2022 Lake and Pond Water Quality Monitoring

City of Richfield

Prepared for
City of Richfield

March 31, 2023

Taft Lake, April 2022

Richfield Lake, July 2022

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2022 Lake and Pond Water Quality Monitoring

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1 Introduction

1.1 Introduction

The City of Richfield (City) conducts routine annual monitoring of surface waters to support their permitting and monitoring activities. Monitoring began in 2009 and has been conducted each year since. Monitoring activities include the collection of water surface elevations, water quality parameters measured in the field (e.g., dissolved oxygen), and water samples for laboratory analyses (e.g., phosphorus). A total of nine waterbodies were monitored in 2022, with some waterbodies having multiple monitoring locations (Table 1-1). Frequency of monitoring and parameters monitored were similar to 2021 monitoring. Wilson Pond was added to the monitoring program in 2022; the pond had not been monitored in previous years. Locations of monitored waterbodies are shown on Figure 1-1. The results of the 2022 monitoring are summarized and discussed below, along with results of monitoring conducted in previous years.

Table 1-1 Summary of 2022 Surface Water Quality and Water Level Monitoring Activities

Waterbody	Water Level Monitoring	Water Quality Monitoring	Other Monitoring
Adams Hill Pond	Staff gage, level logger	One surface location	
Augsburg Pond	Staff gage, level logger	One surface location	
Legion Lake	Staff gage, level logger	Three surface locations	Outlet channel level
Milner Pond	None	One surface location	
Norby's Pond	None	One surface location	
Richfield Lake	Staff gage, level logger	Two surface locations	
Wood Lake	Staff gage, level logger	Two surface locations	
Wilson Pond	Staff gage, level logger	One surface location	
Taft Lake	Staff gage, level logger	One surface location, one depth profile	
Taft Lake outlet	None	None	Area-velocity meter for flow

1.2 Purpose

Water quality data and water surface elevation data is collected annually on City ponds and lakes. Water quality monitoring began in 2009 for Adams Hill Pond, Legion Lake, Milner Pond, Norby's Pond, and Taft Lake. Richfield Lake and Wood Lake water quality monitoring began in 2010, and Augsburg Pond monitoring began in 2011. Wilson Pond was monitored for the first time in 2022. The purpose of the monitoring program is as follows:

- Guide watershed and City Stormwater Management Plan updates for stormwater and water quality management
- Evaluate water quality trends in monitored ponds and lakes
- Generate water quality data to evaluate stormwater pond and other water quality improvement best management practices (BMPs)

1.2.1 Eutrophication parameters

The growth of algae in lakes and ponds is often limited by the availability of phosphorus, a major nutrient required for plant and algae growth. Nitrogen is also required for algae growth, but phosphorus is most often the limiting nutrient in Minnesota lakes. Eutrophication is the process by which nutrients, and subsequent algae growth, increase in a waterbody. Stormwater runoff is the primary cause of eutrophication in an urban environment. Phosphorus and other nutrients can also accumulate in lake and pond sediments and be recycled back into the water column. Therefore, a lake may continue to experience poor water quality even when nutrient loads from the watershed are reduced. Eutrophication can lead to severe, sometimes harmful, algal blooms. Decaying algae and aquatic plants can produce foul odors and consume oxygen, potentially resulting in fish kills.

Three forms of phosphorus were measured in 2022: total phosphorus, dissolved phosphorus, and ortho-phosphorus (also referred to as orthophosphate). Total phosphorus includes the entire pool of phosphorus in the water samples, including dissolved phosphorus and particulate phosphorus. The particulate forms of phosphorus include suspended sediment and algae. Dissolved phosphorus is the fraction of total phosphorus that passes through a 0.45 µm filter. Dissolved phosphorus includes the inorganic orthophosphate molecule (PO_4^{2-}) and various forms of soluble organic phosphorus. The inorganic orthophosphate molecule is readily used by algae, and concentrations are typically less than 10 µg/L (concentrations of all phosphorus compounds are presented as µg/L phosphorus) at the lake surface when phosphorus is the limiting nutrient to algae growth. Other forms of dissolved phosphorus can be used by algae but are less readily available than orthophosphate.

Chlorophyll-a is the primary pigment used for photosynthesis in plants and algae. The concentration of chlorophyll-a was measured as an indication of algal abundance in lakes and ponds.

Secchi disk transparency is a measure of water clarity, determined by lowering a black-and-white disk below the water surface and recording the depth at which it's no longer visible. Secchi disk transparency is strongly correlated with algal abundance in Minnesota lakes and is used as an indicator of eutrophication status, along with phosphorus and chlorophyll-a. Suspended sediment can also reduce water clarity in shallow lakes and ponds. Minnesota has set water quality standards for summer averages (June–September) of total phosphorus, chlorophyll-a, and Secchi disk transparency in lakes. There are separate standards for shallow lakes and deep lakes within the North Central Hardwoods Forest ecoregion (Table 1-2).

Table 1-2 Lake Eutrophication Water Quality Standards for North Central Hardwood Forest Ecoregion

	Total Phosphorus (µg/L)	Chlorophyll-a (µg/L)	Secchi Disk Transparency (m)
Shallow lake	60	20	1.0
Deep lake	40	14	1.4

Shallow lakes often exist in one of two states: (1) a turbid water, algae-dominated state, or (2) a clear water, aquatic-plant-dominated state. Algae and plants compete with one another for nutrients, as well as sunlight. Rooted aquatic plants compete with algae for nutrients, stabilize the benthic sediment (i.e., sediment that is on the bottom of the lake, vs. suspended in the water), and provide refuge to zooplankton that graze on algae. Eutrophication leads to dense algae blooms that block light from reaching aquatic plants. This reduces aquatic plant growth, which leads to even more favorable conditions for algae growth. Preventing the loss of aquatic plants or reducing algal turbidity to allow for light to reach plants is key to managing the water quality of shallow lakes.

1.2.2 Chloride

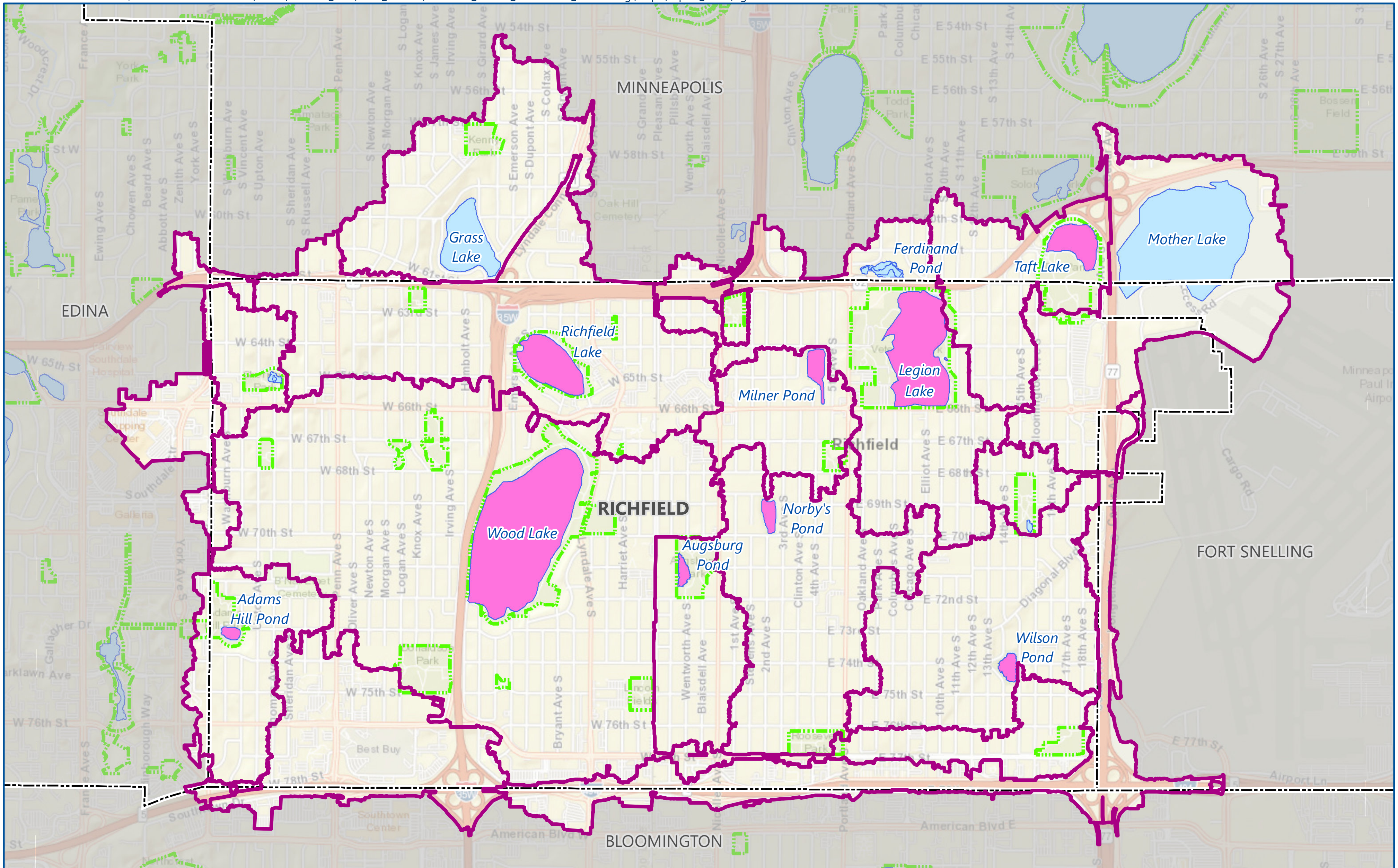
Chloride can be harmful to aquatic organisms when present in high concentrations. The primary source of chloride in urban environments in Minnesota is de-icing salts for roadways, parking lots, and sidewalks. The chronic standard for chloride in Minnesota lakes, streams, and rivers is 230 mg/L; the acute toxicity standard is 860 mg/L. The 230 mg/L chronic standard is based on a 4-day exposure of aquatic organisms to chloride. Dissolved salts also increase the density of the water and can lead to increased stratification in lakes and ponds. This prevents the waterbody from mixing and oxygenating the deeper water in the lake. Chloride concentrations were measured in all lakes and ponds monitored in 2022.

1.2.3 Additional water quality parameters

The fate and transport of nutrients (i.e., phosphorus) in lakes and ponds involves a number of mechanisms, including:

- Settling and resuspension of sediment and algae.
- Uptake of dissolved phosphorus by algae.
- Decomposition of algae and organic matter.
- Release of phosphorus from benthic (i.e., bottom) sediments.

The release of phosphorus from benthic sediments can be due to the decay of organic matter or to the release of phosphorus bound to iron when oxygen is depleted in the sediment. Total suspended solids, dissolved oxygen, and pH were measured to provide additional data that can be used to assess the effectiveness of stormwater ponds in removing sediment and nutrients and the sources and fate of phosphorus and other pollutants in the lakes.



- Monitored Waterbody
- Waterbody
- Subwatershed
- Municipal Boundary
- Park Boundary

0 1,250 2,500
Feet

MONITORED WATERBODIES
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 1-1

2 Methods

2022 water quality monitoring was conducted by Barr staff monthly from May through October. Additionally, Taft Lake was monitored in April after ice out after an unusual brown water color was observed in Spring 2021, and to provide additional data on nutrient concentrations in the lake following ice out. Waterbodies were accessed by canoe to reach the approximate center or deepest points of the pond or lake. Water quality measurements were collected with a YSI ProDSS water quality probe, which was calibrated each day prior to use. With a maximum water depth of 45 feet (13.7 meters), Taft Lake is the only deep lake in the city. A depth profile of field parameters was collected in Taft Lake by lowering the probe and recording readings at each 1-meter interval from surface to bottom. Water clarity for all waterbodies was measured with a Secchi disk. Water samples were collected with a Kemmerer water sampling device. Surface water samples were composites of the top 2 meters of the waterbody, where water depth allowed. Surface samples in ponds that were shallower than 2 meters were composited to a depth that did not disturb sediment while sampling (e.g., 0–1 meter composite). Water samples were also collected at discrete depths in Taft Lake (5m, 8m, and 12m depths) using the Kemmerer sampling device.

Collecting water samples from shallow ponds can present a challenge; therefore, care was taken by field staff to collect representative samples, as well as record limitations related to data collection. Field staff members were careful to collect water samples without disturbing bottom sediments. Where duckweed (an aquatic plant) covered the pond surface, the field crew altered its sampling methodology to avoid entraining the duckweed into the water samples. Field staff recorded when aquatic vegetation obscured the Secchi disk or otherwise limited measurements of Secchi disk transparency.

Composite water samples were mixed in a large plastic jug before transferring them to sample containers provided by the laboratory. Dissolved phosphorus and soluble reactive phosphorus samples were field-filtered using a disposable 0.45 µm filter apparatus and a hand pump vacuum. Samples were placed in a cooler with ice and delivered to the laboratory drop-off location in Bloomington on the same day they were collected. Laboratory analyses were conducted by RMB Environmental Laboratories Inc.

Water surface elevation monitoring was done by installing In Situ Rugged Troll® 100 level loggers and staff gages at monitoring locations. The level loggers allowed for continuous monitoring of water levels, recording the water level every 30 minutes while deployed. The level loggers were installed in stilling wells attached to staff gages. The elevations of the staff gages were surveyed using Real Time Kinematics (RTK) Global Positioning System (GPS) equipment, and all elevations were measured using North American Vertical Datum of 1988 (NAVD 88). Benchmark elevations were established onshore near staff gages to assist in resetting the staff gages in subsequent monitoring seasons.

An area-velocity sensor was installed in the outlet culvert of Taft Lake. The sensor measured water depth and velocity in the culvert at regular intervals to calculate flow in the structure.

Field parameter measurements collected in each lake/pond included Secchi disk transparency, temperature, specific conductivity, dissolved oxygen, and pH. Surface water samples collected from the surface of each lake were sent to a laboratory for analyses of the following parameters:

- Total phosphorus
- Total dissolved phosphorus
- Ortho-phosphorus
- Chlorophyll-a
- Total suspended solids
- Chloride

An additional depth profile of water quality was conducted in Taft Lake, including field parameters collected at 1-meter intervals from surface to lake bottom. Three additional water samples were collected at various depths (a total of four water samples per event, including the surface) and analyzed for total phosphorus, total dissolved phosphorus, ortho-phosphorus, and chloride.

3 Results

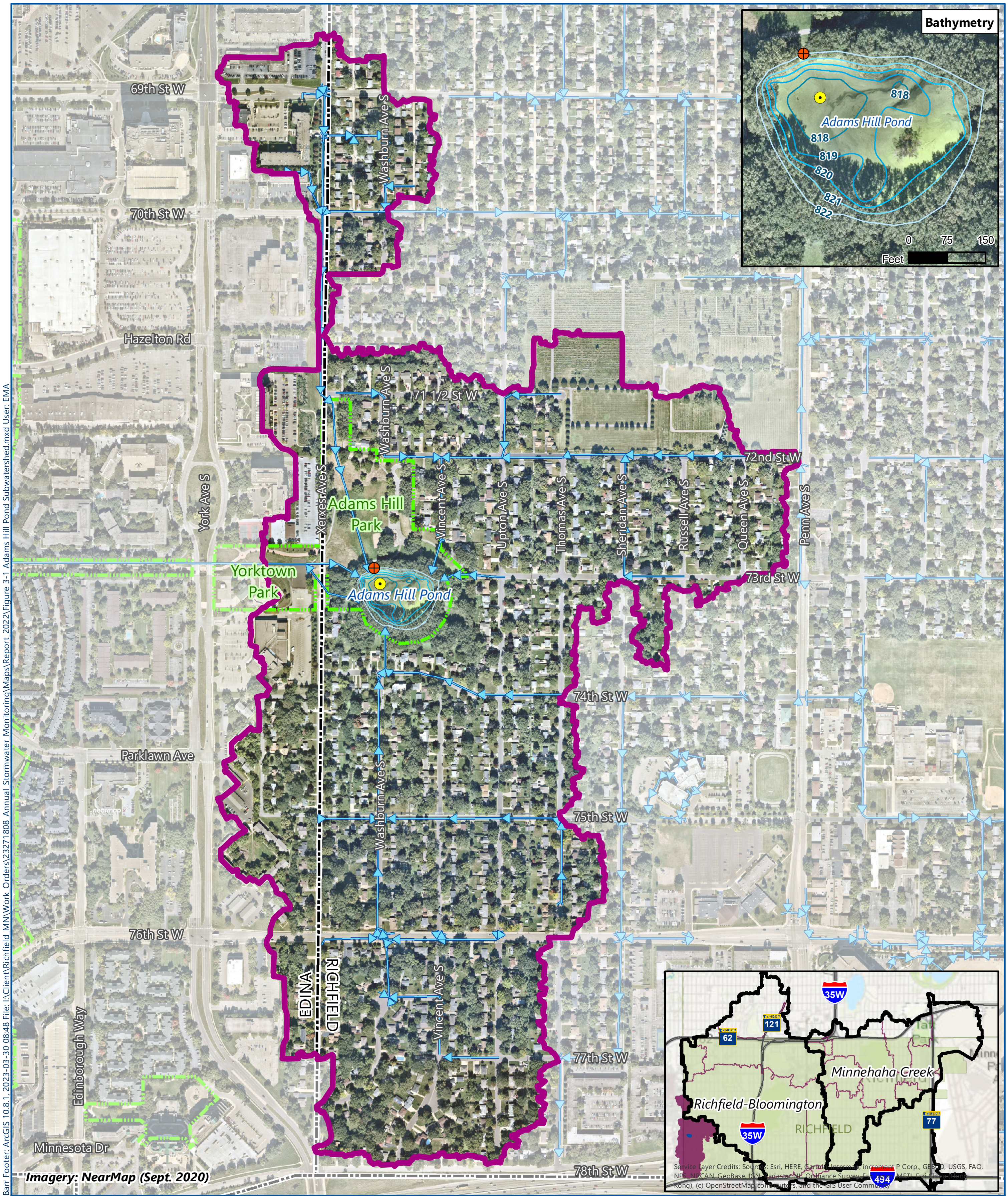
The results of water quality monitoring of eutrophication parameters (phosphorus, chlorophyll-a, and Secchi disk transparency) are discussed in detail below. Tabulated water quality data for all parameters measured in 2022 are included in Attachment A. Photographs collected at each waterbody throughout the monitoring season are included in Attachment B. Miscellaneous observations noted by field staff during 2022 monitoring activities (e.g. accumulation of woody debris obstructing a lake outlet) are summarized in Attachment C. Water level monitoring is also presented for seven waterbodies: Adams Hill Pond, Augsburg Pond, Legion Lake, Richfield Lake, Taft Lake, Wilson Pond, and Wood Lake. Water level monitoring was not conducted in Milner or Norby's Ponds. Water surface elevation figures include daily precipitation values recorded at the Minneapolis-St. Paul International Airport.

3.1 Adams Hill Pond

Adams Hill Pond is a 1.9-acre stormwater pond. The Adams Hill Pond watershed is shown on Figure 3-1. Characteristics of the pond and its watershed are summarized in Table 3-1. Adams Hill Pond is often covered in watermeal (*Wolffia columbiana*), a small floating plant similar to duckweed. The pond was mostly open water during the May 16, 2022 sampling event, but was covered with watermeal by the June 13, 2022 event. Watermeal covered most of the pond's surface during sampling events in May-September, but had largely disappeared from the pond's surface by the October 17 sampling event. A photograph of watermeal covering the pond during the June sampling event is shown on Figure 3-2. When a pond's surface is covered with duckweed or watermeal, the floating plants reduce transfer of oxygen from the atmosphere into the pond. Additionally, the pond becomes more thermally stratified and wind mixing of the water column is reduced. Ponds covered in watermeal and/or duckweed often experience long durations of very low dissolved oxygen in the water column during summer months, which was observed in Adams Hill Pond in 2022 (dissolved oxygen consistently below 1 mg/L). The low dissolved oxygen can lead to increased release of iron-bound phosphorus from sediments in the pond bottom due to the redox chemistry of iron, as Fe[III] is reduced to Fe[II] in the absence of oxygen. Hydrogen sulfide (H_2S) can build up in the pond as well, as microorganisms use sulfate for respiration when oxygen is unavailable. The H_2S can offgas and create a rotten egg smell. While most ponds produce H_2S in the anoxic sediment during warm summer months, it is typically oxidized by the oxygen in the water column before it can accumulate and offgas from the pond.

Table 3-1 Adams Hill Pond Characteristics

Waterbody Characteristics	Adams Hill Pond
Waterbody classification	Stormwater pond
Watershed area	219 acres
Surface area	1.9 acres
Maximum depth	1.3 meters (4.3 feet)
Outlet elevation	No normal outlet. Water is pumped. Pump off elevation 819.98 ft (NAVD 88).



Water Quality Monitoring Location
Water Level Monitoring Location
Storm Sewer
Adams Hill Pond Subwatershed
Municipal Boundary
Park Boundary

Bathymetric Contour
Elevation (feet, NAVD88)
818
819
820
821
822

N

0 350 700
Feet

ADAMS HILL POND SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 3-1

Figure 3-2 Watermeal Covering Adams Hill Pond, June 13, 2022

3.1.1 Adams Hill Pond Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-3. Concentrations of total phosphorus were the highest in June, before decreasing in July and August, and then increasing again in September and October. Dissolved phosphorus and ortho-phosphorus concentrations were highest in October. Chlorophyll-a concentrations peaked in July. Field staff indicated watermeal covered much of the pond surface during each visit from June through September. The watermeal competes with algae for nutrients (e.g., ortho-phosphorus), and the watermeal on the surface blocks light from reaching the algae in the water column. Water sample collection methods largely avoid the watermeal that is floating on the pond surface; therefore, water quality samples do not reflect the mass of chlorophyll-a and phosphorus that is within the watermeal or duckweed on the pond surface.

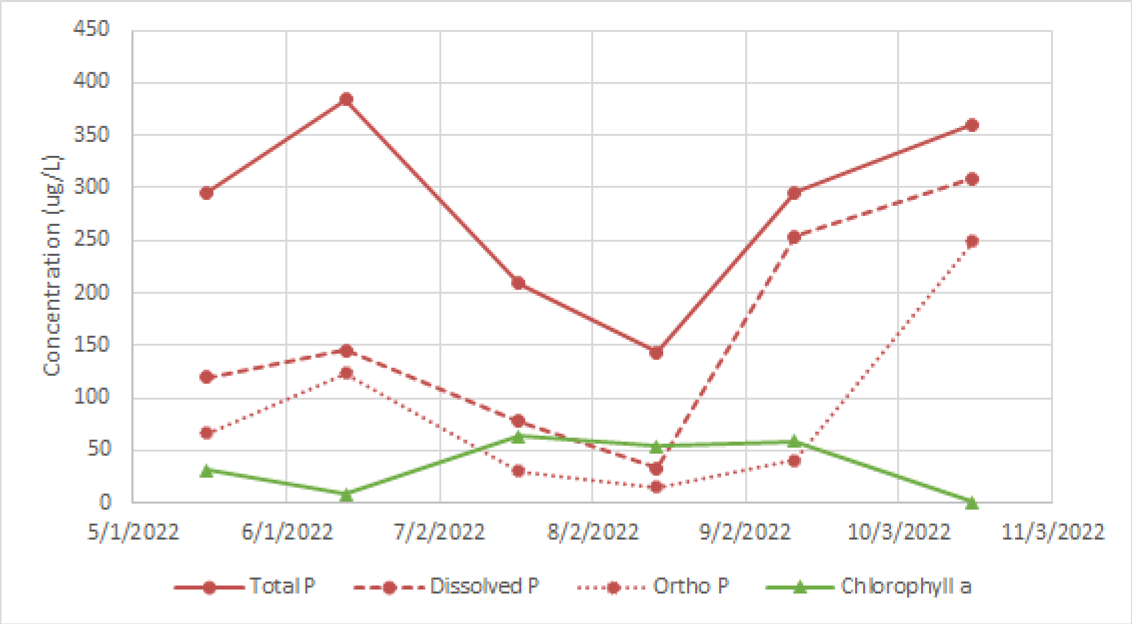


Figure 3-3 Adams Hill Pond 2022 Phosphorus and Chlorophyll-a Concentrations

The Adams Hill Pond summer averages (June–September) of total phosphorus for years 2009–2022 are shown on Figure 3-4; chlorophyll-a monitoring in Adams Hill Pond began in 2020, and summer averages of chlorophyll-a for years 2020-2022 are also included. The 2022 summer average of total phosphorus (258 µg/L) was the highest it has been since 2019. The 2022 summer average of chlorophyll-a was 46 µg/L. As noted previously, Adams Hill Pond is frequently covered by watermeal, which is not captured in water sampling. There is no water quality standard for phosphorus in stormwater ponds. The Minnesota Stormwater Manual summarizes several studies of stormwater pond pollutant concentrations, and outflow concentrations of phosphorus from stormwater ponds were found to typically be in the range of 75 µg/L (25^{th} percentile) to 200 µg/L (75^{th} percentile) (Reference (1)). Summer averages of total phosphorus in Adam's Hill Pond are typically on the high end of this range and have surpassed 200 µg/L in five of the fourteen years monitored.

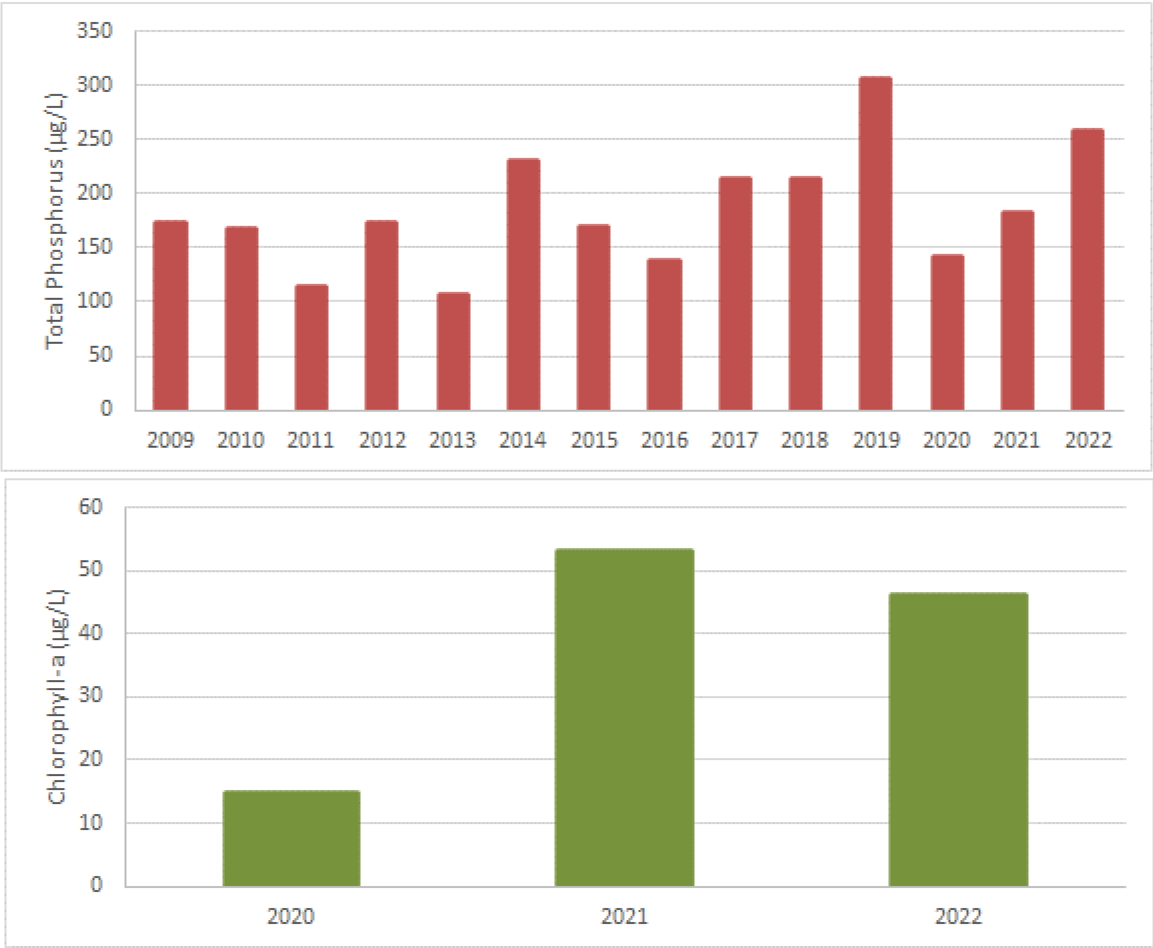
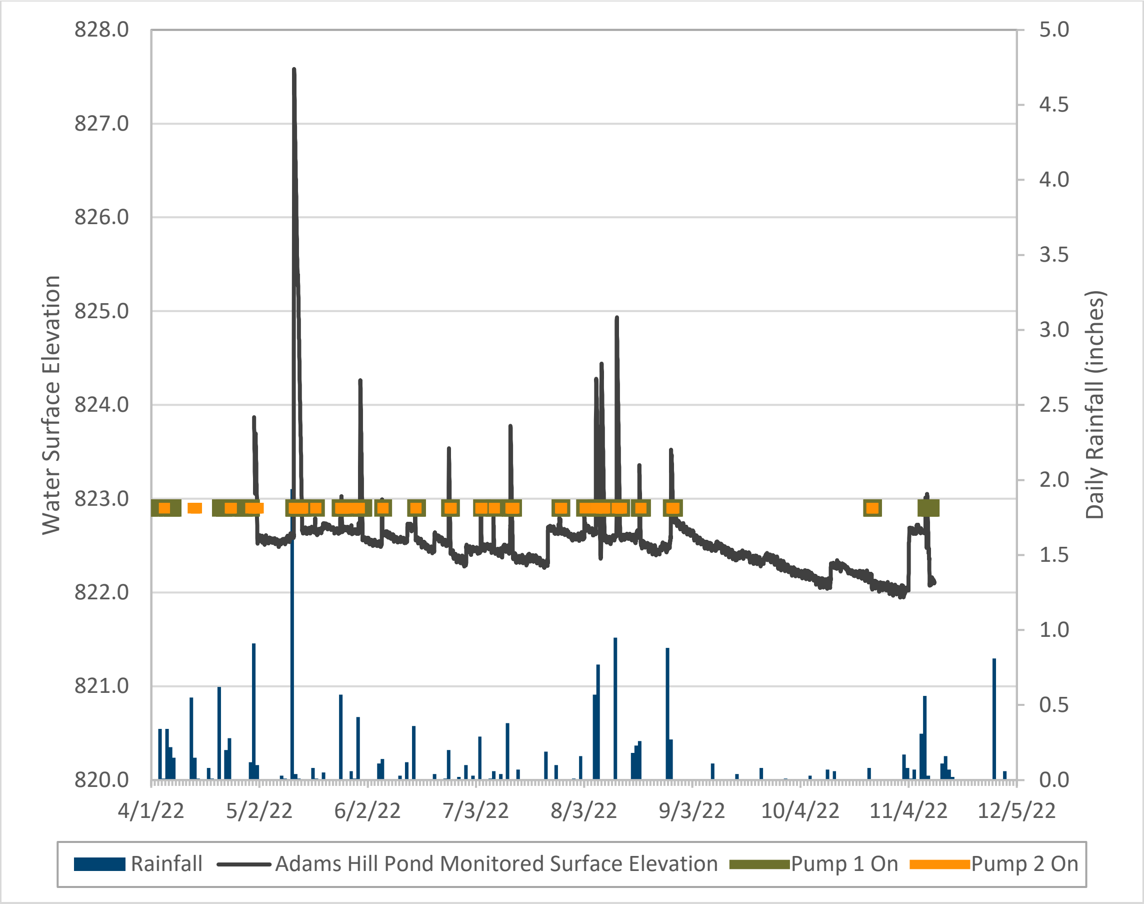


Figure 3-4 **Adams Hill Pond Summer Averages (June-September) of Total Phosphorus and Chlorophyll-a 2009–2022**

3.1.2 Adams Hill Pond Water Level

Adams Hill Pond water levels measured in 2022 are shown on Figure 3-5, along with daily precipitation. There is no normal surface water outlet from Adams Hill Pond, and water is pumped out of the pond. Water levels in the pond fluctuate in response to rainfall events and pumping. Pump information provided by City of Richfield staff indicate the design pump off elevation is 819.98 ft; however, pump operation data (SCADA data provided City of Richfield) from 2020, 2021, and 2022 indicate the pump off elevation is likely higher than 819.98 ft.

As shown on Figure 3-5, pump operation is typically controlling Adam's Hill pond in a ~1-foot depth range of 822.0 – 823.0 ft. The pump off elevation noted in our records is 819.98 ft. This may not correspond to desired pond stage based on the configuration of the pump (e.g., pump operation could be altered to manage to a lower normal pond water surface elevation, thereby increasing available live storage).



Note: Pump on elevation of 822.9 ft is estimated from observed pond elevations. "Pump on" data is shown for timing purposes but is not tied to a vertical elevation.

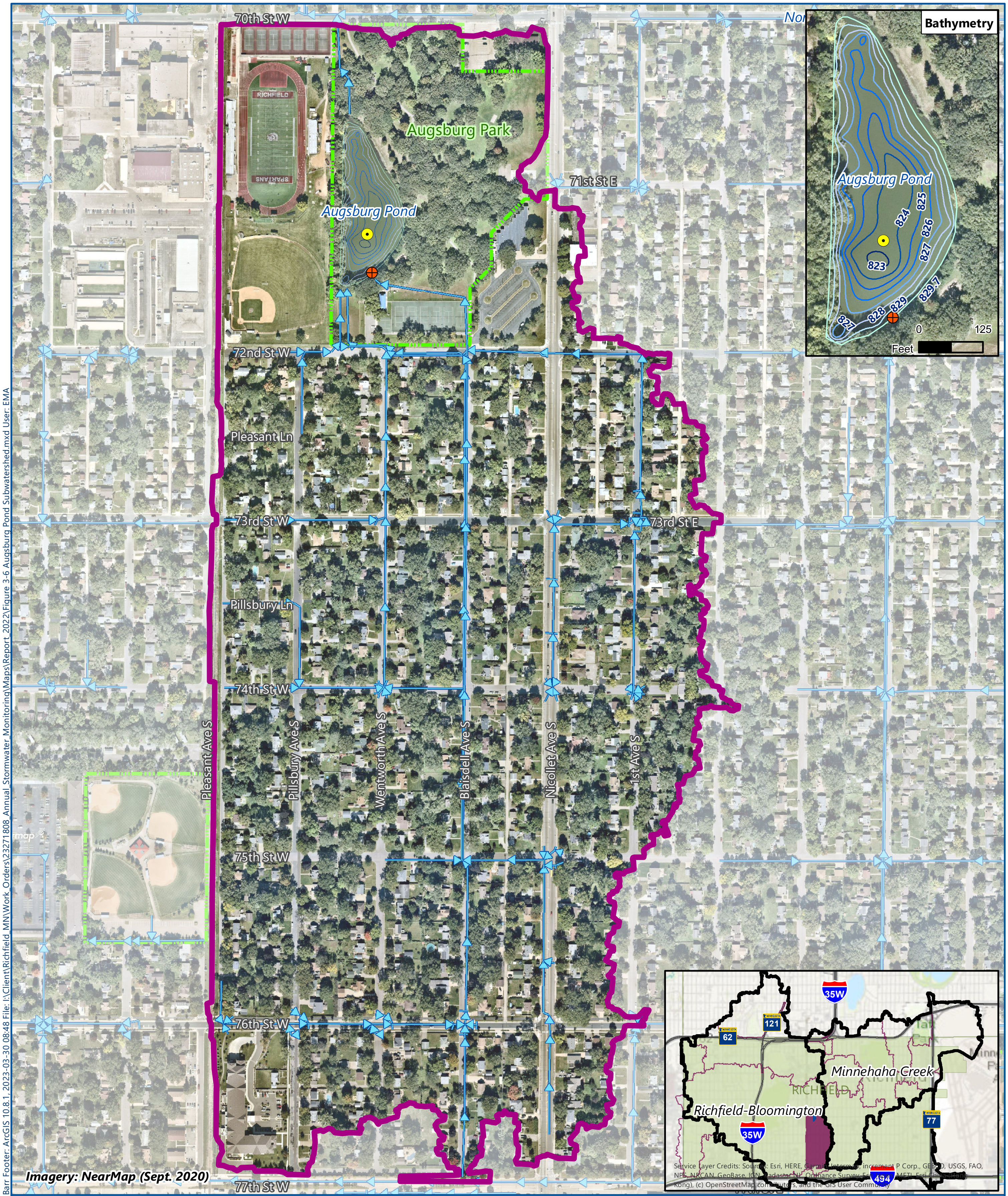
Figure 3-5 Adams Hill Pond Monitored Water Level

3.2 Augsburg Pond

Augsburg Pond is a 2.6-acre stormwater pond. The Augsburg Pond watershed is shown on Figure 3-6. Characteristics of the pond and its watershed are summarized in Table 3-2.

Table 3-2 Augsburg Pond Characteristics

Waterbody Characteristics	Augsburg Pond
Waterbody classification	Stormwater pond
Watershed area	163 acres
Surface area	2.6 acres
Maximum depth	2.3 meters (7.5 feet)
Outlet elevation	No normal outlet. Water is pumped. Pump off elevation 829 ft (NAVD 88).



Water Quality Monitoring Location
Water Level Monitoring Location
Storm Sewer
Augsburg Pond Subwatershed
Park Boundary

Bathymetric Contour
Elevation (feet, NAVD88)
823
824
825
826
827
828
829
829.68

0 250 500
Feet

AUGSBURG POND SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 3-6

3.2.1 Augsburg Pond Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-7. Concentrations of total phosphorus increased in September and October 2022, and reached 575 µg/L on October 17. Concentrations of dissolved phosphorus, and ortho-phosphorus, were a relatively high percentage of the total phosphorus pool in May, but then decreased by June. There was little watermeal or duckweed on the surface of Augsburg Pond for most sampling dates, with the exception of the August sampling event, which saw partial surface coverage from watermeal (see photos in Attachment B). Concentrations of chlorophyll-a were high relative to total phosphorus for the months of July-October, indicating a high phosphorus utilization by algae throughout much of the monitoring season. A chlorophyll-a to total phosphorus ratio of 1 or greater indicates a very high utilization of the phosphorus pool by algae (i.e. much of the phosphorus pool is biologically available to algae, and is incorporated in the algal biomass).

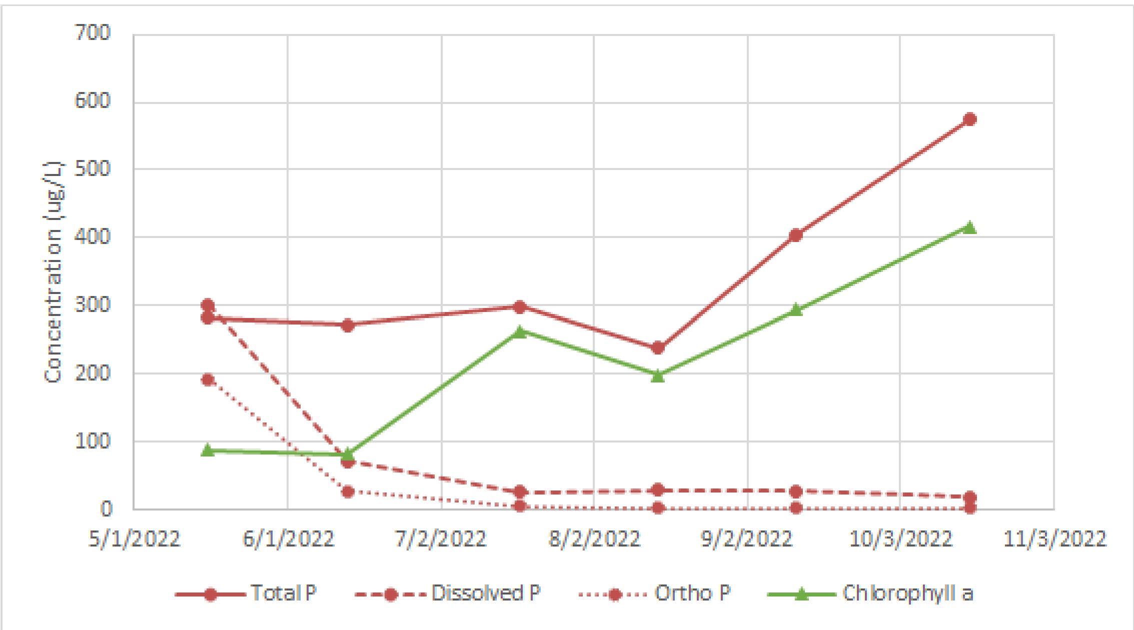


Figure 3-7 Augsburg Pond 2022 Phosphorus and Chlorophyll-a Concentrations

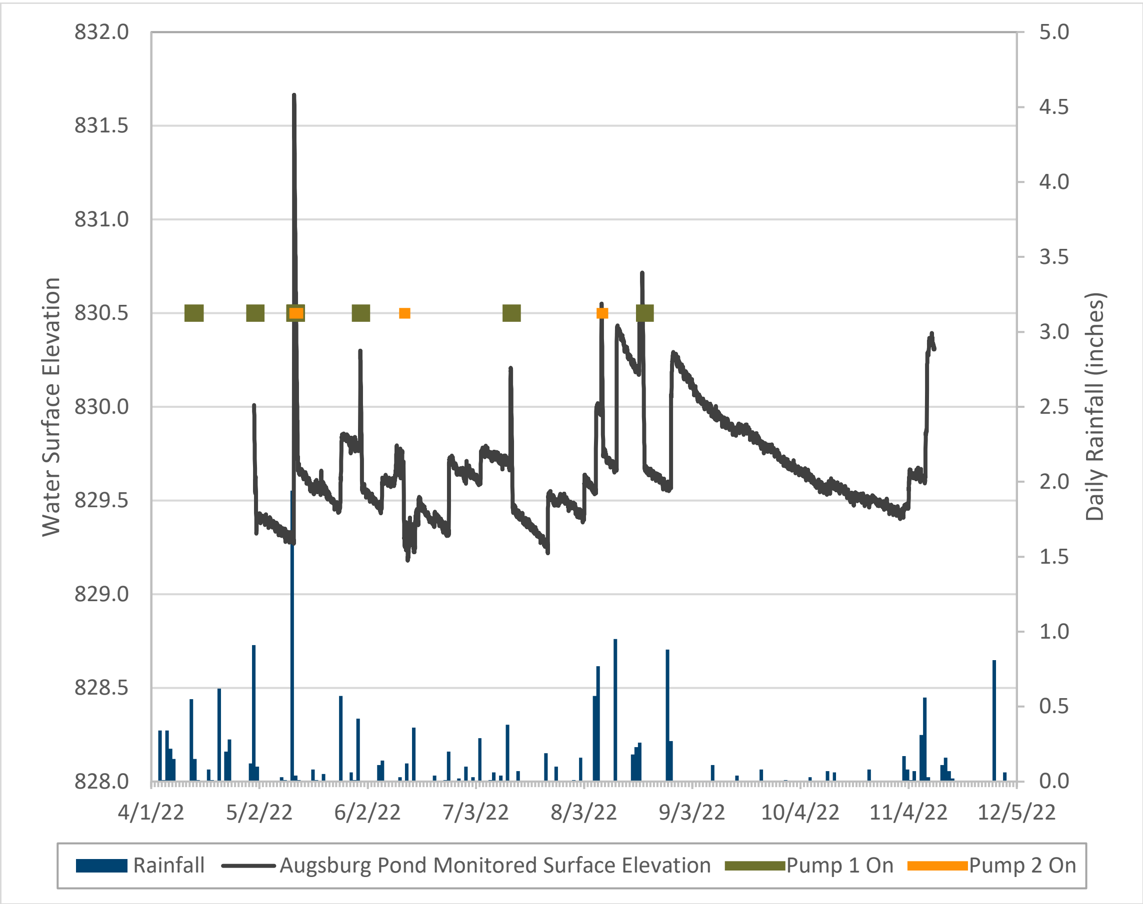
The summer averages (June–September) of total phosphorous in Augsburg Pond are shown on Figure 3-8. The 2022 summer average of total phosphorus (304 µg/L) in Augsburg Pond was the highest on record, and more than double the summer average of 2019 (132 µg/L). The 2022 summer average of chlorophyll-a (209 µg/L) was also the highest on record, although not substantially different than averages for 2020 and 2021. The 2022 summer average Secchi disk transparency was 0.3 meters. Secchi disk transparency and chlorophyll-a data were not collected in Augsburg Pond prior to 2020. There is no water quality standard for phosphorus in stormwater ponds. The Minnesota Stormwater Manual summarizes several studies of stormwater pond pollutant concentrations, and outflow concentrations of phosphorus from stormwater ponds were found to typically be in the range of 75 µg/L (25th percentile) to 200 µg/L (75th percentile) (Reference (1)). Summer averages of total phosphorus in Augsburg Pond have been on the high end of this range for the past 9 years (2014-2022), with the highest concentrations occurring in the last 2 years. Phosphorus concentrations were markedly lower during the first 3 years of Augsburg Pond monitoring (2011-2013).

Figure 3-8 Augsburg Pond Summer Averages of Total Phosphorus and Chlorophyll-a 2011–2022

3.2.2 Augsburg Pond Water Level

Augsburg Pond water levels measured in 2022 are shown on Figure 3-9, along with daily precipitation. There is no normal surface water outlet from Augsburg Pond, and water is pumped out of the pond. Water levels in the pond can fluctuate rapidly in response to rainfall events and pumping. Pump information provided by City of Richfield staff indicate the design pump off elevation is 829 ft; however, pump operation data (SCADA data provided by City of Richfield) from years 2020-2022 indicate the pump off elevation is likely higher than 829 ft.

Similar to Adams Hill Pond, there is a disconnect between pump operation and stage in the pond. Augsburg pond responds more slowly to pumping than Adams Hill, so this may be the intended operation, but pond stage never reaches the pump shut off elevation of 829 ft.



Note: Pump on elevation of 830.5 ft is estimated from observed pond elevations. "Pump on" data is shown for timing purposes but is not tied to a vertical elevation.

Figure 3-9 Augsburg Pond Monitored Water Level

3.3 Legion Lake

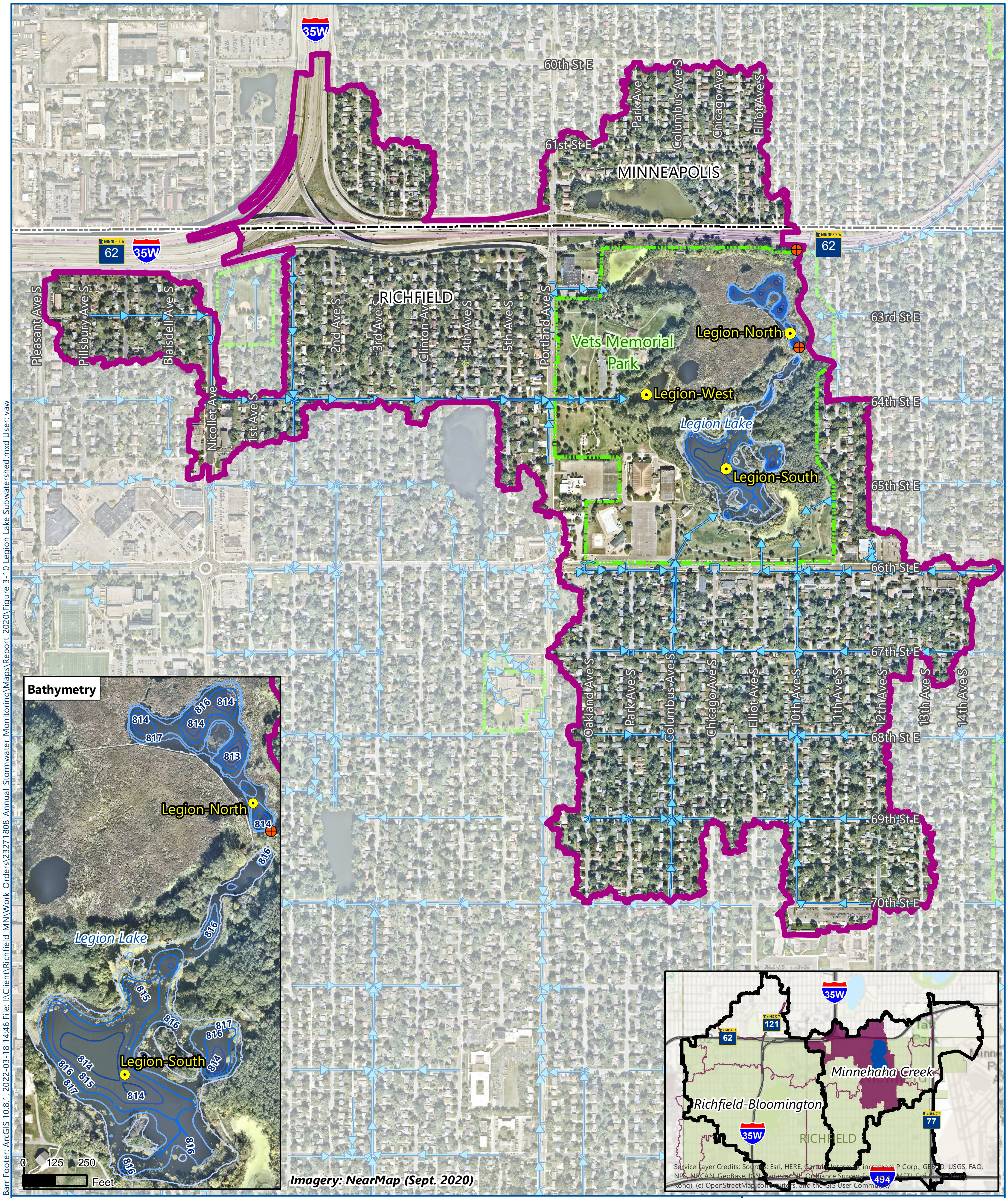
Legion Lake is a shallow lake with a mix of open water and large areas of dense cattails. The Legion Lake watershed is shown on Figure 3-10. Characteristics of the waterbody and its watershed are summarized in Table 3-3. Pedestrian trails surround Legion Lake, and there is a floating boardwalk bisecting the lake.

The north basin of Legion Lake is predominantly a dense growth of cattails, with a small area of open water in the eastern portion of the basin. The south basin of Legion Lake is predominantly open water. The Legion Lake West basin is much smaller than the North and South basins and was monitored to help assess a water quality improvement project on the West basin. The project consists of pumping water to nearby turf grass areas for irrigation and pumping to infiltration trenches to allow infiltration into the ground. Water monitoring was conducted at three locations: Legion Lake (North), Legion Lake (South), and Legion Lake (West). Monitoring locations are identified in Figure 3-10.

Surface water elevations were monitored in the North basin of Legion Lake, as well as in an outlet channel to the northeast of the lake. The outlet channel water level sensor was installed upstream of a weir in the outlet channel.

Table 3-3 Legion Lake Characteristics

Waterbody Characteristics	Legion Lake
Waterbody classification	Shallow lake
Watershed area	452 acres
Surface area	45 acres
Maximum depth	1.8 meters (5.9 feet)
Outlet elevation	820.19 ft (NAVD88) top of stop log; 819.19 ft concrete structure



Water Quality Monitoring Location

Water Level Monitoring Location

Storm Sewer

Legion Lake Subwatershed

Municipal Boundary

Park Boundary

Bathymetric Contour

Elevation (feet, NAVD88)

813

814

815

816

817

817.8

0 500 1,000

Feet

LEGION LAKE SUBWATERSHED

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FIGURE 3-10

3.3.1 Legion Lake Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-11 Legion Lake (North), Figure 3-12 Legion Lake (South), and Figure 3-13 Legion Lake (West). Concentrations of total phosphorus and chlorophyll-a in Legion Lake (North) and Legion Lake (South) generally increased from May to a peak in August, and then declined in September and October. Concentrations of total phosphorus in Legion Lake (West) peaked in July. Similar to 2021, concentrations of dissolved phosphorus were a relatively small percentage of the total phosphorus pool in all three basins for most of the 2022 sampling dates.

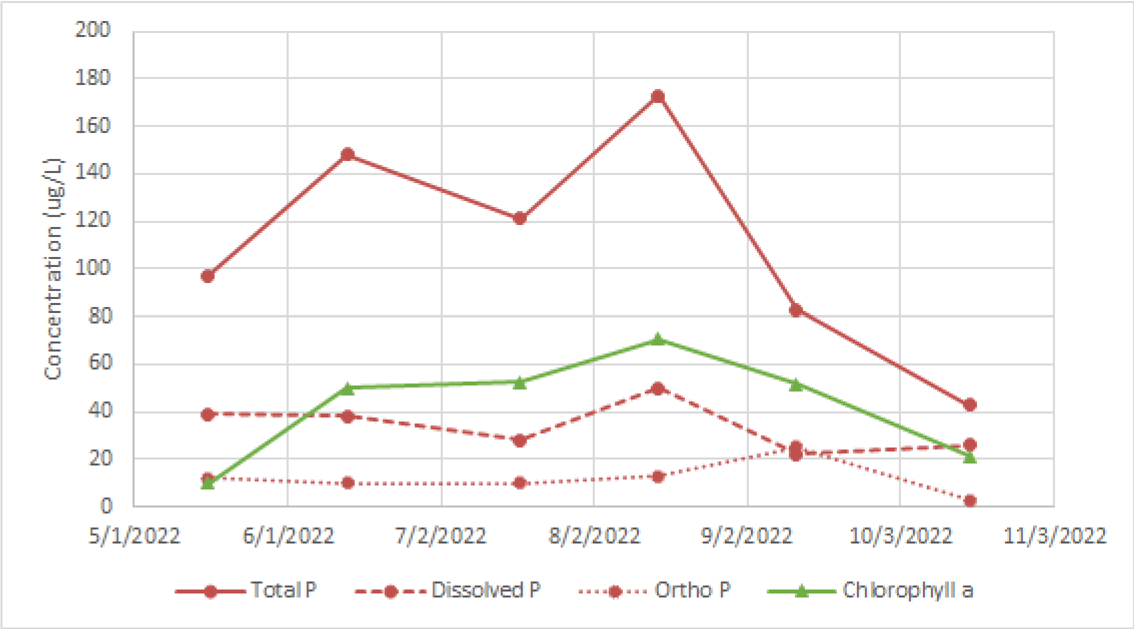


Figure 3-11 Legion Lake (North) 2022 Phosphorus and Chlorophyll-a Concentrations

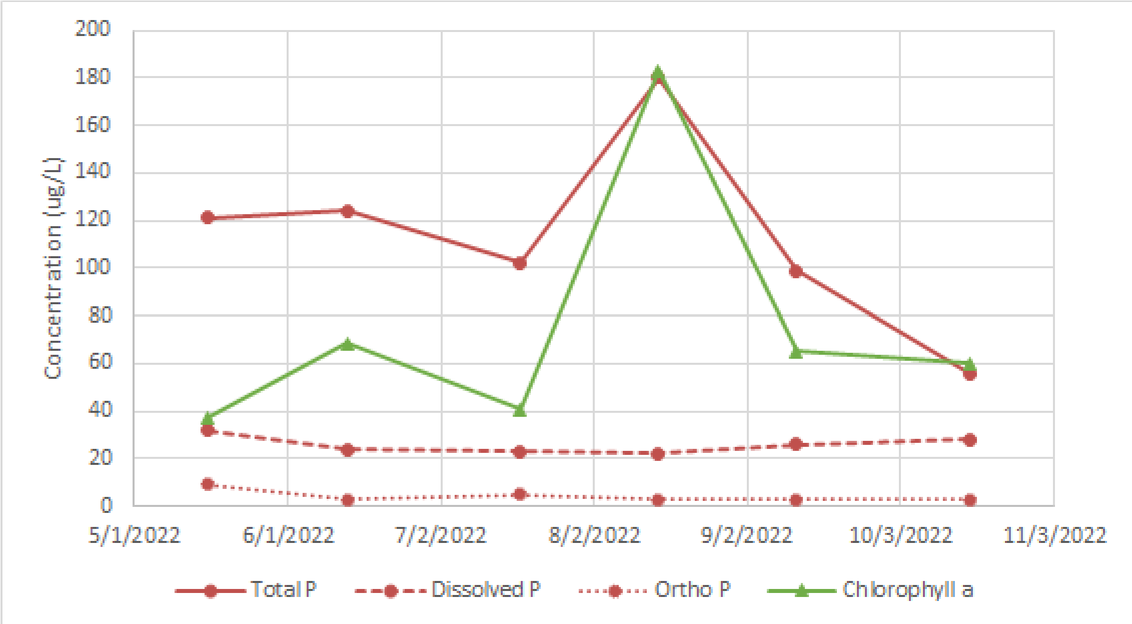


Figure 3-12 Legion Lake (South) 2022 Phosphorus and Chlorophyll-a Concentrations

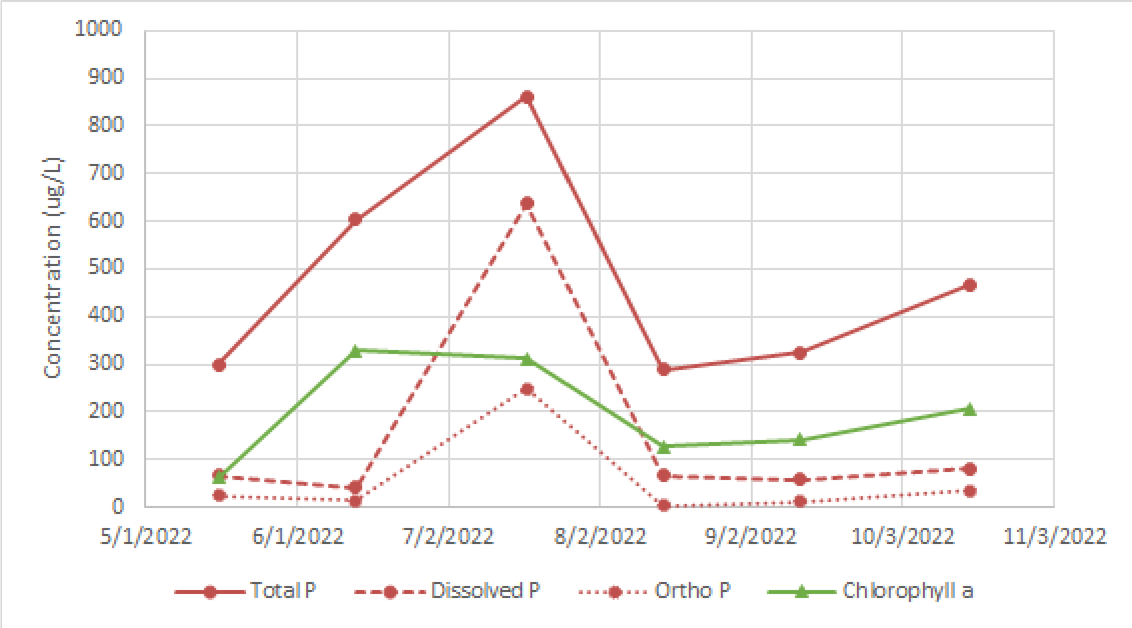


Figure 3-13 Legion Lake (West) 2022 Phosphorus and Chlorophyll-a Concentrations

Summer averages of total phosphorus are presented for Legion Lake (North), Legion Lake (South), and Legion Lake (West) on Figure 3-14, Figure 3-15, and Figure 3-16. The 2022 summer averages in Legion Lake (North) and Legion Lake (South) were lower than 2021 summer averages, but generally similar to summer averages of the previous three years (2019-2021). The 2022 summer average of total phosphorus in Legion Lake (West) was the highest observed in the four years it has been monitored, and was four times higher than concentrations in Legion Lake (North) and Legion Lake (South). The summer averages of total phosphorus were compared to the shallow lake standard of 60 µg/L for Legion Lake (North) and Legion Lake (South). Concentrations of total phosphorus have been higher than the phosphorus standard for all years monitored except 2011, with concentrations more than double the standard in most years. The summer averages of chlorophyll-a have been well above the shallow lake chlorophyll-a standard of 20 µg/L for the three years that it has been monitored. Summer averages of Secchi disk transparency were not graphed, as the Secchi disk is at times resting on the shallow lake bottom or obstructed by vegetation.

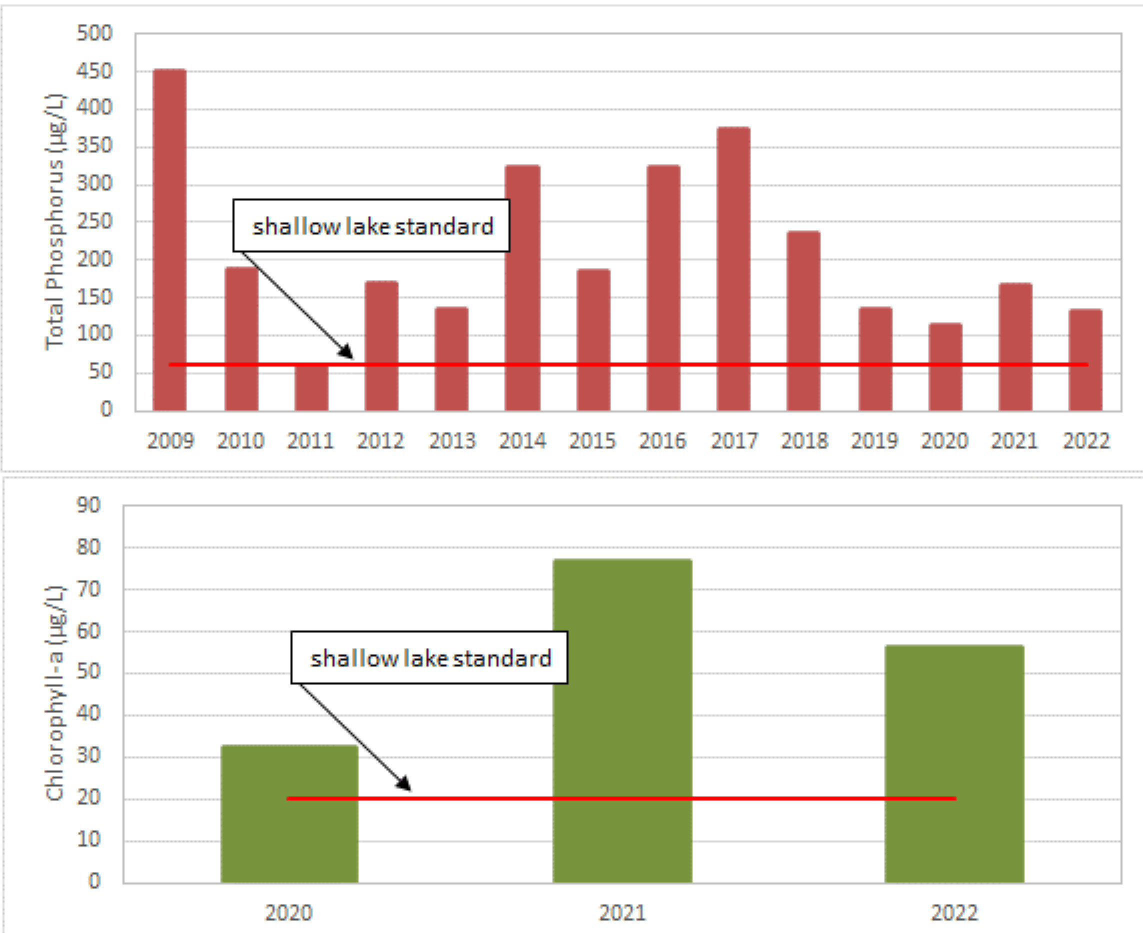
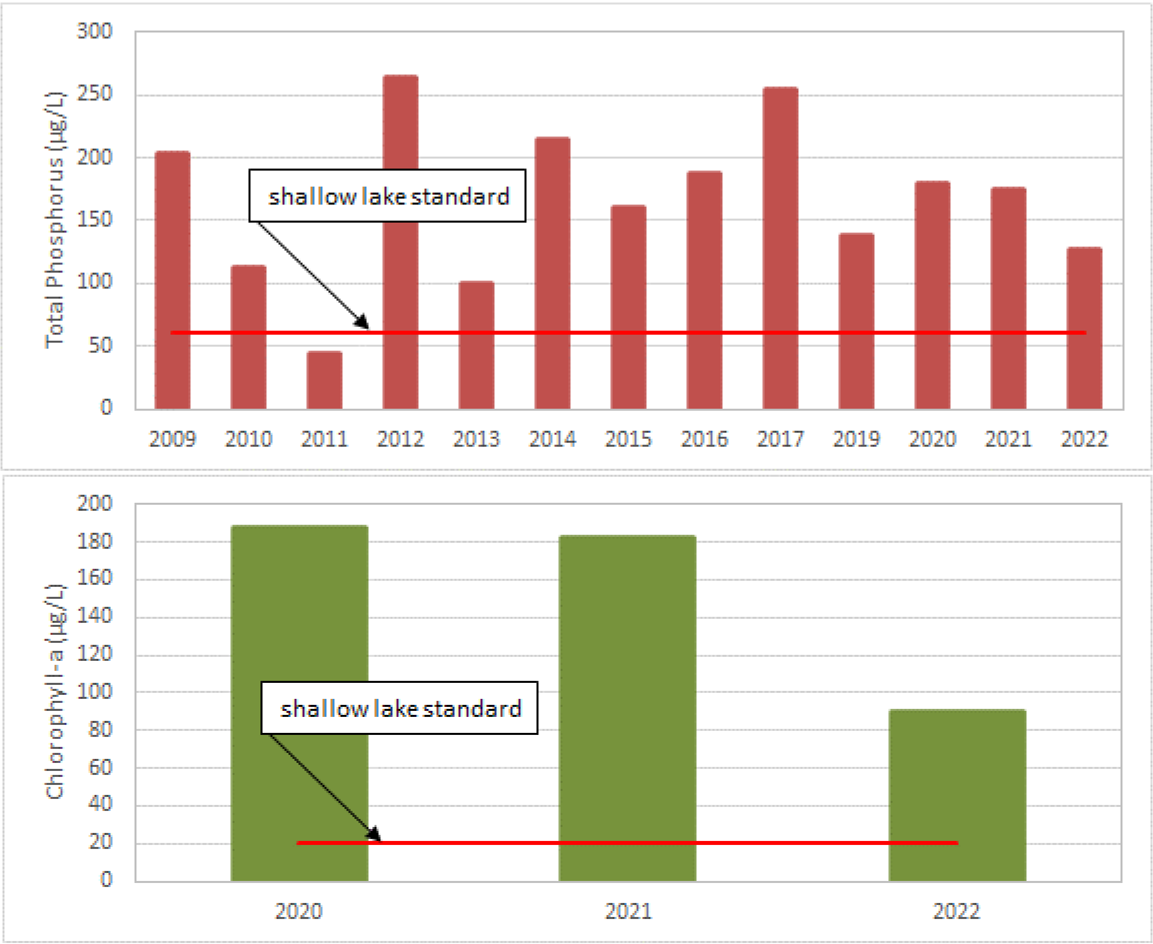


Figure 3-14 Legion Lake (North) Summer Averages of Total Phosphorus (2009 – 2022) and Chlorophyll-a (2020–2022)



Note: No monitoring data collected in 2018.

Figure 3-15 Legion Lake (South) Summer Averages of Total Phosphorus (2009 – 2022) and Chlorophyll-a (2020–2022)

Figure 3-16 Legion Lake (West) Summer Averages of Total Phosphorus (2019 – 2022) and Chlorophyll-a (2020–2022)

3.3.2 Legion Lake Water Level

Legion Lake water levels measured on the east shore of the north basin are shown on Figure 3-17, along with daily precipitation. Water levels measured in the Legion Lake outlet channel adjacent to the weir structure are also included. Precipitation was well below average in 2022, and the water level dropped below the Legion Lake staff gage and water level sensor (818.5ft) in August and October. Water level elevations were estimated in October using occasional manual measurements below the bottom of the staff gage during that period. It is anticipated that the Legion Lake staff gage will be installed in a deeper location in 2023 to ensure that the staff gage and water level sensor remain submerged throughout the monitoring season.

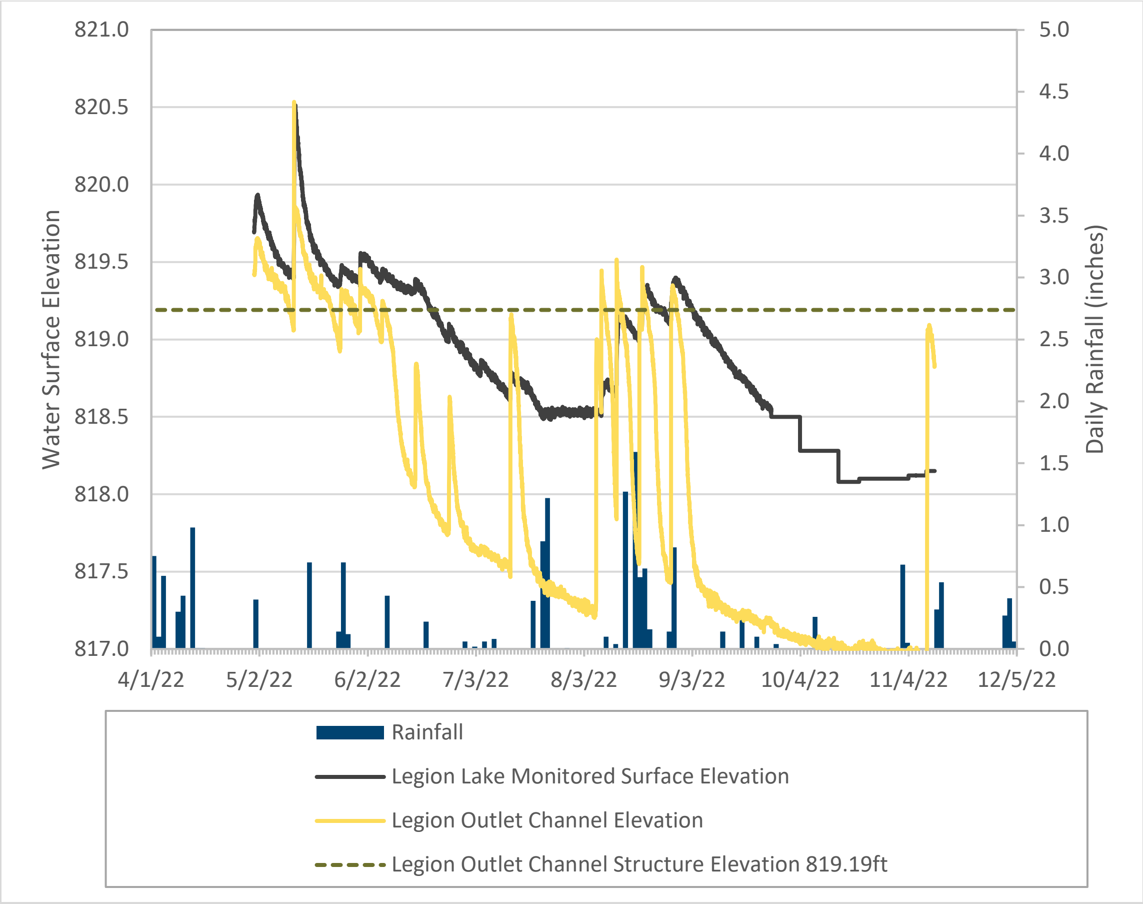


Figure 3-17 Legion Lake Monitored Water Level

3.3.3 Legion Lake Subsurface Infiltration System

In 2015/2016, the City of Richfield installed a subsurface infiltration system around Legion Lake. The City pumps water to an infiltration system from Legion Lake (West). The purpose of the infiltration system is to reduce the amount of outflow from Legion Lake to Taft Lake, and thereby reduce the overall phosphorus load to Taft Lake. Volumes of water pumped to the irrigation/infiltration system for years 2016-2022 are summarized in Table 3-4. Legion Lake (West) at times experiences very low water levels. There is no water level sensor in the west basin, but photos taken during monitoring events show the floating dock partially resting on the pond bottom in June, July, and October of 2022, along with exposed pond bottom near shore.

Table 3-4 Legion Lake Infiltration System Pumped Volumes

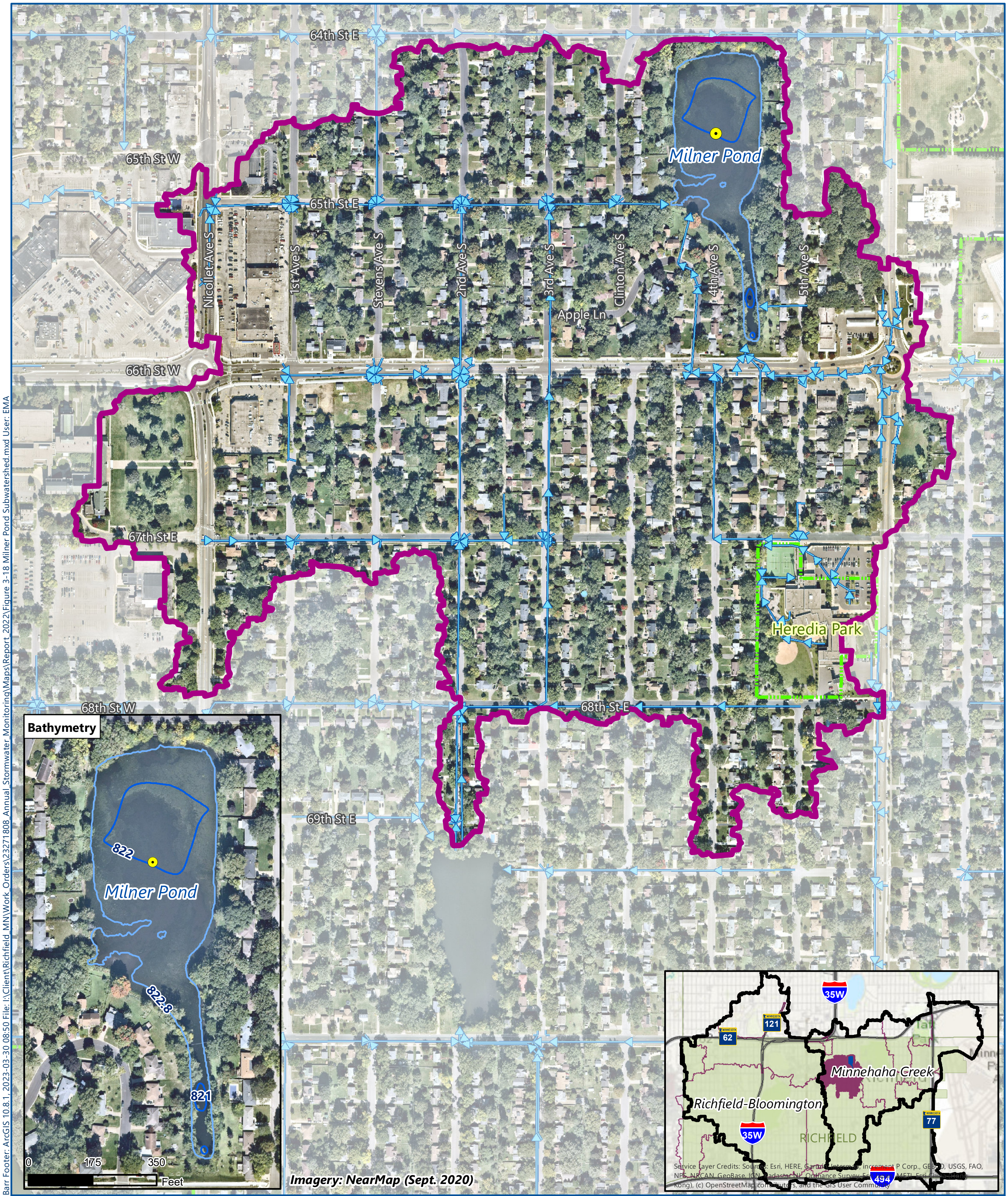
Year	Legion Lake Infiltration Pumped Volume (ac-ft)
2016	26
2017	23
2018	12
2019	111
2020	123
2021	30
2022	50

3.4 Milner Pond

Milner Pond is a 5.8-acre stormwater pond. The watershed of Milner Pond is shown on Figure 3-18. Characteristics of the pond and its watershed are summarized in Table 3-5.

Table 3-5 Milner Pond Characteristics

Waterbody Characteristics	Milner Pond
Waterbody classification	Stormwater pond
Watershed area	167 acres
Surface area	5.8 acres
Maximum depth	1.0 meter (3.3 feet)
Outlet elevation	823.98 ft (NAVD88)



Water Quality Monitoring Location
Storm Sewer
Milner Pond Subwatershed
Park Boundary

Bathymetric Contour

Elevation (feet, NAVD88)

821
822
822.8

0 250 500
Feet

MILNER POND SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 3-18

3.4.1 Milner Pond Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-19. The concentration of total phosphorus was lowest in July, and more than doubled by August. The phosphorus concentration continued to increase in September and October, reaching 528 µg/L on October 17. Concentrations of dissolved phosphorus and ortho-phosphorus were variable, with the highest observed concentration in June and August. The concentration of chlorophyll-a were the highest in July and August. Similar to other ponds, the ratio of chlorophyll-a to total phosphorus was relatively high during the summer months. A chlorophyll-a to total phosphorus ratio approaching 1 or greater indicates a high utilization of phosphorus by algae (i.e. much of the phosphorus pool is biologically available to algae).

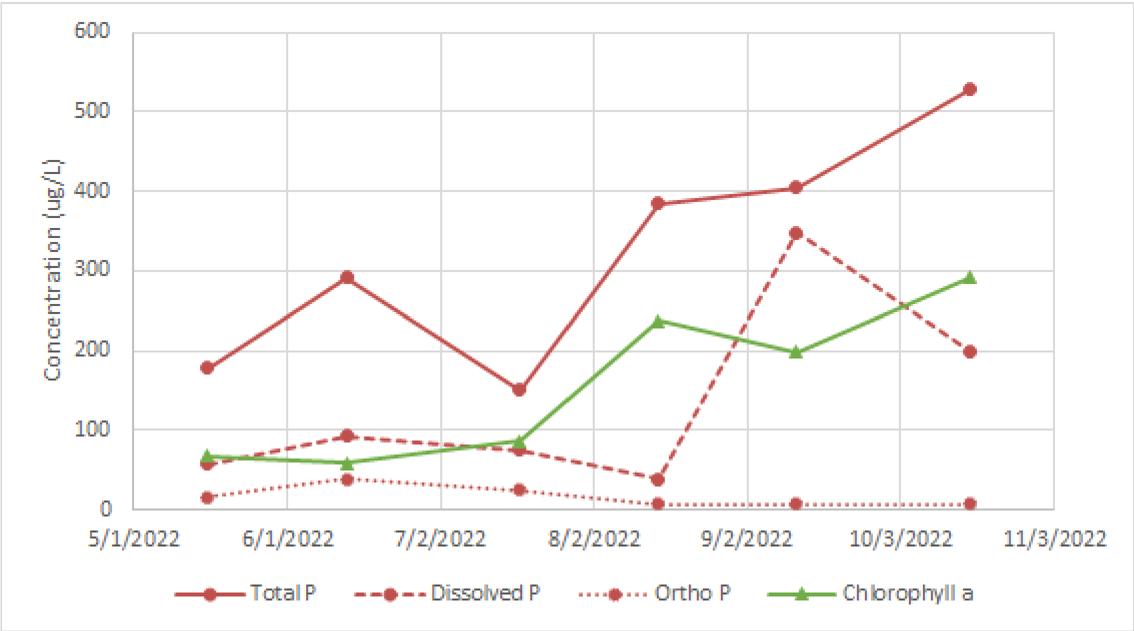


Figure 3-19 Milner Pond 2022 Phosphorus and Chlorophyll-a Concentrations

The summer averages of total phosphorus for Milner Pond are shown on Figure 3-20 for 2009–2022. The 2022 summer average of total phosphorus was higher than the 2020 and 2021 summer averages, but much lower than the 2019 summer average. Total phosphorus concentrations in Milner Pond have shown extreme variations in recent years, and the 2019 summer average of total phosphorus was considerably higher than other years due to very high concentrations measured in June 2019 (1,800 µg/L) and July 2019 (3,200 µg/L). Collecting representative samples of shallow lakes and ponds can be challenging due to sediment disturbance during sample collection, or thick cover of duckweed and watermeal. It is possible samples collected in 2019 had elevated total phosphorus due to sediment disturbance during sample collection, or other factors.

The 2020-2022 summer average of chlorophyll-a are also included on Figure 3-20; chlorophyll-a was not monitored prior to 2020. The Secchi disk transparency measurements in Milner Pond are often obstructed by vegetation or resting on the pond bottom, and therefore summer averages are not graphed. The

Minnesota Stormwater Manual summarizes several studies of stormwater pond pollutant concentrations, and outflow concentrations of phosphorus from stormwater ponds were found to typically be in the range of 75 µg/L (25th percentile) to 200 µg/L (75th percentile) (Reference (1)). Summer averages of total phosphorus in Milner Pond have been highly variable, with concentrations below or slightly above 200 µg/L some years, and above 400 µg/L several years.

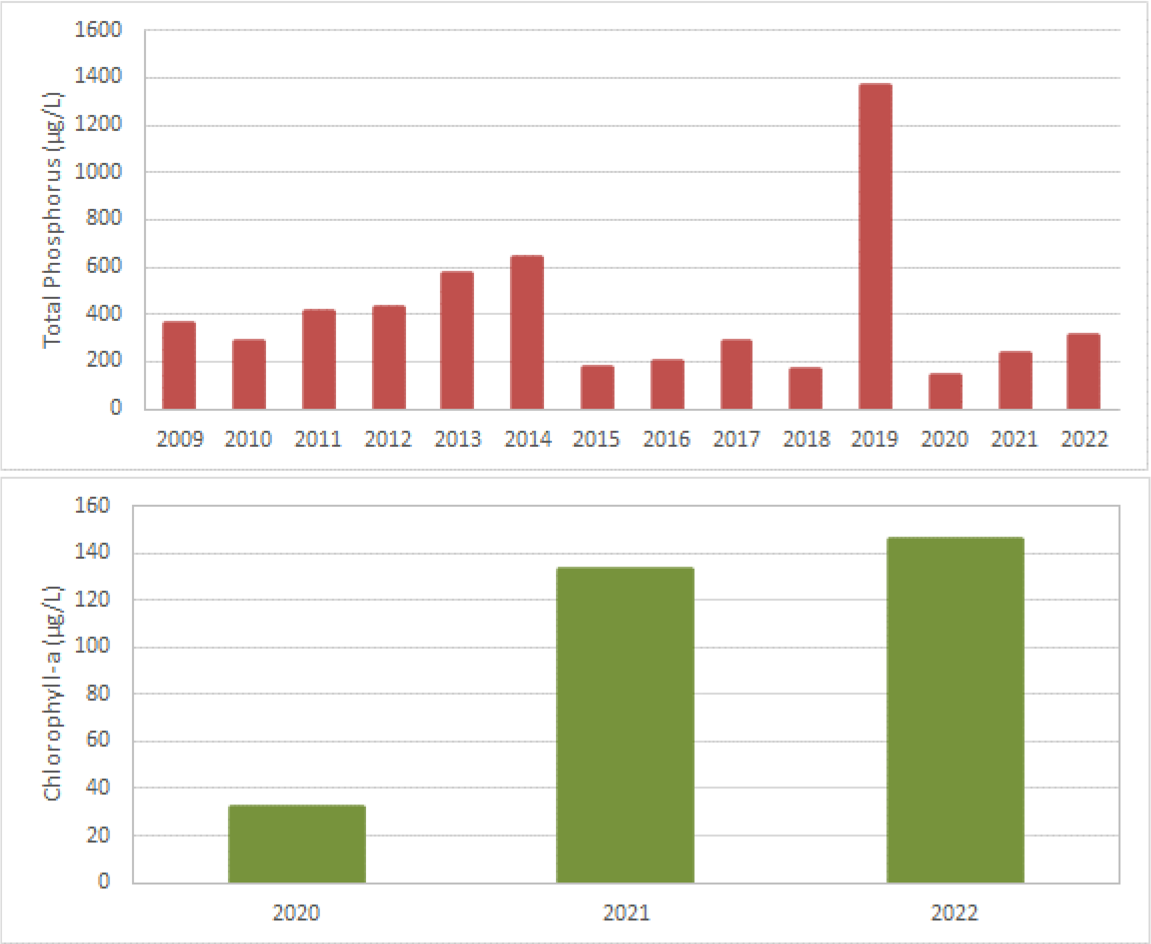


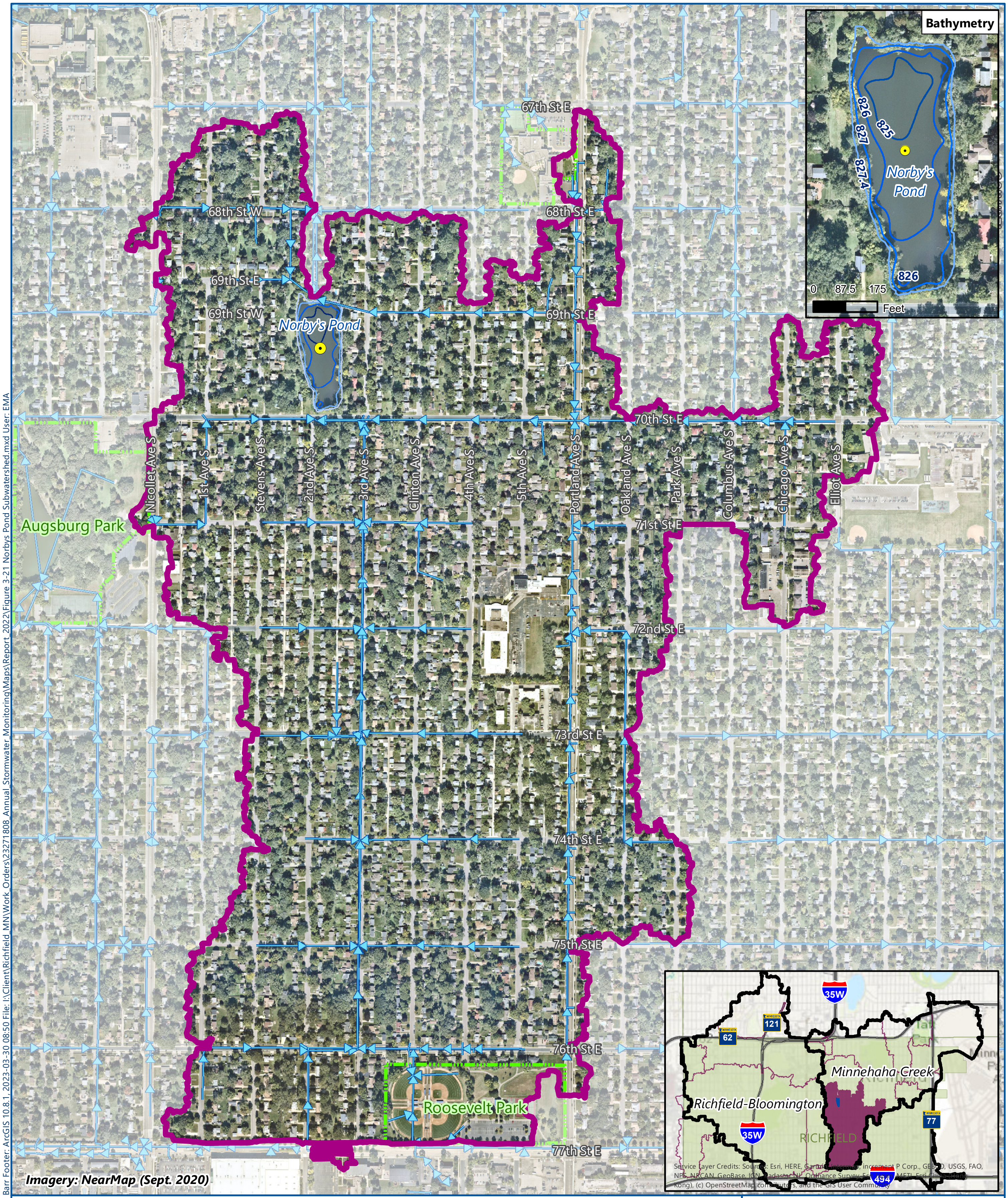
Figure 3-20 Milner Pond Summer Averages of Total Phosphorus (2009 – 2022) and Chlorophyll-a (2020–2022)

3.5 Norby's Pond

Norby's Pond is a 3.6-acre stormwater pond. The Norby's Pond watershed is shown on Figure 3-21. Characteristics of the pond and its watershed are summarized in Table 3-6.

Table 3-6 Norby's Pond Characteristics

Waterbody Characteristics	Norby's Pond
Waterbody classification	Stormwater pond
Watershed area	391 acres
Surface area	3.6 acres
Maximum depth	1.1 meters (3.6 feet)
Outlet elevation	828.24 ft (NAVD88)



- Water Quality Monitoring Location
- Storm Sewer
- Norby's Pond Subwatershed
- Park Boundary

Bathymetric Contour

Elevation (feet, NAVD88)

- 825
- 826
- 827
- 827.4

0 350 700

Feet

NORBY'S POND SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 3-21

3.5.1 Norby's Pond Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-22. Concentrations of total phosphorus in Norby's Pond were highest in May, June, and July, and then decreased by nearly half in August, before increasing again in September. Concentrations of dissolved phosphorus were a relatively small percentage of the total phosphorus pool, with the exception of the September dissolved phosphorus measurement. However, it is unlikely that dissolved phosphorus was such a large fraction of the total phosphorus pool given the high concentration of chlorophyll-a (i.e. phosphorus is largely in algal biomass on that date), and the September dissolved phosphorus measurement is suspect. Ortho-phosphorus concentrations were very low throughout the season. Concentrations of chlorophyll-a were lowest in May, and peaked in July.

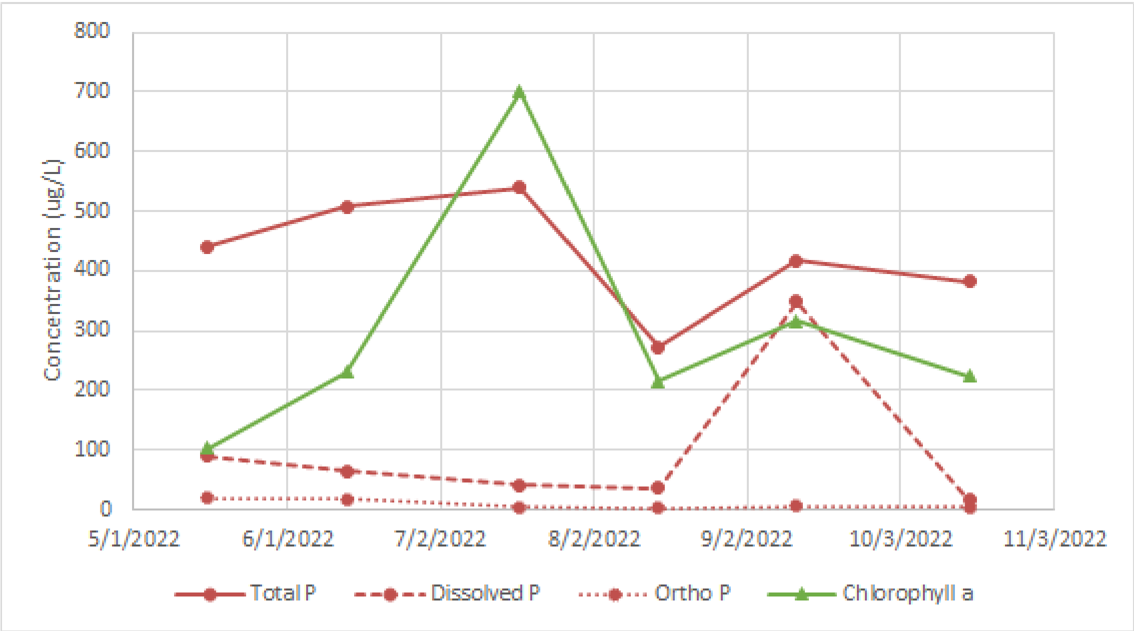


Figure 3-22 Norby's Pond 2022 Phosphorus and Chlorophyll-a Concentrations

The 2009–2022 summer averages of total phosphorus for Norby's Pond are shown on Figure 3-23. The 2020-2022 summer average of chlorophyll-a are also included on Figure 3-23. The summer average of Secchi disk transparency was 0.2 m. Secchi disk transparency and chlorophyll-a data were not collected in Norby's Pond prior to 2020. The Minnesota Stormwater Manual summarizes several studies of stormwater pond pollutant concentrations, and outflow concentrations of phosphorus from stormwater ponds were found to typically be in the range of 75 µg/L (25th percentile) to 200 µg/L (75th percentile) (Reference (1)). Concentrations of total phosphorus are consistently higher than 200 µg/L in Norby's Pond. The 2022 summer average of total phosphorus was 435 µg/L, similar to the 2021 average of 444 µg/L. The 2020 summer average (215 µg/L) was less than half the 2022 summer average, and was the lowest on record for Norby's Pond. The 2022 summer average of chlorophyll-a was 366 µg/L, the highest observed for any of the monitored waterbodies in Richfield.

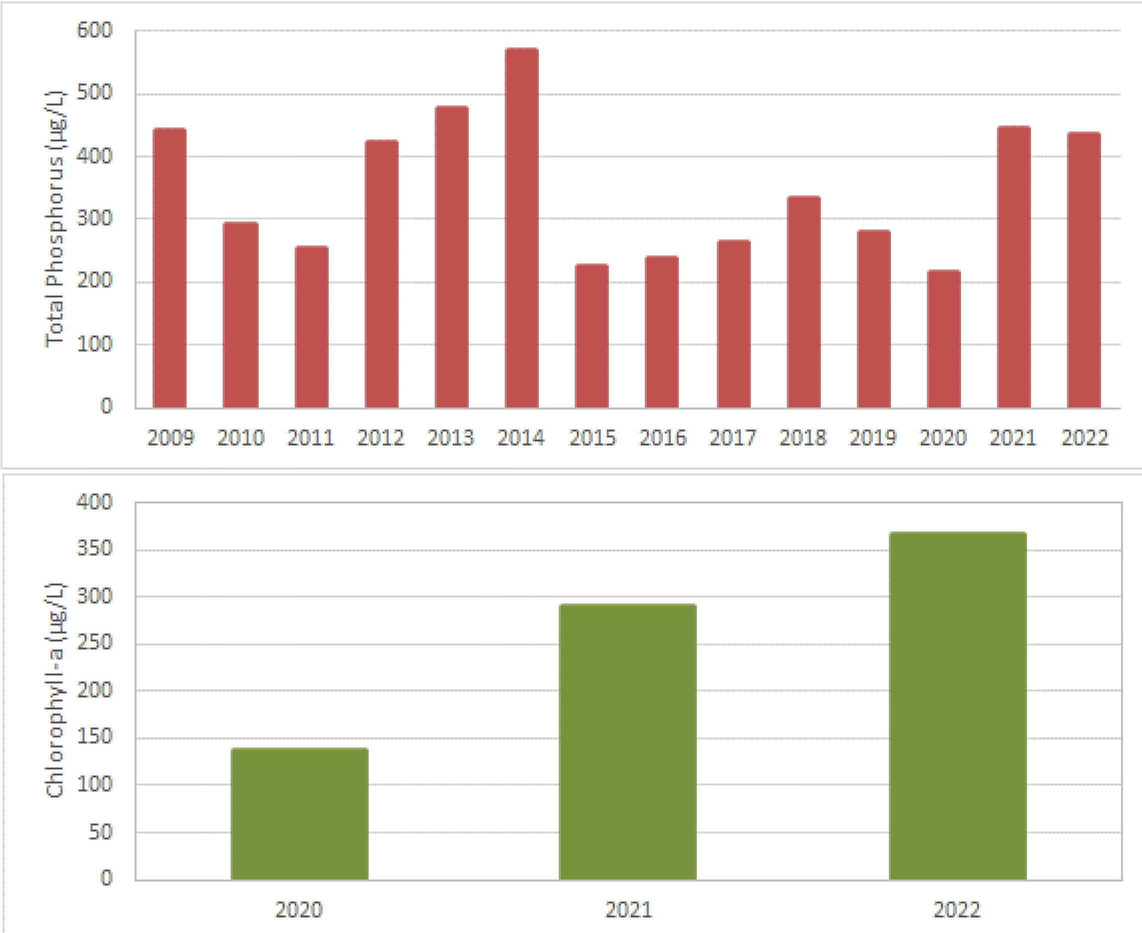


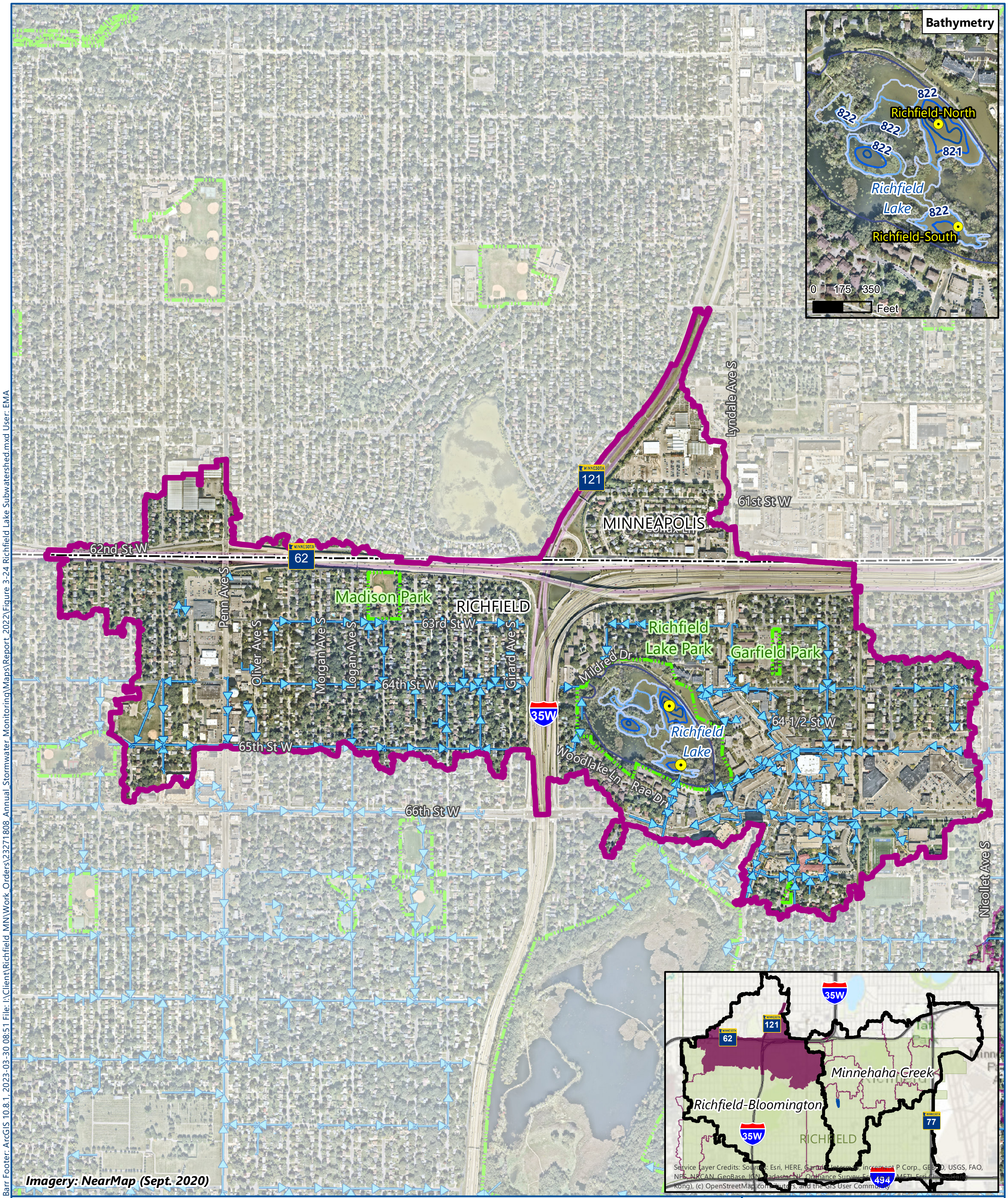
Figure 3-23 **Norby's Pond Summer Averages of Total Phosphorus (2009–2022) and Chlorophyll-a (2020 – 2022)**

3.6 Richfield Lake

Richfield Lake is a 24.6-acre shallow lake. The lake is within Richfield Park, and a pedestrian trail circles the lake. There are several islands with trees in various areas of the lake and some large areas of dense cattails on the east side. The Richfield Lake watershed is shown in Figure 3-24. Characteristics of the waterbody and its watershed are summarized in Table 3-7. Water quality monitoring was conducted at two locations: Richfield Lake (North) and Richfield Lake (South).

Table 3-7 Richfield Lake Characteristics

Waterbody Characteristics	Richfield Lake
Waterbody classification	Shallow lake
Watershed area	494 acres
Surface area	24.6 acres
Maximum depth	2.4 meters (7.9 feet)
Outlet elevation	824.58 feet (NAVD88) top of 2 stop logs; 824 feet top of concrete structure



Water Quality Monitoring Location
Storm Sewer
Richfield Lake Subwatershed
Richfield Lake Boundary
Municipal Boundary
Park Boundary

Bathymetric Contour
Elevation (feet, NAVD88)
819
820
821
822
822.1

0 600 1,200
Feet

RICHFIELD LAKE SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 3-24

3.6.1 Richfield Lake Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-25 and Figure 3-26 for Richfield Lake (North) and Richfield Lake (South), respectively. Concentrations of total phosphorus were consistently less than 150 µg/L in May-August 2022 at both sampling locations, and then doubled to greater than 250 µg/L in September. Total phosphorus concentrations were generally similar at the two monitoring locations through the monitoring season. Chlorophyll-a concentrations were generally higher at the Richfield (North) location compared to Richfield (South), and reached a peak concentration in September – 470 µg/L at location Richfield (North) on 9/12/22. A chlorophyll-a to total phosphorus ratio of 1 or greater indicates a high utilization of phosphorus by algae (i.e. much of the phosphorus pool is biologically available to algae). The large increase in total phosphorus in Richfield Lake in September is likely due to internal loading of phosphorus from sediment. The phosphorus released from the sediment is biologically available, and quickly utilized by algae in the shallow lake, and the ortho-phosphorus concentrations measured in the water column remained low. A high ratio of chlorophyll-a to total phosphorus in late summer is typical when much of the phosphorus pool is from internal loading.

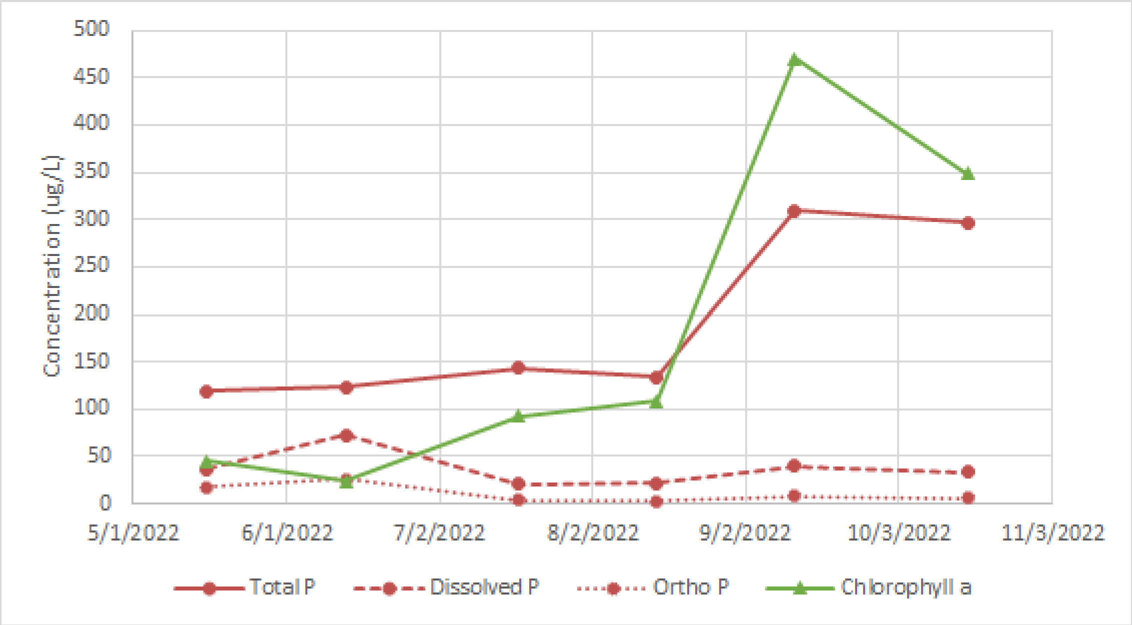


Figure 3-25 Richfield Lake (North) 2022 Phosphorus and Chlorophyll-a Concentrations

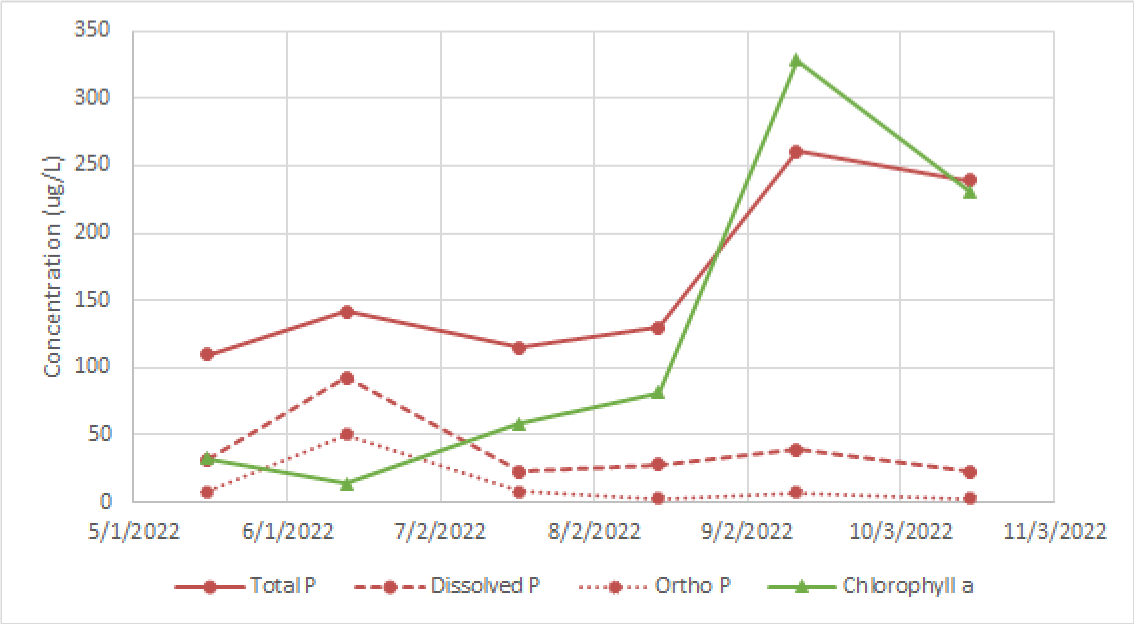


Figure 3-26 Richfield Lake (South) 2022 Phosphorus and Chlorophyll-a Concentrations

Summer averages (June–September) of total phosphorus for the monitoring period of 2010–2022 are shown on Figure 3-27 and Figure 3-28 for Richfield Lake (North) and Richfield Lake (South), respectively. The 2022 summer averages were higher than summer averages of 2020 and 2021; the summer average of 2020 were the lowest on record for Richfield (North) and Richfield (South), while the 2019 summer average for Richfield Lake (North) was the highest on record, more than three times higher than 2020, demonstrating how highly variable from year to year phosphorus concentrations can be in Richfield Lake. The summer averages of total phosphorus were compared to the shallow lake standard of 60 µg/L. Concentrations of total phosphorus have been higher than the phosphorus standard for all years monitored in Richfield Lake (North) and Richfield Lake (South). Concentrations are more than double the water quality standard in most years.

The 2022 summer averages of chlorophyll-a for Richfield Lake (North) and Richfield Lake (South) were 174 µg/L and 121 µg/L, respectively, which is considerably higher than the shallow lake chlorophyll-a standard of 20 µg/L. The 2022 summer average of chlorophyll-a was more than double the 2020-2021 summer averages in Richfield (North), and more than triple in Richfield (South). The 2022 summer average of Secchi disk transparency for Richfield Lake (North) was 0.7 meters, which is worse than the shallow lake standard of 1.0 meters. The Secchi disk was still visible resting on aquatic vegetation in Richfield Lake (South) during one or more events in 2021; therefore, the summer average was not calculated for Richfield Lake (South). Secchi disk transparency and chlorophyll-a data were not collected in Richfield Lake prior to 2020.

Figure 3-27 Richfield Lake (North) Summer Averages of Total Phosphorus (2010 – 2022) and Chlorophyll-a (2020 - 2022)

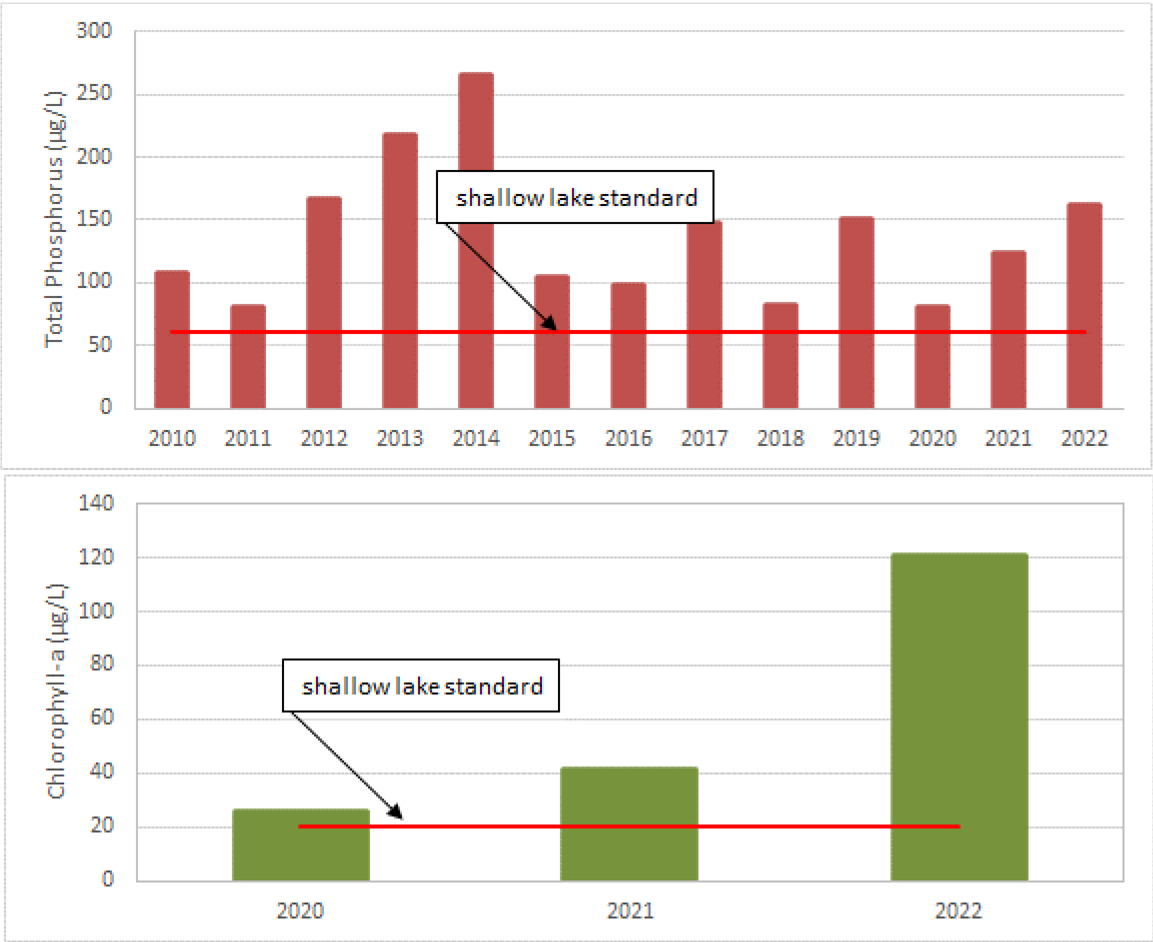


Figure 3-28 Richfield Lake (South) Summer Averages of Total Phosphorus (2010 – 2022) and Chlorophyll-a (2020 – 2022)

3.6.2 Richfield Lake Water Level

Richfield Lake water levels measured in 2022 are shown in Figure 3-29, along with daily precipitation. Water levels were below the lake's outlet for most of July, September, and October. Water levels varied by more than 2.5 feet in 2022, with the season high of 826.12 feet occurring on May 12 . Please note that the outlet elevation was updated to 824.58 feet in the 2020 water quality report (from 825.56 feet as previously stated in the 2019 water quality report). The updated, lower outlet elevation appears to agree more closely with stage trends in other non-pumped waterbodies (e.g., Legion and Taft Lakes) indicating this is a more accurate outlet elevation.

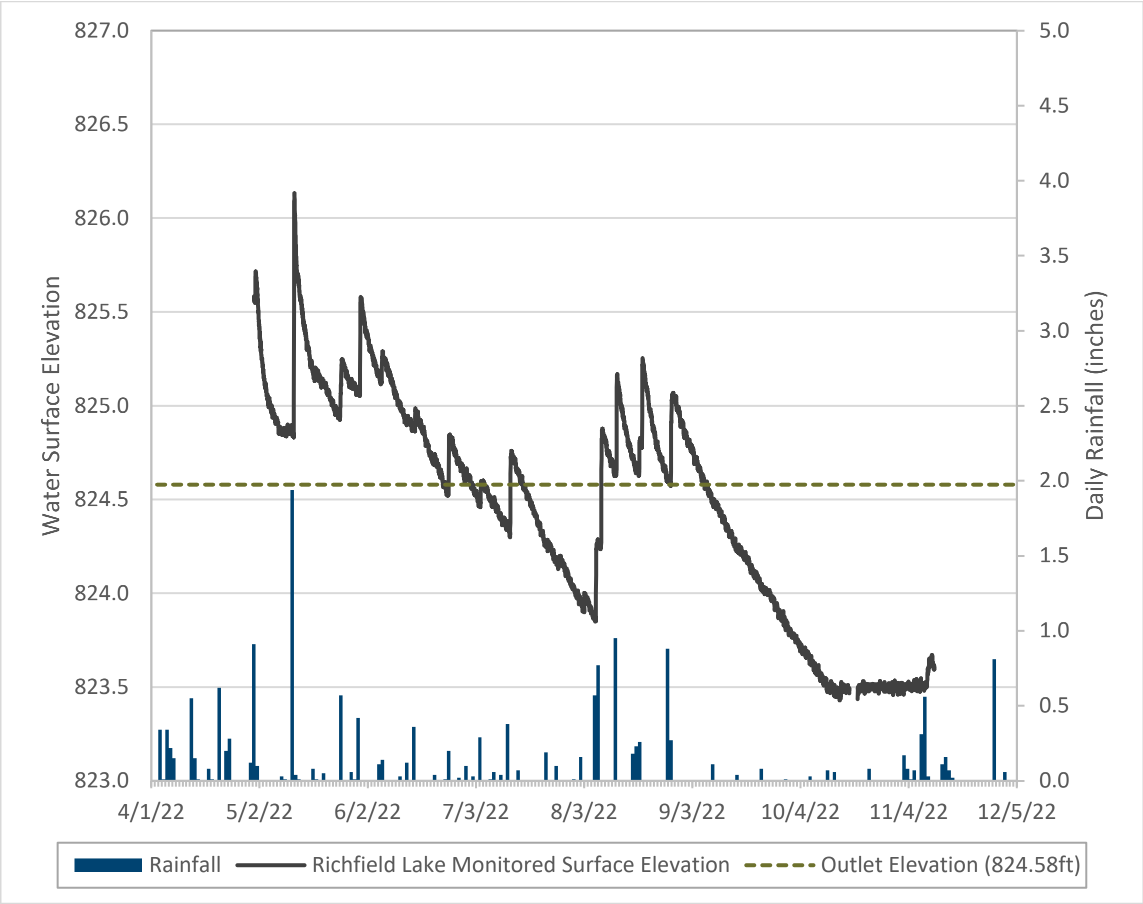


Figure 3-29 Richfield Lake Monitored Water Level

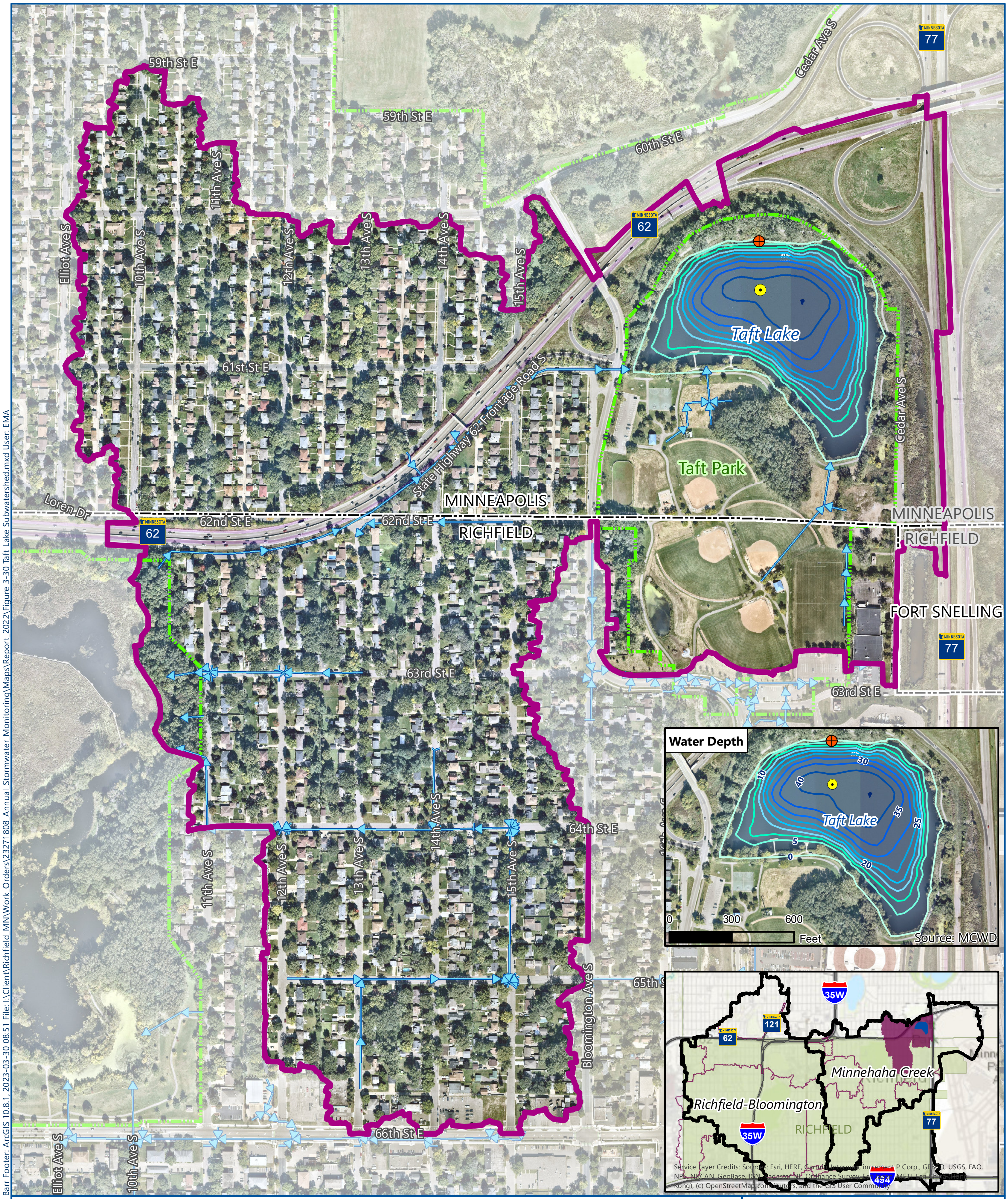
3.7 Taft Lake

Taft Lake, located just outside the City of Richfield within the City of Minneapolis, is a 13.6-acre deep lake. A small portion of the lake's watershed is within the City of Minneapolis, including Mother Lake to the east of Hwy 77. The Taft Lake watershed is shown on Figure 3-30. Characteristics of the waterbody and its watershed are summarized in Table 3-8. The lake discharges to the north, flowing to nearby Lake Nokomis. Lake Nokomis is impaired for eutrophication, and a total maximum daily load (TMDL) study has been completed to address the excess phosphorus contributing to poor water quality. Mitigation measures include reductions in the phosphorus load discharge from Taft Lake. In addition, the City of Richfield has an agreement with Minnehaha Creek Watershed District and the City of Minneapolis to monitor Taft Lake water quality and operate an alum treatment system on Taft Lake. The alum system pumps water from the lake, treats it with alum (aluminum sulfate) to remove phosphorus, and returns the treated water to the lake.

Taft Lake is located within a public park, which includes pedestrian pathways around the lake and a fishing pier on the south shoreline. Taft Lake has been managed by the Minnesota DNR as a fishing pond since 1975 through the Fishing in the Neighborhood (FIN) program. The lake is regularly stocked with fish (Reference (2)), most recently with bluegill sunfish (2012, 2014, 2016, 2019, 2020, 2021, and 2022), northern pike (2013, 2014, 2016, 2017, 2018, 2021, and 2022), and yellow perch (2013, 2014, 2016, 2018). The DNR last conducted a fish survey on Taft Lake in 2017 and reported the following fish species: black bullhead, black crappie, bluegill, channel catfish, green sunfish, hybrid sunfish, largemouth bass, northern pike, pumpkinseed, rock bass, tiger muskellunge, walleye, white crappie, yellow bullhead, yellow perch, bowfin (dogfish), common carp, white sucker, and golden shiner.

Table 3-8 Taft Lake Characteristics

Waterbody Characteristic	Taft Lake
Waterbody classification	Deep lake
Watershed area	159 acres (direct watershed area)
Surface area	13.6 acres
Maximum depth	13.7 meters (45 feet)
Outlet elevation	815.2 feet (NAVD88) (estimated elevation from lidar data)



Water Quality Monitoring Location
Water Level Monitoring Location
Storm Sewer
Taft Lake Subwatershed
Municipal Boundary
Park Boundary

Water Depth Contour
Depth (feet)
0, 5, 10, 15, 20, 25, 30, 35, 40, 45

0 275 550
Feet

TAFT LAKE SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 3-30

In recent years, the City has also operated an aeration system and a water infiltration system on Taft Lake. The aeration system is operated during the open water months, and is not operated in the winter. The purpose of the aeration system on Taft Lake is to increase oxygen and thereby improve fish habitat in the lake. The aeration system also mixes the lake, causing it to destratify and increase oxygen in in the lake's hypolimnion. The depletion of oxygen in a lake can stress or kill fish, and it can also result in the release of soluble phosphorus from lake sediments due to the reduction of ferric iron that would otherwise bind with phosphorus in the sediment. The aeration system was operated continuously during the period of late May to late August in 2022. The aeration system had not been operated continuously in 2021, and the lake was therefore more well mixed in 2022 compared to 2021. After the Taft Lake aeration system was turned on in the spring of 2021,the lake was observed to have turned reddish-brown in color on May 7, 2021 and the aerator was turned off in response, as the City was concerned that the aeration system was the cause of the change in water color. The aeration system was started again on May 18 2021, but at a lower airflow rate for a few weeks before airflow was increased.

Depth profiles of 2022 temperature (Table 3-9) and dissolved oxygen (Table 3-10) show the lake was generally well mixed throughout the monitoring season. The greatest temperature difference between the lake surface and bottom occurred in July, with a temperature difference of 3.0°C (5.4°F). The lake did still experience low dissolved oxygen (<2 mg/L) near the lake bottom in July and August; additionally, the dissolved oxygen was <5 mg/L throughout the water column in July, which could be stressful to fish. Oxygen concentrations increased in August, but were again low during the September monitoring event (5.2-5.7 mg/L in top 2 meters). Although the Taft lake aeration system was able to thermally destratify the lake for much of the 2022 season, oxygen concentrations still drop below 2 mg/L near the lake bottom in the deepest area of the lake. The depth profiles of total phosphorus (Table 3-11) indicate very similar concentrations of phosphorus throughout the water column in 2022. In previous years when thermal stratification contributed to less water column mixing and low dissolved oxygen in the hypolimnion, phosphorus concentrations near the lake bottom were much higher due to accumulated phosphorus from internal loading. It appears the well mixed conditions and higher oxygen concentrations at depth in 2022 compared to previous years contributed to reduced internal loading of phosphorus in 2022. Low precipitation and improved performance of the alum flocculation system may also have contributed to overall improved water quality in Taft Lake in 2022.

Table 3-9 Taft Lake 2022 Temperature (°C) Profiles

Depth (m)	4/19/22	5/17/22	6/13/22	7/18/22	8/15/22	9/12/22	10/17/22
0	6.4	15.9	21.5	27.9	25.3	24.6	14.4
1	5.6	15.8	21.1	26.9	25.2	23.8	14.4
2	5.4	15.7	20.8	26.6	24.9	23.6	14.4
3	5.2	15.4	20.5	26.3	24.8	23.4	14.3
4	5.1	15.3	20.4	26.2	24.8	23.4	14.3
5	5.1	15.3	20.4	26.1	24.7	23.4	14.3
6	5.1	15.2	20.3	26.1	24.7	23.4	14.3
7	5.1	15.1	20.3	26.0	24.7	23.3	14.3
8	5.1	15	20.2	26.0	24.7	23.3	14.2
9	5.0	14.8	20.0	25.9	24.7	23.3	14.2
10	4.9	14.3	19.5	25.6	24.7	23.3	14.2
11	4.9	13.0	19.2	25.3	24.6	23.1	14.2
12	5.1	12.3	18.9	24.9	24.6	23.1	14.2

Table 3-10 Taft Lake 2022 Dissolved Oxygen (mg/L) Profiles

Depth (m)	4/19/22	5/17/22	6/13/22	7/18/22	8/15/22	9/12/22	10/17/22
0	12.2	11.4	8.4	4.6	7.1	5.7	7.7
1	12.3	11.4	8.3	4.0	6.5	5.5	7.0
2	12.1	11.3	7.4	3.8	6.0	5.2	6.7
3	11.8	10.5	6.7	3.6	5.7	4.8	6.6
4	11.3	9.9	6.6	3.5	5.6	4.5	6.4
5	11.1	9.9	6.6	3.4	5.6	4.4	6.4
6	11.1	9.4	6.5	3.4	5.3	4.5	6.3
7	11.0	9.3	6.5	3.2	4.9	4.5	6.3
8	11.0	9.2	6.4	3.0	4.8	4.0	6.3
9	11.0	8.8	5.9	2.4	4.7	3.8	6.2
10	11.0	8.1	5.2	1.5	4.8	3.8	6.2
11	2.7	8.1	4.1	0.6	4.3	2.5	6.1
12	0.8	7.8	3.0	0.4	3.6	1.2	6.0

Table 3-11 Taft Lake 2022 Total Phosphorus (µg/L) Profiles

Depth (m)	4/19/22	5/17/22	6/13/22	7/18/22	8/15/22	9/12/22	10/17/22
0-2	48	62	51	22	24	23	27
5	50	49	43	26	24	21	25
8	49	48	38	22	26	19	30
12	60	38	43	35	31	26	29

3.7.1 Taft Lake Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-31. Concentrations of total phosphorus measured at the lake surface varied from a season high of 62 µg/L in May to a low of 22 µg/L in July. Dissolved phosphorus was highest in June (21 µg/L) and decreased to a season low (3 µg/L) in October. Concentrations of chlorophyll-a were highest at the very beginning of the season (36 µg/L in April), and dropped to just 4 µg/L in July. The very low chlorophyll-a measured in July likely indicates a die-off of algae occurred, and likely contributed to the low dissolved oxygen in the lake in July, due to respiration of bacteria and other microorganisms feeding on the algae,.

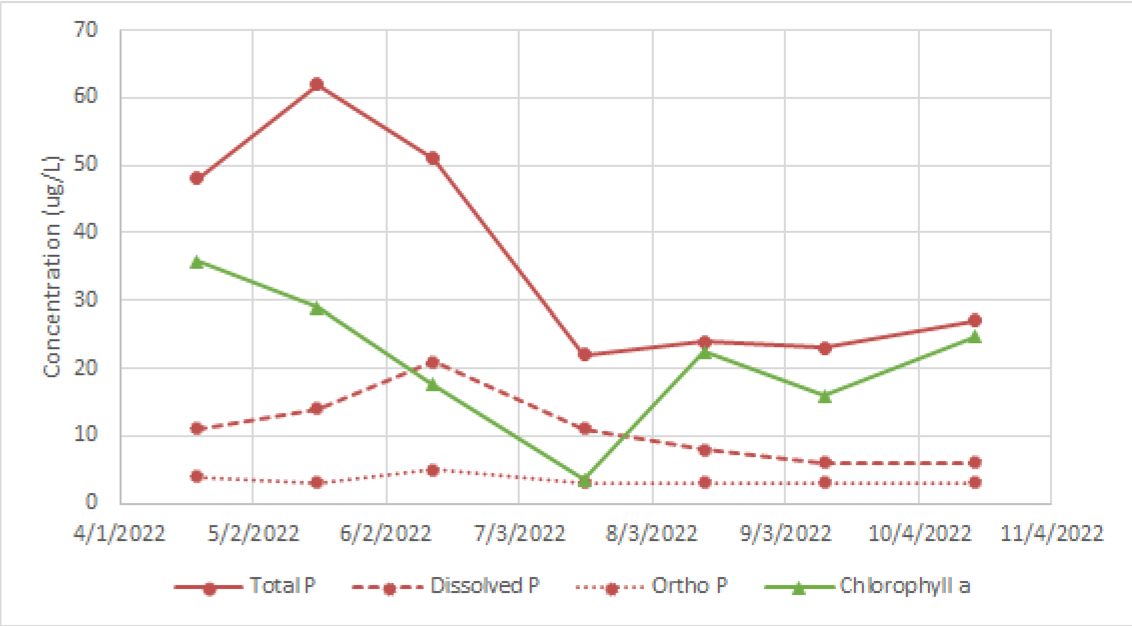


Figure 3-31 Taft Lake Surface 2022 Phosphorus and Chlorophyll-a Concentrations

Summer averages (June-September) of total phosphorus, chlorophyll-a, and Secchi disk transparency are shown on Figure 3-32 for years 2010–2022. Only two samples were collected for total phosphorus in 2009, with concentrations of 300 µg/L and 360 µg/L, resulting in a 2009 summer average that is three times higher than other years, and does not appear to be representative. Therefore, the 2009 summer average is not included on Figure 3-32. Chlorophyll-a and Secchi disc transparency were not monitored in 2009 and

2010, but have been monitored for the period of 2011-2022. The summer averages on Figure 3-32 are compared to the MPCA eutrophication standards for deep lakes in the Northern Central Hardwoods ecoregion.

The 2022 summer average of total phosphorus was 30 µg/L, the best on record for Taft Lake and less than half that observed just 2 years ago (76 µg/L in 2020). The 2022 summer average of total phosphorus was also better than the deep lake standard of 40 µg/L; the Taft Lake summer average total phosphorus has been below the standard four out of the last thirteen years. The 2022 summer average of chlorophyll-a (15 µg/L) was slightly higher than the standard (14 µg/L). The 2022 average of Secchi disk transparency was 1.4 meters, which is equal to the standard (1.4 meters).

Although the Taft Lake 2021 and 2022 summer averages of total phosphorus were better than the standard, chlorophyll-a concentrations and Secchi disk transparency continued to be worse than standards. Over the 13 year period (2010-2022) that Taft Lake has been monitored, the lake has generally had poor water quality with high nutrient concentrations and algae blooms. Summer averages of total phosphorus have been worse than the water quality standard 9 out of the past 13 years, while summer averages of chlorophyll-a and Secchi disk transparency have also been worse than the respective standards in most years. Waterbodies that are impaired due to eutrophication (i.e., phosphorus) can be added to the Minnesota Pollution Control Agency's 303(d) list of impaired waters.

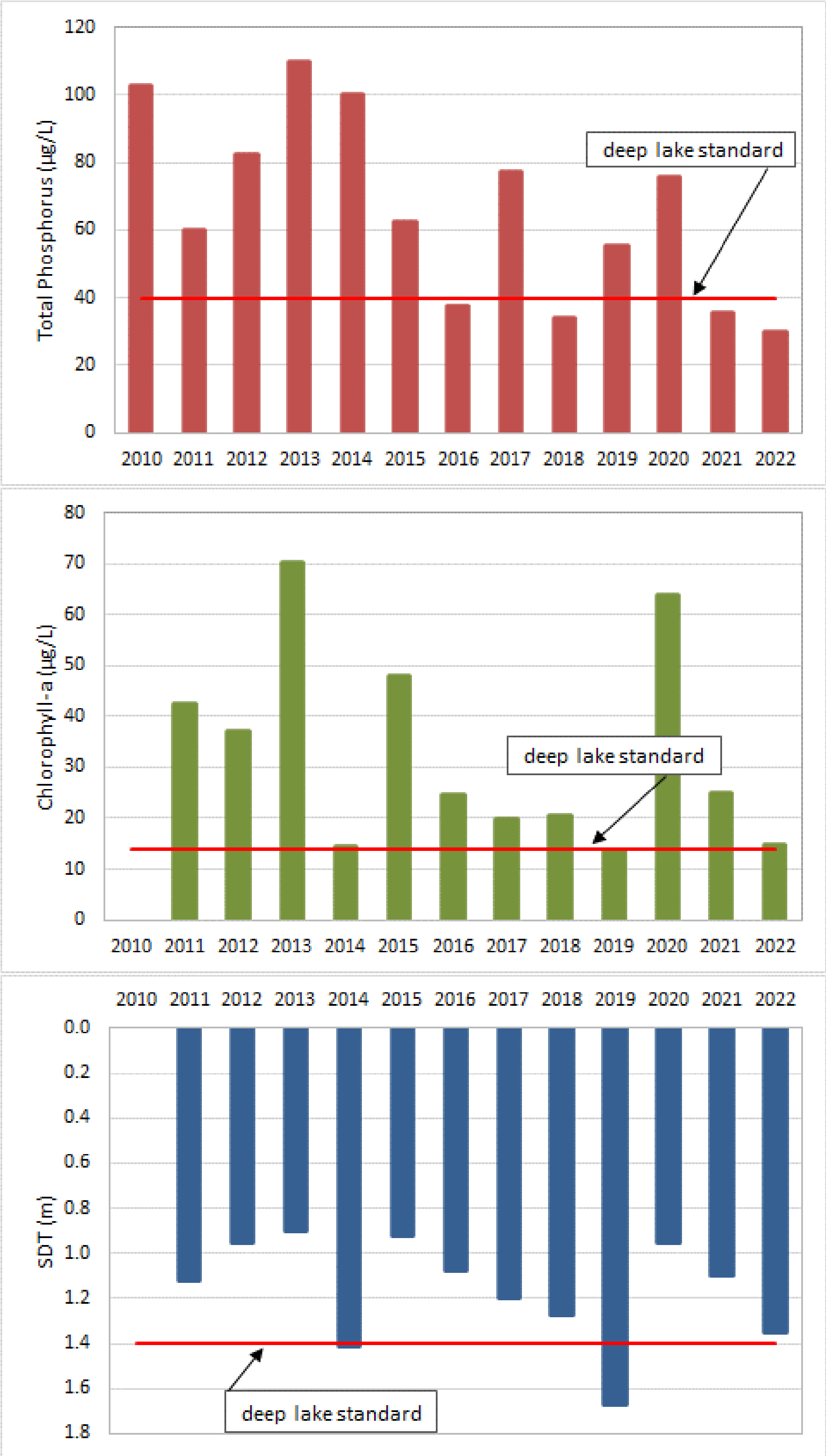


Figure 3-32 Taft Lake Summer Averages of Total Phosphorus, Chlorophyll-a, and Secchi Disk Transparency (SDT) (2010–2022)

3.7.2 Taft Lake Water Level

Taft Lake water levels measured in 2022 are shown in Figure 3-33, along with daily precipitation.

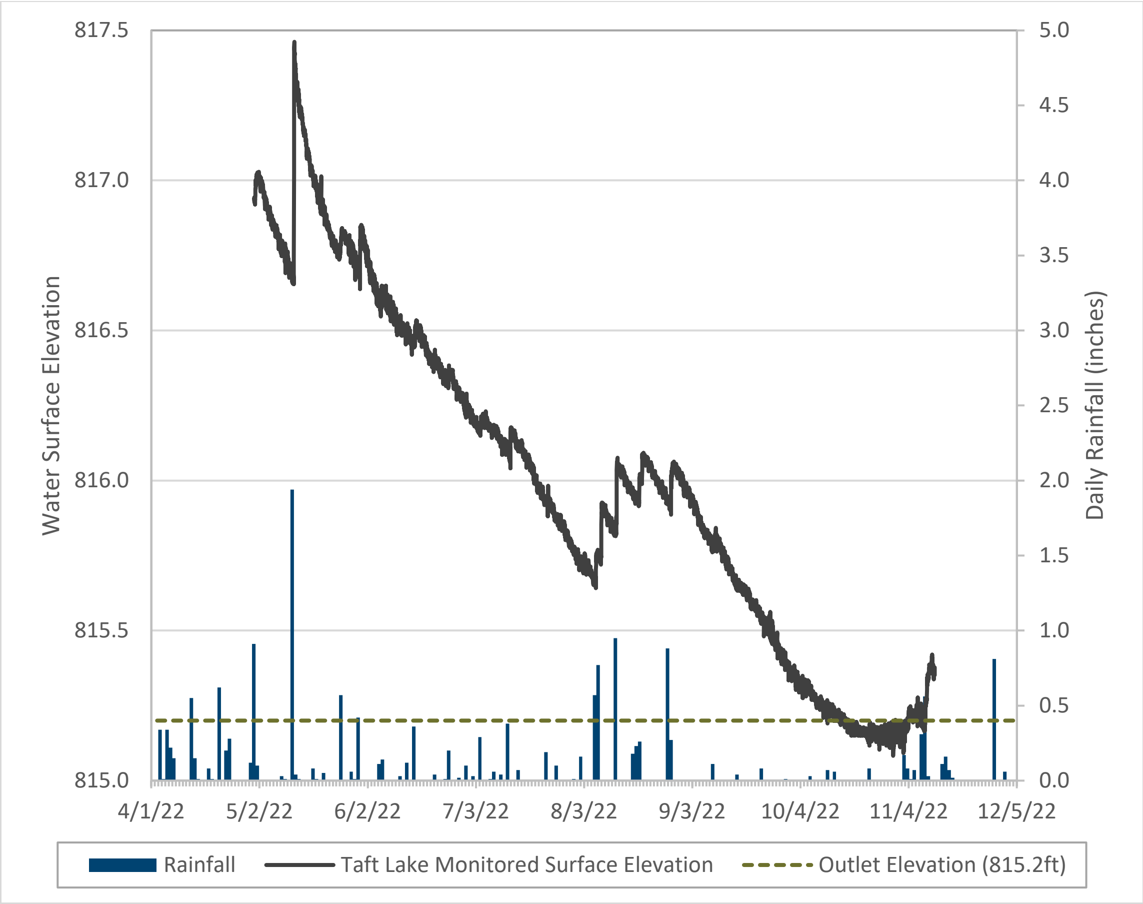


Figure 3-33 Taft Lake Monitored Water Level

3.7.3 Taft Lake Subsurface Infiltration System

In 2015/2016, the City of Richfield installed a subsurface infiltration system north of Taft Lake. The purpose of the system is to increase infiltration to groundwater and thereby reduce the phosphorus export from Taft Lake downstream to Lake Nokomis. The system was not operated in 2018 due to Minnesota Department of Transportation construction in the area. The volumes of water pumped to the infiltration system each year are summarized in Table 3-12.

Table 3-12 Taft Lake Infiltration System Pumped Volumes

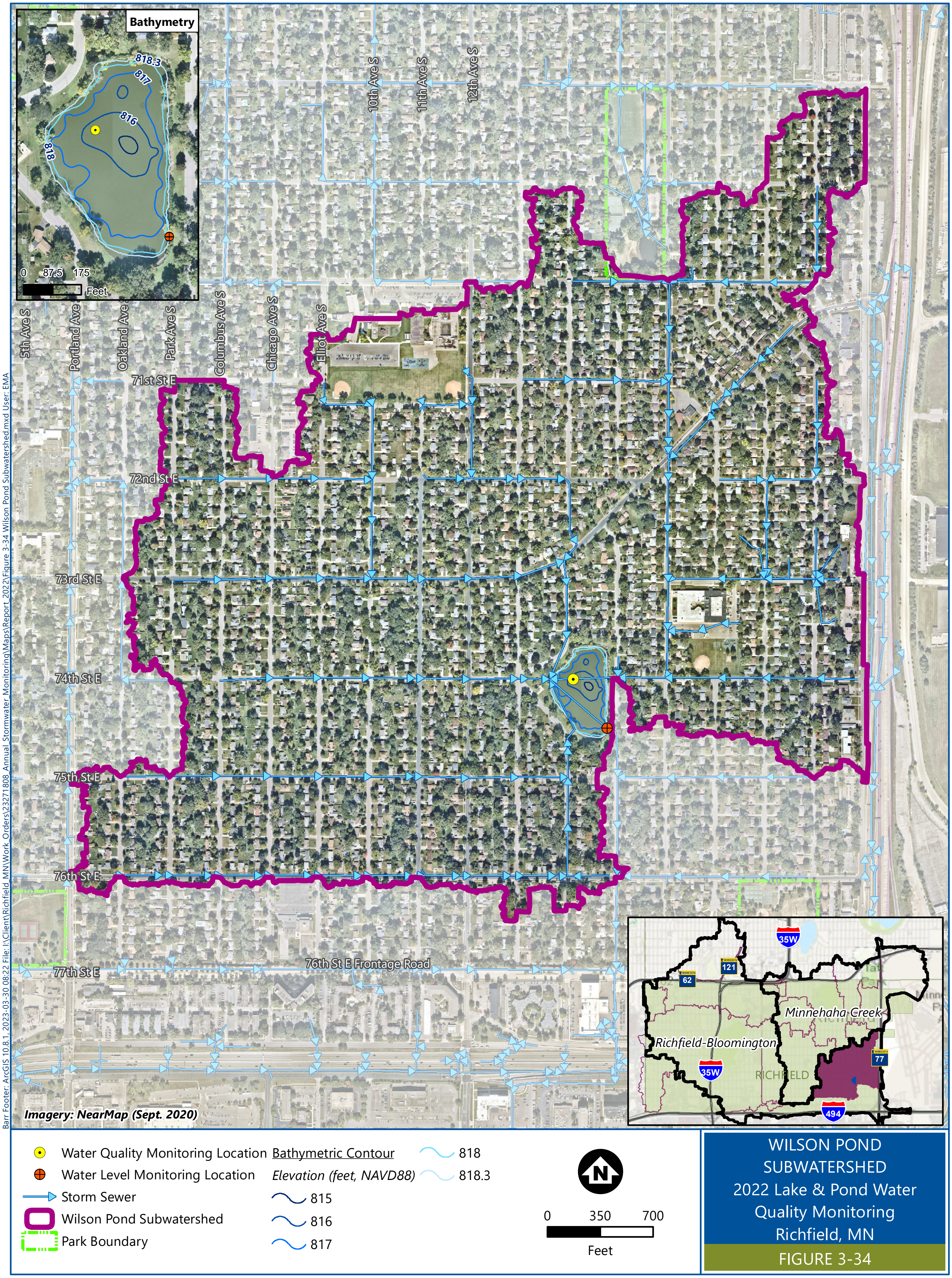
Year	Taft Lake Infiltration Pumped Volume (ac-ft)
2016	50
2017	17
2018	0
2019	28
2020	27
2021	5
2022	85.5

3.8 Wilson Pond

Wilson Pond is an 4.2-acre stormwater pond. The Wilson Pond watershed is shown on Figure 3-34. Characteristics of the waterbody and its watershed are summarized in Table 3-13. The pond is mostly open water, and drains through an outlet on the east shore of the pond. The outlet has a weir structure, and the elevation of the weir was measured at 820.74 ft by Barr staff in 2022. Water samples were collected at one location, in the center of the pond, as shown on Figure 3-34.

Table 3-13 Wilson Pond Characteristics

Waterbody Characteristics	Wilson Pond
Waterbody classification	Stormwater Pond
Watershed area	474 acres
Surface area	4.2 acres
Maximum depth	1.1 meters (3.8 feet)
Outlet elevation	820.58 ft (NAVD88) downstream pipe invert elevation; 820.74 ft (NAVD88) at outlet weir elevation



WILSON POND SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN
FIGURE 3-34

Barr Footer: ArcGIS 10.8.1, 2023-03-30 08:22 File: I:\Client\Richfield_MN\Work_Orders\23271808_Annual_Stormwater_Monitoring\Maps\Report_2022\Figure 3-34 Wilson Pond Subwatershed.mxd User: EMA

3.8.1 Wilson Pond Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a for Wilson Pond are shown on Figure 3-35 for Wilson Pond. Concentrations of total phosphorus and chlorophyll-a were lowest in May, and highest in July.

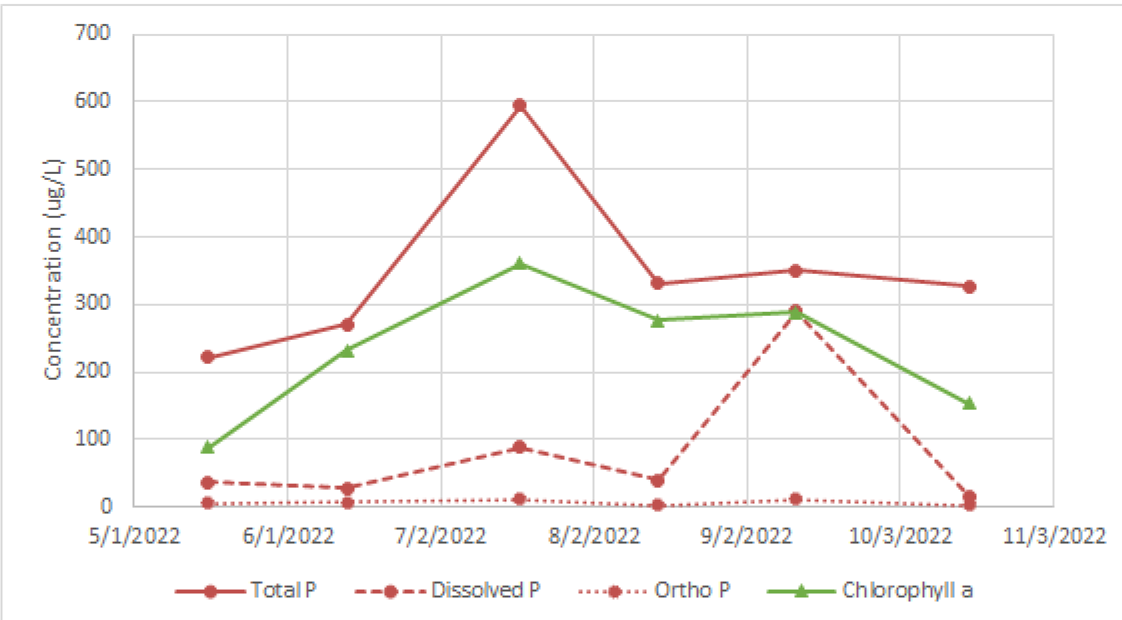
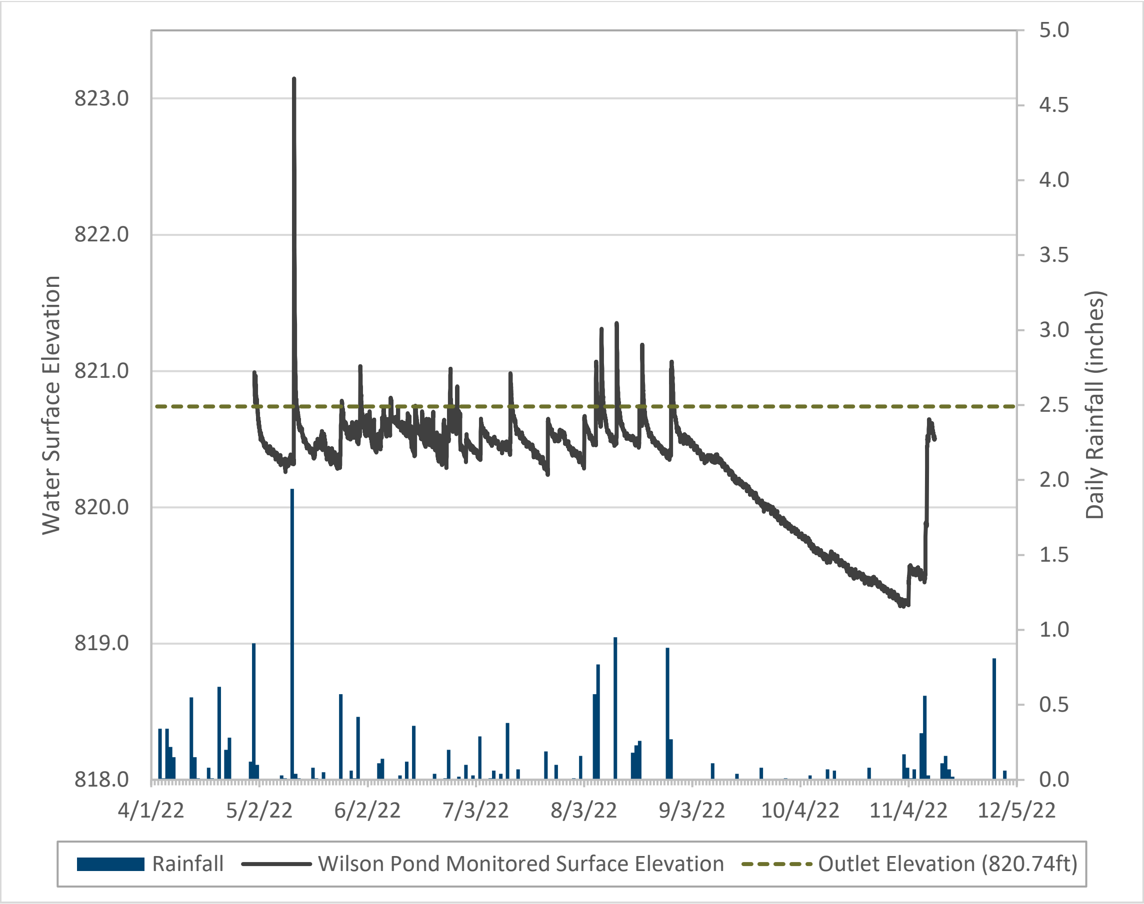


Figure 3-35 Wilson Pond 2022 Phosphorus and Chlorophyll-a Concentrations

The 2022 summer averages (June–September) of total phosphorus (387 µg/L) and chlorophyll-a (289 µg/L) are not graphed, as 2022 was the first year water quality was monitored. The Minnesota Stormwater Manual summarizes several studies of stormwater pond pollutant concentrations, and outflow concentrations of phosphorus from stormwater ponds were found to typically be in the range of 75 µg/L (25^{th} percentile) to 200 µg/L (75^{th} percentile) (Reference (1)). The 2022 total phosphorus concentrations in Wilson Pond are considerably higher than that 75^{th} percentile concentration of 200 µg/L.

3.8.2 Wilson Pond Water Level

A staff gage and level logger were installed in Wilson Lake for the first time in 2022 to measure pond water surface elevations. Wilson Pond water levels measured in 2022 are shown on Figure 3-36, along with daily precipitation. The water levels were below the outlet weir elevation for most of the 2022 monitoring season, and water levels dropped to nearly 1ft below the weir elevation by the end of October.



Note: Outlet elevation based on survey of outlet structure weir in 2022.

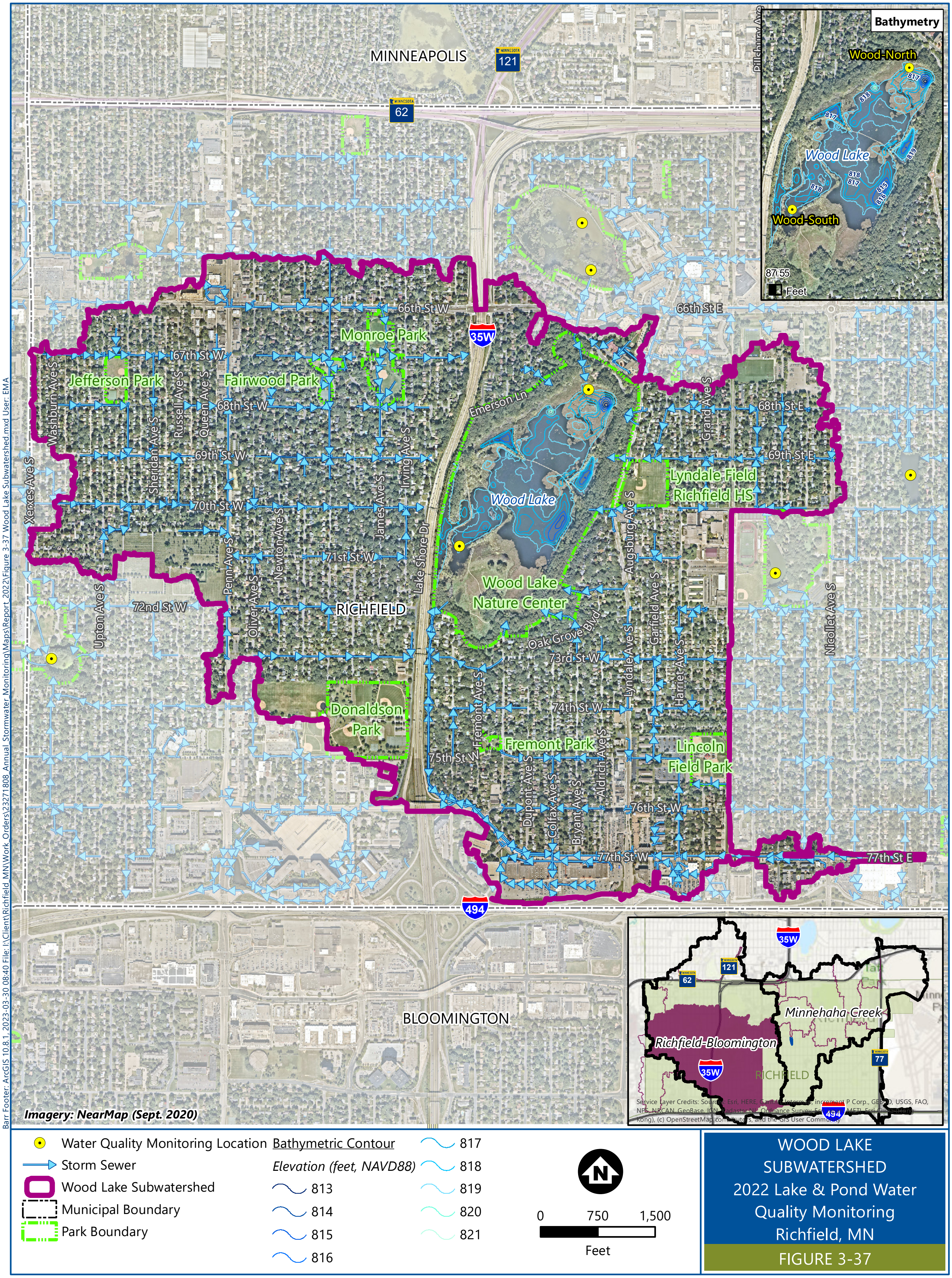
Figure 3-36 Wilson Pond Monitored Water Level

3.9 Wood Lake

Wood Lake is an 85-acre shallow lake. The Wood Lake watershed is shown on Figure 3-37. Characteristics of the waterbody and its watershed are summarized in Table 3-14. Wood Lake is surrounded by the Wood Lake Nature Center, which includes pedestrian trails that circle the lake and a floating boardwalk that crosses the lake. The lake is mostly open water, but large areas of dense cattail growth are present in multiple locations. Water samples were collected at two locations, as shown on Figure 3-37.

Table 3-14 Wood Lake Characteristics

Waterbody Characteristics	Wood Lake
Waterbody classification	Shallow lake
Watershed area	1,309 acres
Surface area	85 acres
Maximum depth	1.0 meters (3.3 feet)
Outlet elevation	818.62 ft (NAVD88) weir elevation; 820.48 ft pump off elevation



WOOD LAKE SUBWATERSHED
2022 Lake & Pond Water Quality Monitoring
Richfield, MN

FIGURE 3-37

3.9.1 Wood Lake Water Quality

2022 measurements of total phosphorus, dissolved phosphorus, ortho-phosphorus, and chlorophyll-a are shown on Figure 3-38 and Figure 3-39 for Wood Lake (North) and Wood Lake (South), respectively. Concentrations of total phosphorus increased dramatically from June to July in both Wood Lake (North) and Wood Lake (South), and then decreased quickly again by August. Concentrations continued to decline in Wood Lake (North) through October, but increased again in September and October in Wood Lake (South).

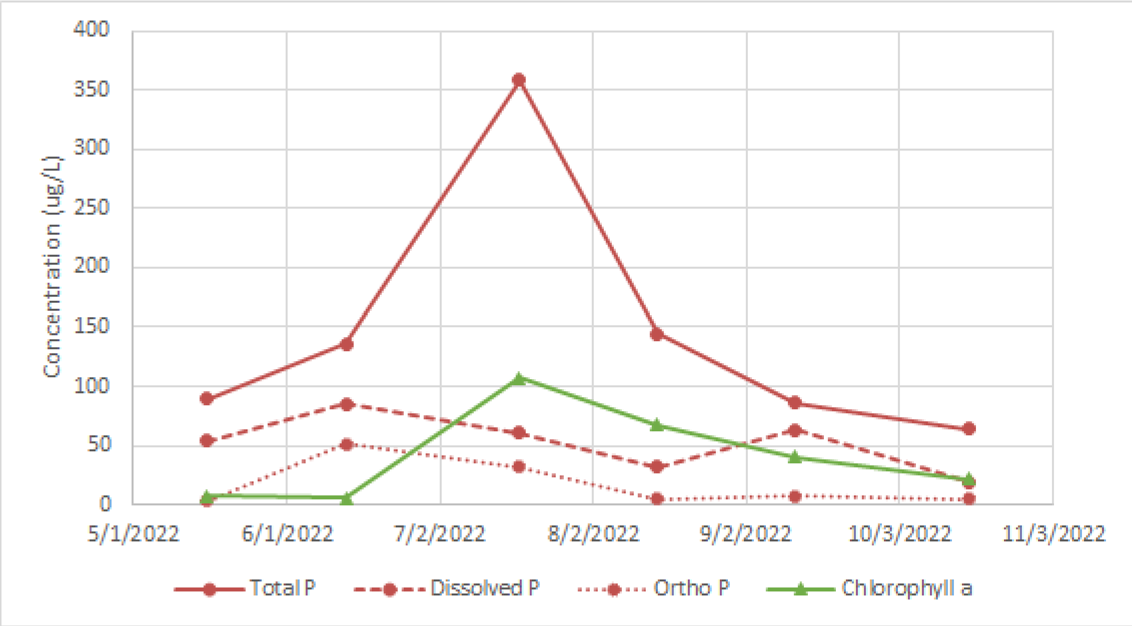


Figure 3-38 Wood Lake (North) 2022 Phosphorus and Chlorophyll-a Concentrations

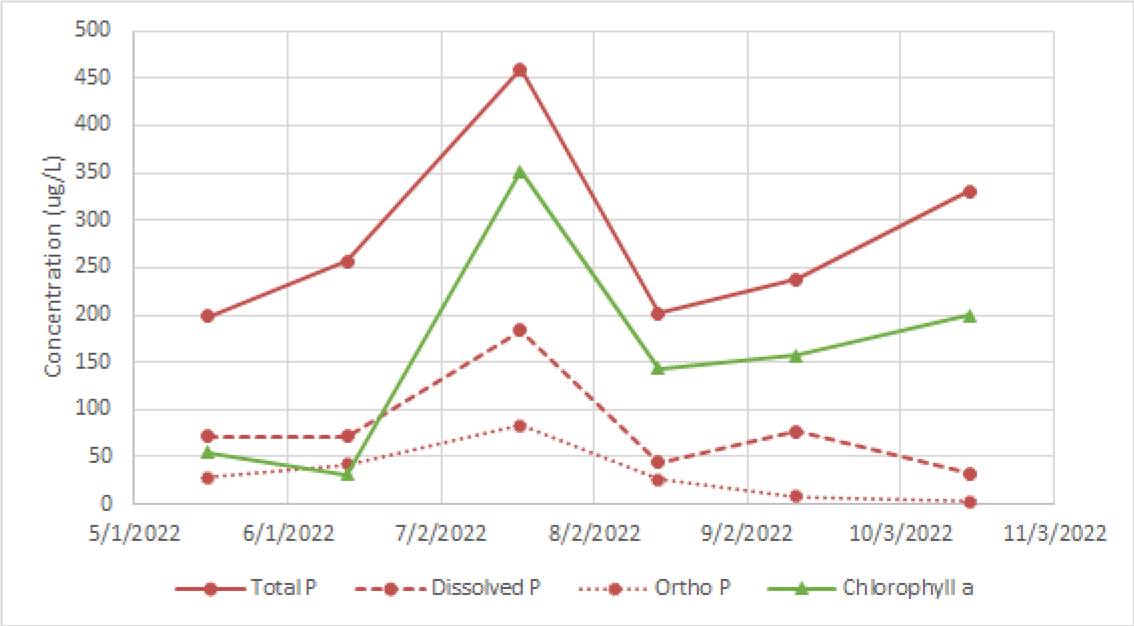


Figure 3-39 Wood Lake (South) 2022 Phosphorus and Chlorophyll-a Concentrations

Summer averages (June–September) of total phosphorus and chlorophyll-a for Wood Lake (North) and Wood Lake (South) are included on Figure 3-40 and Figure 3-41. The 2022 summer averages of total phosphorus increased relative to 2020 and 2021 summer averages for both Wood Lake (North) and Wood Lake (South). The 2020 summer averages were the lowest on record for both Wood Lake (North) and Wood Lake (South). The summer averages of total phosphorus were compared to the shallow lake standard of 60 µg/L. Summer averages of total phosphorus have been higher than the phosphorus standard for all years monitored in Wood Lake (North) and Wood Lake (South), with concentrations more than double the water quality standard in most years. The 2022 summer average of chlorophyll-a was 55 µg/L for Wood Lake (North), and 171 µg/L for Wood Lake (South), well above the shallow lake standard (20 µg/L) at both locations. The Secchi disk was still visible resting on aquatic vegetation on one or occasions in both Wood Lake (North) and Wood Lake (South) in 2022; therefore, summer averages of Secchi disk transparency were not calculated. Secchi disk transparency and chlorophyll-a data were not collected in Wood Lake prior to 2020.

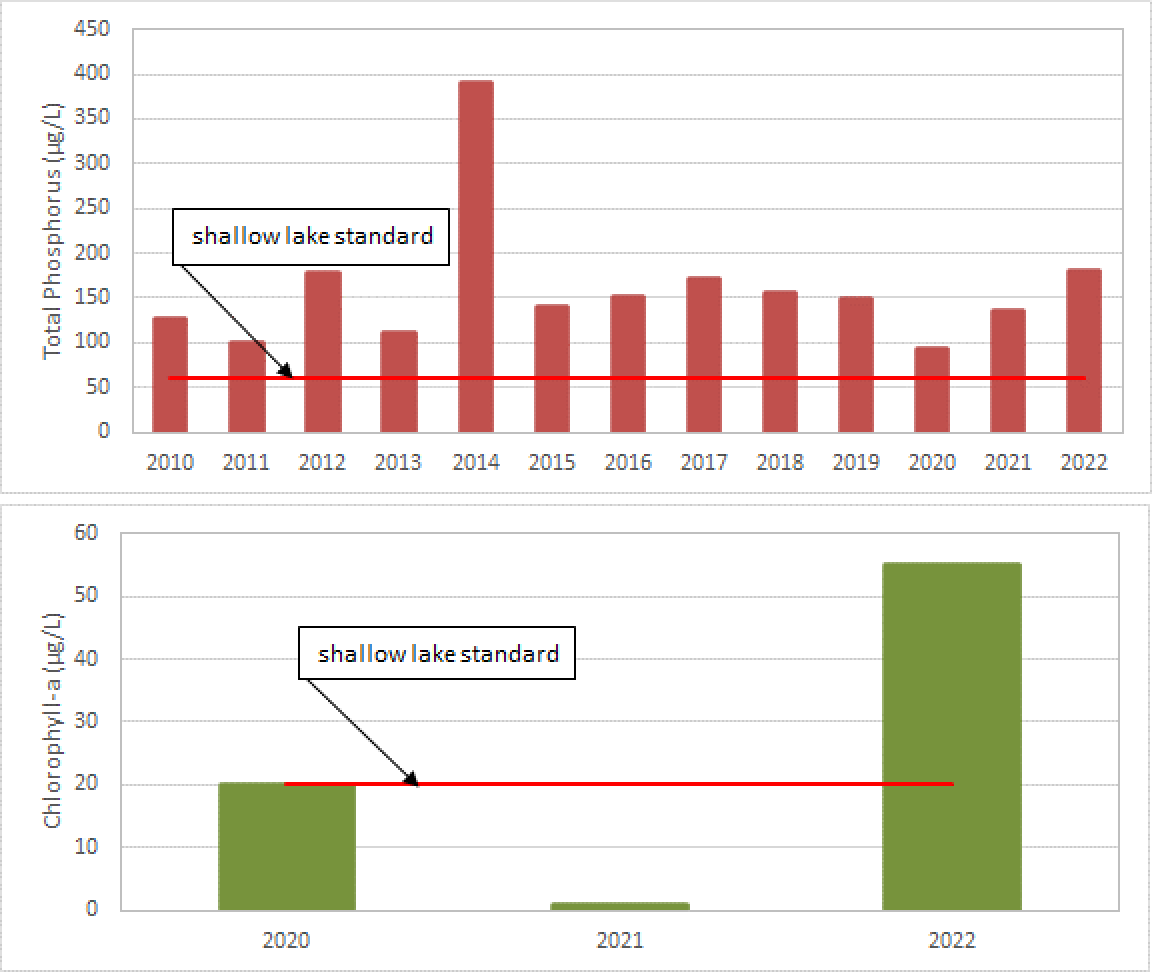


Figure 3-40 **Wood Lake (North) Summer Averages of Total Phosphorus (2010 – 2022) and Chlorophyll-a (2020 –2022)**

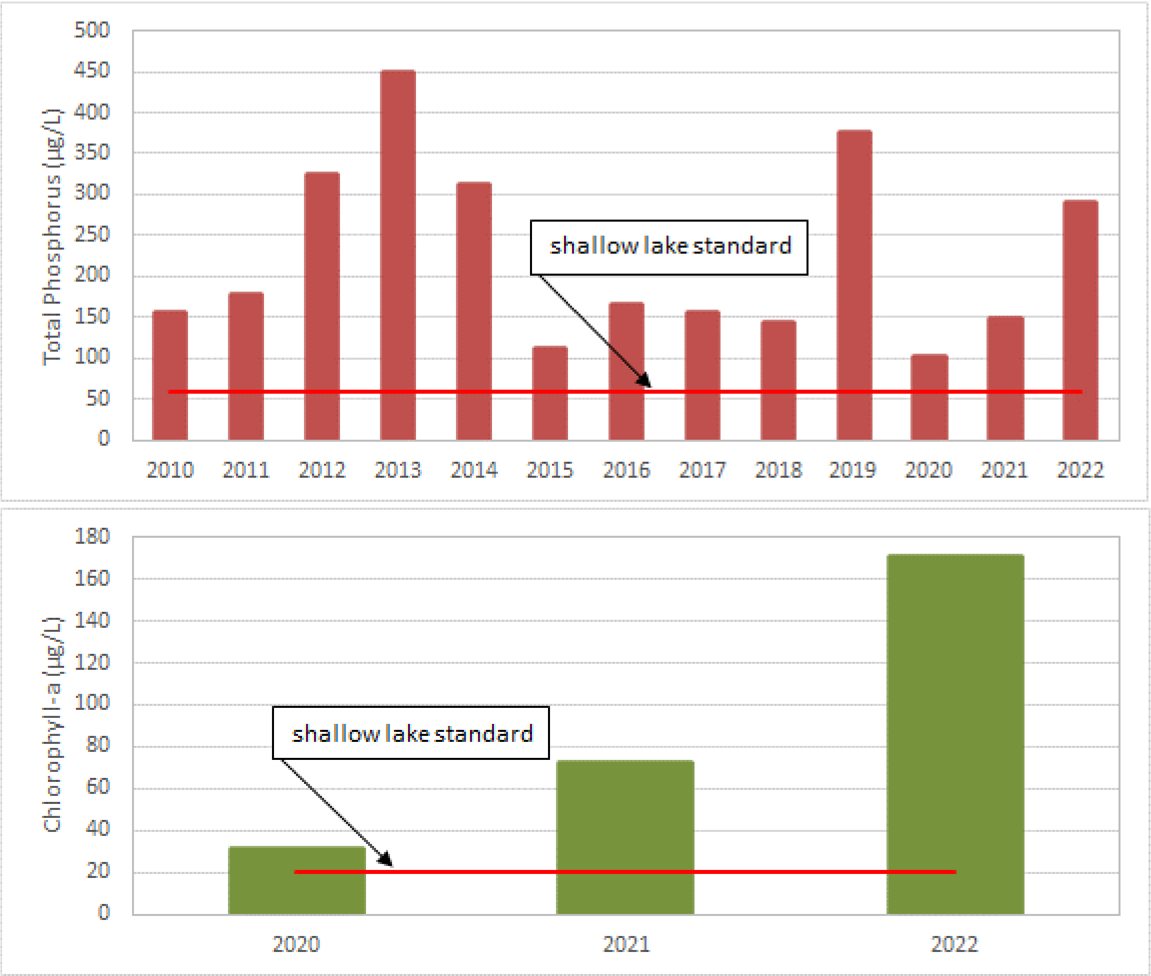
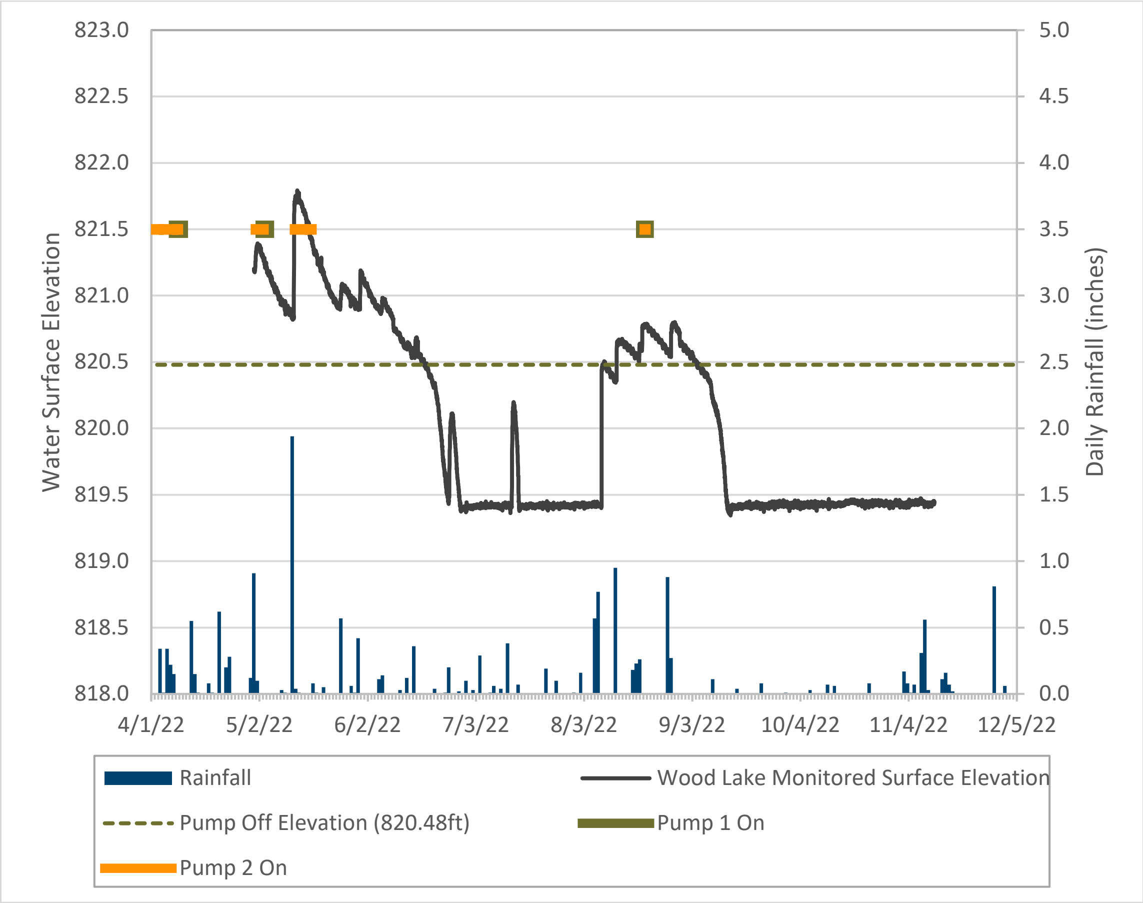


Figure 3-41 Wood Lake (South) Summer Averages of Total Phosphorus (2010 – 2022) and Chlorophyll-a (2020–2022)

3.9.2 Wood Lake Water Level

Wood Lake water levels measured in 2022 are shown on Figure 3-42, along with daily precipitation. The water level dropped below the bottom of the staff gage and elevation that the water sensor was installed, during dry periods in July and September-October. The water level dropped by more than 2 feet from it's season high in mid-May to its season low in late-summer.

As shown on Figure 3-42 pumping data indicates, very little pumping occurred from Wood Lake during the 2022 monitoring season.



Note: "Pump on" data is shown for timing purposes but is not tied to a vertical elevation.

Figure 3-42 Wood Lake Monitored Water Level

3.10 Chloride

Results of chloride monitoring for 2022 are presented on Figure 3-43 for all lakes and ponds monitored. Taft Lake was the only lake monitored in April, while all lakes were monitored for chloride in May-October. Chloride concentrations were not monitored during the winter and early spring when chloride concentrations are expected to be highest due to winter road salt use. Chloride concentrations are expected to decline in summer as runoff dilutes the chloride from winter road salt use. However, several ponds experienced higher chloride concentrations in summer months in 2022 compared to May 2022 concentrations. Adams Hill Pond experienced the highest chloride concentrations in October, and was the one chloride measurement in 2022 that exceeded the 230 mg/L chronic standard. In 2021, concentrations were above Minnesota's chronic chloride standard of 230 mg/L for the May sampling event in several lakes: Adams Hill Pond, Legion (North), Richfield Lake (North), Richfield Lake (South), Wood Lake (North), and Wood Lake (South). Chloride concentrations had remained above the 230 mg/L threshold into June 2021 for Adams Hill Pond and Wood Lake (South), and even into August 2021 in Wood Lake (North). Concentrations have exceeded the chronic chloride standard for several waterbodies during May sampling events conducted in previous years. Generally, the smaller stormwater ponds had lower chloride concentrations than the lakes for the months monitored in 2022, with the exception of Adams Hill Pond. This is to be expected, given their relatively small volume-to-watershed area, which allows for more rapid flushing with summer runoff. The road salt use practices in the watershed would also impact the chloride concentrations in ponds and lakes (e.g. higher road salt use on major highways and commercial parking lots relative to residential streets).

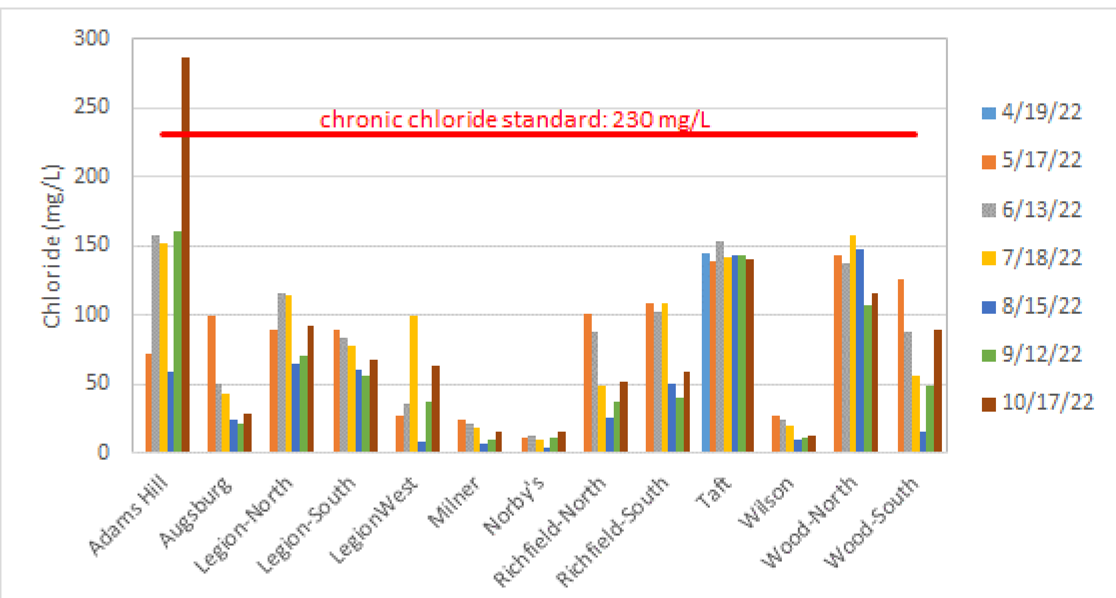


Figure 3-43 2022 Chloride Results

4 Conclusions

Water quality in stormwater ponds, shallow lakes, and wetlands tends to be highly variable from year to year, due to variations in precipitation. The date of ice out and other climate variations can also influence water quality. Several of the Richfield lakes and ponds had worse water quality in 2022 compared to years 2020-2021 (as measured by total phosphorus concentrations); however, it should be noted that 2020 had some of the best water quality on record for several basins.

Overall, the shallow lakes and ponds monitored in 2022 demonstrated lower total phosphorus concentrations during spring and early-summer, and highest concentrations in mid- to late-summer (i.e. July-Sept). It is likely many of the ponds and shallow lakes are experiencing significant internal loading of phosphorus during warm summer months, leading to a build up of phosphorus and algae in the lakes and ponds during the dry summer months of 2022. Adams Hill Pond was covered by dense watermeal and duckweed by the June 13 sampling event, and remained mostly covered throughout the summer months. Legion Lake (North) had areas of dense watermeal/duckweed in August, and Legion Lake (West) was largely covered in watermeal/duckweed during August and September monitoring events. The low water levels in Wood Lake and Richfield Lake in Late-Summer and Fall 2022 resulted in exposed lake bottom in shallow areas of the lakes. The shrinking shoreline and exposed lake bottom can be clearly seen in the 2022 photographs for Wood Lake (South) in Attachment B.

Water levels were lower in all lakes in 2022 compared to years 2020-2021. The Twin Cities experienced a period of record setting high precipitation in years 2019-2020, resulting in high water levels in many lakes and wetlands, as well as rising shallow groundwater table. Precipitation was below average in 2021 and 2022, and water levels in several of the Richfield Lakes fell below normal outlet elevations for portions of the last two monitoring season. Late summer 2022 was especially dry, and lake levels dropped to the lowest levels observed in the most recent three years of lake level monitoring. Legion Lake did not have outflow (as measured at the outlet channel weir structure) for most of the 2022 monitoring season, and very little pumping occurred in Legion Lake. Richfield Lake had water levels below the outlet elevation for much of July, September, and October 2022. Taft Lake water levels remained above the outlet elevation through September, but did drop below the outlet elevation for much of October.

The 2022 summer average of total phosphorus in Taft Lake was lower than previous years, and better than the phosphorus standard for deep lakes. However, the 2022 summer average of chlorophyll-a continued to be slightly worse than water quality standard, and Secchi disk transparency was equal to the standard. The aeration system continued to operate in 2022, and more consistently than in previous years, resulting in more mixed lake conditions and higher oxygen concentrations in deep areas of the lake. The Taft Lake alum treatment system continued to operate in 2022 as well, removing phosphorus from Taft Lake and returning treated water back to the lake. Oxygen concentrations were less than 5 mg/L throughout the water column during the July monitoring event, which could stress the fish community. Low oxygen conditions (<2 mg/L) near the lake bottom can also result in the release of phosphorus from the sediment, as iron that binds with phosphorus is reduced from ferric iron (Fe[III] oxidation state) to the more soluble ferrous iron (Fe[II] oxidation state) form.

Barr recommends continued monitoring of the Richfield lakes and ponds in 2023 for the months of May–October, similar to monitoring conducted in 2020-2022. Water quality monitoring would be conducted once a month from May–October, and water levels would be monitored continuously for several waterbodies by deploying water level data loggers (see Table 1-1). Barr also recommends consideration of additional monitoring for Taft Lake, to provide better understanding of the redox chemistry and nutrient cycling (i.e. internal loading of phosphorus) that is occurring within the lake, which would in turn help guide optimization of the aeration system and alum treatment system on Taft Lake. There are two primary inflows to Taft Lake: 1) the stormwater inflow in the southwest corner of the lake that includes the local Taft Lake watershed and Legion Lake outflow; and 2) the outflow from Mother Lake to the east shore of Taft Lake. The watershed of Mother Lake includes the large commercial shopping area (including Target and Home Depot) to the south of Taft Lake, the adjacent Hwy 77 corridor, and the northwest end of the airport runway.

5 References

1. **Minnesota Pollution Control Agency.** Stormwater Pond Outflow Concentrations and Pollutant Removals. [Online] https://stormwater.pca.state.mn.us/index.php?title=Stormwater_pond_outflow_concentrations_and_pollutant_removals.

2. **Minnesota Department of Natural Resources.** LakeFinder. *Minnesota Department of Natural Resources.* [Online] https://www.dnr.state.mn.us/lakefind/index.html.

Attachment A

Tabulated 2022 Water Quality Monitoring Data

Table A1. Adams Hill Pond 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.4	0.5	0-1	--	--	--	--	31.4	0.296	0.066	0.12	8.0	4.8	72
		--	0.0	0.5	19.0	338	6.50	--	--	--	--	--	--	--
		--	1.0	0.4	18.4	450	6.33	--	--	--	--	--	--	--
6/13/2022	1.5	0.9	0-1	--	--	--	--	8.3	0.384	0.123	0.145	4.8	3.2	157
		--	0.0	1	21.8	567	6.85	--	--	--	--	--	--	--
		--	1.0	0.4	19.4	1028	6.90	--	--	--	--	--	--	--
7/18/2022	1.5	0.4	0-1	--	--	--	--	63.2	0.209	0.030	0.078	11.7	10.3	152
		--	0.0	0.5	23.2	548	7.00	--	--	--	--	--	--	--
		--	1.0	0.5	20.4	1160	6.79	--	--	--	--	--	--	--
8/15/2022	1.5	0.5	0-1	--	--	--	--	54.3	0.143	0.015	0.033	8.0	6.4	59
		--	0.0	2.0	19.5	305	7.73	--	--	--	--	--	--	--
		--	1.0	1.0	19.4	725	6.89	--	--	--	--	--	--	--
9/12/2022	1.5	0.4	0-1	--	--	--	--	58.7	0.296	0.041	0.254	10.3	8.3	160
		--	0.0	17.6	17.6	760	6.90	--	--	--	--	--	--	--
		--	1.0	17.8	17.8	1090	6.77	--	--	--	--	--	--	--
10/18/2022	1.5	1.0	0-1	--	--	--	--	<1.0 [1]	0.360	0.249	0.309	1.3	1.0	287
		--	0.0	2.5	6.5	1387	7.67	--	--	--	--	--	--	--
		--	1.0	2.2	6.5	1388	7.58	--	--	--	--	--	--	--

Notes

<1.0 [1] - Concentration is below the laboratory's method detection limit.

Table A2. Augsburg Pond 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.8	0.5	0-1.5	--	--	--	--	88.1	0.283	0.192	0.302	41	26	100
		--	0.0	9.8	20.7	237	7.87	--	--	--	--	--	--	--
		--	1.0	5.8	19.7	255	7.53	--	--	--	--	--	--	--
		--	1.5	1.3	16.1	560	6.79	--	--	--	--	--	--	--
6/13/2022	1.5	0.4	0-1	--	--	--	--	81.9	0.272	0.027	0.072	14.0	12.7	50.6
		--	0.0	5.2	23.3	249	7.58	--	--	--	--	--	--	--
		--	1.0	1.7	22.6	250	7.16	--	--	--	--	--	--	--
7/18/2022	1.7	0.25	0-1	--	--	--	--	264	0.299	0.006	0.026	25	23	43.0
		--	0.0	13.8	28	231	9.77	--	--	--	--	--	--	--
		--	1.0	0.6	24.3	251	6.91	--	--	--	--	--	--	--
8/15/2022	1.8	0.25	0-1.5	--	--	--	--	198	0.239	< 0.003	0.029	24	22	24.1
		--	0	12.1	21.8	158	8.72	--	--	--	--	--	--	--
		--	1.0	6.0	21.2	158	7.54	--	--	--	--	--	--	--
		--	1.5	0.7	20.4	313	6.24	--	--	--	--	--	--	--
9/12/2022	1.8	0.15	0-1.5	--	--	--	--	294	0.405	< 0.003	0.027	48	44	21.3
		--	0	11.0	20.4	145	7.65	--	--	--	--	--	--	--
		--	1.0	4.8	18.9	144	7.11	--	--	--	--	--	--	--
		--	1.5	3.6	18.7	144	6.83	--	--	--	--	--	--	--
10/17/2022	1.6	0.1	0-1	--	--	--	--	417	0.575	< 0.003	0.019	78	74	29.2
		--	0	8.1	7.1	187	8.21	--	--	--	--	--	--	--
		--	1.0	7.7	7.1	187	8.00	--	--	--	--	--	--	--

Notes

<2.22 [1] - Concentration is below the laboratory's method detection limit.

Table A3. Legion Lake (North) 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (℃)	Specific Conductivity (µS/cm @ 25℃)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.8	1.1	0-1.5	--	--	--	--	10.1	0.097	0.012	0.039	4.0	3.2	90
		--	0.0	5.0	20.3	436	7.10	--	--	--	--	--	--	--
		--	1.0	4.5	19.9	443	7.07	--	--	--	--	--	--	--
		--	1.5	1.0	15.9	465	6.87	--	--	--	--	--	--	--
6/13/2022	1.8	1.0	0-1.5	--	--	--	--	49.8	0.148	0.010	0.038	14.0	10.6	115
		--	0.0	6.1	23.9	480	7.70	--	--	--	--	--	--	--
		--	1.0	5.2	23.7	506	7.54	--	--	--	--	--	--	--
		--	1.5	0.4	20.4	547	7.13	--	--	--	--	--	--	--
7/18/2022	1.8	1.2	0-1.5	--	--	--	--	52.3	0.121	0.010	0.028	10.0	8.0	114
		--	0.0	3.8	27.5	421	7.7	--	--	--	--	--	--	--
		--	1.0	5.4	25.9	469	8.03	--	--	--	--	--	--	--
		--	1.5	0.8	23.9	501	6.76	--	--	--	--	--	--	--
8/15/2022	1.8	0.35	0-1.5	--	--	--	--	70.8	0.173	0.013	0.05	11.0	9.5	65.5
		--	0.0	9.0	21.8	301	7.49	--	--	--	--	--	--	--
		--	1.0	1.0	20.5	318	6.95	--	--	--	--	--	--	--
		--	1.5	0.6	20.2	424	6.65	--	--	--	--	--	--	--
9/12/2022	1.8	0.9	0-1.5	--	--	--	--	51.6	0.083	0.025	0.022	8.8	7.2	71.2
		--	0.0	7.1	21.1	352	7.54	--	--	--	--	--	--	--
		--	1.0	3.1	18.9	352	7.19	--	--	--	--	--	--	--
		--	1.5	1.5	18.8	385	6.32	--	--	--	--	--	--	--
10/17/2022	1.5	1.3	0-1	--	--	--	--	21.4	0.043	< 0.003 [1]	0.026	3.6	2.8	91.7
		--	0.0	12.0	5.6	436	7.94	--	--	--	--	--	--	--
		--	1.0	11.9	5.7	437	8.30	--	--	--	--	--	--	--

Notes

<0.003 [1] - Concentration is below the laboratory's method detection limit.

Table A4. Legion Lake (South) 2021 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.8	0.6	0-1.5	--	--	--	--	37.4	0.121	0.009	0.032	7.3	7.3	89.0
		--	0.0	8.5	22.0	389	7.45	--	--	--	--	--	--	--
		--	1.0	8.0	21	383	7.41	--	--	--	--	--	--	--
		--	1.5	2.2	19.3	412	7.19	--	--	--	--	--	--	--
6/13/2022	1.8	0.45	0-1.5	--	--	--	--	68.4	0.124	0.003	0.024	10.8	10.0	84.1
		--	0.0	10.3	23.7	358	8.92	--	--	--	--	--	--	--
		--	1.0	10	23.6	361	8.91	--	--	--	--	--	--	--
		--	1.5	0.9	21.1	386	7.63	--	--	--	--	--	--	--
7/18/2022	1.6	0.85	0-1	--	--	--	--	40.6	0.102	0.005	0.023	8.3	7.3	77.8
		--	0.0	11.9	29.7	354	9.34	--	--	--	--	--	--	--
		--	1.0	10.1	27.9	358	8.98	--	--	--	--	--	--	--
8/15/2022	1.8	0.5	0-1.5	--	--	--	--	183	0.180	0.003	0.022	16.7	14.7	60.4
		--	0	11.6	23.5	317	9.02	--	--	--	--	--	--	--
		--	1.0	5.5	22.2	324	7.90	--	--	--	--	--	--	--
		--	1.5	0.7	21.9	328	7.32	--	--	--	--	--	--	--
9/12/2022	1.5	0.8	0-1	--	--	--	--	65.1	0.099	< 0.003 [1]	0.026	7.4	6.6	56.8
		--	0	11.1	22.6	302	8.82	--	--	--	--	--	--	--
		--	1.0	12.1	20.7	300	9.00	--	--	--	--	--	--	--
10/17/2022	1.5	0.7	0-1	--	--	--	--	60.1	0.056	< 0.003 [1]	0.028	9.4	8.0	68.0
		--	0	11.5	8.0	350	8.35	--	--	--	--	--	--	--
		--	1	11.4	7.5	350	8.35	--	--	--	--	--	--	--

Notes

<0.003 [1] - Concentration is below the laboratory's method detection limit.

Table A5. Legion Lake (West) 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (℃)	Specific Conductivity (µS/cm @ 25℃)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.2	0.5	0-1	--	--	--	--	61.4	0.300	0.025	0.066	15.0	13.0	26.9
		--	0.0	5.9	21.4	170	7.48	--	--	--	--	--	--	--
		--	1.0	0.4	19.1	186	6.98	--	--	--	--	--	--	--
6/13/2022	0.6	0.25	0.3	5.4	22.4	238	7.55	328	0.604	0.013	0.041	38	33	35.9
7/18/2022	1.5	0.25	0-1	--	--	--	--	312	0.862	0.248	0.636	52	40	99.2
		--	0.0	0.8	27.0	492	6.61	--	--	--	--	--	--	--
		--	1.0	0.6	21.1	1583	6.17	--	--	--	--	--	--	--
8/15/2022	0.6	0.3	0.3	5.6	21.9	100	7.80	128	0.288	< 0.003	0.066	23	20	8.1
9/12/2022	0.6	0.4	0.3	8.9	20.5	242	7.80	141	0.325	0.011	0.057	25	20	37.6
10/17/2022	1.2	0.3	0-1	--	--	--	--	206	0.467	0.035	0.080	28	24	63.5
		--	0.0	5	5.9	392	7.74	--	--	--	--	--	--	--
		--	1.0	3	6.5	422	7.22	--	--	--	--	--	--	--

<u>Notes</u>

<2.22 [1] - Concentration is below the laboratory's method detection limit.

Table A6. Milner Pond 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	0.8	0.5	0.4	9.6	21.0	132	7.78	68	0.178	0.016	0.058	27	19.0	23.8
6/13/2022	0.8	0.4	0.4	9.2	23.3	133	9.68	59	0.291	0.038	0.093	12.7	11.3	20.7
7/18/2022	0.8	>0.8 [2]	0.4	2.2	26.5	136	8.06	87	0.151	0.025	0.075	4.4	4.1	17.9
8/15/2022	0.8	0.35	0.4	4.6	21.4	91	7.63	238	0.384	0.007	0.038	36	33	7.1
9/12/2022	0.7	0.25	0.3	11.0	18.9	102	8.83	198	0.405	0.007	0.348	30	28	9.6
10/17/2022	0.4	0.15	0.2	12.8	5.8	144	8.73	292	0.528	0.007	0.199	48	42	15.7

Notes

<0.003 [1] - Concentration is below the laboratory's method detection limit.

>0.8 [2] - Secchi disk is visible on lake bottom

Table A7. Norby's Pond 2021 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (℃)	Specific Conductivity (µS/cm @ 25℃)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.0	0.4	0.5	5.1	20.6	106	7.35	103	0.44	0.019	0.090	22	20	11.9
6/13/2022	1.1	0.25	0.5	3.3	23.0	135	7.36	231	0.507	0.018	0.065	32	29	12.7
7/18/2022	0.9	0.15	0.5	0.7	25.5	125	6.98	701	0.540	0.004	0.041	54	46	10.4
8/15/2022	0.9	0.25	0.5	12.2	22.1	68	9.50	216	0.273	< 0.003 [1]	0.037	28	26	3.6
9/12/2022	1.0	0.2	0.5	9.1	18.2	119	7.76	317	0.418	0.006	0.348	48	46	10.9
10/17/2022	0.9	0.15	0.4	12.2	5.4	160	8.25	224	0.382	0.005	0.017	52	46	16.0

Notes

<0.003 [1] - Concentration is below the laboratory's method detection limit.

Table A8. Richfield Lake (North) 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (℃)	Specific Conductivity (µS/cm @ 25℃)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.5	0.6	0-1	--	--	--	--	44.7	0.119	0.018	0.037	6.3	5.1	101
		--	0.0	8.5	20.7	397	7.78	--	--	--	--	--	--	--
		--	1.0	6.4	20.2	404	7.60	--	--	--	--	--	--	--
6/13/2022	1.8	1.2	0-1.5	--	--	--	--	23.5	0.123	0.026	0.073	3.5	2.5	87.6
		--	0.0	5.8	23.8	376	8.09	--	--	--	--	--	--	--
		--	1.0	5.6	23.8	376	7.74	--	--	--	--	--	--	--
		--	1.5	3.6	23.8	377	7.60	--	--	--	--	--	--	--
7/18/2022	1.6	0.65	0-1	--	--	--	--	92.6	0.143	0.004	0.021	11.2	9.6	49.0
		--	0.0	10.9	28.1	240	9.41	--	--	--	--	--	--	--
		--	1.0	8.4	27.3	234	8.35	--	--	--	--	--	--	--
8/15/2022	1.8	0.6	0-1.5	--	--	--	--	109	0.134	0.003	0.022	11.6	9.6	25.8
		--	0.0	11.4	22.2	155	9.15	--	--	--	--	--	--	--
		--	1.0	6.0	21.5	154	7.74	--	--	--	--	--	--	--
		--	1.5	1.9	21.1	159	7.40	--	--	--	--	--	--	--
9/12/2022	1.6	0.15	0-1	--	--	--	--	470	0.309	0.008	0.040	41	37	37.7
		--	0	8.6	19.5	210	7.93	--	--	--	--	--	--	--
		--	1.0	6.2	19.1	209	7.49	--	--	--	--	--	--	--
10/17/2022	1.4	0.15	0-1	--	--	--	--	349	0.297	0.006	0.033	52	46	52.2
		--	0.0	11.6	5.3	295	8.44	--	--	--	--	--	--	--
		--	1.0	11.5	5.2	295	8.36	--	--	--	--	--	--	--

Notes
<2.22 [1] - Concentration is below the laboratory's method detection limit.

Table A9. Richfield Lake (South) 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (℃)	Specific Conductivity (µS/cm @ 25℃)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.5	0.8	0-1	--	--	--	--	32.6	0.110	0.008	0.032	5.5	4.2	108
		--	0.0	7.4	20.5	427	7.65	--	--	--	--	--	--	--
		--	1.0	6.8	20.2	423	7.52	--	--	--	--	--	--	--
6/13/2022	1.5	1.2	0-1	--	--	--	--	14.2	0.142	0.050	0.093	3.8	2.8	102
		--	0.0	7.2	23.9	414	7.71	--	--	--	--	--	--	--
		--	1.0	5.9	23.8	414	7.56	--	--	--	--	--	--	--
7/18/2022	1.4	0.9	0-1	--	--	--	--	58.7	0.115	0.008	0.023	7.4	6.0	109
		--	0.0	6.3	27.7	424	7.00	--	--	--	--	--	--	--
		--	1.0	0.6	26.4	407	6.75	--	--	--	--	--	--	--
8/15/2022	1.5	0.7	0-1	--	--	--	--	81.4	0.130	< 0.003	0.028	12.4	10.8	49.7
		--	0.0	7.8	21.8	258	7.64	--	--	--	--	--	--	--
		--	1.0	4.5	21.5	253	7.24	--	--	--	--	--	--	--
9/12/2022	1.2	0.2	0-1	--	--	--	--	328	0.261	0.007	0.039	34	32	40.7
		--	0.0	6.1	18.9	224	7.21	--	--	--	--	--	--	--
		--	1.0	2.4	18.7	227	6.81	--	--	--	--	--	--	--
10/17/2022	0.8	0.15	0.4	11.1	4.5	330	8.09	231	0.239	0.003	0.023	44	38	59.3

Notes

<2.22 [1] - Concentration is below the laboratory's method detection limit.

Table A10. Taft Lake 2022 Water Quality Monitoring Results

Date	Sample Depth (m)	Secchi Disk Trans-parency (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)	Total Iron (mgL)
4/19/2022	0-2	1.3	--	--	--	--	35.8	0.048	0.011	0.004	5.2	3.2	145	0.35
	0		12.2	6.4	721	7.30	--	--	--	--	--	--	--	--
	1		12.3	5.6	720	7.29	--	--	--	--	--	--	--	--
	2		12.1	5.4	718	7.29	--	--	--	--	--	--	--	--
	3		11.8	5.2	719	7.26	--	--	--	--	--	--	--	--
	4		11.3	5.1	719	7.23	--	--	--	--	--	--	--	--
	5		11.1	5.1	718	7.22	--	0.050	0.014	0.004	--	--	145	0.37
	6		11.1	5.1	717	7.22	--	--	--	--	--	--	--	--
	7		11.0	5.1	718	7.20	--	--	--	--	--	--	--	--
	8		11.0	5.1	718	7.21	--	0.049	0.015	0.003	--	--	160	0.38
	9		11.0	5.0	717	7.21	--	--	--	--	--	--	--	--
	10		11.0	4.9	723	7.19	--	--	--	--	--	--	--	--
	11		2.7	4.9	905	6.96	--	--	--	--	--	--	--	--
	12		0.8	5.1	1186	7.52	--	0.060	0.011	0.004	--	--	215	1.47
5/17/2022	0-2	1.0	--	--	--	--	28.9	0.062	0.014	0.003	5.0	5.0	139	0.24
	0		11.4	15.9	683	8.24	--	--	--	--	--	--	--	--
	1		11.4	15.8	682	8.21	--	--	--	--	--	--	--	--
	2		11.3	15.7	681	8.14	--	--	--	--	--	--	--	--
	3		10.5	15.4	681	8.00	--	--	--	--	--	--	--	--
	4		9.9	15.3	684	7.91	--	--	--	--	--	--	--	--
	5		9.9	15.3	684	7.93	--	0.049	0.012	<0.003 [1]	--	--	144	0.29
	6		9.4	15.2	683	7.90	--	--	--	--	--	--	--	--
	7		9.3	15.1	683	7.83	--	--	--	--	--	--	--	--
	8		9.2	15	683	7.83	--	0.048	0.013	<0.003 [1]	--	--	145	0.33
	9		8.8	14.8	682	7.78	--	--	--	--	--	--	--	--
	10		8.1	14.3	683	7.74	--	--	--	--	--	--	--	--
	11		8.1	13	698	7.73	--	--	--	--	--	--	--	--
	12		7.8	12.3	720	7.71	--	0.038	0.010	<0.003 [1]	--	--	149	0.24
6/13/2022	0-2	1.5	--	--	--	--	17.5	0.051	0.021	0.005	3.6	2.8	153	0.49
	0		8.4	21.5	694	7.92	--	--	--	--	--	--	--	--
	1		8.3	21.1	696	7.89	--	--	--	--	--	--	--	--
	2		7.4	20.8	695	7.76	--	--	--	--	--	--	--	--
	3		6.7	20.5	696	7.70	--	--	--	--	--	--	--	--
	4		6.6	20.4	696	7.68	--	--	--	--	--	--	--	--
	5		6.6	20.4	695	7.66	--	0.043	0.018	0.003	--	--	154	0.50
	6		6.5	20.3	695	7.65	--	--	--	--	--	--	--	--
	7		6.5	20.3	695	7.65	--	--	--	--	--	--	--	--
	8		6.4	20.2	694	7.63	--	0.038	0.017	0.003	--	--	153	0.52
	9		5.9	20.0	694	7.59	--	--	--	--	--	--	--	--
	10		5.2	19.5	694	7.56	--	--	--	--	--	--	--	--
	11		4.1	19.2	694	7.52	--	--	--	--	--	--	--	--
	12		3.0	18.9	695	7.47	--	0.043	0.017	0.004	--	--	144	0.66

Table A10. Taft Lake 2022 Water Quality Monitoring Results

Date	Sample Depth (m)	Secchi Disk Trans-parency (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)	Total Iron (mgL)
7/18/2022	0-2	0.9	--	--	--	--	3.6	0.022	0.011	0.003	2.0	1.4	141	0.42
	0		4.6	27.9	685	7.69	--	--	--	--	--	--	--	--
	1		4.0	26.9	684	7.54	--	--	--	--	--	--	--	--
	2		3.8	26.6	683	7.47	--	--	--	--	--	--	--	--
	3		3.6	26.3	683	7.42	--	--	--	--	--	--	--	--
	4		3.5	26.2	682	7.40	--	--	--	--	--	--	--	--
	5		3.4	26.1	682	7.38	--	0.026	0.010	0.003	--	--	143	0.48
	6		3.4	26.1	682	7.37	--	--	--	--	--	--	--	--
	7		3.2	26.0	682	7.35	--	--	--	--	--	--	--	--
	8		3.0	26.0	682	7.34	--	0.022	0.010	<0.003 [1]	--	--	148	0.44
	9		2.4	25.9	682	7.32	--	--	--	--	--	--	--	--
	10		1.5	25.6	682	7.27	--	--	--	--	--	--	--	--
	11		0.6	25.3	682	7.22	--	--	--	--	--	--	--	--
	12		0.4	24.9	687	7.14	--	0.035	0.012	0.005	--	--	150	0.61
8/15/2022	0-2	1.3	--	--	--	--	22.5	0.024	0.008	<0.003 [1]	5.4	4.2	143	0.37
	0		7.1	25.3	721	7.72	--	--	--	--	--	--	--	--
	1		6.5	25.2	722	7.71	--	--	--	--	--	--	--	--
	2		6.0	24.9	722	7.62	--	--	--	--	--	--	--	--
	3		5.7	24.8	722	7.57	--	--	--	--	--	--	--	--
	4		5.6	24.8	723	7.55	--	--	--	--	--	--	--	--
	5		5.6	24.7	723	7.55	--	0.024	0.008	<0.003 [1]	--	--	149	0.43
	6		5.3	24.7	723	7.54	--	--	--	--	--	--	--	--
	7		4.9	24.7	723	7.50	--	--	--	--	--	--	--	--
	8		4.8	24.7	723	7.48	--	0.026	0.007	<0.003 [1]	--	--	149	0.40
	9		4.7	24.7	723	7.48	--	--	--	--	--	--	--	--
	10		4.8	24.7	723	7.47	--	--	--	--	--	--	--	--
	11		4.3	24.6	723	7.47	--	--	--	--	--	--	--	--
	12		3.6	24.6	725	7.37	--	0.031	0.008	<0.003 [1]	--	--	136	0.53
9/12/2022	0-2	1.7	--	--	--	--	16.0	0.023	0.006	<0.003 [1]	3.4	2.6	143	0.40
	0		5.7	24.6	686	7.55	--	--	--	--	--	--	--	--
	1		5.5	23.8	685	7.49	--	--	--	--	--	--	--	--
	2		5.2	23.6	684	7.46	--	--	--	--	--	--	--	--
	3		4.8	23.4	684	7.42	--	--	--	--	--	--	--	--
	4		4.5	23.4	684	7.39	--	--	--	--	--	--	--	--
	5		4.4	23.4	684	7.37	--	0.021	0.008	<0.003 [1]	--	--	139	0.42
	6		4.5	23.4	684	7.36	--	--	--	--	--	--	--	--
	7		4.5	23.3	684	7.36	--	--	--	--	--	--	--	--
	8		4.0	23.3	684	7.34	--	0.019	0.007	<0.003 [1]	--	--	152	0.36
	9		3.8	23.3	685	7.30	--	--	--	--	--	--	--	--
	10		3.8	23.3	685	7.29	--	--	--	--	--	--	--	--
	11		2.5	23.1	686	7.24	--	--	--	--	--	--	--	--
	12		1.2	23.1	690	7.15	--	0.026	0.007	<0.003 [1]	--	--	138	0.70

Table A10. Taft Lake 2022 Water Quality Monitoring Results

Date	Sample Depth (m)	Secchi Disk Trans-parency (m)	Dissolved Oxygen (mg/L)	Temper-ature (℃)	Specific Conductivity (µS/cm @ 25℃)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)	Total Iron (mgL)
10/17/2022	0-2	1.2	--	--	--	--	24.6	0.027	0.006	0.003	4.6	3.6	140	0.32
	0		7.7	14.4	745	7.86	--	--	--	--	--	--	--	--
	1		7.0	14.4	746	7.85	--	--	--	--	--	--	--	--
	2		6.7	14.4	746	7.82	--	--	--	--	--	--	--	--
	3		6.6	14.3	745	7.80	--	--	--	--	--	--	--	--
	4		6.4	14.3	745	7.78	--	--	--	--	--	--	--	--
	5		6.4	14.3	745	7.78	--	0.025	0.006	<0.003 [1]	--	--	141	0.33
	6		6.3	14.3	745	7.78	--	--	--	--	--	--	--	--
	7		6.3	14.3	745	7.77	--	--	--	--	--	--	--	--
	8		6.3	14.2	745	7.77	--	0.030	0.005	<0.003 [1]	--	--	143	0.33
	9		6.2	14.2	745	7.77	--	--	--	--	--	--	--	--
	10		6.2	14.2	746	7.77	--	--	--	--	--	--	--	--
	11		6.1	14.2	746	7.76	--	--	--	--	--	--	--	--
	12		6.0	14.2	746	7.75	--	0.029	0.006	<0.003 [1]	--	--	140	0.41

Notes
<0.003 [1] - Concentration is below the laboratory's method detection limit.

Table A11. Wilson Pond 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.5	0.35	0-1	--	--	--	--	88	0.221	0.006	0.037	22	20	27.8
		--	--	11.9	22.6	145	8.91	--	--	--	--	--	--	--
		--	--	11.7	20.7	142	8.53	--	--	--	--	--	--	--
6/13/2022	1.2	0.2	0.6	12.1	26.1	200	9.01	232	0.271	0.007	0.028	34	34	23.9
7/18/2022	1.5	0.15	0-1	--	--	--	--	360	0.594	0.012	0.088	84	76	19.4
		--	0.0	16.4	30.4	196	10.60	--	--	--	--	--	--	--
		--	1.0	0.8	24.4	161	7.00	--	--	--	--	--	--	--
8/15/2022	1.5	0.15	0-1	--	--	--	--	276	0.331	<0.003 [1]	0.039	56	52	9.3
		--	0.0	15.2	24.4	143	10.50	--	--	--	--	--	--	--
		--	1.0	5.2	21.5	95	8.16	--	--	--	--	--	--	--
9/12/2022	1.5	0.15	0-1	--	--	--	--	288	0.350	0.012	0.289	68	62	11.4
		--	0.0	14.8	23.8	130	9.80	--	--	--	--	--	--	--
		--	1.0	7.8	19.4	105	8.49	--	--	--	--	--	--	--
10/17/2022	1	0.15	0.5	12.3	7.3	140	8.92	153	0.326	<0.003 [1]	0.016	54	50	13.1

Notes

<0.003 [1] - Concentration is below the laboratory's method detection limit.

Table A12. Wood Lake (North) 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (°C)	Specific Conductivity (µS/cm @ 25°C)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.2	>1.2	0-1	--	--	--	--	7.6	0.089	< 0.003	0.054	1.5	1.0	143
		--	0.0	5.6	19.2	540	7.20	--	--	--	--	--	--	--
		--	1.0	4.9	19.2	542	7.14	--	--	--	--	--	--	--
6/13/2022	1.1	>0.7	0.5	8.2	22.8	535	9.66	5.3	0.136	0.051	0.085	2.2	2.0	137
7/18/2022	0.8	>0.4	0.4	1.7	15.7	614	7.53	107	0.358	0.032	0.061	19.0	15.0	157
8/15/2022	0.6	>0.6	0.3	7.0	22.5	623	8.68	67	0.144	0.005	0.032	8.6	6.6	147
9/12/2022	0.6	>0.4	0.3	6.0	18.8	450	8.35	40	0.086	0.007	0.063	7.4	6.0	107
10/17/2022	0.9	>0.9	0.4	12.1	7.0	548	8.62	21	0.064	0.005	0.019	5.7	4.9	116

Notes

<2.22 [1] - Concentration is below the laboratory's method detection limit.

>0.4 [2] - Secchi disk is visible on lake bottom

Table A13. Wood Lake (South) 2022 Water Quality Monitoring Results

Date	Observed Water Depth (m)	Secchi Disk Trans-parency (m)	Sample Depth (m)	Dissolved Oxygen (mg/L)	Temper-ature (℃)	Specific Conductivity (µS/cm @ 25℃)	pH	Chlorophyll-a, pheophytin corrected (ug/L)	Total Phosphorus (mg/L P)	Ortho Phosphate (mg/L P)	Total Dissolved Phosphorus (mg/L P)	Total Suspended Solids (mg/L)	Volatile Residue Suspended Solids (mg/L)	Chloride (mgL)
5/16/2022	1.2	0.6	0-1	--	--	--	--	55	0.198	0.028	0.071	8.5	5.5	125
		--	0.0	4.6	20.2	482	7.05	--	--	--	--	--	--	--
		--	1.0	4.9	20	495	7.04	--	--	--	--	--	--	--
6/13/2022	0.8	>0.8	0.5	3.7	23.6	405	7.35	32	0.257	0.042	0.071	6.2	4.0	87.8
7/18/2022	1.2	0.45	0-1	--	--	--	--	352	0.460	0.083	0.184	25	21	56.5
		--	0.0	4.9	26.9	300	7.76	--	--	--	--	--	--	--
		--	1.0	1.2	26.7	310	7.12	--	--	--	--	--	--	--
8/15/2022	1.5	0.5	0-1	--	--	--	--	143	0.202	0.026	0.044	15.3	12.7	16.0
		--	0.0	11.6	22.0	131	9.31	--	--	--	--	--	--	--
		--	1.0	5.4	21.2	130	8.00	--	--	--	--	--	--	--
9/12/2022	1.2	0.3	0-1	--	--	--	--	157	0.238	0.008	0.077	24	21	49.4
		--	0.0	9.6	19.4	242	8.47	--	--	--	--	--	--	--
		--	1.0	9.0	19.1	243	8.47	--	--	--	--	--	--	--
10/17/2022	1.2	0.25	0.6	12.4	5.0	385	9.20	199	0.331	< 0.003	0.032	43	38	89.1

Notes

<2.22 [1] - Concentration is below the laboratory's method detection limit.

>0.8 [2] - Secchi disk is visible on lake bottom

Attachment B

Photographs


Adams Hill 5/16/22


Adams Hill Pond 6/13/22


Adams Hill 7/18/22


Adams Hill Pond 8/15/22


Adams Hill 9/12/22


Adams Hill 10/17/22


Augsburg Pond 5/16/22


Augsburg Pond 6/13/22


Augsburg Pond 7/18/22


Augsburg Pond 8/15/22


Augsburg Pond 9/12/22


Augsburg Pond 10/17/22

Legion Lake North 5/16/22

Legion Lake North 6/13/22

Legion Lake North 7/18/22

Legion Lake North 8/15/22

Legion Lake North 9/12/22

Legion Lake North 10/17/22


Legion Lake South 5/16/22

Legion Lake South 6/13/22 (no photo)


Legion Lake South 7/18/22


Legion Lake South 8/15/22


Legion Lake South 9/12/22


Legion Lake South 10/17/22


Legion Lake West 5/16/22


Legion Lake West 6/13/22


Legion Lake West 7/18/22


Legion Lake West 8/15/22


Legion Lake West 9/12/22


Legion Lake West 10/17/22


Milner Pond 5/16/22


Milner Pond 6/13/22


Milner Pond 7/18/22


Milner Pond 8/15/22


Milner Pond 9/12/22


Milner Pond 10/17/22

Norby’s Pond 5/16/22

Norby’s Pond 6/13/22

Norby’s Pond 7/18/22

Norby’s Pond 8/15/22

Norby’s Pond 9/12/22

Norby’s Pond 10/17/22

Richfield Lake North 5/16/22

Richfield Lake North 6/13/22

Richfield Lake North 7/18/22

Richfield Lake North 8/15/22

Richfield Lake North 9/12/22

Richfield Lake North 10/17/22

Richfield Lake South 5/16/22

Richfield Lake South 6/13/22

Richfield Lake South 7/18/22

Richfield Lake South 8/15/22

Richfield Lake South 9/12/22

Richfield Lake South 10/17/22


Taft Lake 5/5/17/22


Taft Lake 6/13/22


Taft Lake 7/18/22


Taft Lake 8/15/22


Taft Lake 9/12/22


Taft Lake 10/17/22


Wilson Pond 5/16/22


Wilson Pond 6/13/22


Wilson Pond 7/18/22


Wilson Pond 8/15/22


Wilson Pond 9/12/22


Wilson Pond 10/17/22


Wood Lake North 5/16/22


Wood Lake North 6/13/22


Wood Lake North 7/18/22


Wood Lake North 8/15/22


Wood Lake North 9/12/22


Wood Lake North 10/17/22


Wood Lake South 5/16/22


Wood Lake South 6/13/22


Wood Lake South 7/18/22


Wood Lake South 8/15/22


Wood Lake South 9/12/22


Wood Lake South 10/17/22

Attachment C

Miscellaneous 2022 Field Observations

Attachment C. Richfield 2022 Surface Water Quality Monitoring General Field Observations

Adams Hill Pond
Floating trash, branches, logs; could use a general shoreline cleanup.

Wood Lake (South)
Outlet channel could benefit from cleanup/clean out.

Augsburg Pond
A lot of muck/sediment at south end. May benefit from dredging.

Norby's Pond
North end may benefit from dredging. Outlet pipes have branch/tree debris, sediment delta at inlet pipe, very shallow.

Milner Pond
Outlet debris—branches/logs, very shallow. May benefit from dredging in some areas.

Legion Lake (West)
Trash, floating debris from inlet, may benefit from clean out / dredging and shoreline cleanup.

Legion Lake Outlet
Trash at outlet—trash skimmer present that captures trash, but trash should be removed regularly. May benefit from a channel cleanup.