REPORT SUMMARY

Lake Holiday, Wing Lake, and Lake Rose Water Quality Study

August 2022

Prepared for
Nine Mile Creek
Watershed District

9 MILE CREEK WATERSHED DISTRICT

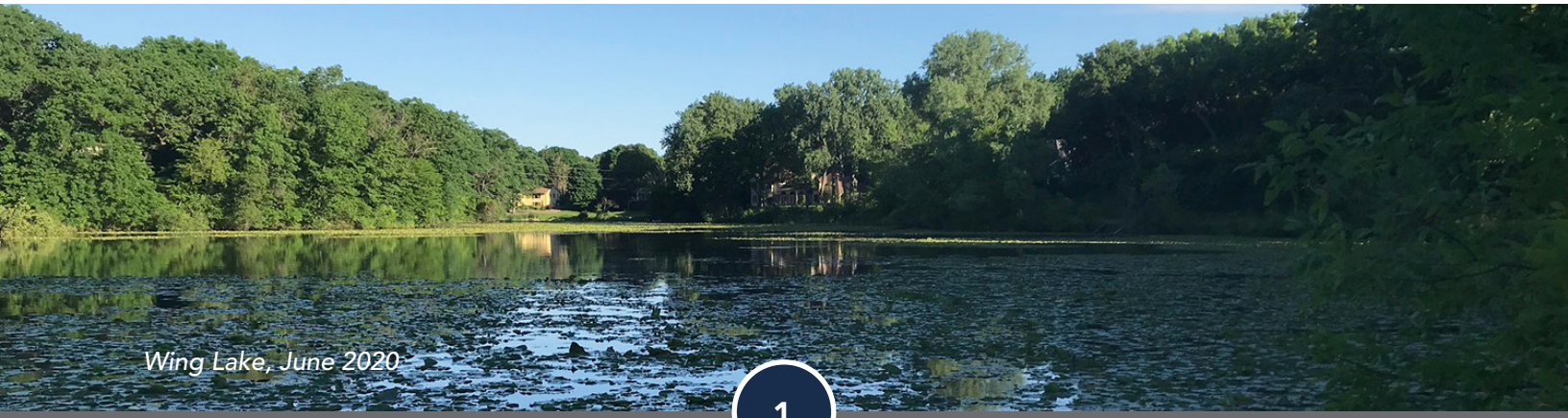
IMPROVING LAKE WATER QUALITY

REPORT SUMMARY CONTENTS

Protecting and Enhancing Water Quality

Lake Holiday, Wing Lake, and Lake Rose are shallow lakes located in the southwestern portion of the city of Minnetonka, south of Highway 7 and west of Highway 494. The shallow, urban lakes suffer from moderate to poor water quality. The Nine Mile Creek Watershed District (NMCWD), a local unit of government that works to address water-related problems, conducted a study of Lake Holiday, Wing Lake, and Lake Rose in 2021 to evaluate current water quality and identify protection and improvement strategies. The study incorporated additional data and advanced modeling and analysis methods to confirm the findings of a 2010 NMCWD study. Additional information on the current lake conditions, water quality challenges, and recommended management strategies, including implementation timelines, are summarized in this project overview.

Protecting and enhancing the water quality of the lakes within the Nine Mile Creek watershed is one of the primary goals of the Nine Mile Creek Watershed District. The NMCWD's lake management program includes data collection (monitoring), assessment (e.g., studies), and implementation of projects and programs to protect and improve water quality and aquatic habitat. Using monitoring data collected by NMCWD in recent years (2019 and 2020), the objectives of this study were to assess or "diagnose" the lakes' water quality problems, understand the cause or sources of the problems, and recommend management strategies to improve the water quality and overall health of the lakes.



Wing Lake, June 2020

Lake Holiday, August 2020

Lake Management Goals

When assessing the ecological health of a lake, it is important to take a holistic approach, considering factors such as in-lake water quality (e.g., phosphorus and nitrogen concentrations), the health and quality of the aquatic communities, and water quantity (see Figure 1). How recreation and wildlife habitat affect and are affected by overall lake health are also considered. Numerical goals exist for some of these factors, such as state water quality standards. However, other factors are assessed relative to narrative criteria that describe the desired condition and do not have strict numerical goals. For this study, the primary goals are to achieve the water quality standards for shallow lakes; attain a diverse, native macrophyte (aquatic plant) population; and support a healthy, balanced aquatic ecosystem.

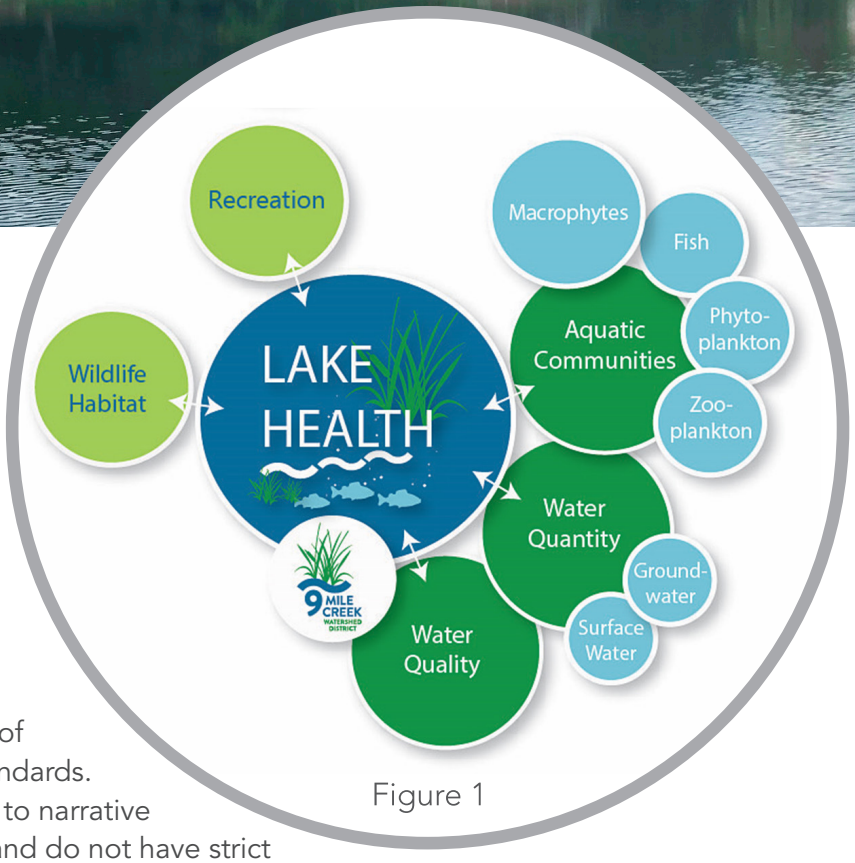


Figure 1

For this study, the primary goals are to achieve the water quality standards for shallow lakes; attain a diverse, native aquatic plant population; and support a healthy, balanced aquatic ecosystem.

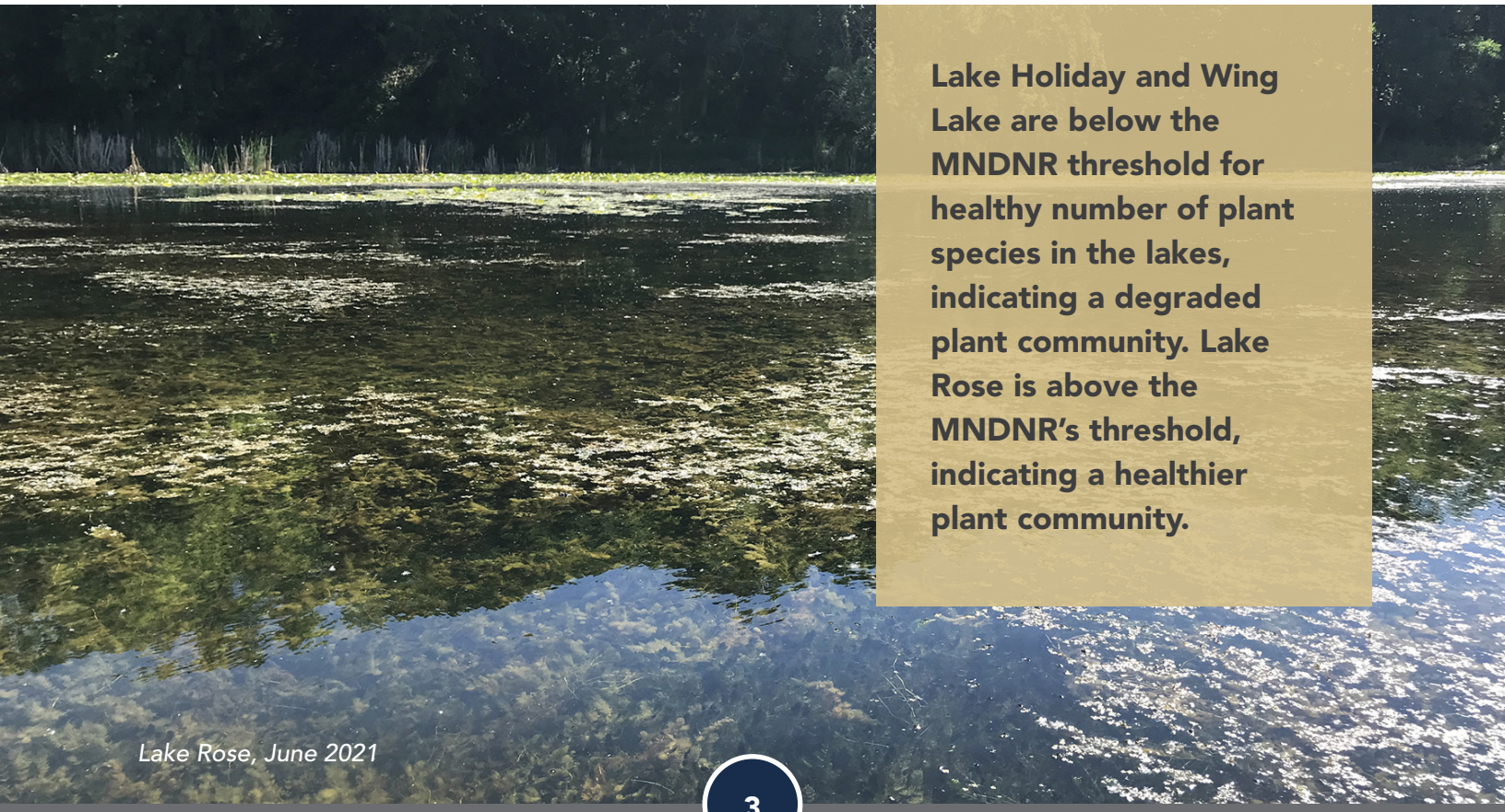
9 MILE CREEK WATERSHED DISTRICT

Looking at Current Lake Conditions

Healthy Shallow Lakes

Shallow lakes are unique ecosystems that differ from deeper lakes. Shallow lakes have depths that allow for light to reach the lake bottom throughout most or all of the lake (often less than 10 feet deep). These lakes also tend to be more nutrient-rich than other deeper lakes, especially in an urban setting where they receive nutrients (e.g., phosphorus and nitrogen) from stormwater. A healthy shallow lake will have abundant aquatic plant growth due to the shallowness and nutrients. However, excess nutrients can lead to algal growth that creates turbid (murky-looking, low clarity) water and limits or prevents aquatic plant growth. Aquatic plants are good for shallow lake ecosystems. Healthy shallow lakes have plants growing throughout the entire lake, with a variety of species such as coontail, native pondweed, and water lily. The plants can take phosphorus and nitrogen from the lake water, reducing the amount of nutrients available for algae. Aquatic plants also provide excellent habitat for insects, zooplankton, fish, waterfowl and other wildlife.

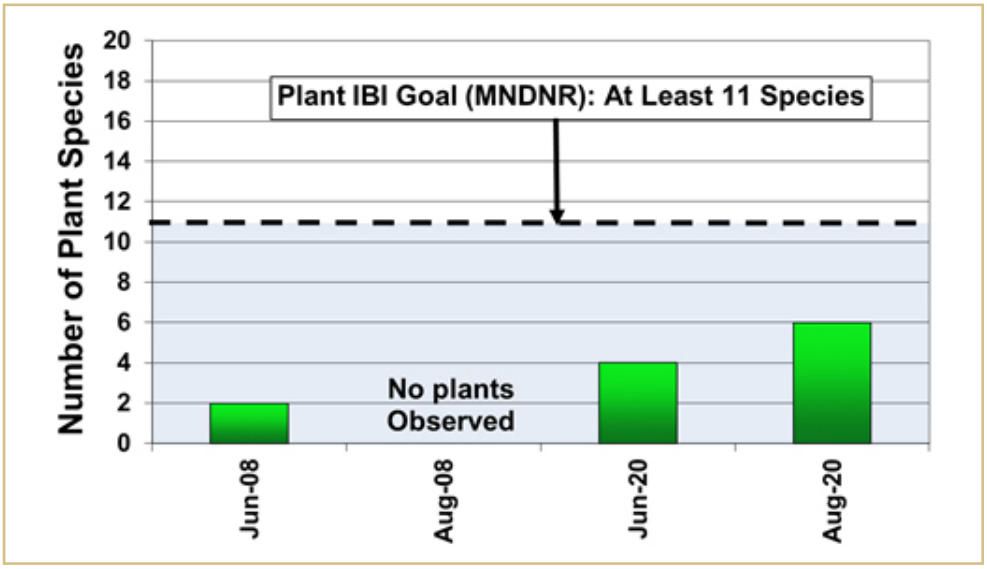
One measure of a lake's health is the community of plants, fish and aquatic life it sustains. For aquatic plants, the Minnesota Department of Natural Resources (MNDNR) has developed an index of biological integrity (IBI), which is a score that compares the types and numbers of plants observed in a lake to what is expected for a healthy lake. As shown on page 4, the number of plant species in Lake Holiday and Wing Lake is below the DNR's threshold of at least 11 species for a healthy lake. In 2020, 4–8 species were found in the lakes. In Lake Rose, 12 plant species were observed in August 2020, which is above the DNR's threshold of at least 11 species indicating a healthier plant community.



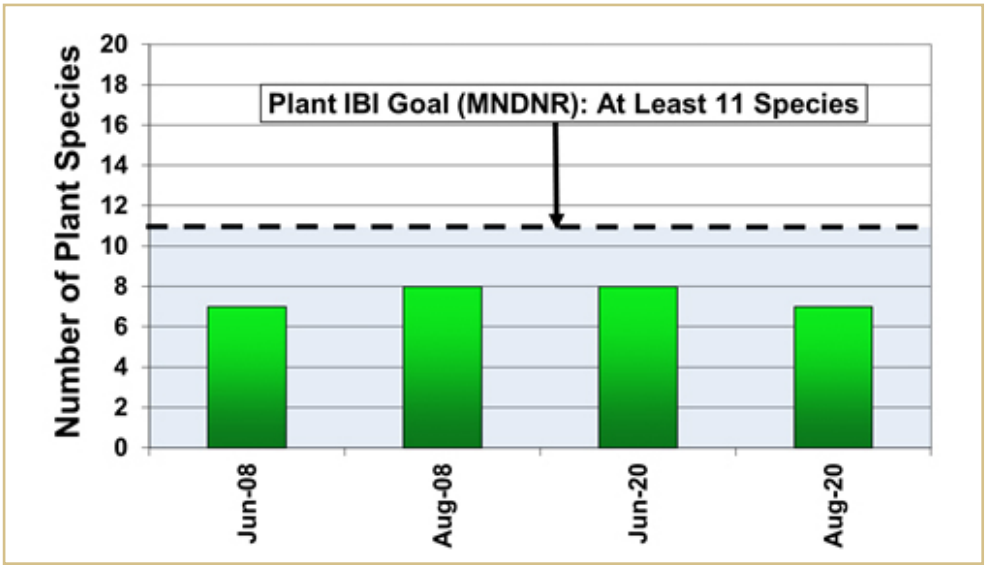
Lake Holiday and Wing Lake are below the MNDNR threshold for healthy number of plant species in the lakes, indicating a degraded plant community. Lake Rose is above the MNDNR's threshold, indicating a healthier plant community.

Lake Rose, June 2021

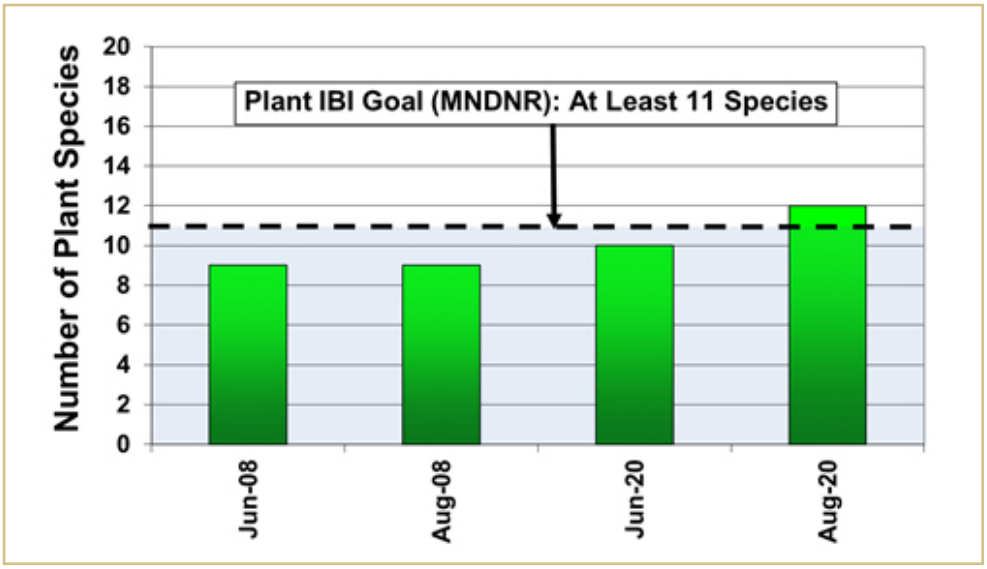
Lake Holiday



Wing Lake

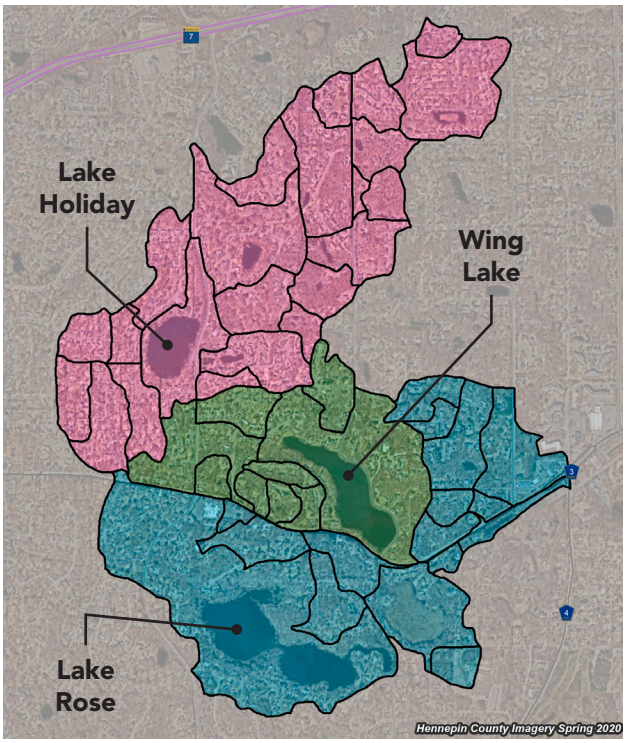


Lake Rose



Urban Watersheds

A lake watershed is all the land area that drains to the lake through overland flow, channels, and storm pipes. Land use practices within a lake's watershed impact the lake and its water quality by altering the amount of stormwater runoff, sediment, and nutrients (namely phosphorus and nitrogen) that reaches the lake. Each type of land use contributes a different amount of runoff and pollutants to the lake, thereby impacting the lake's water quality differently. Land use within the highly developed Lake Holiday, Wing Lake, and Lake Rose watersheds is primarily single family residential and open water. The watershed also includes highway, churches, schools, and open space park and to a lesser extent, forest/grassland, developed parks, commercial, and multi-family residential land uses. When water levels are high enough in Lake Holiday, water is pumped into a storm pipe that flows to Wing Lake. Wing Lake drains by gravity to Lake Rose. Flow through the Lake Rose outlet is routed south and east and is ultimately discharged to Birch Island Lake in Eden Prairie.



Map showing watersheds for Lake Holiday (shaded pink), Wing Lake (shaded green), and Lake Rose (shaded blue).

Lake Rose, August 2020

Sources of Nutrients

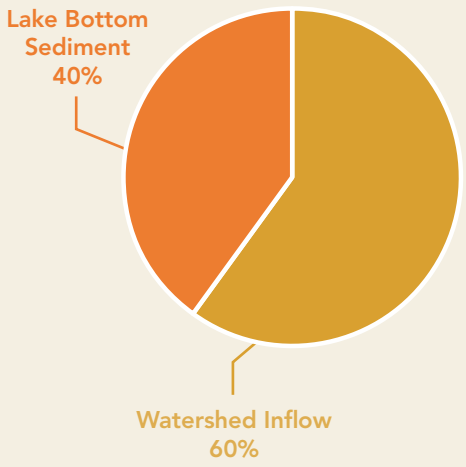
Nutrients (phosphorus and nitrogen) are a food source for algae. An overabundance of these nutrients in a lake can result in nuisance algal blooms and threaten the health of the aquatic plant community. In Minnesota, phosphorus is most commonly the "limiting nutrient," although nitrogen can also be limiting for portions of the growing season. Whether phosphorus or nitrogen is the "limiting nutrient" this means the available quantity of this nutrient tends to control the amount of algae and aquatic plants produced. The three primary sources are summarized on the next page.

- **Phosphorus and nitrogen in stormwater runoff from the direct watershed—**Stormwater runoff conveys phosphorus and nitrogen from streets, lawns, and parking lots within the direct watersheds to Lake Holiday, Wing Lake, and Lake Rose via a series of drainage channels and storm drain pipes. This study confirmed that stormwater runoff is a major contributor of phosphorus and nitrogen to Lake Holiday, Wing Lake, and Lake Rose.

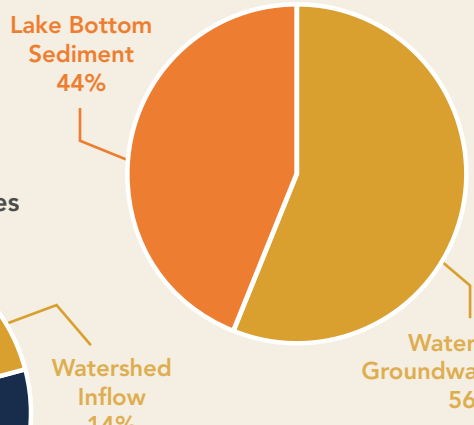
- **Nutrient-rich sediment—**Phosphorus builds up over time in lake bottom sediments as a result of sedimentation and die-off of vegetation and algae. In general, two forms of sediment phosphorus can release back into the water column when certain environmental conditions are met. When oxygen levels are low at the lake bottom (typically periodically throughout the summer), the form of phosphorus called "mobile-P" is released from the sediment into the water column. "Organic-P" can also release from bottom sediments, where the release rate is controlled by lake water temperature. This study confirmed that phosphorus release from lake bottom sediments, typically termed "internal loading," is a major contributor of phosphorus to Lake Holiday, Wing Lake, and Lake Rose.

- **Inflow from upstream lakes—**During precipitation and snowmelt events, lake water levels will rise as stormwater runoff enters the lake from storm pipes and direct runoff from lawns. When water levels are high enough, water, along with in-lake nutrients and pollutants, will discharge from the lakes via pumping (Lake Holiday) or gravity-controlled outlets (Wing Lake, Lake Rose) and flow towards water bodies further downstream. This study confirmed that nutrients from upstream Wing Lake is a contributor of phosphorus and nitrogen to Lake Rose. In 2020, Lake Holiday was not pumped to Wing Lake since water levels never exceeded the pump "turn-on" elevation. Lake Holiday inflows can be another source of nutrients to Wing Lake during wet years when water levels are high, and pumping is required.

Lake Holiday 2020
Total Phosphorus Sources

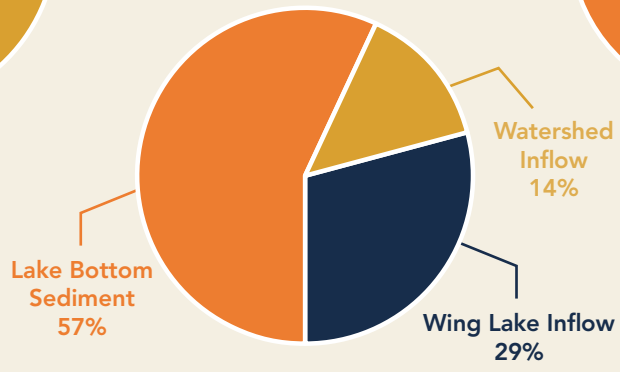


Wing Lake 2020
Total Phosphorus Sources



**In 2020, Lake Holiday was not pumped to Wing Lake*

Lake Rose 2020
Total Phosphorus Sources



Curly-leaf pondweed in Lake Holiday, June 2021

Lake Holiday Water Quality Challenges

Review of historic data indicates that water quality in Lake Holiday is poor, with summer average total phosphorus and chlorophyll-*a* concentrations generally above the state standard for shallow lakes. The poor water quality is primarily due to excess nutrients in the lake, which fuels algal growth and decreases water clarity. The phosphorus in Lake Holiday comes from several sources, including stormwater runoff from the watershed and internal sources such as nutrient-rich sediments. Additionally, the low diversity of plant species, substantial growth of the invasive species, curly-leaf pondweed, as well as the low quantity of plants in the lake throughout the growing season is likely contributing to the decrease in water quality.

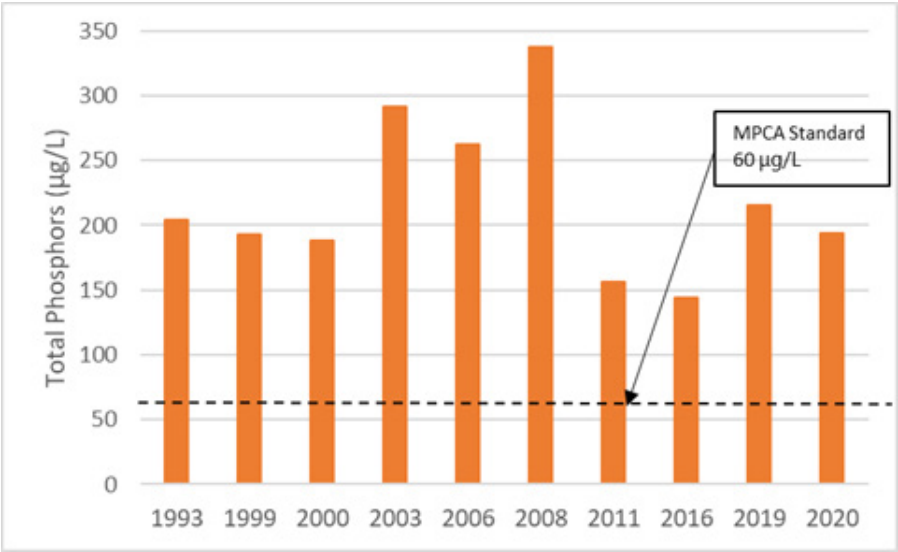
Wing Lake Water Quality Challenges

Review of historic data indicates that water quality in Wing Lake has been moderate to poor, with summer average total phosphorus and chlorophyll-*a* concentrations above the state standards for shallow lakes since 1993. The degradation in water quality is primarily due to excess nutrients in the lake, which fuels algal growth and decreases water clarity. The phosphorus in Wing Lake comes from several sources, including stormwater runoff from the watershed and internal sources such as nutrient-rich sediments. Nutrients from Lake Holiday can also be a source during wet years when water is pumped from Lake Holiday to Wing Lake to control high water levels.

Lake Rose Water Quality Challenges

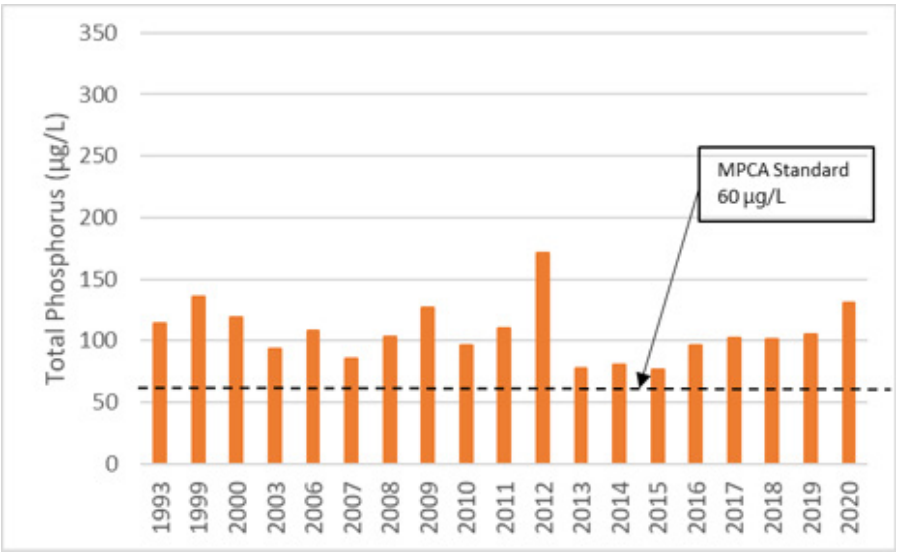
Review of historic data indicates that water quality in Lake Rose has generally been improving. The summer average total phosphorus concentrations measured from 1993 through 2020 in Lake Rose were above the shallow lake state standard, although there has generally been a decreasing trend in concentrations since 2007. The Lake Rose summer average chlorophyll-*a* concentrations measured from 1993 through 2019 were also above the shallow lake state standard, but show a decreasing trend in concentrations since 2007. The summer average chlorophyll-*a* concentration of 15 µg/L observed in 2020 met the shallow lake standard (<20 µg/L). The phytoplankton (algae) and plant surveys completed in 2020 also show improvement in ecosystem health. Phytoplankton concentrations decreased between 2008 and 2020 and the number of plant species increased from 8 to 12 species, indicating a healthy plant community. While Lake Rose water quality has generally been improving, considerations should still be made to reduce nutrient sources. The phosphorus in Lake Rose comes from several sources, including stormwater runoff from the watershed, inflows from upstream lake, Wing Lake, and internal sources such as nutrient-rich sediments.

Lake Holiday



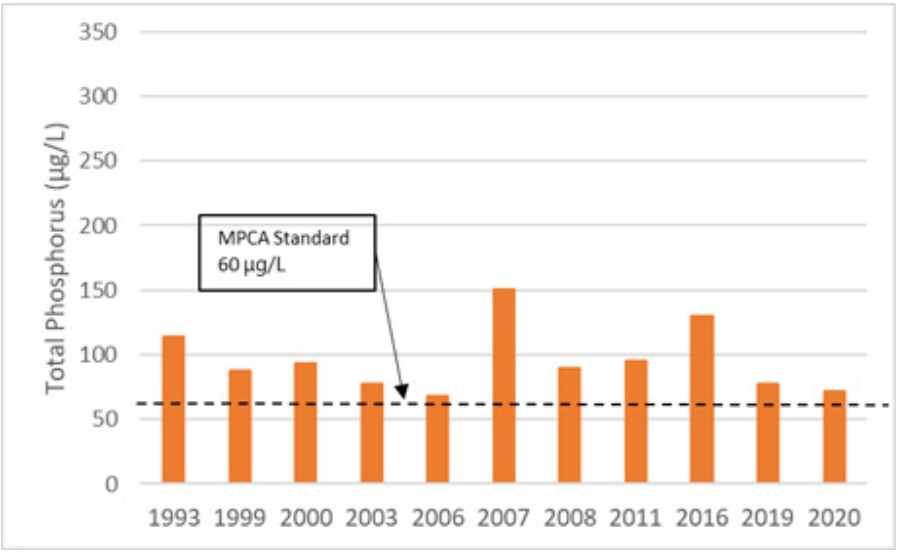
Summer average total phosphorus concentrations measured in Lake Holiday between 1993 and 2020

Wing Lake



Summer average total phosphorus concentrations measured in Wing Lake between 1993 and 2020

Lake Rose



Summer average total phosphorus concentrations measured in Lake Rose between 1993 and 2020

Wing Lake, August 2020

Managing to Protect and Improve Our Lakes

Water quality in Lake Holiday and Wing Lake has been moderate to poor in the past decade and the lakes currently do not meet water quality and ecological health goals. While Lake Rose water quality has generally been improving over the past decade (e.g., decreasing chlorophyll-*a* concentrations, increasing clarity, reduction in phytoplankton (algae), increase in plant species), there are still considerations that can be made to further improve water quality and ecological health. Given this, future management efforts should focus on improving lake water quality and ecosystem health, monitoring for changes, and continuing water quality and ecosystem health protection measures as improvements are obtained. The recommended management and protection strategies for Lake Holiday, Wing Lake, and Lake Rose are summarized on the next page.

Planning-level opinions of probable cost were developed for several new management alternatives evaluated as part of this study. These opinions of cost are intended to provide assistance in evaluating and comparing alternatives and should not be considered as absolute values. All estimated costs are presented in 2021 dollars and include costs for engineering and project administration.

- Lake Holiday Bottom Sediment Treatment: $114,000
- Wing Lake Bottom Sediment Treatment: $141,000
- Rose Lake Bottom Sediment Treatment: $112,000
- Lake Holiday Re-circulating Filtration Basin: $428,000
- Holiday, Wing, and Rose Lakes Street Sweeping Program: $277,000
- Holiday, Wing, and Rose Lakes Fertilization Optimization Program: $30,000

Management/Protection Action		Basis	Estimated Timeline
Address Internal Bottom Sediment Loading – Holiday	Continuous Dissolved Oxygen Monitoring	Determine aeration needs	2022
	Install aeration system	Reduce sediment phosphorus load	2023
	Alum and iron treatment		2023/2024
	Sediment Release Monitoring	Assess management effectiveness	2024 - 2025+
Address Internal Bottom Sediment Loading – Wing/Rose	Alum and iron (Wing) and Alum (Rose) treatments	Reduce sediment phosphorus load	2023/2024
	Sediment release monitoring	Assess management effectiveness	2024 - 2025+
Address High In-lake Nutrients – Holiday	Re-circulating Filtration Basin	Remove and reduce in-lake nutrient concentrations in Lake Holiday	2022/2023 (Feasibility) 2023/2024 (Design) 2024/2025 (Construction)
Address External Nutrient Loading	Enhanced Street Sweeping Program	Reduce pollutant loading from stormwater	2022 – 2023 (Planning begins)
	Fertilizer Management program	Reduce nitrogen sources from excess fertilizer use	2022 – 2023 (Planning begins)
	Chloride Monitoring	Continue to identify/track chloride levels from winter salt use	As part of continued lake monitoring program
	Promote NMCWD Cost-Share Grants to watershed residents	In a fully developed watershed, opportunities for largescale BMPs are limited	2022+
Manage Aquatic Plants (Macrophytes)	Curly-leaf Pondweed Management	Continue to monitor invasive species growth. Consider management efforts in Lake Holiday	2022+
	Promote Native Aquatic Plant Growth	Encourage native plants to promote clear water conditions and competition with algae	2022+

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Prepared for Nine Mile Creek Watershed District

Read the full study:
Lake Holiday, Wing Lake, Lake Rose Water Quality Study (2022)