the North Fork and South Fork of Nine Mile Creek were primarily related to reduced flow resulting from low precipitation as well as diel effects (reduced oxygen during the night due to respiration by plants and/or algae when there is no photosynthesis to add oxygen to the stream). 2023 data collected from the following locations and periods indicate the stream's low dissolved oxygen levels coincided during periods of low flow (Figure 8-14, Figure 8-15, and Figure 8-16):

- North Fork location ECU-2 (near Cahill Road and Brook Drive in Edina (Figure 8-10) in June
- South Fork location N2 (at West 78th Street in Bloomington, (Figure 8-11) during August and September
- South Fork location ECU-5A (in Corridor Park immediately downstream from Interstate 494 in Bloomington, (Figure 8-12) during June and September

2023 was generally dry; however, discharge measurements from South Fork locations N2 and ECU-5A indicate low dissolved oxygen in October may have coincided with increased flow from the addition of stormwater runoff which likely contained oxygen demanding substances.

The biological stressor identification study found that water discharging from Marsh Lake can notably influence the observed dissolved oxygen concentrations at the upstream Main Stem location, ECU-7A/N1 (downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington). Oxygen levels within Marsh Lake fluctuate due to biological activity within the marsh – plant photosynthesis raises oxygen levels and plant decay lowers oxygen levels. Hence, water flowing from the marsh may have either lower or higher oxygen levels than downstream locations, depending upon biological processes occurring within the marsh. Flow at ECU-7A/N1 was low during June and August and there was no flow (i.e., standing pools of water observed) in September (Figure 8-17). The low oxygen measurements in June and August were likely a combination of low stream flow and water discharging from the marsh with low oxygen levels due to biological activity within the marsh. The low oxygen measurement in September was likely due to the lack of flow in the stream.

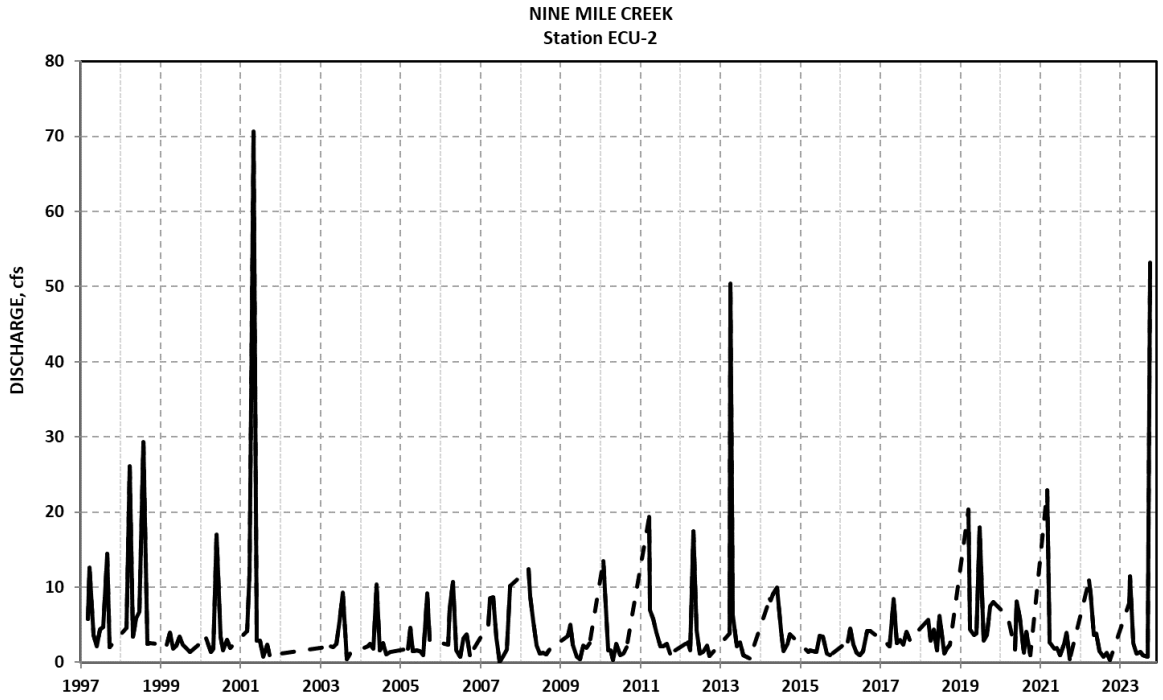


Figure 8-14 **1997-2023 monthly discharge measurements from Station ECU-2 (North Fork near Cahill Road and Brook Drive in Edina)**

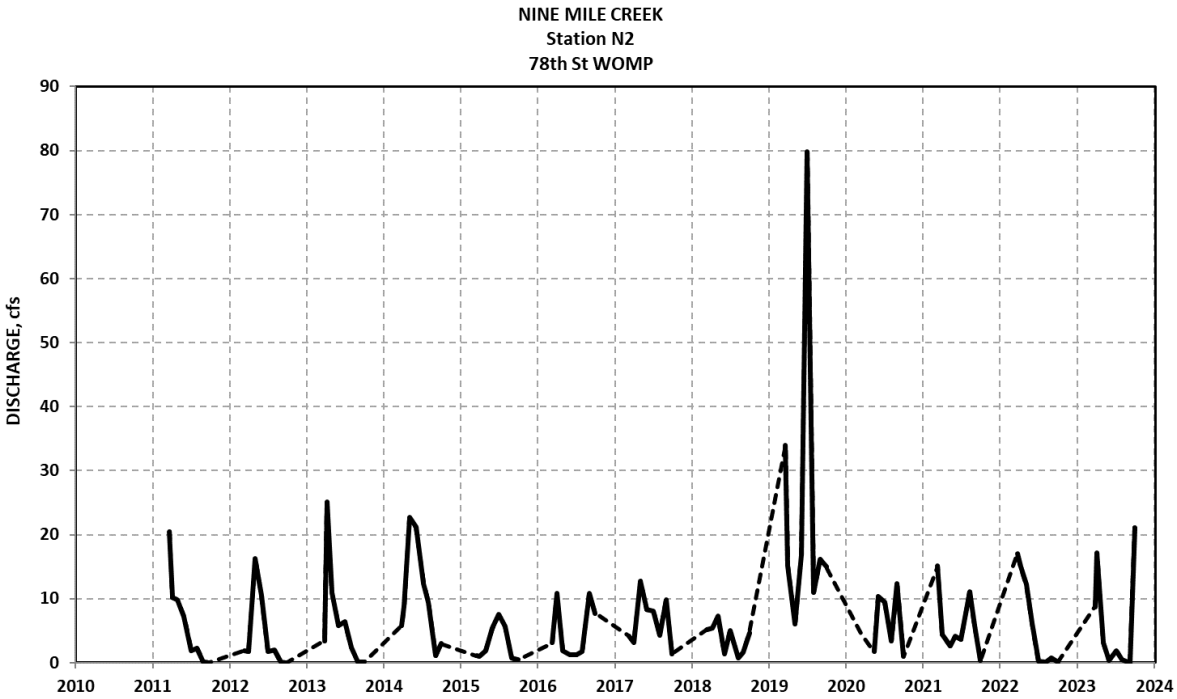


Figure 8-15 **2011-2023 monthly discharge measurements from Station N2 (South Fork at West 78th Street in Bloomington)**

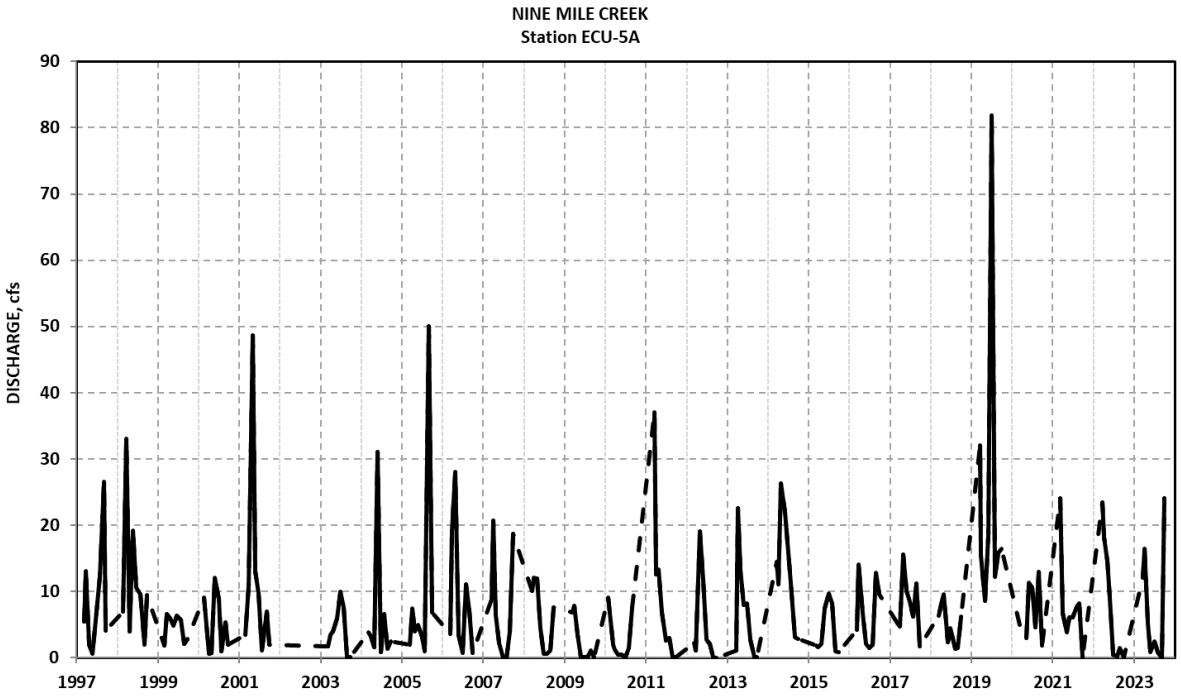


Figure 8-16 **1997-2023 monthly discharge measurements from Station ECU-5A (South Fork in Corridor Park immediately downstream from Interstate 494 in Bloomington and west of East Bush Lake Road)**

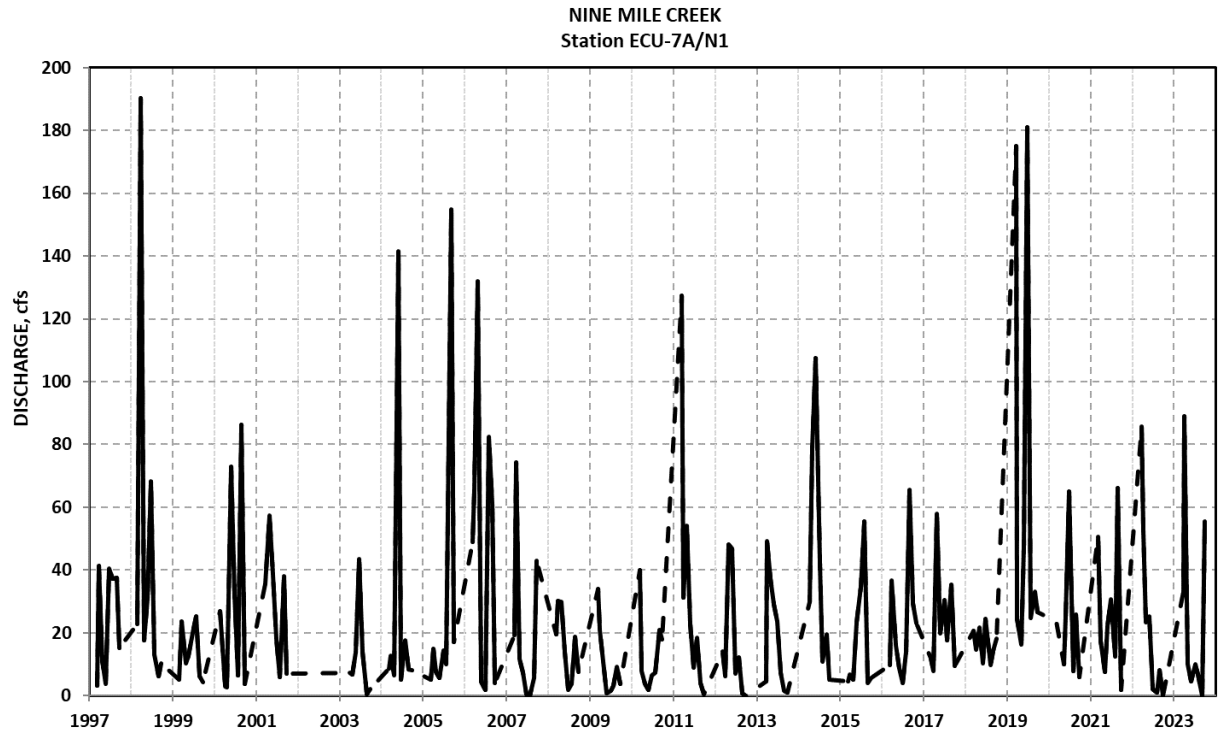


Figure 8-17 **1997-2023 discharge measurements from Station ECU-7A/N1 (Main Stem downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington)**

8.1.3 Additional observations

A comparison of 2023 data with historical data found the following 2023 values were either higher or lower than values measured prior to 2023:

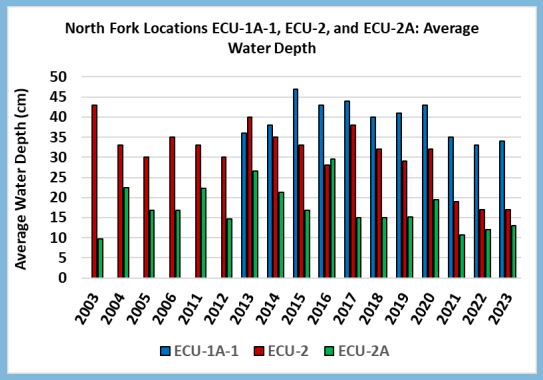
- Lowest temperature value to date on April 6 at the North Fork locations 1A/1A-1 (37.7℉) and ECU-2 (33℉) and Main Stem locations ECU-7A (31.7℉) and ECU-7B (31.7℉)
- Lowest specific conductance value to date on October 1 at North Fork locations ECU-2 (314 µhmos/cm@25℃) and ECU-2A (309 µhmos/cm@25℃)
- Lowest pH value to date at North Fork location ECU-2 on April 6 (6.9) and October 1 (6.9)
- Lowest turbidity value to date at North Fork location ECU-2A (3.1 NTU) on September 8 and at South Fork location ECU-3A (0.5 NTU) on July 7
- Highest dissolved oxygen value to date at South Fork location ECU-5A (11.3 mg/L) on March 27

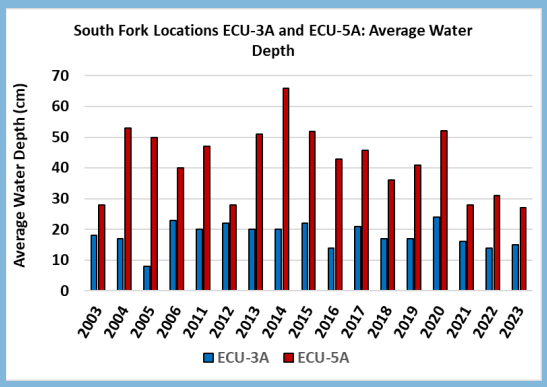
The data collection period has included a range of climatic conditions.

8.2 Water Depths

Water depth is a factor in determining the presence and distribution of fish in streams. Water depths have annually been measured when fish surveys were completed in 2003-2006 and 2011-2023. Measurements are summarized in Figure 8-18. Because 2023 was a very dry year, 2023 water depths at five of the eight monitoring locations were the lowest depths measured since the start of the record in 2003– North Fork location ECU-2, South Fork location ECU-5A, and Main Stem locations ECU-7A, ECU-7B, and ECU-7C (Figure 8-18 and Figure 8-19).

Figure 8-19 Middle Main Stem location ECU-7B on June 1, 2023
The average water depth measured at the middle Main Stem location ECU-7B when the fish survey was completed was the lowest on record.





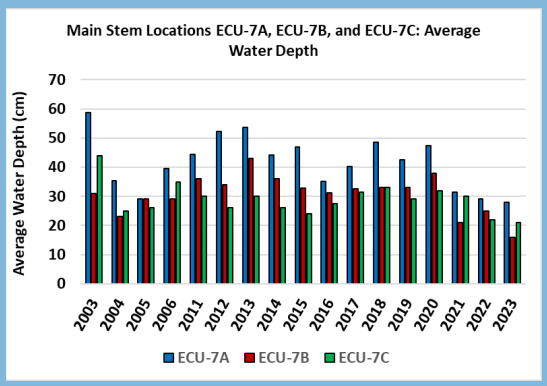


Figure 8-18 Nine Mile Creek historical water depth values
North Fork (top), South Fork (middle), and Main Stem (bottom)

8.3 Fish and Macroinvertebrate Indices of Biotic Integrity

8.3.1 MPCA Development of Biotic Indices

Figure 8-20 Downstream Main Stem location ECU-7C (downstream of 106th Street in Bloomington) on June 22, 2023
The 2023 FIBI value at ECU-7C, pictured above, met the FIBI standard.

Minnesota adopted changes to its water quality standards that establish biological water quality standards for all Minnesota streams and rivers, including Nine Mile Creek. A Fish Index of Biotic Integrity (FIBI) and a Macroinvertebrate Index of Biotic Integrity (MIBI) were added to the Minnesota State standards published in Minn. Rule Chapter 7050.0222. The changes were approved by the United States Environmental Protection Agency on June 26, 2018. Although the MPCA had assessed streams for biological impairment in the past, previous water quality standards (Minn. Rule Chapters 7050 and 7052) did not contain biological criteria. The MPCA developed fish and macroinvertebrate Index of Biotic Integrity (IBI) tools and selected scores for the standards that are comparable with streams that have healthy fish and macroinvertebrate communities. The FIBI and MIBI standards distinguish between healthy fish and macroinvertebrate communities to be protected and unhealthy fish and macroinvertebrate communities in need of improvement.

Although the MPCA water quality standards did not contain biological criteria until 2018, the MPCA assessed surface waters prior to 2018 using fish bioassessment tools to identify biological impairment. Prior to 2018, Nine Mile Creek was assessed using a fish bioassessment tool developed for rivers and streams within the Minnesota River Watershed. The fish bioassessment tool was named the Minnesota Rapid Assessment Project Fish Index of Biotic Integrity (MRAP FIBI). The tool differed from the FIBI added to the MPCA water quality standards in 2018. Based on the results of a fish bioassessment of Nine Mile Creek using the MRAP FIBI, Nine Mile Creek was listed on the MPCA impaired waters list as impaired for aquatic life (fish bioassessment) in 2004.

After biological criteria were added to the MPCA water quality standards in 2018, the MPCA assessed Nine Mile Creek to determine whether the stream was impaired for aquatic life. The MPCA used data it had collected in 2014 from several reaches as well as data collected previously to complete a fish bioassessment of the stream using the FIBI and a benthic macroinvertebrate bioassessment of the stream using the MIBI to determine whether the stream met these MPCA criteria. Table 8-1 summarizes the MPCA assessment results.

Table 8-1 Results of MPCA Aquatic Life Assessment on Nine Mile Creek Stream Reaches

Reach Name*	Reach Length (miles)[1]	Use Class[1]	FIBI[1]	MIBI[1]	Aquatic Life[1]	Year Added to Impaired Waters List[2]	Pollutant or Stressor[2]
Nine Mile Creek, South Fork, Smetana Lake (Eden Prairie) to Nine Mile Creek upstream of West 84th Street (Bloomington)	3.8	2Bg, 3C	Existing Impairment, Fails Standard	Existing Impairment, Fails Standard	Impaired	2018	Fish bioassessments and benthic macroinvertebrates bioassessments
Nine Mile Creek, Headwaters (Hopkins) to Metro Blvd (Edina).	6.2	2Bg, 3C	Existing Impairment, Fails Standard	--	Impaired	2004	Fish bioassessments
Nine Mile Creek, Metro Blvd (Edina) to end of Marsh Lake (Bloomington)	4.9	2Bm, 3C	Existing Impairment, Fails Standard	Existing Impairment, Fails Standard	Impaired	2018	Fish bioassessments and benthic macroinvertebrates bioassessments
Nine Mile Creek, Marsh Lake (Bloomington) to Minnesota River	5.3	2Bg, 3C	Existing Impairment, Fails Standard	Existing Impairment, Fails Standard	Impaired	2018	Fish bioassessments and benthic macroinvertebrates bioassessments

[1] Source: MPCA's Nine Mile Creek Aggregated 12-HUC Summary from Monitoring and Assessment Report. HUC 0702001211- 02

[2] Source: 2020 MPCA Impaired Waters List

For the assessment, the MPCA divided Nine Mile Creek into four stream reaches:

1. South Fork from Smetana Lake to Nine Mile Creek
2. North Fork from Headwaters (Hopkins) to Metro Boulevard (Edina)
3. Metro Boulevard (Edina) to end of Marsh Lake (Bloomington)
4. Marsh Lake (Bloomington) to Minnesota River

In 2007, the MPCA applied the FIBI to data collected from the North Fork of Nine Mile Creek by the Nine Mile Creek Watershed District in 2003, 2004, and 2005 and data collected by the MPCA. Based on the results, the MPCA retained the 2004 impaired waters listing of Nine Mile Creek from its headwaters to Metro Boulevard as impaired for aquatic life and listed the pollutant/stressor as fish bioassessments. Hence, the 2022 MPCA impaired waters list identified this reach as impaired and 2004 as the year it was added to the impaired waters list. The impaired waters list indicates the pollutant or stressor as fish bioassessments.

The MPCA completed bioassessments of the other three reaches using data collected in 2014 as well as previously collected data. A fish bioassessment was completed on each reach using the FIBI and a benthic macroinvertebrate bioassessment was completed on each reach using the MIBI. Based upon the assessment results, the MPCA listed the three reaches of Nine Mile Creek (South Fork from Smetana Lake in Eden Prairie to Nine Mile Creek upstream of West 84th Street in Bloomington, Metro Boulevard in Edina to end of Marsh Lake in Bloomington, and Marsh Lake to Minnesota River) on the impaired waters list in 2018. The impaired waters list indicates the pollutant or stressor for each reach as fish bioassessments and benthic macroinvertebrates bioassessments.

8.3.2 Fish Index of Biotic Integrity (FIBI)

8.3.2.1 Background

The MPCA has classified Minnesota streams into nine types corresponding to regional patterns in the composition of stream fishes; a unique FIBI and biocriterion were developed for each stream type. Stream type is differentiated by geographic region, contributing drainage area, reach-scale gradient, and thermal classification. Nine Mile Creek is a Class 2B Southern Headwaters stream because:

- Nine Mile Creek is a Class 2B stream located within the Minnesota River watershed;
- Nine Mile Creek is a warmwater stream;
- Nine Mile Creek sampling locations have a drainage area of less than 30 square miles; and
- Nine Mile Creek fish monitoring locations have a gradient of more than 0.5 meters per kilometer.

The MPCA assigned a beneficial use classification to each of the four stream reaches. Nine Mile Creek from Metro Boulevard to the end of Marsh Lake was classified as Class 2Bm (Figure 8-21), a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 5 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota (Minnesota Rules 7050.0222 Subp. 4c). The other three reaches were classified as Class 2Bg, a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 4 as established in

Figure 8-21 Downstream North Fork fish sample location ECU-2A (immediately downstream from West 77th Street / West of Highway 100) on June 20, 2023
The 2023 FIBI value at ECU-2A, pictured above, met the FIBI standard.

Calibration of Biological Condition Gradient for Streams of Minnesota (Minnesota Rules 7050.0222 Subp. 4c).

The MPCA FIBI is on a 0 to 100 scale with increasing scores indicating improving stream health. The FIBI standard applicable to the North Fork of Nine Mile Creek (from Metro Boulevard to end of Marsh Lake is Class 2Bm Southern Headwaters stream) is a value greater than 33. The FIBI standard applicable to the other reaches of Nine Mile Creek (as Class 2Bg Southern Headwaters streams) is a value greater than or equal to 55. The MPCA has determined confidence limits around the standards to account for variability within the aquatic community because of natural spatial and temporal differences and sampling or method errors.

8.3.2.2 Monitoring Results

Fish collected from the eight biological monitoring stations (Figure 1-2) in Nine Mile Creek in 2017 through 2023 were assessed to determine the FIBI values and whether the values met the MPCA FIBI standards (Figure 8-22). There are ten total monitoring stations in Nine Mile Creek, but only eight are assessed for biological conditions.

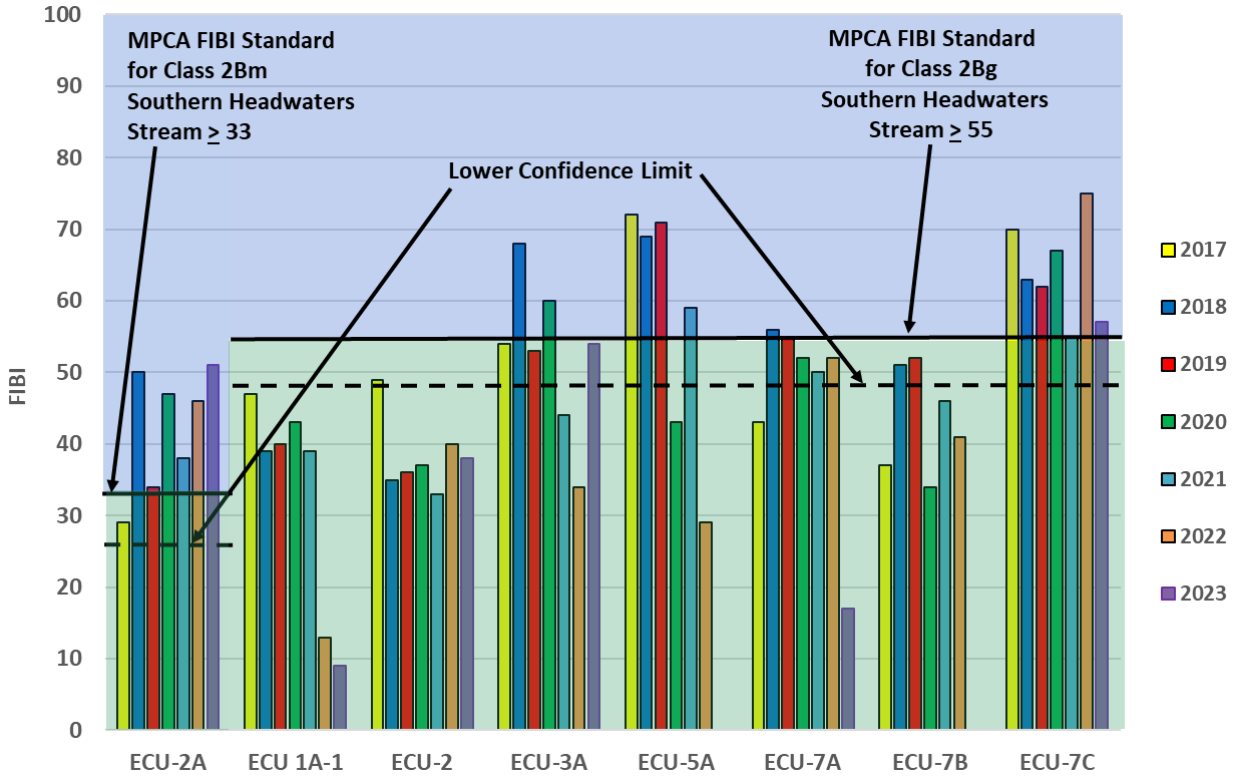


Figure 8-22 2017-2023 Nine Mile Creek Fish Index of Biotic Integrity (FIBI) values compared with the MPCA FIBI standards for a Class 2Bm Southern Headwaters stream and a Class 2Bg Southern Headwaters stream

2023 Results (Figure 8-22):

Fish were monitored at the eight sample locations during June 19 through June 22, 2023. FIBI scores were computed and compared with the applicable FIBI standards for Nine Mile Creek. FIBI scores from the downstream North Fork location, ECU-2A and the downstream Main Stem location, ECU-7C, met their

respective FIBI standard. The FIBI score from the upstream South Fork Main location, ECU-3A did not meet the standard, but its score of 54 is greater than the lower confidence limit of 48 and close to the standard of 55. FIBI scores from the two upstream North Fork locations, ECU-1A-1 and ECU-2, the downstream South Fork location, ECU-5A, the upstream Main Stem location, ECU-7A, and the middle Main Stem location, ECU-7B were below the FIBI standard and the lower confidence limit.

2017-2023 results:

Downstream Main Stem Location (ECU-7C)

FIBI scores from the downstream Main Stem location, ECU-7C, met the FIBI standard during all 7 years. Observed flows on the day of fish surveys completed during 2017 through 2023 are shown in Figure 8-23. The observed flow at ECU-7C during the 2023 fish survey of 3 cubic feet per second (cfs) was low compared with flows ranging from 5 to 33 cfs at this location during the 2017 through 2022 fish surveys. The FIBI score in 2023 was 57 compared with FIBI scores of 55 to 75 during 2017 through 2022 (Figure 8-22).

Middle Main Stem Location (ECU-7B)

FIBI scores from the middle Main Stem location, ECU-7B, failed to meet the FIBI standard during all 7 monitored years. The FIBI score of 0 in 2023 was the lowest to date as compared with FIBI scores of 34 to 52 during 2017 through 2022 (Figure 8-22). The observed flow at ECU-7B during the 2023 fish survey of 3 cfs was low compared with flows ranging from 2 to 24 cfs during 2017 through 2022 (Figure 8-23).

Upstream Mainstem Location (ECU-7A)

FIBI scores from the upstream Main Stem location, ECU-7A, met the FIBI standard during 2018 and 2019, but not during 2017 and 2020 through 2023. However, the 2020 through 2022 values were within the standard's confidence limits indicating the scores were relatively close to the standard. The 2023 FIBI score of 17 was the lowest score to date as compared with FIBI scores of 43 through 56 during 2017 through 2022. The 2023 observed flow at ECU-7A of 3 cfs was low compared with flows ranging from 3 through 24 cfs during 2017 through 2022. The biological stressors identified by the *Nine Mile Creek Biological Stressor Identification* (2010) for the Main Stem of Nine Mile Creek included low dissolved oxygen, high sediment accumulation, and high ionic strength due to excess chlorides. As noted in Section 8.1, low dissolved oxygen and high specific conductance levels measured in 2023 document inadequate oxygen and high specific conductance as possible biological stressors.

Upstream South Fork Location (ECU-3A)

FIBI values from the upstream South Fork location, ECU-3A, met the FIBI standard during 2018 and 2020, but not during 2017, 2019, and 2021 through 2023. However, 2017, 2019 and 2023 values were within the standard's confidence limits indicating the values were fairly close to the standard (Figure 8-22). Low baseflow in 2021 through 2023 likely stressed the fish community. Observed flows on the day of fish surveys completed during 2017 through 2023 are shown in Figure 8-24. Flows in 2021 through 2023 of <0.1 cfs were much lower than flows measured in 2017 through 2020, ranging from 0.4 cfs to 2.6 cfs. Biological stressors identified by the *Nine Mile Creek Biological Stressor Identification* (2010) for the South Fork of Nine Mile Creek include inadequate dissolved oxygen, excess sediment, and inadequate baseflow.

The low flows measured in 2020 through 2023 document inadequate baseflow as a possible biological stressor.

Downstream South Fork Location (ECU-5A)

FIBI values from the South Fork downstream location, ECU-5A, met the FIBI standard during 2017 through 2019 and in 2021, but not during 2020, 2022, and 2023. The 2023 score of 0 was the lowest to date as compared with FIBI scores of 29 through 72 during 2017 through 2022. Low baseflow in 2023 likely stressed the fish community. Observed flows on the day of fish surveys completed during 2017 through 2023 are shown in Figure 8-24. The flow of 0.4 measured at the time of the 2023 fish survey was lower than flows measured in 2017 through 2022, ranging from 0.7 cfs to 12.6 cfs. The biological stressors identified by the *Nine Mile Creek Biological Stressor Identification* (2010) for the South Fork of Nine Mile Creek included inadequate dissolved oxygen, excess sediment, and inadequate baseflow. The low flows and low dissolved oxygen levels measured in 2023 document inadequate baseflow and low dissolved oxygen as possible biological stressors.

Downstream North Fork Location (ECU-2A)

FIBI scores from the downstream North Fork location, ECU-2A, met the FIBI standard during 2018 through 2023, but not during 2017. However, the 2017 value was within the standard's confidence limits indicating it was close to the standard (Figure 8-22). The *Nine Mile Creek Biological Stressor Identification* (2010) concluded excess ionic strength due to excess chloride in the stream was a stressor to the North Fork fish community. Figure 8-8 documents excess ionic strength (chlorides) at this location in 2017 when the FIBI standard was not met indicating a possible biological stressor.

Upstream North Fork Locations (ECU-1A-1 and ECU-2)

FIBI scores from the two most upstream North Fork locations, ECU-1A-1 and ECU-2, did not meet the FIBI standard during 2017 through 2023 (Figure 8-22). The *Nine Mile Creek Biological Stressor Identification* (2010) concluded inadequate oxygen was a primary stressor to the North Fork fish community followed by excess sediment and excess ionic strength due to excess chloride in the stream. Section 8.1 and Appendix A document inadequate oxygen at ECU-2 during 2023, and Figure 8-4 and Figure 8-5 document excess ionic strength (chlorides) at both ECU-1A-1 and ECU-2 in 2023 indicating possible biological stressors.

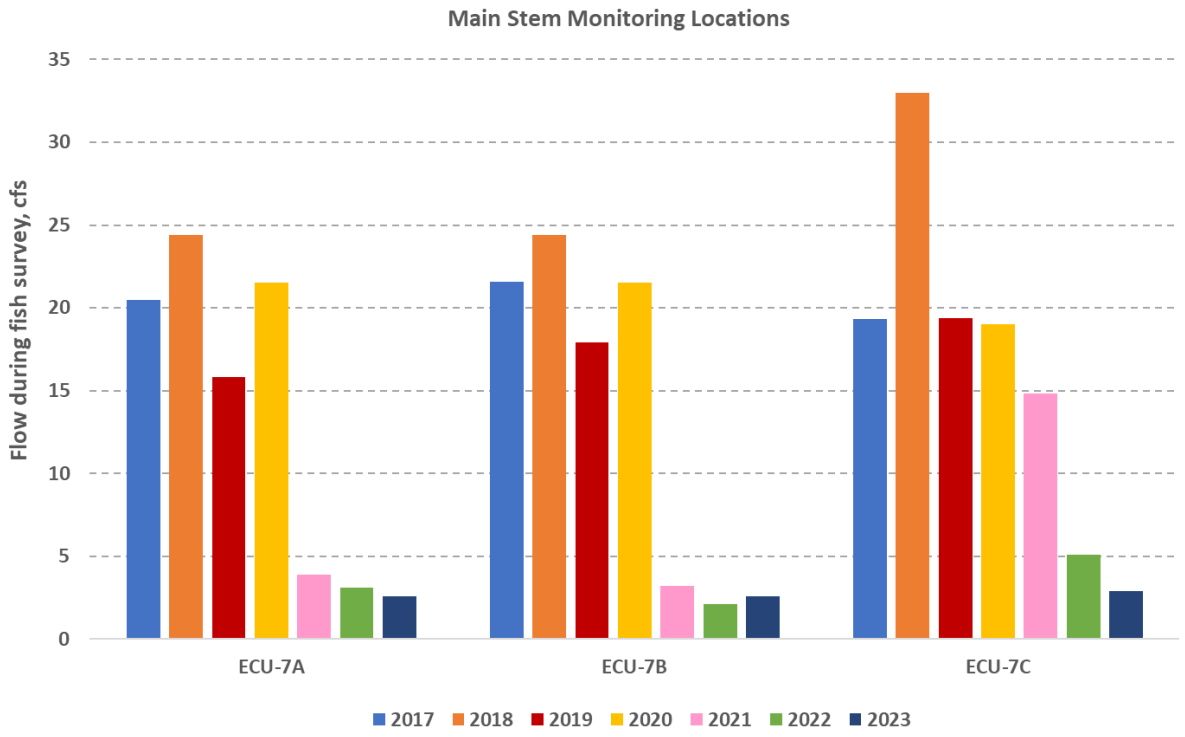


Figure 8-23 **Observed flows at the Main Stem locations ECU-7A, ECU-7B, and ECU-7C during the 2017-2023 fish surveys**

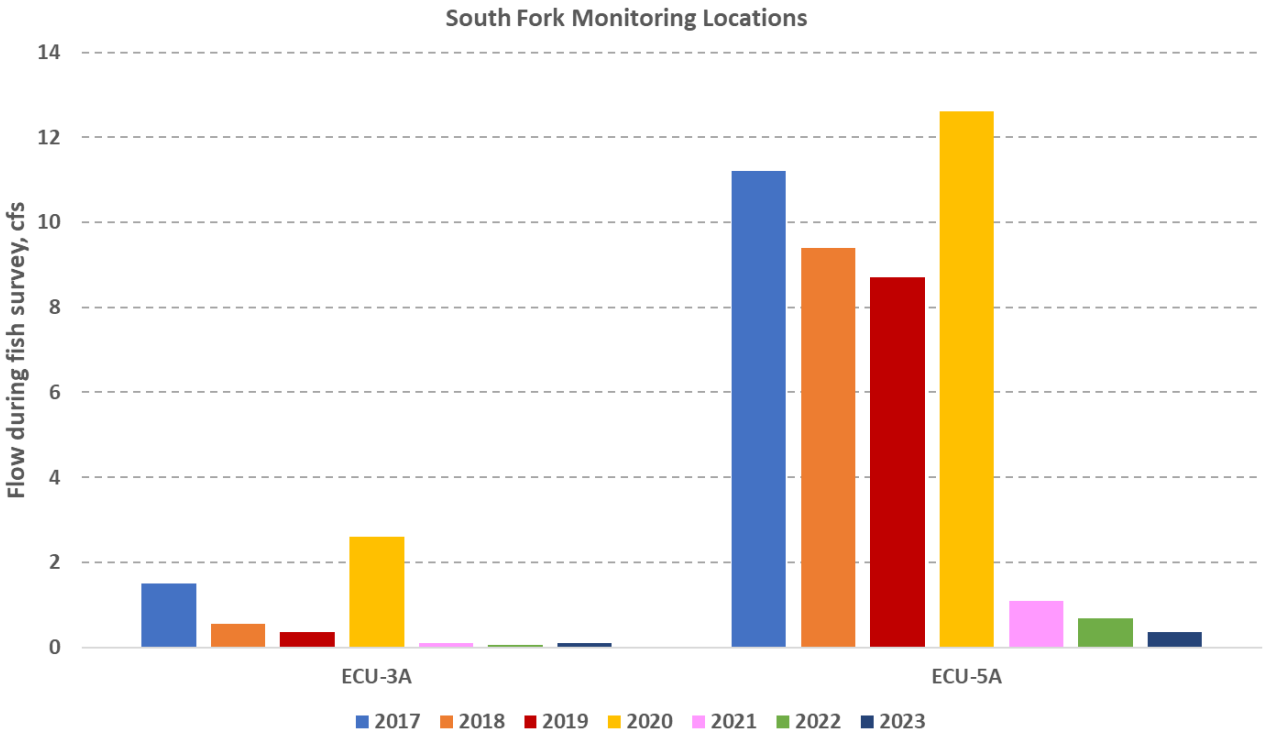


Figure 8-24 **Observed flows at South Fork locations ECU-3A and ECU-5A during the 2017-2023 fish surveys**

8.3.3 Macroinvertebrate Index of Biotic Integrity (MIBI)

8.3.3.1 Background

Minnesota has added a MIBI to MPCA standards published in Minn. Rule Chapter 7050. The MPCA's process of developing MIBI models and biocriteria for the models was similar to the process used to develop the FIBI models and biocriteria for the models. To account for natural differences in macroinvertebrate communities in Minnesota, streams were categorized into different stream types. A MIBI model was developed for each stream type and appropriate biocriteria were determined for each stream type. Each stream type uses a different MIBI model and biocriteria to determine the condition of the macroinvertebrate assemblage and attainment or nonattainment of the MIBI standard. The MPCA classified Minnesota streams into nine macroinvertebrate stream types based on the expected natural composition of stream macroinvertebrates. Stream type was differentiated by drainage area, geographic region, thermal regime, and gradient. These stream types were used to determine thresholds (i.e., biocriteria) that determine whether the calculated MIBI meets or fails to meet the aquatic life use goal for the stream. MIBIs were developed from five individual macroinvertebrate stream groups, with large rivers, wadeable high gradient, and wadeable low gradient stream types each being combined for the purposes of metric testing and evaluation. The MIBIs are on a 0 to 100 scale with increasing scores indicating improving stream health.

Nine Mile Creek is a Class 2B Southern warmwater stream because:

- Nine Mile Creek is located in the Minnesota River watershed;
- Nine Mile Creek is a warmwater stream; and
- Nine Mile Creek has a drainage area less than 500 square miles.

The MPCA subdivided the Southern warmwater streams into two types based on gradient. The wadeable high gradient streams were classified as Southern Streams Riffle Run (RR) and the wadeable low gradient streams were classified as Southern Forest Streams Glide Pool (GP). The primary habitat of Southern Streams RR is riffle run.

Six of the eight Nine Mile Creek sample locations have riffle run as their primary habitat due to a stream gradient that is greater than 1 meter per kilometer and are classified as Southern Streams RR. These include:

- Most upstream South Fork location, ECU-3A;
- Middle and downstream locations on the North Fork, ECU-2 and ECU-2A; and
- The three Main Stem locations, ECU-7A, ECU-7B, and ECU-7C.

Two sample locations have no riffles due to a stream gradient of less than 1 meter per kilometer and are classified as Southern Forest Streams GP. These include:

- Most upstream North Fork location, ECU-1A-1
- Most downstream South Fork location, ECU-5A

Unique MIBI and biocriterion were developed for each stream type—Southern Streams RR and Southern Forest Streams GP. The MPCA has also determined confidence limits around each standard to account for variability within the aquatic community because of natural spatial and temporal differences and sampling or method errors.

- The MIBI standard applicable to the most downstream North Fork location, ECU-2A, is the MPCA MIBI standard for a Class 2Bm Southern Streams RR. The standard is a value equal to or greater than 24. The lower confidence limit for a Class 2Bm Southern Streams RR is 11.4 and the upper confidence limit is 36.6.
- The MPCA MIBI standard for a Class 2Bg Southern Streams RR is a value equal to or greater than 37. The lower confidence limit for a Class 2Bg Southern Streams RR is 24.4 and the upper confidence limit is 49.6.
- The MIBI standard applicable to the most upstream North Fork location, ECU-1A-1, and the most downstream South Fork Location, ECU-5A, is the MPCA MIBI standard for a Class 2Bg Southern Forest Streams GP. The MIBI standard is a value equal to or greater than 43. The lower confidence limit for a Class 2Bg Forest Stream GP is 29.4 and the upper confidence limit is 56.6.

8.3.3.2 Monitoring Results

Nine Mile Creek macroinvertebrates (bugs that can be seen with the naked eye) were monitored at the eight ecological use monitoring stations (Figure 1-2) during October 1 and 6, 2023 and assessed to determine whether the MIBI values met the applicable MPCA MIBI standards for Nine Mile Creek.

2023 results (Figure 8-25):

In 2023, the downstream North Fork Location, ECU-2A was the only sample location that met the applicable MPCA standard. However, four locations had MIBI values greater than their respective lower confidence limits indicating they were close to the applicable MIBI standard. The MIBI values from the middle North Fork location, ECU-2, the upstream South Fork location, ECU-3A, and the upstream and downstream Main Stem locations, ECU-7A, and ECU- 7C ranged from 25 to 36 compared with a standard of 37 and a lower confidence limit of 24. The MIBI values of the most upstream North Fork location, ECU-1A-1, the most downstream South Fork location, ECU-5A, and the middle Main Stem location, ECU-7B, were below the MIBI standard and the lower confidence limit.

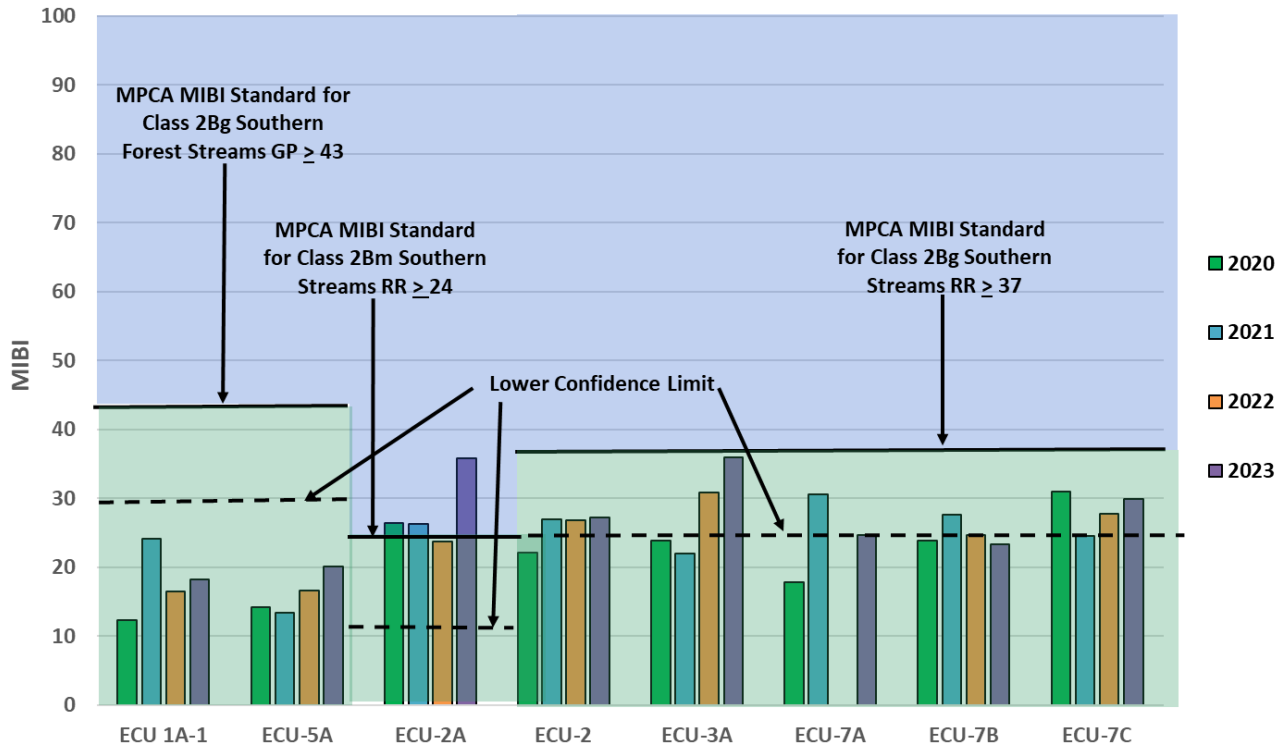


Figure 8-25 **2020-2023 Nine Mile Creek Macroinvertebrate Index of Biotic Integrity (MIBI) values compared with the MPCA MIBI standard for a Class 2Bg Southern Forest Streams GP (ECU-1A-1 and ECU-5A) or a Class 2Bm Southern Streams RR (ECU-2A), or a Class 2Bg Southern Streams RR (ECU-2, ECU-3A, ECU-7A, ECU-7B, and ECU-7C).**

2020-2023 results (Figure 8-25):

Monitoring locations with historical record of meeting MIBI Standard

The most downstream North Fork location, ECU-2A, met the applicable MIBI standard during 2020, 2021, and 2023, but not during 2022. However, the 2022 score of 23.8 was greater than the lower confidence limit of 11 and very close to the standard of 24.

Monitoring locations with historical record of exceeding lower confidence limits of MIBI Standards

None of the other monitoring locations met their respective MIBI standards during 2020 through 2023. However, five locations had MIBI values greater than their respective lower confidence limits indicating they were close to the applicable MIBI standard during one or more years:

- MIBI values from downstream Main Stem location, ECU-7C, were greater than the lower confidence limit during 2020 through 2023.
- MIBI values from middle Main Stem location, ECU-7B, were greater than the lower confidence limit during 2021 and 2022 and below, but very close to, the lower confidence limit in 2020 and 2023.
- Upstream Main Stem location, ECU-7A was not sampled in 2022 due to a dry stream bed. MIBI values from this location were greater than the lower confidence limit in 2021 and 2023, but less than the lower confidence limit in 2020.
- MIBI values from middle North Fork location, ECU-2, were greater than the lower confidence limit in 2021 through 2023, but less than the lower confidence limit in 2020.
- MIBI values from the upstream South Fork location, ECU-3A, were greater than the lower confidence limit in 2022 and 2023, but less than the lower confidence limit in 2020 and 2021.

Monitoring Locations with historical record of values below MIBI Standards and confidence limits

MIBI values from two locations were below both the applicable standard and lower confidence limit during 2020 through 2023:

- Upstream North Fork location ECU-1A-1.
- Downstream South Fork location ECU-5A.

8.4 Stream Monitoring Conclusions

Table 8-2 summarizes stream monitoring data from 2023. Overall, 78 percent of the 2023 observed values were within Minnesota State standards. The Main Stem (81 percent of observed values) met the State standards most frequently followed by the North Fork (77 percent of observed values) and the South Fork (76 percent of observed values). All Nine Mile Creek temperature and pH measurements, 86 percent of the dissolved oxygen measurements, and 26 percent of the specific conductance measurements met MPCA standards in 2023.

Table 8-2 2023 Nine Mile Creek Stream Data Summary

Stream Section	Station	Specific Conductance		Dissolved Oxygen		pH	Temperature	Turbidity		Minimum Baseflow (March-October)	Average Water Depth (June 19-22, 2023)[2]	Fish IBI[2]	Macroinvertebrate IBI[3]
		Failed to Meet Standard (# of monthly events)		Failed to Meet Standard (# of monthly events)		Failed to Meet Standards (# of monthly events)	Failed to Meet Standard (# of monthly events)	Exceeded 25 NTU[1] (# of monthly events)		Cubic feet per second	Centimeters (inches)		
North Fork	ECU-1A-1	7/8	March-September							0.7	34	did not meet standard or lower confidence limit	did not meet standard or lower confidence limit
	ECU-2	6/8	March-July and September	1/8	June					0.7	17	did not meet standard or lower confidence limit	met lower confidence limit
	ECU-2A	7/8	March-September							1.3	13	met standard	met standard
South Fork	ECU-3A	3/8	March, May, and June							0.04	15	met lower confidence limit	met lower confidence limit
	ECU-5A	7/8	March-September	3/8	June, September, and October					0	27	did not meet standard or lower confidence limit	did not meet standard or lower confidence limit
Main Stem	ECU-7A	4/8	March and May-July	3/8	June, August, and September					0	28	did not meet standard or lower confidence limit	met lower confidence limit
	ECU-7B	5/8	March, May-July, and September							0.08	16	did not meet standard or lower confidence limit	did not meet standard or lower confidence limit
	ECU-7C	4/8	March and May through July							1.0	21	met standard	met lower confidence limit

[1]Turbidity was a State standard (25 NTU) from the 1960s through 2014 when it was replaced with total suspended solids. Although turbidity is not currently a State standard, it is a useful surrogate indicator of total suspended solids.
[2]Fish surveys and water depth measurements were completed during June 19-22, 2023
[3]Macroinvertebrate survey was completed October 1 and 6, 2023.

As in previous years, the North Fork locations failed to meet the Minnesota State standard for specific conductance more frequently than other sampling locations—16 percent of the North Fork measurements met the MPCA specific conductance standard in 2023 compared with 29 percent of South Fork and 39 percent of Main Stem measurements.

In 2023, the North Fork met the MPCA standard for dissolved oxygen more frequently than other sampling locations—94 percent of the dissolved oxygen measurements from the North Fork were within the MPCA criterion in 2023 compared with 91 percent of Main Stem and 75 percent of South Fork measurements.

Because 2023 was a very dry year, 2023 water depths at five of the eight monitoring locations were the lowest depths measured during the 2003-2023 period of record. These included the North Fork location ECU-2, South Fork location ECU-5A, and Main Stem locations ECU-7A, ECU-7B, and ECU-7C (Figure 8-18 and Figure 8-19).

The downstream North Fork (ECU-2A) and Main Stem (ECU-7C) locations met the State Fish IBI standard in 2023. The upstream South Fork location (ECU-3A) did not meet the State Fish IBI standard in 2023, but was greater than the lower confidence limit and close to the standard (Table 8-2).

The downstream North Fork (ECU-2A) was the only sample location that met the State Macroinvertebrate IBI standard in 2023 (Table 8-2). However, four locations (middle North Fork location ECU-2, upstream South Fork location ECU-3A, and upstream and downstream Main Stem locations ECU-7A and ECU-7C) had MIBI values greater than their respective lower confidence limits indicating they were close to the applicable MIBI standard

Several biological stressors identified by the *Nine Mile Creek Biological Stressor Identification* (2010) were documented as present in Nine Mile Creek during 2023, including:

- South Fork – inadequate dissolved oxygen, inadequate baseflow, and excess ionic strength
- North Fork – inadequate dissolved oxygen and excess ionic strength
- Main Stem – inadequate dissolved oxygen, excess ionic strength, and inadequate baseflow

8.5 Stream Recommendations

Nine Mile Creek was first listed on the MPCA's 303(d) list of impaired waters for chlorides in 2004. The *Nine Mile Creek Watershed Chloride Total Maximum Daily Load Report* (September 2010) addressed the impairment. Despite efforts to address the impairment, the 2023 data documented high specific conductance measurements (a surrogate for chlorides) at all sample locations. It is recommended that the District continue implementation of the strategies identified in the chloride TMDL study to reduce chloride concentrations in the stream, which included:

- Pilot-Scale Chloride Loading Study—Determine the sources and potential improvement measures for chloride load reductions from representative sources in a smaller portion of the Nine Mile Creek watershed.

- Education and Training—Partner on public education and training/information exchange for MS4 staff and private/commercial salt applicators.
- Cost-Sharing Initiative—Develop [and implement] cost-sharing program for retrofitting and upgrading equipment.

Specific conductance is a measure of the conductive ions in water from dissolved and inorganic materials such as alkalis, chlorides, sulfides, and carbonate compounds, and is often used as a surrogate for measuring chloride levels. In 2023, high specific conductance measurements were observed in the fall at all North Fork locations, and at South Fork location N2 (West 78th Street in Bloomington) and downstream South Fork location ECU-5A, and Main Stem location ECU-7A which differs from a typical pattern of high chloride concentrations in the spring from winter deicing. It is recommended that the District further evaluate potential sources of the high fall chloride concentrations, including potential sources such as fall fertilization practices within the watershed, groundwater containing chlorides from winter deicing, and/or turn-over of stormwater ponds with high bottom chloride concentrations.

A portion of Nine Mile Creek was first listed on MPCA's 303(d) list of impaired waters for fish in 2004. In 2010, a biological stressor identification study was conducted by Barr Engineering Co. on behalf of the MPCA to evaluate probable causes of impairment based on existing biological, chemical, physical, and land-use data (*Nine Mile Creek Biological Stressor Identification, November 2010)*. In 2018, the MPCA added the Fish IBI and Macroinvertebrate IBI to the State's 7050 Rules as metrics to assess attainment of water quality standards. Following this, several portions of Nine Mile Creek were added to the MPCA's 303(d) impaired waters list for both fish and macroinvertebrates. Data from 2023 and other recent years indicate several locations along the North Fork, South Fork, and Main Stem are not meeting the State's fish IBI and/or macroinvertebrate IBI standards. Given this, it is recommended that the District consider updating the biological stressor analysis to determine the probable causes of the biological impairment(s) in the stream and management recommendations to improve the fish and macroinvertebrate communities in Nine Mile Creek. Updating the biological stressor analysis will allow for inclusion of more recent data to help evaluate benefits of recent District projects.

Continuation of water quality and biological monitoring is recommended in upcoming years to assess stream water quality and its biological community. The District should consider contacting MPCA staff in 2025 to discuss ongoing District monitoring efforts and results and seek guidance on future stressor evaluation monitoring.

9 Lake Level Monitoring

9.1 Lake Level Observations

The lake level recording program initiated by the Nine Mile Creek Watershed District in 1960 was comprised of the three Anderson Lakes and Bush Lake. The program was enlarged in 1963 to include Hawkes Lake, Mirror Lake, and Shady Oak Lake. The following year the program was again expanded to monitor a total of 26 lakes in the watershed. Measurements of Mud Lake (Bredesen Park) and of Girard Pond were discontinued in 1964 because extensive macrophyte growth in the summer made periodic readings impractical. In 1973, Lakes Minnetoga and Smetana were added to the program. Since then, the number of lakes being monitored has fluctuated over time in response to specific data needs.

In 2023, the Nine Mile Creek Watershed District recorded monthly lake levels at 29 lakes and waterbodies throughout the Nine Mile Creek watershed. The locations of the lake gages are shown on Figure 1-1. Lake level readings are taken monthly, usually at the same time the groundwater levels are measured. The levels of the lakes are generally measured using an engineering level from permanent structures along the shore.

Lake levels are influenced by groundwater conditions, local precipitation, size of the drainage area, land surface area, outlet elevation and configuration, local land use, and a variety of other factors. The effects of these influences on the lakes differ; there is no general uniformity in the fluctuation of lake levels in the watershed. Table 9-1 summarizes the net change in lake levels between the beginning of 2023 and end of 2023, as well as the historic high and low water elevations. Graphs showing measured lake levels from January 2000 through December 2023 are included in Appendix J.

During 2023, two of the monitored lake levels decreased and 27 of the monitored lake levels increased from the beginning to the end of the year. The increased lake levels reflect that 2023 was a less dry year compared with 2022, where 27 of the monitored lake levels decreased during the dry year in the Twin Cities metropolitan area. The recovering lake levels also generally reflected that many groundwater levels in the region were also recovering in 2023. Arrowhead Lake set a new historical low water elevation of 871.3 feet on 1/30/2023 by a narrow margin; previous record was 871.4 feet, which was set on 2/18/1981, 11/28/2022, and 12/27/2022. The most notable net increase in lake levels from January 2023 to December 2023 was Lake Edina (2.0 feet), Hawkes Lake (2.1 feet), Pauly's Pond (2.1 feet), and Wanda Miller Lake (2.2 feet).

Table 9-1. Summary of 2023 Monthly Observed Lake Levels

Lake	Measured Lake Level-January 2023 (1/30/2023)	Measured Lake Level-December 2023 (12/27/2023)	Net Change in Measured Lake Levels (1/30/2023 - 12/27/2023)	Historical High Water Elevation		Historical Low Water Elevation	
	[feet MSL]	[feet MSL]	[feet]	[feet MSL]	Date	[feet MSL]	Date
NW Anderson	837.6	838.26	0.7	841.8	7/24/1987	833.0	1/5/2009
SE Anderson	834.7	834.18	-0.5	841.8	7/24/1987	833.1	2/28/2013
SW Anderson	838.0	838.49	0.5	841.8	7/24/1987	835.1	12/8/1964
Arrowhead[1]	871.3	872.58	1.3	878.6	7/24/1987	871.3[4]	1/30/2023[4]
Birch Island[3]	877.2	877.85	0.6	891.2	3/24/1969	875.1	2/28/2013
Bryant	850.5	851.51	1.0	854.8	7/24/1987	849.3	1/14/1977
Bush[2]	829.6	829.47	-0.1	836.9	6/11/1999	826.0	8/8/1964
N Cornelia	858.5	859.88	1.4	864.1	7/24/1987	858.1	12/8/1967
S Cornelia	858.3	859.32	1.0	864.1	7/24/1987	858.0	11/28/2022
Edina	820.2	822.17	2.0	825.4	7/24/1987	817.8	2/9/1982
N Garrison	863.4	864.41	1.0	864.8	4/10/1965	860.7	2/28/2012
Glen	900.2	900.41	0.2	905.0	8/6/1965	898.2	7/30/2010
Hawkes[2]	883.7	885.82	2.1	892.2	7/24/1987	881.6	1/14/1977
Indianhead[1]	862.5	863	0.5	865.2	5/31/2019	861.0	2/28/2013
Lone[1]	897.5	897.45	0.0	901.6	10/25/2019	895.4	2/6/1990
Minnetoga	895.2	896.19	1.0	899.1	7/24/1987	894.1	2/6/1990
Mirror[2]	905.3	906.61	1.3	912.1	7/24/1987	901.8	1/14/1977
Nancy (formerly S. Garrison)	862.2	863.17	1.0	863.3	4/10/1965	860.7	12/30/2011
Normandale	808.1	809.22	1.1	815.8	7/24/1987	-	-
Oxboro	804.1	805.33	1.2	813.3	7/24/1987	797.9	1/15/1991
Pauly's Pond	814.3	816.43	2.1	821.2	7/24/1987	811.8	7/29/1988
Penn (Lower)	805.0	806.49	1.5	816.6	7/24/1987	802.3	2/28/2013
Rose	920.1	921.77	1.7	928.4	4/4/1966	919.6	1/8/1990
Shady Oak[5]	900.6	900.91	0.3	905.6	5/31/2019	897.8	1/29/1990
Skriebakken	801.7	803.47	1.8	811.3	7/24/1987	801.2	1/22/1977
Smetana	835.1	835.57	0.5	840.6	7/24/1987	830.2	11/8/1976
Swimming Pool Pond (formerly Valley View)	862.1	862.98	0.9	865.4	7/24/1987	860.1	2/28/2012
Wanda Miller	818.3	820.46	2.2	826.7	7/24/1987	814.8	2/28/2013
Wing	937.0	939.07	2.1	941.5	7/24/1987	933.5	1/31/1989

[1] Land-locked lake

[2] Pumped outlet

[3] High surface outlet. Hasn't discharged since 1987.

[4] Previous record was 871.4 ft on 2/18/1981, 11/28/2022, and 12/27/2022.

[5] Gated high surface outlet.

10 Groundwater Well Monitoring

10.1 Groundwater Well Observations

The Nine Mile Creek Watershed District's groundwater monitoring program began in 1962 when 18 groundwater observation wells were installed at various locations throughout the watershed. The following year, the program was augmented by the installation of 20 additional wells. Since inception of the program, the number of groundwater wells being monitored has fluctuated over time, with wells being added in response to specific information needs and other monitoring wells being lost as land development occurred. In 1989, 16 groundwater monitoring wells were in operation. In 1999, 12 wells were active. In 2023, only 6 of the groundwater observation wells remain active. The active groundwater observation wells are shown in Figure 1-1.

Table 10-1 summarizes the groundwater level observations from 2023. The table includes measured groundwater observations between the beginning of 2023 and end of 2023, as well as the corresponding net change in groundwater levels during that time period. During this year, the net change in groundwater elevation ranged from a 0.1-foot increases in Well 22 (south of Penn Lake in Bloomington) and Well 26 (east of Lake Edina in Edina) to a 0.8-foot increase in Well 52 (west of Bryant Lake in Eden Prairie). Table 10-1 also lists the maximum fluctuation of each well during this year. The maximum fluctuation observed throughout this year ranged from a 1.4-foot increase in Well 41 (northeast of Hawkes Lake in Edina) to a 2.3-foot decrease at Well 7 (northeast of Bredesen Park in Edina), with an average maximum fluctuation of a 0.4-foot increase. There were no new historical high or low water elevation records set in 2023.

Table 10-1 also summarizes the highest and lowest readings of the water table at each well and the date of occurrence.

Graphs of the observed groundwater levels for each active monitoring site from January 2000 through December 2023 are included in Appendix K.

Table 10-1. Summary of 2023 Monthly Groundwater Levels

Well ID	Measured Groundwater Level- January 2023 (1/30/2023)	Measured Groundwater Level- December 2023 (12/27/2023)	Net Change in Measured Groundwater Levels (1/30/2023 - 12/27/2023)	Maximum 2023 Fluctuation	Historical High Water Elevation		Historical Low Water Elevation	
	[feet MSL]	[feet MSL]	[feet]	[feet]	[feet MSL]	Date	[feet MSL]	Date
7	872.6	873.1	0.5	-2.3	894.9	3/25/2004	857.2	10/17/1989
22	796.1	796.2	0.1	0.9	802.3	5/3/1966	791.0	5/31/1990
26	820.9	821.0	0.1	0.1	827.9	4/29/2003	813.4	12/1/1964
35	842.0	842.6	0.6	1.0	848.7	3/15/2005	834.1	1/1/1964
41	879.4	879.8	0.4	1.4	885.8	8/26/2019	871.0	8/10/1977
52	850.6	851.4	0.8	1.2	855.0	3/17/2003	849.1	9/15/1994

Appendices

Appendix A	2023 Water Quality Data: Bush Lake, Lake Cornelia, Lake Edina, Lake Minnetoga, Normandale Lake
Appendix B	2023 Phytoplankton Data: Lake Cornelia and Normandale Lake
Appendix C	2023 Aquatic Plant Survey Maps: Lake Cornelia
Appendix D	2023 Aquatic Plant Survey Maps: Normandale Lake
Appendix E	2023 Curly-leaf Pondweed Turion Survey Methods and Results: Normandale Lake
Appendix F	2023 Aquatic Plant Survey Maps: Lake Minnetoga
Appendix G	2023 Nine Mile Creek Water Quality Data
Appendix H	Nine Mile Creek Water Depth Data Summary
Appendix I	2023 Nine Mile Creek Fish and Macroinvertebrate Data
Appendix J	Lake Level Graphs
Appendix K	Groundwater Level Graphs