Wing Lake Photo by: J. Albers

Nine Mile Creek Watershed District
2016 Annual Water Quality Monitoring Report

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Summary of 2016 Water Quality Monitoring Programs

The 2016 Nine Mile Creek Watershed District (NMCWD) water quality monitoring programs included monitoring five lakes (Southwest Anderson, Smetana, Normandale, Penn, and Cornelia) and Nine Mile Creek.

Figure 1 **The District completed a water quality improvement project of Southwest Anderson Lake, pictured above, during 2008 through 2012 that substantially improved its water quality.**

Nine Mile Lake Monitoring

The 2016 NMCWD lake water quality monitoring program included monitoring five lakes (Southwest Anderson, Smetana, Normandale, Penn, and Cornelia). Each lake was monitored on six occasions for selected parameters including: total phosphorus, soluble reactive phosphorus (ortho phosphorus), total nitrogen, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, pH, chlorophyll *a*, chloride, dissolved oxygen, temperature, specific conductance, turbidity, oxidation reduction potential (ORP), phytoplankton, and zooplankton. Aquatic plant (macrophyte) surveys were performed during June and August. Results of the 2016 lake monitoring program follow.

Figure 2 **The plant community of Southwest Anderson Lake, pictured above, has improved since the onset of the water quality improvement project.**

Southwest Anderson Lake

Southwest Anderson Lake is located in Eden Prairie. The lake is quite shallow, especially in comparison with its large surface area of approximately 110 acres (the open water area is variable, depending upon the seasonally-varying coverage of the lake's cattail fringe). It has a maximum depth of approximately 8 feet and a mean depth of approximately 4 feet. The lake is shallow enough for plants to grow over the entire lake. It is a polymictic lake, mixing many times per year.

In 2016, Southwest Anderson Lake water quality was good. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 15 µg/L and 4 µg/L, respectively, and the lake's summer average Secchi disc transparency was 1.0 meter. As shown on Figure 3, all three 2016 summer averages met the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion published in Minnesota Rules 7050.

The Nine Mile Creek Watershed District completed a water quality improvement project in

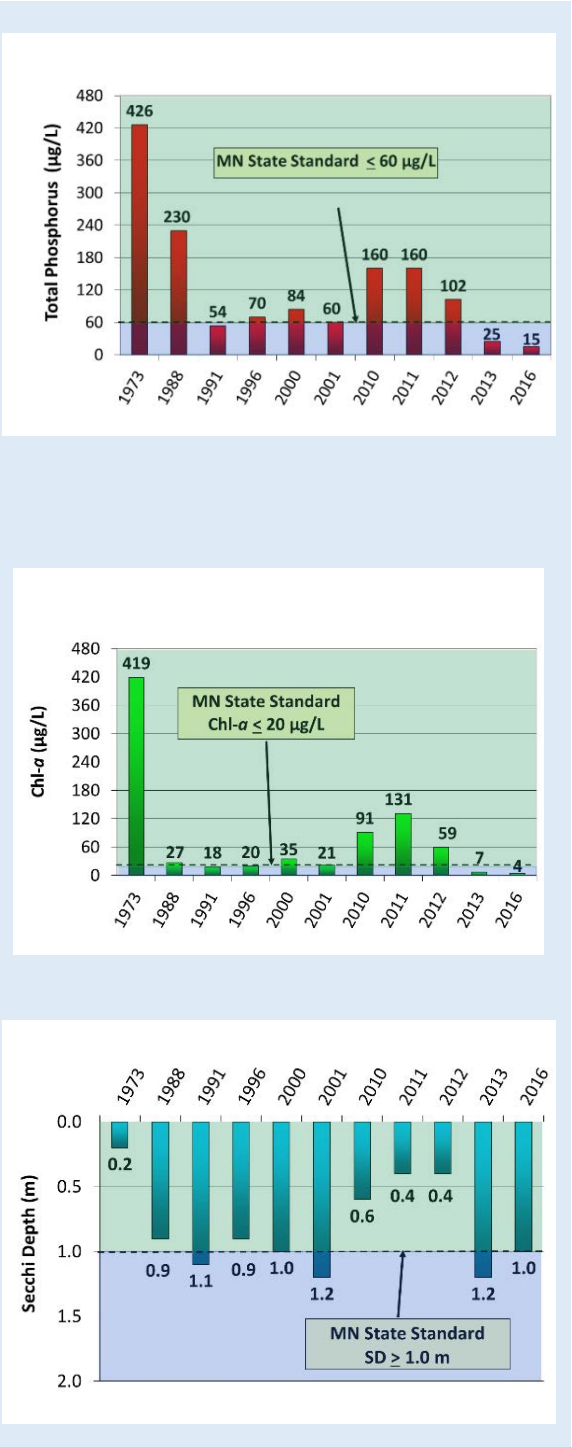

Figure 3 **Southwest Anderson Lake summer average total phosphorus, chlorophyll *a*, and Secchi disc values during 1973-2016.**

Southwest Anderson Lake during 2008 through 2012 to reduce phosphorus loading to the lake from internal sources. A partial lake drawdown in 2008 followed by herbicide treatments in the lake's center during the spring of 2010 and 2011 reduced internal phosphorus loading from curly-leaf pondweed. An alum treatment in the fall of 2012 further reduced internal phosphorus loading from lake sediment. The lake's water quality was substantially improved by the project (Figure 1 and Figure 3).

- The lake's pre-treatment summer average total phosphorus concentration (i.e., average of 1988-2001) was 100 µg/L compared with a post-treatment concentration (i.e., average of 2013-2016) of 20 µg/L. The 1973 value was excluded from the pre-treatment average because only 1 sample was collected in 1973 (i.e., August).
- The lake's pre-treatment summer average total chlorophyll *a* concentration (i.e., average of 1988-2001) was 23.3 µg/L compared with a post-treatment concentration (i.e., average of 2013-2016) of 5.7 µg/L.
- The lake's pre-treatment summer average Secchi disc transparency (i.e., average of 1988-2001) was 1.0 meters compared with a post-treatment transparency (i.e., average of 2013-2016) of 1.1 meters.

Chloride is present in deicing chemicals applied to streets in the Southwest Anderson Lake watershed. When snow and ice melts, the salt goes with it, washing into the lake. Chloride levels in Southwest Anderson Lake in 2016 were low and met the MPCA chronic exposure standard of 230 mg/L. In 2016, chloride levels in Southwest Anderson Lake ranged from 31 mg/L to 35 mg/L, indicating very little chloride is added to the lake from deicing chemicals.

The Minnesota Department of Natural Resources (MDNR) recently developed metrics to determine the overall health of a lake's aquatic plant community. The Lake Eutrophication Index of Biological Integrity (IBI) is intended to be used by the MPCA to determine whether a lake is meeting the federal Clean Water Act standards intended to protect aquatic life. The plant IBI has not yet been used by the MPCA to determine biological impairment, but is expected to eventually be used. The plant 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).

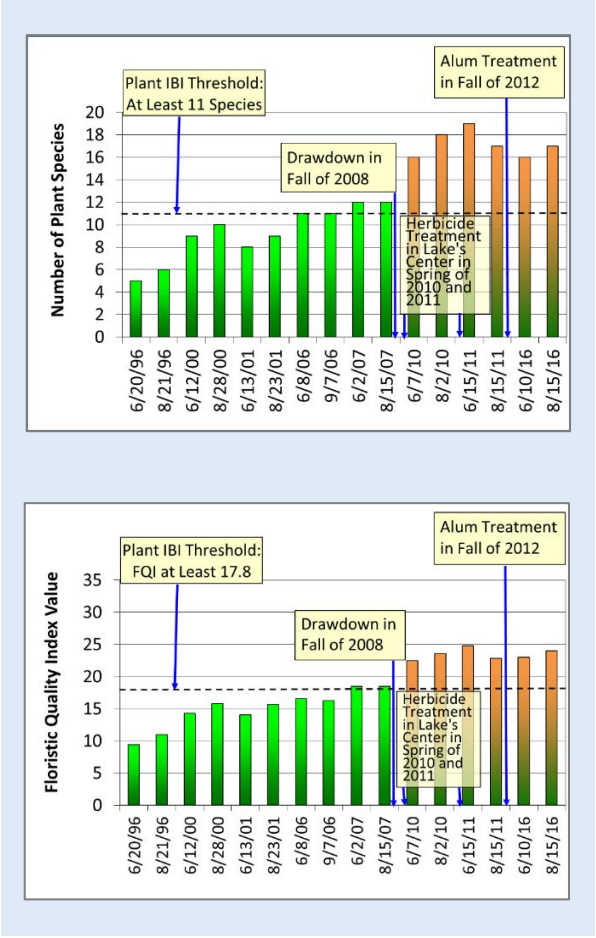

Figure 4 **1996-2016 Southwest Anderson Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).**

Southwest Anderson Lake plant survey data from 1996 through 2016 were assessed to determine plant IBI values. Figure 4 shows the number of species and FQI for that period compared to the MDNR plant IBI impairment thresholds.

Prior to the lake water quality improvement project, plant IBI values generally failed to meet the proposed impairment thresholds. During 1996 through 2006, the number of species in Southwest Anderson Lake ranged from 5 to 11 compared with the impairment threshold of at least 11 species. FQI values during that period ranged from 9.4 to 16.3 compared with the impairment threshold of at least 17.8. The plant community would be considered impaired throughout that

period. The quality of the plant community improved in 2007 and the plant community would not be considered impaired—12 species and a FQI value of 18.5. Reduction of curly-leaf pondweed and improvement of lake water quality substantially improved the health of the plant community. During 2010 through 2016, the number of species in Southwest Anderson Lake ranged from 16 to 19, exceeding the proposed impairment threshold of at least 11 species. FQI values during this period ranged from 22.5 to 24.8, which also exceeded the proposed impairment threshold (17.8 minimum). The lake would have consistently met plant IBI criteria since onset of the lake's water quality improvement project and would not be considered impaired in terms of its ability to support aquatic life (Figure 4).

In 2016, one invasive species was known to be present in Southwest Anderson Lake. Curly-leaf pondweed (*Potamogeton crispus*) was present at the lake's center and near the south shore, but was not considered problematic. It coexisted with native plants at relatively low densities.

Smetana Lake

Smetana Lake is located in Eden Prairie, with the south fork of the creek flowing through the lake. The lake has a surface area of 52 acres, a maximum depth of 10 feet, and a mean depth of 5 feet. The lake is shallow enough for plants to grow over the entire lake. It is a polymictic lake, mixing many times per year.

In 2016, Smetana Lake water quality was good. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 41 µg/L and 9 µg/L, respectively, and the lake's summer average Secchi disc transparency was 2.0 meters. As shown on Figure 6, all three 2016 summer averages met the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion.

The Nine Mile Creek Watershed District completed a water quality improvement project in Bryant Lake during 2008—an alum treatment of Bryant Lake in fall. Because the outflow from Bryant Lake comprised 76 percent of the annual phosphorus load to Smetana Lake, the Bryant Lake improvement project substantially improved the water quality of Smetana Lake.

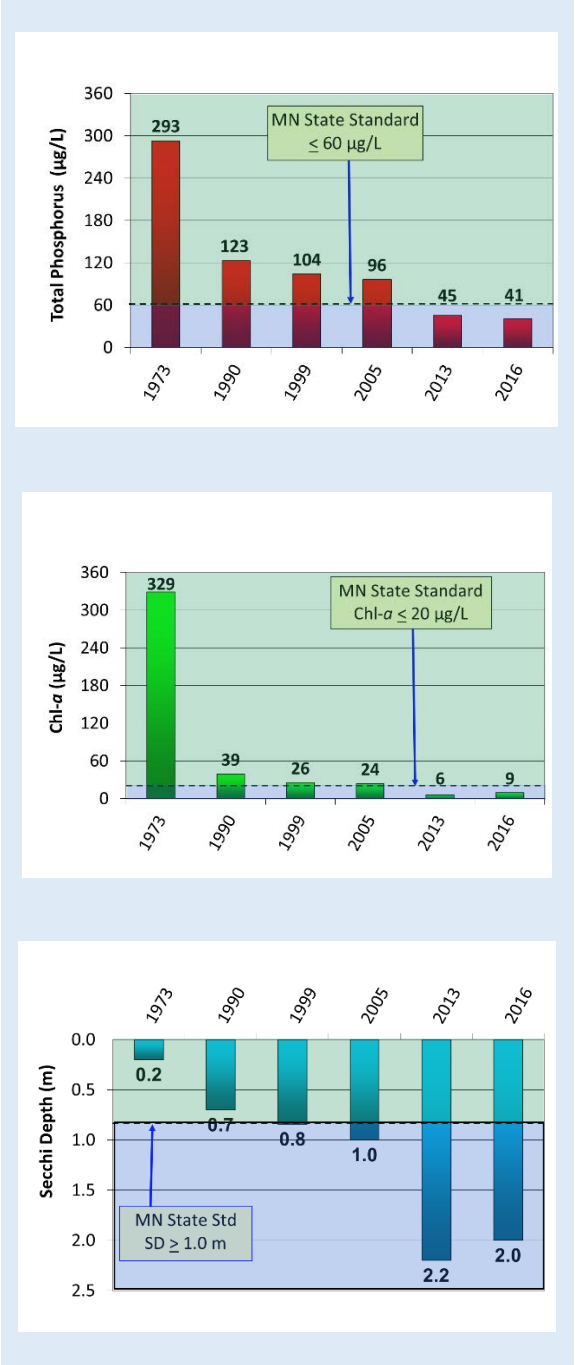

Figure 5 **Smetana Lake summer average total phosphorus (top), chlorophyll *a* (middle), and Secchi disc (bottom) values during 1973-2016.**

- Pre-treatment of Bryant Lake, the lake's summer average total phosphorus concentration (i.e., average of 1990-2005) was 108 µg/L, compared with a post-treatment concentration (i.e., average of 2013-2016) of 43 µg/L. The 1973 value was excluded from the pre-treatment average because only 1 sample was collected in 1973 (i.e., August).
- Pre-treatment of Bryant Lake, the lake's summer average total chlorophyll *a* concentration (i.e., average of 1990-2005) was 30 µg/L compared with a post-treatment concentration (i.e., average of 2013-2016) of 7.5 µg/L.
- Pre-treatment of Bryant Lake, the lake's summer average Secchi disc transparency (i.e., average of 1990-2005) was 0.8 meters compared with a post-treatment transparency (i.e., average of 2013-2016) of 2.1 meters.

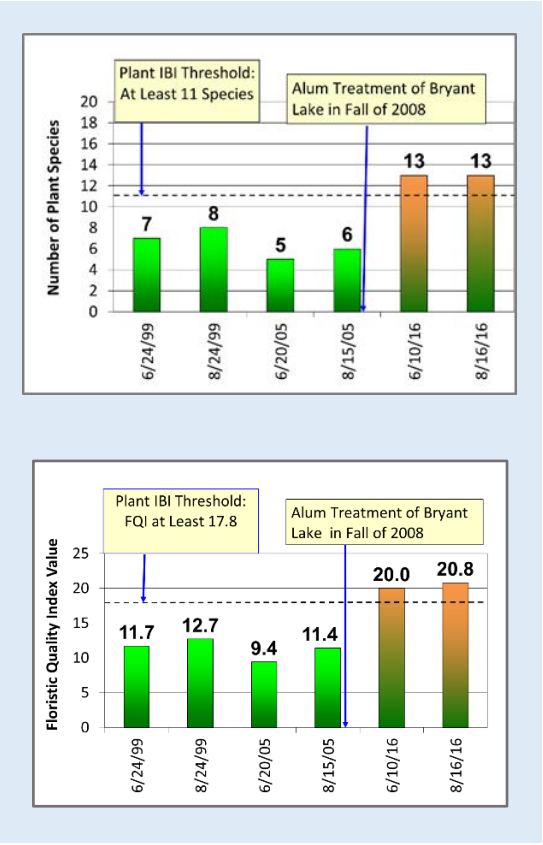

Figure 6 **1999-2016 Smetana Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).**

Chloride present in deicing chemicals applied to streets in the Smetana Lake watershed is conveyed to the lake by snowmelt and rainfall runoff. In 2016, chloride levels in Smetana Lake ranged from 78 mg/L to 137 mg/L and met the MPCA chronic exposure standard of 230 mg/L or less.

Smetana Lake plant survey data from 1999 through 2016 were assessed to determine plant IBI values. Figure 7 shows the number of species and FQI for that period compared to the MDNR plant IBI impairment thresholds.

Prior to the improvement of Smetana Lake water quality, plant IBI values consistently would have failed to meet the proposed impairment thresholds. During 1999 through 2005, the number of species in Smetana Lake ranged from 5 to 8 compared with the proposed impairment threshold of at least 11 species. FQI values during that period ranged from 9.4 to 12.7 compared with the proposed impairment threshold of at least 17.8. Since the Bryant Lake alum treatment in fall of 2008, the Smetana Lake water quality and plant community improved and the plant community would meet plant IBI criteria in 2016—13 species and FQI ranging from 20.0 to 20.8 (Figure 7).

Figure 7 **In 2016, Smetana Lake, pictured above, had good water quality.**

In 2016, two invasive species were known to be present in Smetana Lake, curly-leaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*). Both species were prevalent, but coexisted with native plants at relatively low densities. Neither species was considered problematic.

Penn Lake

Penn Lake is located in Bloomington. The lake has a water surface area of approximately 32 acres, a maximum depth of approximately 7 feet, and a mean depth of 5.6 feet at a water surface elevation of 807.0 MSL.

In 2016, Penn Lake water quality was poor. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 115 µg/L and 71 µg/L, respectively, and the lake's summer average Secchi disc transparency was 0.3 meters. As shown on Figure 8, the three 2016 summer averages failed to meet the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion.

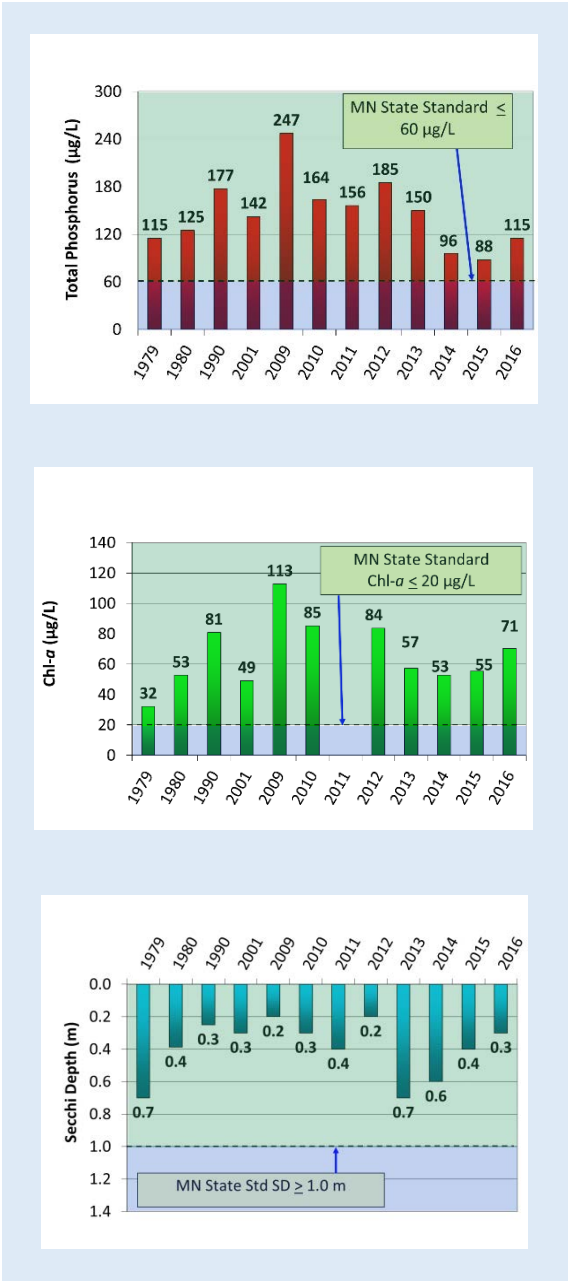

Figure 8 Penn Lake summer average total phosphorus, chlorophyll *a*, and Secchi disc values during 1979-2016.

The poor water quality observed in 2016 was typical of the water quality observed in previous years. Previous summer average total phosphorus concentrations ranged from 88 µg/L to 247 µg/L compared with 115 µg/L in 2016. Previous summer average chlorophyll *a* concentrations ranged from 32 µg/L to 113 µg/L compared with 71 µg/L in 2016. Previous summer average Secchi disc transparencies ranged from 0.2 meters to 0.7 meters compared with 0.3 meters in 2016. Summer averages for total phosphorus, chlorophyll *a*, and Secchi disc transparency failed to meet the

Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion during the entire period of record (Figure 8).

Chloride concentrations in area lakes have increased since the early 1990s when many government agencies switched from sand or sand/salt mixtures to salt for winter road maintenance. The Penn Lake watershed is highly impervious and includes portions of I-494, I-35W, Southtown, and several car dealerships along the freeway corridor. Because high concentrations of chloride can harm fish and plant life, the MPCA has established a chronic exposure chloride standard of 230 mg/L or less. In 2016, chloride concentrations in Penn Lake ranged from a high of 229 mg/L in April to a low of 23.5 mg/L in August. All 2016 chloride concentrations met the MPCA standard.

Samples of phytoplankton (microscopic aquatic plants) were collected from Penn Lake in 2016 to evaluate water quality, determine the quality of food available to the lake's zooplankton (microscopic animals), and estimate the public health risk posed by blue-green algae, which can produce toxins. In high concentrations, these toxins can be harmful to pet and human health. The World Health Organization (WHO) has established the following guidelines for assessing the risk posed to lake users by exposure to blue-green algae.

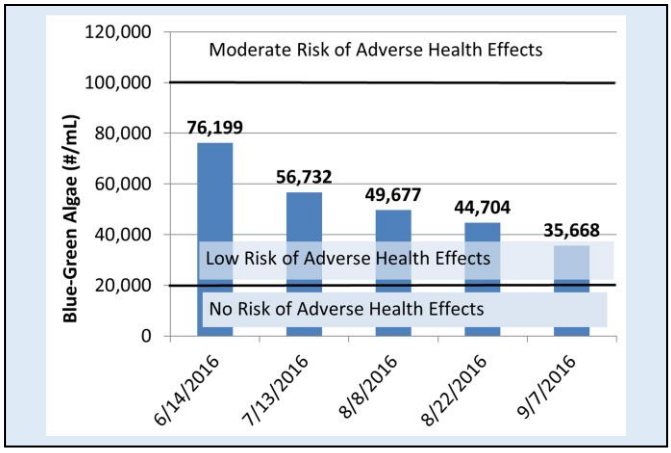

Figure 9 **Penn Lake blue-green algae numbers during 2016 compared with WHO guidelines for assessing risk posed to lake users by exposure to blue-green algae.**

- Lakes with blue-green algae densities less than 20,000 cells per milliliter pose no risk to the health of humans or pets

- Exposure to lakes with blue-green algae density levels between 20,000 and 100,000 cells per milliliter poses a low risk of adverse health impacts (i.e., skin irritation or allergenic effects such as watery eyes).
- Exposure to lakes with blue-green algae densities greater than 100,000 cells per milliliter poses a moderate health risk (i.e., long-term illness from algal toxins is possible).

Figure 10 **In 2016, blue-green algae numbers in Penn Lake, pictured above, were within the low-risk of adverse health effects category.**

Blue-green algae, a poor food source for zooplankton, dominated the Penn Lake algae community throughout 2016. Blue-green numbers were highest in June and consistently declined throughout the growing season. The abundance of blue-green algae was consistent with the poor water quality observed in the lake in 2016. As shown on Figure 9, blue-green algae numbers were within the low-risk of adverse health effects category throughout 2016.

Penn Lake plant survey data from 2001 through 2016 were assessed to determine plant IBI values. Figure 11 shows the number of species and FQI for that period compared to the MDNR plant IBI impairment thresholds.

During 2001 through 2016, the number of plant species in Penn Lake ranged from 1 to 3 compared with the proposed impairment threshold of at least 11 species. FQI values during that period ranged from 5.0 to 10.4 compared with the proposed impairment threshold of at least 17.8. Because both the number of species in the lake and the FQI values were below proposed

impairment thresholds for the entire period of record, Penn Lake would be considered impaired for plants. As mentioned previously, the plant IBI has not yet been used by the MPCA/MDNR to determine impairment. However, it is expected to eventually be used to determine biological impairment.

There were no invasive species known to be present in Penn Lake during 2016.

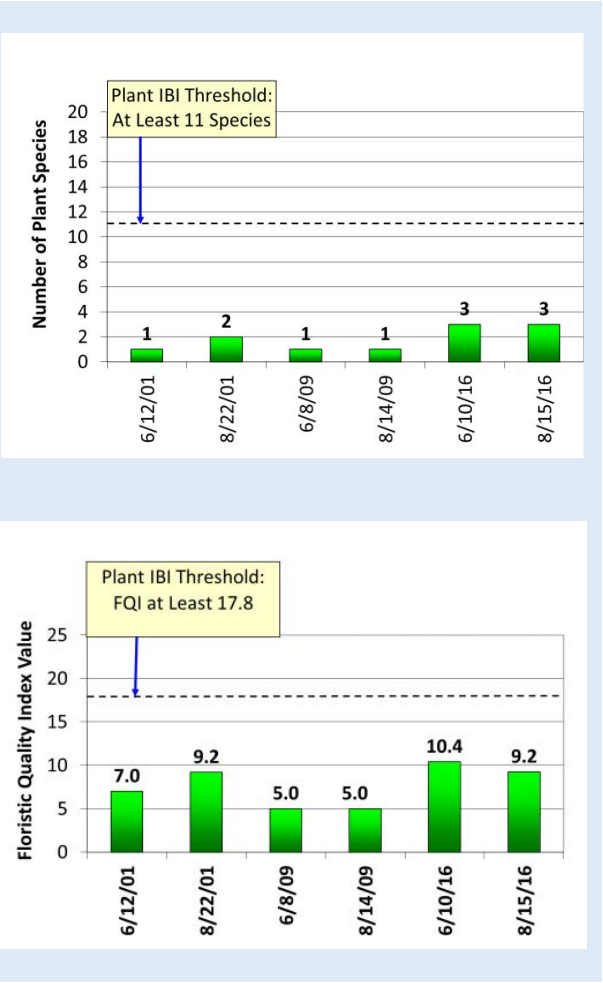

Figure 11 2001-2016 Penn Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with MDNR Plant IBI Threshold Goals: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).

Lake Cornelia

Lake Cornelia is located in the north central portion of Edina. Lake Cornelia is comprised of North (North Lake Cornelia) and South (South Lake Cornelia) basins. The two basins are connected by a 12-inch culvert under 66th Street (with an invert elevation of 859.0 MSL) on the south side of North Lake Cornelia, and a secondary 12-inch pipe located on the southeast side of North Lake Cornelia (with an invert elevation of 860.22 MSL). Ultimately the water levels in North Lake Cornelia are controlled by the outlet structure at South Lake Cornelia. The outflow from South Lake Cornelia discharges over a 14-foot long weir structure with a control elevation of 859.1 MSL. Discharges from South Lake Cornelia are conveyed to Lake Edina through an extensive storm sewer network. Due to limited stormsewer capacity downstream of Lake Cornelia, stormwater runoff backs-up into the lake during large storm events, which provides temporary storage of the flood volumes.

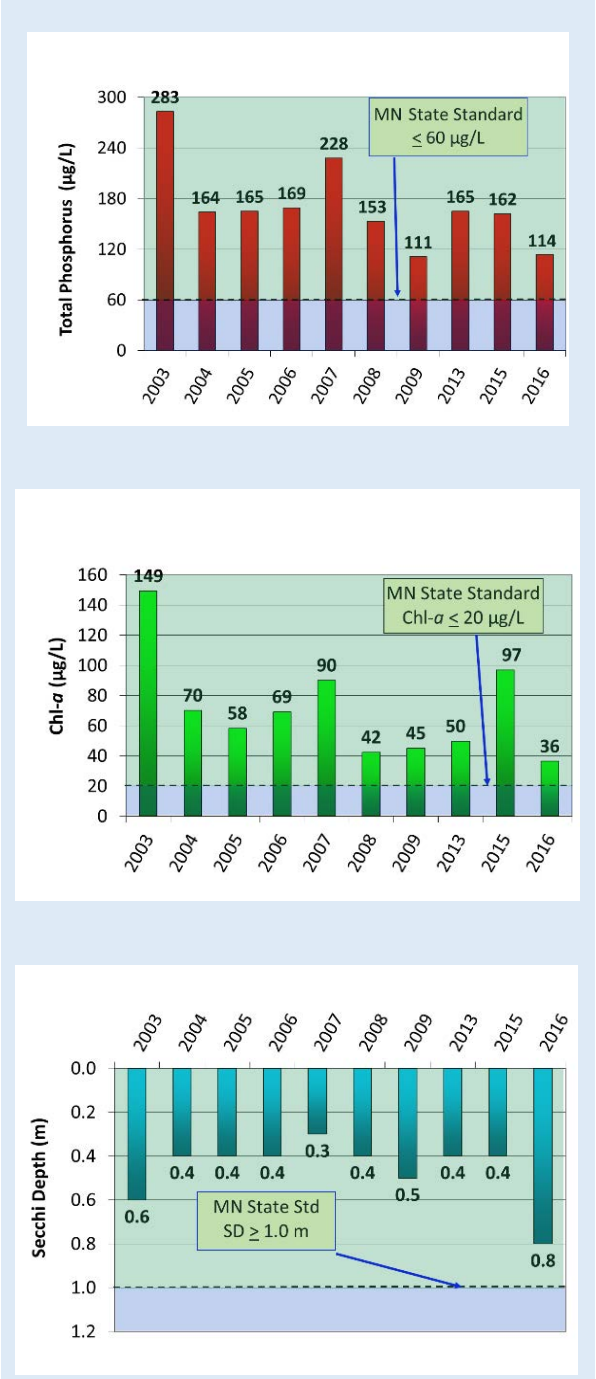

Figure 12 North Lake Cornelia summer average total phosphorus, chlorophyll *a*, and Secchi disc values during 2003-2016.

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

North Lake Cornelia

North Lake Cornelia 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 bed. It is a polymictic lake, mixing many times per year.

In 2016, North Lake Cornelia water quality was poor. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 114 µg/L and 36 µg/L, respectively. The lake's summer average Secchi disc transparency was 0.8 meters. All three summer averages failed to meet the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion in 2016.

Figure 13 **Dense curly-leaf pondweed in North Lake Cornelia, pictured above, in June of 2016.**

Poor water quality during the entire period of record has been observed in North Lake Cornelia. However, summer average water quality in 2016 was generally better than previous years. Summer average chlorophyll *a* concentration was lower in 2016 than previous years—36 µg/L in 2016 compared with 42 µg/L to 149 µg/L in 2003 to 2015. Summer average Secchi disc transparency was higher in 2016 than previous years—0.8 meters in 2016 compared with 0.3 meters to 0.6 meters in 2003 to 2015. Summer average total phosphorus concentration in 2016 was the second lowest to date—114 µg/L compared with 111 µg/L to 283 µg/L during 2003 to 2015. Nonetheless, as previously stated, North Lake Cornelia summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc

transparency failed to meet the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion during the entire period of record.

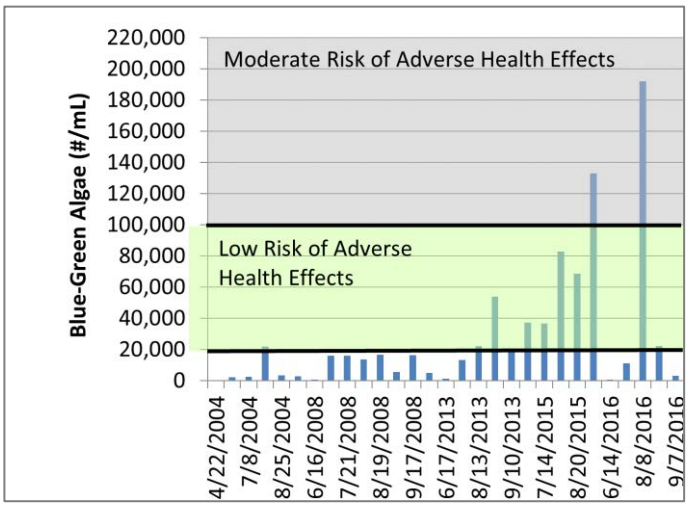

Figure 14 **North Lake Cornelia blue-green algae numbers compared with WHO guidelines for assessing the risk posed to lake users by exposure to blue-green algae.**

The lake's 2016 water quality was heavily influenced by the lake's severe curly-leaf pondweed infestation. The June plant survey documented dense curly-leaf pondweed growth throughout the entire lake (Figure 13). The 2016 curly-leaf pondweed growth was much denser than in 2015. The dense curly-leaf pondweed growth in June of 2016 was associated with lower phosphorus and chlorophyll *a* concentrations and higher Secchi disc transparency in June of 2016 than had been observed in previous years.

Curly-leaf pondweed naturally dies at the end of June and then decays, adding a pulse of phosphorus to the lake. When the lake's 2016 dense growth of curly-leaf pondweed (Figure 13) senesced, the lake's phosphorus concentrations rapidly increased, fueling a severe algal bloom. As shown on Figure 14, high numbers of blue-green algae were present during the lake's early August algal bloom. A similar scenario occurred in 2015. The 2016 curly-leaf pondweed infestation was more severe than 2015 and the resultant blue-green algae bloom was more severe in 2016 than 2015 (Figure 14).

Figure 16 **On September 7, 2016, near shore algal scum was observed in North Lake Cornelia, pictured above. Algal toxin samples were collected from the algal scum.**

WHO guidelines indicate users of North Lake Cornelia in early August of 2016 had a moderate risk of adverse health effects from exposure to the blue-greens in the lake (Figure 14). The City of Edina performed a chemical treatment of the lake with algaecide on August 8 to manage the lake's algal bloom. Although the numbers of blue-green algae were reduced by the treatment, the District and City were concerned that algal toxins could still be present in the lake and pose health risks for lake users. Hence, the District collected algal toxin samples from the lake on September 7. Blue-green numbers at the mid-lake sample location were relatively low on September 7 (Figure 14), but near shore algal scum was observed (Figure 15). Algal toxin samples were collected from the mid-lake sample location and from the near shore algal scum.

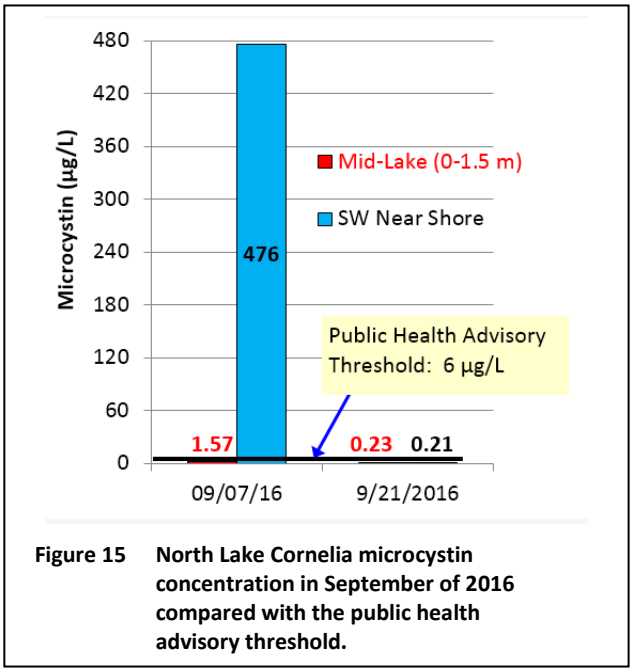

Figure 15 **North Lake Cornelia microcystin concentration in September of 2016 compared with the public health advisory threshold.**

As shown on Figure 16, high concentrations of the algal toxin microcystin were observed in the near shore algal scum sample collected on September 7—476 µg/L compared with the public health advisory threshold of 6 µg/L. However, the concentration of microcystin in the mid-lake sample was below the public health advisory threshold.

The District alerted the City of Edina and the public to the high algal toxins in the lake, advising no contact with the water until the lake's algal toxin levels declined below the public health advisory threshold.

The District again collected algal toxin samples from the lake on September 21. Algal scum was no longer observed in the lake and microcystin concentrations were below the public health advisory threshold (Figure 16). The District contacted the City of Edina and posted an update on the District website notifying the public they could again fully use the lake, including contact with the water.

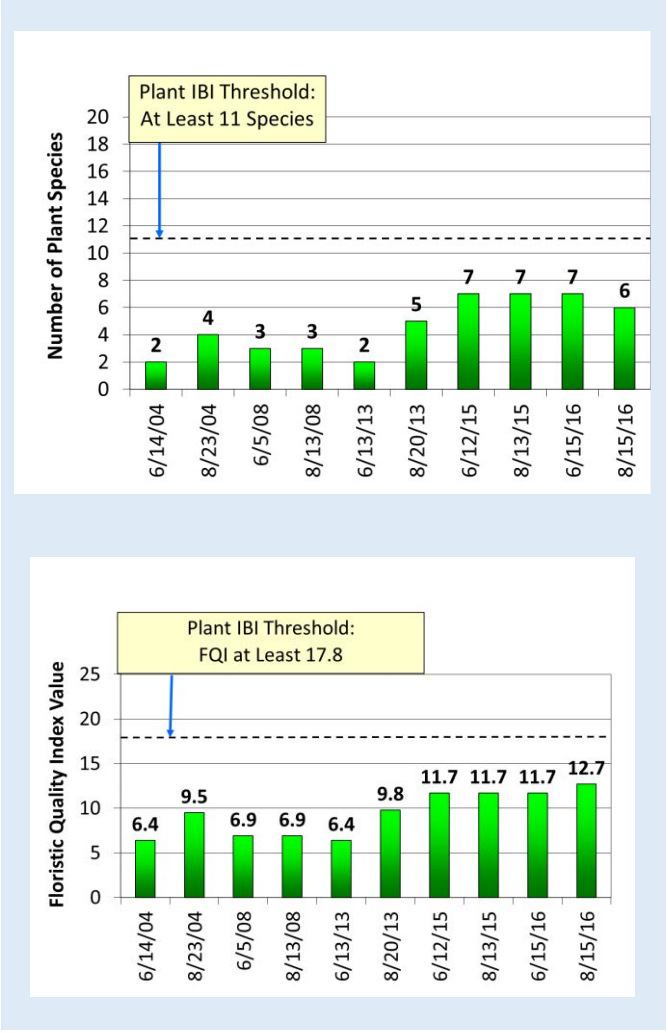

Figure 17 2004-2016 North Lake Cornelia Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).

Chloride present in deicing chemicals applied to streets in the North Lake Cornelia watershed is conveyed to the lake by snowmelt and rainfall runoff. As expected, the highest 2016 chloride concentration in North Lake Cornelia was observed in April when the April chloride concentration of 314 mg/L failed to meet the MPCA chronic exposure standard of 230 mg/L. Chloride concentrations consistently declined from April to September when the lowest concentration of 28 mg/L was observed. All other 2016 concentrations met the MPCA standard.

North Lake Cornelia plant survey data from 2004 through 2016 were assessed to determine plant IBI values. Figure 17 shows the number of species and FQI for that period compared to the MDNR plant IBI proposed impairment thresholds.

During 2004 through 2016, the number of plant species in North Lake Cornelia ranged from 2 to 7 compared with the proposed impairment threshold of at least 11 species. FQI values during that period ranged from 6.4 to 12.7 compared with the proposed impairment threshold of at least 17.8. Because both the number of species in the lake and the FQI values were below proposed impairment thresholds for the entire period of record, North Lake Cornelia would be considered impaired for plants. As mentioned previously, the plant IBI has not yet been used by the MPCA/MDNR to determine impairment. However, it is expected to eventually be used to determine biological impairment.

In 2016, two aquatic invasive species were known to be present in North Lake Cornelia: curly-leaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*). Purple loosestrife was not problematic, but curly-leaf pondweed was very problematic in June (Figure 14). In August, curly-leaf pondweed was not observed in the lake due to its natural die-off by the end of June.

South Lake Cornelia

South Lake Cornelia 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.

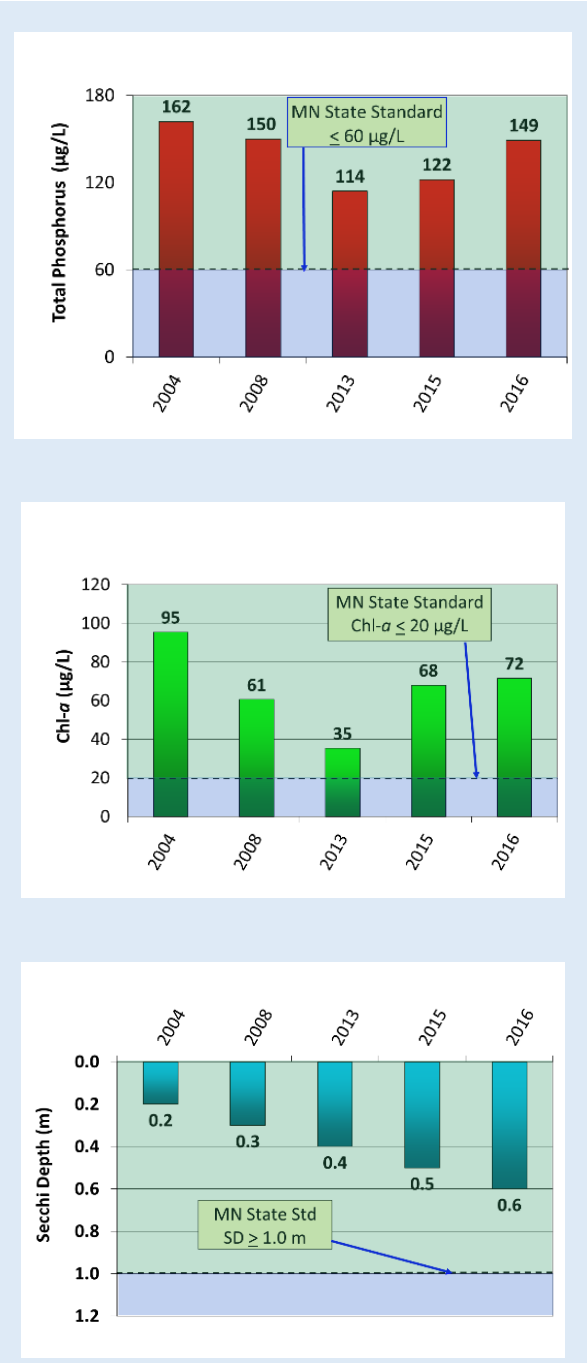

Figure 18 **South Lake Cornelia summer average total phosphorus, chlorophyll *a*, and Secchi disc values during 2003-2016.**

In 2016, South Lake Cornelia water quality was poor. The lake's summer average total phosphorus and chlorophyll *a* concentrations were 149 µg/L and 72 µg/L, respectively. The lake's summer average Secchi disc transparency was 0.6 meters. All three 2016 summer averages failed to meet the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion (Figure 18).

The poor water quality observed in 2016 was typical of the water quality observed in previous years. Previous summer average total phosphorus concentrations ranged from 114 µg/L to 162 µg/L, compared with 149 µg/L in 2016. Previous summer average chlorophyll *a* concentrations ranged from 35 µg/L to 95 µg/L, compared with

72 µg/L in 2016. Summer average Secchi disc transparency has consistently improved during the period examined, from 0.2 meters in 2004 to 0.6 meters in 2016, but was still considered poor in 2016. All three summer averages failed to meet the Minnesota State water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion during the entire period of record (Figure 18).

In 2016, South Lake Cornelia water quality, like North Lake Cornelia water quality, was heavily influenced by the lake's severe curly-leaf pondweed infestation. The June plant survey documented dense curly-leaf pondweed growth throughout the entire lake (Figure 19). As with North Lake Cornelia, the 2016 curly-leaf pondweed growth was much denser than 2015.

Figure 19 Dense curly-leaf pondweed in South Lake Cornelia in June of 2016.

Senescence of the 2016 dense growth of curly-leaf pondweed (Figure 19) appears to have fueled a severe algal bloom. As shown on Figure 20, high numbers of blue-green algae occurred during the mid-July through August algal bloom. A similar scenario occurred in 2015. However, the 2016 curly-leaf pondweed infestation was more severe than 2015 and the resultant 2016 blue-green algal bloom began earlier and was more severe than 2015 (Figure 20).

World Health Organization guidelines indicate the users of South Lake Cornelia in mid-July through early August of 2016 had a moderate risk of adverse health effects from exposure to the blue-greens in the lake (Figure 20). The City of Edina performed a chemical treatment of the lake with algaecide on August 8 to manage the lake's algal bloom. Although the numbers of

blue-green algae were reduced by the treatment, both the District and City were concerned that algal toxins could still be present in the lake and pose health risks for lake users. Hence, the District collected algal toxin samples from the lake on September 7. Near shore algal scum was observed on September 7 (Figure 21). Algal toxin samples were collected from the mid-lake sample location and the near shore algal scum.

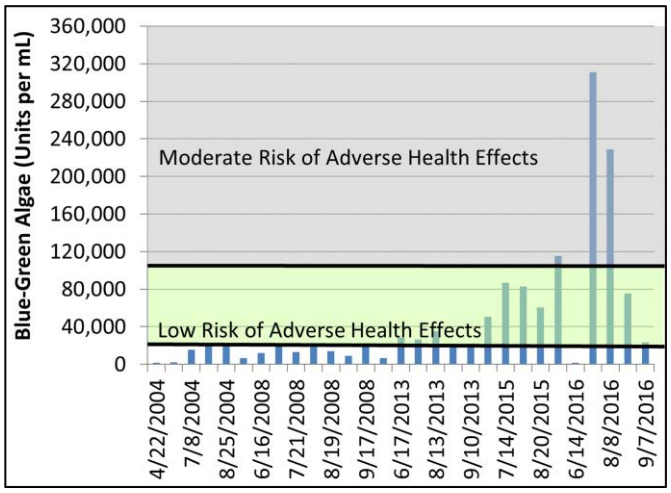

Figure 21 **South Lake Cornelia blue-green algae numbers compared with WHO guidelines for assessing the risk posed to lake users by exposure to blue-green algae.**

Figure 20 **On September 7, 2016, near shore algal scum was observed in South Lake Cornelia, pictured above. Algal toxin samples were collected from the algal scum.**

As shown on Figure 22, high concentrations of the algal toxin microcystin were observed in the near shore algal scum sample collected on September 7—99 µg/L compared with the public health advisory threshold of 6 µg/L. However, the concentration of microcystin in the mid-lake sample was below the public health advisory threshold.

The District alerted the City of Edina and the public to the high algal toxins in the lake, advising no contact with the water until the lake's algal toxin levels declined below the public health advisory threshold.

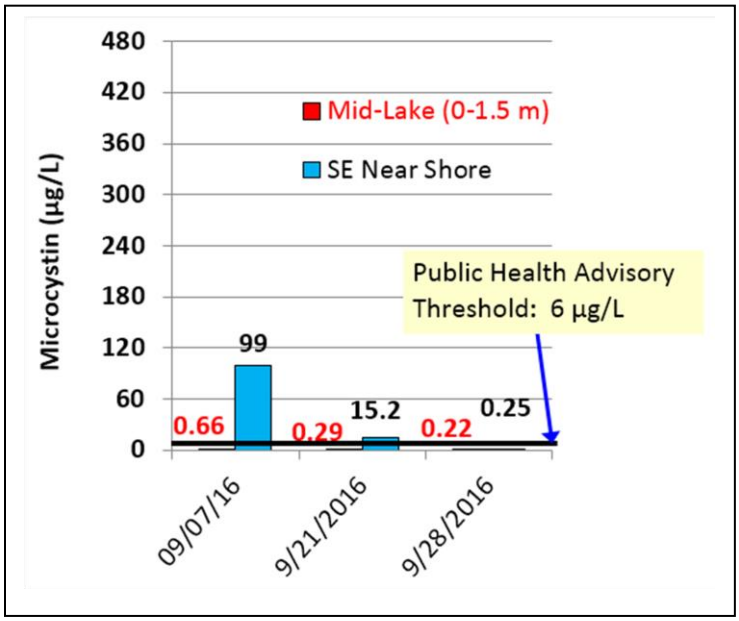

Figure 22 **South Lake Cornelia microcystin concentration in September of 2016 compared with the public health advisory threshold.**

The District again collected algal toxin samples from the mid-lake location and near shore algal scum on September 21. The September 21 results indicated microcystin concentrations in the algal scum had declined since September 7, but continued to exceed the public health advisory threshold—15 µg/L compared with the public advisory threshold of 6 µg/L. The District collected algal toxin samples on September 28 and documented that microcystin levels had declined below the public health advisory threshold. The District contacted the City of Edina and an update was posted on both the District's and City's website letting the public know they could again fully use the lake, including contact with water.

Figure 23 **Chloride present in deicing chemicals applied to streets in the South Lake Cornelia watershed is conveyed to the lake by snowmelt and rainfall runoff.**

Chloride present in deicing chemicals applied to streets in the South Lake Cornelia watershed (Figure 23) is conveyed to the lake by snowmelt and rainfall runoff. In 2016, chloride concentrations in South Lake Cornelia ranged from a high of 194 mg/L in June to a low of 82 mg/L in September. All 2016 chloride concentrations met the MPCA chronic exposure standard of 230 mg/L.

South Lake Cornelia plant survey data from 2004 through 2016 were assessed to determine plant IBI values. Figure 24 shows the number of species and FQI for that period compared to the proposed MDNR plant IBI impairment thresholds. The number of species in South Lake Cornelia consistently increased from 2008 through 2015 – from 3 in 2008 to 12 in 2015 – and then declined in 2016 – 11 in June and 9 in August. The number of species in the lake was above the proposed impairment threshold of 11 in August of 2015 and June of 2016. The number of species during the rest of the period examined was below the proposed impairment threshold.

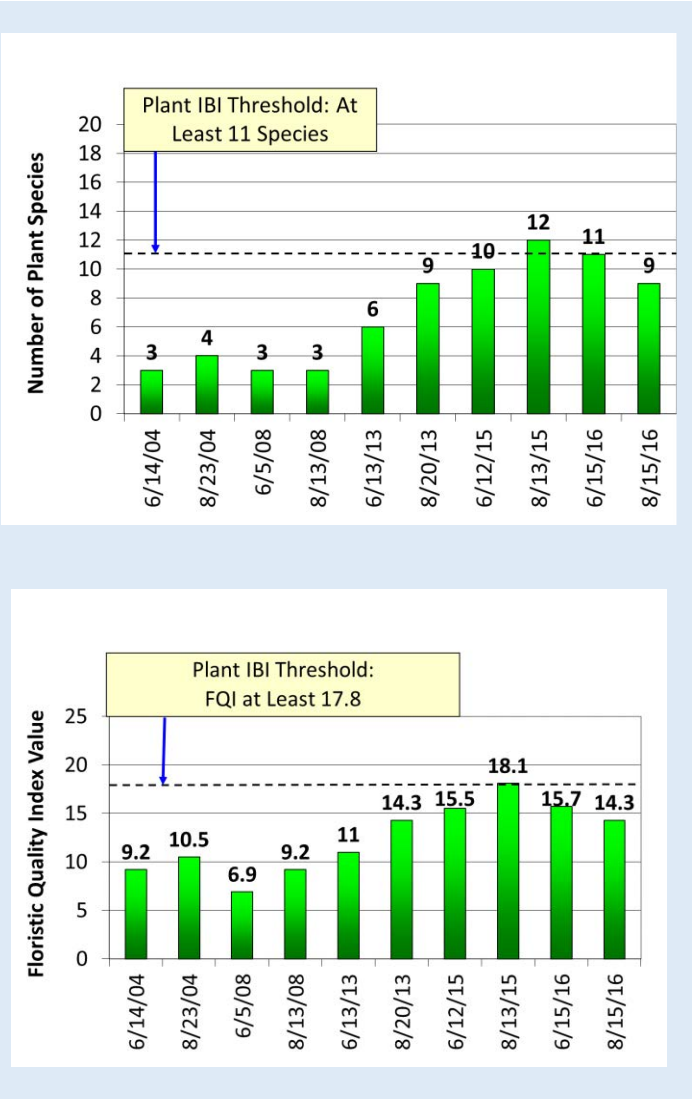

Figure 24 **2004-2016 South Lake Cornelia Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).**

FQI values in South Lake Cornelia

consistently increased from 2008 through 2015—from 6.9 to 18.1—and then declined in 2016—15.7 in June and 14.3 in August. The FQI value in August of 2015 was above the proposed impairment threshold of 17.8. All other FQI values during the period examined were below the proposed impairment threshold.

Normandale Lake

Normandale Lake is located in northwest Bloomington. In the early 1980s the Normandale Lake Basic Water Management Project converted an existing wetland area west of Normandale Boulevard which the creek flows through into a flood control management area. Prior to this project, Hennepin County Ditch #1, which was established in 1904, conveyed Nine Mile Creek flows from the location where the north and south forks merged downstream to roughly 300 feet south of 98th street. The ditching prevented the natural marsh area, currently known as Normandale Lake and Marsh Lake, from being fully utilized to mitigate flood flows. The flood control project involved construction of a dam across Nine Mile Creek to the west of Normandale Boulevard, which created Normandale Lake. The lake has a water surface of approximately 112 acres, a maximum depth of approximately 10 feet, and a mean depth of 4.2 feet at normal

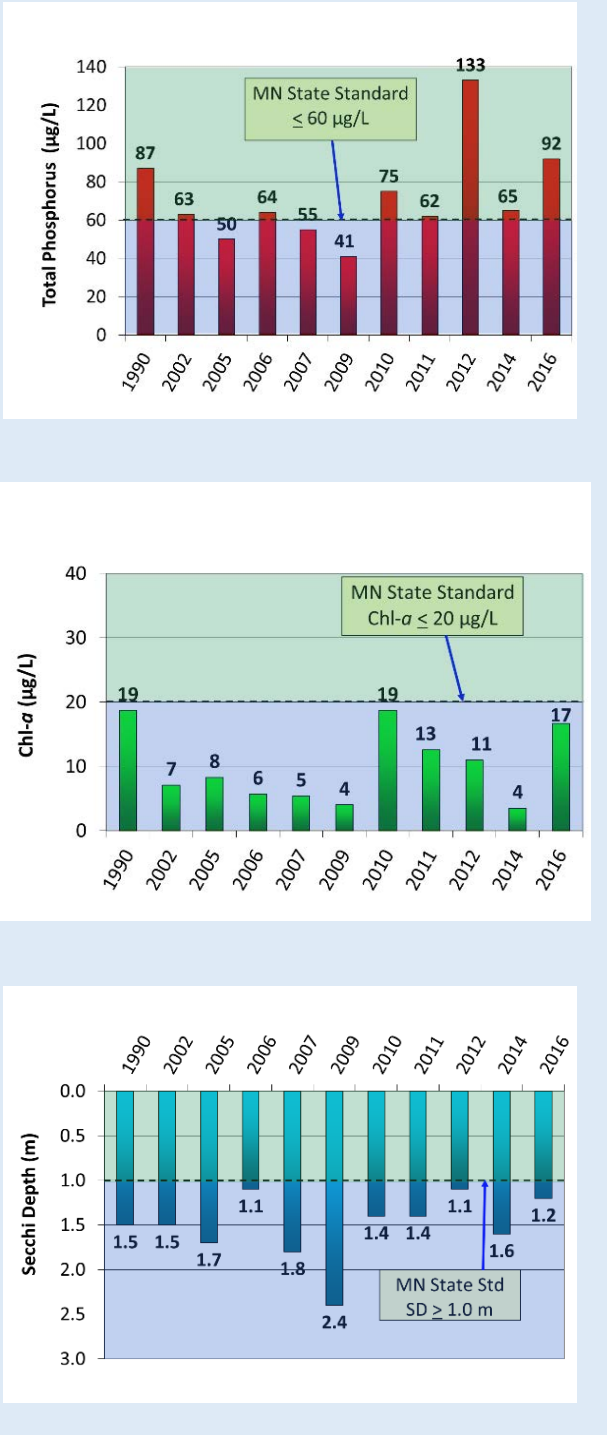

Figure 25 **Normandale Lake summer average total phosphorus, chlorophyll *a*, and Secchi disc values during 2003-2016.**

water surface elevation of 808.0 MSL. The lake is shallow enough for plants to grow over the entire lake bed. It is a polymictic lake, mixing many times per year.

In 2016, as in previous years, chlorophyll *a* concentration and Secchi disc transparency both met the Minnesota State water quality standard for shallow lakes in the North Central Hardwood Forest Ecoregion, but total phosphorus concentration did not meet the State Standard. The lake's summer average total phosphorus concentration was 92 µg/L, which failed to meet the Minnesota State Standard of 60 µg/L or less. The lake's summer average chlorophyll *a* concentration was 17 µg/L, which met the Minnesota State Standard of 20 µg/L or less. The lake's summer average Secchi disc depth was 1.2 meters which met the Minnesota State Standard of at least 1.0 meter (Figure 25).

The 2016 Normandale Lake water quality was similar to previous years. Summer average total phosphorus concentrations during 1990 through 2014 ranged from 41 µg/L to 133 µg/L compared with 92 µg/L in 2016. Summer average chlorophyll *a* concentrations during 1990 through 2014 ranged from 4 µg/L to 19 µg/L compared with 17 µg/Lin 2016. Summer average Secchi disc transparencies during 1990 through 2014 ranged from 1.1 meters to 2.4 meters compared with 1.2 meters in 2016 (Figure 25).

Figure 26 **Chloride from deicing chemicals applied to streets in the Normandale Lake watershed was conveyed to the lake, resulting in a high chloride concentration in April of 2016 that failed to meet the MPCA chronic exposure standard. All other 2016 concentrations met the MPCA standard.**

Chloride present in deicing chemicals applied to streets in the Normandale Lake watershed (Figure 26) is conveyed to the lake by snowmelt and rainfall runoff. As expected, the highest

2016 chloride concentration in Normandale Lake was observed in April. Chloride concentrations consistently declined from April to September when the lowest concentration of 55 mg/L was observed. The April concentration of 235 mg/L failed to meet the MPCA chronic exposure standard of 230 mg/L, but all other 2016 concentrations met the MPCA standard.

In 2016, a reduction in vegetation occurred in Normandale Lake between June and August. A statistical comparison of June and August vegetation data documented a statistically significant decline in frequency for filamentous algae, large duckweed (*Spirodela polyrhiza*), common waterweed (*Elodea canadensis*), and curly-leaf pondweed (*Potamogeton crispus*). The decline in curly-leaf pondweed was due to natural die-off. A statistical comparison of June and August plant density documented a statistically significant decline in coontail (*Ceratophyllum demersum*) density. The reduction in Normandale Lake vegetation between June and August is pictured on Figure 27 and Figure 28.

Figure 28 **June plant growth in Normandale Lake, picture above, was dense.**

Figure 27 **August vegetation in Normandale Lake, pictured above, was reduced from June.**

Plant survey data collected from Normandale Lake during 2002 through 2016 were assessed to determine plant IBI trends. Figure 29 shows the number of species and the quality of the species, as measured by the floristic quality index (FQI) for that period compared to the proposed MDNR plant IBI impairment thresholds.

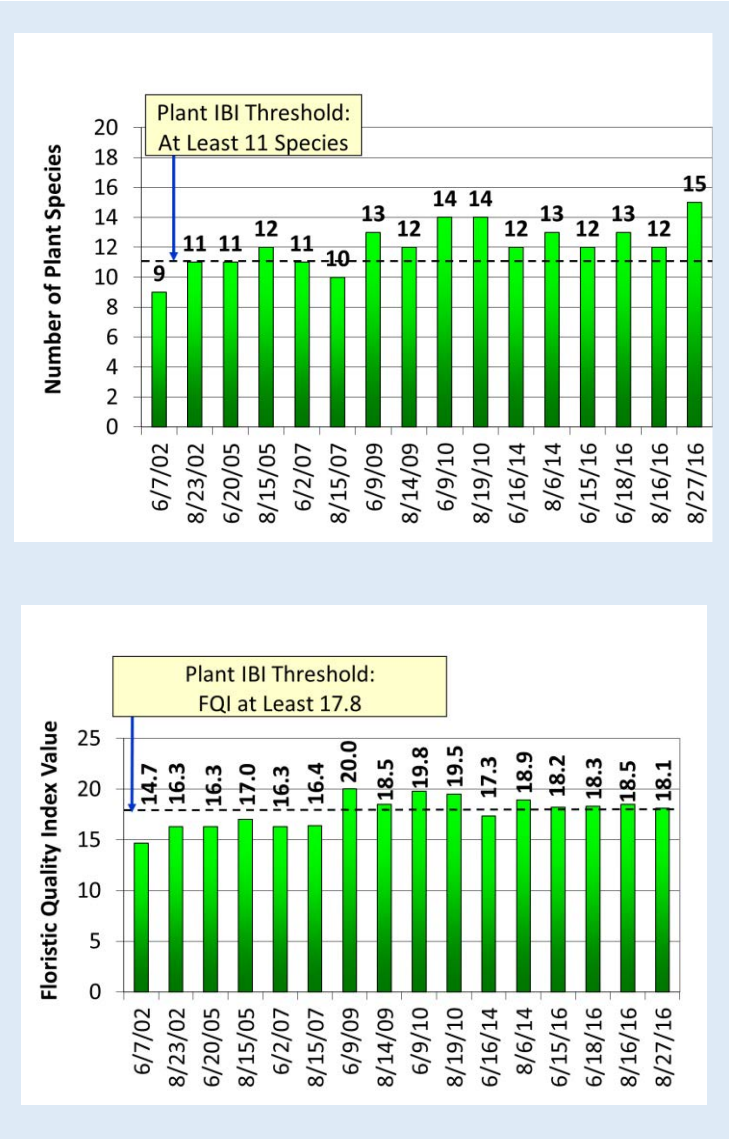

Figure 29 **2004-2016 Normandale Lake Plant Index of Biotic Integrity (IBI) Threshold Values compared with Plant IBI Thresholds: Number of Plant Species (top) and Floristic Quality Index (FQI) Values (bottom).**

A shallow lake would be considered impaired when it has fewer than 11 species. During the period examined, the number of species in Normandale Lake ranged from 9 to 15. The proposed minimum IBI threshold that defines impairment was exceeded during all but the June 2002 and August 2007 sample periods. The highest number of species to date was observed on August 27, 2016.

The proposed impairment threshold for species quality in shallow lakes, as measured by FQI, is a minimum value of 17.8. During the period examined, FQI values ranged from 14.7 to 20.0. All values during 2002 through 2007 were below the proposed impairment

threshold. During 2009 through 2016, all values except the June 2014 value exceeded the proposed impairment threshold. Because both the number of species in the lake and FQI values in 2016 exceeded the proposed minimum IBI thresholds that define impairment, Normandale Lake would not currently be considered impaired for aquatic plants.

Nine Mile Creek

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. The 2016 Nine Mile Creek monitoring program included:

Figure 30 **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 the Main Stem of Nine Mile Creek at Station ECU-7C, pictured above**

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

Monitoring locations are shown on Figure 31.

Data collected during 2016 were evaluated to determine whether:

- Specific conductance, dissolved oxygen, pH, temperature, and turbidity levels met Minnesota Pollution Control Agency (MPCA) standards for Class 2B waters published in Minnesota Rules 7050.
- Flow and water quality data were consistent with historical values.
- 2016 fish and aquatic life communities were consistent with the stream's ecological use determined from assessments completed in 1997 and 2003.

- The 2016 fish community met the MPCA Fish Index of Biological Integrity (IBI) standard for Nine Mile Creek.
- 2016 macroinvertebrate communities, assessed by biological indices, were consistent with historical data.

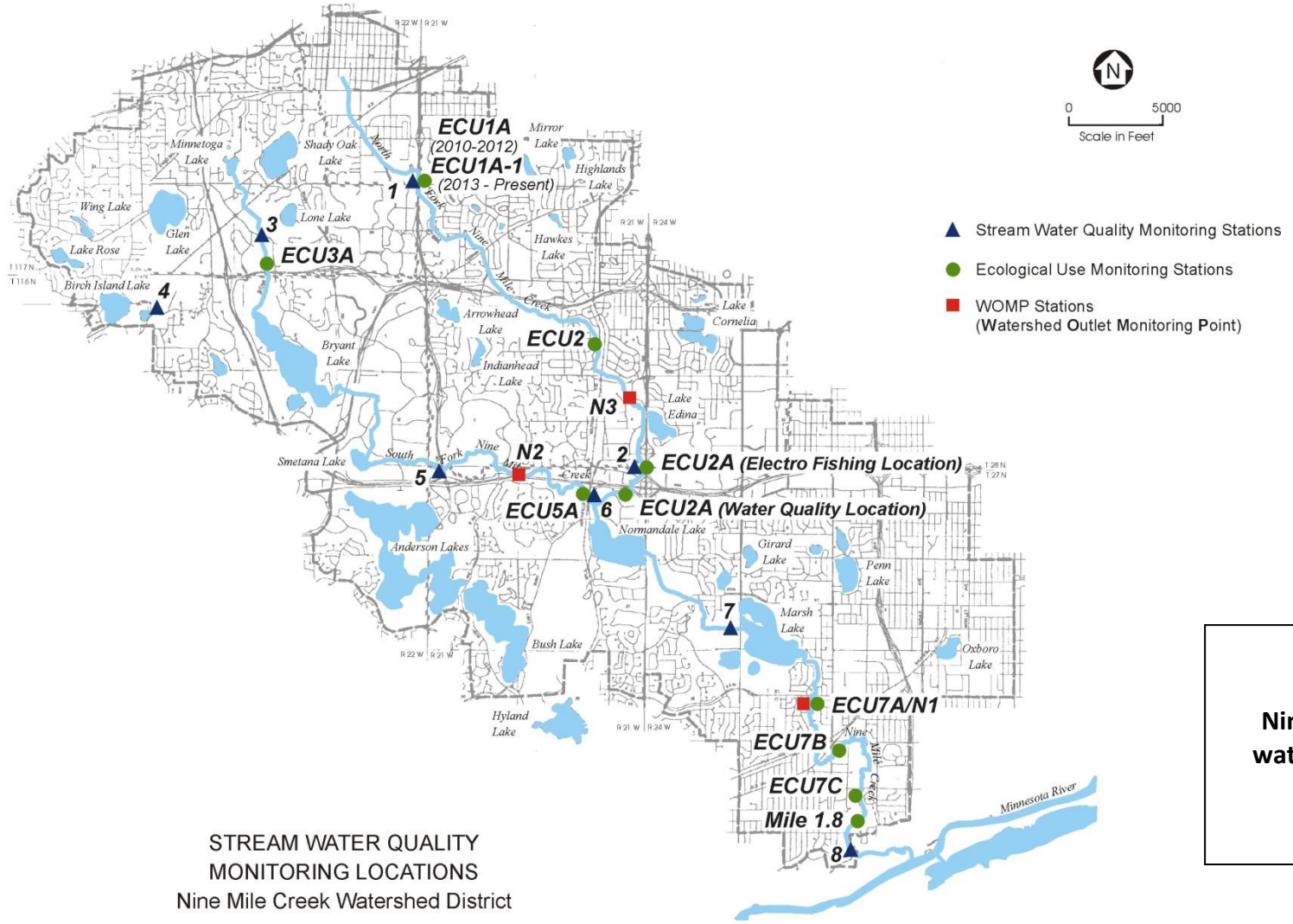

Figure 31
Nine Mile Creek stream water quality monitoring stations

Evaluation results follow.

In 2016, the levels of specific conductance, dissolved oxygen, pH, temperature, and turbidity in Nine Mile Creek generally met MPCA standards for Minnesota Class 2B waters. Overall, the 2016 values were within MPCA standards for Minnesota Class 2B waters more than 87 percent of the time. The South Fork met MPCA standards for Minnesota Class 2B waters most frequently (95 percent) followed by the Main Stem (91 percent) and North Fork (79 percent).

Figure 32 **In 2016, a tolerant forage fish assemblage, an indicator of average to poor water quality, was observed at the most upstream North Fork location, ECU-1A/1A-1, pictured above.**

In 2016, the specific conductance criterion was met less frequently than other MPCA standards for Minnesota Class 2B waters. All Nine Mile Creek temperature and pH measurements, 89 percent of the dissolved oxygen measurements, and 60 percent of the specific conductance measurements met MPCA standards for Minnesota Class 2B waters. As in previous years, the North Fork locations met the MPCA standard for specific conductance less frequently than other sampling locations (e.g., Nineteen percent of the North Fork measurements met the MPCA specific conductance standard in 2016 compared with 75 percent of Main Stem and 100 percent of South Fork measurements). The North Fork of Nine Mile Creek met the MPCA

Figure 33 **In 2016, an intolerant forage fish assemblage, an indicator of better water quality, was observed at the most downstream North Fork location, ECU-2A, pictured above**

dissolved oxygen standard for Minnesota Class 2B waters more frequently than the Main Stem and South Fork locations in 2016 – 97 percent of North Fork dissolved oxygen measurements met the MPCA standard compared with 89 percent of South Fork and 88 percent of Main Stem measurements.

Water quality data collected from Nine Mile Creek in 2016 indicate the stream's water quality generally remained stable and almost all values (99 percent) were within the range of historical values.

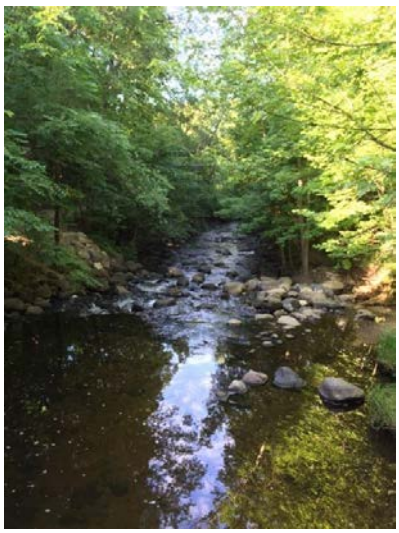

Figure 34 **In 2016, a warmwater sport fish assemblage was observed at the most downstream Main Stem location, ECU-7C, pictured above.**

Ecological use is a term used to describe the fish assemblage/aquatic life use that the stream has the capacity to support per the stream's flow, water quality, and habitat characteristics. The 2016 fish data indicate Nine Mile Creek is currently supporting the ecological use determined from assessments completed during 1997 and 2003. In 2016, a tolerant forage fish assemblage (e.g., creek chub—an indicator of average to poorer water quality) was found at the majority of sample locations—ECU-1A/1A-1 (Figure 32) and ECU-2 on the North Fork, ECU-3A and ECU-5A on the South Fork, and the most upstream Main Stem location, ECU-7A/N1 (Figure 35). An intolerant forage fish assemblage (e.g., western blacknose dace – an indicator of better water quality) was found at the most downstream North Fork location, ECU-2A (Figure 33), and the middle Main Stem location, ECU-7B. A warm water sport fish assemblage (e.g., green sunfish, largemouth bass) was found at the most downstream Main Stem location, ECU-7C (Figure 34).

A comparison of 2016 data with historical data indicates the current fish assemblage is generally similar to or better than the stream's average long-term fish assemblage. Main Stem monitoring locations ECU-7B (Figure 37) and ECU-7C (Figure 34) observed a higher quality fish assemblage in 2016 than had, on average, been observed at these locations historically. A tolerant forage fish community has historically been observed at ECU-7B compared to an intolerant forage fish community observed in 2016. An intolerant forage fish community has historically been observed at ECU-7C compared to a warm water sport fish community observed in 2016.

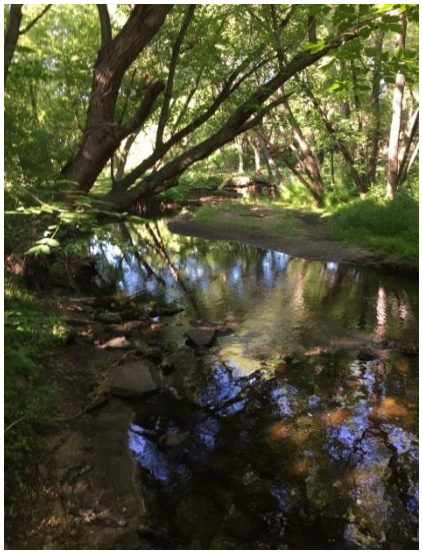

Figure 35 **In 2016, four of the six Nine Mile Creek monitoring locations with a watershed area greater than 5 miles met the MPCA biological standard for fish, including the most upstream Main Stem location, ECU-7A/N1 pictured above.**

The 2016 fish assemblage found at the most upstream Main Stem location, ECU-7A/N1 (Figure 35), was poorer than compared with the long-term average at this location. An intolerant forage fish community has historically been observed at this location compared with a tolerant forage fish community observed in 2016. The fish community at ECU-7A/N1 fluctuates widely from year to year. However, the 2016 and 2015 fish communities at this station were similar (tolerant forage fish) at this location. This is an expected fish community based on the stream's flow, water quality, and habitat characteristics. However, the average fish community over the past 43 years has continued to be better than expected (intolerant forage fish), and better than the fish communities observed in 2015 and 2016.

Fish collected from Nine Mile Creek in 2016 were assessed to determine whether the stream met the MPCA biological standard for fish. In Minnesota, biological impairment for fish in streams tributary to the Minnesota River, including Nine Mile Creek, is defined as failing to meet the Minnesota River Assessment Project (MRAP) Index of Biotic Integrity (IBI) impairment threshold score of 30 or greater

out of a possible score of 60. Only streams with a watershed area of at least 5 square miles are obligated to comply with the IBI impairment threshold.

In 2016 four of the six Nine Mile Creek monitoring locations with a watershed area greater than 5 square miles met the MPCA biological standard for fish – on the North Fork locations ECU-2 and ECU-2A and on the Main Stem locations ECU-7A and ECU-7C (Figure 38). Reaches of the creek not meeting the MPCA fish biological standard in 2016 include ECU-5A along the South Fork and ECU-7B along the Main Stem.

The most downstream location of Nine Mile Creek, ECU-7C, has met the MPCA biological standard for fish annually during 2003 through 2016. All other locations have either met or sometimes failed to meet the standard during this time period. In 2006 and 2012, all Nine Mile Creek locations met the MPCA biological standard for fish. During the 14 years of monitoring, 2003 through 2016:

- The most upstream North Fork location, ECU-1A/1A-1, met the standard 57 percent of the time
- The most downstream North Fork location, ECU-2A, met the standard 64 percent of the time
- The most downstream South Fork location, ECU-5A, met the standard 29 percent of the time
- The most upstream Main Stem location, ECU-7A, met the standard 57 percent of the time
- The middle Main Stem location, ECU-7B, met the standard 50 percent of the time
- The most downstream Main Stem location, ECU-7C, met the standard 100 percent of the time.

Figure 36 During 2003 through 2016, the most downstream South Fork location, ECU-5A, pictured above, met the Fish IBI standard 29 percent of the time.

Figure 37 During 2003 through 2016, the middle Main Stem location, ECU-7B, pictured above, met the Fish IBI standard 50 percent of the time.

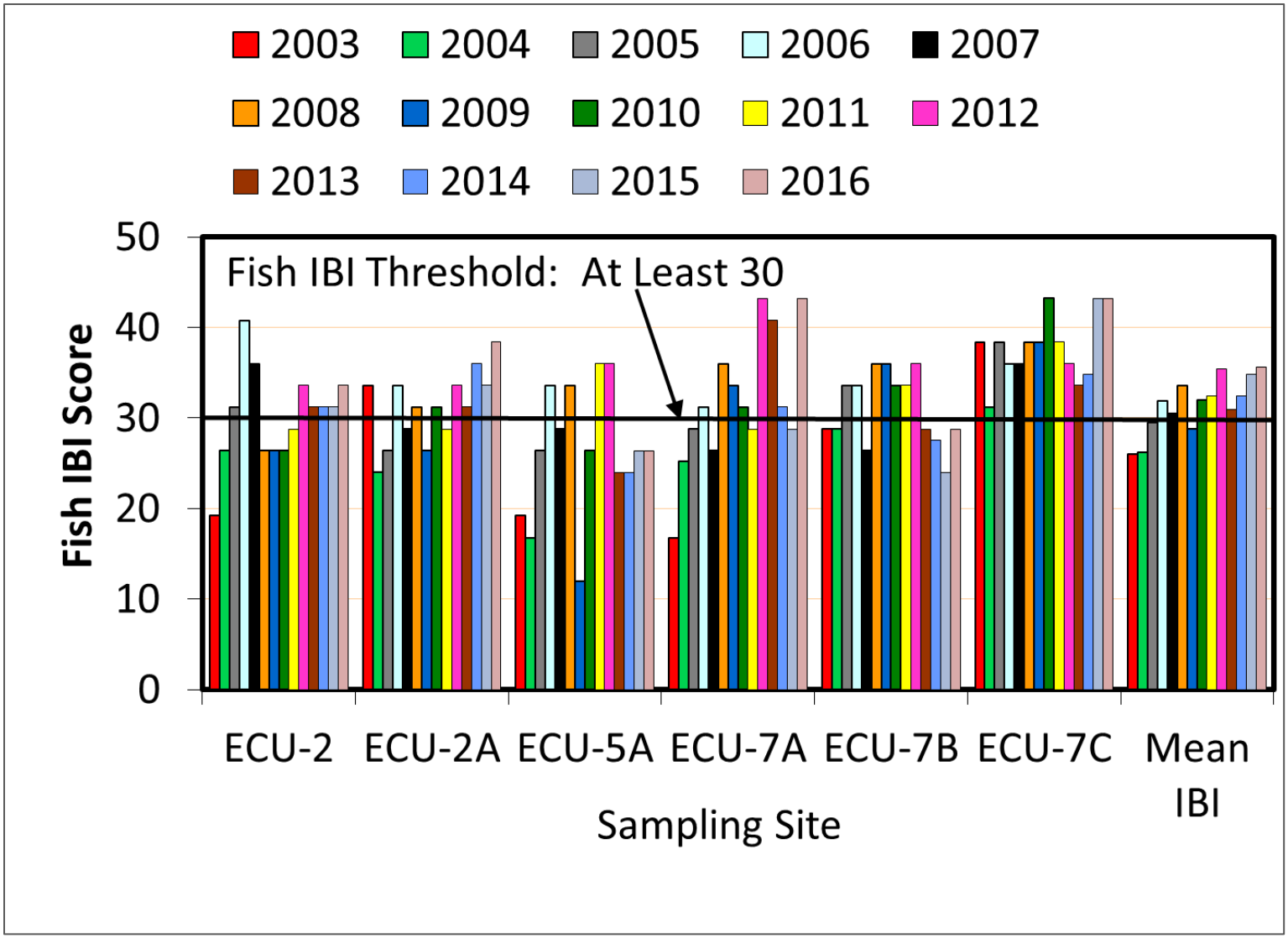

Figure 38 **2003-2016 Nine Mile Creek Fish IBI Scores**

Habitat and water quality improvements from the North Fork stream stabilization project have improved fish IBI scores at North Fork location ECU-1A/1A-1. The pre-project Fish IBI score from ECU-1A/1A-1 was 26.4, which did not meet the MPCA standard of at least 30. Following completion of the North Fork stream stabilization project, Fish IBI scores from ECU-1A/1A-1 have consistently met the MPCA standard even though not required since the tributary watershed to this reach is less than 5 square miles. Scores continue to improve annually—from 33.6 in 2014 to 36.0 in 2015 to 38.4 in 2016 (Figure 39).

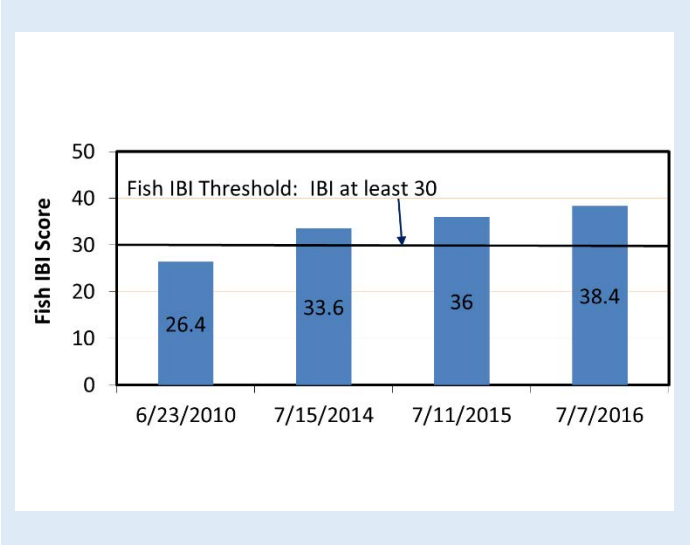

Figure 39 **Fish IBI Scores for Nine Mile Creek Station ECU-1A/1A-a during 2010 and 2014-2016**

Since 2011, ECU-3A, the most upstream location on the South Fork, has annually met the MPCA biological standard for fish. Fish IBI scores from ECU-3A have ranged from 31.2 to 55.2 during the 2011 through 2016 period (Figure 40). Prior to 2011, this location met the standard only 38 percent of the time. However, since the watershed tributary to ECU-3A is less than 5 square miles, the MPCA biological standard is not required to be met.

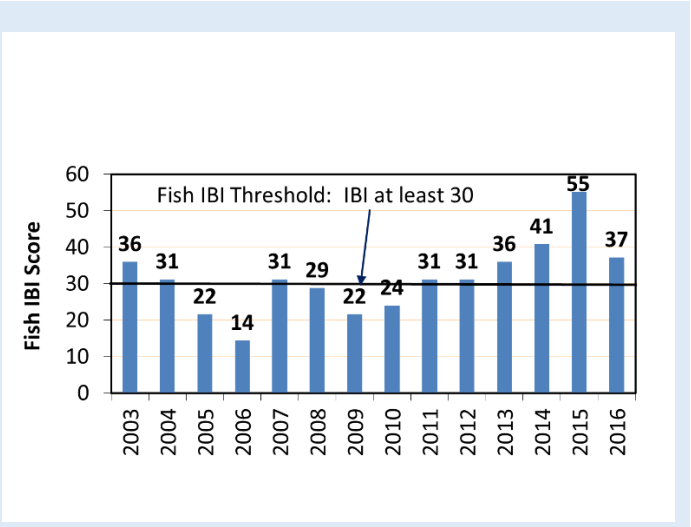

Figure 40 **Fish IBI Scores for Nine Mile Creek Station ECU-3A during 2003-2016**

Nine Mile Creek macroinvertebrates (bugs that can be seen with the naked eye) were assessed using two biotic indices to evaluate the water quality of Nine Mile Creek. The Hilsenhoff Biotic Index (HBI) was used to assess the long-term oxygen content of the stream. HBI assesses stream oxygen by determining the average tolerance of the macroinvertebrate community to low oxygen conditions. A second index, the Invertebrate Community Index (ICI), provides a broader view of the stream's water quality than the HBI, determining the average tolerance of the macroinvertebrate community to a wide range of pollutants.

In 2016, the HBI and ICI values from the two downstream locations on the Main Stem of Nine Mile Creek (ECU-7B and ECU-7C), the most upstream North Fork Location (ECU-1A/1A-1), and the most downstream South Fork location (ECU-5A) were similar to past values, indicating stream water quality, including oxygen conditions, have remained stable.

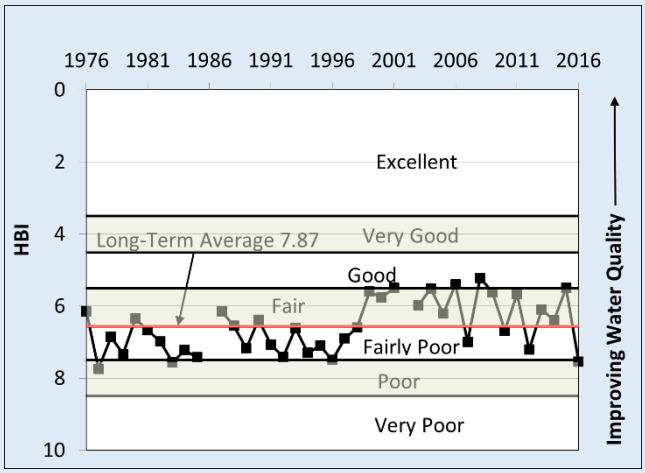

Figure 41 **1976-2016 Nine Mile Creek HBI: Main Stem Station ECU-7A/N1**

The HBI and ICI values from the most upstream location on the Main Stem of Nine Mile Creek (ECU-7A) indicated a significant decline in 2016. Frequent fluctuations in both HBI and ICI values have occurred at this location during the period of record (Figure 41 and Figure 42). The frequent changes in the macroinvertebrate assemblage at this location is primarily due to the influence of Marsh Lake on the oxygen concentrations of downstream waters. Oxygen levels within Marsh Lake fluctuate due to biological activity within the marsh – plant photosynthesis during the day raises oxygen levels and at night plant respiration lowers oxygen levels. Water exiting the marsh may have either lower or higher oxygen levels than downstream locations, depending upon biological processes occurring within the marsh. The fluctuations in stream oxygen levels downstream from Marsh Lake cause changes in the macroinvertebrate assemblage, reflected by fluctuating HBI and ICI values.

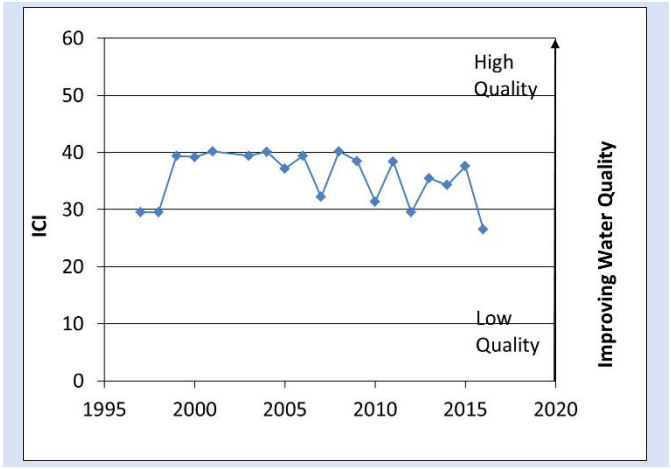

Figure 42 **1997-2016 Nine Mile Creek ICI: Main Stem Station ECU-7A/N1**

Figure 43 **In 2016, ECU-3A, pictured above, continued a trend toward improving HBI values and fish IBI scores. The ICI score also**

Figure 45 **In 2016, North Fork location ECU-2, pictured above, and ECU-2A continued a trend toward improving water quality and oxygen conditions.**

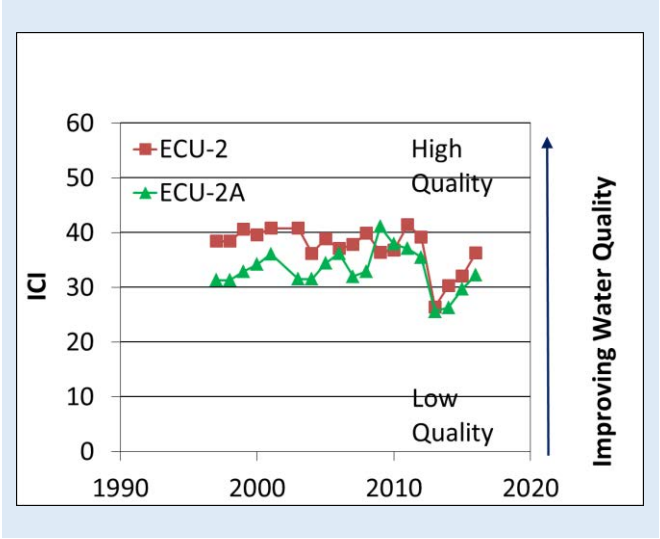

Figure 44 **1997-2016 Nine Mile Creek ICI: North Fork Stations ECU-2 and ECU-2A**

In 2016, North Fork locations ECU-2 (Figure 45) and ECU-2A (Figure 33) continued a trend toward improving water quality and oxygen conditions that began in 2013. A rapid decline in caddisflies at ECU-2 and ECU-2A in 2013 resulted in the poorest biological index (i.e., HBI and ICI) values since monitoring began. However, increases in caddisflies since 2013 have improved both HBI and ICI values. ICI values during 1997 through 2016 are shown in Figure 44.

In 2016, South Fork location ECU-3A (Figure 43) continued a trend toward improving HBI values that began in 2013, indicating improved oxygen conditions in the stream (Figure 46). The 2016 ICI value also indicated improving water quality. Increasing numbers of fish and improved fish IBI scores have coincided with improving HBI values

Figure 46 **1997-2016 Nine Mile Creek HBI: South Fork Station ECU-3A**

during 2013 through 2016 (Figure 40).

The 2016 water quality, fish, and macroinvertebrate data indicate that despite urbanization impacts, water quality conditions in Nine Mile Creek during 1968 through 2016 have generally remained relatively stable over time.

Continued monitoring at the annual monitoring stations is recommended to maintain this long-term record of water quality and biota in Nine Mile Creek and to assess the biological community to determine changes in stream habitat or water quality that warrant further investigation or management measures.