Nine Mile Creek Watershed District

Summary of 2022 Water Monitoring Program

Prepared for
Nine Mile Creek Watershed District

August 2023

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1 Introduction

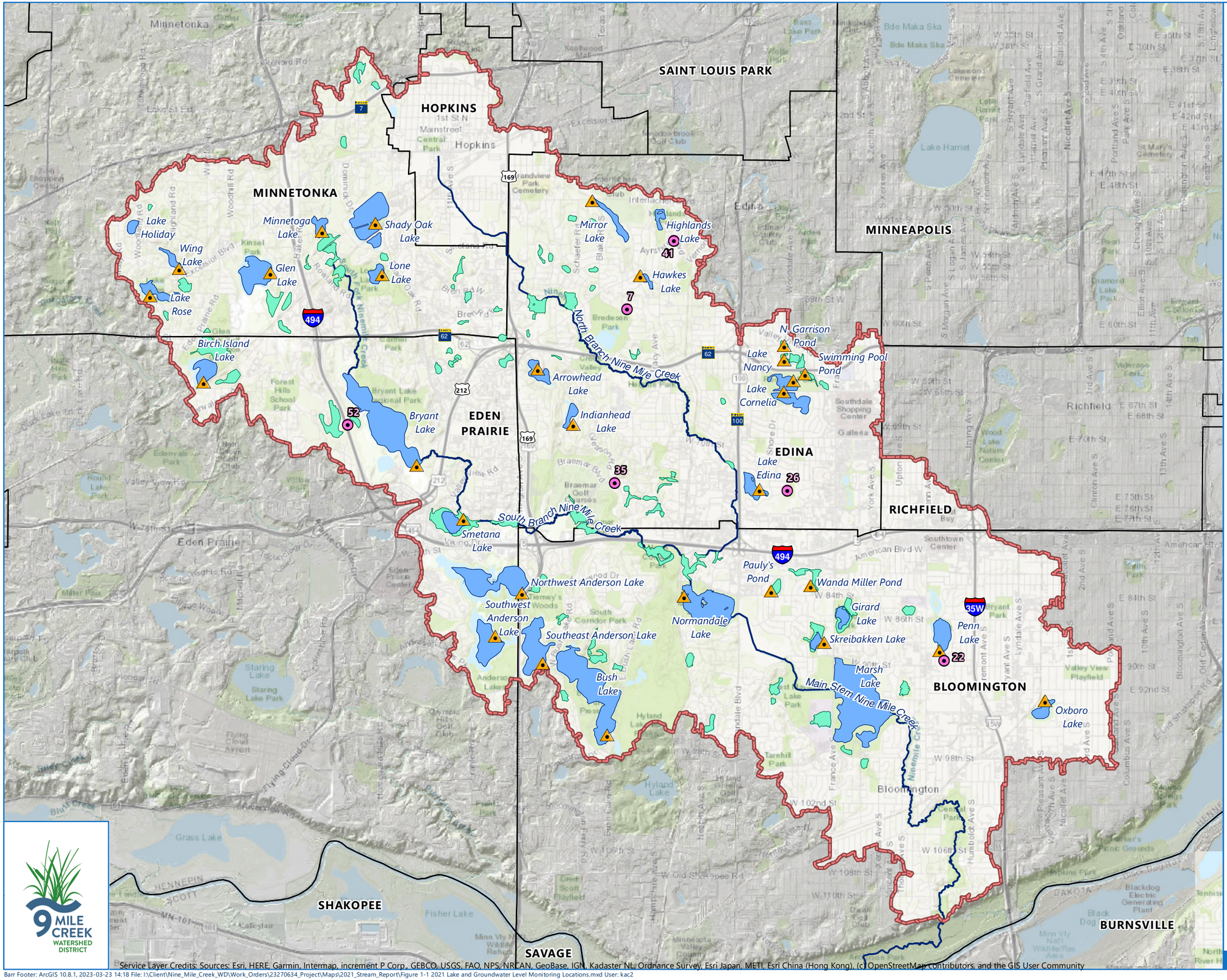
Monitoring of waterbodies in the Nine Mile Creek watershed is essential to developing an understanding of past and present conditions within the watershed and determining the need for action by the Nine Mile Creek Watershed District (District) or other entities. The District annually implements a lake, 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 2022.

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 2022, 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 2022 District water quality monitoring program included monitoring six lakes (Bush, Cornelia, Normandale, Holiday, Rose, and Wing), and Nine Mile Creek (Figure 1-2).

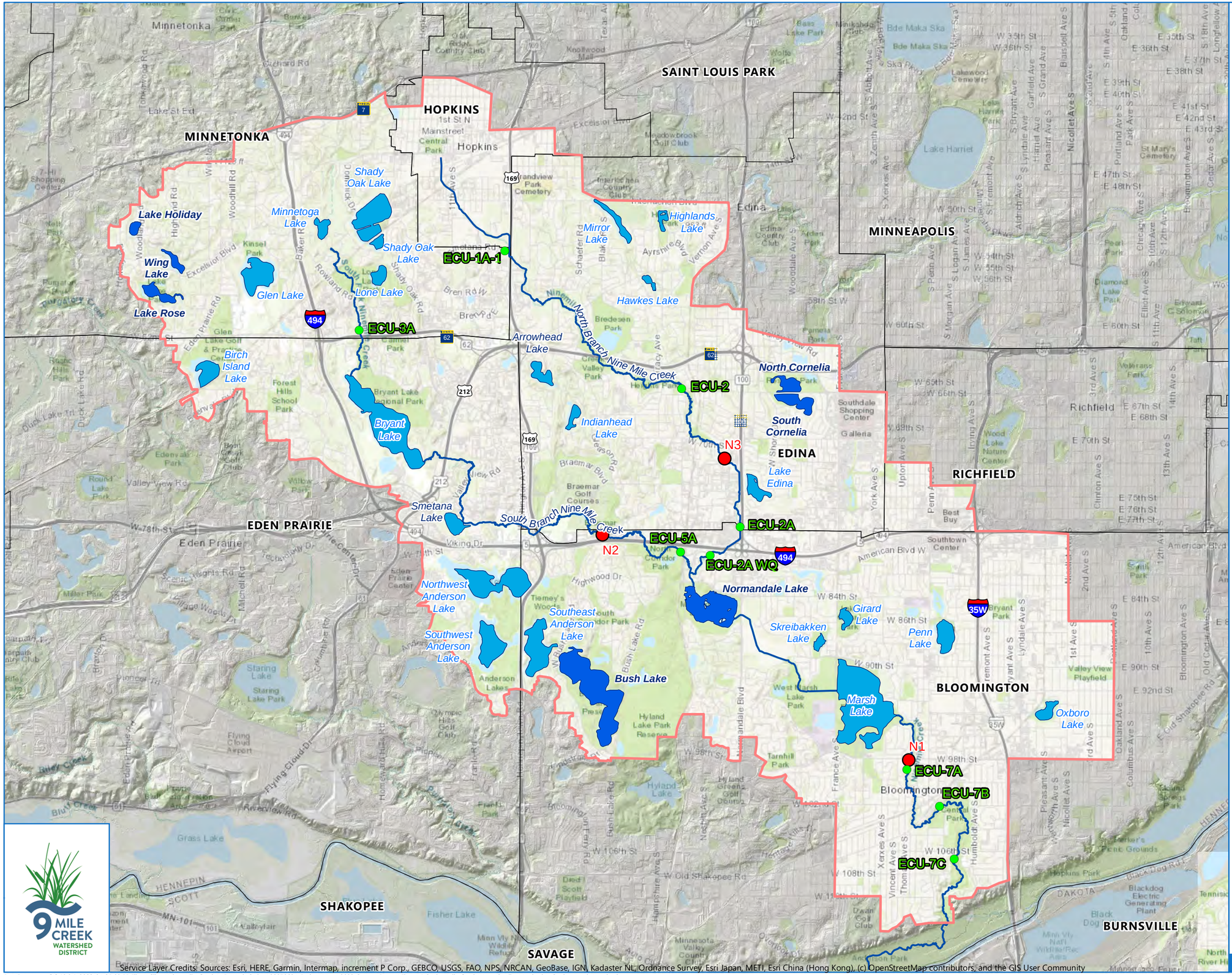


2022 LAKE AND GROUNDWATER LEVEL MONITORING LOCATIONS
Nine Mile Creek Watershed District
Hennepin County, Minnesota

Figure 1-1

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Barr Footer: ArcGIS 10.8.1, 2023-03-23 14:18 File: I:\Client\Nine_Mile_Creek_WD\Work_Orders\23270634_Project\Maps\2021_Stream_Report\Figure 1-1 2021 Lake and Groundwater Level Monitoring Locations.mxd User: kac2



2022 LAKE AND STREAM MONITORING LOCATIONS
Nine Mile Creek Watershed District
Hennepin County, Minnesota

Figure 1-2

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

2 Lake Water Quality Monitoring Conclusions and Recommendations

The Nine Mile Creek Watershed District monitors the water quality of its lakes on a rotating basis. Lakes to be monitored in a given year are selected to track water quality conditions, 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 2022. 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 2022 Lake Monitoring by the Nine Mile Creek Watershed District

Lake	Water Quality Monitoring	Phytoplankton	Zooplankton	Aquatic Plant Surveys
Bush	X	X	X	(1)
Cornelia	X	X		(1)
Normandale	X	X		(2)
Holiday				(1)
Rose				(1)
Wing				(1)

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

Results of the District's 2022 lake monitoring are summarized in detail by lake in Sections 3 through Section 9. Overall conclusions and recommendations from the 2022 lake monitoring are described below.

2.1 Bush Lake

Bush Lake water quality was excellent in 2022. Monitoring results indicate Bush Lake met the Minnesota Pollution Control Agency (MPCA) acute and chronic exposure chloride criteria, as well as the MPCA lake eutrophication water quality standards for total phosphorus, chlorophyll *a*, and Secchi disc depth.

In 2022, both the number of aquatic plant species in the lake and FQI values were well above (better than) the MNDNR Plant IBI thresholds and were higher (improved) than previous years.

Five aquatic invasive species (AIS) were observed in Bush Lake in 2022: Eurasian watermilfoil (EWM), curly-leaf pondweed (CLP), purple loosestrife, reed canary grass, and common reed. Despite the EWM and CLP management efforts by the Army Corp of Engineers during 2004 through 2007, both species have increased in prevalence and density since the project concluded. In 2022, EWM and CLP were prevalent throughout the lake, ranging in density from light to heavy. Purple loosestrife, reed canary grass, and common reed were each observed at one location in 2022.

Phytoplankton numbers in 2022 reflected the lake's excellent water quality. Green algae, diatoms, and cryptomonads, good sources of food for zooplankton, were well represented. Comparison of blue-green numbers to the World Health Organization (WHO) guideline thresholds for probability of adverse health effects to recreational users indicates all observed values in 2022 were below the threshold for low probability of adverse health effects. In 2022, small rotifers and copepods dominated the zooplankton community, but cladocerans, including large-bodied species such as *Daphnia retrocurva* and *Daphnia galeata mendotae*, were also consistently present.

2.2 Lake Cornelia

Water quality in Lake Cornelia was especially poor in 2022. Lake Cornelia is comprised of two basins, north basin and south basin. Monitoring results indicate chloride concentrations in the north basin exceeded the MPCA chronic criteria in April, July, and early August while chloride concentrations in the south basin exceeded chronic criteria in June through August. Both basins failed to meet State eutrophication water quality standards for a shallow lake in 2022 due to excess phosphorus and algae in the lake and poor water clarity. The 2022 summer average chlorophyll *a* concentration in North Lake Cornelia was higher (poorer) than previous years. The higher than usual chloride concentrations and especially poor water quality throughout the summer were likely due to the especially dry climatic conditions and resulting lack of flushing.

A severe blue-green algal bloom was observed in Lake Cornelia during the 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. 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.

The number of aquatic plant species and FQI values in Lake Cornelia in 2022 were below the MNDNR Plant IBI thresholds. Review of aquatic plant data from 2017 through 2022 indicate that annual herbicide

treatments by the City of Edina significantly reduced the frequency of CLP in both basins. However, the health of the native plant community in both basins is poor. Comparison of data from 2017 to 2022 indicates a significant decline in coontail and common waterweed frequency in the north basin. The health of the native plant population has declined in the south basin since prior to the curly-leaf infestation and subsequent treatments.

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 in the lake, which fuels algal production and decreases water clarity. The recommended management strategy to improve water quality in Lake Cornelia is 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 indicate 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. The District is considering conducting another sediment treatment in Lake Cornelia in the upcoming years.

Other watershed practices are underway to help improve Lake Cornelia. In summer of 2021, the District completed construction of a stormwater filtration system in Rosland Park to reduce the amount of phosphorus to Lake Cornelia. The innovative upflow filtration system includes three parallel filtration chambers to evaluate the effectiveness of different filtration media in removing dissolved phosphorus.

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.

2.3 Normandale Lake

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, an invasive aquatic plant that dies off in late June, releasing phosphorus to the lake as it decays which 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 2022, 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.

In 2022, the summer average total phosphorus and chlorophyll *a* concentrations and summer average Secchi disc (measure of clarity) in Normandale Lake met the State eutrophication criteria for shallow lakes. 2022 monitoring results indicate that chloride concentrations in July and August exceeded the MPCA chronic chloride criterion, but all 2022 chloride concentrations met the MPCA acute chloride criterion.

The phytoplankton communities in Normandale Lake in 2022 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. Blue-green algae can produce algal toxins, which can be harmful to humans or other animals. The blue-green algae numbers observed at the District's routine monitoring location during 2022 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 2022 indicate the frequency and biomass of curly-leaf pondweed continues to be lower than levels prior to implementation of the water quality improvement project.

The lake's plant community in 2022 met the MNDNR Plant IBI thresholds, with the highest number of species to date observed in August of 2021 and August 2022. 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 2022 show a moderate overall decrease in biomass of the plant community after the project. The dominant species observed in 2022 included coontail, common waterweed, and white water lily, which were generally the three species with the greatest biomass prior to the drawdown.

Continuation of periodic water quality and biological monitoring is recommended in upcoming years to assess the impacts of the improvement project(s) on the condition of the lake's water quality and biological community.

2.4 Lake Holiday

2022 aquatic plant data indicated the plant community had few species, was of poor quality, and failed to meet the MDNR Plant IBI thresholds. Lakes that score below the thresholds contain degraded plant communities and are likely stressed from anthropogenic eutrophication.

Three aquatic invasive species were found in the lake in 2022, curly-leaf pondweed, purple loosestrife and reed canary grass. Dense growth of curly-leaf pondweed, first observed in the lake in 2008, was prevalent throughout the lake in June of 2022.

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.

2.5 Lake Rose

The lake's plant community in 2022 met the MNDNR Plant IBI thresholds. The number of species and the quality of the plant community as measured by FQI values have increased since 2008 and the August 2022 values were the highest observed to date.

Three aquatic invasive species were observed in Lake Rose in 2022: curly-leaf pondweed, purple loosestrife, and reed canary grass. CLP was observed in the lake during 2008, 2020, and 2022, but was less prevalent in 2022, likely because of the lake's low water levels. Herbicide treatment of the reed canary grass is recommended to remove it from the lake. A MNDNR permit would be required.

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.

2.6 Wing Lake

The lake's plant community in 2022 met the MNDNR Plant IBI thresholds. In 2022, the number of species and the quality of the plant community as measured by FQI values were the highest observed to date. Three aquatic invasive species were found in the lake in 2022: purple loosestrife, curly-leaf pondweed, and narrow-leaved cattail. Extent of these species decreased between 2020 and 2022.

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.

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.

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).

In 2022, 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
- Phytoplankton and zooplankton (microscopic plants and animals)
- Macrophytes (aquatic plants)

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

Figure 3-1 Bush Lake on August 11, 2022

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

Figure 3-2 shows the 2022 summer average (June through September) conditions for total phosphorus, chlorophyll *a*, and Secchi disc transparency, in comparison with monitoring results from past years. The lake's 2022 summer average total phosphorus concentration of 14 µg/L, the lake's summer-average chlorophyll *a* concentration of 3.5 µg/L, and the lake's summer average Secchi disc transparency of 3.3 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) (Figure 3-2). 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, 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, and 2022), 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 MPCA standard and all but the 2001 summer average chlorophyll *a* concentration met the MPCA standard (Figure 3-2).

Review of the monitoring data suggests that the water quality of Bush Lake generally

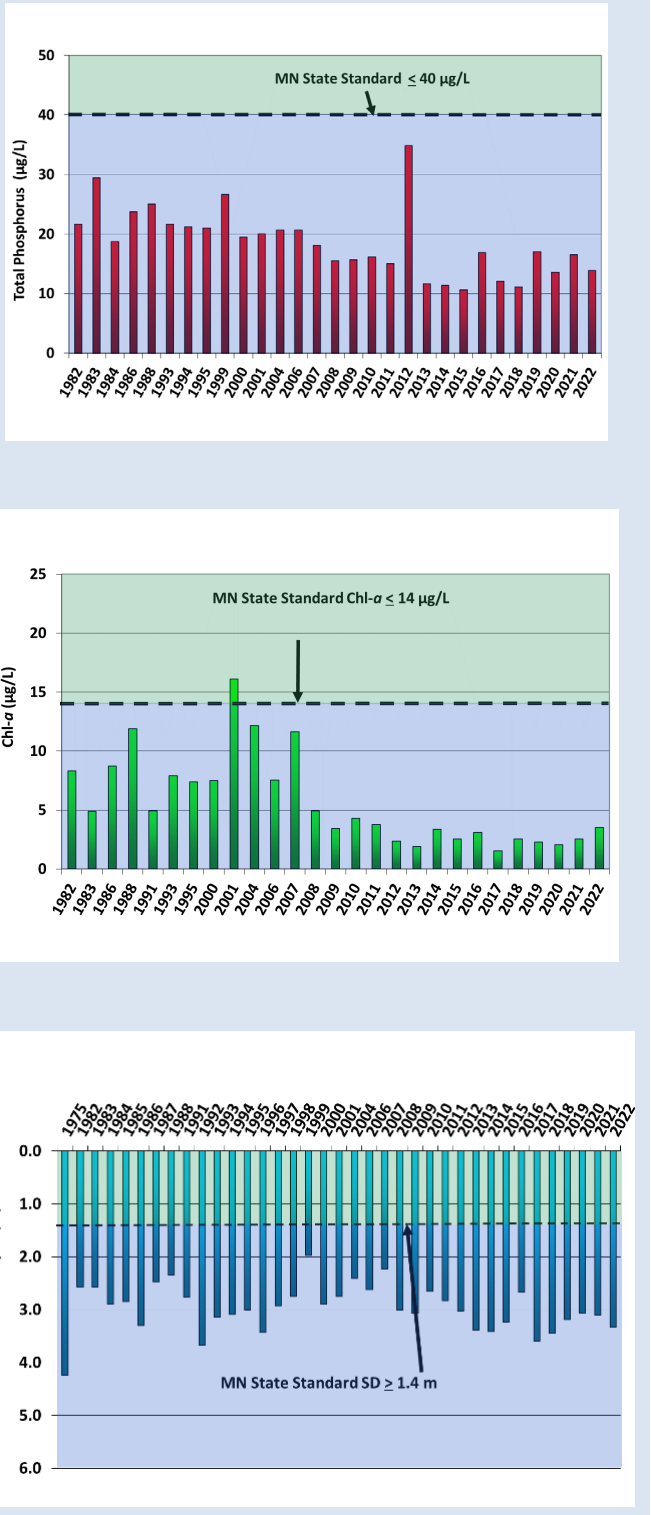


Figure 3-2 Bush Lake historical summer average values
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

improved after completion of the AIS management project in 2007. The improved water quality was generally sustained through 2022. The lake's summer average total phosphorus concentration ranged from 18 to 29 µg/L during 1982 through 2007 and from 11 to 18 µg/L during 2008 through 2022, except for 2012 (summer average concentration of 35 µg/L). The lake's summer average chlorophyll *a* concentration ranged from 4.9 to 12.2 µg/L in 1982 through 2007 and from 1.9 through 4.9 µg/L during 2008 through 2022. The summer average Secchi disc depth ranged from 2.4 to 4.3 meters during 1975 through 1996, from 2.0 to 2.9 meters during 1997 through 2007, and from 2.7 through 3.6 meters during 2008 through 2022.

3.2 Chlorides

Chloride concentrations were measured in 2010, 2014, 2018, and 2022, generally between April and September. Figure 3-3 shows the observed 2022 chloride concentrations, in comparison with historical observations. The observed 2022 chloride concentrations were similar but slightly higher than in past years. 2022 chloride concentrations ranged from 55 to 64 mg/L compared with concentrations ranging from 44 to 58 mg/L in previous years. 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 well below the acute and chronic MPCA criteria. The 2022 data are summarized in Appendix A.

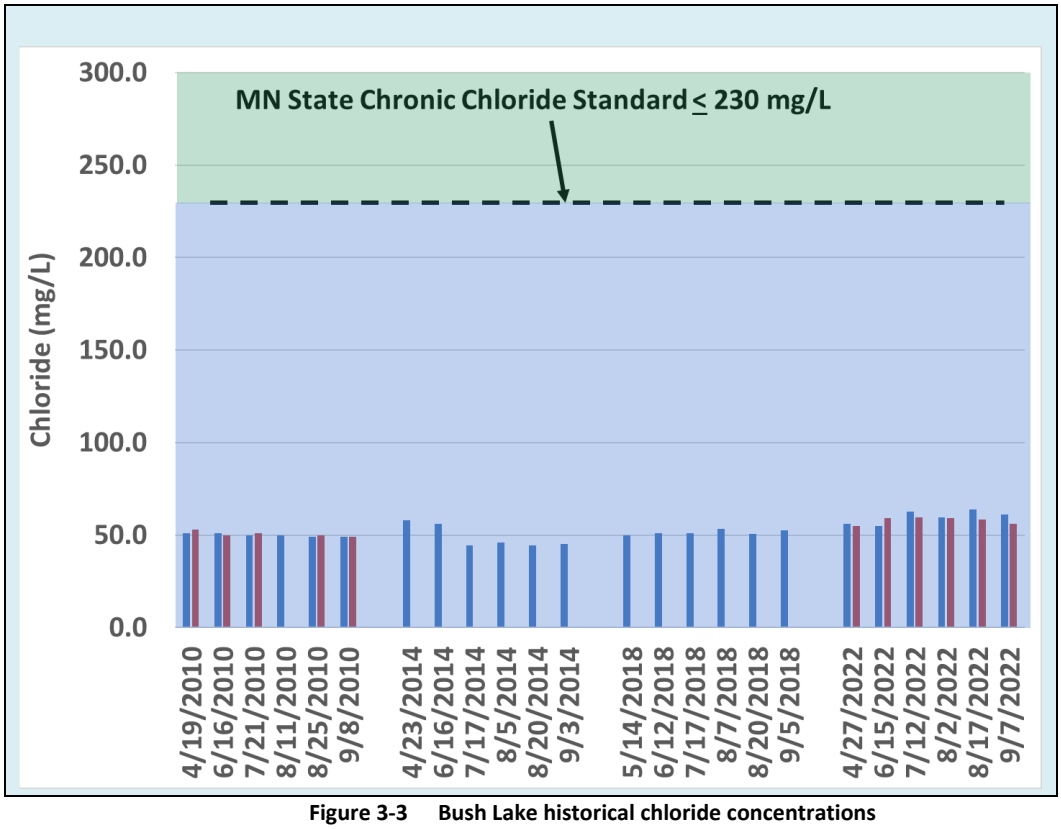


Figure 3-3 Bush Lake historical chloride concentrations

3.3 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.

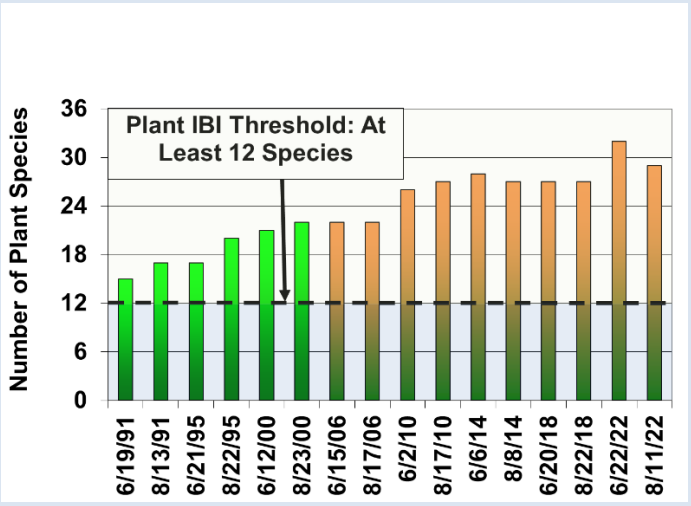


Figure 3-4.A

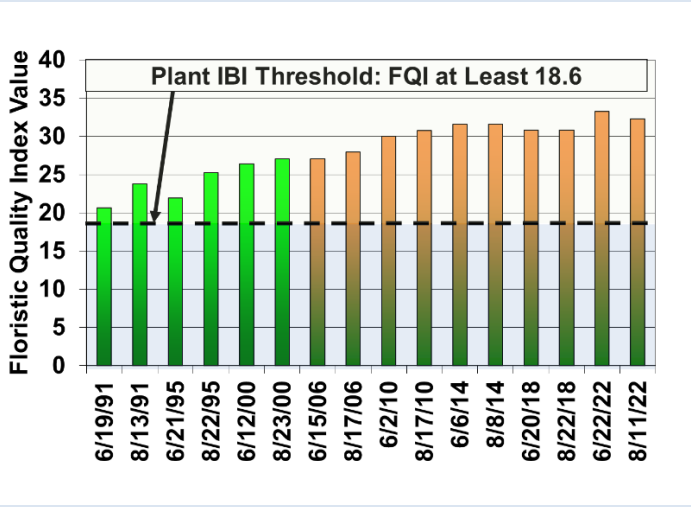


Figure 3-4.B

Figure 3-4 Bush Lake 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 during (2006) and after (2010-2022) completion of the AIS management project.

The District conducted point intercept plant surveys of Bush Lake in June and August of 2022. Maps showing survey results are included in Appendix C. Plant survey data from 1991 through 2022 were assessed to track changes in plant IBI scores. Figure 3-4 shows the number of species and FQI scores in Bush Lake for that period compared to the MNDNR Plant IBI thresholds. Both the number of species in the lake and FQI values in 2022 were better than the MNDNR Plant IBI thresholds and were higher than previous years.

- **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 Bush Lake ranged from 15 to 32, bettering the MNDNR Plant IBI threshold during the entire period (Figure 3-4.A). The number of species in the lake has been higher (improved) since completion of the AIS management project in 2007. The number of species in the lake prior to the project (1991 to 2000) ranged from 15 to 22 and was 22 during the project (2006). The number of species in the lake since project completion (2010 to 2022) has ranged from 26 to 32.

- **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 Bush Lake ranged from 21 to 33, bettering the MNDNR Plant IBI threshold during this entire period (Figure 3-4.B). The lake's FQI values have been higher (improved) since completion of the AIS management project in 2007.The FQI values prior to the project (1991 to 2000) ranged from 21 to 27 and were 27 to 28 during the project (2006). The FQI values since project completion (2010 to 2022) have ranged from 30 to 33.

Five aquatic invasive species were found in Bush Lake in 2022:

Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*) – collected on the rake at 54 locations (45 percent) and visually observed at an additional 7 locations in June. In August, EWM was collected on the rake at 53 locations (44 percent) and visually observed at an additional 9 locations. Dense beds of canopied EWM dominated the lake from the 4 to 12-foot depth during June and August. On a scale of 1 (low) to 3 (high), the average EWM rake density was 2.0 in June and August (rake head about half full). The plant surveyor noted the EWM looked like hybrid watermilfoil, which is a cross between EWM and native watermilfoil (*Myriophyllum sibiricum*). Genetic testing is required to distinguish between EWM and hybrid watermilfoil.

Curly-leaf pondweed (CLP) (*Potamogeton crispus*) – collected on the rake at 28 locations (23 percent) and visually observed at an additional two locations in June. On a scale of 1 to 3, the average rake density was 1.4. CLP was not observed during August.

Purple loosestrife (*Lythrum salicaria*) – observed at one location along the southeast shore of the lake in August.

Reed canary grass (*Phalaris arundinaceae*)– Observed at one location along the southwest shore in June and August.

Common Reed (Phragmites australis) – A few scattered individuals were observed at one location along the northwest shore in June and August.

3.4 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 District has historically monitored the phytoplankton community as part of its routine monitoring program, 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 has 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 3-5 summarizes the number and major groups of phytoplankton observed in Bush Lake in monitored years. Phytoplankton numbers throughout the period of record have reflected the lake's excellent water quality (Figure 3-5). Green algae, diatoms, and cryptomonads, good sources of food for zooplankton, have been well represented throughout the monitoring period. Blue-green algae, which are associated with water quality problems, were consistently present in low numbers, but were never problematic.

Figure 3-6 summarizes the blue-green algae numbers at the District's routine monitoring location in Bush 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.

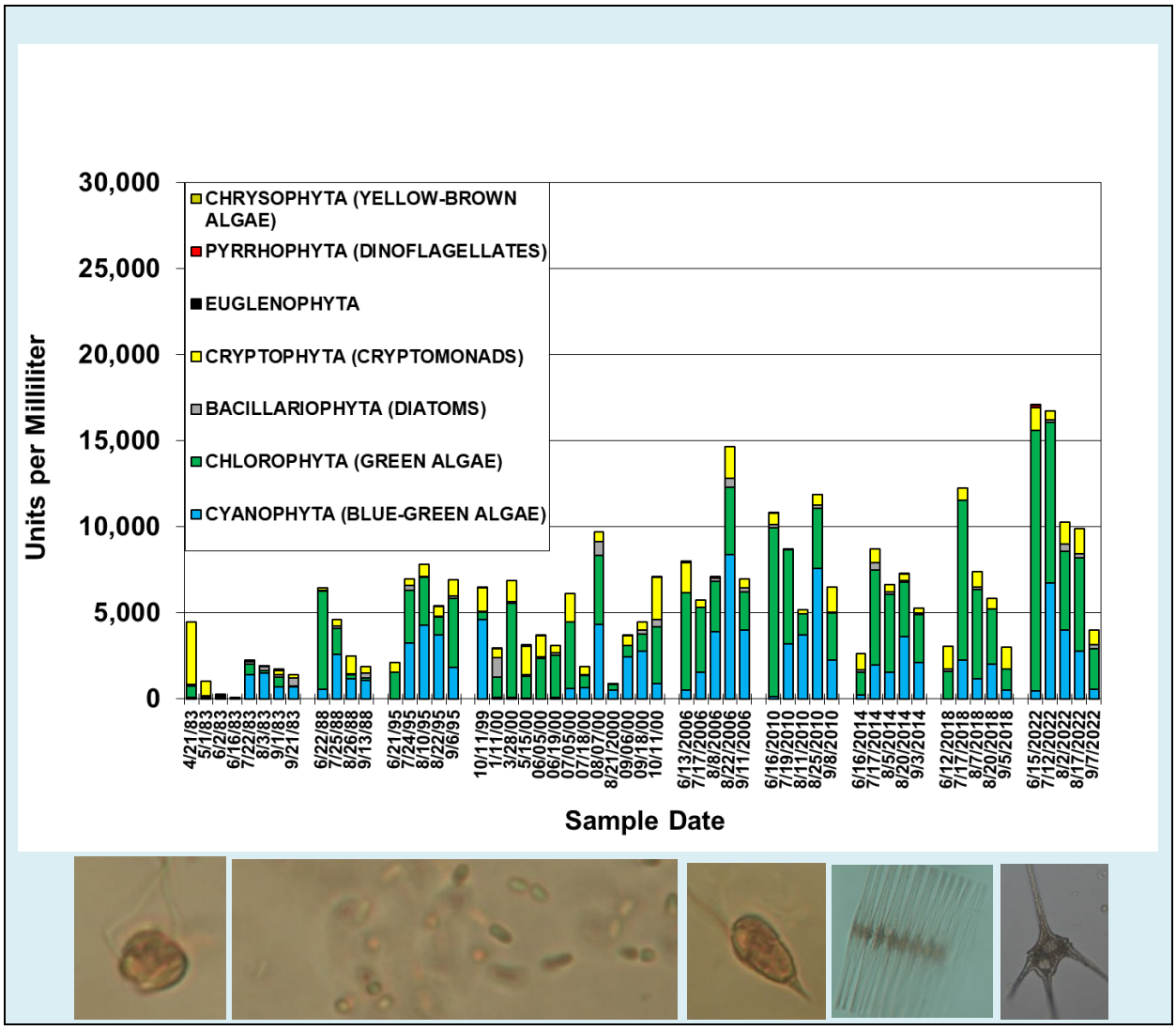


Figure 3-5 Bush Lake Phytoplankton

Top, Bush Lake 1983, 1988, 1995, 2000, 2006, 2010, 2014, 2018, 2022 phytoplankton numbers and bottom, microscopic pictures of phytoplankton species found in the lake, from left to right, *Chlamydomonas globosa* (green algae), *Aphanothece sp.* (blue-green algae), *Cryptomonas erosa* (cryptomonad), *Fragilaria crotonensis* (diatom), and *Ceratium hirundinella* (dinoflagellate).

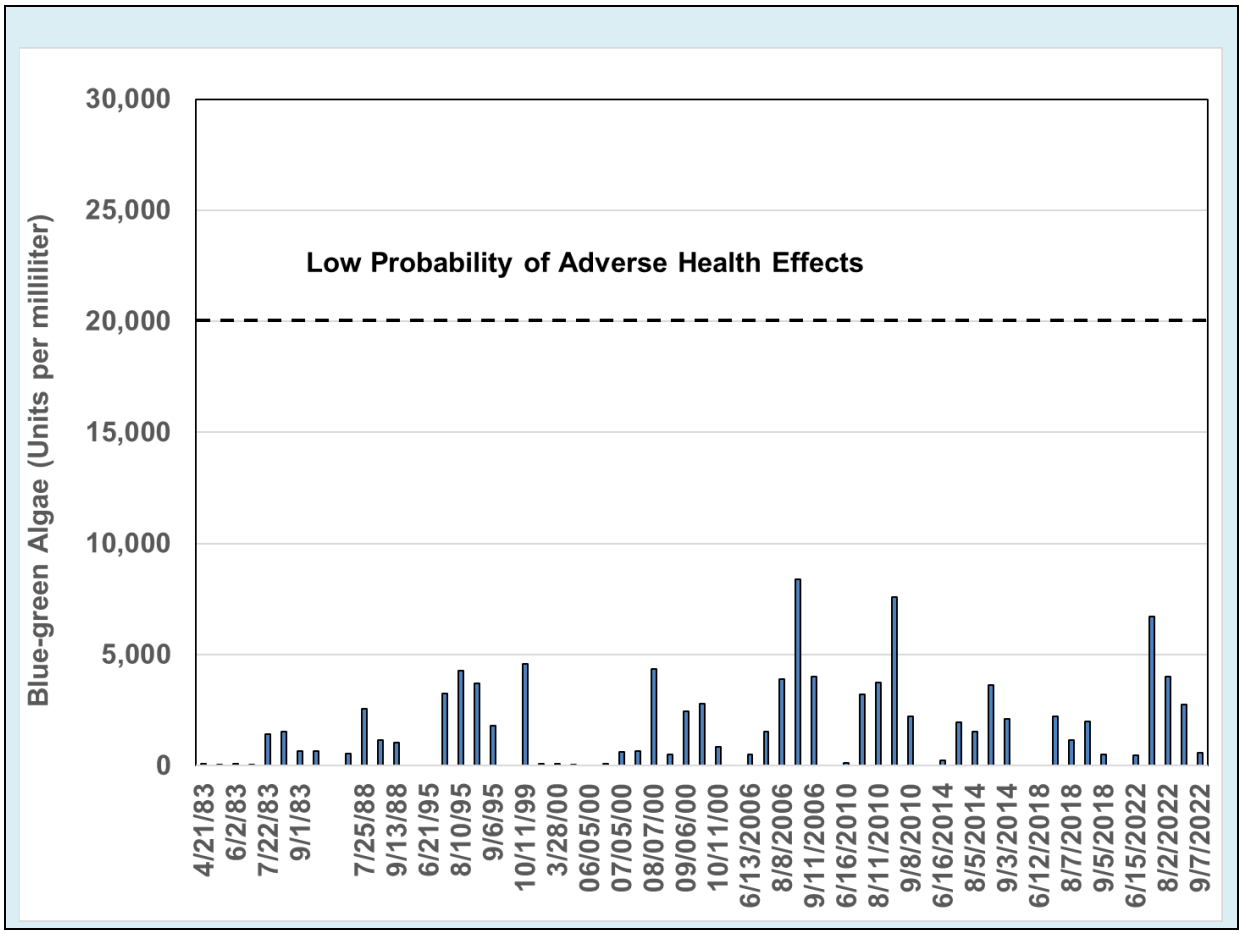


Figure 3-6 **Bush Lake blue-green algae compared with World Health Organization (WHO) threshold for low probability of adverse health effects to recreational users.**

3.5 Zooplankton

Samples of zooplankton, microscopic aquatic animals, were collected from Bush Lake to evaluate the food available to planktivorous fish. Identification and enumeration of the zooplankton species were completed, and results are included in Appendix B.

Figure 3-7 summarizes the number and major groups of zooplankton observed in Bush Lake in monitored years. During the period of record, small rotifers and copepods have generally dominated the community, but cladocerans, including large-bodied species such as *Daphnia retrocurva* and *Daphnia galeata mendotae*, have consistently been present. Cladocerans graze more heavily on algae than small rotifers and copepods and have a greater impact on the lake's water quality.

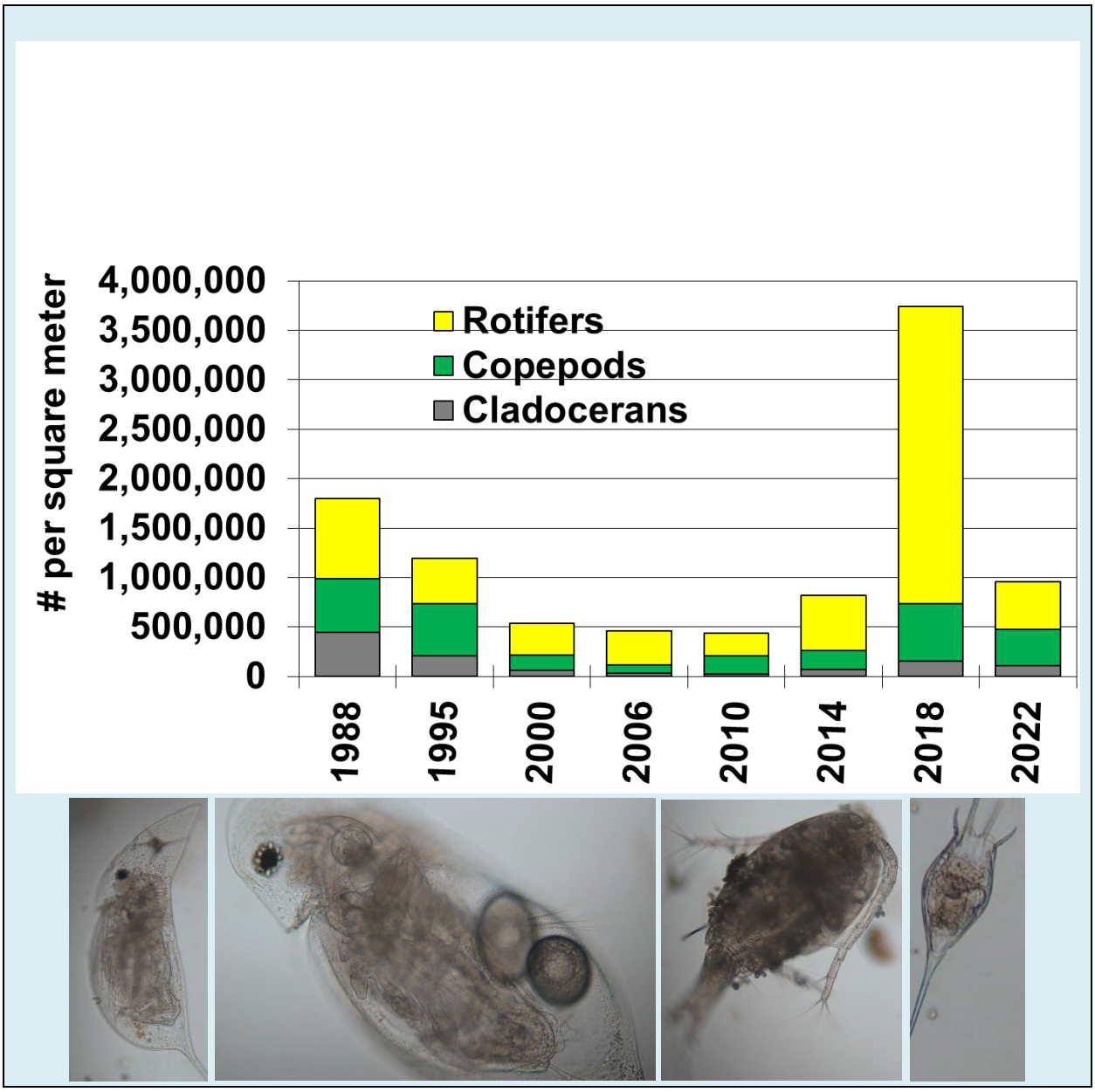


Figure 3-7 Bush Lake Zooplankton

Top, Bush Lake 1988, 1995, 2000, 2006, 2010, 2014, 2018, 2022 zooplankton numbers and bottom, microscopic pictures of zooplankton species found in the lake, from left to right*, Daphnia retrocurva* (cladoceran), *Daphnia galeata mendotae.* (cladoceran), *Cyclops sp.* (copepod), and *Kellicottia bostoniensis* (rotifer).

3.6 Conclusions and Recommendations

Bush Lake water quality was excellent in 2022. Monitoring results indicate Bush Lake met the Minnesota Pollution Control Agency (MPCA) acute and chronic exposure chloride criteria, as well as the MPCA lake eutrophication water quality standards for total phosphorus, chlorophyll *a*, and Secchi disc depth.

Both the number of aquatic plant species in the lake and FQI values were better than the MNDNR Plant IBI thresholds and were higher (improved) than previous years.

Five aquatic invasive species (AIS) were observed in Bush Lake in 2022: Eurasian watermilfoil (EWM), curly-leaf pondweed (CLP), purple loosestrife, reed canary grass, and common reed. Despite the EWM and CLP management efforts during 2004 through 2007, both species have increased in prevalence and density since the project concluded. In 2022, EWM dominated the lake and CLP was prevalent throughout the lake, ranging in density from light to heavy. Purple loosestrife, reed canary grass, and common reed were each observed at one location in 2022.

Phytoplankton numbers in 2022 reflected the lake's excellent water quality. Green algae, diatoms, and cryptomonads, good sources of food for zooplankton, were well represented. Comparison of blue-green numbers to the World Health Organization (WHO) guideline thresholds for probability of adverse health effects to recreational users indicates all observed values in 2022 were below the threshold for low probability of adverse health effects. In 2022, small rotifers and copepods dominated the zooplankton community, but cladocerans, including large-bodied species such as *Daphnia retrocurva* and *Daphnia galeata mendotae* were consistently present.

4 Lake Cornelia

4.1 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 2022, 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)

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

Figure 4-1 Lake Cornelia - North Basin on June 21 (left) and August 9 (right).

4.1.1 Lake Cornelia – North Basin

Lake Cornelia – North Basin (Figure 4-1) has a water surface area of approximately 19 acres, a maximum depth of 5 feet, and a mean depth of approximately 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).

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

In 2022, Lake Cornelia – North Basin water quality was poor. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 184 µg/L and 173 µg/L, respectively (Figure 4-2). The lake's 2022 summer average Secchi disc transparency was 0.2 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 2022 which are ≤60 µg/L, ≤20 µg/L, and ≥1 meter for total phosphorus, chlorophyll *a*, and Secchi disc transparency, respectively.

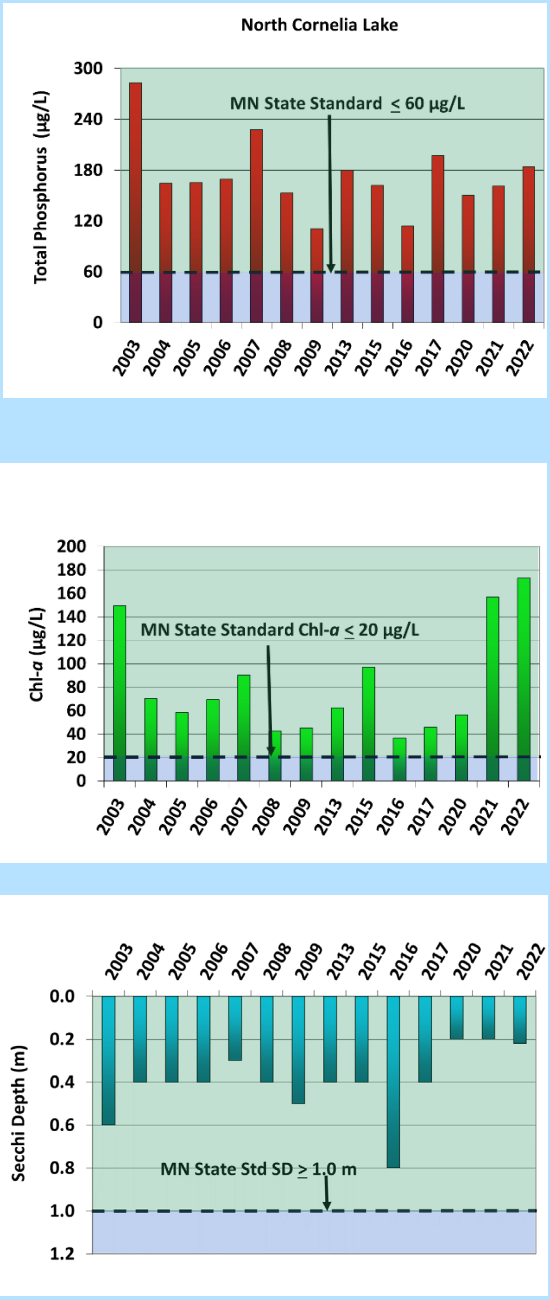


Figure 4-2 **Lake Cornelia – North Basin historical summer average values**
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc transparency (bottom)

Water quality data have been collected from Lake Cornelia – North Basin by Nine Mile Creek Watershed District (NMCWD) during 2004, 2008, 2013, 2015, 2016, 2017, 2020, 2021, and 2022 and by the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) during 2003, 2005, 2006, 2007, 2008, and 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). While the lake's 2022 summer average total phosphorus concentration and Secchi disc depth were within the range observed in previous years,

the 2022 summer average chlorophyll *a* concentration was higher (poorer) than previous years (Figure 4-2).

4.1.1.2 Chlorides

Chloride concentrations were measured in 2013, 2015, 2016, 2017, 2020, 2021, and 2022 generally between April and September. The observed chloride concentrations from 2013 through 2022 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. Chloride measurements were above the chronic criterion in April/May during each of the years in which April/May samples were collected - 2013, 2015, 2016, 2020, 2021, and 2022. In 2022, chloride measurements on July 12 and August 2 were above the chronic criterion. The higher than usual chloride concentrations throughout the summers of 2021 and 2022 were likely due to the dry climatic conditions and resulting lack of flushing. 2022 data are summarized in Appendix A.

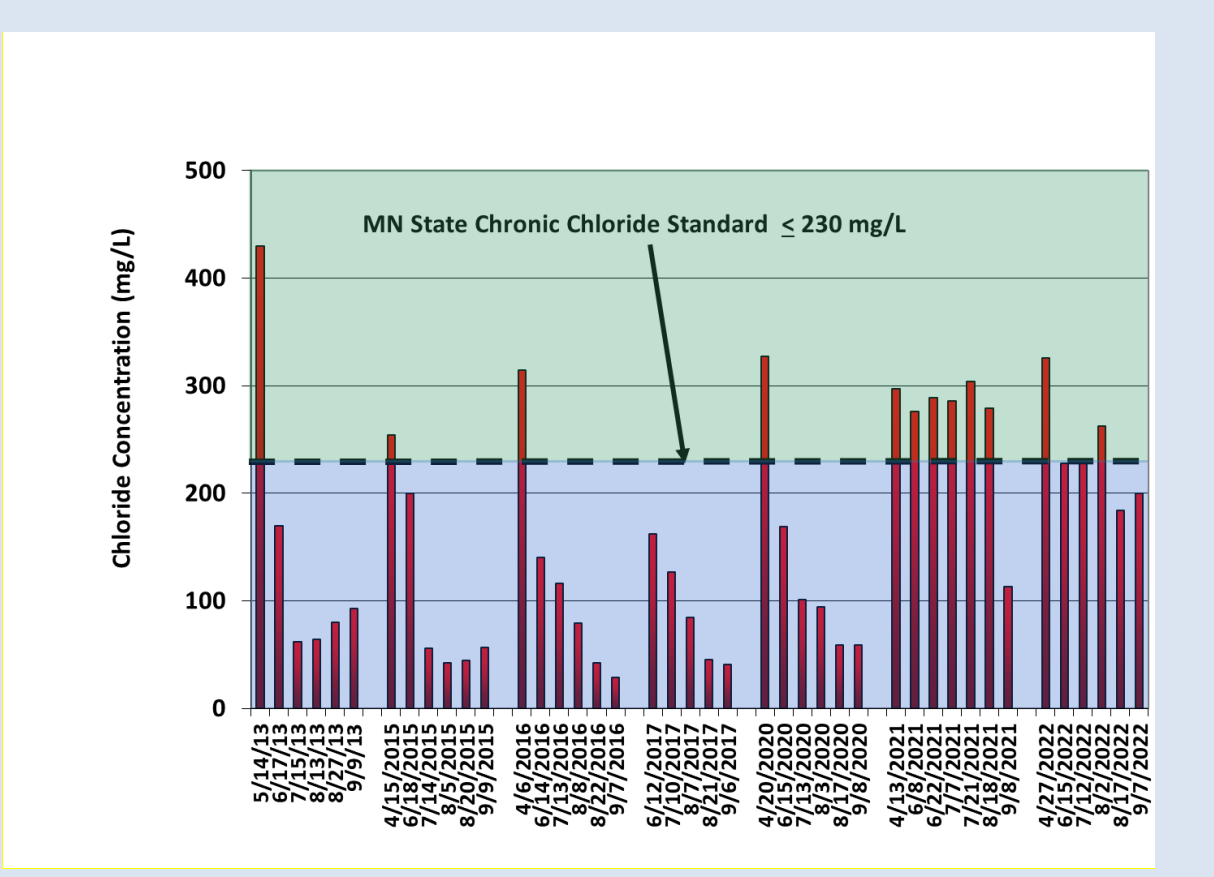


Figure 4-3 Lake Cornelia – North Basin historical chloride concentrations

4.1.1.3 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.

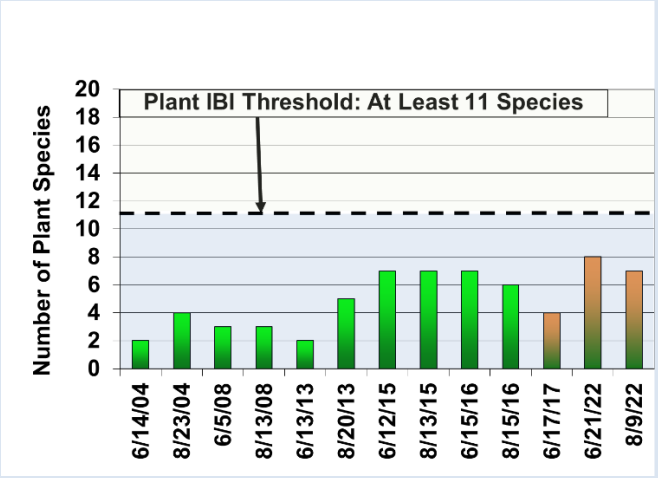


Figure 4-4.A

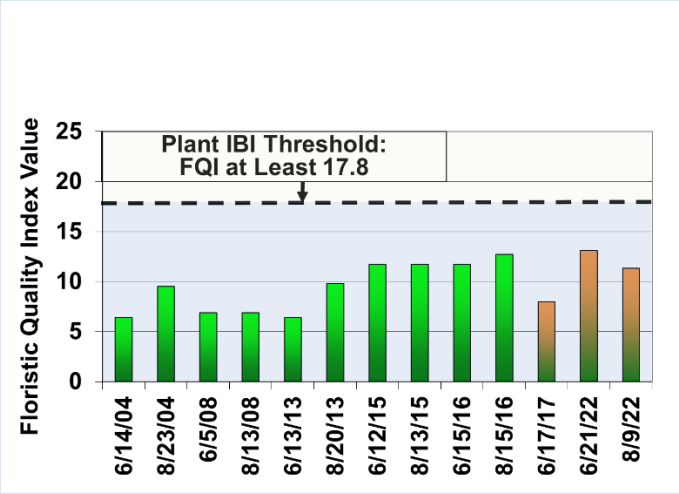


Figure 4-4.B

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 2022. Maps showing survey results are included in Appendix D. Plant survey data from 2004 through 2022 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 2022, 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 8 and failed to meet the MNDNR Plant IBI threshold during the entire period (Figure 4-4.A).

- **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 to 13, failing to meet the MNDNR Plant IBI threshold during this entire period (Figure 4-4.B).

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 2022 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 was not treated with herbicide in 2022.

Significant frequency changes in plant species between 2017 and 2022 were documented by a Chi squared analysis using point intercept plant survey data collected from the lake on June 10, 2017 by the City of Edina and on June 21, 2022 by the Nine Mile Creek Watershed District. 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 two native species significantly changed in frequency (Figure 4-6):

- Coontail (Ceratophyllum demersum) declined in frequency from 36 percent in June 2017 to 2 percent in June 2022
- Common waterweed (*Elodea canadensis*) declined in frequency from 11 percent in June 2017 to 0 percent in June 2022

Curly-leaf pondweed (*Potamogeton crispus*) significantly increased in frequency from 0 percent in June 2017 to 9 percent in June 2022 (Figure 4-6). The higher frequency in 2022 occurred because curly-leaf pondweed was not treated with herbicide in 2022. The lake was treated with herbicide prior to the June 2017 survey and curly-leaf pondweed was not observed in the post-treatment June survey. A May plant survey in 2022 documented a curly-leaf pondweed frequency of 8 percent (Figure 4-5), slightly less than the 9 percent frequency observed in June (Figure 4-6).

One native species observed in June 2017 was not observed in June 2022 (Large duckweed, *Spirodela polyrhiza*), while 3 native species not observed in June 2017 were observed in 2022 (leafy pondweed, *Potamogeton foliosus*, small pondweed, *Potamogeton pusillus*, and sago pondweed, *Stuckenia pectinata*) (Figure 4-6). However, these changes were not statistically significant.

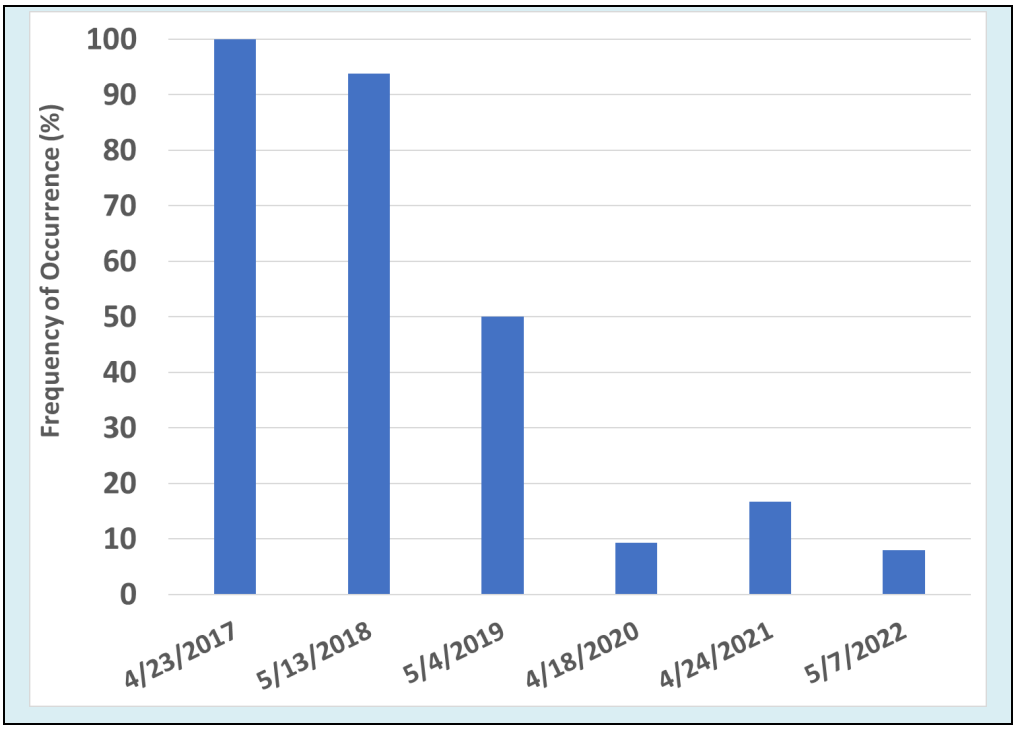


Figure 4-5 **2017-2022 Lake Cornelia-North Basin curly-leaf pondweed frequency of occurrence Data collected and provided by the City of Edina.**

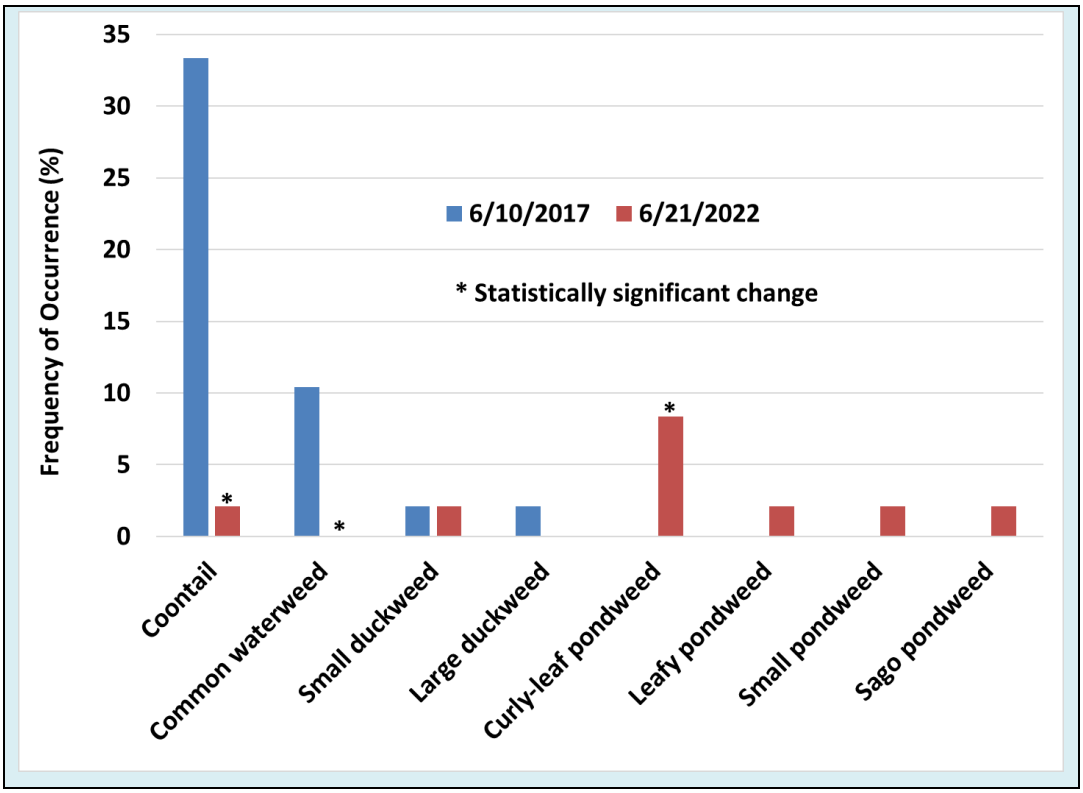


Figure 4-6 **2017-2022 Lake Cornelia-North Basin frequency of occurrence and significant change between years. 2017 data collected and provided by the City of Edina. 2022 data collected by Nine Mile Creek Watershed District.**

Four aquatic invasive species were found in Lake Cornelia – North Basin in 2022:

- **Curly-leaf pondweed (CLP) (*Potamogeton crispus*)** – CLP was collected on the rake at 4 locations (9 percent) and visually observed at an additional two locations in June (Figure 4-6). In August, CLP was collected on the rake at 3 locations (8 percent) and visually observed at an additional 4 locations (Appendix D). On a scale of 1 (low) to 3 (high), the average rake density was 1 during both June and August (Appendix D).
- **Purple loosestrife (*Lythrum salicaria*)** – Observed at one location along the western shore in June and August. The purple loosestrife plants were covered with purple loosestrife eating beetles (*Galerucella*) (Figure 4-7). 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.

Figure 4-7 Purple loosestrife plants in Lake Cornelia-North Basin covered with Galerucella beetles on August 9, 2022

- **Reed canary grass (*Phalaris arundinaceae*)** – Observed at one location along the western shore in June and August.
- **Hybrid cattail (*Typha X glauca*)** – Observed at one location in the northwest corner of the lake in June and August.

4.1.1.4 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 2022, 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 4-8 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 2022 than previous years, with the highest observed counts to date in 2021 (Figure 4-9). The increase in blue-green algae numbers during 2020 through 2022 is an unfavorable change for the lake.

In 2022, a severe blue-green algal bloom was observed in the lake during the July through September sample events (Figure 4-9). Blue-green algae numbers during this period ranged from approximately 258,000 units per milliliter in July to approximately 461,000 units per milliliter in August, well above the WHO threshold of 100,000 per milliliter for a moderate probability of adverse health effects to recreational users (Figure 4-9). 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.

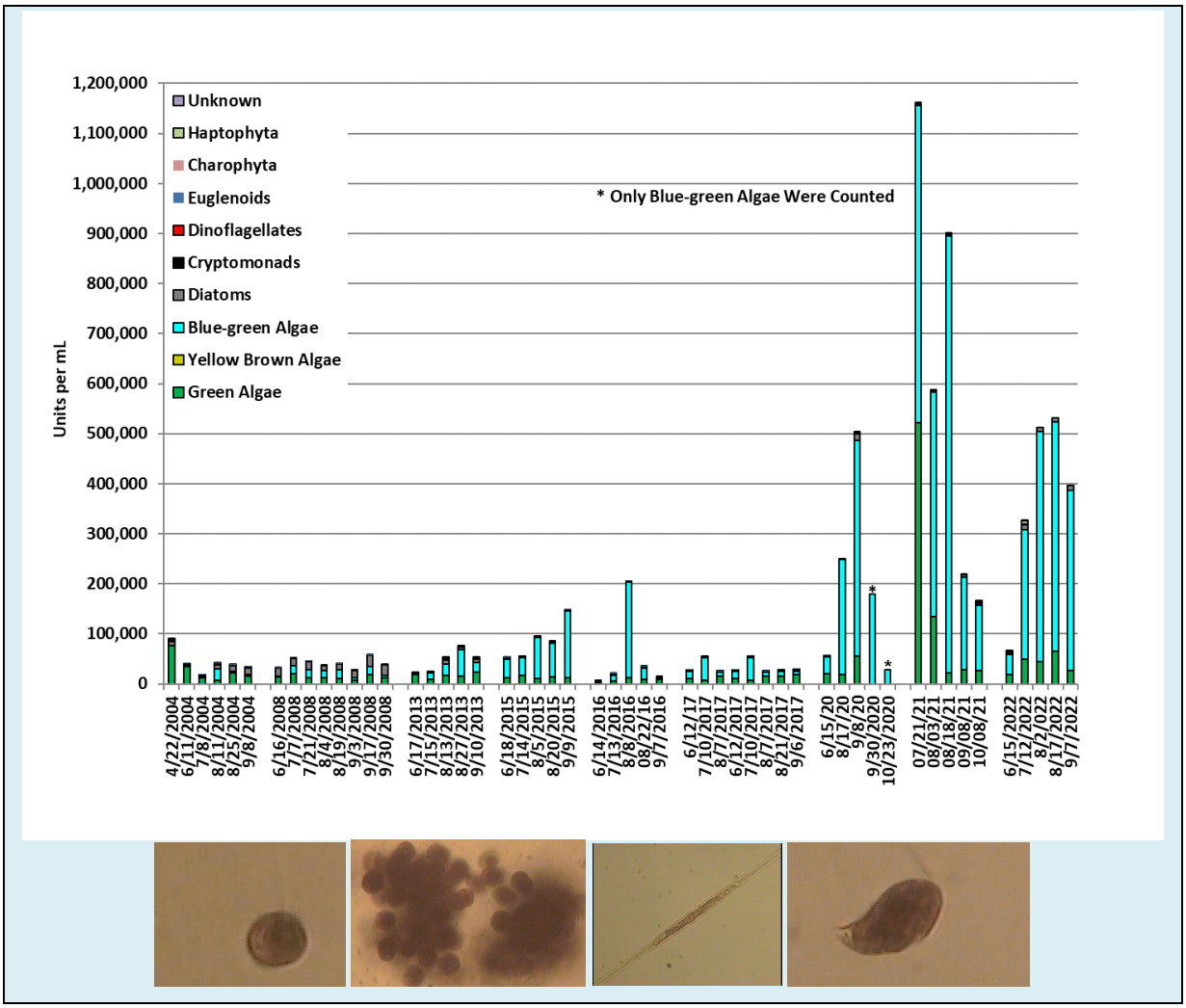


Figure 4-8 Lake Cornelia – North Basin phytoplankton

Top, Lake Cornelia – North Basin 2004, 2008, 2013, 2015, 2016, 2017, 2020, 2021, and 2022 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)

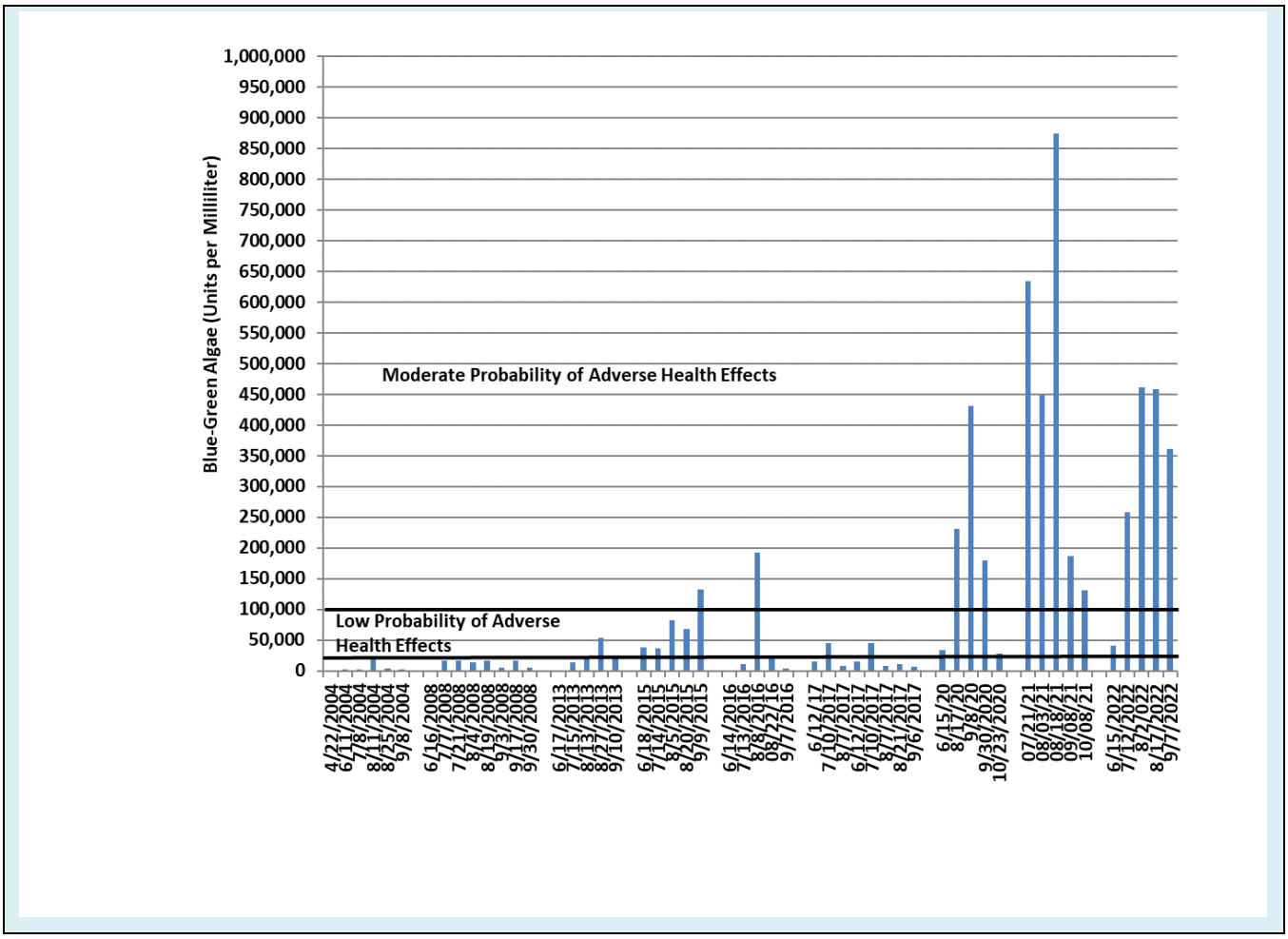


Figure 4-9 **Lake Cornelia – North Basin blue-green algae compared with World Health Organization (WHO) thresholds for adverse health effects to recreational users.**

4.1.1.5 Conclusions and Recommendations

Water quality of Lake Cornelia – North Basin was especially poor in 2022. Chloride concentrations in Lake Cornelia – North Basin exceeded the Minnesota Pollution Control Agency (MPCA) chronic criteria in the April, July, and early August measurements. The lake failed to meet State eutrophication water quality standards for shallow lakes in 2022 due to excess phosphorus and algae in the lake and poor water clarity. In 2022, a severe blue-green algal bloom was observed in the lake during the 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 failed to meet the MNDNR Plant IBI thresholds. Annual herbicide treatments by the City of Edina during 2017 through 2021 significantly reduced curly-leaf pondweed frequency. The lake was not treated with herbicide in 2022. Significant declines in the frequency of the native species coontail and common waterweed occurred during 2017 through 2022. Leafy pondweed, small pondweed and sago pondweed were not observed in the lake in 2017 but were present in 2022, while large duckweed was observed in 2017 and was not observed in 2022.

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 in the lake, which fuels algal production and decreases water clarity. The recommended management strategy to improve water quality in Lake Cornelia is 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 indicate 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.

The City of Edina annually conducted spring herbicide treatments from 2017 to 2022 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.

Other watershed practices are underway to help improve Lake Cornelia. In summer of 2021, the District completed construction of a stormwater filtration system in Rosland Park to reduce the amount of phosphorus to Lake Cornelia. The innovative upflow filtration system includes three parallel filtration chambers to evaluate the effectiveness of different filtration media in removing dissolved phosphorus.

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.

4.1.2 Lake Cornelia – South Basin

Lake Cornelia – South Basin has a water surface area of approximately 31 acres, a maximum depth of 7 feet, and a mean depth of 4.2 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).

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

In 2022, Lake Cornelia – South Basin water quality was poor. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 86 µg/L and 90 µg/L, respectively (Figure 4-10). The lake's summer average Secchi disc transparency was 0.3 meters (Figure 4-10). 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 2022 which are ≤ 60 µg/L, ≤ 20 µg/L, and ≥ 1 meter for total phosphorus, chlorophyll *a*, and Secchi disc transparency, respectively.

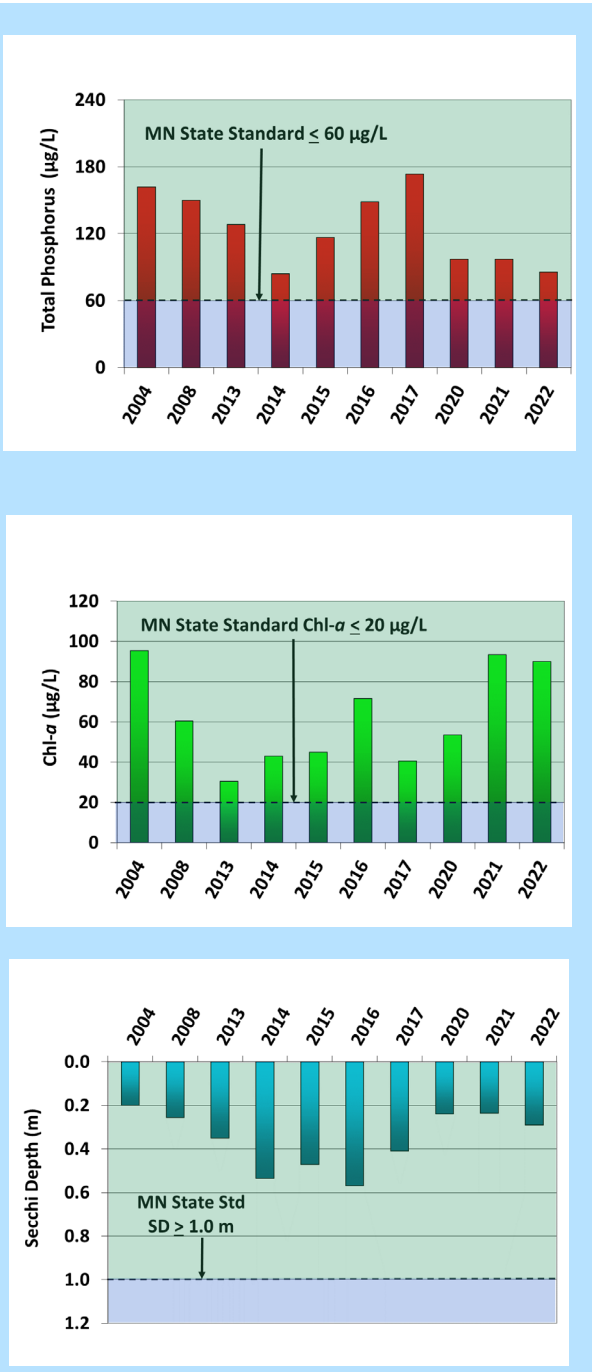


Figure 4-10 Lake Cornelia – South Basin historical summer average values
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

Water quality data were collected from Lake Cornelia – South Basin by Nine Mile Creek Watershed District (NMCWD) during 2004, 2008, 2013, 2015, 2016, 2017, 2020, 2021, and 2022 and by the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) during 2013, 2014, and 2015. The poor water quality observed in 2022 was typical of the water quality observed in previous years. All summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency values failed to meet the State eutrophication water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion (Figure 4-10). Summer average total phosphorus concentrations have been lower following the spring 2020 alum treatment. The

lake's 2022 summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency were within the range observed in previous years (Figure 4-10).

4.1.2.2 Chlorides

Chloride concentrations were measured in 2013, 2015, 2016, 2017, 2020, 2021, and 2022 generally between April and September. The observed chloride concentrations from 2013 to 2022 are summarized in Figure 4-11. 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 2022 measurements were below the acute criterion; concentrations from four sampling events, June 15, 2022, July 12, 2022, August 2, 2022, and August 17, 2022, exceeded the chronic criterion. The 2022 annual average chloride concentration (240 mg/L) was the highest to date. The higher than usual chloride concentrations in the summer of 2022 were likely due to the dry climatic conditions and resulting lack of flushing. 2022 data are summarized in Appendix A.

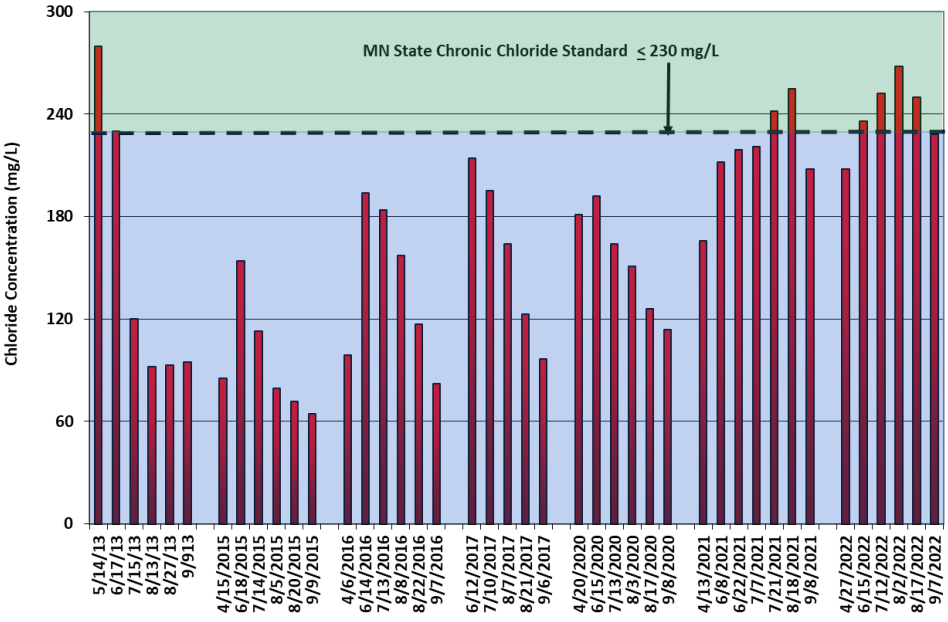


Figure 4-11 Lake Cornelia – South Basin historical chloride concentrations

4.1.2.3 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.

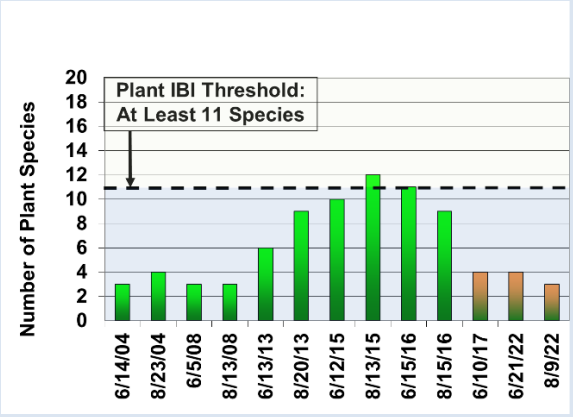


Figure 4-12.A

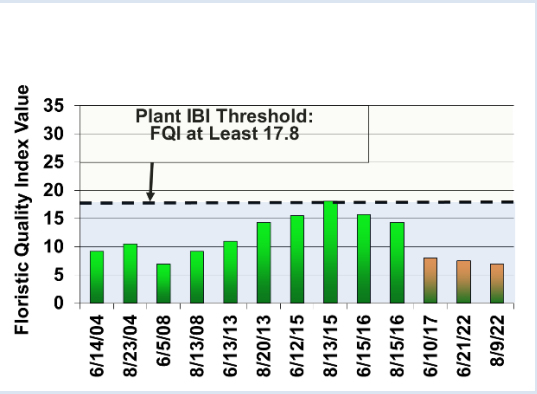


Figure 4-12.B

Figure 4-12 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 2022. Maps showing survey results are included in Appendix D. Plant survey data from 2004 through 2022 were assessed to track changes in plant IBI scores. Figure 4-12 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 2022 (Figure 4-12).

- **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 – South Basin ranged from 3 to 12, bettering 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 2022 four species were found in June and three 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. During the period examined, FQI values in Lake Cornelia – South Basin ranged from 6 to 18, bettering 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 in 2022 – 8 in June and 7 in August.

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 2022 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 4-13). The 2022 herbicide treatment reduced CLP frequency to 1 percent in June which was the same post-treatment frequency observed in June 2017 (Figure 4-14).

The native plant community was assessed to document changes in the plant community during the 2017 to 2022 treatment period. Significant frequency changes in plant species occurring between 2017 and 2022 were documented by a Chi squared analysis of June 10, 2017 collected by the City of Edina and June 21, 2022 data collected by the Nine Mile Creek Watershed District. Only species collected on the rake were included in the Chi squared analysis. Species visually observed but not collected on the rake were excluded from the analysis. One native species, common waterweed (*Elodea canadensis*), significantly increased in frequency from 1 percent in June 2017 to 18 percent in June 2022 (Figure 4-14). Filamentous algae and two native species (small duckweed, *Lemna minor*, and large duckweed, *Spirodela polyrhiza*) observed in June 2017 were not observed in June 2022. However, these changes were not statistically significant (Figure 4-14).

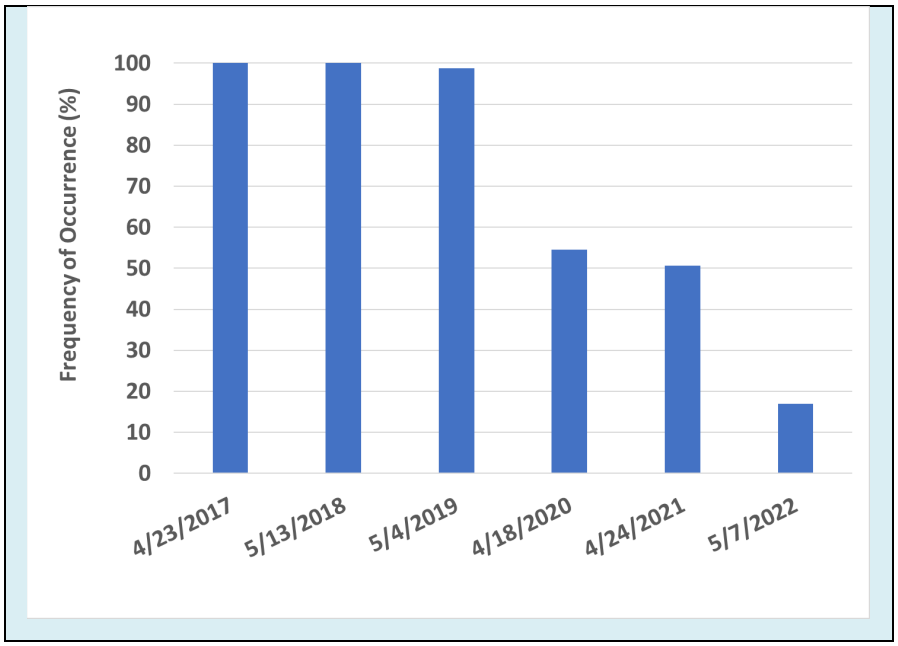


Figure 4-13 2017-2022 Lake Cornelia-South Basin Curly-leaf Pondweed Frequency of Occurrence. Data collected and provided by the City of Edina.

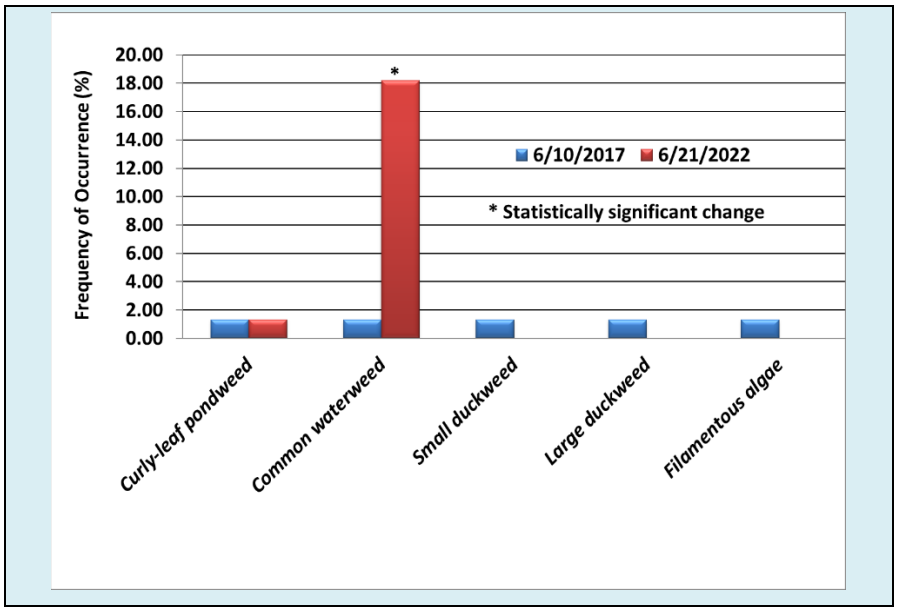


Figure 4-14 2017-2022 Lake Cornelia-South Basin frequency of occurrence and significant change between years. 2017 data collected and provided by the City of Edina. 2022 data collected by the Nine Mile Creek Watershed

One aquatic invasive species was found in Lake Cornelia – South Basin in 2022:

- **Curly-leaf pondweed (CLP) (*Potamogeton crispus*)** – CLP was collected on the rake at 1 location (1 percent) in June (Figure 4-14) and was not observed in August (Appendix D). On a scale of 1 (low) to 3 (high), the rake density at the single location CLP was collected in June was 1.

4.1.2.4 Phytoplankton

In 2022, the District monitored the phytoplankton community in June, July, August (twice), and September. Results of the 2022 identification and enumeration of the phytoplankton species can be found in Appendix B.

Figure 4-15 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 (Figure 4-16). The increase in blue-green algae numbers over time is an unfavorable change for the lake.

In 2022, a severe blue-green algal bloom was observed in the lake during the July through September sample events (Figure 4-16). Blue-green algae numbers during this period ranged from approximately 147,000 units per milliliter to 469,000 units per milliliter, well above the WHO threshold of 100,000 per milliliter for a moderate probability of adverse health effects to recreational users (Figure 4-16). 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.

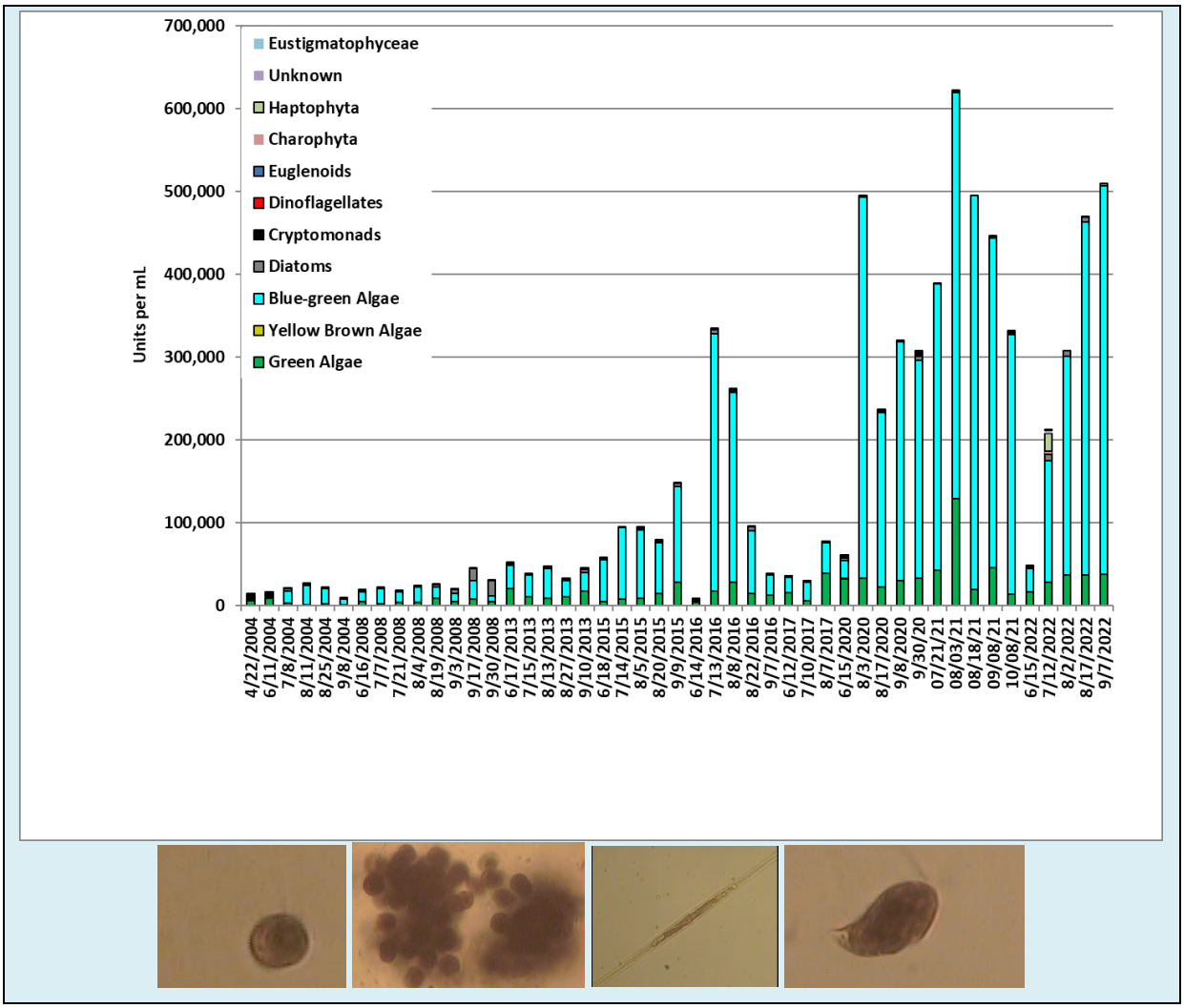


Figure 4-15 Lake Cornelia – South Basin phytoplankton

Top, Lake Cornelia – South Basin 2004, 2008, 2013, 2015, 2016, 2017, 2020, 2021, and 2022 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)

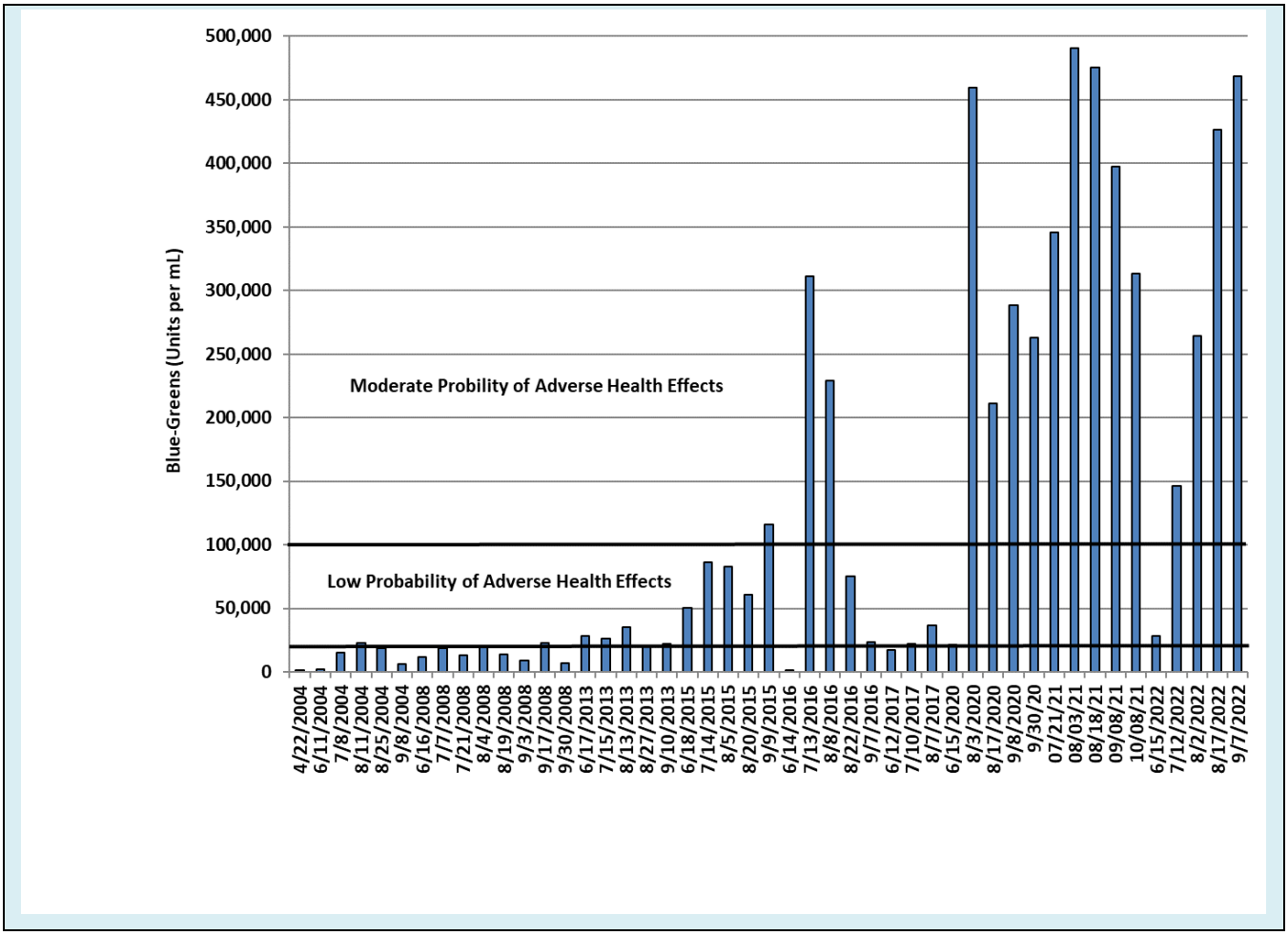


Figure 4-16 Lake Cornelia – South Basin blue-green algae compared with World Health Organization (WHO) thresholds for adverse health effects to recreational users.

4.1.2.5 Conclusions and Recommendations

Water quality of Lake Cornelia – South Basin was especially poor in 2022. Chloride concentrations in Lake Cornelia – South Basin exceeded the MPCA chronic criterion during June through August; the 2022 annual average chloride concentration was the highest to date. The lake failed to meet State eutrophication water quality standards for shallow lakes in 2022 due to excess phosphorus and algae in the lake and poor water clarity. A severe blue-green algal bloom was 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 failed to meet the MNDNR Plant IBI thresholds in 2022. The City of Edina annually conducted spring herbicide treatments in Lake Cornelia – South Basin from 2017 to 2022, which successfully reduced the presence of curly-leaf pondweed.

However, the health of the native plant population has declined, with the number and quality of plant species observed in 2022 lower than observations prior to the curly-leaf infestation and subsequent treatments.

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 Normandale Lake

Normandale Lake (Figure 5-1 and Figure 5-2) 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. 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 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. This summer addition of phosphorus can fuel algal growth and degrade 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 2022, 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.

In 2022, 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*, chloride, and turbidity.
- Water field measurements- dissolved oxygen, pH, temperature, specific conductance, 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 5-1 Normandale Lake on July 6, 2022

Figure 5-2 Normandale Lake on August 11, 2022 (Photo Credit: Endangered Resource Services, LLC)

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

Figure 5-3 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 2022, the lake's summer average total phosphorus and chlorophyll *a* concentrations of 31 µg/L and 5 µg/L respectively, and the lake's summer average Secchi disc transparency (water clarity) of 2.3 meters Figure 5-3met 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.

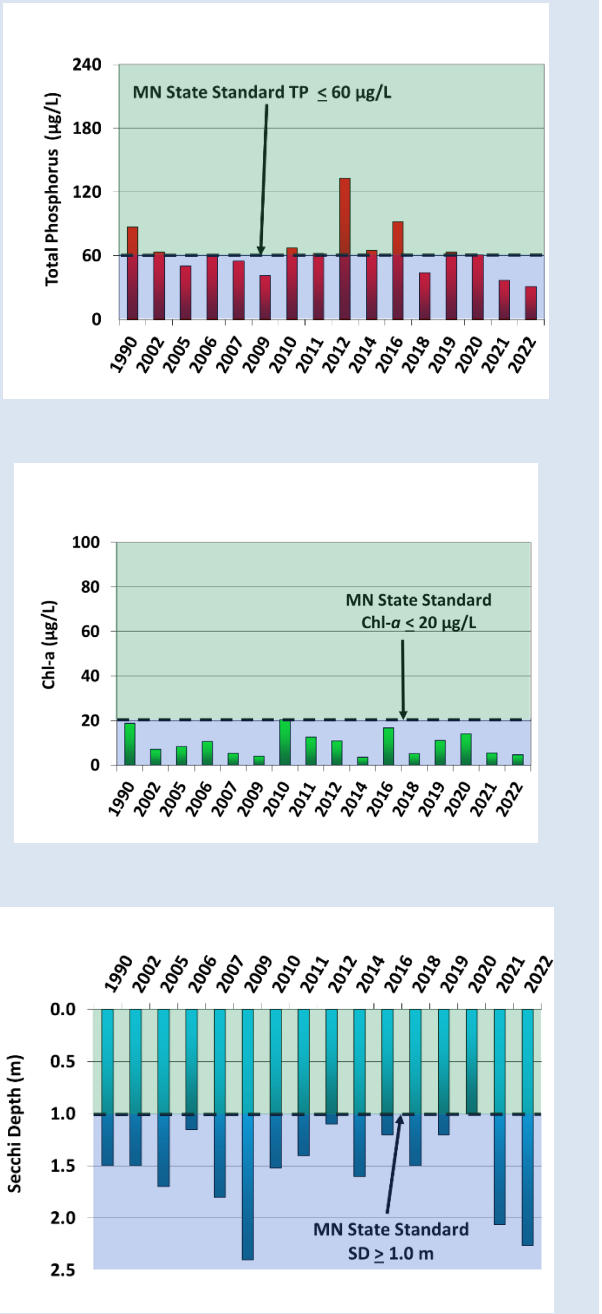


Figure 5-3 Normandale Lake historical summer average values.
total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom)

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, and 2022, 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. Data from these sources has generally been included in computation of the historic summer average values shown in Figure 5-3 when sampling was conducted at a location consistent with the District's routine monitoring location.

Comparison of the 2022 data with historical monitoring results indicates the 2022 summer average total phosphorus concentration in Normandale Lake was the lowest on record (Figure 5-3). The 2022 summer average chlorophyll *a* concentration and Secchi disc depth were within the range of historical data (Figure 5-3). 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 31 µg/L to 133 µg/L during the monitored period and have failed to meet the Minnesota State water quality standard 63 percent of monitored years.

In 2020 through 2022, 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 significant phosphorus loading to the lake. 2020 through 2022 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 5-4, comparison of the phosphorus concentrations collected by the District demonstrates that the lake removes phosphorus, likely through settling and uptake of nutrients by aquatic plants. Normandale Lake and the 2020-2022 District monitoring locations are shown in Figure 5-5.

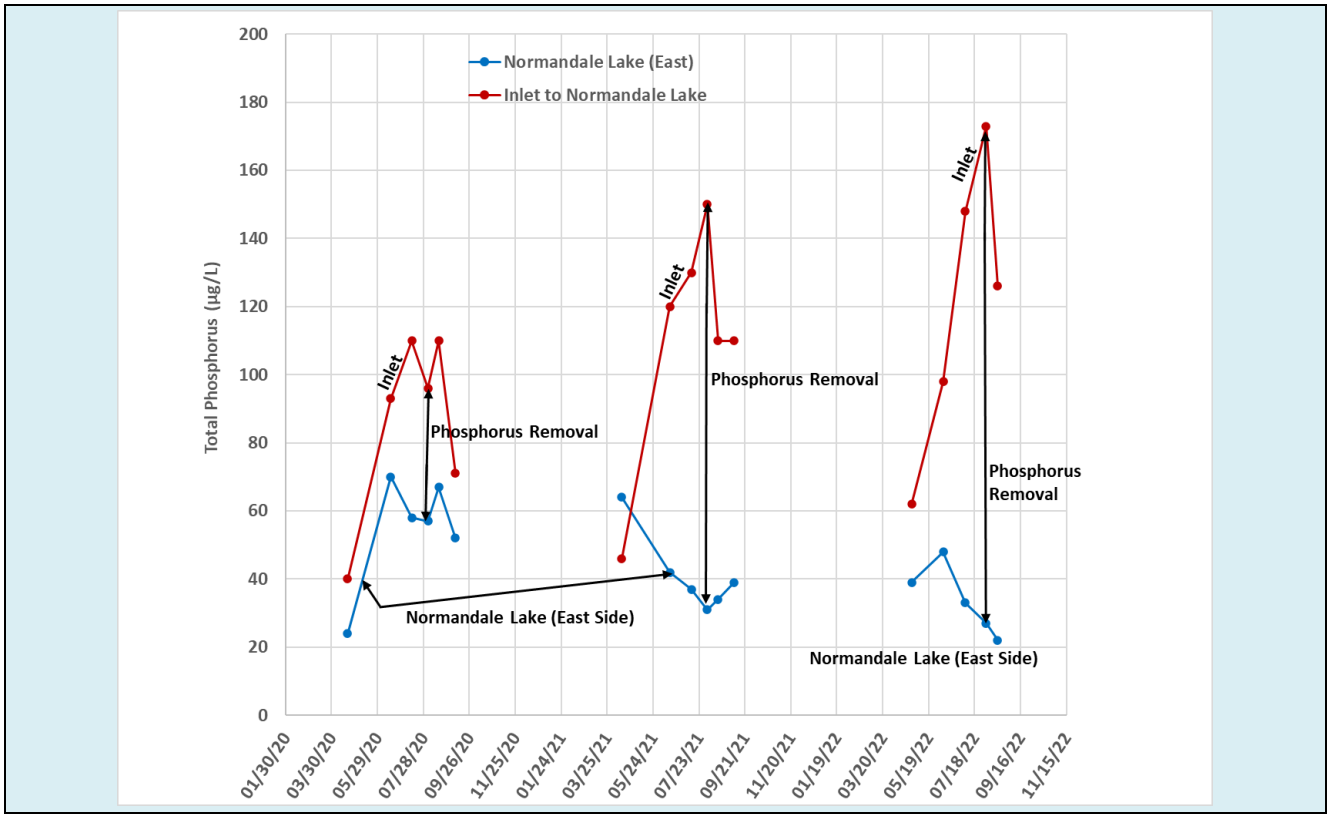


Figure 5-4 2020-2022 Normandale Lake total phosphorus concentrations measured at the lake inlet and on the east side at the deepest portion of the lake near the outlet (District's routine monitoring location)

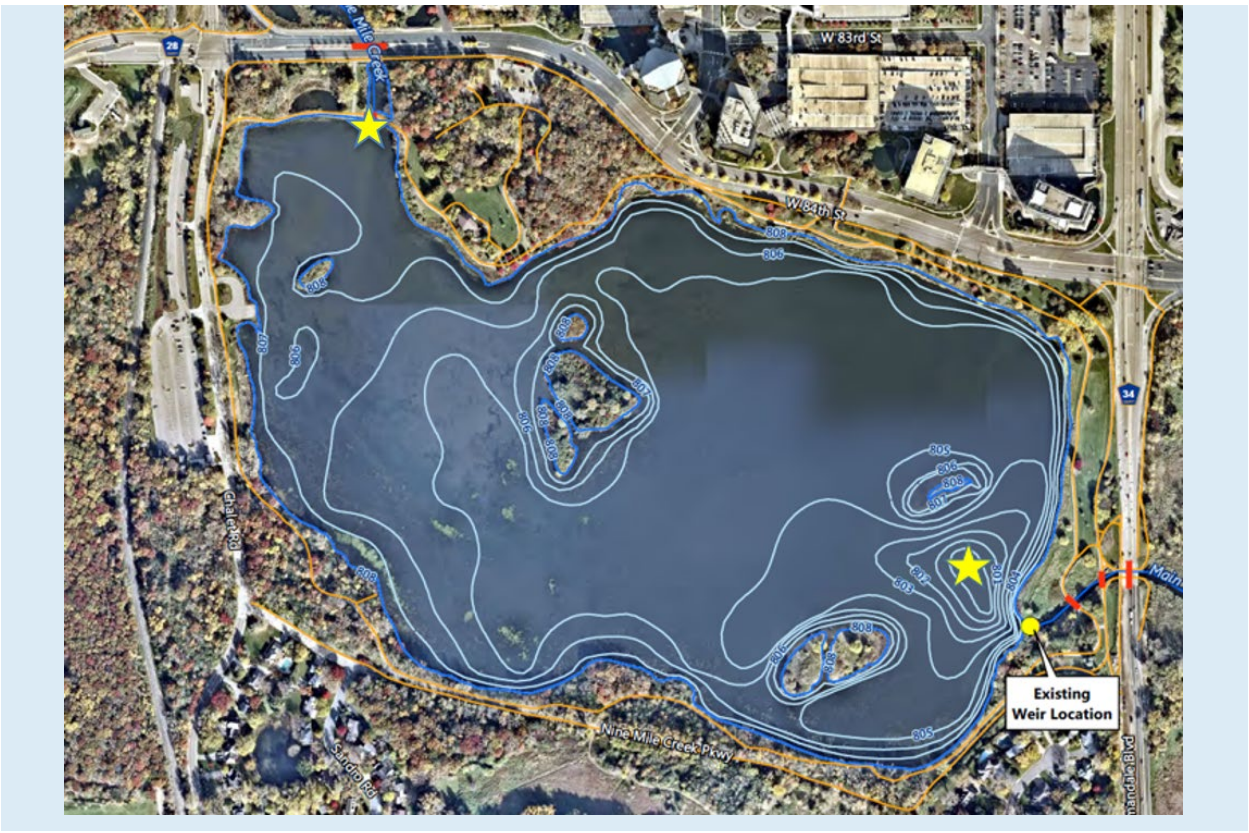


Figure 5-5 **Normandale Lake 2020-2022 District sample locations: on the east side at the deepest portion of the lake near the outlet (the District's routine monitoring location) and at the inlet of Nine Mile Creek on the northwest side of the lake.**

5.2 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 nitrogen is the "limiting nutrient" at times, phosphorus and nitrogen are colimiting at times, and phosphorus is the "limiting nutrient" at times. 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.

5.3 Chlorides

Chloride concentrations were measured during April/May through September in 2010, 2014, 2016, 2018, 2019, 2020, 2021, and 2022. Figure 5-6 summarizes the observed chloride concentrations from 2010 through 2022. 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. Chloride concentrations observed during April of 2014, April 2016, May and June 2018, April and June of 2021, and July and early August of 2022 were above the MPCA chronic chloride criteria. All measurements during 2010 through 2022 were below the acute MPCA criterion. 2022 chloride data are summarized in Appendix A.

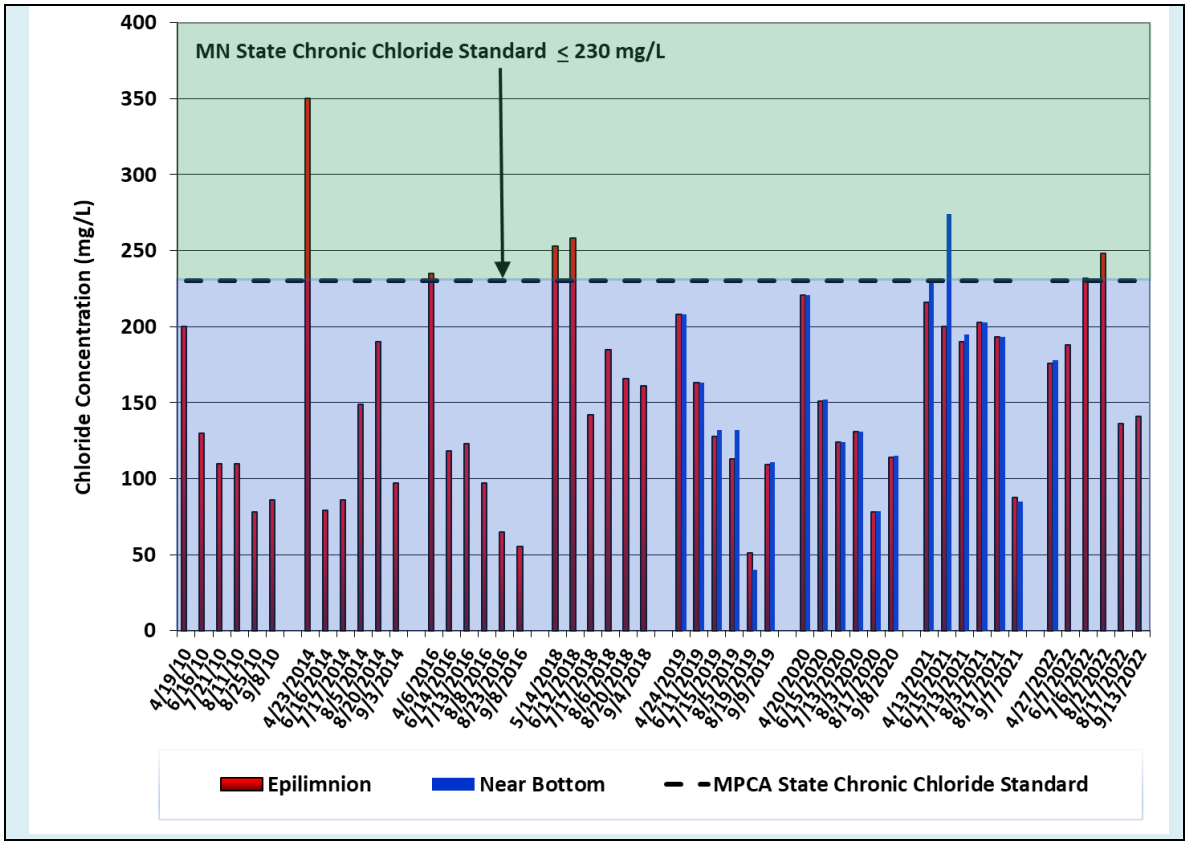


Figure 5-6 Normandale Lake historical chloride concentrations

5.4 Phytoplankton

In 2022, the District monitored phytoplankton, microscopic aquatic plants, in Normandale Lake as part of its routine monitoring program. Results of the 2022 identification and enumeration of the phytoplankton species can be found in Appendix B.

Figure 5-8 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.

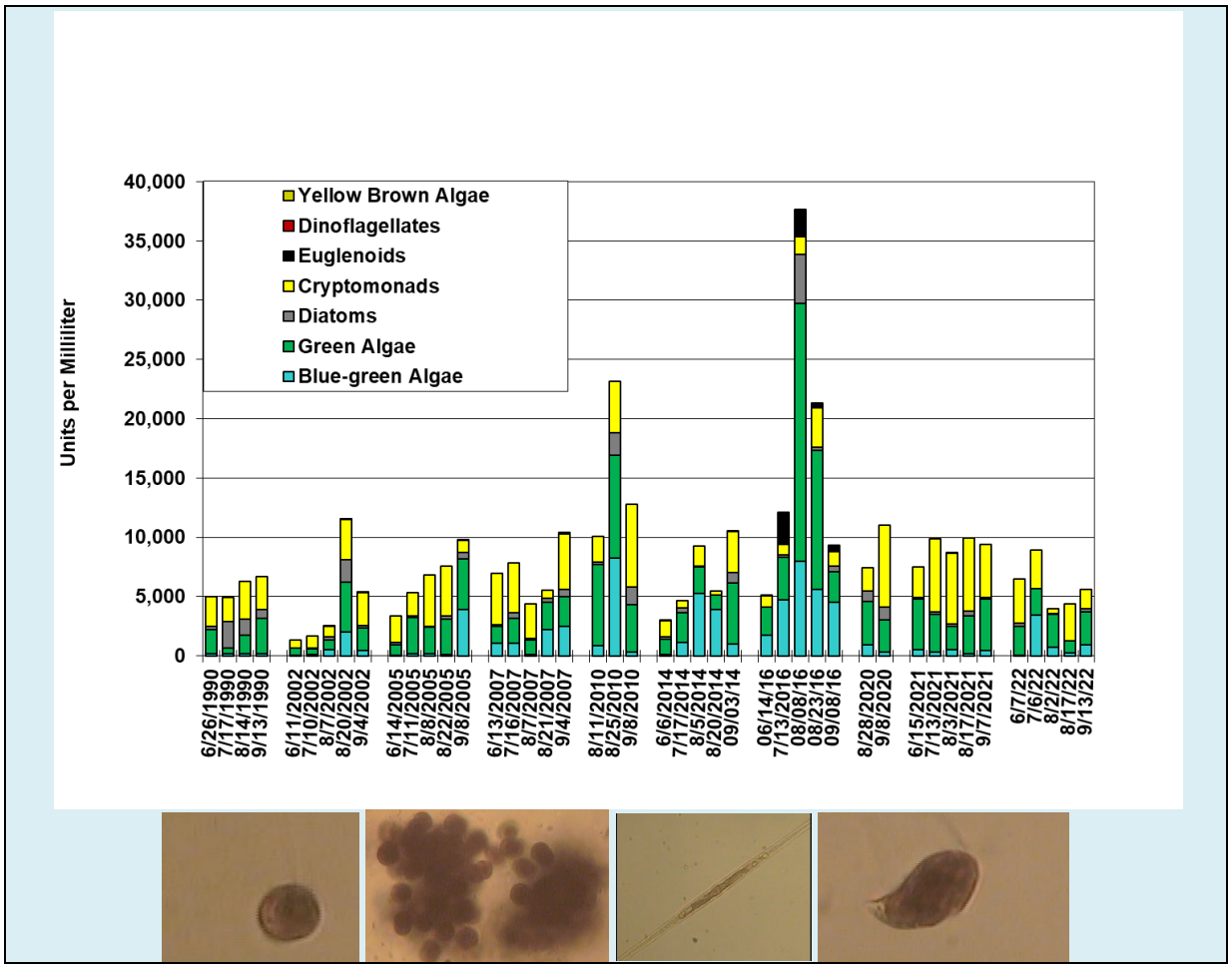


Figure 5-7 Normandale Lake historic summer phytoplankton communities.

Top, Normandale Lake 1990, 2002, 2005, 2007, 2010, 2014, 2016, 2020, 2021, and 2022 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 5-8 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.

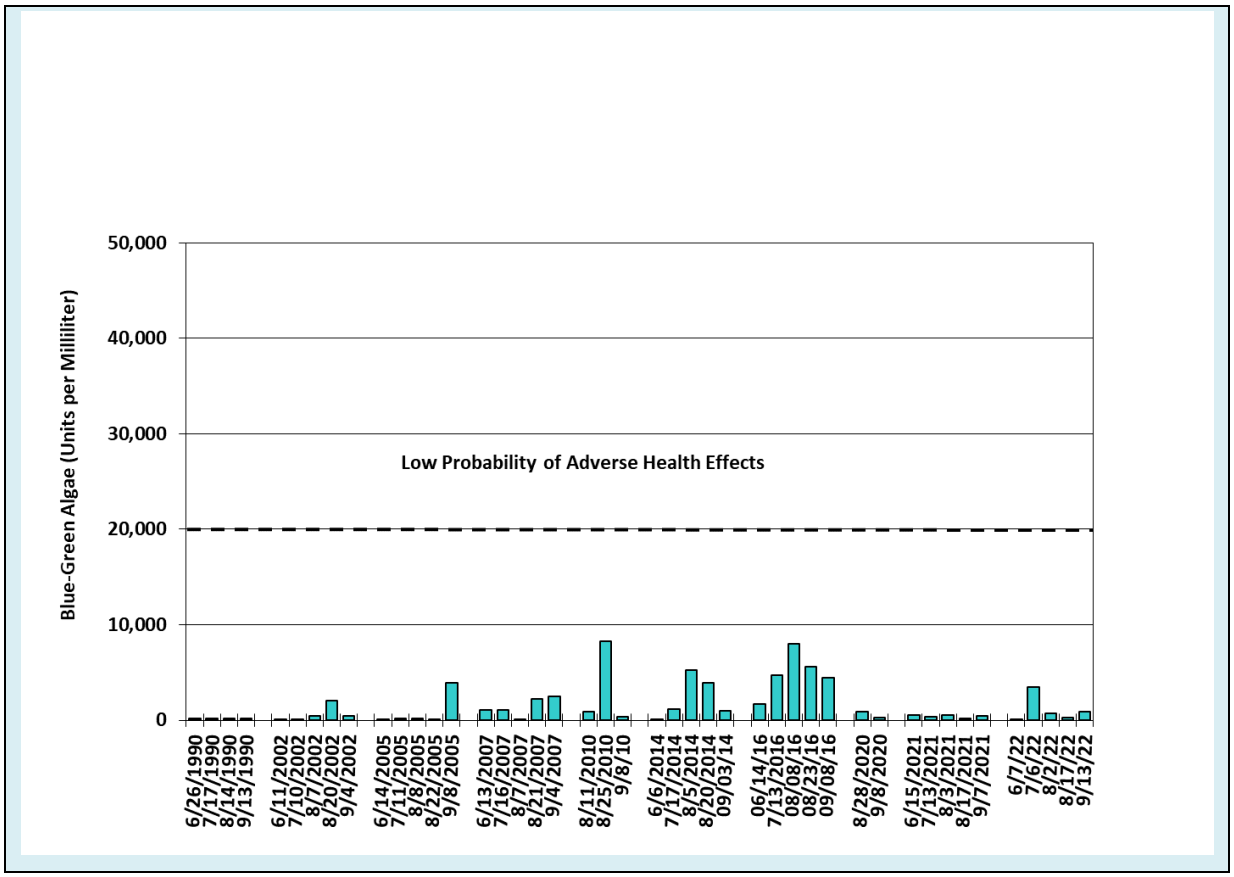


Figure 5-8 Normandale Lake blue-green algae numbers compared with World Health Organization (WHO) thresholds for adverse health effects to recreational users.

5.5 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, these 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 of algae. 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 5-9 summarizes the frequency of filamentous algae in Normandale Lake during plant surveys completed in June and August of years 2016 through 2022. Filamentous algae frequency of occurrence at sampling points has ranged from a low of 9 percent on August 27, 2016 to a high of 74 percent on June 22, 2022. In 2022, filamentous algae frequency of occurrence at sample points ranged from 45 percent in August to 74 percent in June, which was the highest frequency observed during 2016 through 2022.

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. Because the lake generally has adequate nutrients and light for the growth of these algae, the lake can support their growth 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 68º F). The end of their growing season occurs when light, nutrient, or temperature conditions become unfavorable for growth of filamentous algae. The most effective long-term management option for filamentous algae is nutrient reduction.

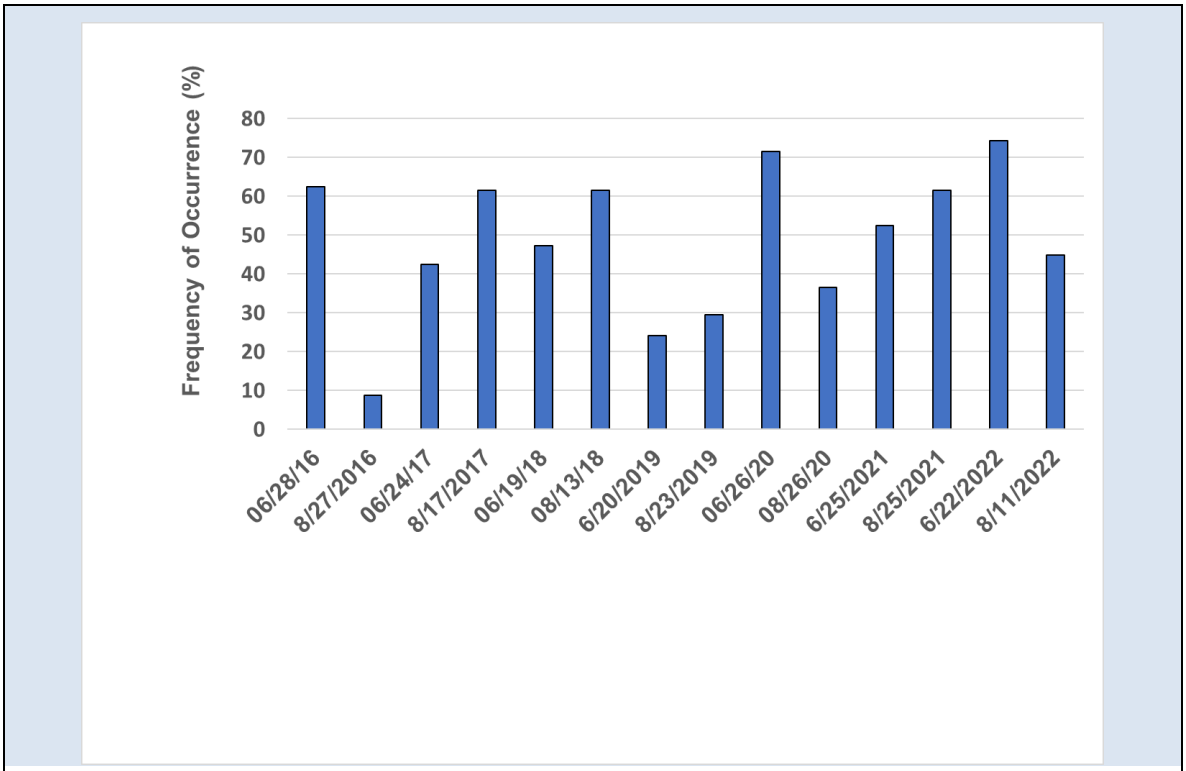


Figure 5-9 Normandale Lake filamentous algae frequency of occurrence

2016- 2022 Normandale Lake filamentous algae frequency of occurrence at the 125 sample locations throughout Normandale Lake

5.6 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.

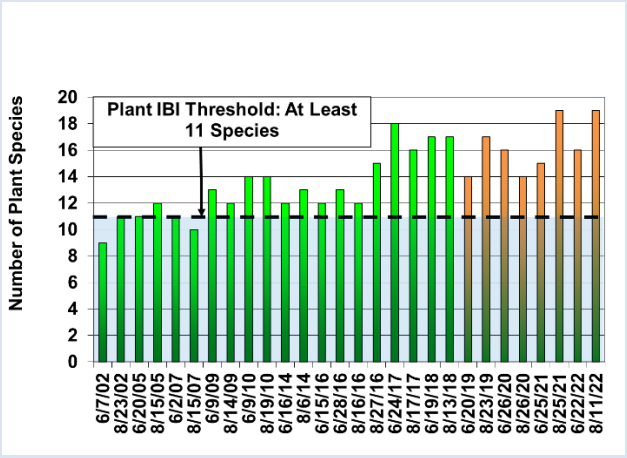


Figure 5-10.A

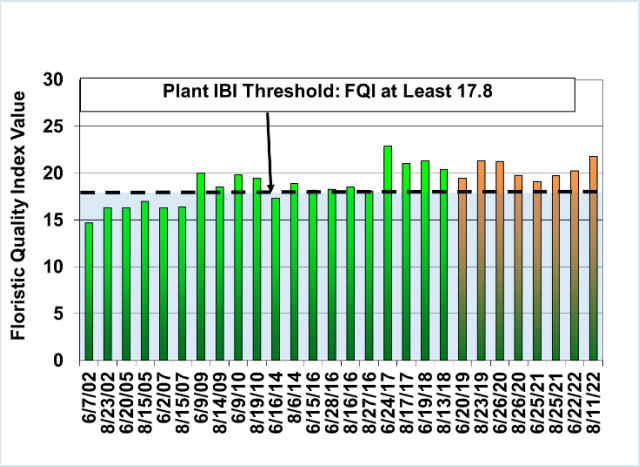


Figure 5-10.B

Figure 5-10 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)

The District conducted point-intercept and biomass aquatic plant surveys of Normandale Lake in June and August of 2022. Results are included in Appendix E. Plant survey data from 2002 through 2022 were assessed to track changes in plant IBI scores. Figure 5-10 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 2022). In 2022, 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 2021 and 2022.

- **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 19. 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 than in previous years and the highest number to date was observed in August of 2021 and 2022 (Figure 5-10.A).

- **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 5-10.B).

5.6.1 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 water quality improvement project (drawdown occurred in winter of 2018-2019). 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 2022 (Figure 5-11). The observed frequencies of curly-leaf pondweed in June and August 2022 were within the range of frequencies observed in 2019 through 2021.

Plant survey data indicate an overall reduction in biomass of curly-leaf pondweed in the lake since implementation of the water quality improvement project (drawdown occurred in winter of 2018-2019). 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 2022 (Figure 5-12). The biomass of curly-leaf pondweed, measured as wet weight, was higher in June 2022 than June 2019 through 2021.

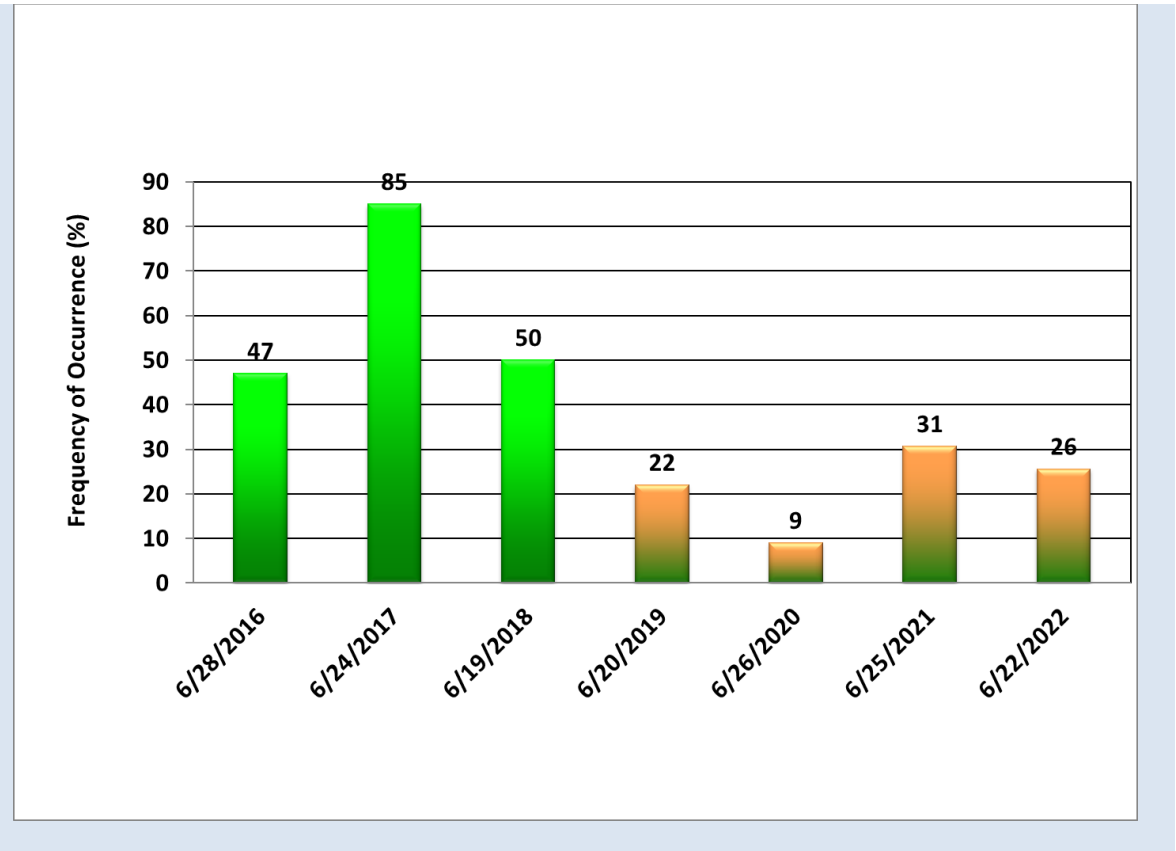


Figure 5-11 **2016-2022 comparison of Normandale Lake curly-leaf pondweed frequency of occurrence in June prior to and after initiation of the water quality improvement project. Note: green bars indicate values prior to water quality improvement project and orange bars indicate values during water quality improvement project (i.e., after drawdown and/or during years in which curly-leaf pondweed was treated with herbicide).**

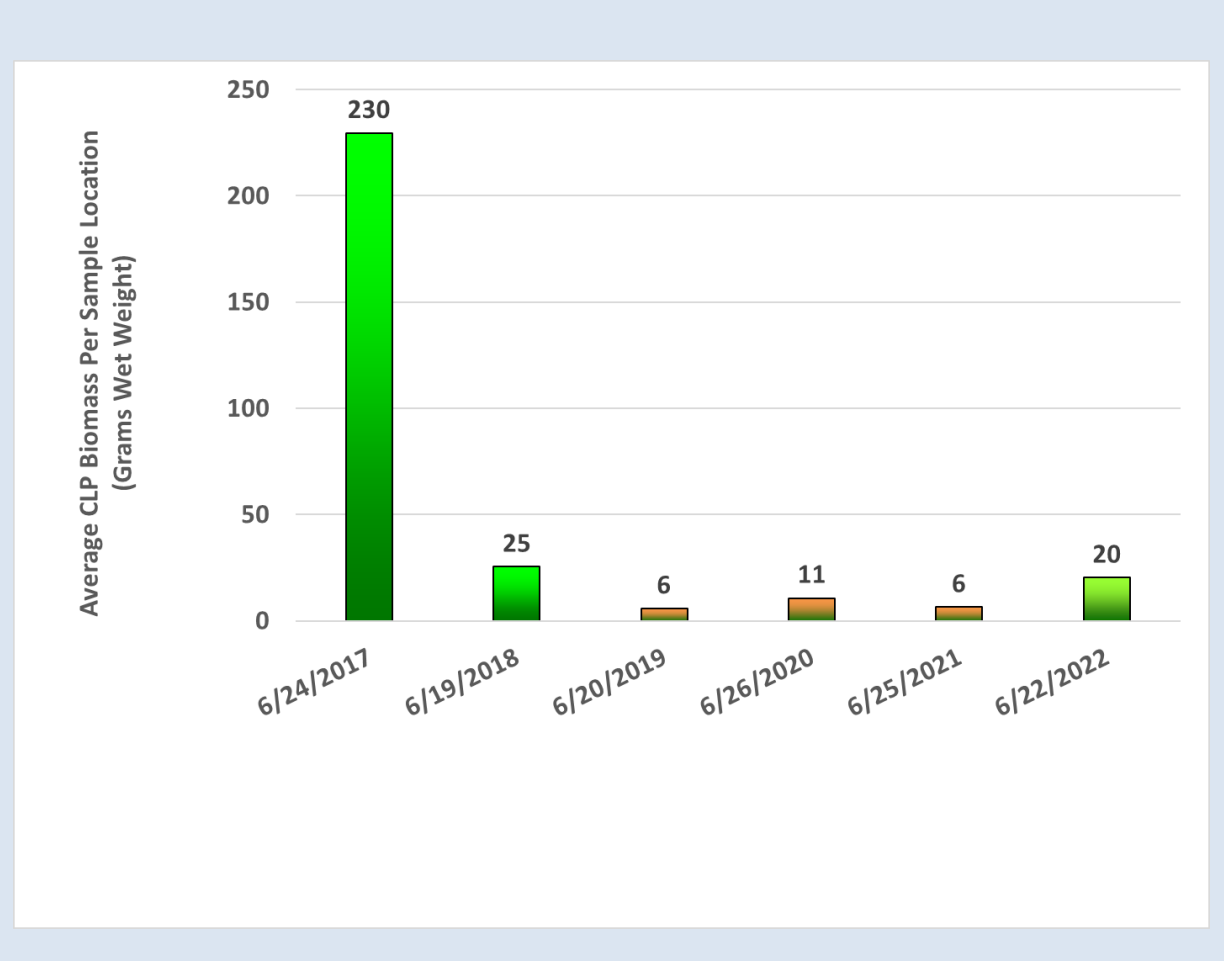


Figure 5-12 **2017-2022 comparison of Normandale Lake curly-leaf pondweed biomass (average wet weight per sample location) in June prior to and after initiation of the water quality improvement project. Note: green bars indicate values prior to water quality improvement project and orange bars indicate values during water quality improvement project (i.e., after drawdown and/or during years in which curly-leaf pondweed was treated with herbicide).**

5.6.2 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 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 2022 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 1,291 grams per sample point compared with a total post-project biomass range of 697 to 897 grams per sample point (Figure 5-13). All post-project total biomass values, measured as wet weight, were lower, on average, than total pre-project biomass values except for the value measured on August 26, 2020 (897 grams). 2022 total biomass values, on average, ranged from 778 to 798 grams per sample point.

The data in Figure 5-13 also show the dominant species throughout the period of record. In 2022, 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.

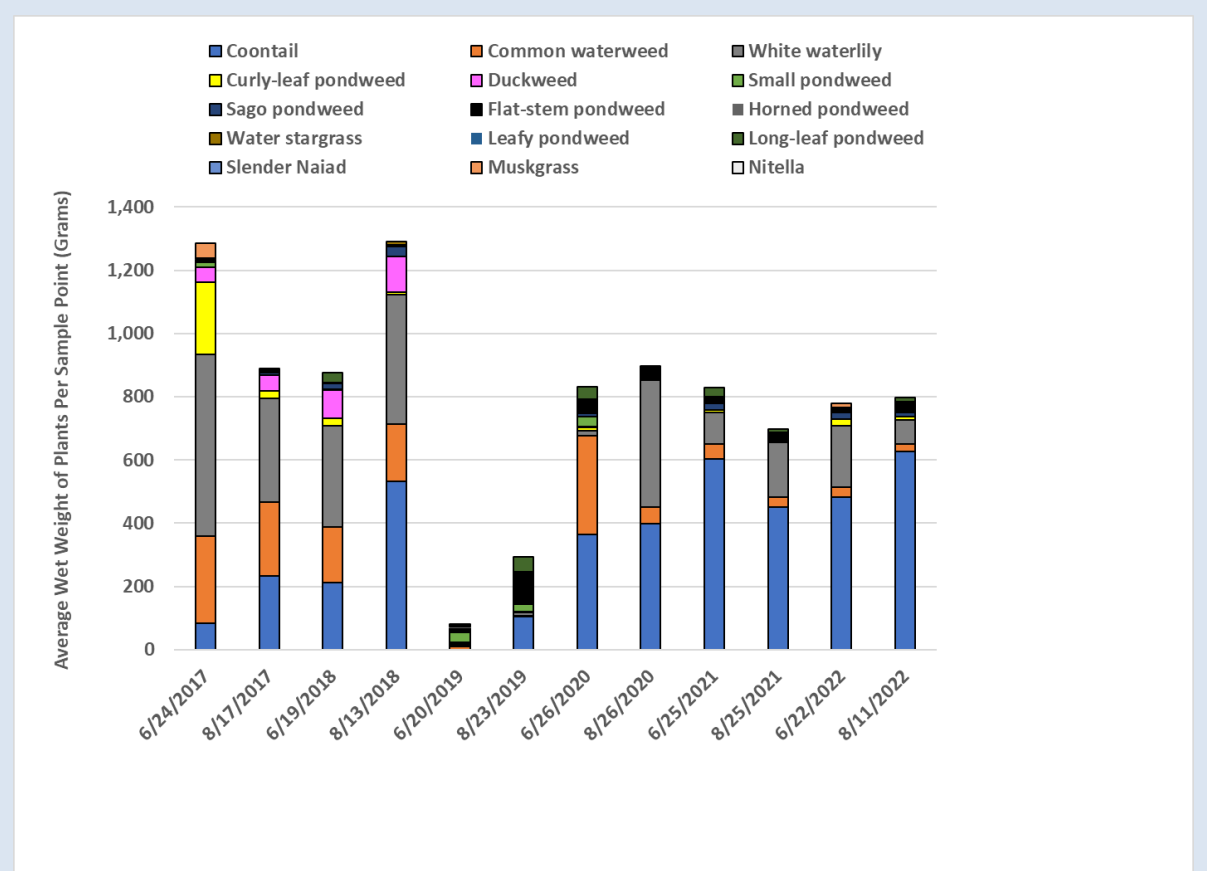


Figure 5-13 2017-2022 comparison of Normandale Lake plant biomass, measured as average wet weight of plants per sample point. The stacked bar graph above shows individual species wet weights (average per sample point) and the collective total of all species' average wet weights per sample point for each sample event.

The frequency of occurrence of individual species in the plant community was measured in Normandale Lake during 2016 through 2022 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 5-14 compares the frequencies of the ten most commonly occurring species in 2022 with frequencies observed before the water quality improvement project. The two most frequently occurring species prior to the drawdown, coontail and common waterweed, were also the two 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 and 2022, nearly attaining pre-drawdown frequency by August 2022. CLP frequency decreased after the drawdown and has remained below pre-drawdown frequencies.

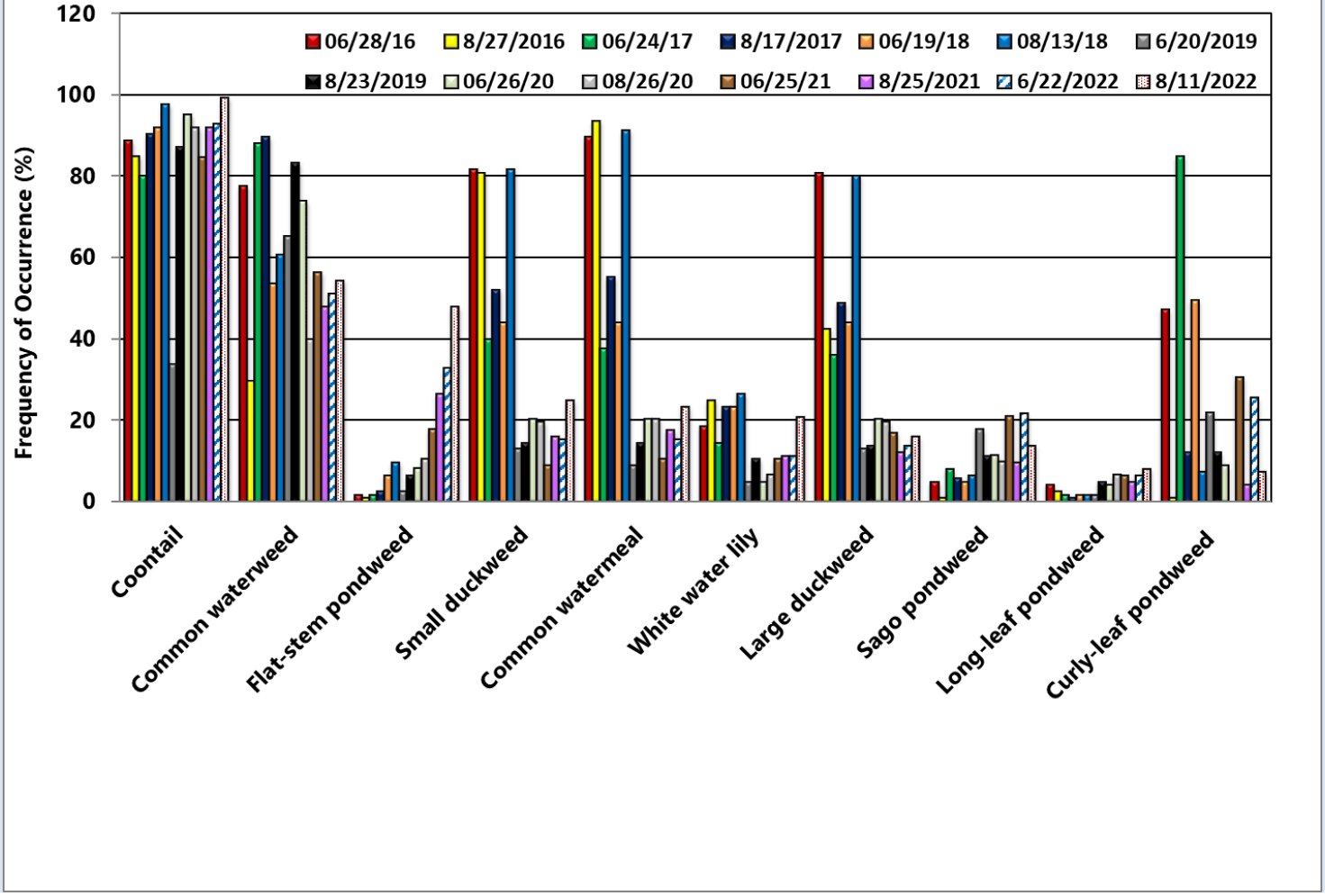


Figure 5-14 **2016-2022 comparison of Normandale Lake frequency of occurrence of individual species. Above graph shows the 2016-2022 frequency of occurrence of the ten individual species occurring most frequently in Normandale Lake in 2022**

5.6.3 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 5-15). 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 2022 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 2022, a moderately significant decrease occurred in the number of curly-leaf pondweed turions and in the locations where turions were found. The decreases indicate the success of the 2020 through 2022 herbicide treatment programs to 1) reduce curly-leaf pondweed levels in the lake, 2) prevent curly-leaf pondweed plants from producing turions, and 3) exhaust the turion supply in the sediment. In 2022, 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 5-16). A total of 7 live turions were collected from all 50 sample points in 2022 compared with 21 to 36 live turions during 2019 through 2021 (Figure 5-17).

Figure 5-15 A germinating curly-leaf pondweed turion (Photo Credit: Endangered Resource Services, LLC)

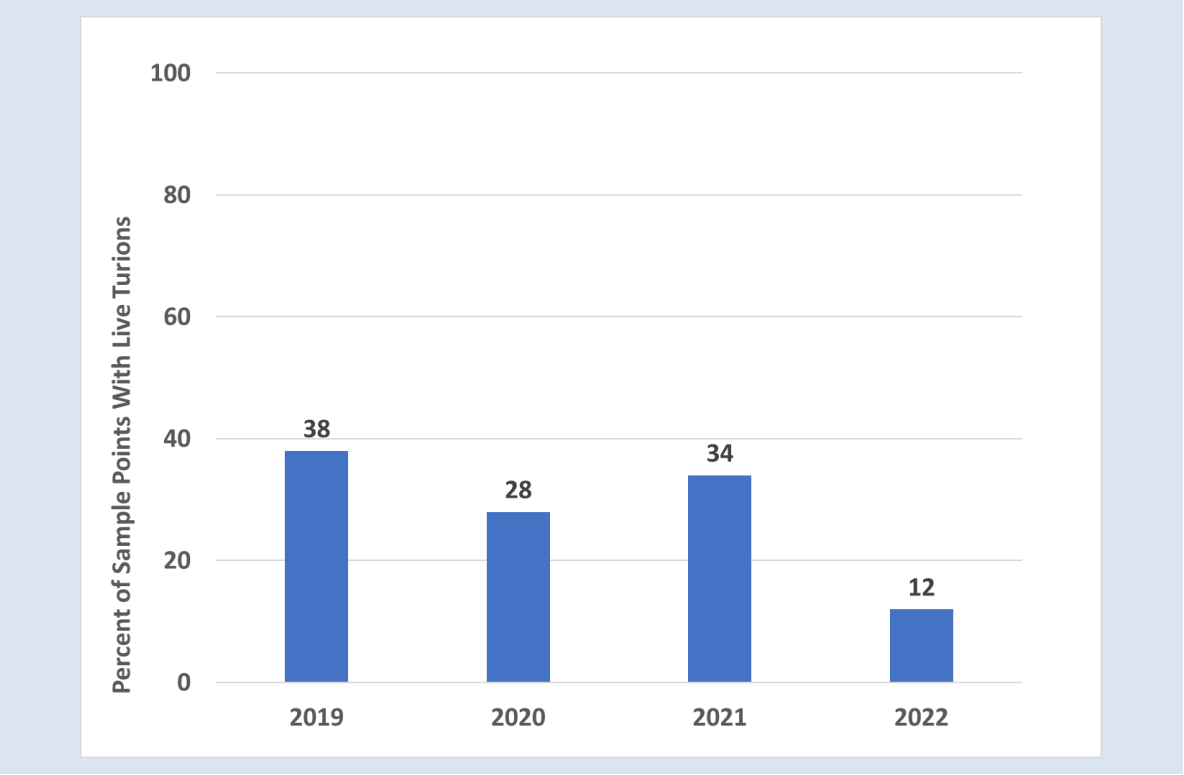


Figure 5-16 Percent of sample points in Normandale Lake with live turions during 2019-2022 survey.

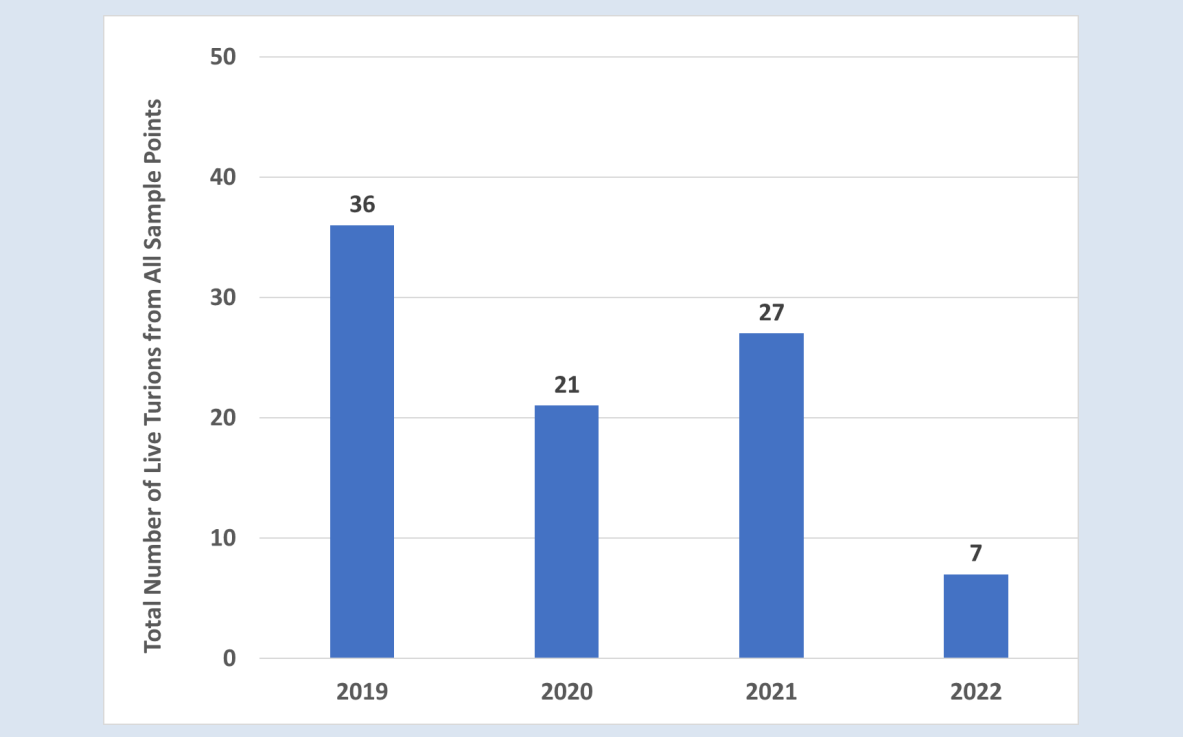


Figure 5-17 Total number of live turions collected from all Normandale sample points in 2019-2022

5.7 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, an invasive aquatic plant that dies off in late June, releasing phosphorus to the lake as it decays which 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 2022, 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.

In 2022, the summer average total phosphorus and chlorophyll *a* concentrations and summer average Secchi disc (measure of clarity) in Normandale Lake met the State eutrophication criteria for shallow lakes. 2022 monitoring results indicate that chloride concentrations in July and August exceeded the MPCA chronic chloride criterion, but all 2022 chloride concentrations met the MPCA acute chloride criterion.

The phytoplankton communities in Normandale Lake in 2022 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. Blue-green algae can produce algal toxins, which can be harmful to humans or other animals. The blue-green algae numbers observed at the District's routine monitoring location during 2022 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 2022 indicate the frequency and biomass of curly-leaf pondweed continues to be lower than levels prior to implementation of the water quality improvement project.

The lake's plant community in 2022 met the MNDNR Plant IBI thresholds, with the highest number of species to date observed in August of 2021 and August 2022. 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. The 2019-2022 data show a moderate decrease in biomass of the plant community after the project. The dominant species observed in 2022 included coontail, common waterweed, and white water lily, which were generally the three species with the greatest biomass prior to the drawdown. The frequencies of the ten most commonly occurring species in 2022 were compared with frequencies observed before the water quality improvement project. The comparison indicated the two most frequently occurring species before the drawdown, coontail and common waterweed, were the most frequently occurring species after the drawdown.

Continuation of water quality and biological monitoring is recommended in upcoming years to assess the impacts of the improvement project(s) on the condition of the lake's water quality and biological community.

6 Lake Holiday

Lake Holiday (Figure 6-1) is a small waterbody with a water surface area of approximately 8 acres, a maximum depth of about 7 feet, and a mean depth of 3.7 feet at a water surface elevation of 936.7. At this elevation the lake volume is approximately 29 acre-feet. The water level in the lake is controlled by weather conditions (snowmelt, rainfall, and evaporation), inflow from Woodgate Pond, inflow from its direct subwatershed, and by a pumped outlet. When pumped, water from Lake Holiday is discharged to Wing Lake.

In 2022, the District monitored Lake Holiday for macrophytes (aquatic plants). Point intercept surveys were completed during June and August. Monitoring results are discussed in the following paragraphs.

Figure 6-1 Lake Holiday on June 27, 2022 (top) and August 9, 2022 (bottom)

6.1 Aquatic Plants

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. 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. The Plant IBI can provide important context to understanding information about water quality, shoreline health, and the fish community.

The MDNR has developed metrics to determine the overall health of a lake's aquatic plant community. The 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.

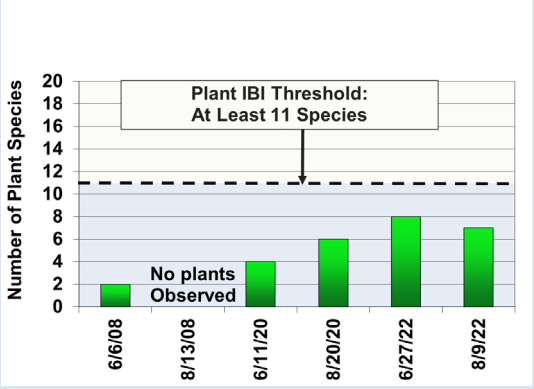


Figure 6-2.A

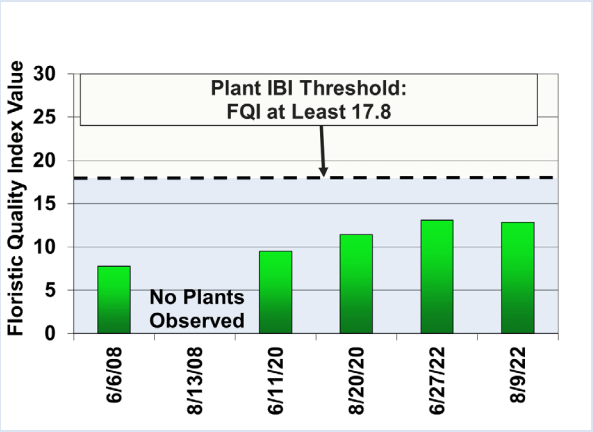


Figure 6-2.B

Figure 6-2 Lake Holiday 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).

The District conducted point intercept aquatic plant surveys of Lake Holiday in June and August of 2022. Maps showing survey results are included in Appendix G. Plant survey data from 2008, 2020, and 2022 were assessed to track changes in plant IBI scores. Figure 6-2 shows the Lake Holiday number of species and FQI scores for 2008, 2020, and 2022 compared to the MNDNR Plant IBI thresholds. In 2022, both the number of species in the lake and FQI values were poorer than the MNDNR Plant IBI thresholds but were higher (better) than previously monitored years.

- **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 2008, 2020, and 2022 the number of species in Lake Holiday ranged from 0 to 8 and was less (poorer) than the MNDNR Plant IBI threshold during all years (Figure 6-2.A).

- **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 2008, 2020, and 2022 FQI values ranged from 0 to 13.1 and was less (poorer) than the MNDNR Plant IBI threshold during all years (Figure 6-2.B).

Three aquatic invasive species were found in Lake Holiday in 2022:

- **Curly-leaf pondweed (*Potamogeton crispus*)**– Curly-leaf pondweed was first observed in the lake in 2008. Although this invasive species was prevalent and grew densely in many areas of the lake in June of 2008, the data indicate both extent and density increased from June 2008 to June 2020 when a dense growth was found throughout the lake. In 2022, curly-leaf pondweed was collected on the sample rake at 90 percent of sample locations in June and the average rake fullness was 2.4 on a scale of 1 to 3 (Figure 6-3 and Appendix G). Curly-leaf pondweed typically dies off at the end of June and was not observed in August.

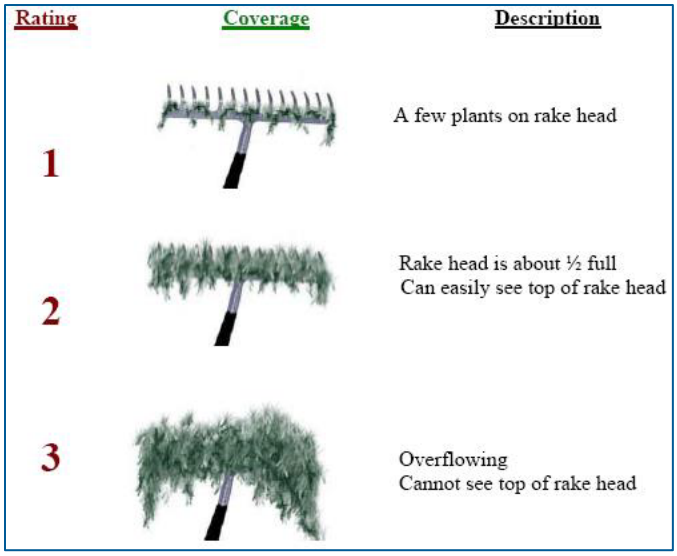


Figure 6-3 Rake fullness rating, coverage, and description

- **Purple loosestrife (Lythrum salicaria)** – Purple loosestrife was first observed in the lake in 2008. In 2008 and 2020, this emergent species was growing sporadically along the entire shoreline during both June and August. In 2022, purple loosestrife was not observed in June, but was observed at one location in August. Beetles were present on the scattered plants but were causing only limited damage. The beetles can control purple loosestrife plants by eating the plants. Because the beetles were causing only limited damage, they may only cause limited control of the purple loosestrife.

- **Reed canary grass (*Phalaris arundinacea*)**– Reed canary grass was first observed in the lake in 2022. This emergent species was observed at one location at the northeast corner of the lake in June and August.

6.2 Conclusions and Recommendations

2022 aquatic plant data indicated the plant community had few species, was of poor quality, and failed to meet the MDNR Plant IBI thresholds. Lakes that score below the thresholds contain degraded plant communities and are likely stressed from anthropogenic eutrophication.

Three aquatic invasive species were found in the lake in 2022, curly-leaf pondweed, purple loosestrife and reed canary grass. Curly-leaf pondweed was first observed in the lake in 2008. Although this invasive species was prevalent and grew densely in many areas of the lake in June of 2008, the data indicate both extent and density increased from June 2008 to June 2020 when a dense growth was found throughout the lake. In 2022, curly-leaf pondweed was collected on the sample rake at 90 percent of sample locations in June and the average rake fullness was 2.4 on a scale of 1 to 3.

The District completed a water quality study of Holiday, Wing, and Rose Lakes in 2021to identify potential improvement measures for the lakes. Review of historic data indicated Lake Holiday water quality is poor with summer average total phosphorus, chlorophyll *a*, and Secchi disc values generally not meeting the state standards for shallow lakes. The poor water quality is generally due to excess nutrients in the lake, which fuels algal growth and decreases water clarity. The phosphorus in Lake Holiday comes from several sources including stormwater runoff from the watershed and internal sources such as nutrient-rich sediments. Additionally, the low diversity of plant species, substantial growth of the invasive species, curly-leaf pondweed, as well as the low quantity of plants in the lake throughout the growing season is likely contributing to the poor water quality. The District is currently conducting a feasibility study to evaluate potential watershed and in-lake management activities to improve water quality in Lake Holiday and downstream Wing and Rose lakes.

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

7 Lake Rose

Lake Rose (Figure 7-1) is a shallow lake with a water surface area of approximately 26 acres, a maximum depth of about 14 feet, and a mean depth of 3.8 feet. At this elevation the lake volume is approximately 102 acre-feet. The water level in the lake is controlled primarily by weather conditions (snowmelt, rainfall, and evaporation), groundwater seepage, inflow from its direct subwatershed, and inflow from Wing Lake. Lake Rose has a high-level outlet. When water levels reach the elevation of the high-level outlet, water from Lake Rose is discharged and conveyed to Birch Island Lake in Eden Prairie. The lake is currently on the MPCA's impaired waters list for excess nutrients (since 2010).

In 2022, the District monitored Lake Rose for macrophytes (aquatic plants). Point intercept surveys were completed during June and August. 2022 was a dry year causing the water level in the lake to be very low and causing portions of the lake to be a wet mud flat (Figure 7-1). The plant survey was completed by kayak. Plants found at locations inaccessible by kayak were sampled on foot and plants found at locations inaccessible by kayak or on foot were visually estimated. Monitoring results are discussed in the following paragraphs.

Figure 7-1 Lake Rose on June 27, 2022 - west basin (top left) and east basin (top right) - and on August 11, 2022 – west basin (bottom left) and east basin (bottom right)

7.1 Aquatic Plants

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. 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. The Plant IBI can provide important context to understanding information about water quality, shoreline health, and the fish community.

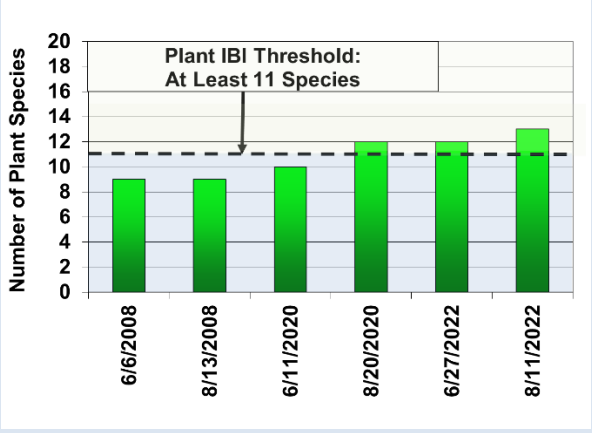


Figure 7-2.A

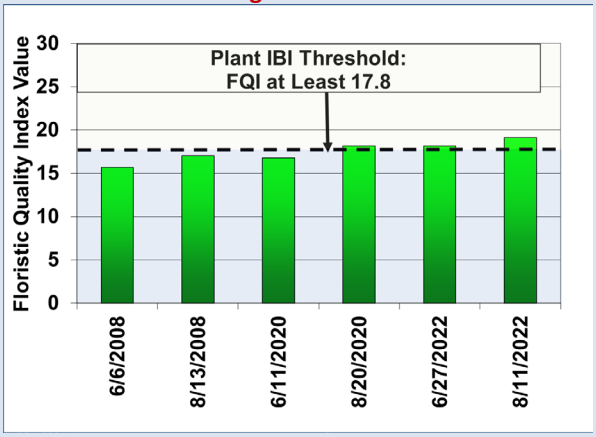


Figure 7-2.B

Figure 7-2 Lake Rose 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).

The MDNR has developed metrics to determine the overall health of a lake's aquatic plant community. The 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 aquatic plant surveys of Lake Rose in June and August of 2022. Maps showing survey results are included in Appendix H. Plant survey data from 2008, 2020, and 2022 were assessed to track changes in plant IBI scores. Figure 7-2 shows the Lake Rose number of species and FQI scores for 2008, 2020, and 2022 compared to the MNDNR Plant IBI thresholds. In 2022, both the number of species in the lake and FQI values were greater (better) than the MNDNR Plant IBI thresholds.

- **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 2008, 2020, and 2022 the number of species in Lake Rose ranged from 9 to 13. The number of species has increased since 2008 and the number of species observed in August 2022 was the highest observed to date.

- **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 2008, 2020, and 2022 FQI values ranged from 15.7 to 19.1. FQI values have increased since 2008 and the FQI value in August 2022 was the highest observed to date.

Three aquatic invasive species were found in Lake Rose in 2022:

- **Purple loosestrife (*Lythrum salicaria*)** – This emergent species was first observed in the lake in 2008. It was observed sporadically along the entire perimeter of the lake during 2008 and 2020. In 2022 it was observed at 3 locations in June and at 1 location in August (Appendix H). During both June and August, the purple loosestrife plants were covered with *Gallerucella* beetles, a beetle that eats purple loosestrife and is used as a biological control. Because the beetles are expected to control the purple loosestrife in the lake, no additional management is needed.

- **Curly-leaf pondweed (*Potamogeton crispus*)** – This invasive species was prevalent throughout the lake in both 2008 and 2020. In 2022, it was only observed at 4 locations in June and was not observed in August. Its reduced prevalence in 2022 may have been due to the lower water levels.

- **Reed canary grass (*Phalaris arundinaceae*)** – This emergent species was first observed in the lake in 2022. It was observed at 6 locations in June and 12 locations in August.

7.2 Conclusions and Recommendations

The lake's plant community in 2022 met the MNDNR Plant IBI thresholds. The number of species and the quality of the plant community as measured by FQI values have increased since 2008 and the August 2022 values were the highest observed to date.

Three aquatic invasive species were observed in Lake Rose in 2022. CLP and purple loosestrife were observed in the lake during 2008, 2020, and 2022. CLP was less prevalent in 2022, likely because of the lake's low water levels. Purple loosestrife was also less prevalent in 2022 and the plants were covered with *Gallerucella* beetles, a beetle that eats purple loosestrife and is used as a biological control. Because the plants were covered with *Gallerucella* beetles, no additional management is needed. Reed canary grass was first observed in the lake in 2022. Herbicide treatment of the reed canary grass is recommended to remove it from the lake. A MNDNR permit would be required.

The District completed a water quality study of Holiday, Wing, and Rose Lakes in 2021to identify potential improvement measures for the lakes. The study found that water quality in Lake Rose has generally been improving since 2007. The average summer total phosphorus and chlorophyll *a* concentrations and summer average Secchi disc (measure of clarity) met the State eutrophication criteria for shallow lakes in 2020. Consistent with the improving water quality, phytoplankton numbers decreased from 2008 to 2020 and both the number of plant species and the quality of the plant community as measured by FQI improved since 2008. While Lake Rose water quality has generally been improving, considerations should still be made to reduce nutrient sources. The phosphorus in Lake Rose comes from several sources, including stormwater runoff from the watershed, inflows from upstream Wing Lake, and internal sources such as nutrient-rich sediments. The District is currently conducting a feasibility study to evaluate

potential watershed and in-lake management activities to improve water quality in Lake Rose and upstream Wing Lake and Lake Holiday.

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

8 Wing Lake

Wing Lake (Figure 8-1) is a shallow lake with a water surface area of approximately 14 acres, a maximum depth of about 8.5 feet, and a mean depth of 4.4 feet. At this elevation the lake volume is approximately 63 acre-feet. The water level in the lake is controlled by weather conditions (snowmelt, rainfall, and evaporation), pumped inflow from Lake Holiday, inflow from its direct subwatershed, and the elevation of the Wing Lake outlet. Discharge from Wing Lake is conveyed south to Lake Rose. The lake is currently on the MPCA's impaired waters list for excess nutrients (since 2010).

In 2022, the Nine Mile Creek Watershed District monitored Wing Lake for macrophytes (aquatic plants) during June and August. Monitoring results are discussed in the following paragraphs.

Figure 8-1 Wing Lake on June 27, 2022 (top picture) and August 10, 2022 (bottom picture). 2022 was a dry year causing the water level to be low.

8.1 Aquatic Plants

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. 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. The Plant IBI can provide important context to understanding information about water quality, shoreline health, and the fish community.

The MNDNR has developed metrics to determine the overall health of a lake's aquatic plant community. The 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.

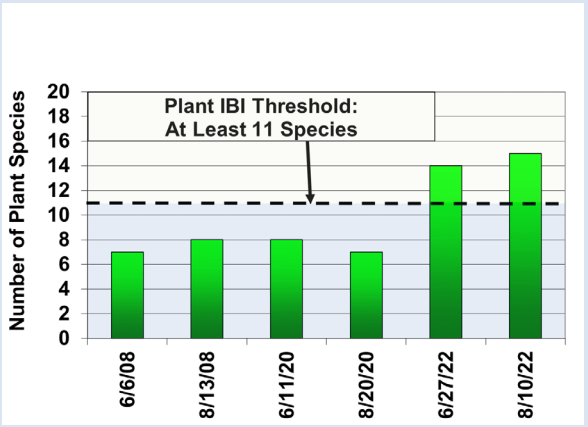


Figure 8-2.A

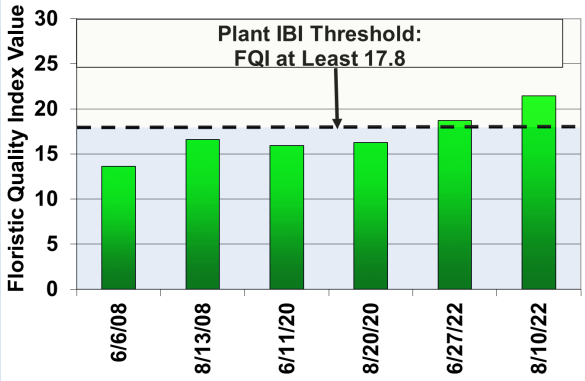


Figure 8-2.B

Figure 8-2 Wing Lake Plant Index of Biological Integrity (IBI) values compared with Plant IBI thresholds (MNDNR) Number of plant species (top) and Floristic Quality Index (FQI) values (bottom).

The District conducted point intercept aquatic plant surveys of Wing Lake in June and August of 2022. Maps showing survey results are included in Appendix I. Plant survey data from 2008 and 2022 were assessed to track changes in plant IBI scores. Figure 8-2 shows the Wing Lake number of species and FQI scores for 2008, 2020 and 2022 compared to the MNDNR Plant IBI thresholds. In 2022, both the number of species in the lake and FQI values were greater (better) than the MNDNR Plant IBI thresholds and the June and August number of species and FQI values were the highest observed to date (Figure 8-2).

- **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 2008 and 2020, the number of species in Wing Lake ranged from 7 to 8 and was less (poorer) than the MNDNR Plant IBI threshold during both

years. In 2022, the number of species in the lake ranged from 14 in June to 15 in August and was greater (better) than the MNDNR Plant IBI threshold during both months (Figure 8-2.A).

- **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 2008 and 2020, FQI values ranged from 13.6 to 16.6 and were less (poorer) than the MNDNR Plant IBI threshold during both years. In 2022, FQI values ranged from 18.7 in June to 21.4 in August and were greater (better) than the MNDNR Plant IBI threshold during both months (Figure 8-2.B)

Three aquatic invasive species were found in Wing Lake in 2022:

- **Purple loosestrife (*Lythrum salicaria*)** – This emergent species was observed sporadically along the entire perimeter of the lake during 2008 and 2020. In 2022, purple loosestrife was observed at one location in the southwestern area of the lake during June and August.
- **Curly-leaf pondweed (*Potamogeton crispus*)** – A light density of this invasive species was prevalent in the lake during both 2008 and 2020. In 2022, it was observed at four locations in June and was not observed in August (Appendix I).
- **Typha angustifolia (narrow-leaved cattail)** – In 2022, this emergent species was observed at one location in the northwest corner of the lake during June and August (Appendix I). Cattail has been present in the lake since 2008, but its extent increased from one location in 2008 to multiple locations along the perimeter of the lake in 2020 and back to one location in 2022.

8.2 Conclusions and Recommendations

The lake's plant community in 2022 met the MNDNR Plant IBI thresholds. In 2022, the number of species and the quality of the plant community as measured by FQI values were the highest observed to date. Three aquatic invasive species were found in the lake in 2022, purple loosestrife, curly-leaf pondweed, and narrow-leaved cattail. Extent of these species decreased between 2020 and 2022.

The District completed a water quality study of Holiday, Wing, and Rose Lakes in 2021 to identify potential improvement measures for the lakes. The study found that water quality in Wing Lake has been moderate to poor, with total phosphorus and chlorophyll-*a* concentrations above the state standards for shallow lakes since 1993. The degradation in water quality is primarily due to excess nutrients in the lake, which fuels algal growth and decreases water clarity. The phosphorus in Wing Lake comes from several sources, including stormwater runoff from the watershed and internal sources such as nutrient-rich sediments. Nutrients from Lake Holiday can also be a source during wet years when water is pumped from Lake Holiday to Wing Lake to control high water levels. The District is currently conducting a feasibility study to evaluate potential watershed and in-lake management activities to improve water quality in Wing Lake, as well as Lake Holiday (upstream) and Lake Rose (downstream).

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

9 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 9-1). The 2022 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 9-1 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 2022, 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 a WOMP Station
- **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 a WOMP station.
- **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 2022 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 J. Water depth data are summarized in Appendix K. Fish and macroinvertebrate results are summarized in Appendix L.

9.1 Nine Mile Creek Water Quality

In 2022, measurements for dissolved oxygen, temperature, specific conductance, pH, turbidity, and discharge occurred monthly during March through October at 10 sample locations (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 MPCA standards for Class 2B streams and specific conductance was compared with the MPCA standard for a Class 4A stream because they are the most restrictive water quality standards for these parameters. Overall, 87 percent of the 2022 observed values were within MPCA standards. The South Fork (87 percent of observed values) and Main Stem (95 percent of observed values) met MPCA standards most frequently followed by the North Fork (82 percent of observed values). In 2022, all observed values from the upstream South Fork location, ECU-3A, met the MPCA standard (Figure 9-2). All Nine Mile Creek temperature and pH measurements, 87 percent of the dissolved oxygen measurements, and 62 percent of the specific conductance measurements met MPCA standards.

Figure 9-2 Upstream South Fork Location ECU-3A on September 1, 2022

In 2022, 87% of South Fork specific conductance, dissolved oxygen, pH, and temperature values met the MPCA standards. At the South Fork upstream location, ECU-3A pictured above, the levels of these parameters met the MPCA standards 100 percent of the time.

Figure 9-3 Upstream North Fork Location ECU-1A-1 on July 1, 2022

In 2022, the North Fork met the specific conductance standard less frequently than other locations. All 2022 specific conductance measurements from upstream North Fork location ECU-1A-1 failed to meet the specific conductance standard.

9.1.1 Specific Conductance

Consistent with previous years, the specific conductance criterion was met less frequently in 2022 than other MPCA standards. 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 MPCA 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 more frequently in 2022 than 2021—62 percent met the MPCA standard in 2022 compared with 55 percent in 2021. Specific conductance was high in the fall at several locations. As in previous years, the North Fork locations met the MPCA standard for specific conductance less frequently than other sampling locations—34 percent of the North Fork measurements met the MPCA specific conductance standard in 2022 compared with 71 percent of South Fork and 91 percent of Main Stem measurements.

Specific conductance measurements from station ECU-1A-1 (North Fork just upstream of Hopkins/Edina boundary, Figure 9-3) exceeded the water quality criteria during each sampling event (March through October) in 2022. During the period of record (2009 through 2022), 91 percent of specific conductance measurements at this location have exceeded the MPCA standard (Figure 9-4).

In 2022, specific conductance measurements also failed to meet the MPCA standard:

- during May, July, September, and October at North Fork location ECU-2 (near Cahill Road and Brook Drive in Edina) (Figure 9-5 and Figure 9-10).

- during May, July, August, and October at North Fork location N3 (at Metro Boulevard in Edina) (Figure 9-6 and Figure 9-7).
- during May and July through October at North Fork location ECU-2A (downstream of Interstate 494 and immediately upstream from 81st Street in Bloomington) (Figure 9-8 and Figure 9-9).
- during May, July, August, and October at South Fork location N2 (West 78th Street in Bloomington) (Figure 9-11).
- during May, August, and October 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 9-12 and Figure 9-19).
- during August at Main Stem locations ECU-7A/N1 (Main Stem of Nine Mile Creek, downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington) (Figure 9-13), and ECU-7B (Main Stem of Nine Mile Creek, downstream of Old Shakopee Road at 103rd Street in Bloomington) (Figure 9-23).

During the period of record (1997 through 2022), specific conductance has failed to meet the MPCA standard for:

- 45 percent of measurements from North Fork location ECU-2 (Figure 9-5)
- 55 percent of measurements from North Fork location ECU-2A (Figure 9-8)
- 17 percent of measurements from South Fork location ECU-5A (Figure 9-12 and Figure 9-19)
- 18 percent of measurements from Main Stem location ECU-7A/N1 (Figure 9-13); and
- 19 percent of measurements from Main Stem location ECU-7B (Figure 9-23).

During the period of record (2011 through 2022), specific conductance has failed to meet the MPCA standard for:

- 59 percent of measurements from North Fork location N3 (Figure 9-6); and
- 25 percent of measurements from South Fork location N2 (Figure 9-11).

The exceedance of the MPCA specific conductance standard in Nine Mile Creek in 2022 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 ionic strength due to chlorides as one of the stressors to the biological community in Nine Mile Creek.

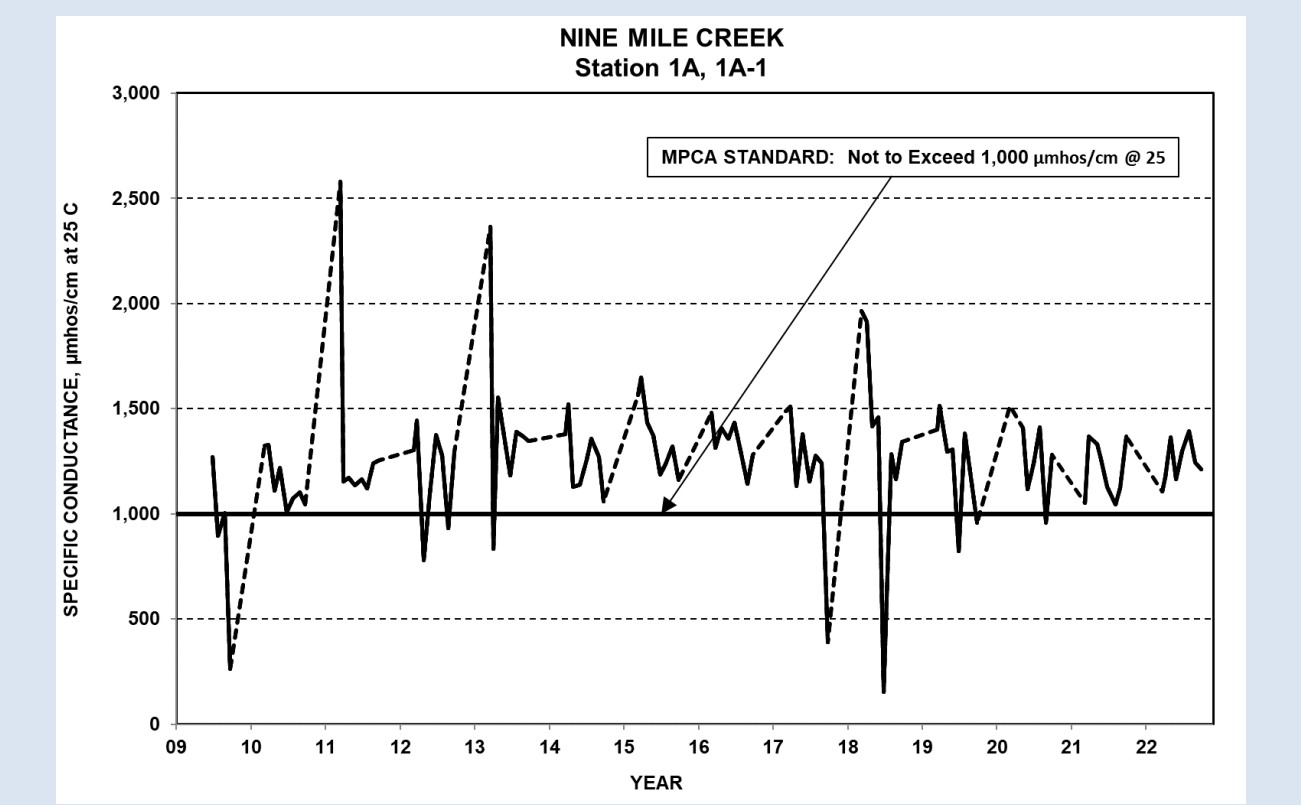


Figure 9-4 **2009-2022 specific conductance measurements from Station ECU-1A-1 (North Fork Just Upstream of the Hopkins/Edina Boundary) Compared with the MPCA Standard**

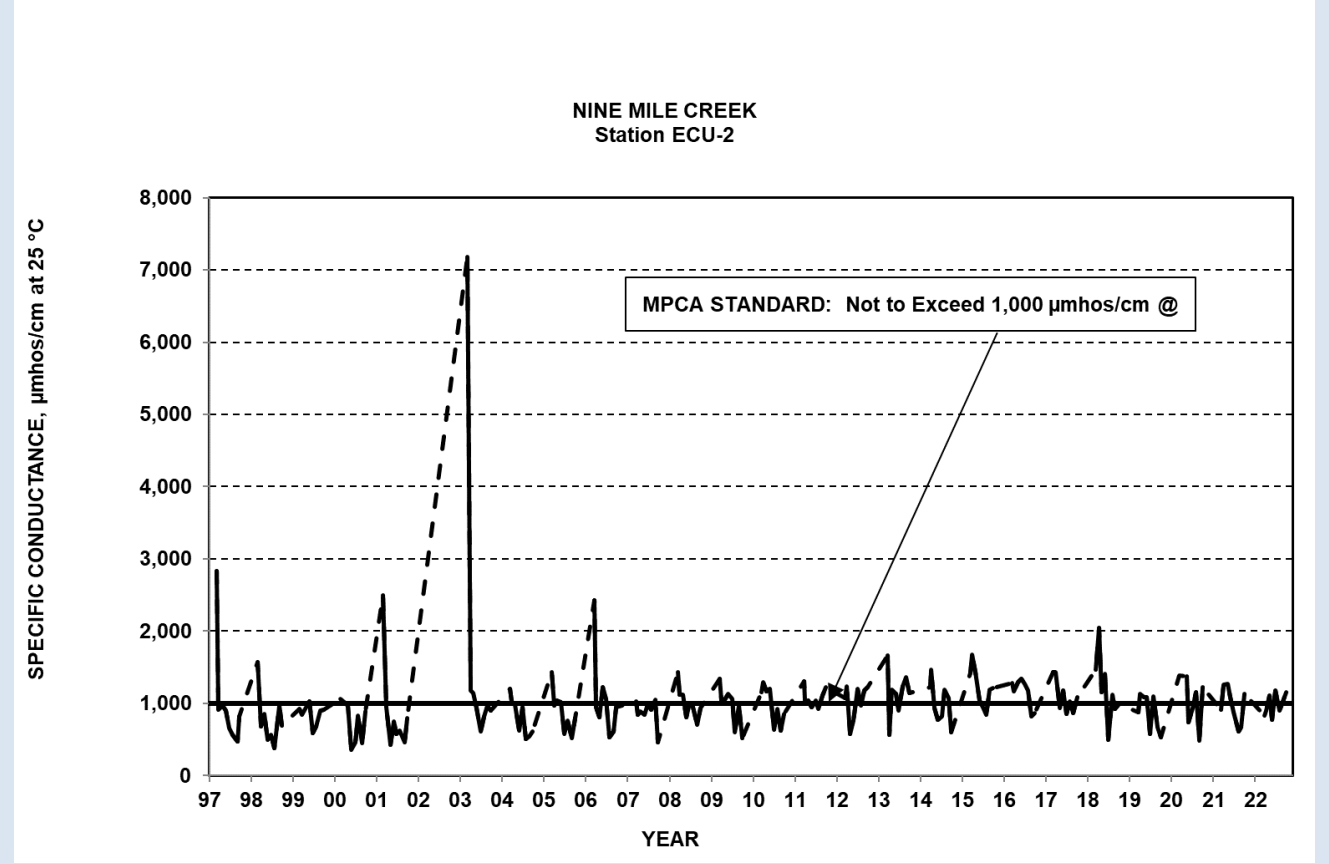


Figure 9-5 **1997-2022 specific conductance measurements from Station ECU-2 (North Fork near Cahill Road and Brook Drive in Edina) compared with the MPCA standard.**

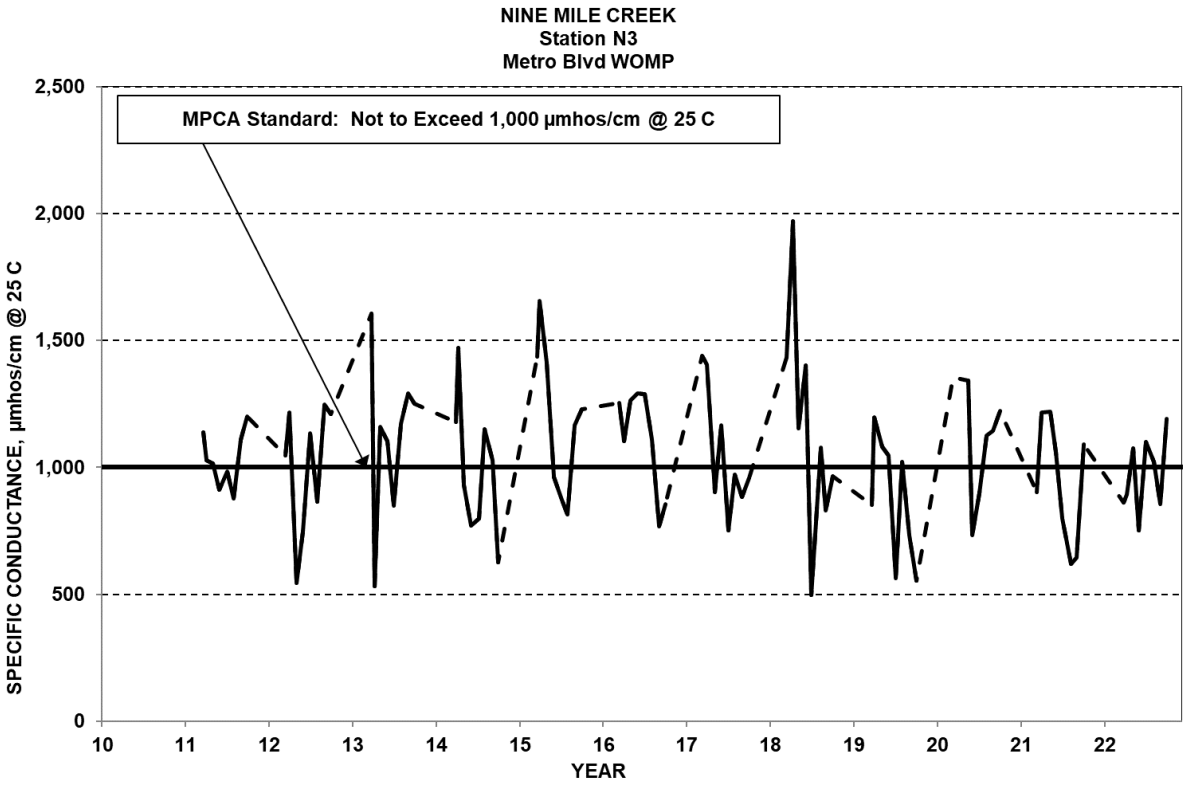


Figure 9-6 **2011-2022 specific conductance measurements from Station N3 (North Fork at Metro Blvd WOMP in Edina) compared with the MPCA standard.**

Figure 9-7 **North Fork Location N3 on August 5, 2022**

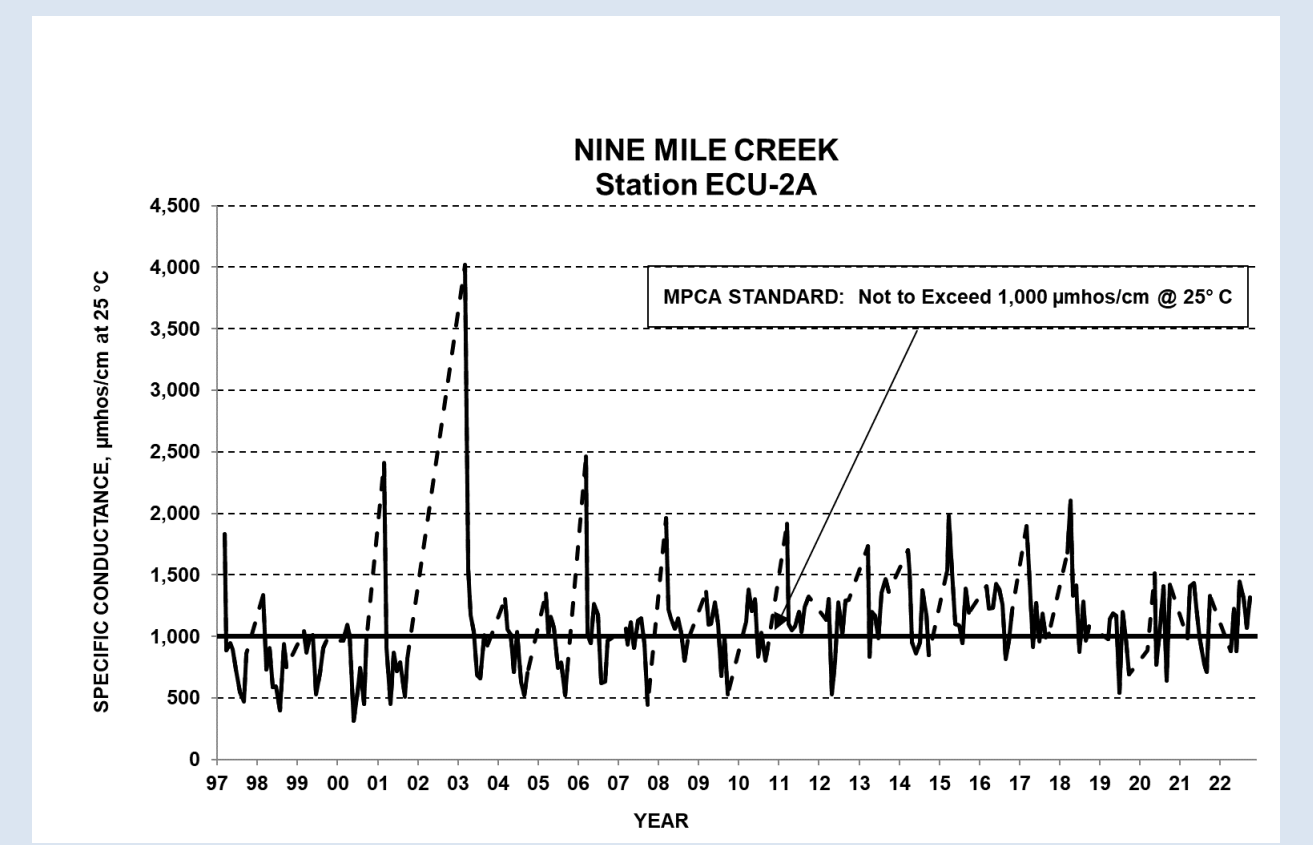


Figure 9-8 **1997-2022 specific conductance measurements from Station ECU-2A (North Fork downstream of Interstate 494 and immediately upstream of 81st Street in Bloomington) compared with the MPCA standard.**

Figure 9-9 **North Fork Location ECU-2A on July 1, 2022**

9.1.2 Dissolved Oxygen

Dissolved oxygen measurements from Nine Mile Creek met the MPCA standard with a similar frequency in 2022 and 2021—87 percent met the MPCA standard in 2022 compared with 86 percent in 2021. In 2022, the South Fork met the MPCA standard for dissolved oxygen less frequently than other sampling

locations — 75 percent of the dissolved oxygen measurements from the South Fork were within the MPCA criterion in 2022 compared with 91 percent of Main Stem and 94 percent of North Fork measurements.

In 2022, dissolved oxygen levels were below (poorer than) the MPCA standard at the following locations:

- ECU-2 (North Fork near Cahill Road and Brook Drive in Edina, Figure 9-10) during July and September;
- N2 (South Fork at West 78th Street in Bloomington, Figure 9-11) during July through October;
- ECU-5A (South Fork in Corridor Park immediately downstream from Interstate 494 in Bloomington and west of East Bush Lake Road, Figure 9-12) during July and September; and
- ECU-7A/N1 (Main Stem of Nine Mile Creek, downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington, Figure 9-13) during July and September.

Figure 9-10 North Fork location ECU-2 on July 1, 2022

Figure 9-11 South Fork location N2 on August 5, 2022

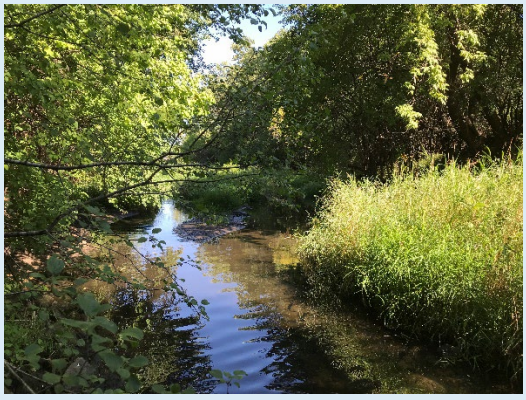


Figure 9-12 South Fork location ECU-5A on September 1, 2022

Figure 9-13 Upstream Main Stem location 7A on July 1, 2022

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). 2022 data collected from North Fork location ECU-2 (near Cahill Road and Brook Drive in Edina, Figure 9-10) and South Fork locations N2 (at West 78th Street in Bloomington, Figure 9-11) and ECU-5A (in Corridor Park immediately downstream from Interstate 494 in Bloomington, Figure 9-12) indicate the stream's low dissolved oxygen levels occurred during periods of low flow (Figure 9-14, Figure 9-15, and Figure 9-16). 2022 was a very dry year.

The biological stressor identification study found that when water flows from Marsh Lake, low dissolved oxygen concentrations at the upstream Main Stem location, ECU-7A/N1 (downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington), were due to the influence of Marsh Lake on downstream waters. 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 very low during July through September (Figure 9-13) and the stream was a dry stream bed with some scattered puddles of water in October (Figure 9-21). The low oxygen measurement in July was likely due to the very low flow (1 cubic foot per second). The low oxygen value in September was likely a combination of low stream flow and water flowing from the marsh with low oxygen levels due to biological activity within the marsh Figure 9-17.

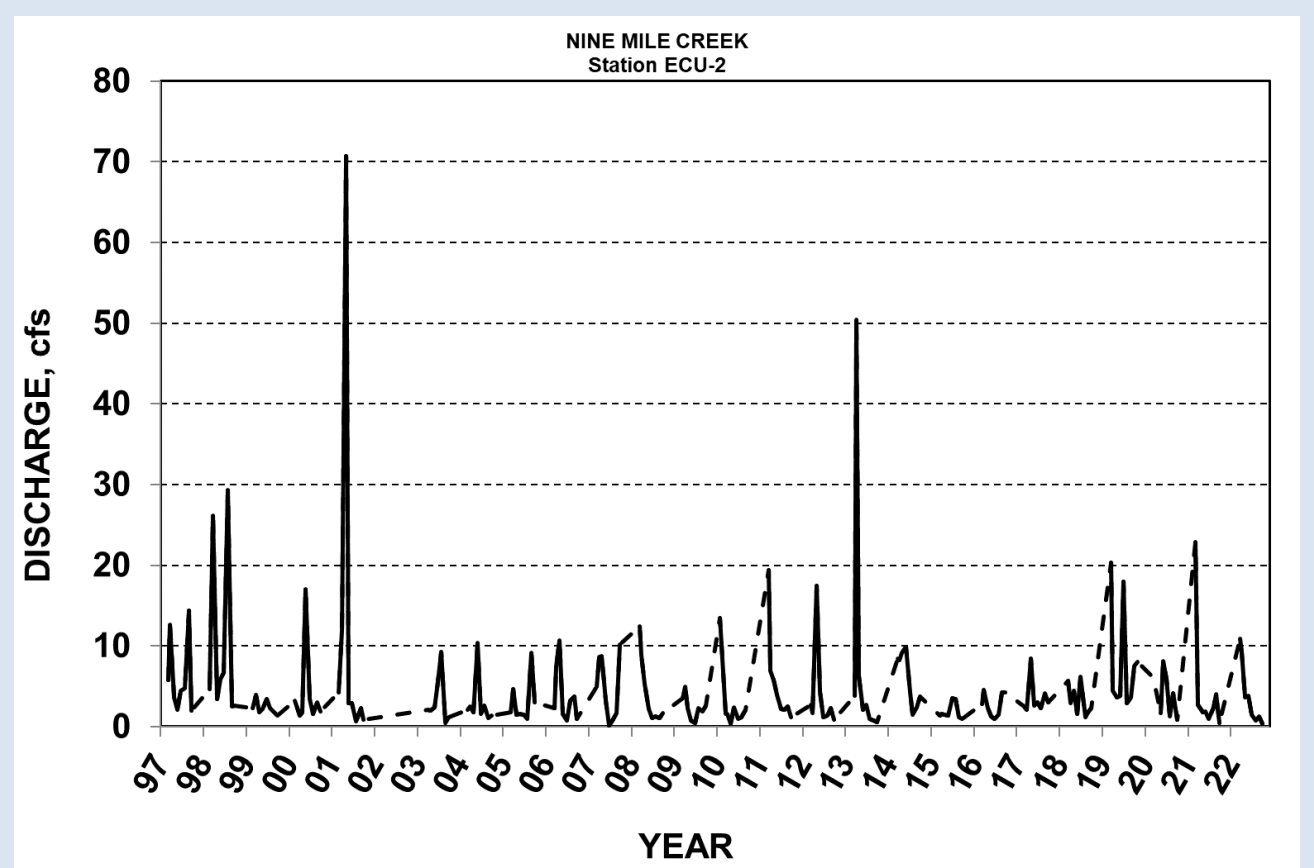


Figure 9-14 1997-2022 monthly discharge measurements from Station ECU-2 (North Fork near Cahill Road and Brook Drive in Edina).

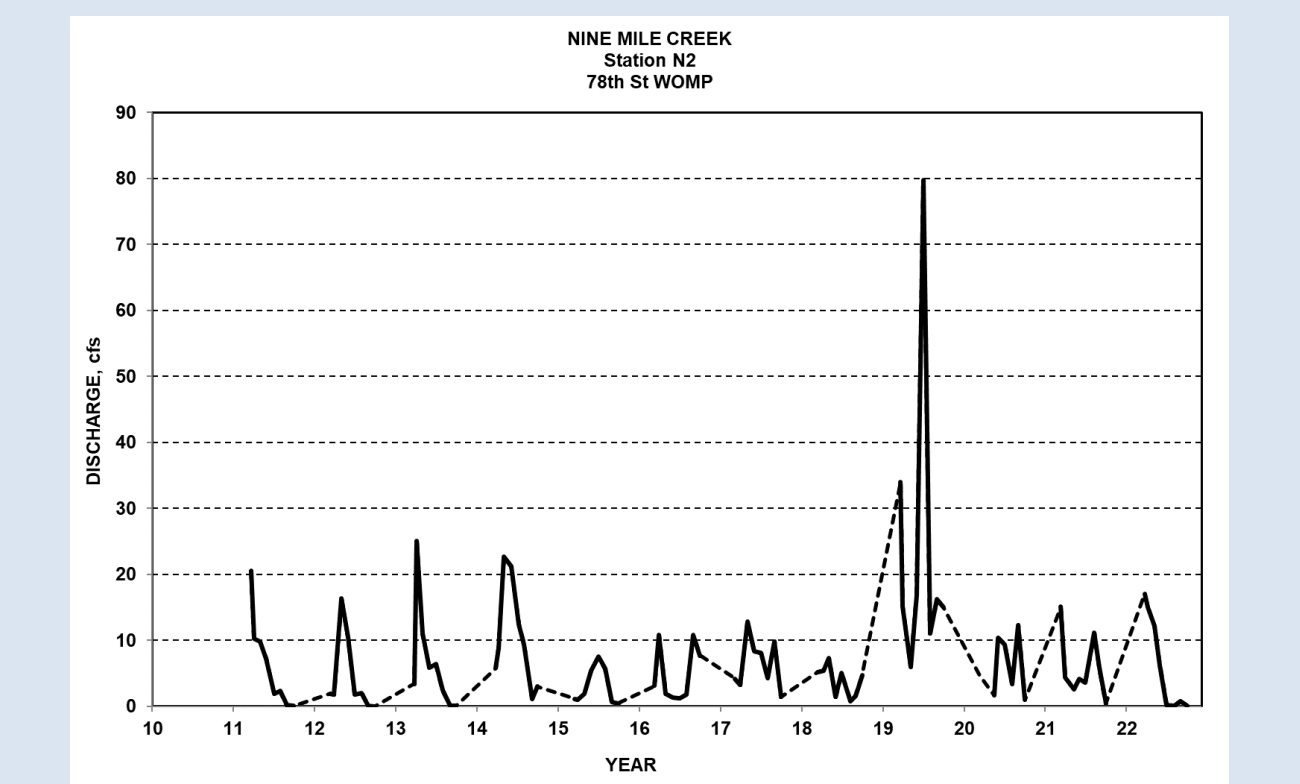


Figure 9-15 2011-2022 monthly discharge measurements from Station N2 (South Fork at West 78th Street in Bloomington).

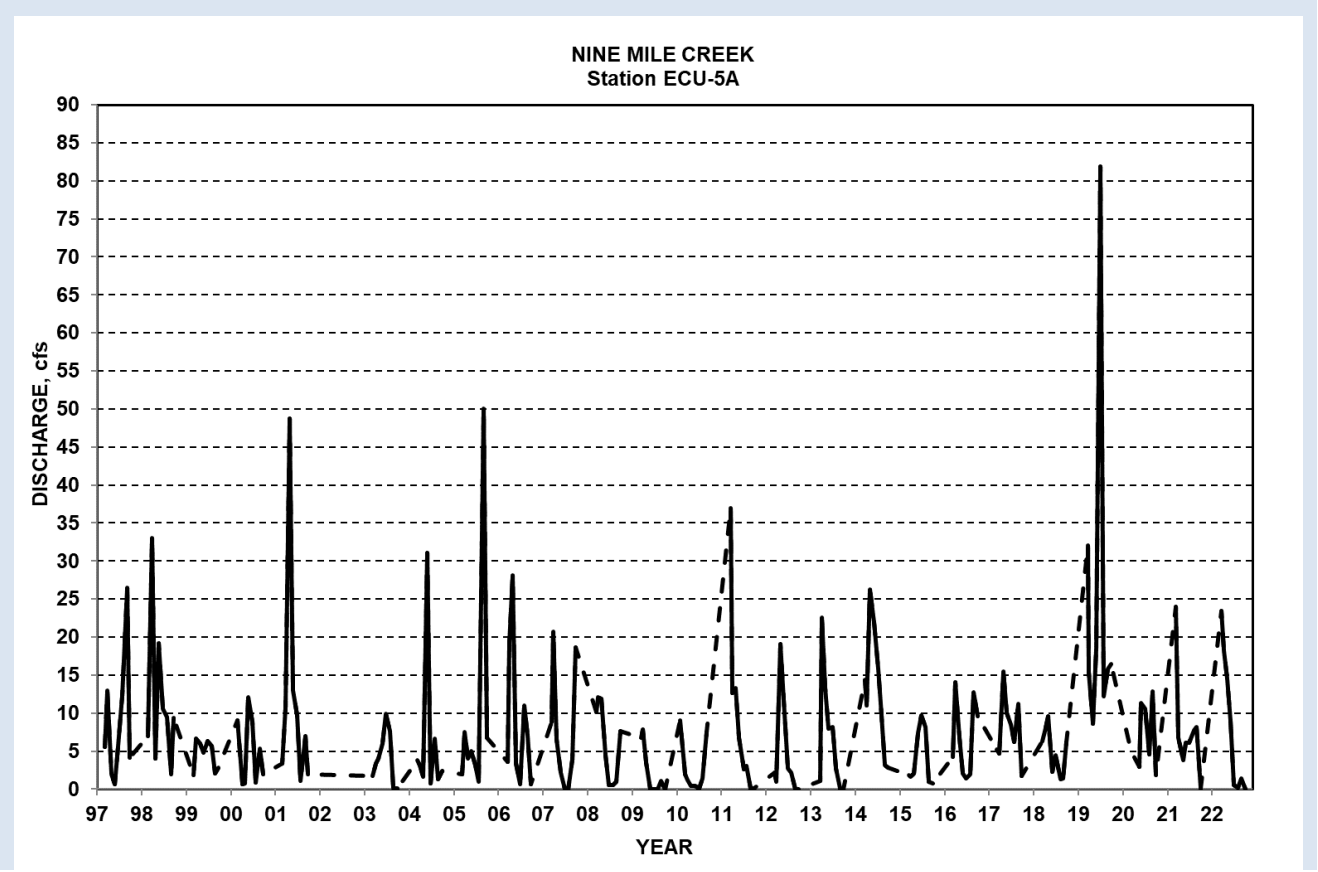


Figure 9-16 1997-2022 monthly discharge measurements from Station ECU-5A (South Fork in Corridor Park immediately downstream from Interstate 494 in Bloomington and west of East Bush Lake Road).

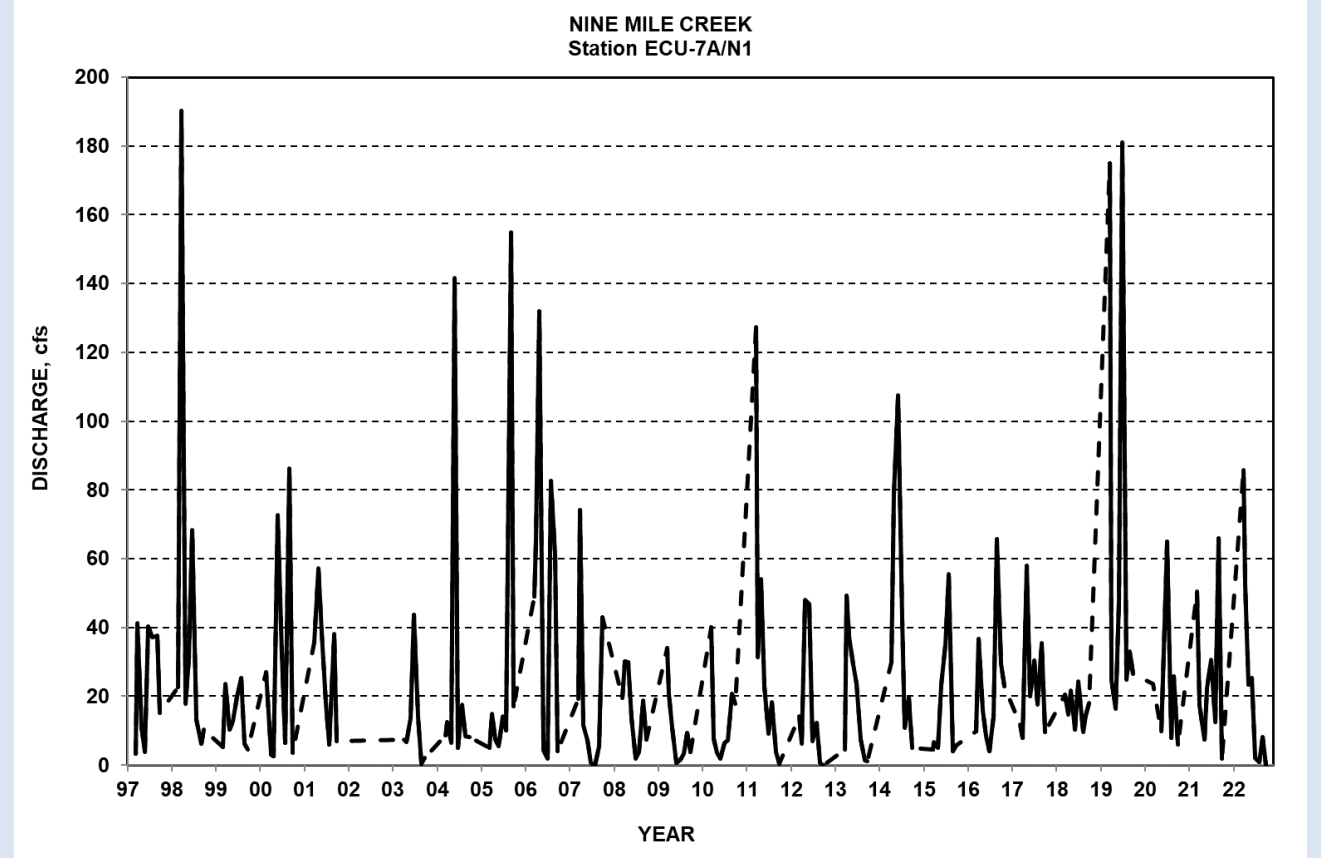


Figure 9-17 1997-2022 discharge measurements from Station ECU-7A/N1 (Main Stem downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington).

In 2022, all temperature, pH, dissolved oxygen, specific conductance, turbidity, and discharge values were within the range of values measured during the period in which data were collected. The data collection period has included a range of climatic conditions, including very dry years such as occurred in 2022. The pictures shown in Figure 9-18, Figure 9-19, Figure 9-20, Figure 9-21, Figure 9-22, and Figure 9-23 provide a comparison of stations ECU-5A, ECU-7A/N1, and ECU-7B during two very dry years, 2007 and 2022.

Figure 9-18 Downstream South Fork location ECU-5A on August 1, 2007

Figure 9-19 Downstream South Fork location ECU-5A on July 1, 2022

Figure 9-20 Upstream Main Stem location ECU-7A/N1 on August 1, 2007

Figure 9-21 Upstream Main Stem location 7A on October 1, 2022

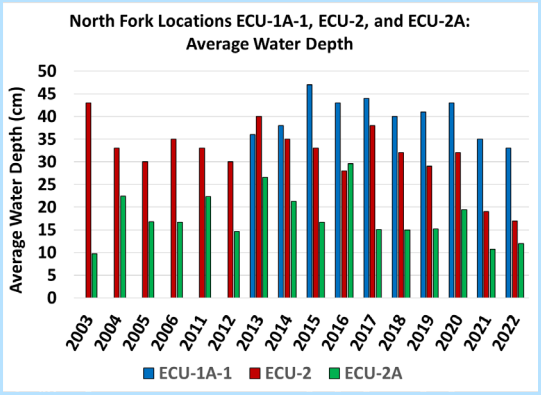
Figure 9-22 Middle Main Stem location ECU-7B on August 1, 2007

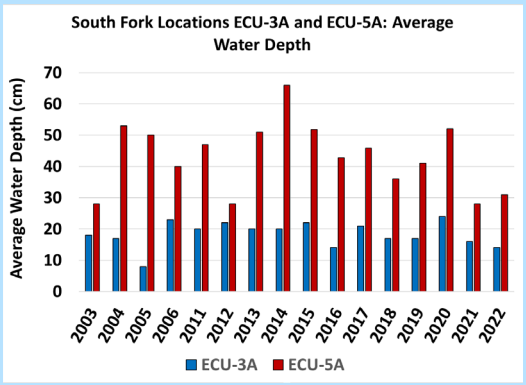
Figure 9-23 Middle Main Stem location ECU-7B on October 1, 2022

9.2 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 to 2006 and 2011 to 2022. Measurements are summarized in Figure 9-24. Because 2021 and 2022 were dry years, water depths in 2022 were generally similar to 2021 depths and lower than most historical depths. 2022 water depths at upstream North Fork locations ECU-1A-1 and ECU-2 and downstream Main Stem location ECU-7C (Figure 9-25) were the lowest depths measured during the 2003 through 2022 period of record.

Figure 9-25 Downstream Main Stem location ECU-7C on July 1, 2023
The average water depth measured at downstream Main Stem location ECU-7C when the fish survey was completed was the lowest on record.





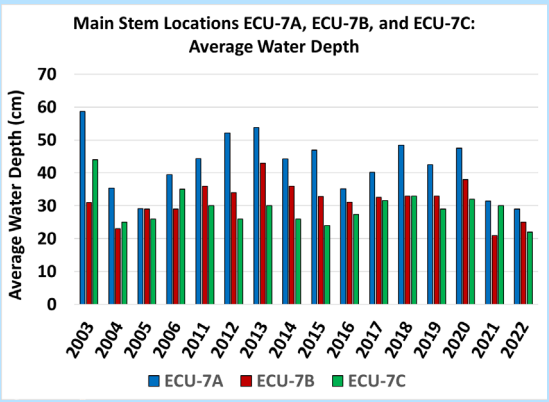


Figure 9-24 Nine Mile Creek historical water depth values
North Fork (top), South Fork (middle), and Main Stem (bottom)

9.3 FIBI and MIBI

9.3.1 MPCA Development of FIBI and MIBI

Figure 9-26 Downstream Main Stem location ECU-7C (downstream of 106th Street in Bloomington) on June 27, 2022.
The 2022 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 MPCA 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 MPCA 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 prior to 2018, the MPCA assessed surface waters 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 9-1 summarizes the MPCA assessment results.

Table 9-1 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 to Nine Mile Creek	3.8	2Bg, 3C	Existing Impairment, Fails Standard	Existing Impairment, Fails Standard	Impaired	2018	Fish bioassessments and benthic macroinvertebrates bioassessments
Nine Mile Creek, Headwaters to Metro Blvd.	6.2	2Bg, 3C	Existing Impairment, Fails Standard	--	Impaired	2004	Fish bioassessments
Nine Mile Creek, Metro Blvd. to end of Unnamed Wetland	4.9	2Bm, 3C	Existing Impairment, Fails Standard	Existing Impairment, Fails Standard	Impaired	2018	Fish bioassessments and benthic macroinvertebrates bioassessments
Nine Mile Creek, Unnamed Wetland 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:

- South Fork from Smetana Lake to Nine Mile Creek
- Headwaters to Metro Boulevard (North Fork)
- Metro Boulevard to end of unnamed wetland
- Unnamed wetland 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 identifies 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 to Nine Mile Creek, Metro Boulevard to end of unnamed wetland, and unnamed wetland 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.

9.3.2 Fish Index of Biotic Integrity (FIBI)

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;
- 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. The North Fork of Nine Mile Creek from Metro Boulevard to end of unnamed wetland was classified as Class 2Bm, 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 Calibration of Biological Condition Gradient for Streams of Minnesota (Minnesota Rules 7050.0222 Subp. 4c).

Figure 9-27 Downstream North Fork fish sample location ECU-2A (immediately downstream from West 77th Street / West of Highway 100) on June 22, 2022.
The 2022 FIBI value at ECU-2A, pictured above, met the FIBI standard.

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 unnamed wetland is Class 2Bm Southern Headwaters stream, a value greater than 33. The FIBI standard applicable

to the other reaches of Nine Mile Creek is a Class 2Bg Southern Headwaters stream, 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.

Monitoring Results

Fish collected from the eight biological monitoring stations (Figure 1-2) in Nine Mile Creek in 2017 through 2022 were assessed to determine the FIBI values and whether the values met the MPCA FIBI standard (Figure 9-28).

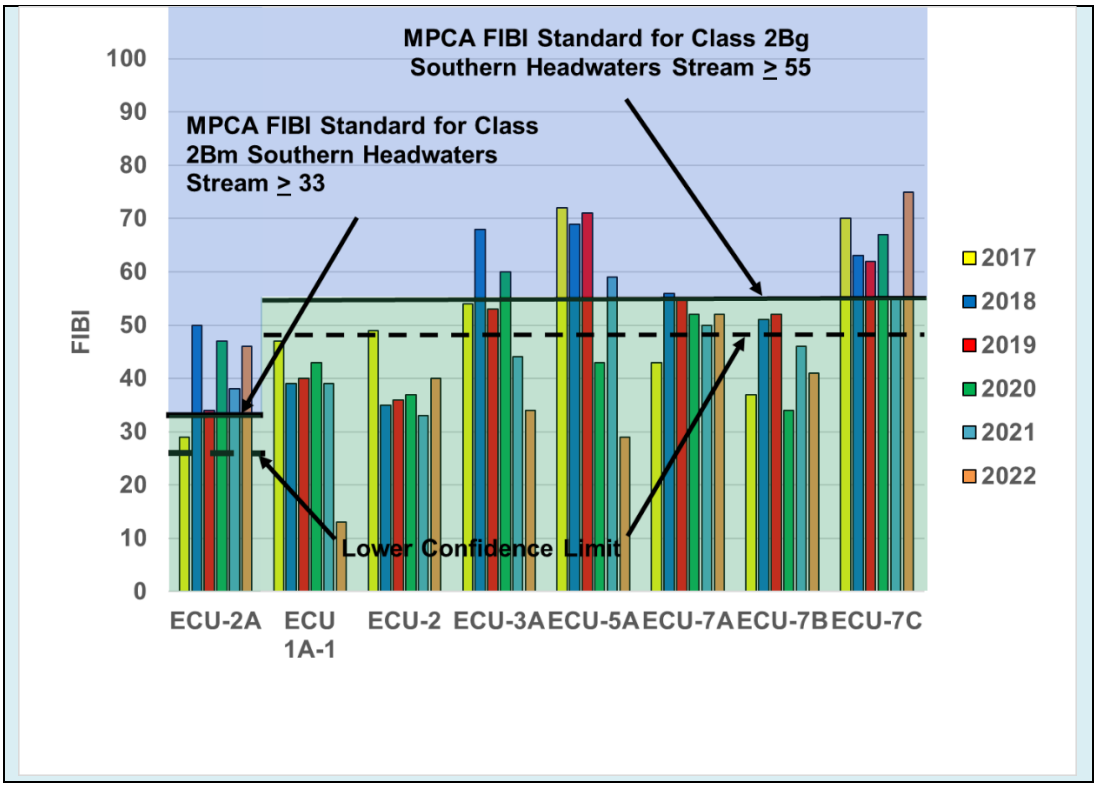


Figure 9-28 2017-2022 Nine Mile Creek Fish Index of Biotic Integrity (FIBI) values compared with the MPCA FIBI standards for a Class 2Bm Southern Headwaters stream and a Class 2Bg Southern Headwaters stream.

2022 results: Fish were monitored at the eight sample locations during June 20 through June 27, 2022. 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 (Figure 9-27) and the downstream Main Stem location, ECU-7C (Figure 9-26), met the FIBI standard (Figure 9-28). The FIBI score from the upstream Main Stem location, ECU-7A (Figure 9-29) did not meet the standard, but its score of 52 is greater than the lower confidence limit of 48 (Figure 9-28) indicating it is close to the standard of 55. FIBI scores from the two upstream North Fork locations, ECU-1A-1 (Figure 9-30) and ECU-2 (Figure 9-31), the upstream South Fork location, ECU-3A (Figure 9-32), the downstream South Fork location, ECU-5A (Figure 9-33) and the

middle Main Stem location, ECU-7B (Figure 9-34) were below the FIBI standard and the lower confidence limit.

2017-2022 results:

Downstream Mainstem Location (ECU-7C)

FIBI scores from the downstream Main Stem location, ECU-7C, met the FIBI standard during all 6 years. The 2022 FIBI score of 75 was the highest FIBI score to date and compares with 2017 through 2021 scores ranging from 55 to 70. Observed flows on the day of fish surveys completed during 2017 through 2022 are shown in Figure 9-35. The observed flow at ECU-7C during the 2022 fish survey of 5 cubic feet per second (cfs) compares with flows ranging from 15 to 33 cfs at this location during the 2017 through 2021 fish surveys. The lower flows in 2022 appear to be correlated with the highest FIBI score to date.

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 2022. However, the 2020 through 2022 values were within the standard's confidence limits indicating the scores were relatively close to the standard. 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, sediment, and ionic strength due to excess chlorides. As noted in Section 9.1, both low dissolved oxygen and high specific conductance from excess chlorides were documented at this location in 2022.

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 and 2019 through 2022. However, 2017 and 2019 values were within the standard's confidence limits indicating the values were fairly close to the standard. Low baseflow in 2021 and 2022 likely stressed the fish community. Observed flows on the day of fish surveys completed during 2017 through 2022 are shown in Figure 9-36. Flows in 2021 and 2022 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 2022 document inadequate baseflow as a 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 and 2022. The 2022 score was the lowest to date. Low baseflow in 2022 likely stressed the fish community. Observed flows on the day of fish surveys completed during 2017 through 2022 are shown in Figure 9-36. The flow of 0.7 measured at the time of the 2022 fish survey was lower than flows measured in 2017 through 2021, ranging from 1.1 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 2022 document inadequate baseflow and dissolved oxygen

as biological stressors. As noted in Section 9.1, inadequate dissolved oxygen and low flows were documented at this location in 2022.

Downstream North Fork Location (ECU-2A)

FIBI scores from the downstream North Fork location, ECU-2A, met the FIBI standard during 2018 through 2022, but not during 2017. However, the 2017 value was within the standard's confidence limits indicating it was close to the standard (Figure 9-28). The *Nine Mile Creek Biological Stressor Identification* (2010) concluded ionic strength due to excess chloride in the stream was a stressor to the North Fork fish community. Figure 9-8 documents excess ionic strength (chlorides) at this location in 2017 when the FIBI standard was not met.

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 2022 (Figure 9-28). 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 ionic strength due to excess chloride in the stream. Section 9.1 and Appendix A document inadequate oxygen at ECU-2 during 2022, and Figure 9-4 and Figure 9-5 document excess ionic strength (chlorides) at both ECU-1A-1 and ECU-2.

Figure 9-29 Upstream Main Stem location ECU-7A (downstream of Marsh Lake and immediately downstream of 98th Street in Bloomington) on June 23, 2022.

Figure 9-30 North Fork location 1A-1 (just upstream of the Hopkins/Edina Boundary) on June 20, 2022.

Figure 9-31 North Fork location ECU-2 on June 23, 2022.

Figure 9-32 Upstream South Fork location ECU-3A (immediately upstream of the Highway 62 crossing in Minnetonka) on June 20, 2022.

Figure 9-33 Downstream South Fork location ECU-5A (in Corridor Park immediately downstream from Interstate 494 in Bloomington) on June 22, 2022.

Figure 9-34 Middle Main Stem location ECU-7B (downstream of Old Shakopee Road at 103rd Street in Bloomington) on June 25, 2022.

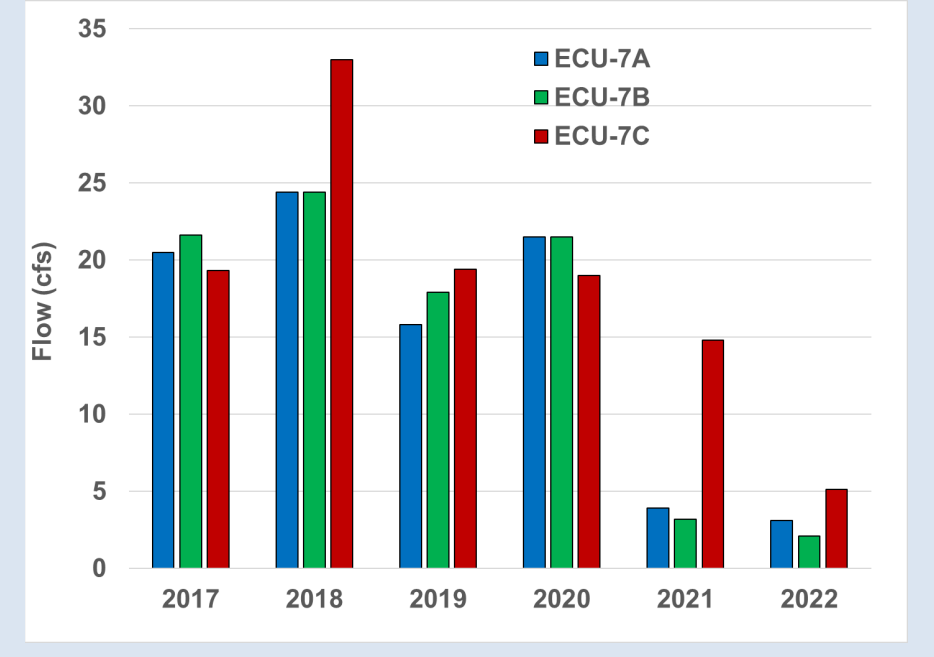


Figure 9-35 Observed flows at the Main Stem locations ECU-7A, ECU-7B, and ECU-7C during the 2017-2022 fish surveys.

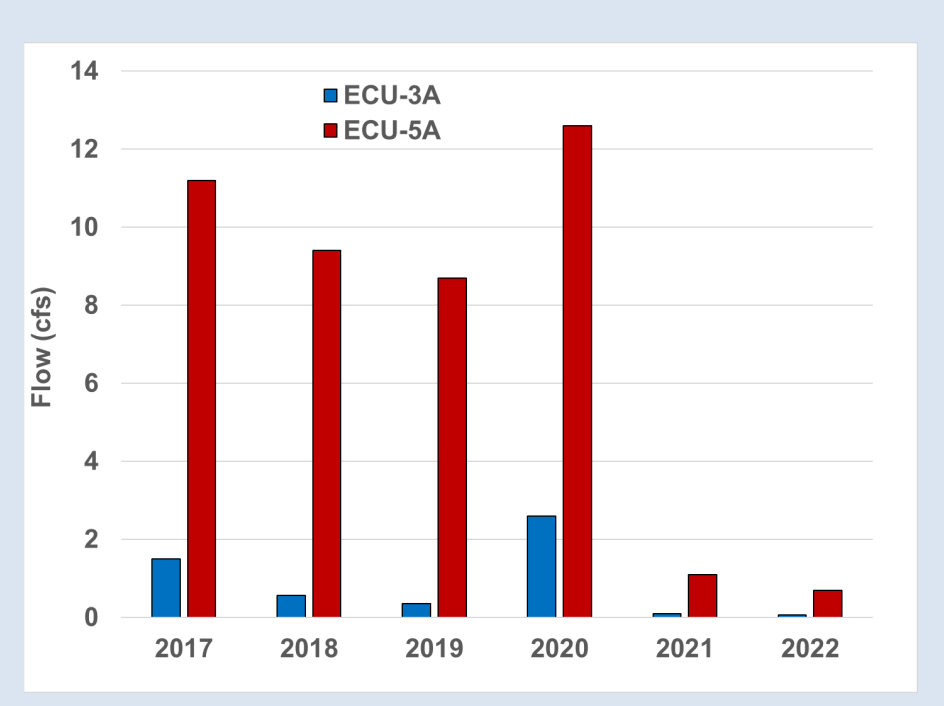


Figure 9-36 Observed flows at South Fork locations ECU-3A and ECU-5A during the 2017-2022 fish surveys.

9.3.3 Macroinvertebrate Index of Biotic Integrity (MIBI)

9.3.3.1 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;
- Nine Mile Creek has a drainage area less than 500 square miles.

The MPCA assigned a beneficial use classification to each of the four Nine Mile Creek stream reaches. The North Fork of Nine Mile Creek from Metro Boulevard to end of unnamed wetland was classified as Class 2Bm. The other reaches of Nine Mile Creek were classified as Class 2Bg.

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—the most upstream South Fork location, ECU-3A, the 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—the most upstream North Fork location, ECU-1A-1 and the 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 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 MPCA has determined

confidence limits around the standard to account for variability within the aquatic community because of natural spatial and temporal differences and sampling or method errors. The lower confidence limit for a Class 2Bg Southern Forest Streams GP is 29.4 and the upper confidence limit is 56.6.

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.

9.3.3.2 Monitoring Results

Nine Mile Creek macroinvertebrates (bugs that can be seen with the naked eye) were monitored at seven of the eight ecological use monitoring stations (Figure 1-2) during October 1 and 2 and assessed to determine whether the MIBI values met the applicable MPCA MIBI standards for Nine Mile Creek. Samples were not collected from ECU-7A because the stream was dry on October 2 (Figure 9-37 and Figure 9-38).

Figure 9-37 Upstream Main Stem macroinvertebrate monitoring location ECU-7A/N1 on October 2, 2022 (looking upstream towards the outflow from Marsh Lake).

Figure 9-38 Upstream Main Stem macroinvertebrate monitoring location ECU-7A/N1 on October 2, 2022.

2022 results: In 2022, although none of the sample locations met the applicable MPCA standard, five of the seven locations had MIBI values greater than their respective lower confidence limits indicating they were close to the applicable MIBI standard (Figure 9-39). The MIBI value from the downstream North Fork Location, ECU-2A (Figure 9-40), of 23.8 was very close to the applicable standard of 24. The MIBI values from the middle North Fork location, ECU- 2 (Figure 9-41), the upstream South Fork location, ECU- 3A (Figure 9-42), and the two downstream Main Stem locations, ECU-7B (Figure 9-43), and ECU- 7C (Figure 9-44) ranged from 25 to 31 compared with a standard of 37 and a lower confidence limit of 24 (Figure 9-39). The MIBI values of the most upstream North Fork location, ECU-1A-1 (Figure 9-45) and the most downstream South Fork location, ECU-5A (Figure 9-46), were below the MIBI standard and the lower confidence limit.

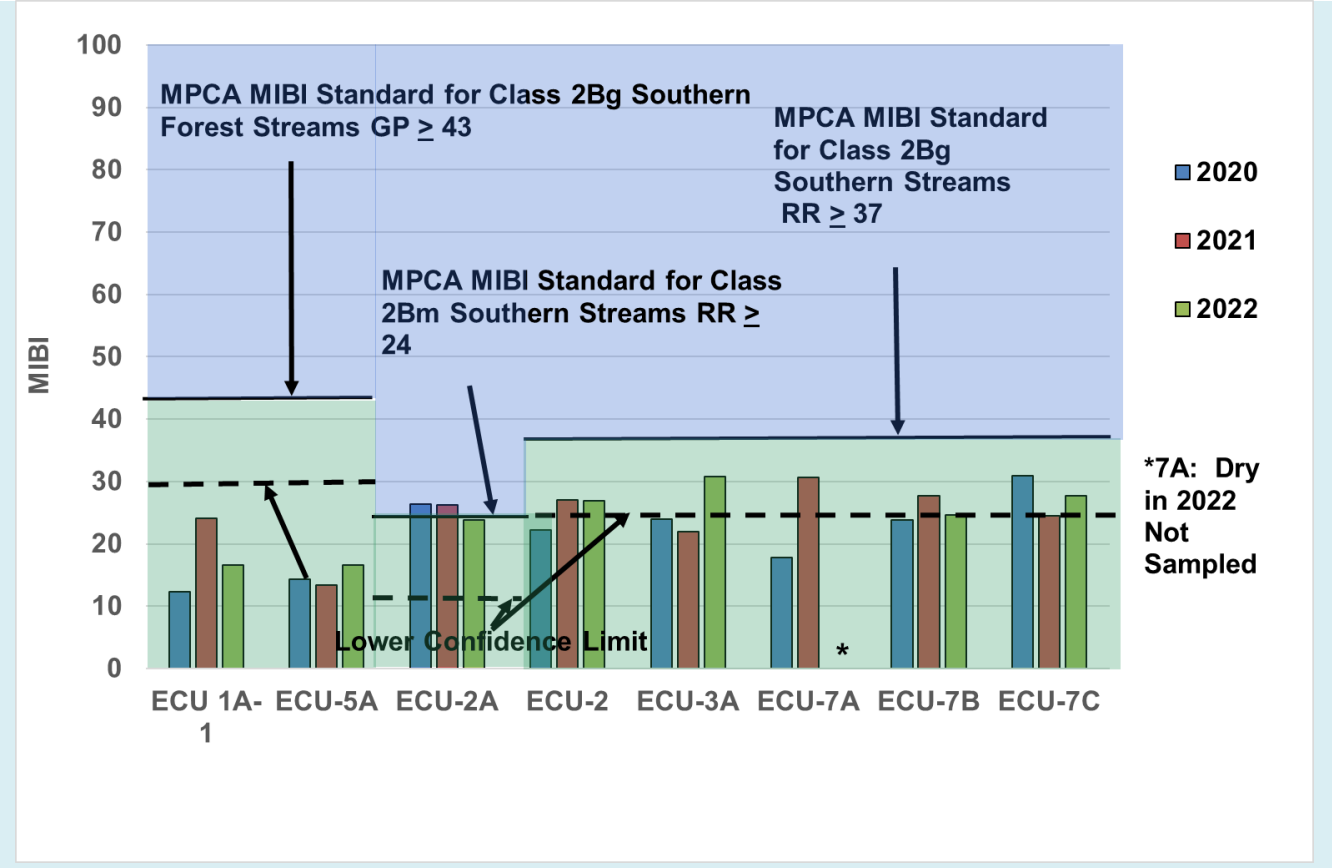


Figure 9-39 2020-2022 Nine Mile Creek Macroinvertebrate Index of Biotic Integrity (MIBI) values compared with the MPCA MIBI standard for a Class 2Bg Southern Forest Streams GP (ECU-1A-1 and ECU-5A) or a Class 2Bm Southern Streams RR (ECU-2A), or a Class 2Bg Southern Streams RR (ECU-2, ECU-3A, ECU-7A, ECU-7B, and ECU-7C).

Figure 9-40 Downstream North Fork location ECU-2A October 1, 2022.

Figure 9-41 Middle North Fork location ECU-2 on October 1, 2022.

Figure 9-42 Upstream South Fork location ECU-3A on October 1, 2022.

Figure 9-43 Middle Main Stem location ECU-7B on October 1, 2022.

Figure 9-44 Downstream Main Stem location ECU-7C on October 1, 2022.

Figure 9-45 Upstream North Fork location ECU-1A-1 on October 1, 2022.

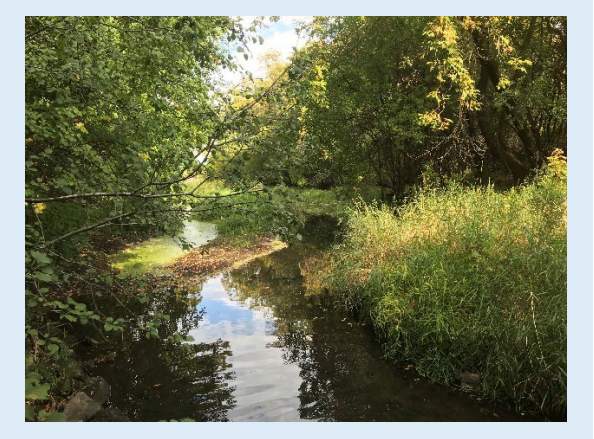


Figure 9-46 Downstream South Fork location ECU-5A on October 1, 2022.

2020-2022 results: The most downstream North Fork location, ECU-2A, met the applicable MIBI standard during both 2020 and 2021, 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. None of the other locations met the applicable standard during 2020 through 2022. 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 2022.
- 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.
- 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 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 and 2022, 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 less than the lower confidence limit in 2020 and 2021.

MIBI values from two locations were below both the applicable standard and lower confidence limit during 2020 through 2022:

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

The following biological stressors identified by the *Nine Mile Creek Biological Stressor Identification* (2010) were documented at Nine Mile Creek macroinvertebrate monitoring stations during 2022:

- South Fork of Nine Mile Creek - low dissolved oxygen (ECU-5A), low baseflow (ECU-3A and ECU-5A), and ionic strength due to excess chlorides (ECU-5A).
- North Fork of Nine Mile Creek - low dissolved oxygen (ECU-2) and ionic strength due to excess chlorides (ECU-1A-1, ECU-2, and ECU-2A).
- Main Stem of Nine Mile Creek - low dissolved oxygen (ECU-7A/N1) and ionic strength due to excess chlorides (ECU-7A/N1 and ECU-7B)
- Main Stem of Nine Mile Creek - low dissolved oxygen (ECU-7A/N1) and ionic strength due to excess chlorides (ECU-7A/N1 and ECU-7B)

9.4 Stream Monitoring Conclusions

Table 9-2 summarizes stream monitoring data from 2022. Overall, 87 percent of the 2022 observed values were within MPCA standards. The South Fork (87 percent of observed values) and Main Stem (95 percent of observed values) met MPCA standards most frequently followed by the North Fork (82 percent of observed values). All Nine Mile Creek temperature and pH measurements, 87 percent of the dissolved oxygen measurements, and 62 percent of the specific conductance measurements met MPCA standards.

As in previous years, the North Fork locations met the MPCA standard for specific conductance less frequently than other sampling locations—34 percent of the North Fork measurements met the MPCA specific conductance standard in 2022 compared with 71 percent of South Fork and 91 percent of Main Stem measurements.

In 2022, the South Fork met the MPCA standard for dissolved oxygen less frequently than other sampling locations — 75 percent of the dissolved oxygen measurements from the South Fork were within the MPCA criterion in 2022 compared with 91 percent of Main Stem and 94 percent of North Fork measurements.

Because 2021 and 2022 were dry years, water depths in 2022 were generally similar to 2021 depths and lower than most historical depths. 2022 water depths at upstream North Fork locations ECU-1A-1 and ECU-2 and downstream Main Stem location ECU-7C were the lowest depths measured during habitat surveys during the 2003 through 2022 period of record.

Table 9-2 2022 Nine Mile Creek Stream Data Summary

Stream Section	Station	Specific Conductance		Dissolved Oxygen		pH	Temperature	Turbidity		Minimum Baseflow (March-October)	Average Water Depth (June 20-27, 2022)[3]	Fish IBI[3]	Macroinvertebrate IBI[4]
		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	8/8	March - Oct							0.6	33 (13)	did not meet standard or lower confidence limit	did not meet standard or lower confidence limit
North Fork	ECU-2	4/8	May, July, September, October	2/8	July, September,					0.3	17 (7)	did not meet standard or lower confidence limit	met lower confidence limit
North Fork	ECU-2A	5/8	May, July, August, September, October							1.3	12 (5)	met standard	met lower confidence limit
South Fork	ECU-3A									<0.1	14 (6)	did not meet standard or lower confidence limit	met lower confidence limit
South Fork	ECU-5A	3/8	May, August, October	2/8	July September					<0.1	31 (12)	did not meet standard or lower confidence limit	did not meet standard or lower confidence limit
Main Stem	ECU-7A	1/7[2]	August	2/7[2]	July, September					Dry stream bed	29 (11)	met lower confidence limit	dry stream bed – not sampled
Main Stem	ECU-7B	1/8	August							0.1	25 (10)	did not meet standard or lower confidence limit	met lower confidence limit
Main Stem	ECU-7C									1.1	22 (9)	met standard	met lower confidence limit

[1]Turbidity was a State standard (25 NTU) from the 1960's 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]ECU7-A was dry in October

[3]Fish surveys and water depth measurements were completed during June 20-27, 2022.

[4]Macroinvertebrate survey was completed October 1-2, 2022.

The downstream North Fork (ECU-2A) and Main Stem (ECU-7C) locations met the State Fish IBI standard in 2022. The upstream Main Stem location (ECU-7A) did not meet the State Fish IBI standard in 2022 but met the lower confidence limit indicating it was close to the standard.

None of the stations met the State Macroinvertebrate IBI standard in 2022. However, the middle (ECU-2) and downstream North Fork (ECU-2A) locations, the upstream South Fork location (ECU-3A), and the middle (ECU-7B) and downstream Main Stem (ECU-7C) locations met the applicable lower confidence limit in 2022, indicating the scores were close to the standard. The 2022 MIBI score of 23.8 at downstream North Fork location ECU-2A was very close to the applicable standard of 24.

Several biological stressors identified by the *Nine Mile Creek Biological Stressor Identification* (2010) were documented as present in Nine Mile Creek during 2022, including:

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

9.5 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 2022 data documented high specific conductance measurements (a surrogate for chlorides) at all North Fork locations, the downstream South Fork location (ECU-5A), and the upstream (ECU-7A/N1) and middle (ECU-7B) Main Stem locations, an indication of high chloride concentrations in the stream. 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 2022, 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 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 2022 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 MPCA is scheduled to conduct stream monitoring in the Lower Minnesota River watershed in 2025 to assess attainment of State water quality standards. The District should consider contacting MPCA staff in 2023 to discuss ongoing District monitoring efforts and results and seek guidance on future stressor evaluation monitoring.

10 Lake Level Monitoring

10.1 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 weed 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 2022, 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 10-1 summarizes the net change in lake levels between the beginning of 2022 and end of 2022, as well as the historic high and low water elevations. Graphs showing measured lake levels from January 2000 through December 2022 are included in Appendix M.

During 2022, 27 of the monitored lake levels decreased and 2 of the monitored lake levels increased from the beginning to the end of the year. The lowered lake levels reflect that 2022 was an especially dry year, as compared with 2019 which was the wettest year on record for the Twin Cities metropolitan area. The declining lake levels also generally reflect that many groundwater levels in the region were also declining in 2022. Several of the lakes came very close to meeting historical low water elevation records, and two lakes were either equal to or lower than the historical low water elevation record: Arrowhead Lake in Edina (871.4 feet on 2/18/1981, 11/28/2022, and 12/27/2022) and South Lake Cornelia in Edina (858.0 feet on 11/28/2022, previous record was 858.1 feet on 12/8/1967). Note that in late-September, City of Edina staff repaired the outlet weir structure at South Lake Cornelia, replacing a small chunk of missing concrete that was causing flow out of the lake below the normal water control elevation. The most notable net drop in lake level was Birch Island Lake in Eden Prairie, which dropped 2.6 feet from December 2021 to December 2022.

Table 10-1. Summary of 2022 Monthly Observed Lake Levels

Lake	Measured Lake Level-December 2021 (12/28/2021)	Measured Lake Level-December 2022 (12/27/2022)	Net Change in Measured Lake Levels (12/28/2021 - 12/27/2022)	Historical High Water Elevation		Historical Low Water Elevation	
	[feet MSL]	[feet MSL]	[feet]	[feet MSL]	Date	[feet MSL]	Date
NW Anderson	838.3	837.5	-0.8	841.8	7/24/1987	833.0	1/5/2009
SE Anderson	836.7	834.7	-2.0	841.8	7/24/1987	833.1	2/28/2013
SW Anderson	838.4	837.8	-0.6	841.8	7/24/1987	835.1	12/8/1964
Arrowhead[1]	873.4	871.4	-2.0	878.6	7/24/1987	871.4 (871.4)	2/18/1981 (11/28/2022 & 12/27/2022)
Birch Island[3]	879.7	877.1	-2.6	891.2	3/24/1969	875.1	2/28/2013
Bryant	851.3	850.3	-1.0	854.8	7/24/1987	849.3	1/14/1977
Bush[2]	830.8	829.5	-1.2	836.9	6/11/1999	826.0	8/8/1964
N Cornelia	859.3	858.6	-0.8	864.1	7/24/1987	858.1	12/8/1967
S Cornelia	859.2	858.1	-1.1	864.1	7/24/1987	858.0	11/28/2022
Edina	821.1	819.8	-1.3	825.4	7/24/1987	817.8	2/9/1982
N Garrison	864.2	863.4	-0.9	864.8	4/10/1965	860.7	2/28/2012
Glen	901.8	900.3	-1.5	905.0	8/6/1965	898.2	7/30/2010
Hawkes[2]	885.3	884.1	-1.2	892.2	7/24/1987	881.6	1/14/1977
Indianhead[1]	862.5	862.6	0.1	865.2	5/31/2019	861.0	2/28/2013
Lone[1]	898.8	897.4	-1.4	901.6	10/25/2019	895.4	2/6/1990
Minnetoga	896.2	895.1	-1.1	899.1	7/24/1987	894.1	2/6/1990
Mirror[2]	906.3	905.3	-1.0	912.1	7/24/1987	901.8	1/14/1977
Nancy (formerly S. Garrison)	863.0	862.0	-1.0	863.3	4/10/1965	860.7	12/30/2011
Normandale	808.3	808.1	-0.2	815.8	7/24/1987	-	-
Oxboro	802.0	804.0	2.1	813.3	7/24/1987	797.9	1/15/1991
Pauly's Pond	816.0	814.5	-1.5	821.2	7/24/1987	811.8	7/29/1988
Penn (Lower)	807.3	805.1	-2.2	816.6	7/24/1987	802.3	2/28/2013
Rose	922.7	920.3	-2.4	928.4	4/4/1966	919.6	1/8/1990
Shady Oak[1]	901.8	900.6	-1.2	905.6	5/31/2019	897.8	1/29/1990
Skriebakken	803.1	801.6	-1.5	811.3	7/24/1987	801.2	1/22/1977
Smetana	835.2	835.1	-0.1	840.6	7/24/1987	830.2	11/8/1976
Swimming Pool Pond (formerly Valley View)	862.7	861.9	-0.8	865.4	7/24/1987	860.1	2/28/2012
Wanda Miller	819.9	818.8	-1.1	826.7	7/24/1987	814.8	2/28/2013
Wing	938.0	937.1	-0.9	941.5	7/24/1987	933.5	1/31/1989

[1] Land-locked lakes

[2] Pumped outlet

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

11 Groundwater Well Monitoring

11.1 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 2022, only 6 of the groundwater observation wells remain active. The active groundwater observation wells are shown in Figure 1-1.

Table 11-1 summarizes the groundwater level observations from 2022. The table includes measured groundwater observations from the end of 2021 (12/26/2021) and end of 2022 (12/26/2022), 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 0.3 foot increase in Well 35 (east of Lake Edina in Edina) to a 2.4 foot decrease in Well 7 (northeast of Bredesen Park in Edina). Table 11-1 also lists the maximum fluctuation of each well during this year. The maximum fluctuation observed throughout this year ranged from an approximately 1.8 foot increase at Well 35 (east of Braemar Golf Course in Edina) to a 3.0 foot decrease at Well 7 (northeast of Bredesen Park in Edina), with an average maximum fluctuation of 1.2 feet decrease. There were no new historical high or low water elevation records set in 2022.

Table 11-1 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 2022 are included in Appendix N.

Table 11-1. Summary of 2022 Monthly Groundwater Levels

Well ID	Measured Groundwater Level- December 2021 (12/26/2021)	Measured Groundwater Level- December 2022 (12/26/2022)	Net Change in Measured Groundwater Levels (12/26/2021 - 12/26/2022)	Maximum 2022 Fluctuation	Historical High Water Elevation		Historical Low Water Elevation	
	[feet MSL]	[feet MSL]	[feet]	[feet]	[feet MSL]	Date	[feet MSL]	Date
7	875.2	872.8	-2.4	-3.0	894.9	3/25/2004	857.2	10/17/1989
22	798.3	796.3	-2.0	-1.8	802.3	5/3/1966	791.0	5/31/1990
26	821.0	820.9	-0.1	-0.1	827.9	4/29/2003	813.4	12/1/1964
35	841.5	841.8	0.3	1.8	848.7	3/15/2005	834.1	1/1/1964
41	881.5	879.6	-1.9	-2.1	885.8	8/26/2019	871.0	8/10/1977
52	851.8	850.6	-1.2	-1.7	855.0	3/17/2003	849.1	9/15/1994

Appendices

Available as separate PDF