WENCK File #B1240-0189
April 2018

# 2017 Annual Water Quality Report

*Prepared for:*

Shingle Creek and West Mississippi Watershed Management Commissions

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(Appendices are available at http://www.shinglecreek.org/water-quality.html.)

# Executive Summary

The Shingle Creek and West Mississippi Watershed Management Commissions annually monitor water quality in the lakes, streams and outfalls of the watersheds. The Commissions' technical staff obtains the stream and some lake water quality data while volunteers collect most lake water quality and stream and wetland macroinvertebrate and vegetation data.

Water quality in a given year is influenced by the amount of precipitation and the type of precipitation events. Overall, 2017 was an above average precipitation year. The first half of the year was slightly above normal (0.4 inches), while the second half was 1.7 inches above normal. This annual variability is why ongoing, long-term monitoring is necessary to determine potential trends in the data and what may be considered natural variability.

Water quality in Shingle Creek and Bass Creek and in the outfalls of the West Mississippi watershed is typical of an urban stream in the Twin Cities metropolitan area, and is dominated by watershed runoff. Both streams are listed as Impaired Waters for chloride, bacteria, biota, and dissolved oxygen. The lakes in Shingle Creek are typical of urban lakes. Thirteen of the 16 lakes were originally listed as Impaired Waters due to excess nutrients. TMDLs and Implementation Plans have been approved for all the Impaired Waters, and the Commissions and the member cities have been actively implementing improvements.

Trends in water quality are mostly stable, but there are encouraging signs. Three of the lakes– Lower Twin Lake, Ryan Lake, and Schmidt Lake – have been delisted on the pending 303(d) list of Impaired Waters due to improvements to water quality. And water quality in Shingle Creek at the outlet monitoring site in Minneapolis shows an *improvement* – a decreasing trend in total phosphorus (TP) and total suspended solids (TSS). In 2017, many stream pollutant concentrations (TSS, TP, $NO_2/NO_3$) were among the best seen throughout the monitoring history of Shingle Creek. This improvement is likely the result of several factors, including improved erosion control and street sweeping in the watershed; the ban on phosphorus in fertilizer; retrofitting Best Management Practices in the watershed, both as part of redevelopment and as stand-alone projects; and stream stabilization projects reducing bank erosion.

The Shingle Creek Commission recently completed the identification of Directly Connected Untreated Areas that discharge directly to Shingle Creek without any water quality treatment or an intervening lake or wetland. These areas can be targeted for focused BMPs to further reduce pollutants to the stream. Similar areas will be identified tributary to the lakes and to the Mississippi River.

# 1.0 Introduction

## BACKGROUND

Minnesota Administrative Rule 8410.0100 Subp.5 requires watershed management organizations to conduct monitoring programs "capable of producing accurate data to the extent necessary to determine whether the water quality and quantity goals of the organization are being achieved."

The Shingle Creek and West Mississippi Watershed Management Commissions (WMC) began monitoring water quality and streamflow in 1990. In Shingle Creek, 12 sites were monitored from 1990-1992, however monitoring was discontinued from 1992 – 1995. Shingle Creek has since resumed on an annual basis at two long-term monitoring sites (SC-0 and SC-3) (Figure 1.1). In 2013, a third stream monitoring site was added near the outlet of Bass Creek (BCP). The West Mississippi WMC monitored water quality and streamflow from 1990-1992 at two outfall sites in the Oxbow Creek and Mattson Brook watersheds (Figure 1.1). Results indicated very little flow in these tributaries and no water quality or quantity problems or concerns. Thus, the Commission chose to discontinue monitoring after the 1992 monitoring season. In 2010, the Commission elected to once again monitor water quality and flow at 2-3 outfall monitoring sites per year in the West Mississippi watershed.

Thirteen of the sixteen lakes in Shingle Creek are periodically monitored for water quality by volunteers through the Citizen Assisted Monitoring program (CAMP) (Figure 1.1). Additionally, Wenck staff conducted intensive monitoring on two lakes per year as part of the 5-year TMDL review for these lakes. High school volunteers coordinated by Hennepin County Environmental Services (HCES) performed macroinvertebrate monitoring at various locations in the watersheds (Figure 1.1). HCES also coordinates wetland monitoring by adult volunteers (Figure 1.1).

## OBJECTIVES

The Shingle Creek and West Mississippi WMCs have established monitoring objectives to guide their monitoring programs. The following objectives have been established for stream, outfall and lake monitoring in both watersheds:

- To quantify the current status of streams/outfalls and lakes (Shingle Creek only) throughout the watershed in comparison to state water quality standards established for nutrients, turbidity, chloride, bacteria, and other parameters currently regulated by the State.
- To quantify changes over time, or trends, in stream and lake water quality in the Shingle Creek and West Mississippi watersheds.
- To quantify the effectiveness of implemented BMPs throughout the watershed for the protection of water quality.

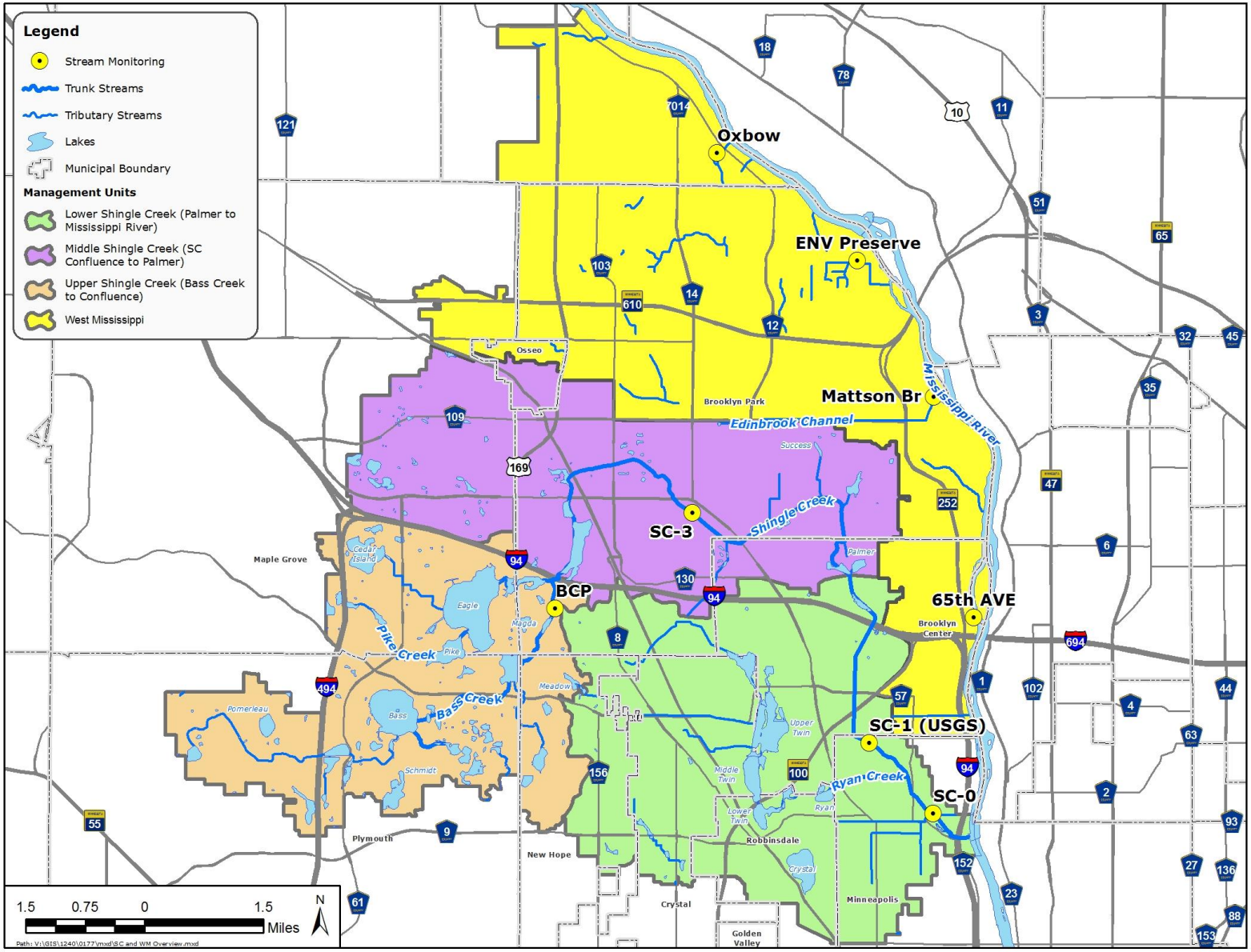


**Figure 1-1. Shingle Creek and West Mississippi management units, streams, lakes, and monitoring sites.**

## TMDLS AND IMPLEMENTATION PLANS

Most of the lakes in the Shingle Creek watershed do not meet state standards for water quality, and are included on the Minnesota Pollution Control Agency (MPCA) 303(d) List of Impaired Waters. The 303(d) list is named after the section of the federal Clean Water Act that requires states to set water quality standards and to assess conditions in lakes, rivers, and streams to determine if those standards are being met. If the standards are not met, a Total Maximum Daily Load (TMDL) study must be completed to identify the course of action needed to restore the resource to meet state standards. Table 1.1 below shows the Impaired Waters in the Shingle Creek watershed. Regional or statewide impairments that affect the watershed are also noted in Table 1.1 and are being sponsored by the MPCA. The Commission has completed TMDLs for the balance of the impairments.

Each TMDL establishes a water quality goal and a pollutant load reduction to achieve that goal. A separate TMDL Implementation Plan sets forth actions that will be undertaken by various stakeholders. Those actions include the continuation and expansion of lake and stream monitoring to assess progress toward the load reductions and water quality goals.

**Table 1-1. Impaired Waters in the Shingle Creek watershed.**

| Water Resource | Impairment | Date TMDL Approved | 5-year Review |
|---|---|---|---|
| Bass Lake | Nutrients | 9/25/09 | 2016-2017 |
| Cedar Island Lake | Nutrients | 4/14/10 | 2017-2018 |
| Crystal Lake | Nutrients | 3/25/09 | Completed 2016 |
| Eagle Lake | Nutrients | 4/14/10 | 2017-2018 |
| Lake Magda | Nutrients | 9/30/10 | 2018 |
| Meadow Lake | Nutrients | 3/23/10 | 2018 |
| Pike Lake | Nutrients | 4/14/10 | 2017-2018 |
| Pomerleau Lake | Nutrients | 9/25/09 | 2016-2017 |
| Ryan Lake | Nutrients | 11/9/07 | Completed 2014 |
| Schmidt Lake | Nutrients | 9/25/09 | 2016-2017 |
| Upper, Middle, and Lower Twin Lake | Nutrients<br>Mercury in fish<br>PFOS, PCB in fish | 11/9/07<br>3/27/07 (MPCA)<br>Not yet begun (MPCA) | Completed 2014 |
| Shingle Creek | Chloride | 2/14/07 | Completed 2014 |
| Shingle Creek | Dissolved oxygen | 11/4/11 | 2018-19 |
| Shingle Creek | Biota-macroinvertebrates | 11/4/11 | 2018-19 |
| Shingle Creek | *E. coli* | 11/20/14 (MPCA) | 2018-19 |
| Bass Creek | Biota-fish | 11/4/11 | 2018-19 |
| Bass Creek | Chloride | Metro wide TMDL (MPCA) | 2018-19 |

# 2.0 Overview of 2017 Monitoring Efforts

2017 monitoring activities in the Shingle Creek and West Mississippi watersheds included stream and outfall monitoring, lake monitoring, and volunteer macroinvertebrate and wetland monitoring. Each of these efforts are described below in more detail.

**STREAM AND OUTFALL MONITORING**

Continuous flow measurements and water quality samples were collected by the Commissions at six locations in the Shingle Creek and West Mississippi watersheds in 2017. Two of the stations, 65$^{th}$ Avenue (65th) and Mattson Brook (MB), are located in the West Mississippi Management Unit (Figure 1-1). The other stations include Bass Creek Park (BCP), SC-3, and SC-0 and are located in the Upper, Middle, and Lower Shingle Creek Management Units, respectively (Figure 1-1). Additionally, the USGS, in partnership with the Shingle Creek WMC, monitored continuous flow at station SC-1 in the Lower Shingle Creek Management near the outlet of Shingle Creek in 2017. Each monitoring station is described in more detail in Sections 3.0 through 6.0.

Stream stage (water level) was continuously recorded from April through October at all monitoring station in 2017. Stage was converted to flow using site-specific stage-discharge relationships (Appendix B). Routine water quality grab samples were collected one time per month at the West Mississippi sites and two times per month at the Shingle Creek sites. In addition to the water quality grab samples, at least three storm composite samples were collected at each monitoring station in 2017 using automated sampling equipment. Routine and storm samples at each site were analyzed for total suspended solids (TSS), total phosphorus (TP), ortho-P, total Kjehldal nitrogen (TKN), and chloride. Field parameters including dissolved oxygen (DO), temperature, pH, and conductivity were also recorded during each routine sample site visit.

Overall, rainfall in the Shingle Creek and West Mississippi Watersheds was approximately 2.1 inches above normal in 2017 (Appendix A). During the first half of 2017 (January to June), precipitation was 0.4 inches above normal, while the second half of 2017 (July through December) was 1.7 inches above normal. This pattern resulted in normal low-flow conditions throughout the watersheds during spring and early summer with a slight increase in flow conditions during late summer. In a normal year, we typically see higher flow conditions during spring and early summer followed by low-flow conditions in the late summer and early fall.

In 2017, many stream pollutant concentrations (TSS, TP, NO2/NO3) were among the best seen throughout the monitoring history of Shingle Creek, while a few others (DO, Chloride) were average throughout the monitoring history. More detailed results of the stream and outfall flow and water quality sampling are presented in the following sections and in the Appendices A-C. Sections 4.0 through 7.0 of this report provide more in-depth analysis of the impairment status within each management unit along with long-term trend analysis.

**LAKE MONITORING**

There are 16 lakes in the Shingle Creek watershed, and none in the West Mississippi watershed. The Shingle Creek WMC has monitored 14 of the lakes routinely since 1996 through the Citizen Assisted Lake Monitoring Program (CAMP) and the Commission's

Intensive Lake Monitoring Program (Palmer and Curtis Lakes have not been monitored). The CAMP was initiated by the Met Council to supplement the water quality monitoring performed by Met Council staff and to increase knowledge of water quality of Metro area lakes. Volunteers in the program monitor their lake every other week from mid-April to mid-October. They measure surface water temperature, Secchi depth, and collect surface water samples that are analyzed by the Met Council for TP, TKN, and chlorophyll-a.

The Commission's Intensive Lake Monitoring Program was established in 2012. Through this program, each lake in the watershed is monitored once every five years to evaluate protection efforts for lakes that are not impaired, and to assess progress toward achieving the TMDLs and state water quality standards for the impaired lakes. Monitoring activities included in the program include early and late season vegetation surveys, sediment core collection, fish community surveying and bi-weekly water quality sampling, including water column sampling. The methods and sampling techniques for biological communities is outlined in the Appendix E.

Two lakes were monitored in 2017: Magda Lake, and Pomerleau Lake. A detailed review of the 2017 data is presented in Appendix D and the long-term trends for both lakes are discussed in Sections 4.0 and 5.0. The data collected for Magda Lake will be used in the upcoming five-year review of TMDL progress which will be started in 2018. Intensive biological sampling occurred on Bass Lake in 2017 in an effort to establish pre-aluminum sulfate treatment information. An aluminum sulfate treatment is planned for the 2018 open water season. Sampling on Pomerleau Lake observed the best water quality in the history of the monitoring program with many of the parameters meeting water quality standards in 2017.

## VOLUNTEER MONITORING

Both Commissions have sponsored volunteer opportunities for students and adults to undertake lake, stream and wetlands monitoring. The Citizen Assisted Monitoring Program (CAMP) is managed by the Metropolitan Council. The Shingle Creek Commission participates by recruiting and training volunteers and paying a modest fee each year for lab sample processing and consumables. In 2017 only one lake was monitored through CAMP- Bass Lake in Plymouth, and that data can be found in the Upper Shingle Creek Management Unit section below.

Both Commissions work with Hennepin County Energy and Environment to offer opportunities for high school students to monitor stream macroinvertebrates (RiverWatch) and for adult volunteers to monitor wetland health (WHEP). That data can be found in Appendices F and G.

# 3.0 Figure Interpretation

The following sections contain dot charts that summarize the most recent (blue circle and year label) and historic (open black circle) water quality conditions and biota health indices (Figure 3.1). Each dot within the chart represents the percent difference from the respective impairment threshold/criteria for each parameter. Positive percent difference values (red shaded area) are exceedances of the standard while negative percent difference values (green shaded area) are conditions meeting standards. Values that deviate from the standard by more than double (> ±100%) are represented by a black open circle with a 'x' through it. These values are also reported as ± 110% (i.e. Fig 3.1 – Chloride). Parameters with no value assignment are current data gaps (i.e. Fig 3.1 – *E. coli*). Stream and lake specific metrics, standards and data manipulations are reported in the following subsections.

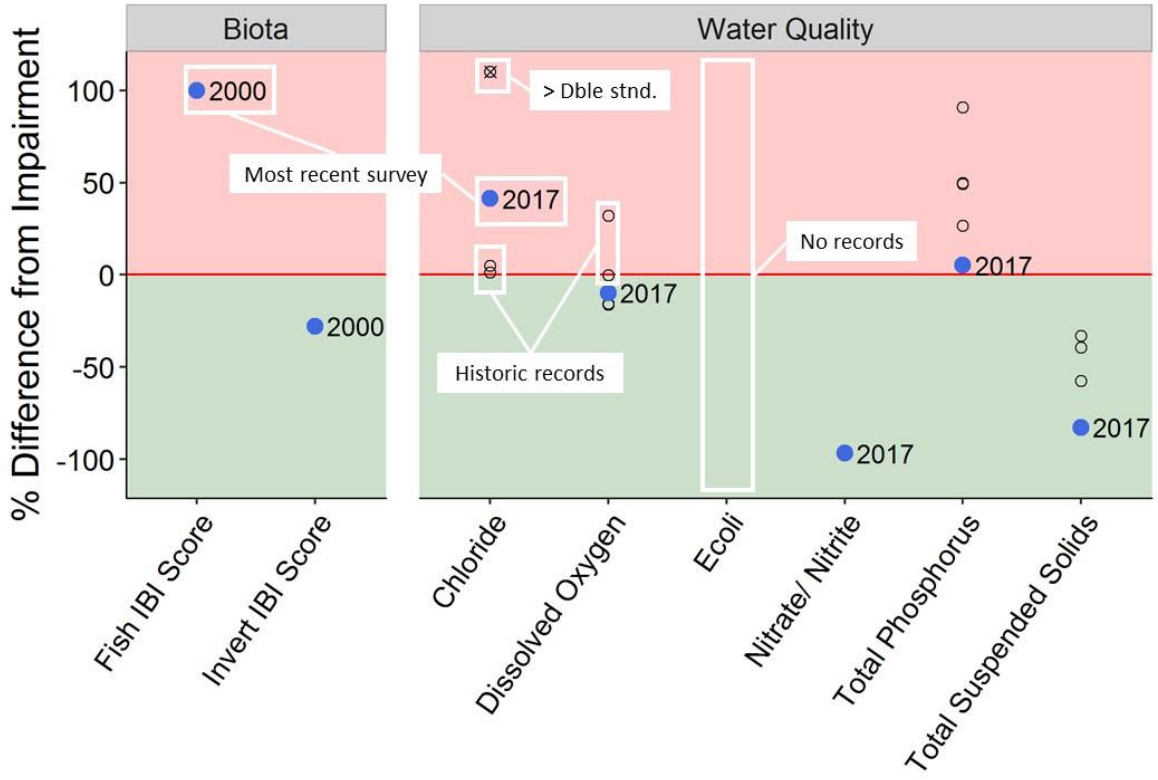


**Figure 3-1. Example of data summary reporting for a stream habitat.**

## 3.1 Streams

Stream metrics and respective threshold criteria reported in the dot charts are:

- Dissolved Oxygen (DO) [1] = 5 mg/L = MPCA standard
- Total Phosphorus (TP) [1] = 100 ug/L = MPCA standard
- Total Suspended Solids (TSS) [1] = 30 mg/L = MPCA standard
- Nitrate/ Nitrite ($NO_3/NO_2$) [1] = 4.9 mg/L= MPCA draft aquatic toxicity chronic standard
- Chloride [2] = 230 mg/L = MPCA standard
- *Escherichia coli* (*E.coli*) [3] = 126 cfu/100mL = MPCA standard

- Fish Indices of Biotic Integrity (Fish IBI) [4] = 42 = MPCA standard
- Invert Indices of Biotic Integrity (Invert IBI) [5] = 43 = MPCA standard

[1] Summer month average (6/1 - 9/30)
[2] Winter month average (11/1 - 4/30)
[3] Monthly geomean from previous 10 years
[4] Low gradient IBI standard
[5] Southern forest glide pool IBI standard

## 3.2 Deep Lakes

Deep lake metrics and respective threshold criteria reported in the dot charts are:

- Chlorophyll-*a* (Chla) [1] = 14 µg/L = MPCA standard
- Total Phosphorus (TP) [1] = 0.04 mg/L = MPCA standard
- Secchi Depth [1] = 1.4 m = MPCA standard
- Floristic Quality Index (FQI) = 18.6 = MnDNR 2B standard
- Species Richness = 12 = MnDNR 2B standard
- Common Carp Density = 100 kg/ha = critical impairment threshold
- Fish IBI Tool #2 [2] = 45 = MnDNR standard
- Fish IBI Tool #4 [2] = 39 = MnDNR standard
- Fish IBI Tool #7 [2] = 37 = MnDNR standard

[1] Summer month average (6/1 - 9/30)
[2] Fish IBI tool is determine by MnDNR lake class grouping

## 3.3 Shallow Lakes

Shallow lake metrics and respective threshold criteria reported in the dot charts are:

- Chlorophyll a (Chla) [1] = 20 µg/L = MPCA standard
- Total Phosphorus (TP) [1] = 0.06 mg/L = MPCA standard
- Secchi Depth [1] = 1.0 m = MPCA standard
- Floristic Quality Index (FQI) = 17.8 = MnDNR 2B standard
- Species Richness = 11 = MnDNR 2B standard
- Common Carp Density = 100 kg/ha = critical impairment threshold

[1] Summer month average (6/1 - 9/30)

# 4.0 West Mississippi Management Unit

## WEST MISSISSIPPI MANAGEMENT UNIT OVERVIEW

The West Mississippi Management Unit encompasses the entire West Mississippi Watershed Management Commission jurisdictional boundary. This management unit covers 16,000 acres across five municipalities in Hennepin County. Brooklyn Park (64%) covers a majority of the management unit, with Champlin (20%), Brooklyn Center (11%), Maple Grove (5%), and Osseo (1%) making up the rest (Figure 4-1 and Table 4-1).

The West Mississippi Management Unit is highly developed, however there is still approximately 1,000 acres (7% of management unit) agricultural land still in production within the City of Brooklyn Park in the western portion of the watershed. Most of the developed land in the watershed is single family residential and therefore the most common land use classification is low-moderate impervious development (38%). Due to soil conditions within the watershed, there are no lakes and very few wetlands. Land use for the West Mississippi Management Unit is summarized in Table 4-1 and presented on a map in Appendix G.

One of the defining characteristics of the West Mississippi Management Unit is its sandy, well-draining soils. Much of the watershed is located within the Anoka Sand Plain and therefore approximately 88% of the management unit contains type A, A/D, or B soils (Table 4-1). Soil type for the West Mississippi Management Unit is summarized in Table 4-1.

There are four major outfalls in West Mississippi: Oxbow, Environmental Preserve, Mattson Brook, and 65th Avenue outfalls. Located in Champlin, the Oxbow storm sewer outfall consists of a series of storm sewer pipes that drain approximately 1,167 acres of land in Champlin and Maple Grove. The Environmental Preserve is a small stream located in Brooklyn Park. This stream drains approximately 2,160 acres upstream of Brooklyn Park's Environmental Preserve and outlets to a small wetland in the Coon Rapids Dam Regional Park. Mattson Brook is another small surface channel/stream that drains most of central Brooklyn Park (approximately 3,500 acres) and includes a tributary, Edinbrook/Century Channel. The 65th Avenue outfall is located in Brooklyn Center at the northeast corner of the Highway 252 and Interstate 694 interchange. This outfall drains approximately 590 acres of land in Brooklyn Center, which includes runoff from the commercial and industrial land west of Highway 252. The remainder of the West Mississippi Management Unit is made up of a series of small outfalls with relatively small drainage areas that discharge directly to the Mississippi River.

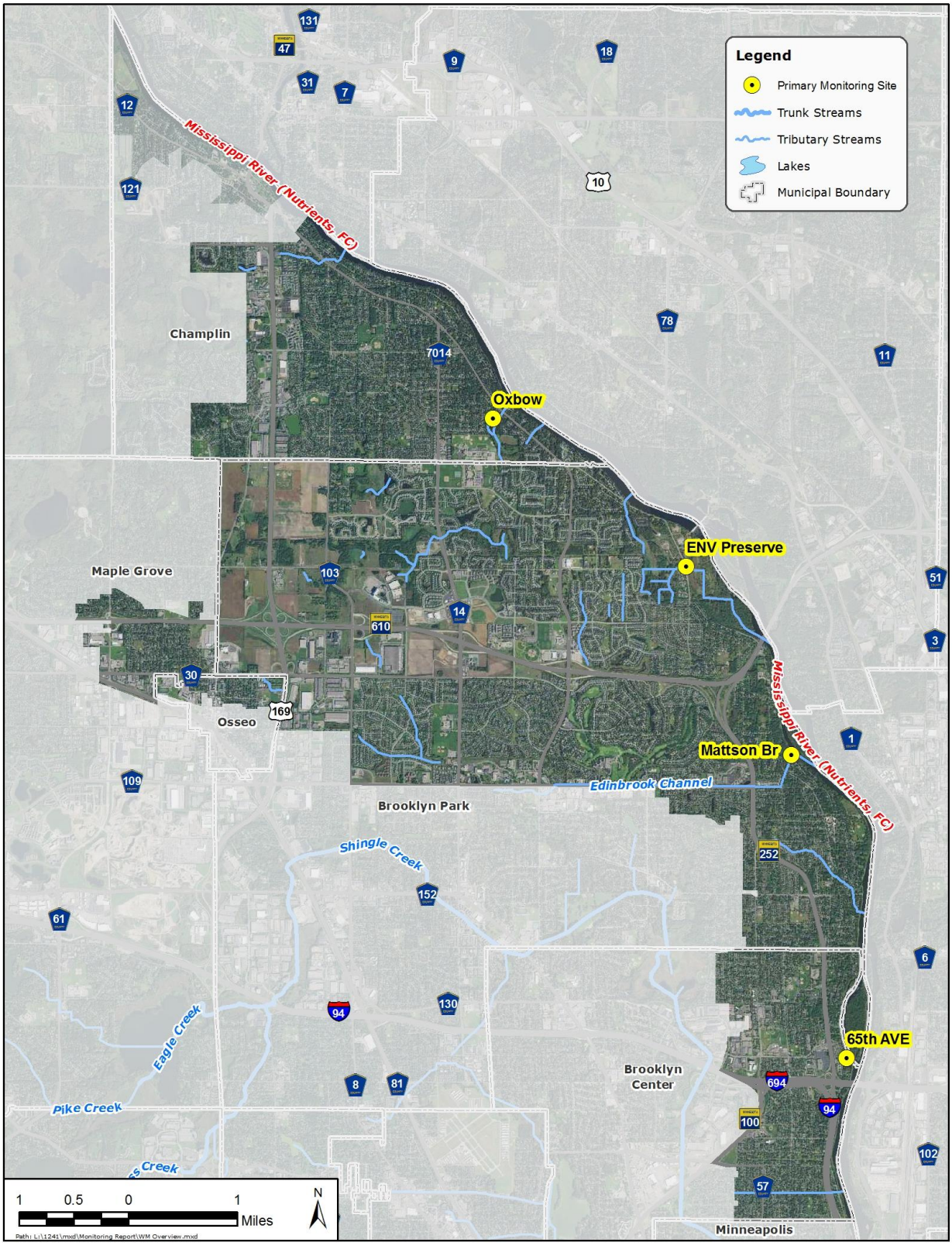


**Figure 4-1. West Mississippi Management Unit Overview**

**Table 4-1. West Mississippi Management Unit water resources and land features.**

| Streams/Outfalls | Type | Impairment Status |
|---|---|---|
| 65th Ave Outfall | Storm sewer/Intermittent | Not Assessed |
| Mattson Brook | Storm sewer/Intermittent | Not Assessed |
| Environmental Preserve | Storm sewer/Intermittent | Not Assessed |
| Oxbow Creek | Storm sewer/Intermittent | Not Assessed |

| Lakes | Type | Impairment Status |
|---|---|---|
| None | | |

| Cities | Acres | Percent |
|---|---|---|
| Brooklyn Park | 9,920 | 64% |
| Champlin | 3,123 | 20% |
| Brooklyn Center | 1,693 | 11% |
| Maple Grove | 559 | 5% |
| Osseo | 190 | 1% |

| Landuse | Acres | Percent |
|---|---|---|
| Low-Moderate Impervious (5-50%) | 6,062 | 38% |
| Highly Impervious (51-100%) | 4,078 | 25% |
| Grassland/Shrubland | 2,679 | 17% |
| Agriculture | 1,105 | 7% |
| Wetland | 850 | 5% |
| Forest | 669 | 4% |
| Open Water | 618 | 4% |

| Soil Type | Acres | Percent |
|---|---|---|
| A | 7,910 | 51% |
| A/D | 4,419 | 29% |
| B | 1,221 | 8% |
| B/D | 320 | 2% |
| C | 30 | <1% |
| C/D | 58 | <1% |
| Not Assessed (Heavily Disturbed) | 1,032 | 7% |

| Untreated Area | Acres |
|---|---|
| Not Yet Estimated | |

## OUTFALL MONITORING CURRENT CONDITIONS AND TRENDS

The West Mississippi WMC monitored water quality and streamflow from 1990-1992 at two of the four major outfalls (Oxbow Creek and Mattson Brook). Results indicated very little flow in these tributaries and no water quality or quantity problems or concerns. Thus, the Commission chose to discontinue monitoring after the 1992 monitoring season. In 2010, the Commission elected to once again monitor water quality and flow at two outfall monitoring sites per year in the West Mississippi watershed.

Due to the extensive storm stewer infrastructure and other drainage alterations, the four major outfalls in West Mississippi are likely considered Class 7 waters. By definition, Class 7 waters are "limited resource value waters and are typically not protected for aquatic life and recreation due to lack of water, lack of habitat, or extensive physical alteration." While these outfalls are not subject to water quality standards/assessments, they all discharge to the Mississippi River, which is a Class 2B water that is currently impaired for bacteria and

nutrients (TP). Thus, the Class 2B water quality standards developed by the State of Minnesota provide a good benchmark to evaluate water quality of the four major outfalls.

Below is a general summary and description of current water quality conditions of each outfall based on recent monitoring data (2010 through 2016). At this time, we were not able to calculate long-term data trends due to the limited amount of data for each site.

## 4.1 Oxbow Outfall

*Water Quality*

- TP concentrations currently exceed Class 2B standards.
- Ortho-phosphorus (not shown on figures) concentrations measured at this station were relatively high indicating phosphorus loads are coming from both dissolved and particulate sources.
- TSS and chloride levels are below standards.

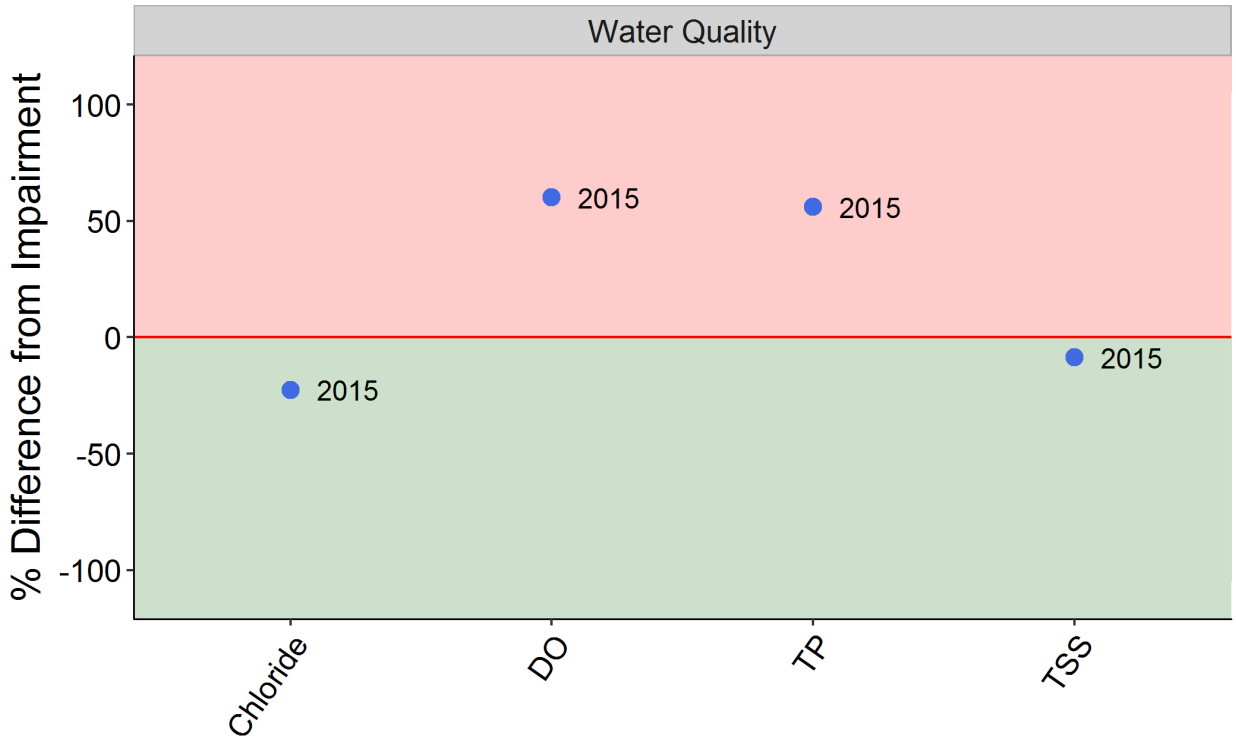


**Figure 4-2. Oxbow Outfall water quality summary (since 2010).**

*Recommendations*

- Increase sampling efforts: Water quality monitoring will occur in 2018.

## 4.2 Environmental Preserve Outfall

*Water Quality*

- TP and DO concentrations exceed standards.
- TSS, NO3/NO2, and chloride concentrations are at or below standards.

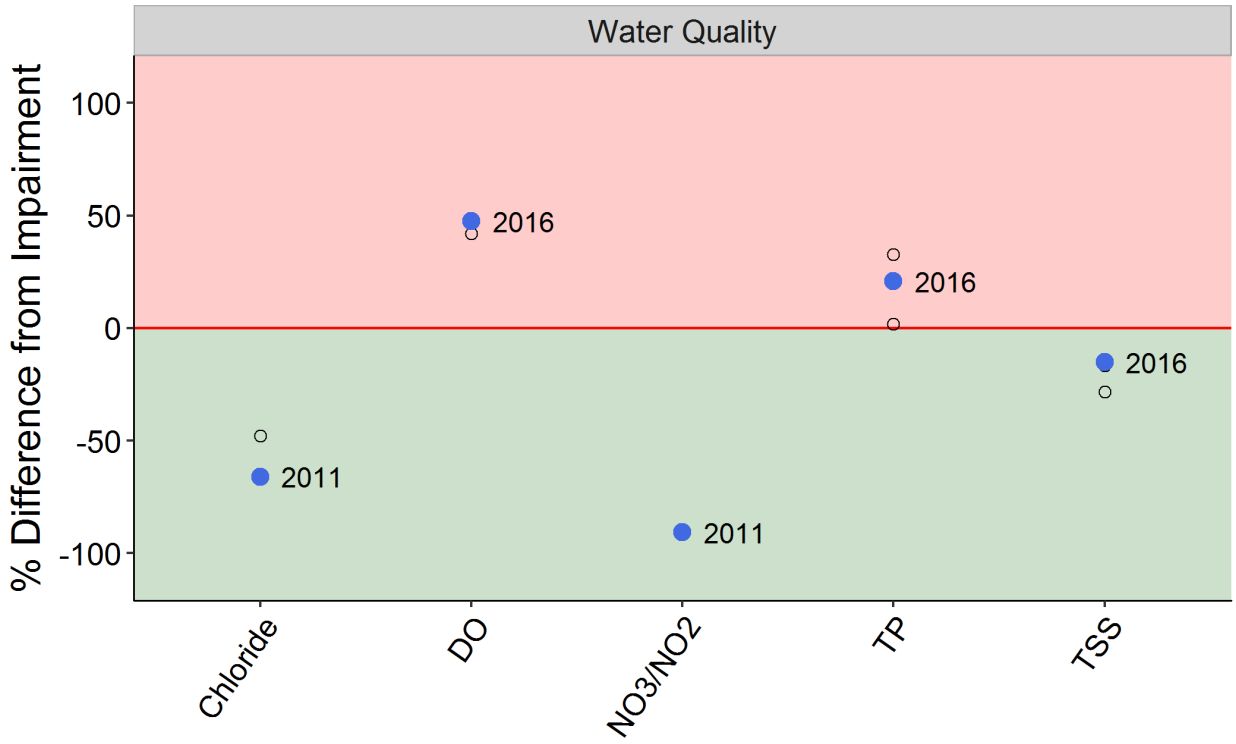


**Figure 4-3. Environmental Preserve Outfall water quality summary (since 2010).**

*Recommendations*

- Increase sample efforts: Water quality monitoring may occur in 2018. Coon Rapids Dam Regional Park impervious replacement project may not allow access to site in 2018.

### 4.3 Mattson Brook Outfall

*Water Quality*

- TSS and TP met standards in 2017 and were the best observation compared to historic records.
- Ortho-phosphorus (not shown on figures) concentrations measured at this station were relatively high indicating phosphorus loads are coming from both dissolved and particulate sources.
- DO and chloride concentrations exceeded standards.

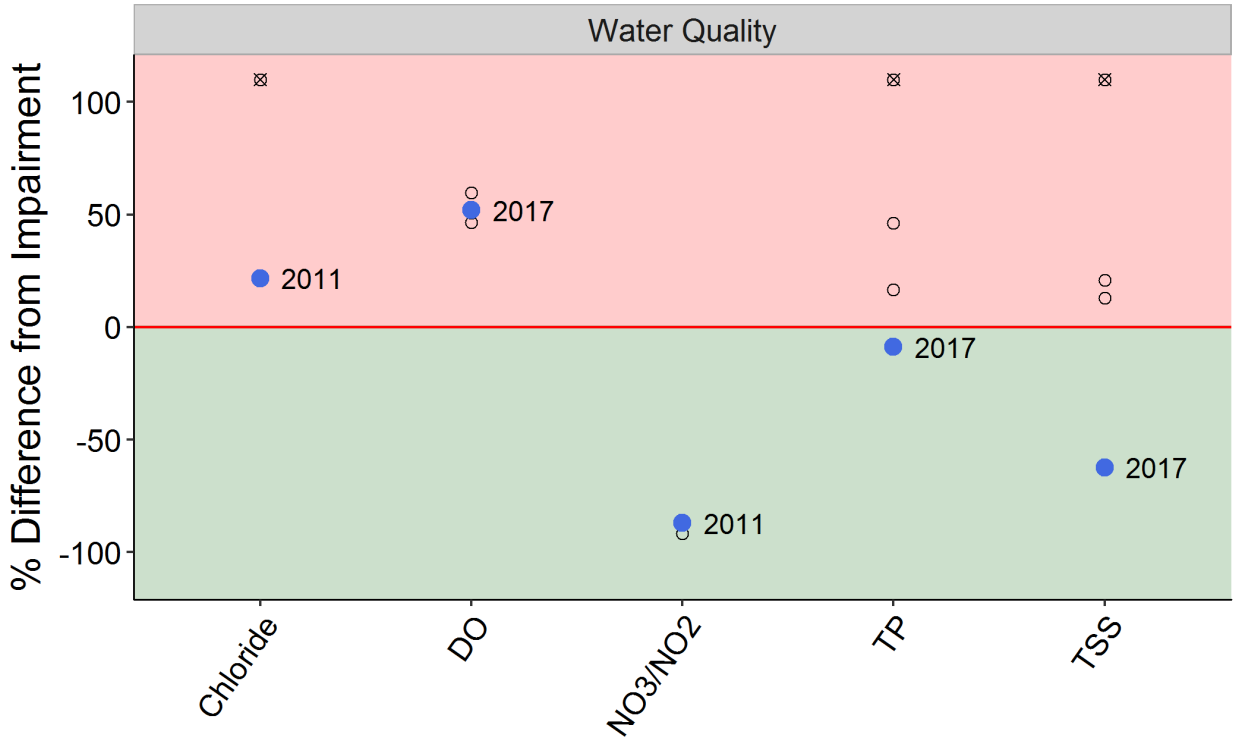


**Figure 4-4. Mattson Brook Outfall water quality summary (since 2010).**

### 4.4 65th Ave Outfall

*Water Quality*

- TSS and TP met standards in 2017 and were the best observation compared to historic records.
- DO and chloride concentrations exceeded standards.

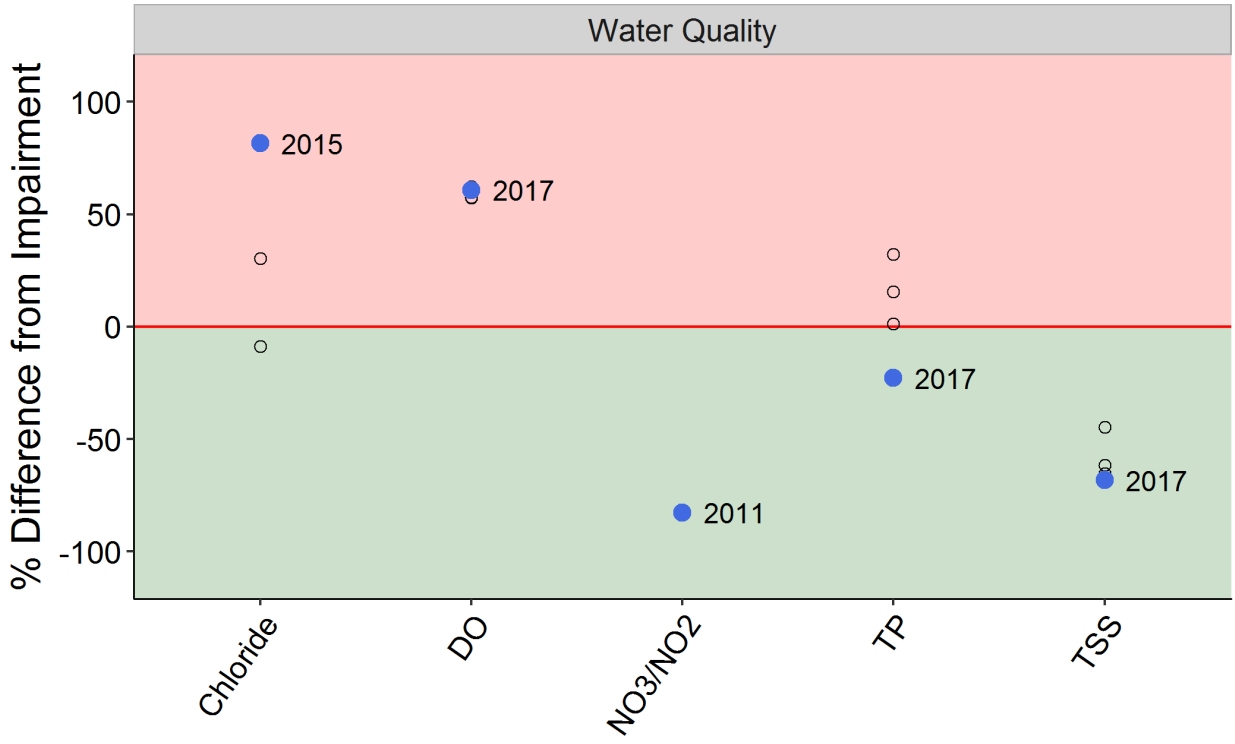


**Figure 4-5. 65th Ave Outfall water quality summary (since 2010).**

# 5.0 Upper Shingle Creek Management Unit

## UPPER SHINGLE CREEK MANAGEMENT UNIT OVERVIEW

The Upper Shingle Creek Management Unit is the headwaters of the Shingle Creek watershed and covers approximately 8,300 acres across four municipalities in Hennepin County. Plymouth (53%) and Maple Grove (30%) make up a majority of this management unit, with New Hope (12%) and Brooklyn Park (5%) also having small portions (Figure 5-1 and Table 5-1).

Lakes and wetlands are a common feature in the Upper Shingle Creek Management Unit. The Bass Chain of Lakes is located in the City of Plymouth and includes Bass, Schmidt and Pomerleau Lakes. Bass and Schmidt are shallow lakes, while Pomerleau Lake is a deep lake. The major inflow to Bass Lake and out of the lake is Bass Creek. Bass Creek starts as a series of wetlands west of Vicksburg Lane in Plymouth and flows east into New Hope and then north to where it meets Eagle Creek just south of Interstate 694 in Brooklyn Park.

The other major lake chain in the Upper Shingle Creek Management Unit is the Eagle Chain of Lakes. This chain includes Eagle, Cedar Island, and Pike Lakes. The Eagle Chain of Lakes is primarily in the City of Maple Grove, however portions of Pike Lake and the watershed draining to Pike Lake are located in Plymouth. Eagle Lake outlets to Eagle Creek which flows a short distance through a series of wetlands prior to its confluence with Bass Creek just south of Interstate 694 in Brooklyn Park.

Lake Magda and Meadow Lake are two shallow lakes in the Upper Shingle Creek Management Unit. Lake Magda is a small (10 acre) lake located Brooklyn Park. Meadow Lake is also a very small lake (12 acres) located in New Hope. Both lakes have relatively small contributing watersheds.

The Upper Shingle Creek Management Unit is almost fully developed, however it was one of the last areas in the Shingle Creek watershed to develop. Thus, much of this management unit was developed under stormwater management rules and therefore has some level of water quality treatment. Most of the water quality treatment throughout the watershed consists of stormwater ponds and wetlands. A recent desktop analysis determined that approximately 66 acres of the watershed flows directly to Bass Creek with no water quality treatment (see Table 4-1 and map in Appendix G). By comparison, the Middle and Lower Shingle Creek Management Units have approximately 1,700 and 2,000 acres of untreated area, respectively, that discharge directly to Shingle Creek.

Land use within the Upper Shingle Creek Management Unit is predominantly high impervious urban development (28%) and low-moderate impervious urban development (26%). While this management unit is almost fully developed, it has significantly less impervious coverage (54%) compared to the Middle (73%) and Lower (84%) Shingle Creek Management Units. The Upper Shingle Creek Management Unit also has the highest percentage of wetlands and open water (lake) features compared to the other Shingle Creek management units.

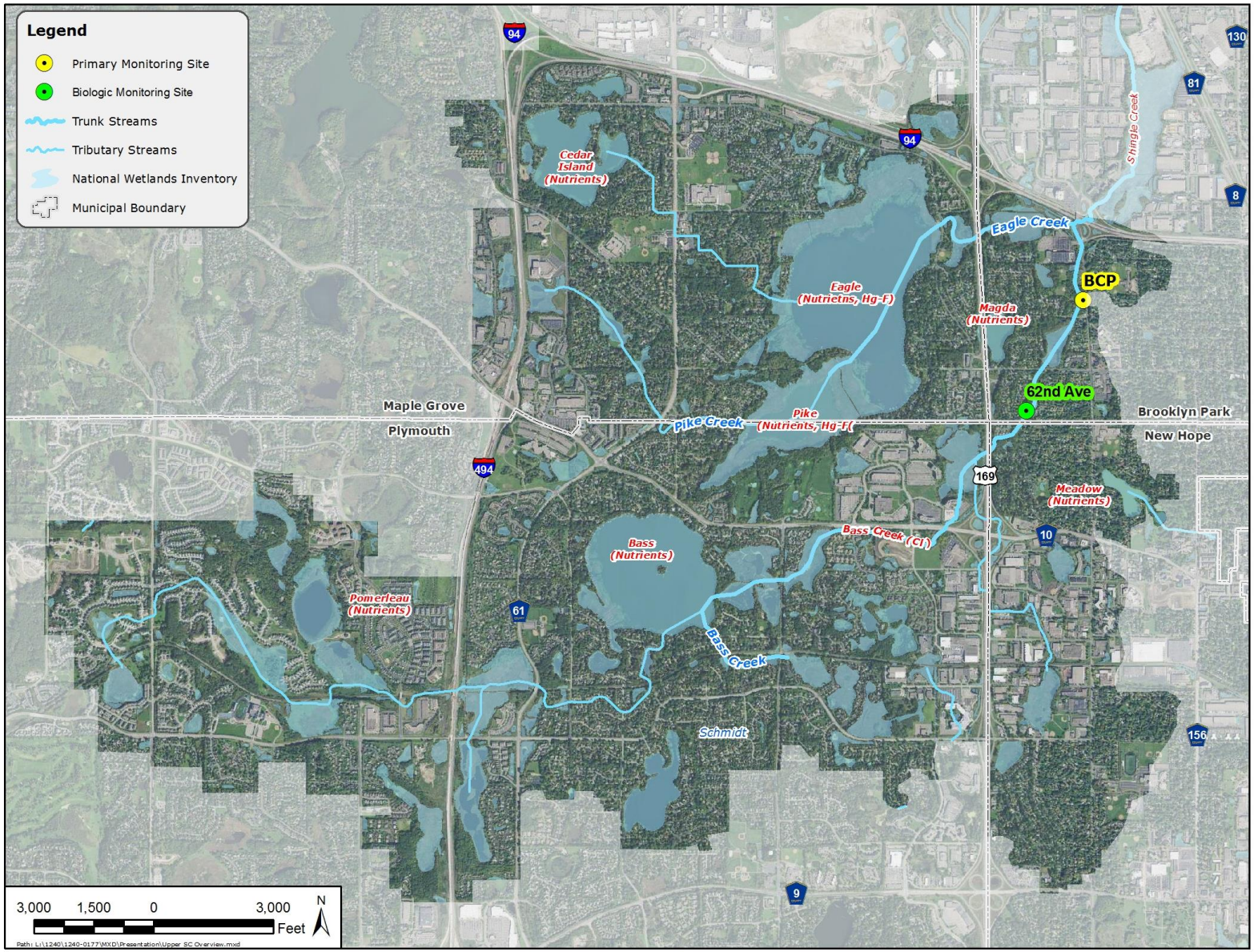


**Figure 5-1. Upper Shingle Creek Management Unit Overview.**

**Table 5-1. Upper Shingle Creek Management Unit water resources and land features.**

| Streams | Type | Impairment Status |
|---|---|---|
| Bass Creek (07010206-784) | Class 2B | Impaired (Cl, Biota – Fish) |
| Eagle Creek (07010206-671) | Class 2B | Not Assessed |
| Pike Creek (07010206-667) | Class 2B | Not Assessed |

| Lakes | Type | Impairment Status |
|---|---|---|
| Pomerleau | Deep Lake | Impaired (nutrients) |
| Curtis | Shallow Lake | No Data |
| Schmidt | Shallow Lake | Not Impaired (de-listed in 2016) |
| Bass | Shallow Lake | Impaired (nutrients) |
| Meadow | Shallow Lake | Impaired (nutrients) |
| Magda | Shallow Lake | Impaired (nutrients) |
| Cedar Island | Shallow Lake | Impaired (nutrients) |
| Pike | Shallow Lake | Impaired (nutrients) |
| Eagle | Deep Lake | Impaired (nutrients) |

| Cities | Acres | Percent |
|---|---|---|
| Plymouth | 4,417 | 53% |
| Maple Grove | 2,477 | 30% |
| New Hope | 965 | 12% |
| Brooklyn Park | 463 | 6% |

| Landuse | Acres | Percent |
|---|---|---|
| Highly Impervious (51-100%) | 2,367 | 28% |
| Low-Moderate Impervious (5-50%) | 2,165 | 26% |
| Wetlands | 1,250 | 15% |
| Grassland and Shrubland | 1,104 | 13% |
| Open Water | 665 | 8% |
| Forest | 617 | 7% |
| Agriculture | 154 | 2% |

| Soil Type | Acres | Percent |
|---|---|---|
| A | 2,346 | 28% |
| A/D | 2 | <1% |
| B | 1,892 | 23% |
| B/D | 1,006 | 12% |
| C | 89 | 1% |
| C/D | 1,003 | 12% |
| Water | 736 | 9% |
| Not Assessed (Heavily Disturbed) | 1,249 | 15% |

| Untreated Area (Creek Corridor) | Acres |
|---|---|
| Maple Grove | 48 |
| Plymouth | 18 |

## 5.1 Monitoring History

### STREAMS

Stream flow and water quality are monitored at one location, Bass Creek Park (BCP), in the Upper Shingle Creek Management Unit. BCP is in Brooklyn Park and drains approximately 65% of the Upper Shingle Creek Management Unit. This station was monitored briefly in 2000 by the MPCA as part of a water quality assessment project, which determined that Bass Creek was impaired for chloride and biotic integrity as measured by Fish IBI scores. TMDL studies were completed by the Commission and the MPCA in 2007 to address the chloride impairment and in 2011 to address the Fish IBI impairment. The Commission began monitoring the BCP site in 2013 to continually assess water quality conditions in Bass Creek and measure progress toward achieving the TMDLs. Bass Creek is considered a Class 2B water and is subject to the North Central Hardwood Forest Class 2B water quality standards.

### LAKES

Lake water quality have has been monitored for eight lakes in the Upper Shingle Creek Management Unit (excluding Curtis Lake) since at least the mid-1990s. All the monitored lakes in the Upper Management Unit were classified as impaired for nutrients (TP) in the early 2000s.

#### 5.1.1 Bass Lake Chain

- Water quality in 2017 generally appeared to be on the better end of historic measurements. Historically, Pomerleau and Bass Lake tend to exceed water quality standards while Schmidt Lake tends to flip between exceeding and meeting standards.
- Schmidt Lake was listed as impaired in 2002 and this listing was based on limited data at that time from the 1990s. The lake was recently removed from the State's 303(d) list of impaired waters in 2016. There does not appear to be any clear trends in the water quality data for Schmidt Lake over the past 10 years and the lake has consistently met water quality standards since the early 2000s.

#### 5.1.2 Eagle Lake Chain

- Cedar Island and Pike Lakes have consistently exceeded water quality standards over the past 10 years. Cedar Island has some of the highest TP and chlorophyll-a concentrations of any lake monitored in the Shingle Creek watershed.
- There does not appear to be any positive or negative trends in water quality for Cedar Island and Pike Lakes and both lakes are still considered impaired.
- Eagle Lake has met standards in 2 of the past 4 years in which it has been monitored, however the 10-year average still exceeds State standards.
- Limited fisheries information exists within the shallow lakes of this chain, yet remains important to assess as water quality can be significantly influenced by fish in these systems.

#### 5.1.3 Lake Magda and Meadow Lake

- Meadow Lake and Lake Magda have consistently exceeded water quality standards over the past 10 years.
- Both lakes have fish communities that may be leading to water quality impairments, a turbid water state, and a poor vegetation community.
- Meadow Lake has some of the highest TP and chlorophyll-a concentrations of any lake monitored in the Shingle Creek watershed over the past 10 years.

## 5.2 Bass Creek Park Stream Reach

*Water Quality*

- In 2017, TSS and $NO_3/NO_2$ are well below the impairment threshold, DO and TP are right around impairment thresholds and chloride is well above the impairment threshold.
- Relative to previous years, 2017 values are above average water quality scores.
- Trend assessment: SRP is increasing. TKN is decreasing.

*Biota*

- In 2000, the Fish IBI scored a zero suggesting that no or no index sensitive species were captured at the site. The invertebrate IBI scored 55, suggesting that the assemblage observed in 2000 was in relatively healthy condition.

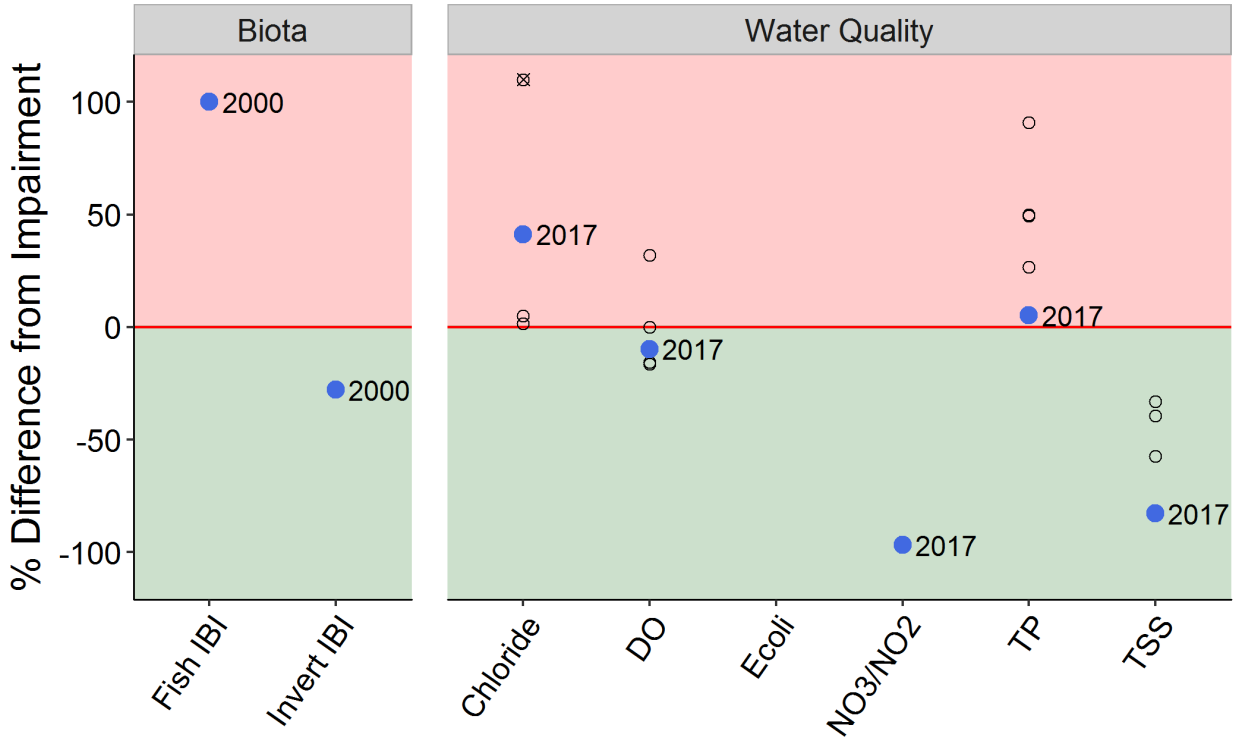


**Figure 5-2. Bass Creek Park stream water quality and biota health summary since 2000.**

*Recommendations*

- The last biotic data collected at BCP was in 2000. Biotic surveys will be conducted in 2018 to provide a recent account of the community condition.

## 5.3 Bass Lake

*Water Quality*

- TP, Chl-a, and Secchi depth within Bass Lake are relatively poor. The 2017 water quality was the best recorded in the past decade, yet, all parameters exceeded standards.
- Historic trend assessment: TP and Chl-a are increasing, Secchi depth is decreasing.

*Fisheries – See Appendix E for detailed summary of 2017 survey.*

- Relatively healthy, diverse and balanced trophic structure resulting in a healthy community.

*Vegetation*

- Lack of quantity and quality of species within the lake. Improved water quality conditions may improve vegetation community health.

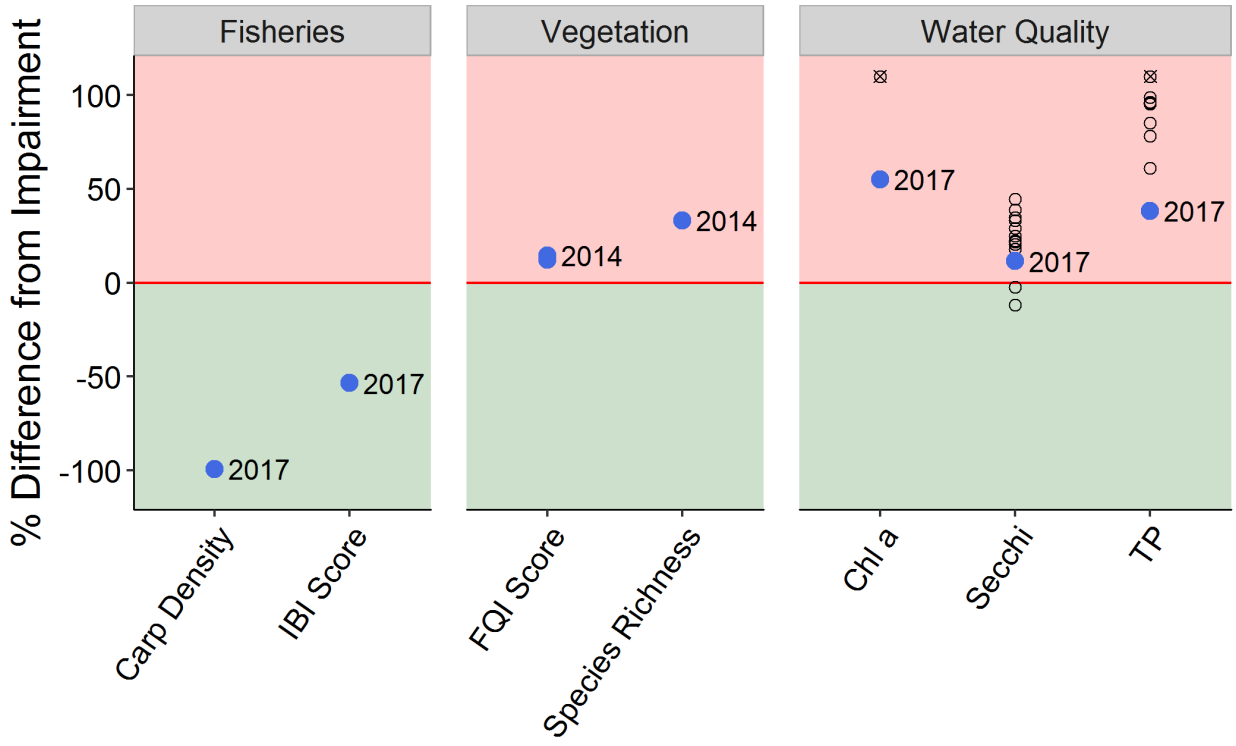


**Figure 5-3. Biota and water quality summary (since 2000) for Bass Lake.**

*Recommendations*

- Bass Lake will be receiving an alum sulfate treatment in 2018 to reduce internal loads resulting from summer hypoxia within the lake. Treatment is expected to improve all three water quality parameters and possibly the vegetation community.
- Follow up water quality and biological monitoring.

## 5.4 Schmidt Lake

*Water Quality*

- TP, Chl-a, and Secchi have annual records of both meeting and exceeding standards. In 2017, TP exceeded, while Chl-a and Secchi depth both meet water quality standards.
- Historic trend assessment: TP is decreasing, Secchi depth is increasing.

*Fisheries*

- No fish community information is readily available since 2000.
- The lake does not currently meet the size and/or lake class grouping to be evaluated with MnDNR IBI tools.

*Vegetation*

- The vegetation community was observed as biologically impaired. Vegetation impairments often result from poor water quality and/or poor fish community health.

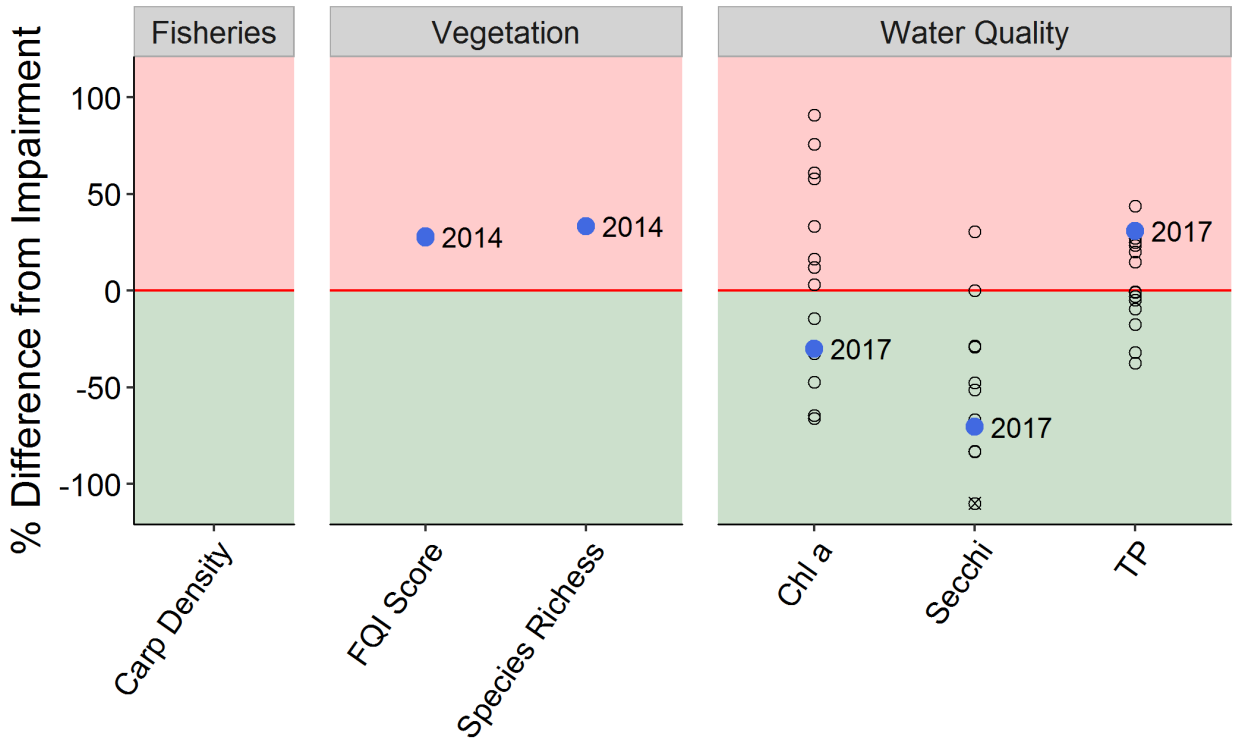


**Figure 5-4. Biota and water quality summary (since 2000) for Schmidt Lake.**

*Recommendations*

- Updating fisheries information on the lake and pairing with water quality sampling may elude top down mechanisms driving water quality within Schmidt Lake.
- Periodic water quality impairments and high nutrients may be contributing to an impaired vegetation community.

## 5.5 Pomerleau Lake

*Water Quality*

- TP, Chl-a, and Secchi all met water quality standards in 2017. 2017 experienced the best water quality records since 2000.
- Historic trend assessment: Chl-a is decreasing.

*Fisheries – See Appendix E for detailed summary of 2017 survey.*

- 2017 surveying observed a relative low amount of stress tolerant fish.
- It is possible that a change in the fish community was one factor in the improved water quality conditions seen in 2017.
- The lake was not sampled using standard common carp survey techniques, however, no carp were observed during standard trap and gill net surveys.

*Vegetation - See Appendix E for detailed summary of 2017 survey.*

- The vegetation community was observed to decrease in both species richness and quality species between spring and summer surveys and did not meet biological health thresholds.
- Overall, a limited number of species were observed with select species dominating the community. Vegetation growth was relatively abundant with dense surface growth around most of the lake's perimeter.

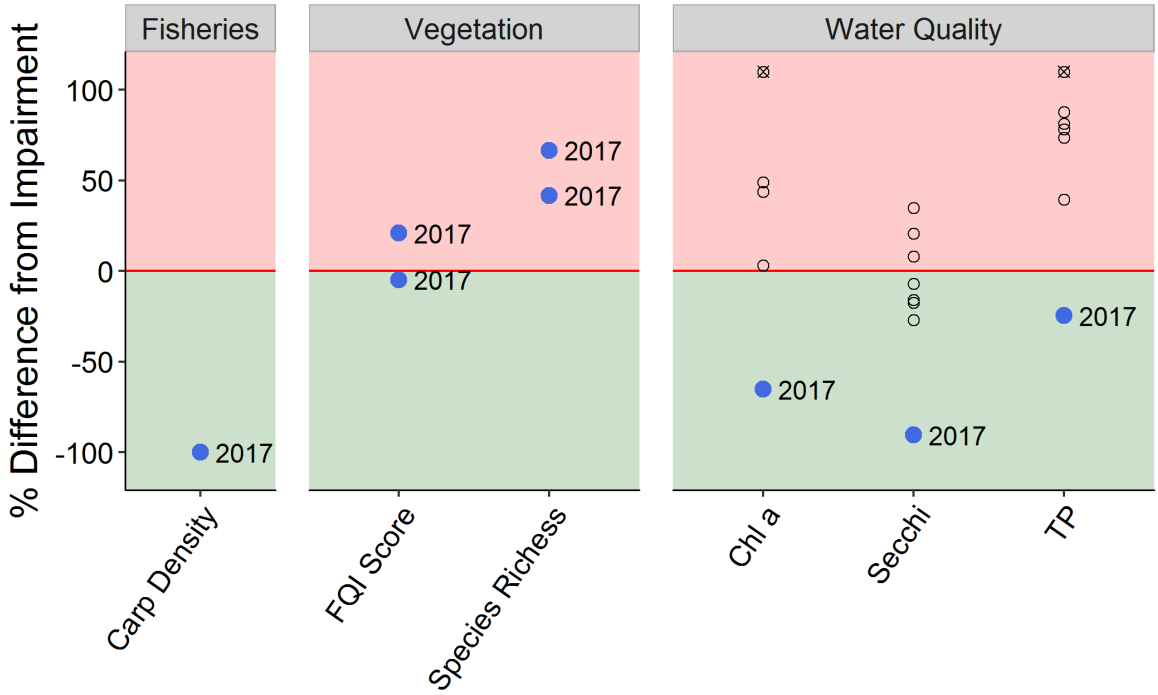


**Figure 5-5. Biota and water quality summary (since 2000) for Pomerleau Lake.**

*Recommendations*

- No direct management activity was pursued in 2017, therefore, the drivers contributing to improved water quality are uncertain.
- The influence of fisheries on Pomerleau Lake is unknown but should be monitored to better understand the influence on water quality.
- Vegetation management may be needed to improve community health due to dominance by select species.

## 5.6 Cedar Island Lake

*Water Quality*

- All three water quality parameters are poor and exceed standards with Chl-a and TP greater than double the impairment threshold.
- Historic trend assessment: Chl-a is increasing and decreasing Secchi depth.

*Fisheries*

- No fisheries assessment has been conducted to our knowledge.
- Cedar Island is a shallow lake with water quality that could be driven by the fish community

*Vegetation*

- The vegetation community is biological impaired and lacked both diversity of species and quality of species.
- An impaired vegetation community may be explained by reduced water quality conditions as high nutrients and limited light penetration can favor a few select species.

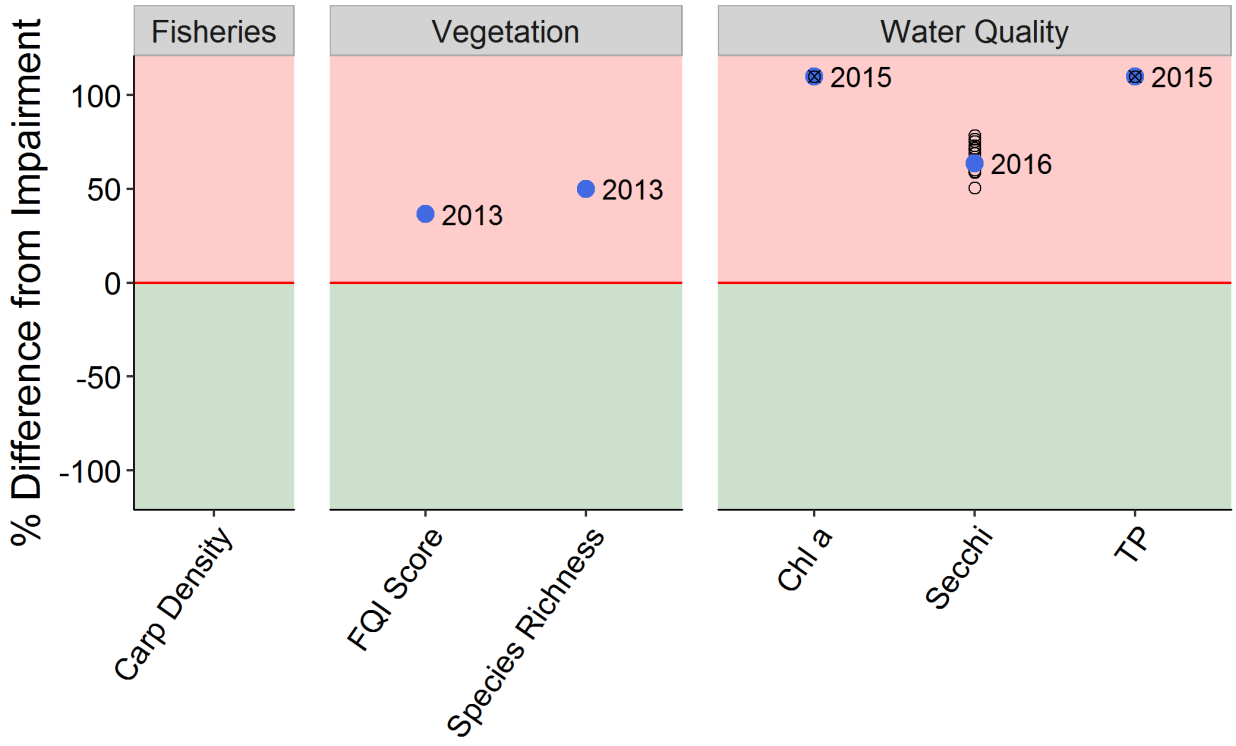


**Figure 5-6. Biota and water quality summary (since 2000) for Cedar Island Lake.**

*Recommendations*

- The influence of the fishery is unknown but should be assessed to understand the potential top-down influence it is having on water quality.

## 5.7 Eagle Lake

*Water Quality*

- Water quality has historic variability with the most recent suggesting impaired water quality. Secchi depth was the only 2017 parameter observed to be meeting standards.
- Historic trend assessment: TP is increasing and Secchi depth is decreasing.

*Fisheries*

- The MnDNR conducted an IBI assessment in 2011 and observed a fish community that was right at the biological impairment threshold.
- No common carp population assessment has been conducted, however, Eagle fits the characteristics that could support significant carp population.

*Vegetation*

- Spring and summer surveys in 2015 found a vegetation community that increased in species richness and vegetation quality and is meeting biological health conditions.
- Generally, high light penetration and bathymetric diversity provide ample growing conditions for various species within the lake.
- A large presence of curlyleaf pondweed exists in the lake and senesce by early summer.

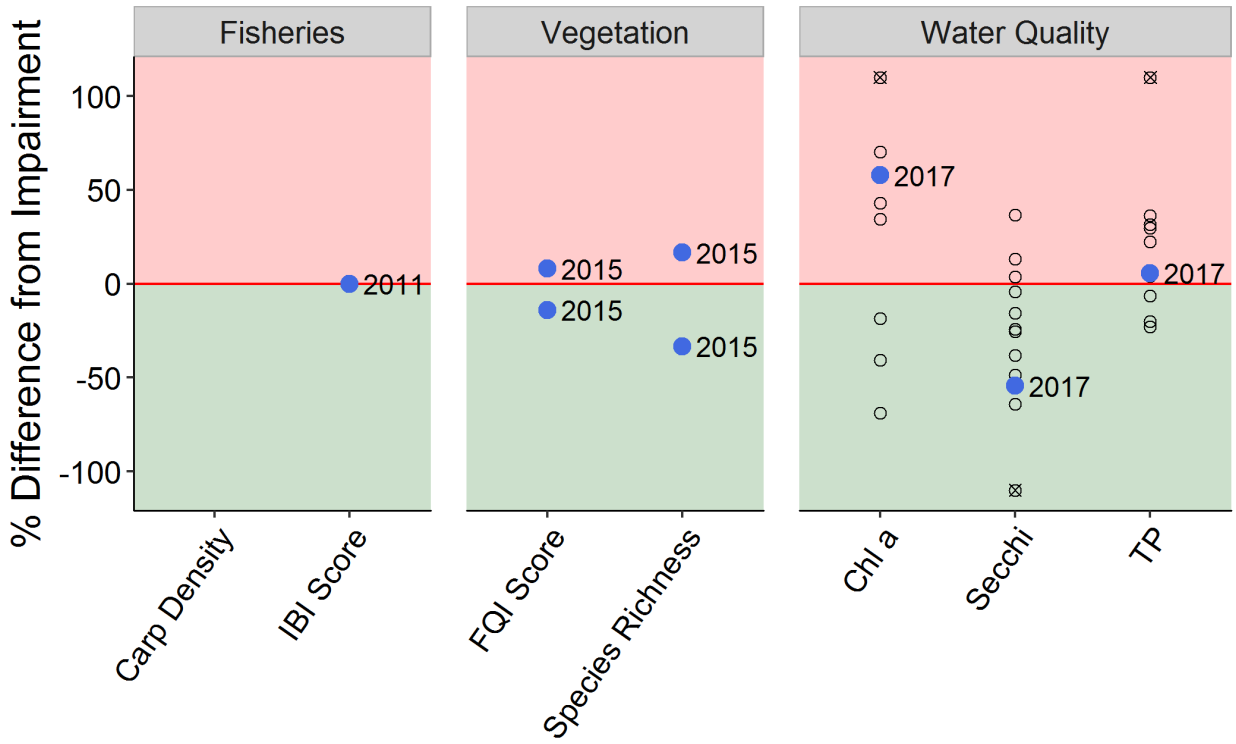


**Figure 5-7. Biota and water quality summary (since 2000) for Eagle Lake.**

*Recommendations*

- Efforts to assess the carp population within the lake are needed.
- Continued efforts to improve water quality may ensure that vegetation quality within the lake continues to meet biological health standards.

## 5.8 Pike Lake

*Water Quality*

- Overall water quality is poor and not meeting water quality standards.
- Historic trend assessment: TP is increasing.

*Fisheries*

- We are not aware of a fisheries assessment that has been conducted on, however, with a large surface connection to Eagle, the exchange of individuals is likely high between the lakes.
- No carp assessment has been conducted on the lake but Eagle Lake has the potential to support carp that could make their way into Pike during the open water season.

*Vegetation*

- The vegetation community is biological impaired and lacked both diversity of species and quality of species.
- An impaired vegetation community may be explained by poor water quality conditions as high nutrients and limited light penetration can favor a degraded vegetation community.

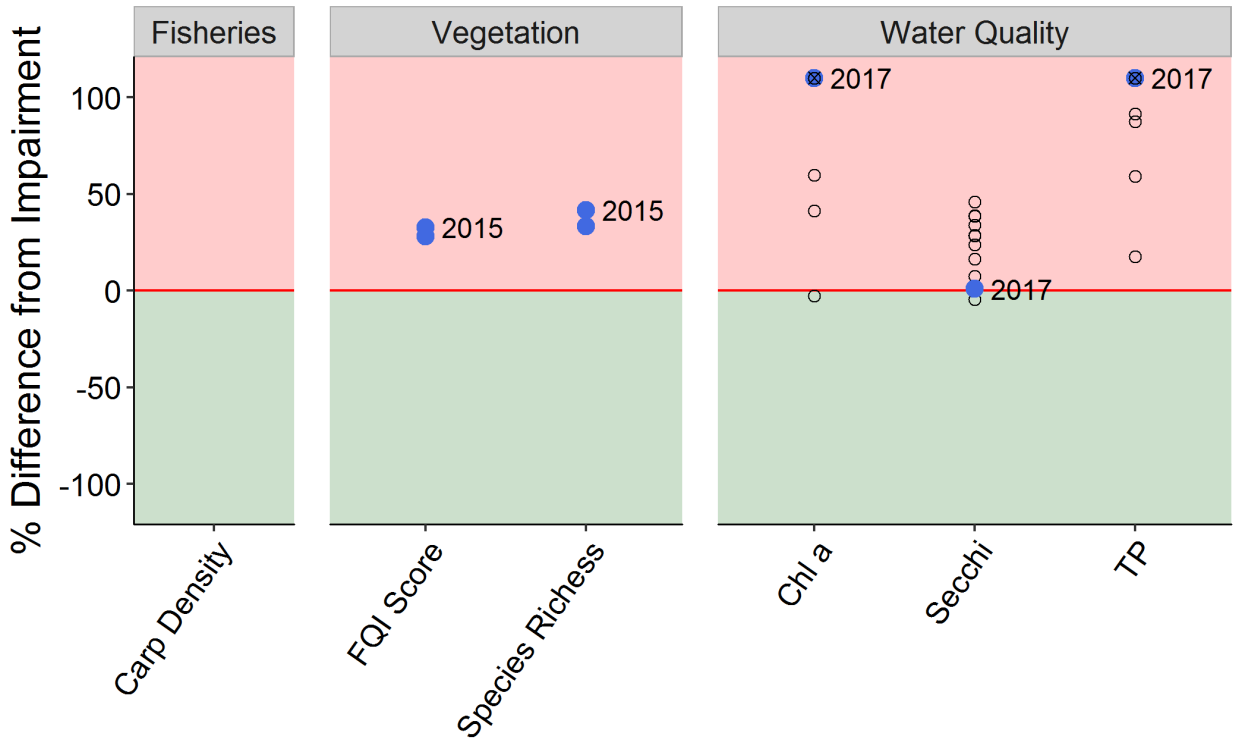


**Figure 5-8. Biota and water quality summary (since 2000) for Pike Lake.**

*Recommendations*

- Efforts to assess the carp population within the lake are needed.
- Subwatershed assessment is being assessed for BMP are being proposed.

## 5.9 Magda Lake

*Water Quality*

- Water quality is degraded and does not meet water quality standards.
- Brown milky water condition were observed in the lake after precipitation events which likely resulted from storm sewer inputs during summer street repairs within the watershed.
- Historic trend assessment: No trends observed.

*Fisheries – See Appendix E for detailed summary of 2017 survey.*

- Fisheries survey conducted in 2017 did not observe common carp, however, a large population of bullheads and an imbalanced fishery were observed.
- Water quality has the potential to be greatly influence by the fish community in shallow lakes. It is likely that the current fish community is contributing to impairments within the lake.

*Vegetation – See Appendix E for detailed summary of 2017 survey.*

- The vegetation community is biologically impaired and health decreased through the open water season.
- Poor water quality impedes the ability of plants to grow as they quickly become light limited.

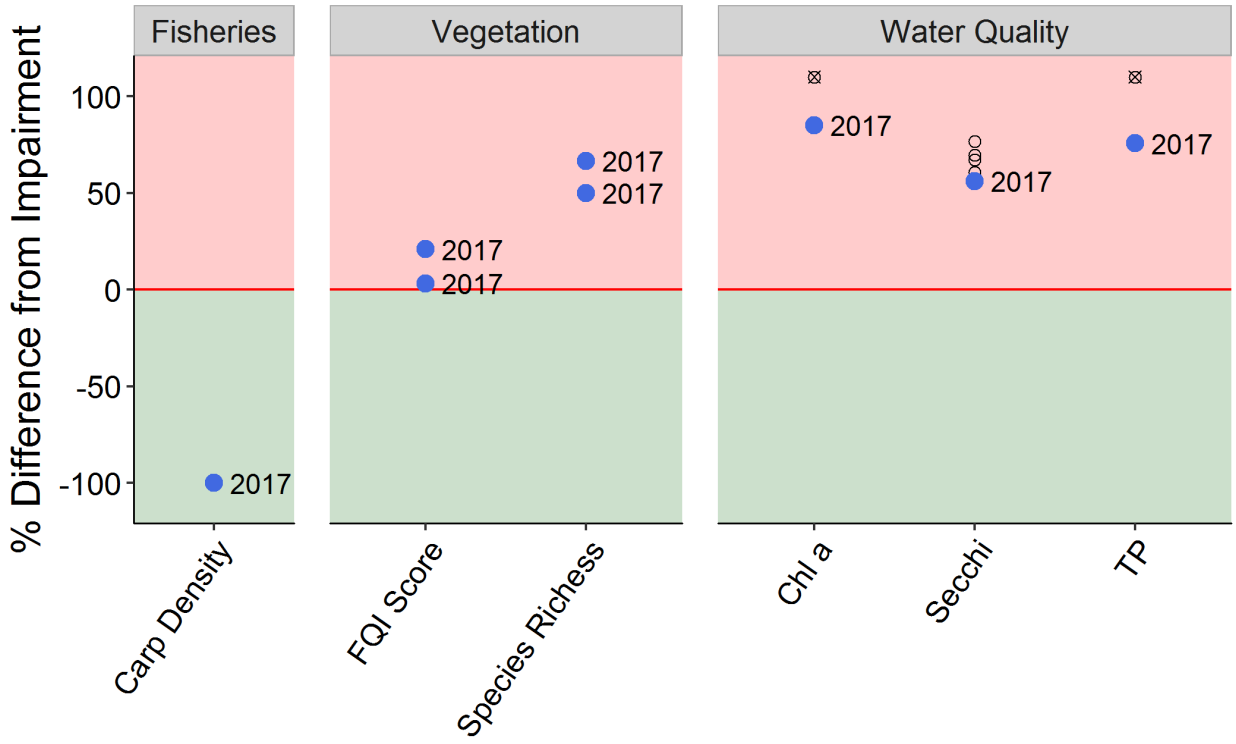


**Figure 5-9. Biota and water quality summary (since 2000) for Magda Lake.**

*Recommendations*

- Efforts to remove fish or maintain a healthy fishery should become a priority to increase water quality and biotic community health.

## 5.10 Meadow Lake

*Water Quality*

- Water quality is degraded and does not meet water quality standards.
- Historic trend assessment: No trends observed.

*Fisheries*

- Fisheries survey conducted in 2017 did not observe common carp, however, a large population of fathead minnows was observed.
- Water quality has the potential to be greatly influence by the fish community in shallow lakes. We believe that the current fish community is contributing to impairments within the lake.

*Vegetation*

- Vegetation quantity and quality are below impairments thresholds and are likely the result of poor water quality conditions.
- Vegetation health decreased across the open water season as water quality decreased.

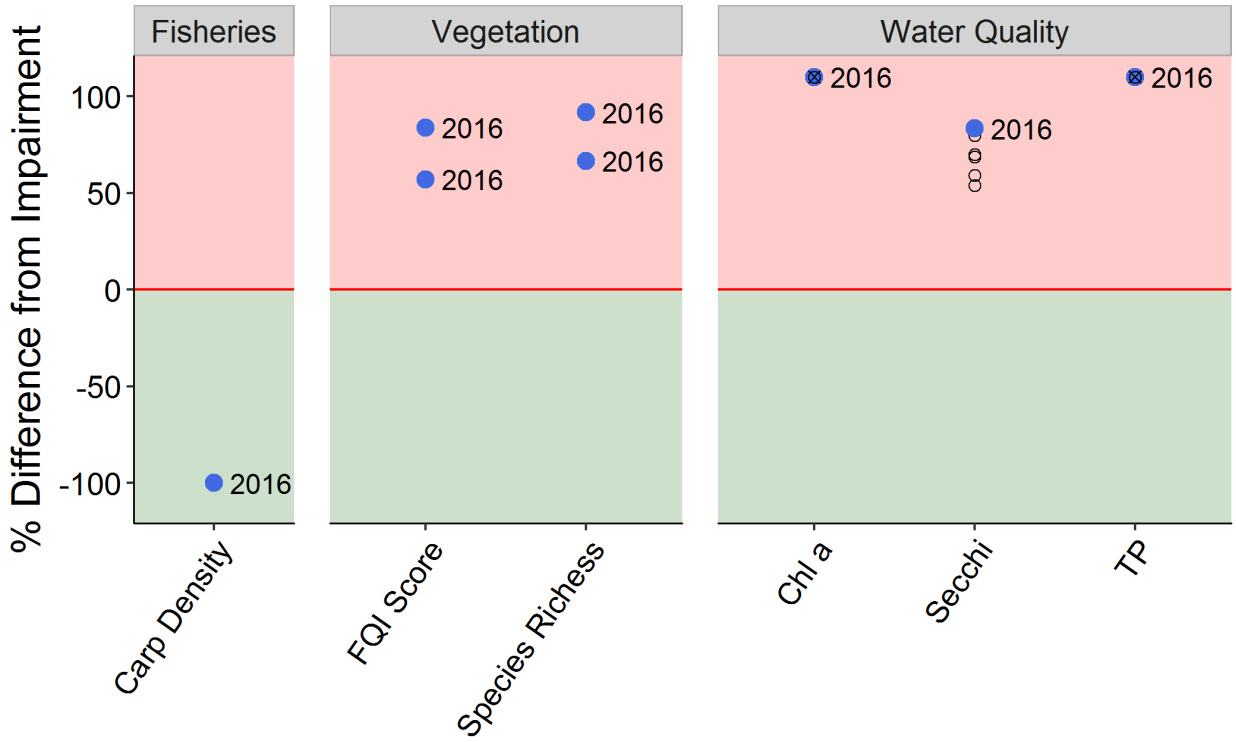


**Figure 5-10. Biota and water quality summary (since 2000) for Meadow Lake.**

*Recommendations*

- A greater fisheries assessment and efforts to keep fish out of Meadow Lake will likely have a significant impact on the water quality and vegetation community health.

# 6.0 Middle Shingle Creek Management Unit

**MIDDLE SHINGLE CREEK MANAGEMENT UNIT OVERVIEW**

The Middle Shingle Creek Management Unit covers Shingle Creek from the confluence of Eagle and Bass Creeks to Palmer Lake in Brooklyn Park. This management unit covers approximately 9,500 acres across four municipalities in Hennepin County. A majority of the management unit is located in Brooklyn Park (62%), with the rest covering portions of Maple Grove (27%), Brooklyn Center (8%), and Osseo (3%) (Figure 6-1 and Table 6-1).

The Middle Single Creek Management Unit is fully developed. Most of the eastern portion of the management unit (Brooklyn Park and Brooklyn Center) was developed in the 1960s and 1970s with minimal stormwater treatment. The western portion of the watershed, particularly Maple Grove, was developed more recently in the 1980s and 1990s and therefore much of this area has some level of stormwater quality treatment. A recent desktop analysis determined that there are approximately 1,700 acres of the watershed flowing directly to Shingle Creek with no water quality treatment, most of which is in the City of Brooklyn Park (see Table 6-1).

Land use within the Middle Shingle Creek Management Unit is predominantly high impervious urban development (45%) and low-moderate impervious urban development (28%). In general, development through the Shingle Creek watershed occurred from east to west and therefore the Middle Shingle Creek Management Unit has the second most impervious coverage of the three management units. Lakes are a not a common feature in the Middle Shingle Creek Management Unit. Lake Success is the only lake in the watershed by DNR definition. Palmer Lake is another shallow water body located in this management unit, however it is classified as a wetland by DNR standards.

Similar to the West Mississippi Management Unit, the Middle Shingle Creek Management Unit is characterized by sandy, well-draining soils. Approximately 62% of the management unit contains type A, A/D, or B soils. Soil type for the Middle Shingle Creek Management Unit is summarized in Table 6-1.

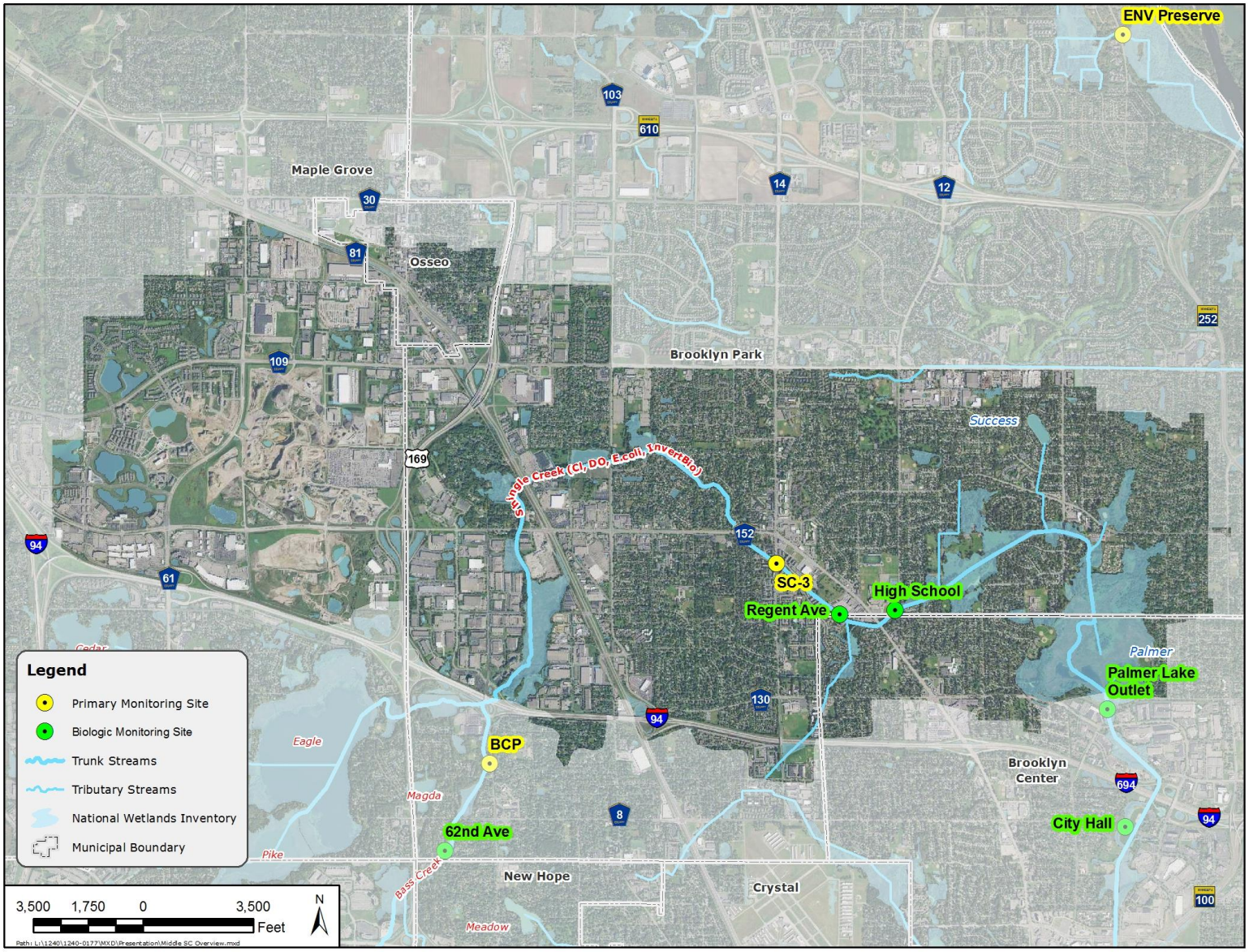


**Figure 6-1. Middle Shingle Creek Management Unit Overview.**

**Table 6-1. Middle Shingle Creek Management Unit water resources and land features.**

| Streams | Type | Impairment Status |
|---|---|---|
| Shingle Creek (07010206-506) | Class 2B | Impaired (Cl, DO, *E. coli*, Biota – Invert.) |

| Lakes | Type | Impairment Status |
|---|---|---|
| Palmer | Shallow | Not Assessed |
| Success | Shallow | Not Impaired |

| Cities | Acres | Percent |
|---|---|---|
| Brooklyn Park | 5,839 | 62% |
| Maple Grove | 2,558 | 27% |
| Brooklyn Center | 769 | 8% |
| Osseo | 273 | 3% |

| Landuse | Acres | Percent |
|---|---|---|
| Highly Impervious (51-100%) | 4,215 | 45% |
| Low-Moderate Impervious (5-50%) | 2,645 | 28% |
| Grassland and Shrubland | 1,422 | 15% |
| Wetlands | 893 | 9% |
| Forest | 236 | 3% |
| Agriculture | 19 | <1% |
| Open Water | 10 | <1% |

| Soil Type | Acres | Percent |
|---|---|---|
| A | 2,943 | 31% |
| A/D | 2,138 | 23% |
| B | 772 | 8% |
| B/D | 228 | 2% |
| C | 36 | <1% |
| C/D | 39 | <1% |
| Water | 86 | 1% |
| Not Assessed (Heavily Disturbed) | 3,197 | 34% |

| Untreated Area (Direct) | Acres |
|---|---|
| Brooklyn Park | 1,637 |
| Brooklyn Center | 95 |

## 6.1 Monitoring History

### STREAMS

Stream flow and water quality have been monitored at one location, SC-3, in the Middle Shingle Creek Management Unit. This station is located at the intersection of Shingle Creek and Brooklyn Boulevard in Brooklyn Park. This monitoring location drains approximately 54% of the Middle Shingle Creek Management Unit. The Shingle Creek WMC began monitoring this station in the early 2002. Shingle Creek was placed on the State's 303(d) list of impaired waterbodies in 1998 for chloride, in 2004 for DO, and in 2006 for macroinvertebrate IBI scores. TMDL studies were completed by the Commission and the MPCA in 2007 to address the chloride impairment and in 2011 to address the DO and macroinvertebrate IBI impairments. The Commission has continued to monitor this station every year since the completion of the TMDLs to assess water quality conditions in the Middle Shingle Creek Management Unit and measure progress toward achieving the TMDLs. Shingle Creek is considered a Class 2B water and is therefore subject to the North Central Hardwood Forest Class 2B water quality standards for streams.

Four main water quality parameters of concern have been sampled at the SC-3 monitoring station since 2002: TSS, TP, dissolved oxygen (DO), and chloride. Figure 5-2 contains a series of bar figures that summarize current water quality conditions at the SC-3 station for each of the aforementioned parameters. Each bar figure depicts the current condition, parameter units, parameter, and associated Class 2B water quality standard. The color gradient on each bar depicts how far above (red) or below (blue) each parameter is compared to the Class 2B standard. Long-term data trends for these parameters were assessed using a Mann-Kendall trend analysis corrected for flow. Parameters with long-term trends are denoted with red (declining) and blue (improving) arrows.

Monitoring results for other water quality parameters not covered in this section (ortho-P, TKN and nitrate) are presented in Appendices B and C. Also included in Figure 5-2 is the fish/macroinvertebrate IBI monitoring results for two biological monitoring stations in the Middle Shingle Creek Management Unit: Regent Avenue (10UM032) and Park Center High School (Figure 5-1). Fish and macroinvertebrate IBI assessments were performed at the Regent Ave site in 2010, and a macroinvertebrate IBI assessment was conducted at the High School site in 2015 in support of the Shingle Creek Art Aeration Project.

Below is a general summary of the current conditions of the four main water quality parameters of concern and IBI monitoring results in the Middle Shingle Creek Management Unit.

### LAKES

Lake water quality has been monitored on the only lake in the Middle Shingle Creek Management Unit, Lake Success, since the 1990s (Palmer Lake is a wetland.) Historic monitoring for Lake Success indicates the lake is currently meeting state water quality for two of the three water quality parameters: TP and Secchi depth (Figure 5-3). Lake Success is not currently meeting state water quality standards for chlorophyll-a, however since it is meeting standards for two of the three parameters it is not considered impaired and would not be placed on the 303(d) list of impaired waters. Since the lake is very close to exceeding state water quality standards, it should be considered a high priority protection lake. Lake Success was monitored by the Commission in 2016 through the Intensive Lake Monitoring program. Detailed results of the 2016 monitoring are presented in Appendix E.

## 6.2 SC03 Stream Reach

*Water Quality*

- In 2017, TSS, TP and NO3/NO2 are below the impairment threshold. DO and Chloride are above impairment thresholds.
- Relative to previous years, 2017 observed above average water quality parameter scores.
- Historic trend assessment: TP, TSS and TKN have been improving. SRP has been deteriorating.

*Biota*

- Biota have not been assessed at this site.

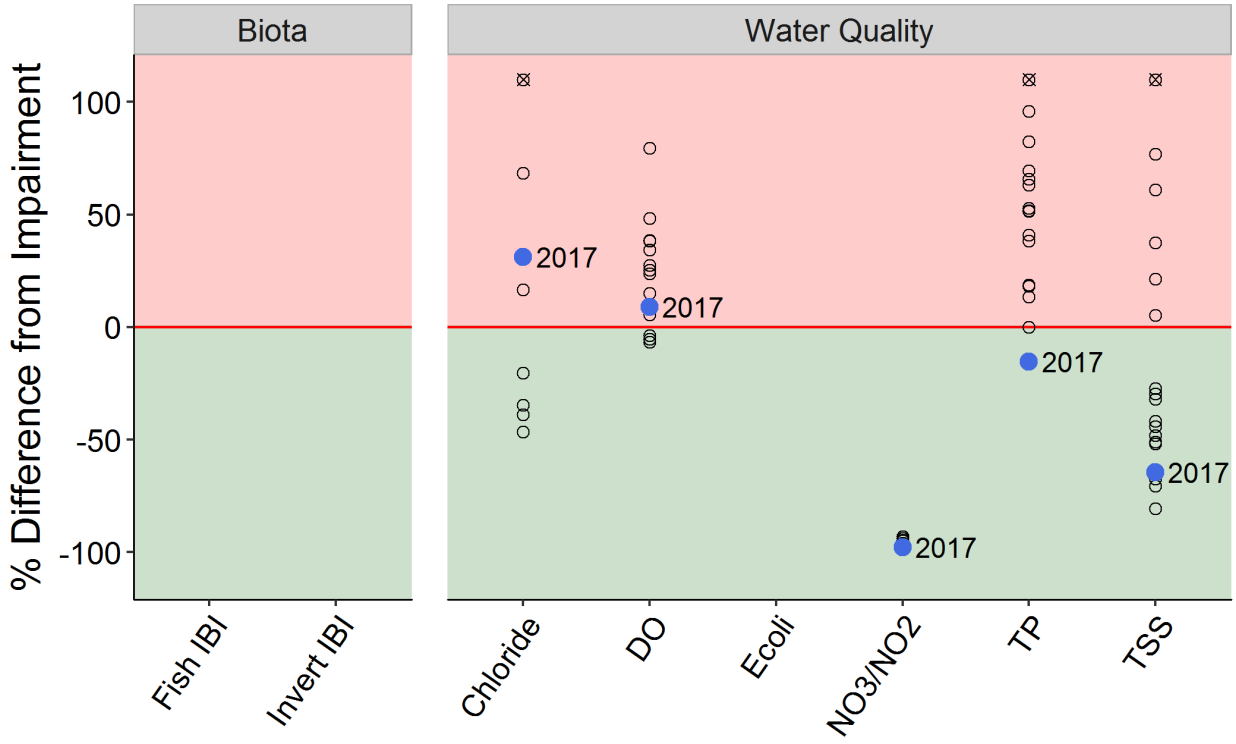


**Figure 6-2. SC03 stream water quality and biota health summary since 2000.**

*Recommendations*

- Biotic surveys will be conducted in 2018 to provide an account of community conditions.

## 6.3 Lake Success

*Water Quality*

- TP and Secchi were not meeting standards, while Chl-a was slightly above impairment threshold. Overall water quality is poor.
- Historic trend assessment: Secchi depth is decreasing.

*Fisheries*

- No fisheries assessment has been conducted.

*Vegetation*

- No vegetation was observed in spring or summer surveys.

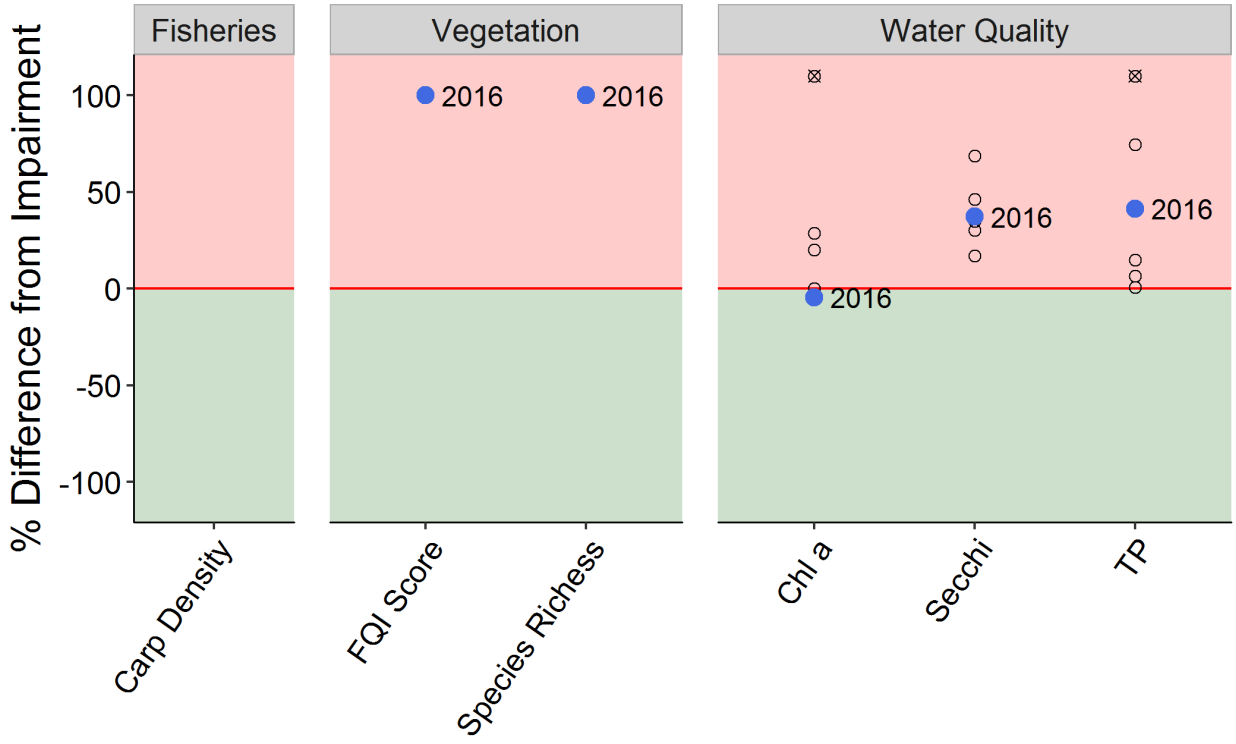


**Figure 6-3. Biota and water quality summary (since 2000) for Lake Success.**

*Recommendations*

- Conduct a fish community assessment.
- Investigate why there is no vegetation growth.

# 7.0 Lower Shingle Creek Management Unit

## LOWER SHINGLE CREEK MANAGEMENT UNIT OVERVIEW

The Lower Shingle Creek Management Unit covers Shingle Creek from the outlet of Palmer Lake in Brooklyn Park to the creek's confluence with Mississippi River in Minneapolis. This management unit covers approximately 11,000 acres across six municipalities in Hennepin County. This management unit is split up fairly evenly between Brooklyn Center (27%), Crystal (23%), Minneapolis (19%), Robbinsdale (14%), New Hope (10%), and Brooklyn Park (7%) (Figure 7-1 and Table 7-1).

Lakes are a common feature in the Lower Shingle Creek Management Unit. The Twin Chain of Lakes is located in Crystal, Brooklyn Center, and Robbinsdale and includes Upper Twin, Middle Twin and Lower Twin Lakes. Upper (118 acres) and Lower Twin (30 acres) are shallow lakes, while Middle Twin Lake (54 acres) is a deep lake. Flow through the lake chain is from north to south or from Upper to Middle to Lower Twin. Lower Twin Lake outlets over a weir located at France Avenue to a small channel (Ryan Creek) that flows downstream to Ryan Lake. Ryan Lake is a small (15 acres) deep lake located in Robbinsdale, Brooklyn Center, and Minneapolis. Ryan Lake outlets to Ryan Creek which flows east to where it discharges to Shingle Creek near 49th Ave N in Minneapolis. Crystal Lake is the other lake in the Lower Shingle Creek Management Unit. Crystal Lake is a moderate sized (89 acres) deep lake located in the City of Robbinsdale.

The Lower Shingle Creek Management Unit is fully developed. Most of this management unit was developed in the 1950s and 1960s or earlier and therefore has minimal stormwater treatment. A recent desktop analysis determined that there are approximately 2,000 acres of the watershed flowing directly to Shingle Creek with no water quality treatment, most of which is in Minneapolis (see Table 7-1).

Land use within the Lower Shingle Creek Management Unit is predominantly high impervious urban development (71%). In general, development through the Shingle Creek watershed occurred from east to west and therefore the Lower Shingle Creek Management Unit has the highest impervious coverage of the three Shingle Creek Management Units. The remainder of land in the Lower Shingle Creek Management Unit is split between grassland and shrubland (13%), low-moderate impervious urban development (8%), open water (3%), wetlands (3%) and forest (2%) (see Table 7-1).

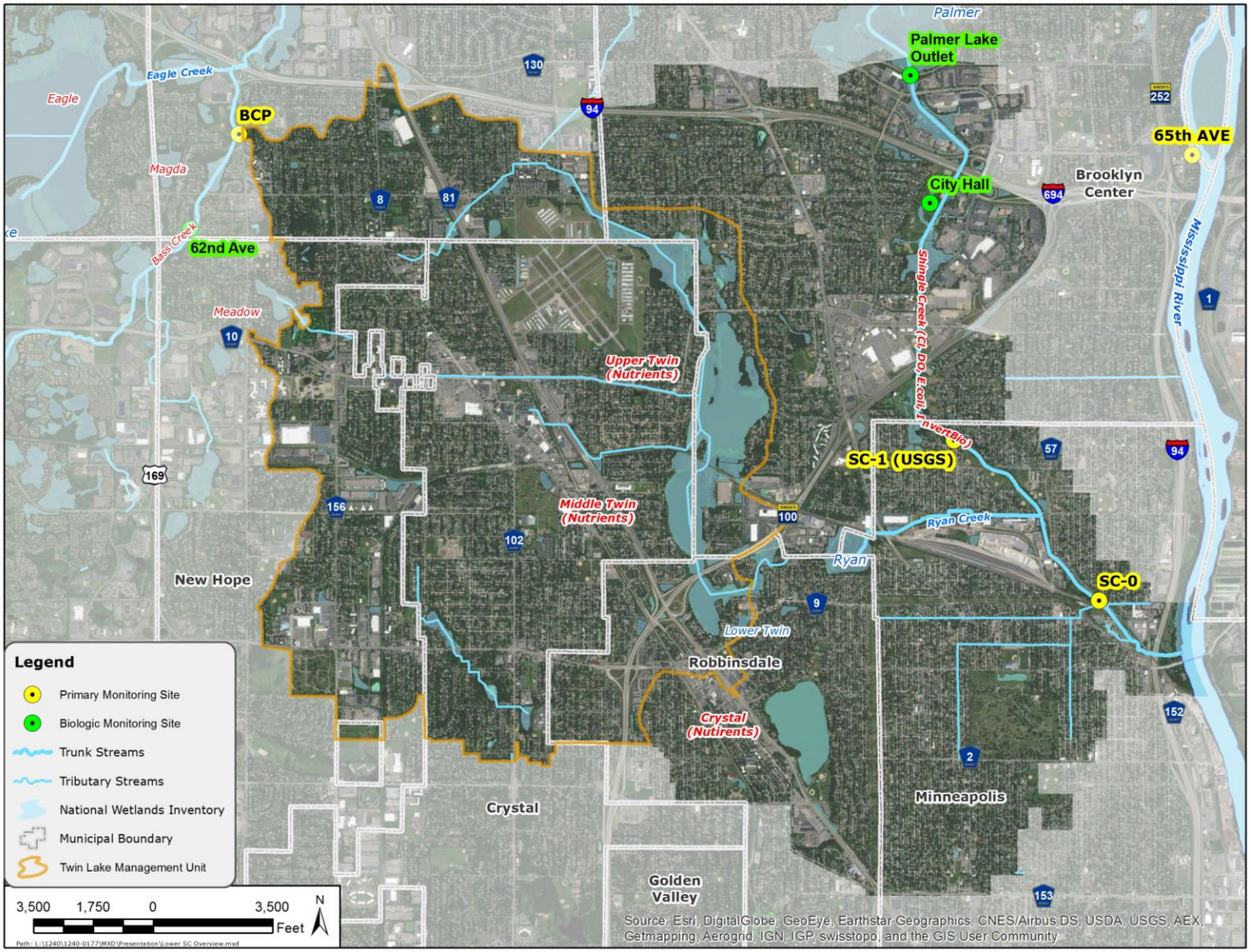


**Figure 7-1. Lower Shingle Creek Management Unit Overview.**

**Table 7-1. Lower Shingle Creek Management Unit water resources and land features.**

| Streams | Type | Impairment Status |
|---|---|---|
| Shingle Creek (07010206-506) | Class 2B | Impaired (Cl, DO, *E. coli*, Biota – Invert.) |
| Ryan Creek (07010206-536) | Class 2B | Not Assessed |

| Lakes | Type | Impairment Status |
|---|---|---|
| Crystal | Deep Lake | Impaired (nutrients) |
| Upper Twin | Shallow Lake | Impaired (nutrients) |
| Middle Twin | Deep Lake | Impaired (nutrients) |
| Lower Twin | Shallow Lake | Not Impaired (de-listed in 2016) |
| Ryan | Shallow Lake | Not Impaired (de-listed in 2016) |

| Cities | Acres | Percent |
|---|---|---|
| Brooklyn Center | 2,902 | 27% |
| Crystal | 2,515 | 23% |
| Minneapolis | 2,048 | 19% |
| Robbinsdale | 1,485 | 14% |
| New Hope | 1,092 | 10% |
| Brooklyn Park | 810 | 7% |

| Landuse | Acres | Percent |
|---|---|---|
| Highly Impervious (51-100%) | 7,700 | 71% |
| Grassland and Shrubland | 1,425 | 13% |
| Low-Mod Impervious (5-50%) | 835 | 8% |
| Open Water | 370 | 3% |
| Wetlands | 309 | 3% |
| Forest | 196 | 2% |
| Agriculture | 16 | 0% |

| Soil Type | Acres | Percent |
|---|---|---|
| A | 2,346 | 28% |
| A/D | 2 | <1% |
| B | 1,892 | 23% |
| B/D | 1,006 | 12% |
| C | 89 | 1% |
| C/D | 1,003 | 12% |
| Water | 736 | 9% |
| Not Assessed (heavily disturbed) | 1,249 | 15% |

| Untreated Area (Direct to Creek) | Acres |
|---|---|
| Minneapolis | 1,342 |
| Brooklyn Center | 301 |
| Robbinsdale | 295 |
| Crystal | 57 |

## 7.1 Monitoring History

### STREAMS

Water quality has been monitored routinely at one location, SC-0, in the Lower Shingle Creek Management Unit. This station is located in Webber Park in Minneapolis just upstream of 45th Ave. The SC-0 monitoring station drains approximately 82% of the Lower Shingle Creek Management Unit, as well as the entire Middle and Upper Shingle Creek Management Units. The Shingle Creek WMC began monitoring this station routinely in 2002. Shingle Creek was placed on the State's 303(d) list of impaired waterbodies in 1998 for chloride, in 2004 for DO, and in 2006 for macroinvertebrate IBI scores. TMDL studies were completed by the Commission and the MPCA in 2007 to address the chloride impairment and in 2011 to address the DO and macroinvertebrate IBI impairments. The Commission has continued to monitor this station every year since the completion of the TMDLs to assess water quality conditions in the Middle Shingle Creek Management Unit and measure progress toward achieving the TMDLs. Shingle Creek is considered a Class 2B water and is therefore subject to the North Central Hardwood Forest Class 2B water quality standards for streams.

Four main water quality parameters of concern have been sampled at the SC-0 monitoring station since 2002: TSS, TP, dissolved oxygen (DO), and chloride. Figure 7-2 contains a series of bar figures that summarize current water quality conditions at the SC-0 station for each of the aforementioned parameters. Each bar figure depicts the current condition, parameter units, parameter, and associated Class 2B water quality standard. The color gradient on each bar depicts how far above (red) or below (blue) each parameter is compared to the Class 2B standard. Long-term data trends for these parameters were assessed using a Mann-Kendall trend analysis corrected for flow. Parameters with long-term trends are denoted with red (declining) and blue (improving) arrows.

Monitoring results for other water quality parameters not covered in this section (ortho-P, TKN and nitrate) are presented in Appendices B and C. Also included in Figure 7-2 is the fish/macroinvertebrate IBI monitoring results for four biological monitoring stations in the Lower Shingle Creek Management Unit: SC-0, SC-1 (USGS), City Hall, and the Palmer Lake Outlet (Figure 7-1). Fish and macroinvertebrate IBI assessments were performed by the MPCA at the USGS site in the late 1990s and at the SC-0 site in 2010. Macroinvertebrate IBI assessments were conducted at the City Hall and Palmer Lake Outlet Sites in 2015 in support of the Shingle Creek Art Aeration Project.

Below is a general summary of the current conditions of the four main water quality parameters of concern and IBI monitoring results in the Lower Shingle Creek Management Unit.

### LAKES

Lake water quality has been monitored for all five lakes in the Lower Shingle Creek Management Unit since at least the mid-1990s. All of the lakes in the Lower Management Unit were assessed as impaired for nutrients (TP) in the early 2000s. TMDL studies for each lake were completed by the Commission and the MPCA through two different TMDL studies:

- The Twin and Ryan Lakes Nutrient TMDL (2007)
- The Crystal Lake Nutrient TMDL (2008)

Historic water quality sampling on each lake has focused on three main parameters: TP, chlorophyll-a, and Secchi depth (transparency). Figures 7-3 and 7-4 contain a series of bar

figures that summarize the three water quality parameters for each lake. Each bar figure depicts the current condition, parameter units, parameter, and associated lake water quality standard. The color gradient on each bar depicts how far above (red) or below (blue) each parameter is compared to the standard. Long-term data trends for each lake are presented in Appendix D. While no formal trend analysis has been performed on these data, visual inspection of the figures in Appendix D does not indicate any increasing or decreasing data trends for the five lakes in the Lower Shingle Creek Management Unit over the past 10 years.

The following is a general summary of water quality conditions for each lake in the Lower Shingle Creek Management Unit over the past 10 years.

*Twin Lake Chain*

- Upper Twin and Middle Twin Lakes have consistently exceeded water quality standards over the past 10 years
- There does not appear to be any positive or negative trends in water quality for Upper Twin and Middle Twin and both lakes are still considered impaired
- Lower Twin has met state water quality standards over the past 10 years and was removed from the State's 303(d) list of impaired waters in 2016.

*Ryan Lake*

- Similar to Lower Twin, Ryan Lake has met state water quality standards over the past 10 years and was recently removed from the State's 303(d) list of impaired waters in 2016.

*Crystal Lake*

- Crystal Lake has not met State water quality standards over the past 10 years.

## 7.2 USGS SC01 Stream Reach

The USGS has been conducting water quality and biological assessments at site SC01 since the 90s. In consultation with the MPCA it was determined that the fisheries data was collected in a similar manner to the MPCA fish IBI sampling protocol and the data was scored using the MPCA IBI health assessment tool. Overall, the historic IBI records suggest a shift in community health, however, all records indicate a community of poor resilience with high variability from year to year (Figure 7.2).

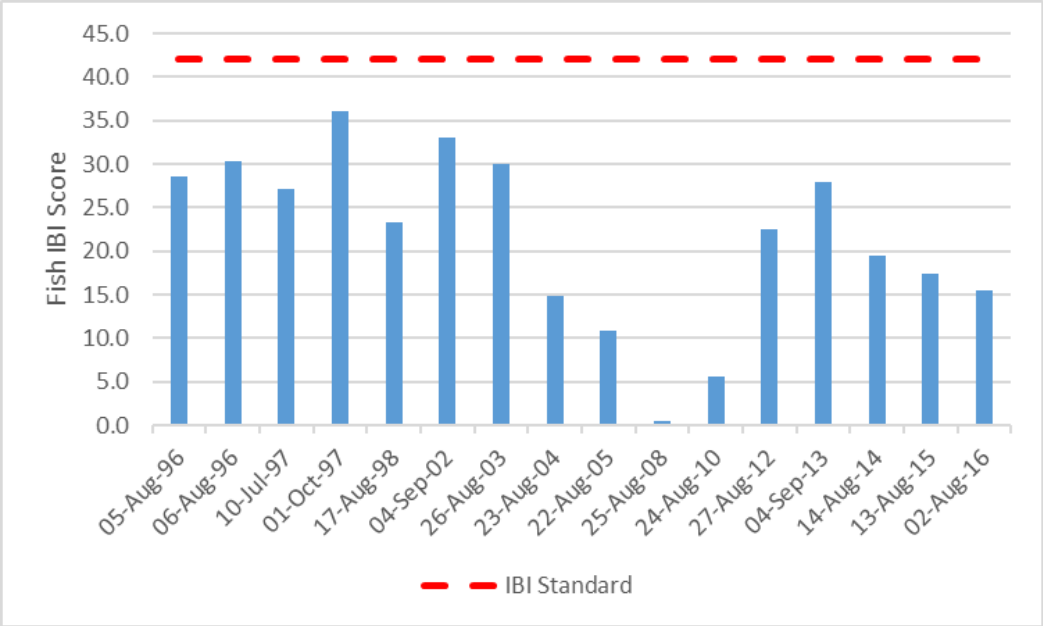


**Figure 7-2. SC01 fisheries health summary since 1996.**

Observations made before 2004 had relatively greater species diversity (average = 13 taxa) and abundance (average = 475 individuals) when compared to 2004 and beyond (richness = 7.1 taxa, abundance = 119 individuals). However, all sampling efforts have reported community health well below the standard value.

It is difficult to state whether/what environmental changes occurred to cause the community changes. The stream is documented as being dry in 2008-2009 due to severe drought, therefore, it is possible only the hardiest species survived and the community has not recovered. It was also noted in the USGS sampling notes that in 2004 the sampling techniques changed from a barge to a backpack sampling method. The impact of this switch cannot be assessed with the available dataset and it is uncertain the impact it had. Without a more intensive assessment and review of abiotic data at this site, we cannot make any conclusive statements.

## 7.3 SC00 Stream Reach

*Water Quality*

- TSS, TP and NO3/NO2 are meeting standards, while DO, Chloride and *E. coli* are not.
- 2017 observed above average water quality results.
- Historic trend assessment: TP, TSS and TKN have been improving. SRP has been deteriorating.

*Biota*

- Biota have not been recently assessed.

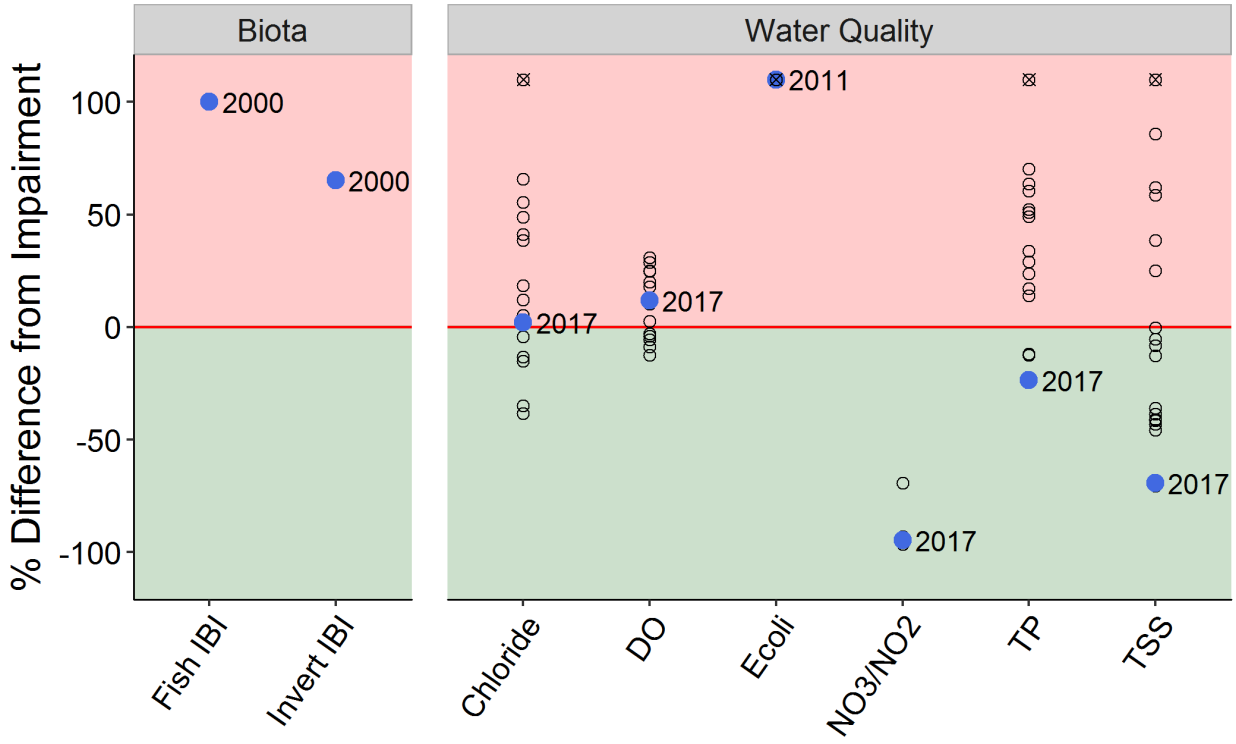


**Figure 7-3. SC00 stream water quality and biota health summary since 2000.**

*Recommendations*

- Update biotic surveys (occurring in 2018).

## 7.4 Upper Twin Lake

*Water Quality*

- No water quality parameter met standard. Chl-a and TP were very poor at > double impairment standard value.
- Historic trend assessment: Chl-a is decreasing.

*Fisheries*

- Carp density exceeds the critical threshold by more than 100%.

*Vegetation*

- Vegetation community is poor and lacked both species richness and quality of species. Community conditions degraded across the open water season.

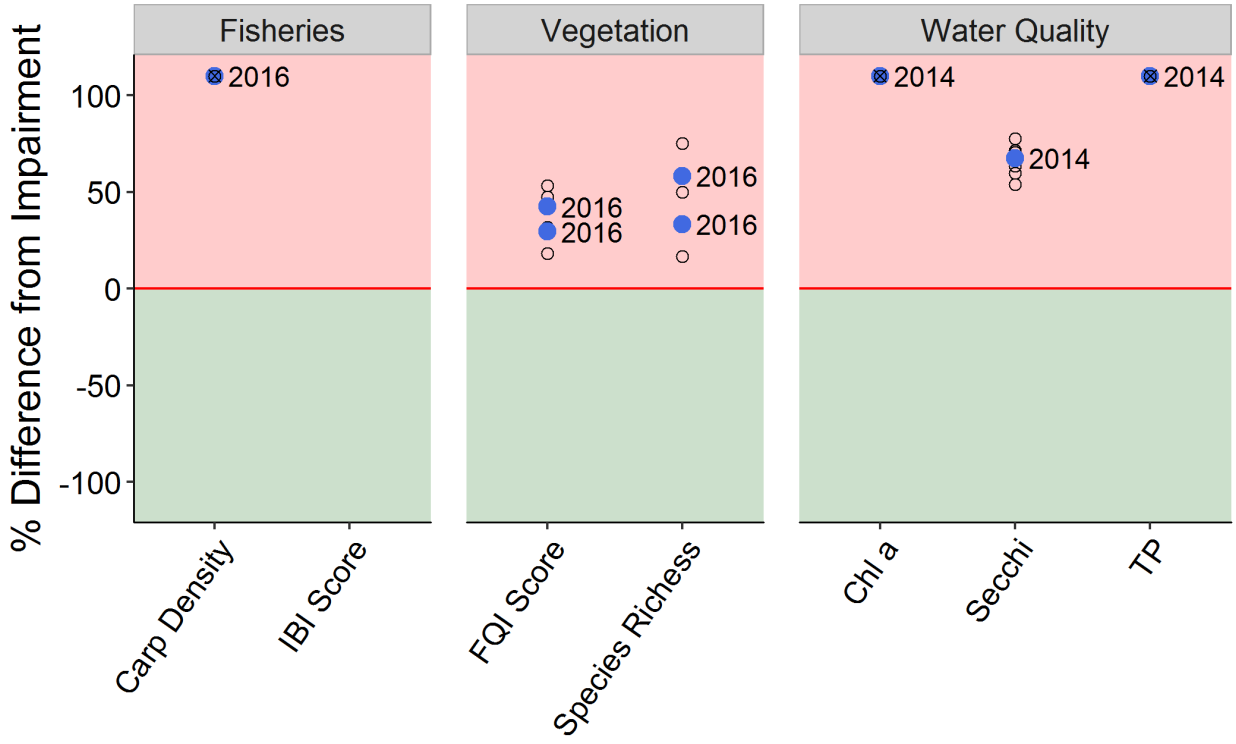


**Figure 7-4. Biota and water quality summary (since 2000) for Upper Twin Lake.**

*Recommendations*

- The MnDNR will be conducting a Fish IBI assessment in 2018.
- Continued carp management efforts are on-going within the Twin Lake chain (2018).
- Develop and execute of an aquatic vegetation management plan (begins 2018).
- Water quality and submerged aquatic vegetation sampling will be copmleted in 2018

## 7.5 Middle Twin Lake

*Water Quality*

- No water quality parameter met standard. Chl-a was very poor at > double impairment standard value.
- Historic trend assessment: No trends observes.

*Fisheries*

- Carp density exceeds the critical threshold by more than 100%.

*Vegetation*

- Vegetation community is poor and lacked both species richness and quality of species.

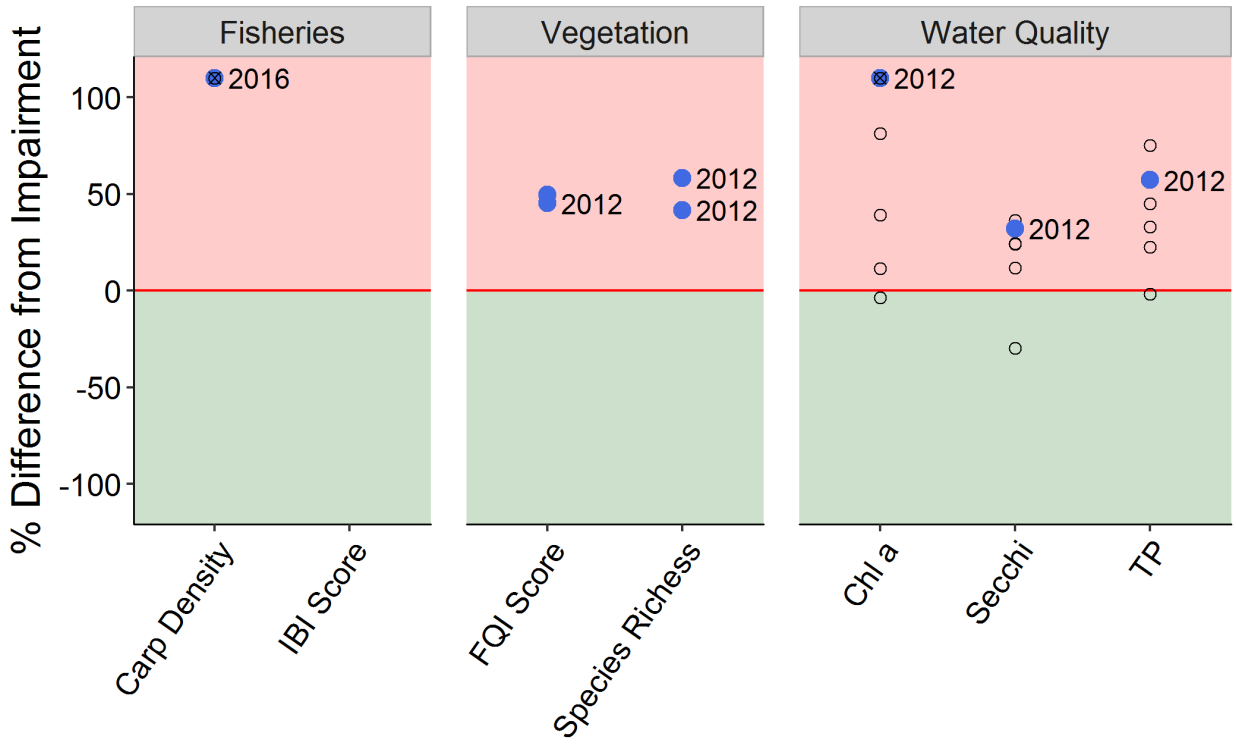


**Figure 7-5. Biota and water quality summary (since 2000) for Middle Twin Lake.**

*Recommendations*

- The MnDNR will be conducting a Fish IBI assessment in 2018.
- Continued cap management efforts are on-going within the Twin Lake chain (2018).
- Water quality and submerged aquatic vegetation sampling will be completed in 2018.

## 7.6 Lower Twin Lake

*Water Quality*

- Most recent water quality was in sampled in 2014 and demonstrated that TP and Secchi did not meet water quality standards while Chl-a met the standard.
- Historic trend assessment: TP is decreasing. Secchi depth is increasing.

*Fisheries*

- Carp density was less than threshold and met the threshold, however, is well connected to the other Twin lakes and contributes to the overall carp density problem.

*Vegetation*

- Vegetation community is poor and lacked both species richness and quality of species.

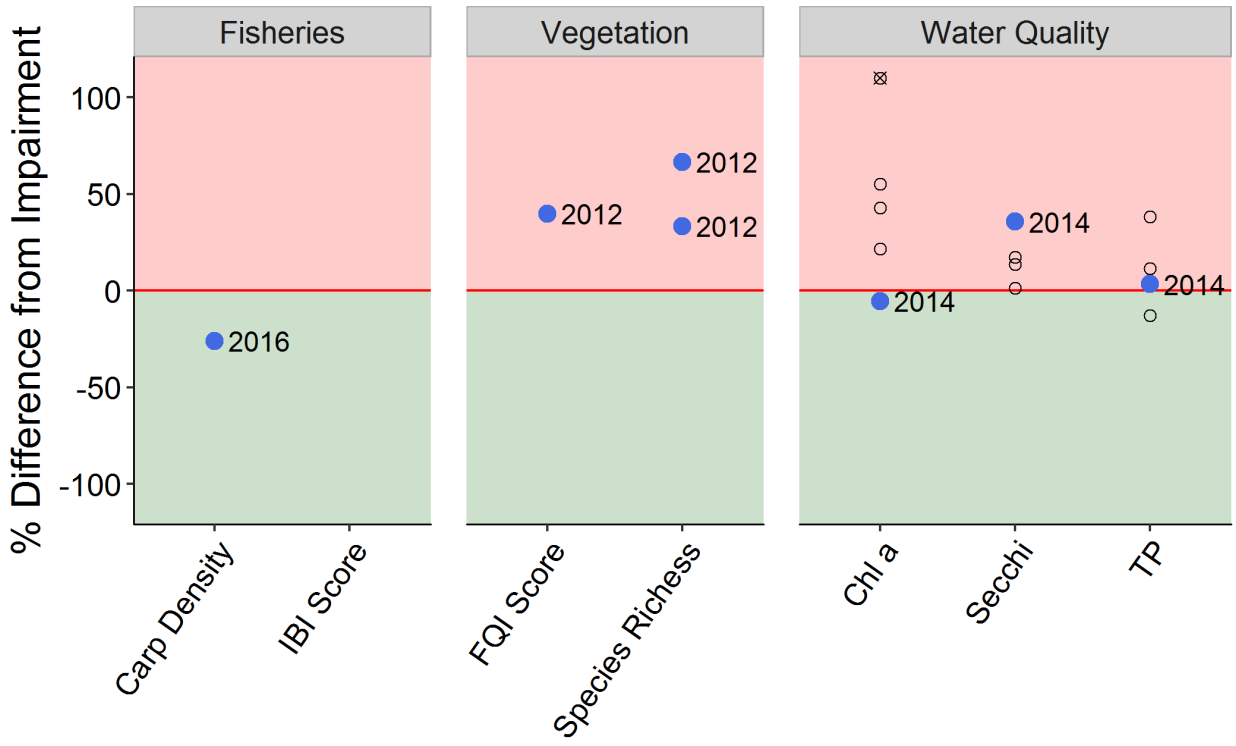


**Figure 7-6. Biota and water quality summary (since 2000) for Lower Twin Lake.**

*Recommendations*

- The MnDNR will be conducting a Fish IBI assessment in 2018.
- Continued carp management efforts are on-going within the Twin Lake chain (2018).
- Water quality and submerged aquatic vegetation sampling will be completed in 2018.

## 7.7 Ryan Lake

*Water Quality*

- Most recent water quality was in sampled in 2013 and demonstrated that TP did not meet water quality standards while Chl-a and Secchi met standards.
- Historic trend assessment: No trends were observed.

*Fisheries*

- No fisheries assessment has recently been conducted.

*Vegetation*

- No vegetation assessment has been conducted.

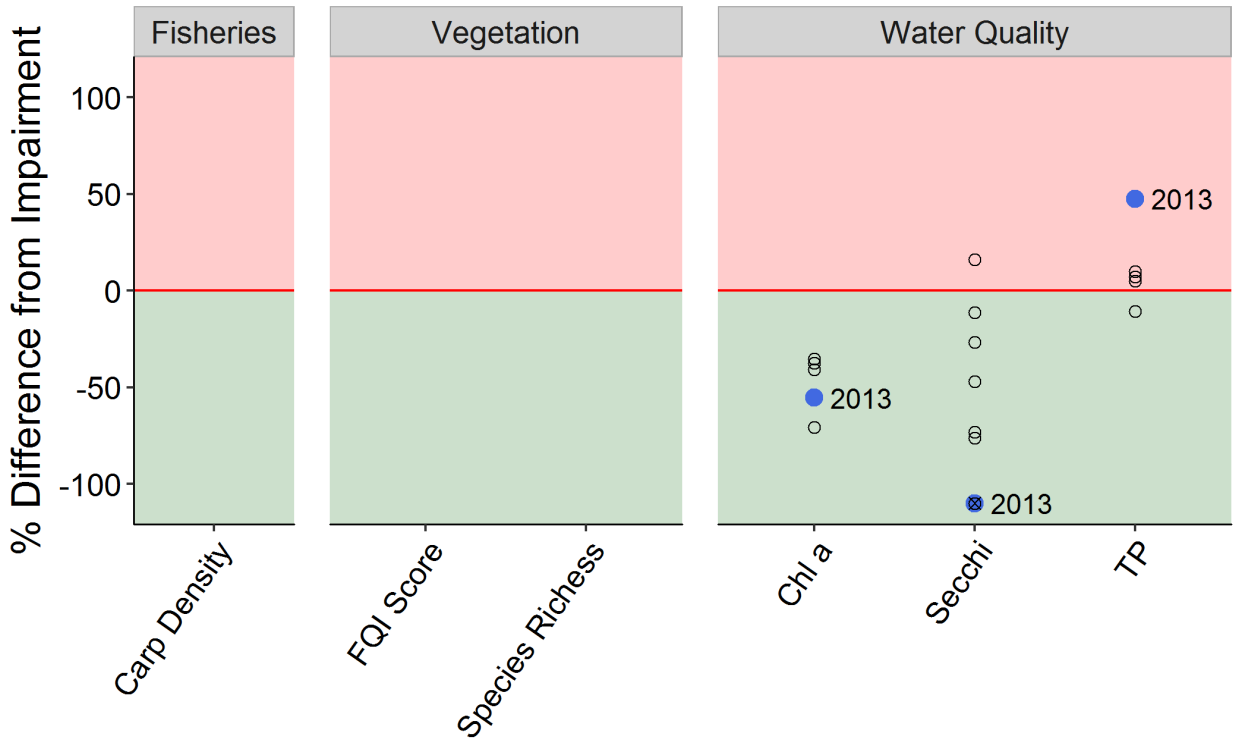


**Figure 7-7. Biota and water quality summary (since 2000) for Ryan Lake.**

*Recommendations*

- MnDNR is conducting a fisheries survey in 2018.
- Water quality and submerged aquatic vegetation sampling will be completed in 2018.

## 7.8 Crystal Lake

*Water Quality*

- Most recent water quality was in sampled in 2014 and demonstrated that TP did not meet water quality standards while Chl-a and Secchi met standards.
- Historic trend assessment: TP is decreasing.

*Fisheries*

- No fisheries assessment has recently been conducted.

*Vegetation*

- No vegetation assessment has been conducted.

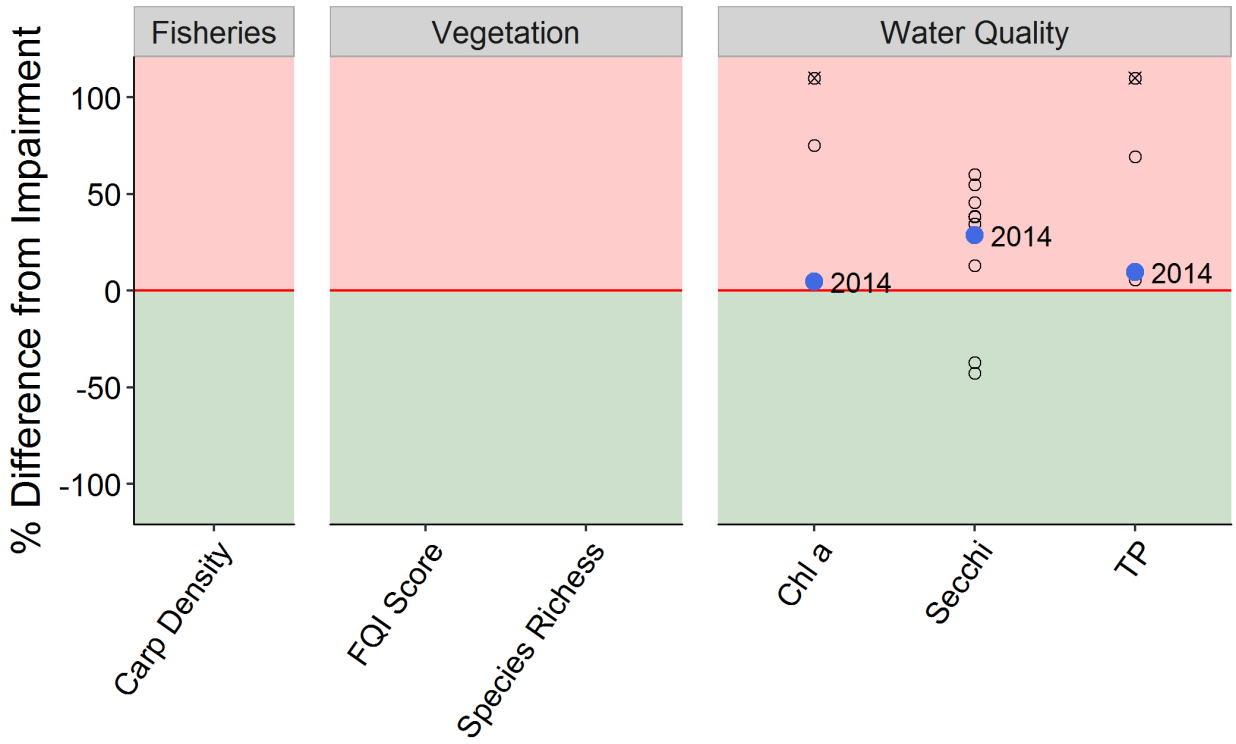


**Figure 7-8. Biota and water quality summary (since 2000) for Crystal Lake.**

*Recommendations*

- MnDNR is conducting a fisheries survey in 2019.
- Water quality and submerged aquatic vegetation sampling will be completed in 2018.

# 8.0 Recommendations

Results of the historic water quality monitoring for the four management units support the following conclusions and recommendations.

*West Mississippi Management Unit*

- Identify areas that currently have no water quality treatment and/or minimal treatment. Once these areas have been identified, they should be targeted for enhanced street sweeping and assessed for potential BMP retrofit opportunities.
- Identify bacteria sources and high potential loading areas.
- Salt management practices in the impervious areas upstream of the 65th Avenue outfall should be reviewed to determine potential sources of chloride at this location.

*Upper Shingle Creek Management Unit*

- TP concentrations currently exceed State standards near the outlet of Bass Creek, and monitoring indicates a high dissolved phosphorus component. The dissolved phosphorus is likely coming from the breakdown of organic matter and sediment release of phosphorus in the lakes, ponds and flow-through wetlands throughout the Upper Management Unit. Identify ponds and wetlands in or near the main channel (such as the Cherokee wetland) that are currently releasing phosphorus and investigate strategies to decrease these loads.
- Update biotic community information in streams and lakes and following alum-sulfate treatment on Bass and Pomerleau Lakes.

*Shingle Creek Watershed-Wide*

- Refine the stream Directly Connected Untreated Areas, target them for enhanced street sweeping and assess for potential BMP retrofit opportunities.
- Identify bacteria sources and high potential loading areas.
- Identify the Directly Connected Untreated Areas tributary to the lakes. Once these areas have been identified, they should be targeted for enhanced street sweeping and assessed for potential BMP retrofit opportunities.
- Evaluate opportunities for additional stream restoration and habitat enhancement.
- Update biotic community information in streams and lakes.