Integrated Monitoring Report
2022 Season

Fall River Subwatershed

Mississippi Valley Conservation Authority

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Cover photos
Top: White Lake, May 2022
Bottom: Mississippi Lake outlet, September 2022

Executive Summary

The purpose of this integrated monitoring report is to present an overview of the environmental monitoring that Mississippi Valley Conservation Authority (MVCA) completed during the 2022 season. The emphasis of this report is on results of the lake monitoring program but also includes water levels and flow, snow pack, and stream monitoring data. MVCA samples each of its 10 subwatersheds on a 5-year rotation. The Fall River watershed was the primary focus for 2022. Due to continued Covid-19 related program adjustments a revised lake sampling schedule was implemented with eight lakes being visited three times during the ice-free season. Restrictions remained in place throughout 2022 which limited MVCA's ability to conduct in-stream sampling, such as electro-fishing.

The watershed saw a long-drawn-out snow melt event, resulting in multiple below average spring peaks. The most significant factor affecting the lakes and streams in the summer of 2022 was a below average spring, followed by numerous significant rain events in early June. These brought the lakes and streams up to above normal conditions, prompting multiple dam operations. MVCA issued three Watershed Condition-Water Safety statements to warn residents of above average conditions. Above average rainfall throughout the summer months, resulted in higher than average levels and flows across the watershed and there was no threat of drought conditions. Refer to Pages 6-13.

The Fall River subwatershed consists of White Lake, Black Lake, Sharbot Lake, Silver Lake and Bennett Lake. Additionally, Dalhousie Lake and Mississippi Lake were monitored in 2022 which represents the water quality within the main Mississippi River. Constance Lake within the City of Ottawa was also sampled this year. The sampled lakes maintained their typical nutrient profile characteristics as well as typical dissolved oxygen and temperature profiles for the seasons that were sampled. Refer to Pages 14-30.

Through the stream monitoring program, 21 sites within the Mississippi River Watershed, and 1 site from the Constance Creek Watershed were selected for thermal habitat assessment in 2022. Five of these sites were found to support cold-cool water fish habitat, five supported cool water habitat and seven were classified as having cool-warm water habitat. Performing these monitoring programs annually helps account for the impacts of variable climate influences through analysis of long-term datasets. Refer to Pages 31-34.

This report emphasizes the value of the combined monitoring conducted through MVCA's Water Management, Lake Monitoring, and Stream Monitoring programs. The information gathered through these efforts supports MVCA's Stewardship program as well as the Planning and Regulations department.

Introduction

The goal of the Lake Monitoring program is to accumulate reliable environmental data on the lakes within the watershed. Despite various adjustments to the protocol throughout the years, the program has remained a fundamental part of MVCA's environmental monitoring program. It continues to provide valuable baseline data while promoting stewardship within the watershed.

This is achieved by collecting water quality data and monitoring the lakes for changing trends. Due to the large number of lakes monitored within the MVCA area (45 lakes monitored out of over 300 lakes in total), a rotational sampling program is undertaken with the goal to collect baseline data and to monitor general trends. MVCA collects relatively simple data on parameters that are easy to repeat and are important indicators in water quality assessments. Many of the lakes not sampled on a regular basis by MVCA are sampled/monitored through other programs such as the Ministry of Environment, Conservation and Parks' Lake Partner Program (LPP). Relying on volunteer effort, this program provides equipment and an excellent framework for yearly data collection. It is also an excellent means to promote awareness and ownership of lake health to the lake communities. If lake stewards are interested in more detailed yearly assessments of their lake, they should consider the LPP which is coordinated through the Dorset Environmental Science Centre.

MVCA's Stream Monitoring program collects valuable information on stream temperature, as well as fish and benthic communities of the watershed's many tributaries. It follows the Ontario Stream Assessment Protocol (OSAP) methods to conduct stream site identifications, electrofishing, benthic surveys, and temperature monitoring at various sites throughout the year. Due to continued Covid-19 restrictions, MVCA was only able to perform temperature monitoring with the Mississippi River subwatersheds, as many other stream assessment protocols required close physical contact.

The goal of MVCA's fish data collection is largely to determine the presence or absence of cold or cool water species. These species are indicators of the thermal regime of a stream as they require very specific conditions to thrive, and thus are sensitive to changes caused by climate change or nearby development pressure. Fish sampling was not carried out in the summer of 2022 but MVCA was able to monitor the water temperature at select sites throughout the watershed to confirm the potential thermal habitat available for fish populations. The results are also used for tracking thermal trends for longer-term climate analysis.

Water Quantity Monitoring

Summary

Three types of water quantity monitoring occurred in the Mississippi Lakes subwatershed in 2022; snow pack, water levels and flow, and precipitation. Figure 1 shows the locations of the various gauges used to collect water level and flow data, the locations of snow courses where snow pack water content is measured, and the lakes monitored in 2022.

There are 2 flow stations, 3 level gauges, 2 precipitation gauges and 2 snow courses in the Fall River subwatershed.

The watershed did not experience a significant spring freshet/thaw in 2022. The freshet was drawn-out and had several below average peaks on the main system. Ferguson Falls flow peaked on March 28th at 119 cm/s and again on April 11th at 123 cm/s, which are both below the historical peak average of 150 cm/s. There was average rainfall for both April and May that, coupled with the spring melt, resulted in average flows as the season moved into June. Rainfall for June was significantly above average triggering 3 Watershed Condition-Water Safety statements due to the above average levels and flows. July and August both saw above average rainfall eliminating any concerns on drought in the system and leaving the system slightly above average going into the fall months. October and November were extremely dry months leaving levels and flows slightly below normal coming into the winter months. In contrast December was then a very wet month leaving the overall system with above average conditions at the end of the year.

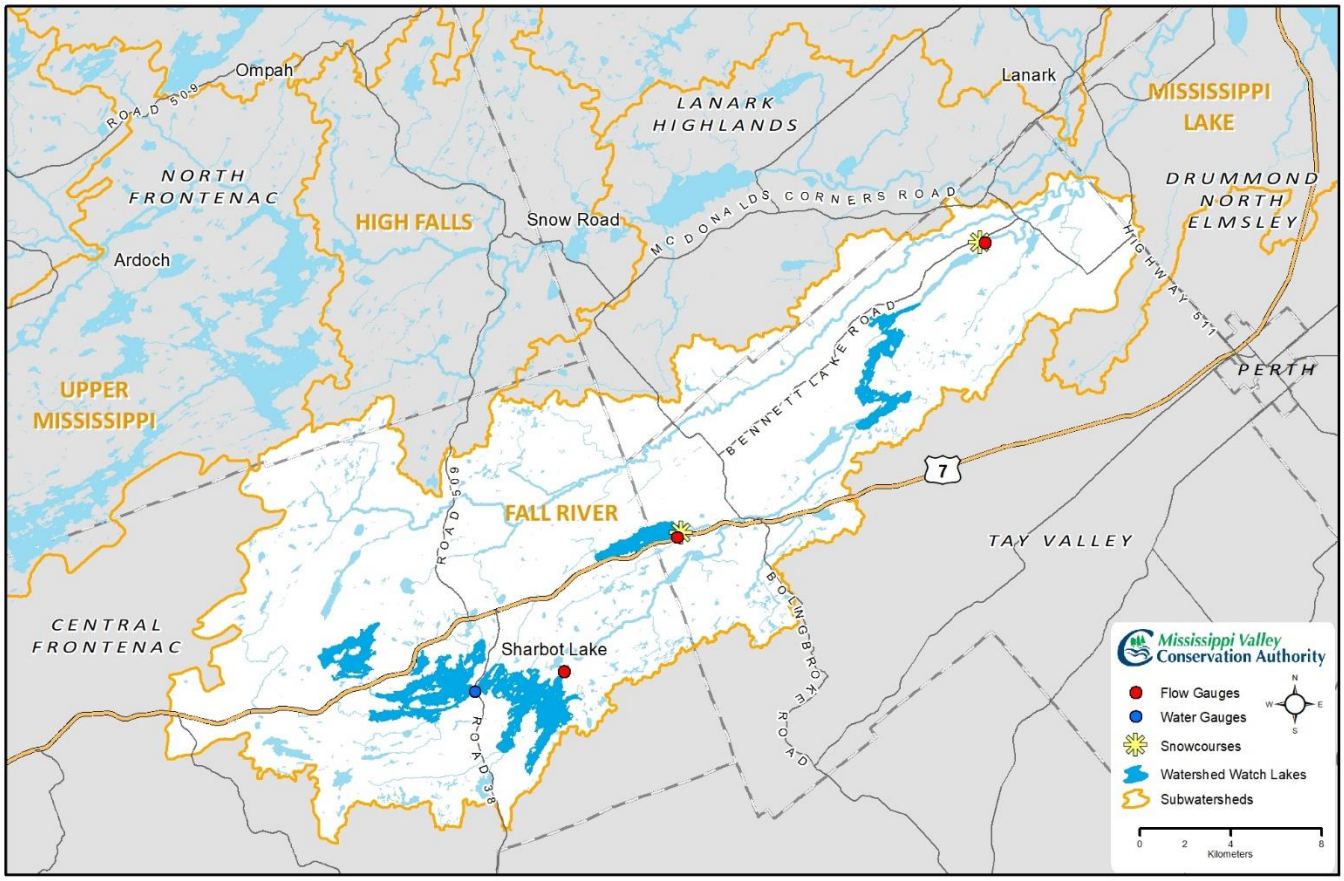


Figure 1: The various water quantity monitoring sites in the Fall River subwatershed, plus the lakes within the subwatershed that were monitored in 2022.

Snow Pack

Snow pack is measured at 16 sites within the MVCA's jurisdiction. This program provides MVCA with information on the expected spring runoff for that year. This assists in decisions related to dam operations and flood forecasting. These water management efforts are critical to minimizing flood damage, maintaining flows and water levels for fish and wildlife, and meeting the target levels for summer recreational activities. Results from four snow course stations have been interpreted to describe the diversity of snowpack conditions across the Mississippi Valley watershed that contribute to the observed spring water levels. The four sites were selected for analysis due to their proximity to lakes that were studied in 2022 (Figure 1, Figure 5). Maberly is downstream of Silver Lake and Fallbrook is downstream of Bennett Lake, while High Falls is upstream of Dalhousie Lake, and Innisville is upstream of Mississippi Lake. Results from these stations can be seen in Figures 2a and 2b.

Measuring snow depth and equivalent water content

Due to the wet December and the lack of snow in January the area saw average snow conditions by early March. The snow courses in the rest of the Mississippi Valley showed a similar trend. In March temperatures were favorable for a slow, controlled melt. Runoff flows began in March and slowly continued into April. A snow melt event at the end of March developed into the first spring peak and alleviated the majority of the remaining snow content. The second peak in early April was driven by a rain event.

It can be seen in Figure 2b that snow water equivalent levels in the Fall River subwatershed maintained an above average trend at the end of winter of 2022. All the other stations maintained an average snow water equivalent trend.

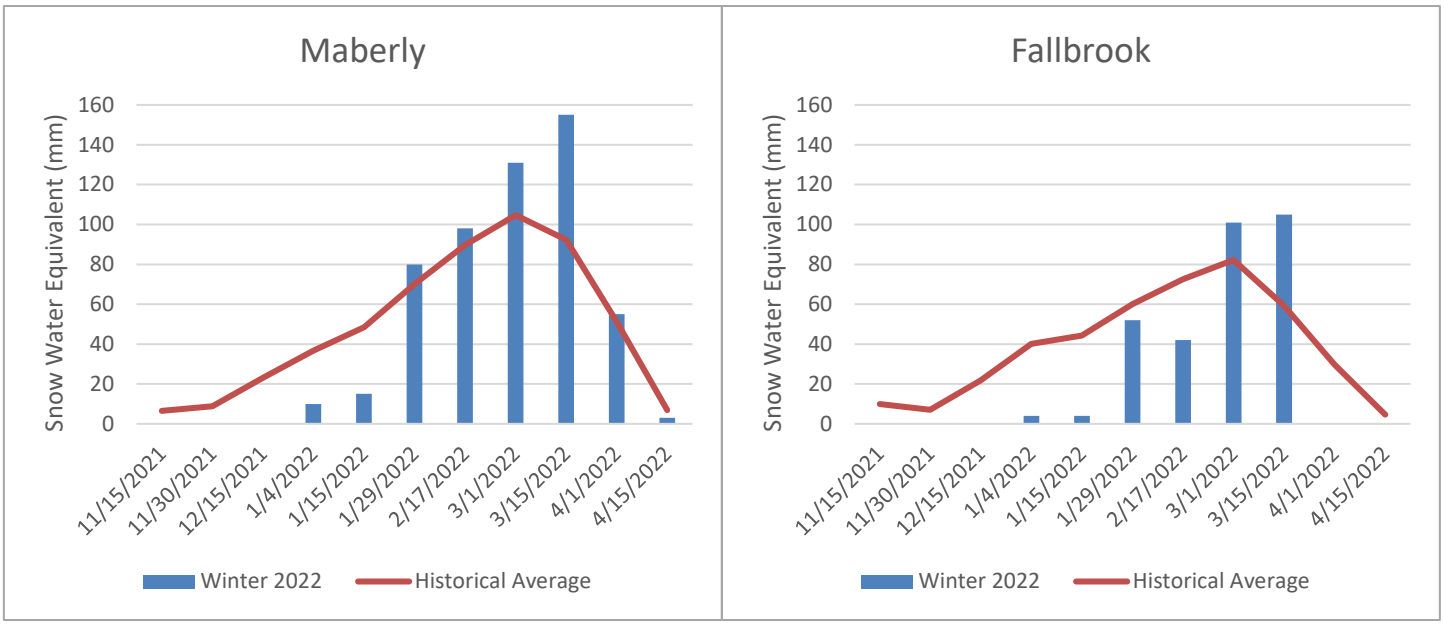


Figure 2a: 2022 snow water equivalent levels vs. historical averages sampled at the Maberly and Fallbrook snow course stations within the Fall River subwatershed.

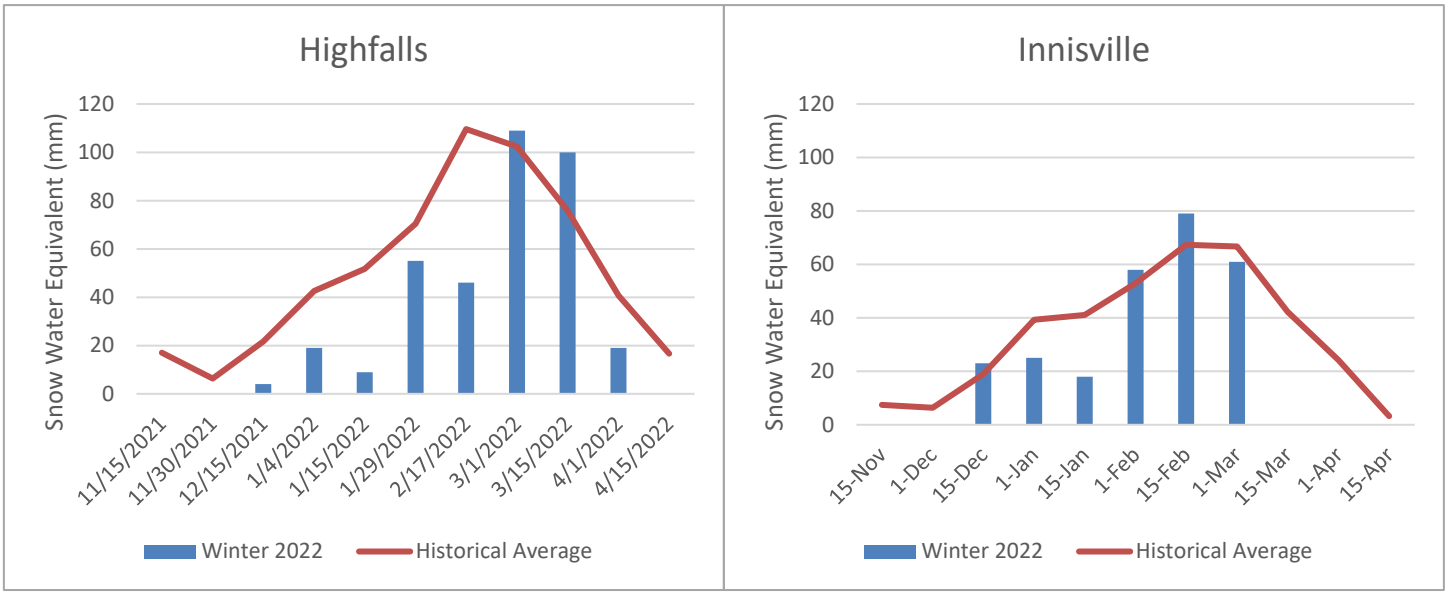


Figure 2b: 2022 snow water equivalent levels vs. historical averages sampled at the High Falls and Innisville snow course stations within the Mississippi Lakes subwatershed near Dalhousie Lake and Mississippi Lakes respectively.

Stream Flow and Precipitation

Precipitation gauges are located with streamflow gauge stations across the watershed. These gauges provide information on weather events or climactic conditions which influence water levels in the Mississippi River Watershed. This report focuses on 2022 data from the stream flow and rain gauge station at the outlet of Bennett Lake, the outlet of Dalhousie Lake, and in the community of Ferguson's Falls upstream of Mississippi Lakes. The daily total precipitation and the daily mean flows at these stations are included in Figures 3a, 3b and 3c respectively.

The Figures show two peak flows occurring on March 28th and April 11th during the below average spring freshet. With the above average rainfall in June MVCA issued 3 Water Safety – Water Condition Statements which were in place for a month, until the excess water made its way through the system.

Figures 3a, b and c also illustrate the precipitation events that occurred throughout the year. The largest precipitation event occurred the first week of June with multiple back to back events and contributed close to 100 mm to the Mississippi Lake area. Due to the continued rainfall into the Fall season, the majority of the system experienced higher than normal conditions into December.

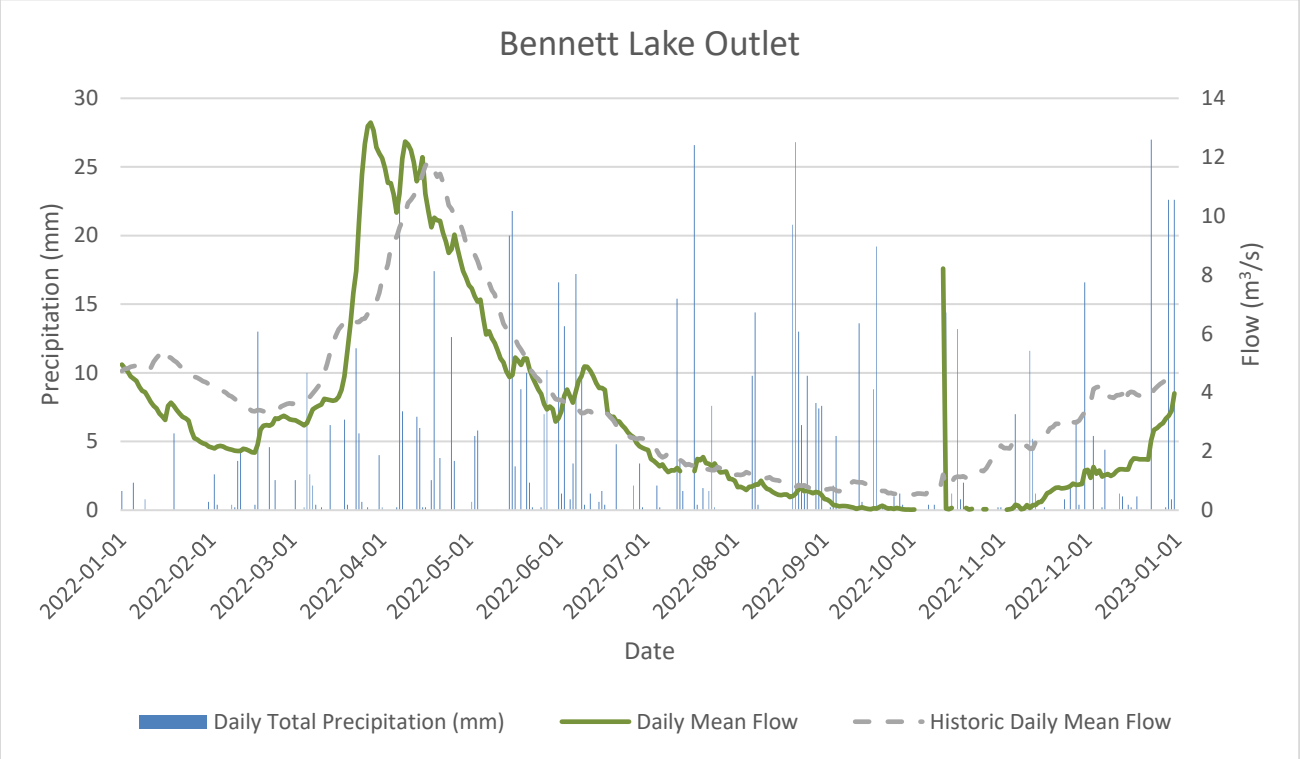


Figure 3a: Daily total precipitation and daily mean water flows at the Bennett Lake gauge station for 2022 compared to the historic daily mean flows for the site.

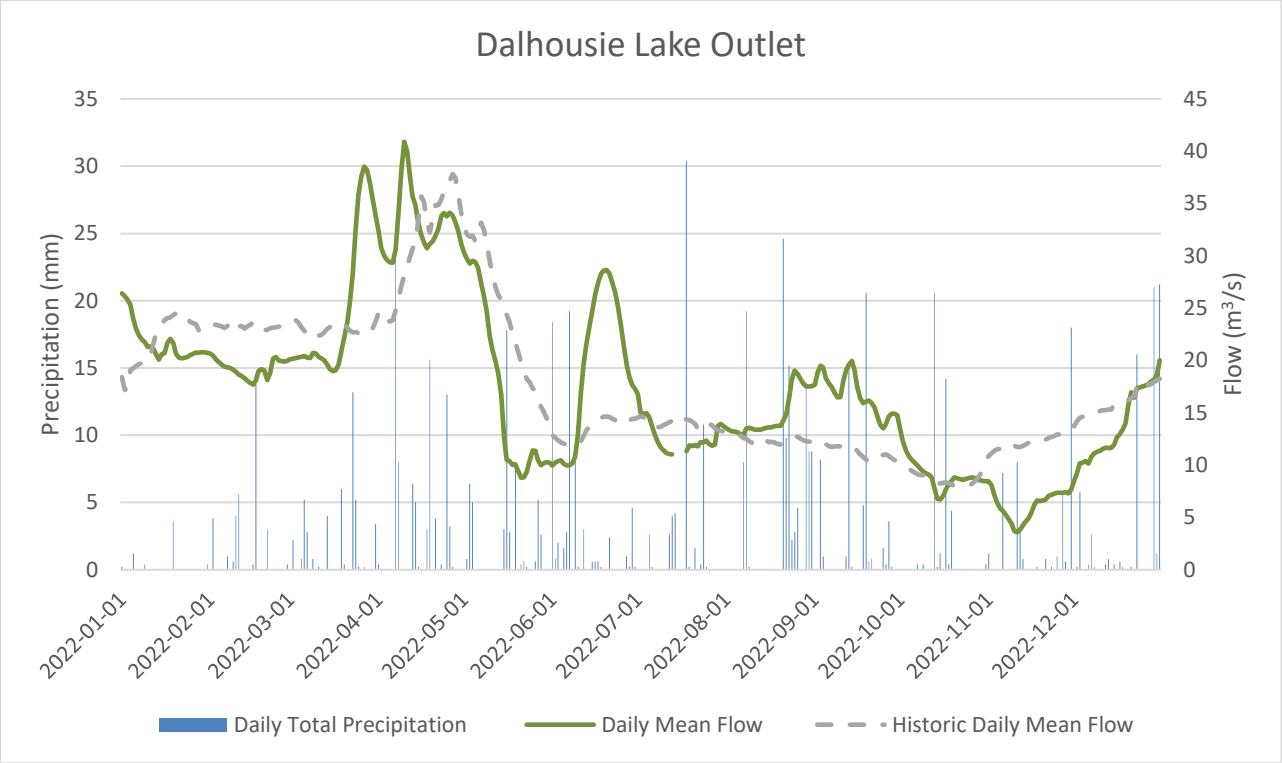


Figure 3b: Daily total precipitation and daily mean water flows at the Dalhousie Lake gauge station for 2022 compared to the historic daily mean flows for the site.

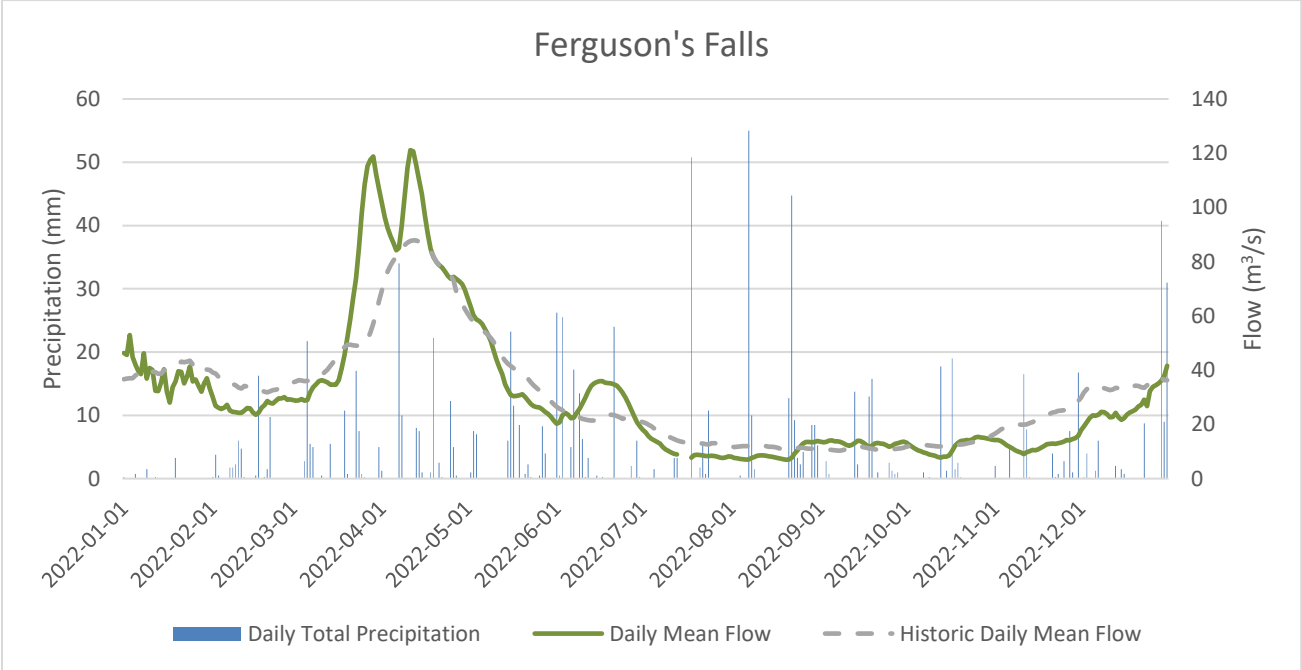


Figure 3c: Daily total precipitation and daily mean water flows at the Ferguson's Falls gauge station for 2022 compared to the historic daily mean flows for the site.

Lake Water Levels

Water levels are measured from gauges installed at many dams and gauge stations throughout the watershed. MVCA operates 18 dams throughout the watershed; water levels in two of the lakes monitored in 2022 are managed by a dam; Bennett Lake (Figure 4c) and Mississippi Lake (Figure 4e). Water levels in Sharbot Lake (Figure 4a), Silver Lake (Figure 4b), and Dalhousie Lake (Figure 4d) are not controlled by dams, and the data used for analysis comes from Water Survey of Canada Gauge stations at their outlets. White Lake, Black Lake and Constance Lake do not have control structures or gauge stations.

Due to the above average rain events in June, the lakes started the season with above average water levels. The lakes were able to be near normal levels throughout the season with no issues of drought. (Figures 4a, b, and c).

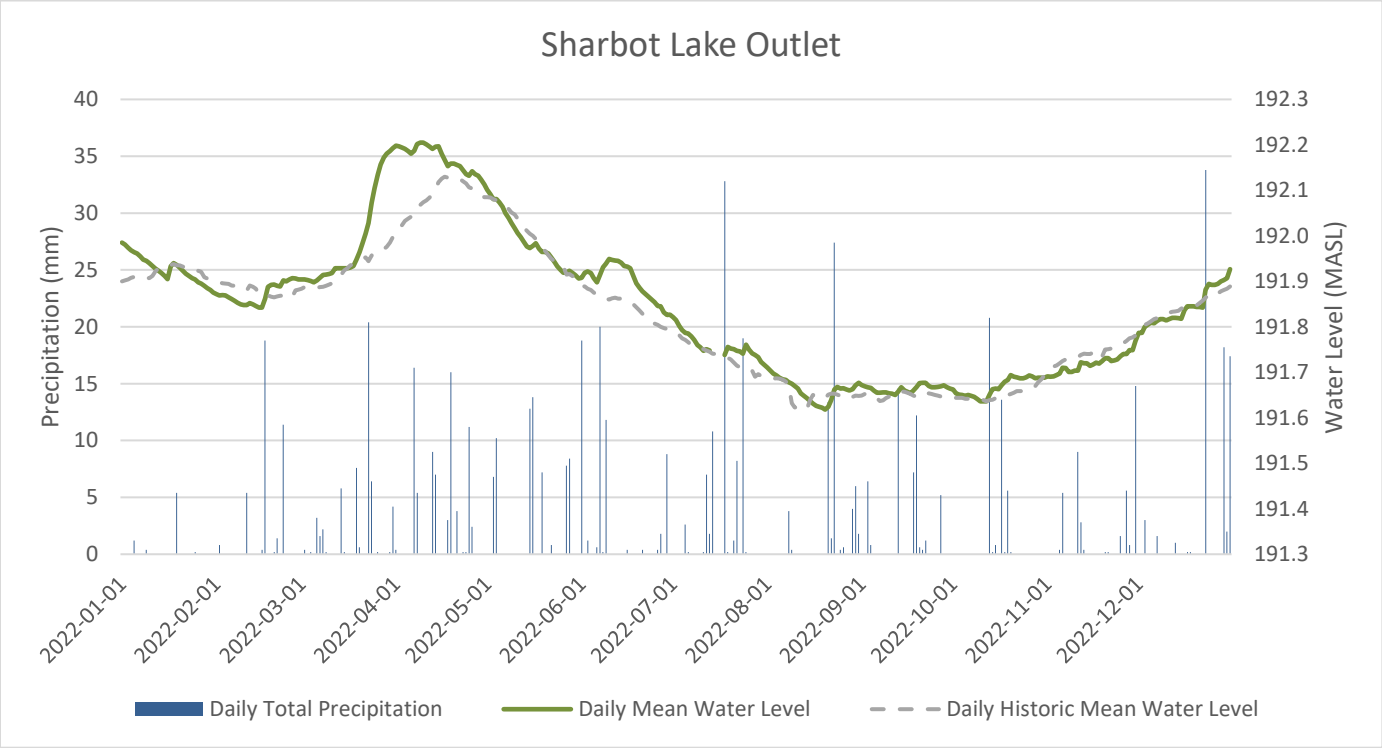


Figure 4a: 2022 and historic daily mean water levels (meters above sea level - MASL) at the Sharbot Lake gauge compared to the 2022 daily total precipitation at the same gauge.

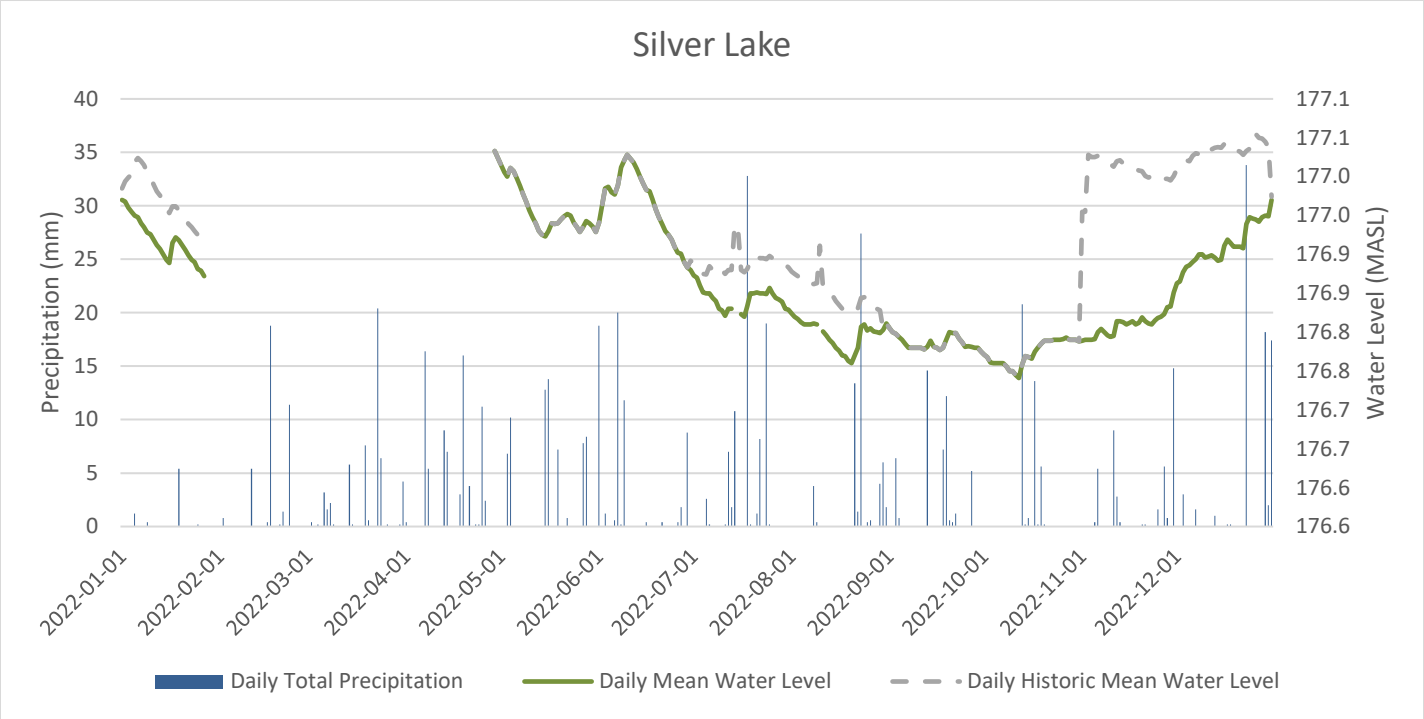


Figure 4b: 2022 and historic daily mean water levels (meters above sea level - MASL) at Silver Lake compared to the 2022 daily total precipitation at the nearby Sharbot Lake stream gauge station. Note: the Silver Lake gauge is fairly new, being installed in 2020, so the historic dataset is not as robust as other stations discussed in this report and there is a data gap from early spring 2022.

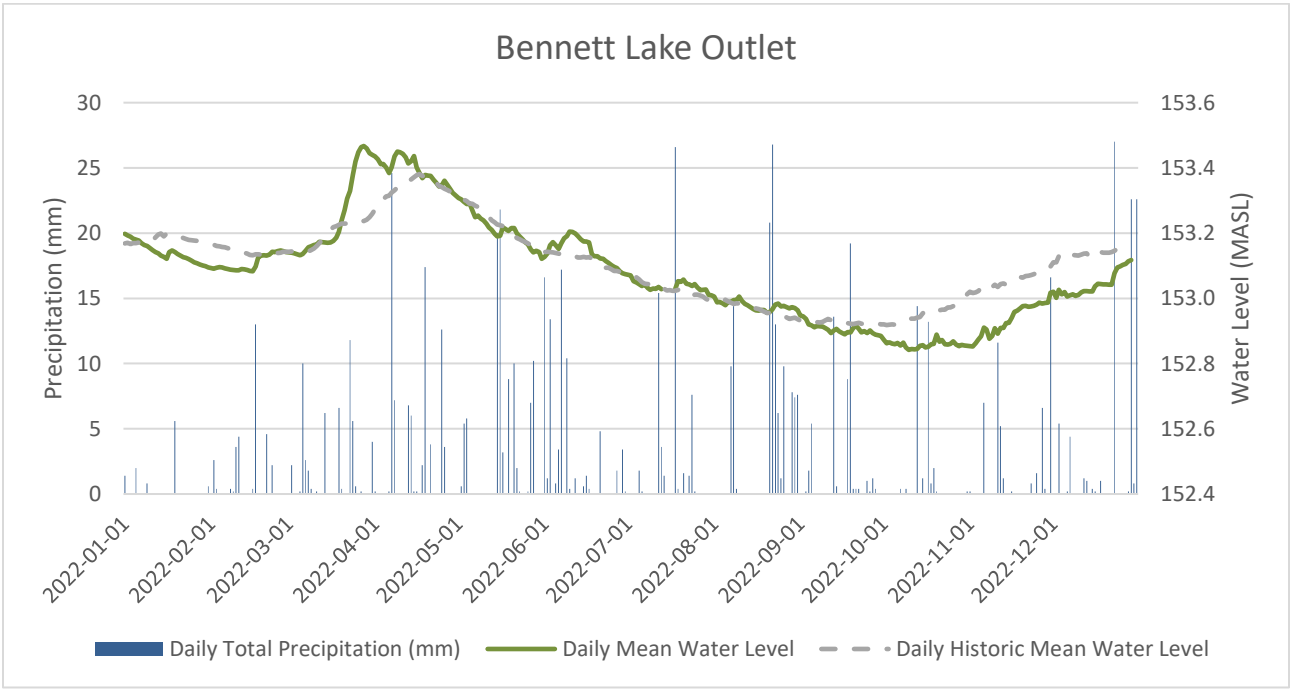


Figure 4c: 2022 and historic daily mean water levels (meters above sea level - MASL) at Bennett Lake compared to the 2022 daily total precipitation at the same stream gauge station.

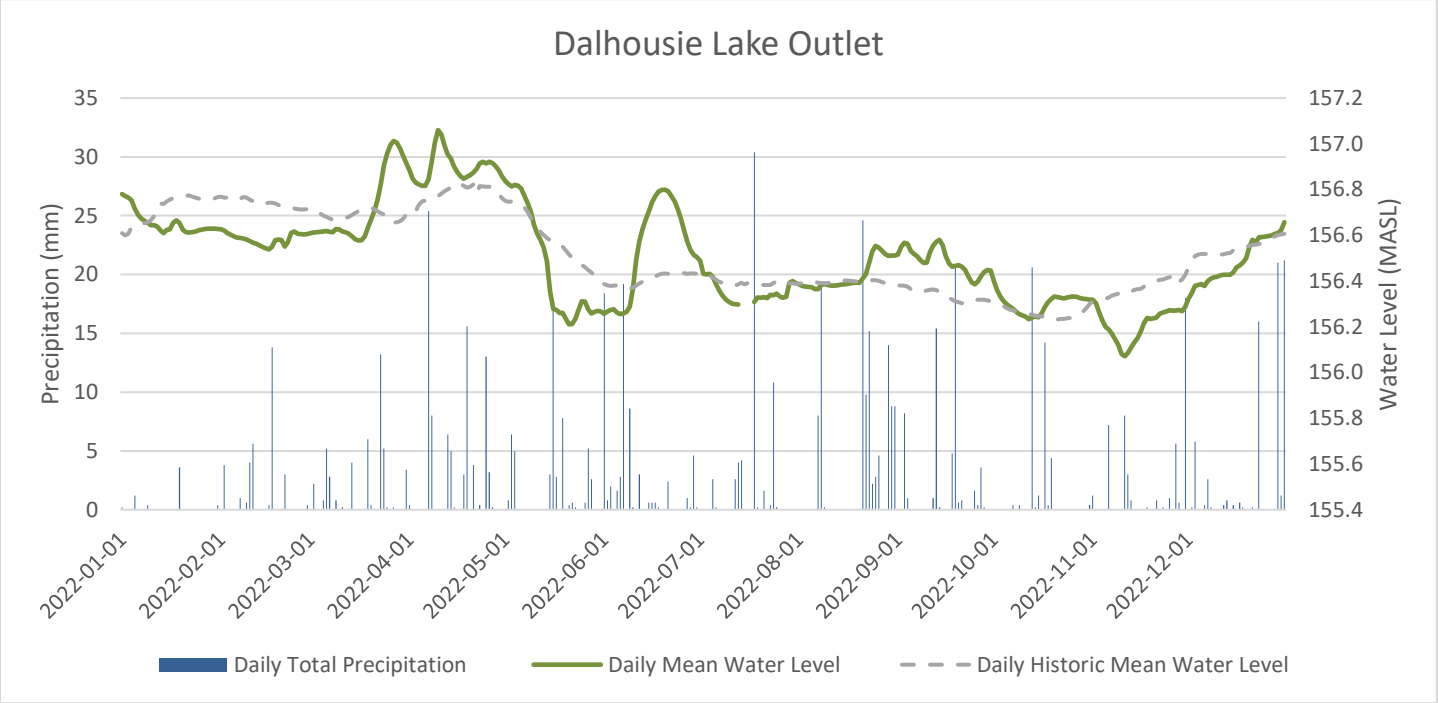


Figure 4d: 2022 and historic daily mean water levels (meters above sea level - MASL) at the Dalhousie Lake gauge compared to the 2022 daily total precipitation at the same gauge.

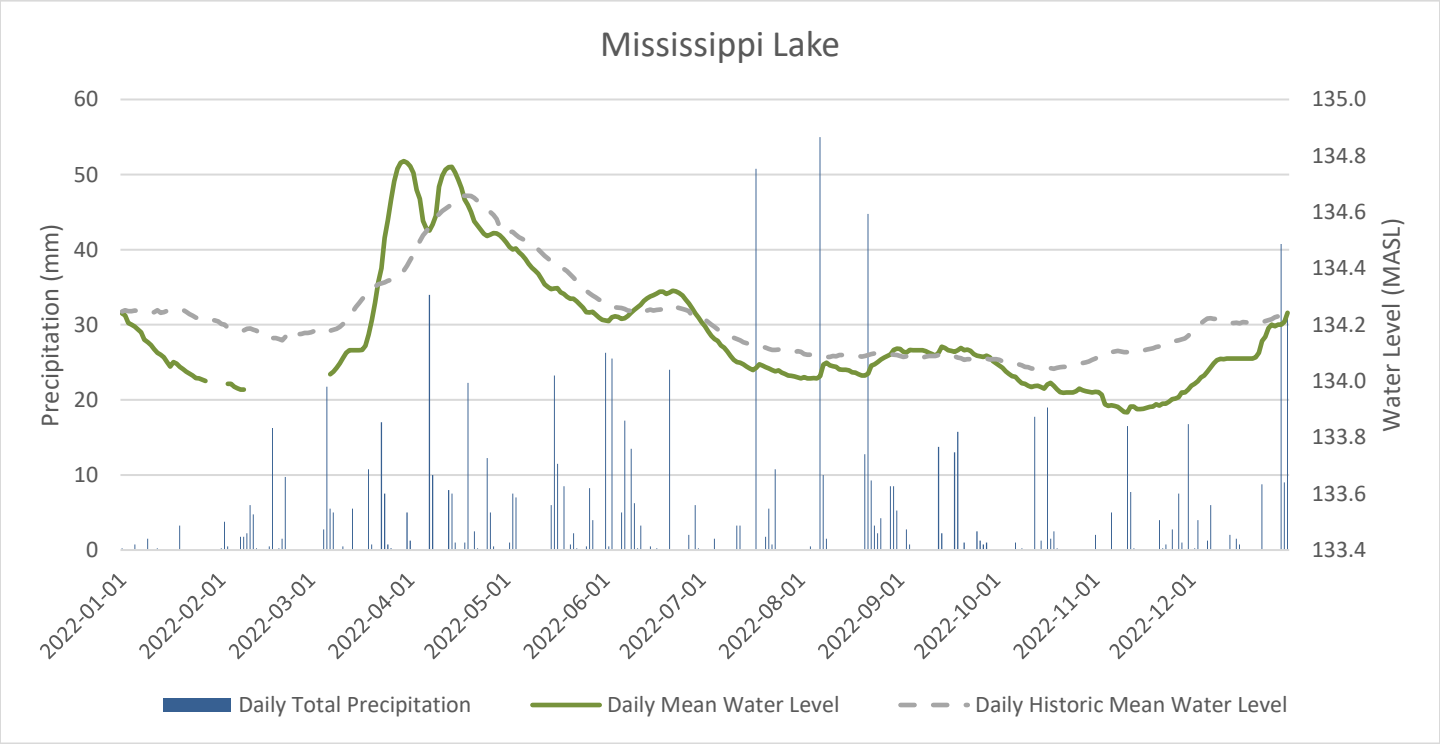


Figure 4e: 2022 and historic daily mean water levels (meters above sea level - MASL) at the Mississippi Lake gauge compared to the 2022 daily total precipitation at the nearby Ferguson's Falls gauge.

Lake Monitoring Program

In 2022, the sampling focus was on the Fall River subwatershed. Located in the south-central portion of the watershed, the Fall River flows from northwest of the town of Sharbot Lake to the Mississippi River near Lanark. The Fall River is 43 km long from the outlet of Sharbot Lake, and has a watershed area of 484.76 km^2. Five lakes were sampled in the Fall River subwatershed two were sampled to represent the main Mississippi River, and one lake was sampled within the City of Ottawa for a total of eight lakes sampled in 2022. Table 1 lists the lakes sampled by subwatershed in order from upstream to downstream. Figure 5 highlights the lake sites where sampling occurred in 2022.

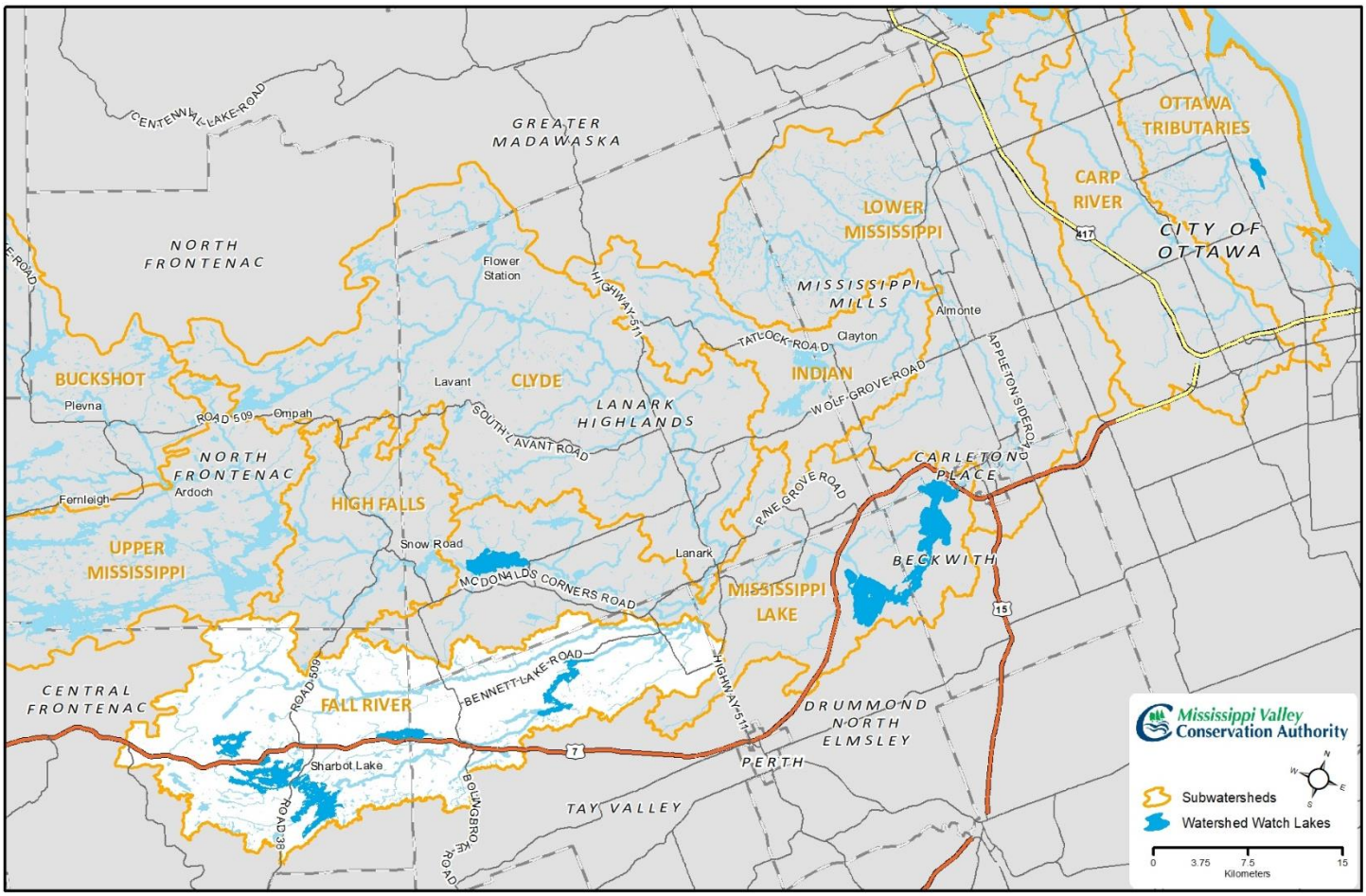
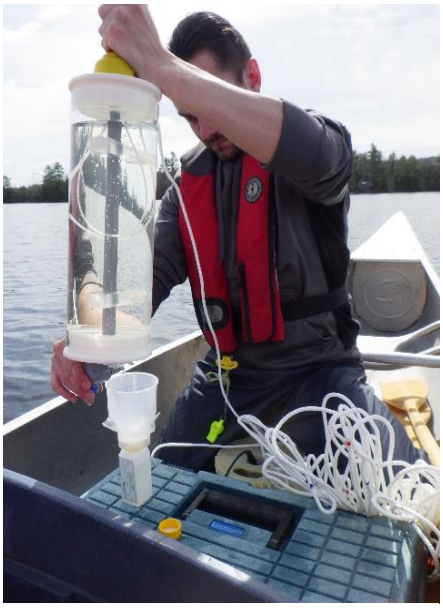


Figure 5: The lakes shown in darker blue are the 7 lakes monitored in 2022. The Fall River subwatershed is shown in white.

Table 1: Lakes sampled in 2022.

Mississippi Main Stem	Fall River	Ottawa River
Dalhousie Lake	White Lake	Constance Lake
Mississippi lake	Black Lake	
	Sharbot Lake	
	Silver Lake	
	Bennett Lake	

Results Summary



Filtering a bottom sample

Overall, the lakes sampled in 2022 were consistent with historic trends for Total Phosphorus (TP) levels, Secchi depth and trophic status. The lakes will continue to be sampled as part of the regular rotation to further support the establishment of a long-term data set characterizing the condition of watershed lakes.

To help interpret and display the results of the lake monitoring program, a box and whisker plot has been used. This type of chart is used to highlight the middle 50% of the data set. 50% of all data points lie within the box and the additional 50% is shown by the lines (whiskers) extending from the top and bottom of the box, 25% respectively. The median value of the data set is shown with a line indicating the middle of the data set. Outliers are any data points that fall outside of the reach of the box and whisker area. This type of graph shows if any results are considered outliers from the data set as dots above/below the whiskers. As seen in the examples below (Figure 6 and 7). MVCA has chosen to use Box and Whisker plots in order to help interpret the TP results seen in 2022 against the full data set for each of the sampling locations. If a result is between the minimum and maximum values, it would tend to indicate that the value was a part of the natural variance in the lake. When a TP result is determined to be beyond the minimum or maximum values, it is classified an outlier, indicating that the result could be attributed to sampling error or contamination. The lakes will continue to be monitored as part of the regular sampling rotation which enhances the robustness of MVCA's long-term data set and improves understanding of yearly results.

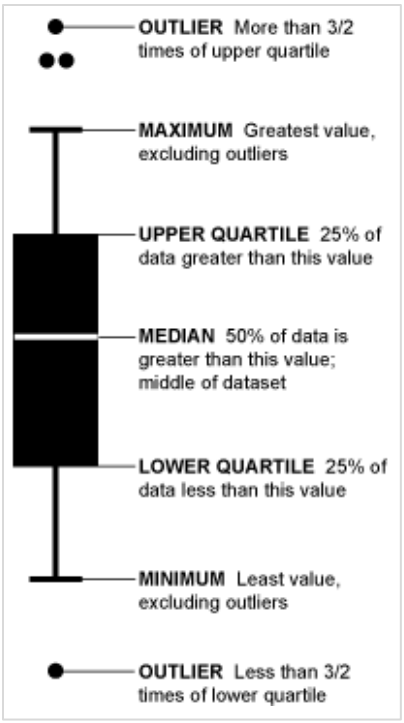


Figure 6: How to interpret a Box and Whisker Plot.

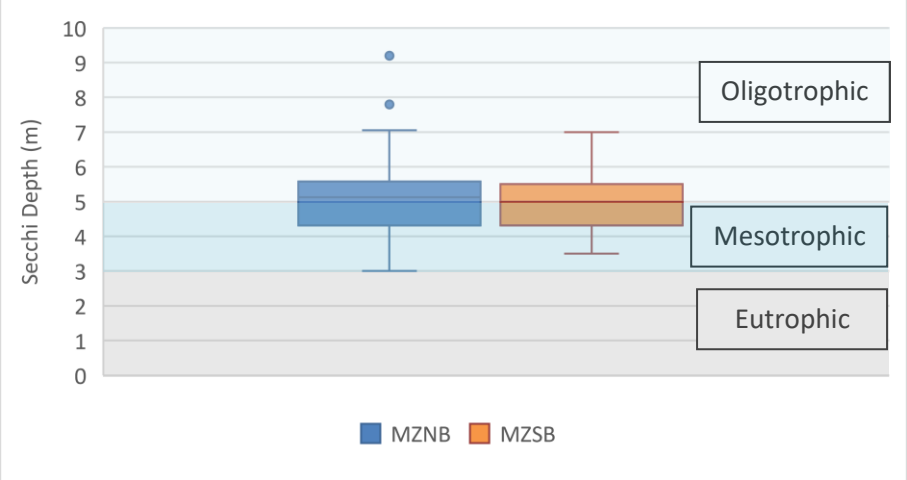


Figure 7: An example of a box and whisker plot from Mazinaw Lake's 2019 Secchi depth results compared to trophic statuses.

Lake Monitoring Indicators and Methodology

The Lake Monitoring Program tests for six water quality parameters. These parameters are selected for their relative simplicity of collection, reproducibility, and ability to determine trophic status. These parameters are further described below.

Calcium

Calcium in lakes is a measure of the levels of calcium (Ca^{2+}), magnesium (Mg^{2+}) and bicarbonate (HCO_3^-) ions in the water. Higher levels of these ions classify the water as 'hard' water, and lower levels 'soft' water. This can be measured in various ways but is usually done either as the concentration of free calcium ions (Ca^{2+}) (mg/L) or, calcium hardness because most hard water ions stem from calcium carbonate ($CaCO_3$ in mg/L). For this program, MVCA measures calcium hardness in the field, the result is then multiplied by 0.4 to determine the concentration of calcium freely available in the water. Calcium in freshwater usually falls within the range of 4 to 100 mg/L.

Calcium enters a lake largely through the mineral weathering of rocks (especially marbles and limestones). It is then either used by aquatic organisms for bones or shells or as a component in the cell walls of aquatic plants, and eventually deposits into the sediment of the lake. Because of its importance in shell/body coverings, calcium has been shown to influence zooplankton (small planktonic invertebrates) communities, which are an important food source for many baitfish species. Higher calcium levels are also required for zebra mussels to thrive.

Calcium sampling only occurs as part of the spring sampling protocol.

Secchi Depth

Secchi depth is a measure of water clarity and is collected using a Secchi disc. The Secchi disc is a black and white disc that is lowered into the water on the shady side of the boat to the point where it can no longer be seen. The greater the Secchi depth, the clearer the lake is. The Secchi depth also helps determine the euphotic zone (the depth of water through which light is able to penetrate). Secchi depth can be influenced by the concentration of algae or the presence of other suspended materials in the water. The presence of zebra mussels can also influence Secchi depth as they filter the water and feed on the algae and zooplankton, making the water clearer and possibly increasing Secchi depths. Often a decrease in Secchi depth occurs in unison with an increase in phosphorus. The following guideline shown in Table 2 is used to determine your lake's nutrient status according to Secchi depth.

Secchi disc

Table 2: Interpreting Secchi disc results.

Secchi Depth	Lake Nutrient Status
≥ 5 meters	Oligotrophic – unenriched, few nutrients
3.0 – 4.9 meters	Mesotrophic – moderately enriched, some nutrients
< 3.0 meters	Eutrophic – enriched, higher levels of nutrients

Total Phosphorus

Phosphorus is an essential nutrient for all living organisms as it plays a role in numerous aspects of biological metabolism. It is also the limiting nutrient in biological activity and therefore when phosphorus levels get too high there tend to be adverse effects such as algae blooms. Phosphorus can be found naturally in the environment, as well as in many man-made products such as soaps, detergents, fertilizers and septic waste. Total phosphorus (TP) is measured in micrograms per liter (µg/L).

Kemmerer Bottle

As part of the Lake Monitoring program, two types of total phosphorus levels are measured at each sampling location: euphotic zone phosphorus (TPA) and bottom phosphorus (TPB). All TP samples are filtered through an 80-micron mesh to remove zooplankton which could skew results. The euphotic zone is defined as twice the Secchi depth and is the depth to which light can reach and influence plant growth.

The bottom phosphorus sample is collected at sites that have a depth greater than the euphotic zone, using a device called a Kemmerer Bottle. The bottle is sent down to the appropriate depth, approximately 1 meter off the bottom of the lake, with both ends open. A weight on the rope is then dropped, causing both ends to close when the weight hits the bottle, sealing the sample water in the bottle, providing a discrete volume of water from the appropriate depth.

Total phosphorus levels provide an accepted standard to characterize a lake's trophic status following the general guidelines seen in Table 3. It should be noted that while these numbers provide an idea of a lake's current trophic status, lakes naturally progress over time from oligotrophic to eutrophic, so an 'ideal' trophic status does not exist. Furthermore, natural variation can cause a great deal of change from year to year and even within years, so it is important to look at larger trends rather than one or two exceptional years.

Table 3: Interpreting total phosphorus results.

Total Phosphorus Level	Lake Trophic Status
≤ 10 µg/L	Oligotrophic – unenriched, few nutrients
10.1 – 19.9 µg/L	Mesotrophic – moderately enriched, some nutrients
≥ 20 µg/L	Eutrophic – enriched, higher levels of nutrients

The Provincial Water Quality Objective (PWQO) for total phosphorus in lakes is 20 µg/L (*Water Management, Policies and Guidelines, Provincial Water Quality Objectives of the Ministry of the Environment and Energy. MOE. 1994*). The goal is to keep phosphorus below this level in order to maintain aquatic health and the recreational value of watershed lakes.

pH

The pH scale is a logarithmic measure of the concentration of hydrogen ions in solution. It is a measure of the acidity of a solution and ranges from 0 to 14. A pH of 7 is considered neutral, values above 7 are basic, and values below 7 are acidic. The logarithmic scale means that a change from pH 7 to pH 8 is a ten-fold decrease in the concentration of hydrogen ions in solution.

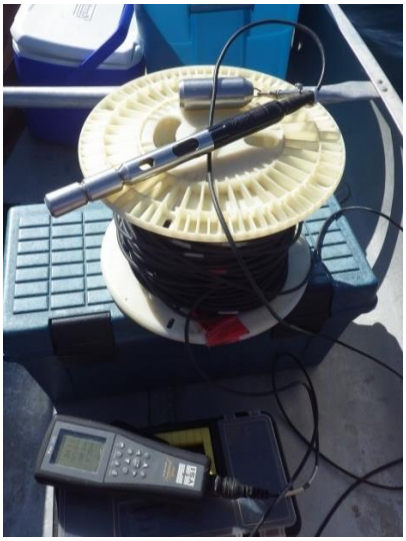
The acidity of a water body affects all chemical reactions within the water. Even small changes in pH can have a large influence on the solubility of some nutrients, including phosphorus, which in turn can influence plant growth. The PWQO

for pH in lakes is 6.5 – 8.5, which ensures optimal conditions for most aquatic species.

Dissolved Oxygen and Water Temperature

Dissolved oxygen (D.O.) is essential to all aquatic life, including fish, invertebrates and bacteria. Many factors can influence dissolved oxygen concentrations in a lake, but two key factors are lake stratification (water temperature) and the amount of phytoplankton (microscopic algae) produced in the lake.

Lake stratification is the separation of the lake into three layers: the epilimnion (top layer), metalimnion (middle layer) and the hypolimnion (bottom layer). Stratification is caused by changes in water temperature with depth, and occurs from late spring to early fall.



Optical Dissolved Oxygen Probe

Deeper water D.O. is at its lowest during the late summer and early fall. This is when the water in the hypolimnion cannot recharge its oxygen concentrations because it is isolated from the atmosphere by the epilimnion and the thermocline (the steep temperature gradient between the warm sunlight epilimnion water and the cooler hypolimnion water below). Also, during the fall the phytoplankton that have been active during the summer months begin to die and settle to the bottom of the lake. The bacteria that decompose the phytoplankton consume large amounts of dissolved oxygen, further depleting stores in the hypolimnion. The low levels of D.O. in the bottom depths of a lake decrease the amount of critical habitat available for cool water fish species to thrive as they can also be stressed by the warmer temperatures in the oxygen rich epilimnion.

Dissolved oxygen and water temperature are measured using an Optical Dissolved Oxygen Probe. This instrument, pictured above, is lowered through the water at one-meter intervals, where it takes both water temperature and D.O. readings. This creates a dissolved oxygen profile where changes in temperature and D.O. can be recorded as depth increases. Table 4 shows the optimal temperature/D.O. combinations for cold, cool, and warm water fish habitat. Results from the D.O. and water temperature profiles for each of the 2022 lake monitoring sites are available in Appendix A.

Table 4: Optimal conditions for different fish habitat.

	Dissolved Oxygen		Water Temperature
Cold Optimal	>6 mg/L	AND	<10 °C
Cool Optimal	>4 mg/L	AND	<15.5 °C
Warm Optimal	>4 mg/L	AND	<25 °C

Source: Coker, G.A., Portt, C.B., & Minns, C.K.(2001). Morphological and Ecological Characteristics of Canadian Freshwater Fishes. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2554.

Main Mississippi River

Dalhousie Lake

Dalhousie Lake is the last main river lake before the Clyde and Fall Rivers join the Mississippi River near Lanark. It is located at the transition between the Canadian Shield and the St. Lawrence lowlands geologic zones. It is a wide and shallow lake with the deepest area at 11 meters, located in the western portion of the lake. The lake provides warm water habitat to northern pike, small and large mouth bass, walleye and other fish species.

A summary of the 2022 sampling results are shown in Table 5 and are compared to past years results in Figure 8. In 2022 Dalhousie Lake experienced moderate levels of total phosphorous in both the euphotic zone and near the bottom of the lake. The lake has maintained a mesotrophic status throughout the ten ice-free seasons that it has been sampled by MVCA. The 2022 sample results further support this classification.

As a large main river lake, Dalhousie will continue to be monitored frequently to track the lake's condition, in particular the high total phosphorus results that occurred in the bottom samples in past years.

The water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 5: 2022 sampling summary for Dalhousie Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)	Calcium (Ca2+) (mg/L)
Main Basin	05/06/2022	4	14	10	32
Main Basin	08/02/2022	3.5	10	11	
Main Basin	09/15/2022	5	2	9	

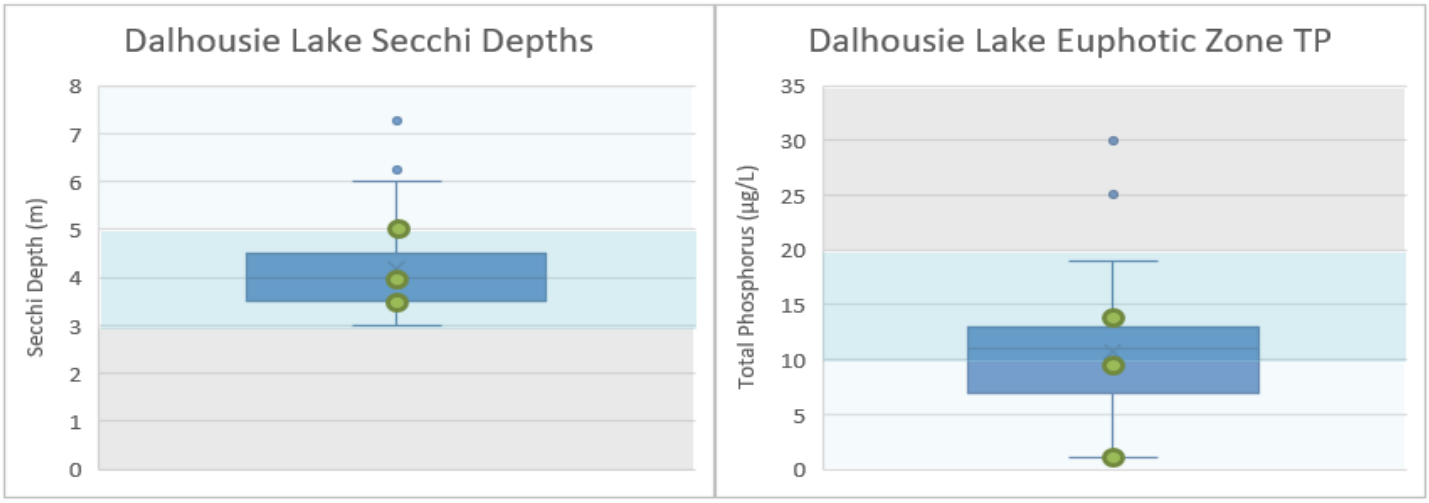


Figure 8: Secchi Depth and Euphotic Zone Total Phosphorus results from ten sampling years for the main basin of Dalhousie Lake. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours.

Mississippi Lake

Mississippi Lake is a large and shallow warm water lake in Lanark County. It is the furthest downstream lake on the main stem of the Mississippi River system and its outlet is at the town of Carleton Place. It has a maximum depth of 10 meters. MVCA has now monitored it through 18 ice-free seasons. A summary of the results from the 2022 survey are presented in Table 6.

Figure 9 illustrates how this year's results for Secchi depth and euphotic zone total phosphorus samples compare with the overall data set for each of the four sampling locations on the lake. The overall historical trend for both Secchi depth results and TP show the lake is predominantly within the mesotrophic classification and the 2022 results further support this classification. While the July total phosphorus results were above the 20 µg/L threshold for eutrophic classification, they are still within the typical range for the lake.

Water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 6: 2022 sampling summary for Mississippi Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L) *	Calcium (Ca2+) (mg/L)
Inlet (MLI)	5/11/2022	4	14	24	40
Inlet	7/13/2022	4	29	36	
Inlet	9/8/2022	6	7	25	
Burnt Island (MLB)	5/11/2022	4.5	7	8	
Burnt Island	7/13/2022	5.5	31	30	
Burnt Island	9/8/2022	4	16	16	
Pretties Island (MLP)	5/11/2022	3.5	6	-	
Pretties Island	7/13/2022	4.5	36	29	
Pretties Island	9/8/2022	3.5	15	18	
Outlet (MLO)	5/11/2022	2.2	9	-	40
Outlet	7/13/2022	2.5	32	-	
Outlet	9/8/2022	2	13	-	

*Total Phosphorus samples are only taken from 1 m off the bottom of the lake if the euphotic zone does not extend to the bottom.

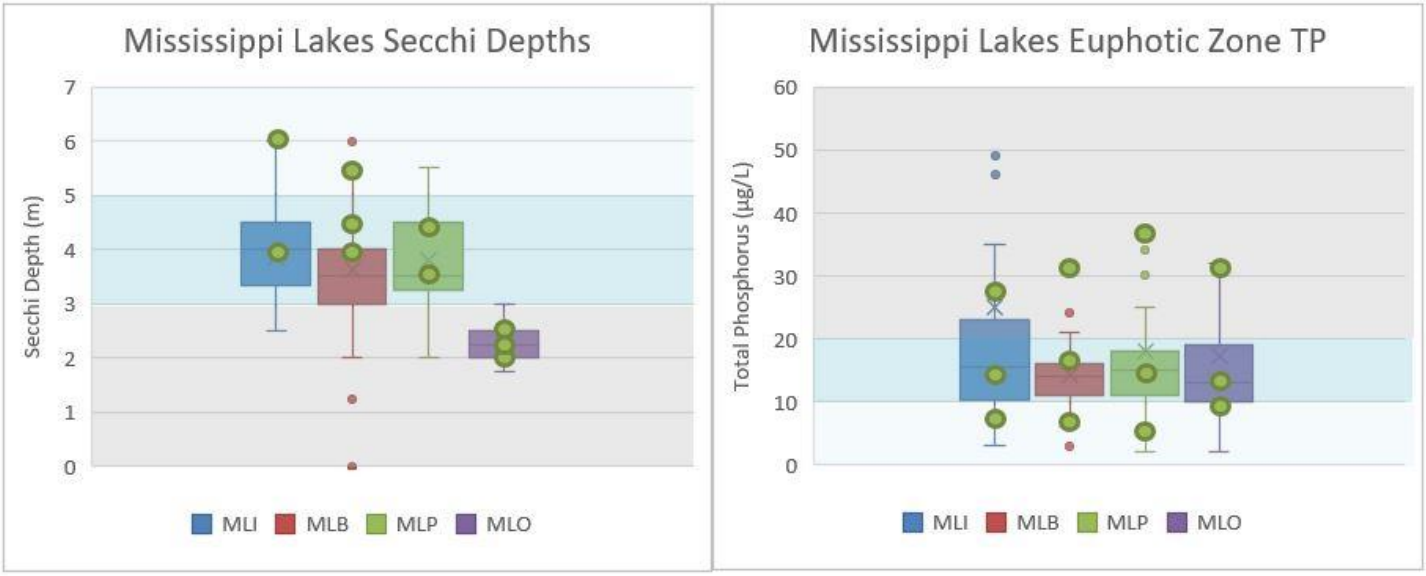


Figure 9: Secchi Depth and Euphotic Zone Total Phosphorus results from 18 sampling years for all four sites. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours. Note: the maximum Secchi depth possible at the outlet site (MLO) is limited by the water depth (3 m) and by a thick bed of aquatic plants inhabiting the area.

Fall River Subwatershed

White Lake

White Lake is a headwater lake in the Fall River subwatershed, north of Sharbot Lake Provincial Park. Its main features include a Ministry of Natural Resources and Forestry Fish Culture Station which uses the lake water to support the reproduction and growth of various sport fish species as part of the fisheries management system in Ontario.

White Lake is 26 m deep and supports cold-water fish habitat for most of the season. To manage the ecosystem of the lake it is listed as a fish sanctuary and angling is strictly prohibited.

As seen in Figure 10, the 2022 total phosphorus values for White Lake place it consistently in the oligotrophic range. The unusually high result from the July sample (44 µg/L) (Table 7) is considered to be an outlier in the data set and is not representative of typical conditions. The Secchi depth results from 2022 indicate high water clarity for most of the season and support the oligotrophic categorization.

Water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 7: 2022 sampling summary for White Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)	Calcium (Ca2+) (mg/L)
Main Basin	05/09/2022	8	9	16	48
Main Basin	07/04/2022	5	44	29	
Main Basin	8/29/2022	4	6	54	

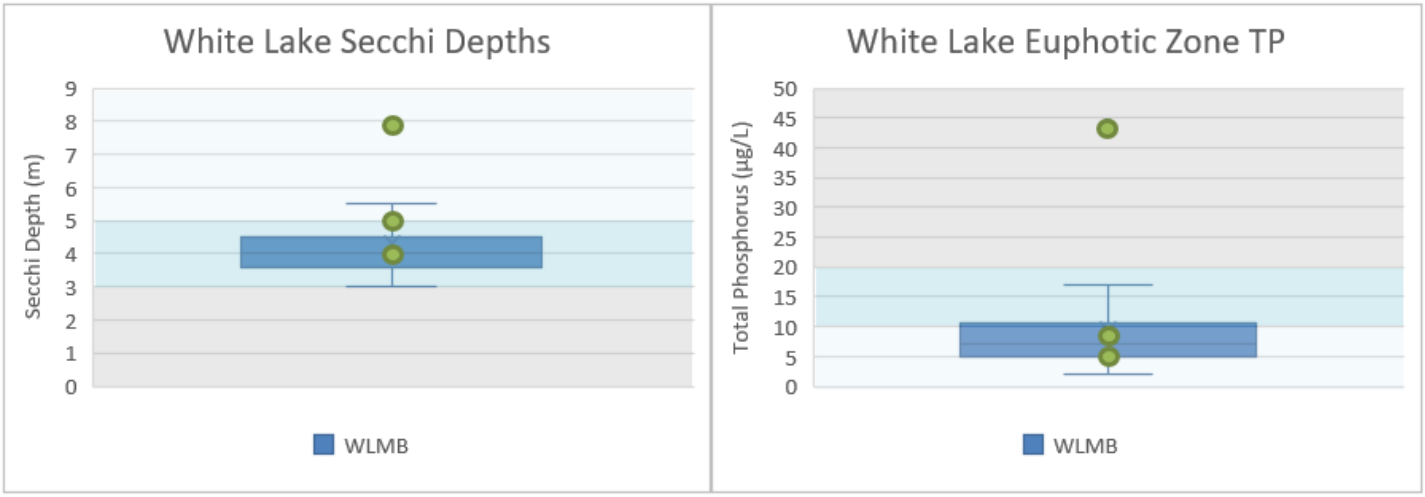


Figure 10: Secchi Depth and Euphotic Zone Total Phosphorus results from five sampling years for the main basin of White Lake. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours.

Black Lake

Black Lake is positioned south of Highway 7 and upstream Sharbot Lake. A portion of this lake is within the boundary of the Sharbot Lake Provincial Park. Park users are able to enjoy the lake from the shore side campsites, the beach or by launching at the park's boat launch. The lake is 18 m deep and supports small and largemouth bass, northern pike, walleye, black crappie and yellow perch.

Black Lake has been sampled four times now, and with the exception of some mesotrophic results in 2011, the lake predominantly classifies as oligotrophic as shown in Figure 11. Table 8 summarizes the 2022 Secchi depth and total phosphorus results which support this classification.

Water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 8: 2022 sampling summary for Black Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)	Calcium (Ca2+) (mg/L)
Main Basin	05/24/2022	6	<2	4	40
Main Basin	08/05/2022	7.5	10	64	
Main Basin	09/25/2022	9	<2	6	

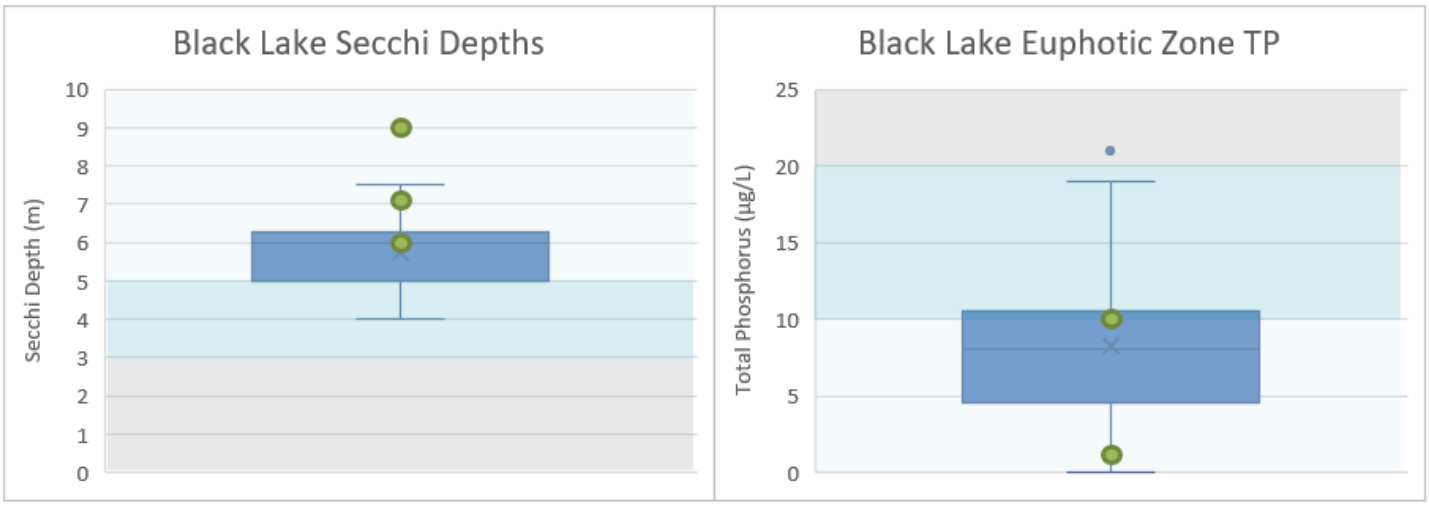


Figure 11: Secchi Depth and Euphotic Zone Total Phosphorus results from four sampling years for the main basin of Black Lake. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours.

Sharbot Lake

Sharbot Lake is predominately a deep (30 m) cold-water lake on the west side of Highway 38 (West Basin). To the east of Highway 38 the lake is shallower and warmer, but also contains a 30 m deep basin (East Basin). The lake is known to support sport fish species such as lake trout, cisco, northern pike, small and large mouth bass and walleye.

Results from the 2022 sampling events can be found in Table 9 and are compared to past results in Figure 12. All four of the July 2022 total phosphorus results were above the 20 µg/L threshold for eutrophic classification while the Secchi depth readings remained within the mesotrophic range. It can also be seen that by the September sample total phosphorus results had dropped to a more expected higher end of the oligotrophic range. As shown in Figure 12 these higher values are out of character for the lake and are possibly due to a sampling error rather than an indicator of shifting nutrient enrichment status. Based on the Secchi depth and surface water total phosphorus results in 2022 (Table 9, Figure 12) the lake maintains a meso-oligotrophic status.

The water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 9: 2022 sampling summary for Sharbot Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)	Calcium (Ca2+) (mg/L)
North West Basin	05/12/2022	4.5	15	18	40
North West Basin	07/07/2022	4.5	25	25	
North West Basin	09/07/2022	4.5	8	16	
Main West Basin	05/12/2022	4.5	16	17	
Main West Basin	07/07/2022	5.5	28	38	
Main West Basin	09/07/2022	5	7	21	
South West Basin	05/12/2022	3.5	5	12	
South West Basin	07/07/2022	4.5	26	34	
South West Basin	09/07/2022	4.5	9	28	
East Basin	05/12/2022	5.5	12	37	40
East Basin	07/07/2022	4	27	32	
East Basin	09/07/2022	4	10	20	

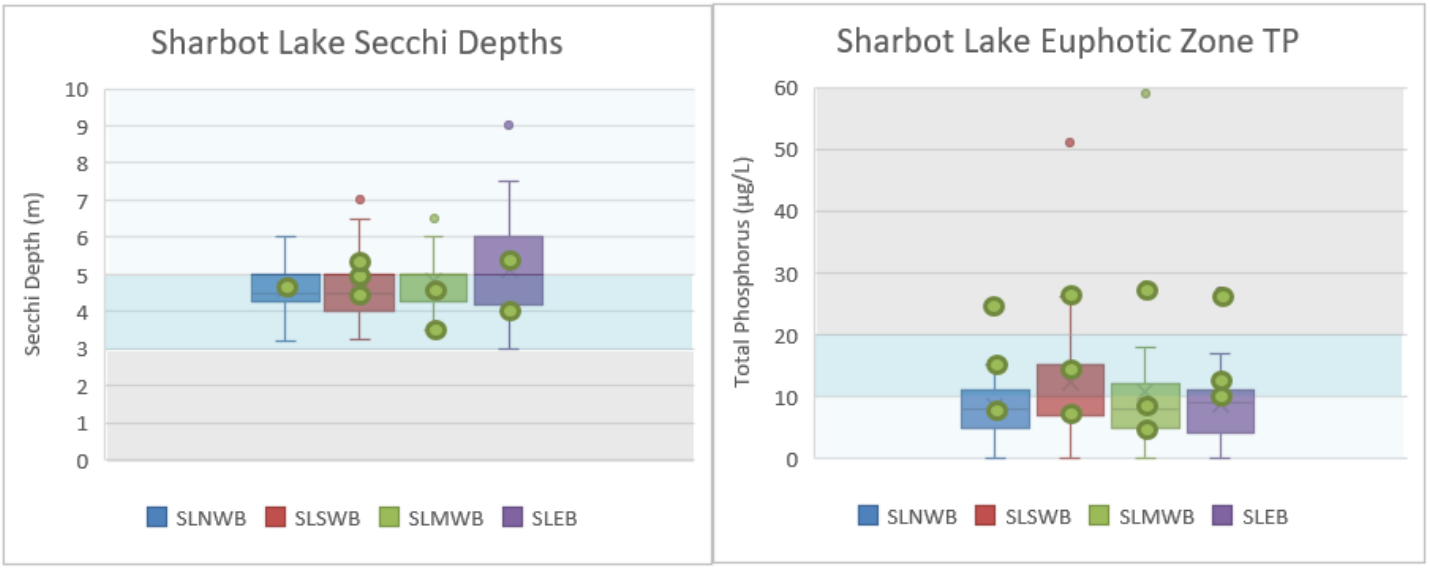


Figure 12: Secchi Depth and Euphotic Zone Total Phosphorus results from six sampling years for Sharbot Lake. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours.

Silver Lake

Silver Lake is a spring fed, headwaters system feeding into the Fall River just east of the community of Sharbot Lake and north of Highway 7. It is a fairly deep lake with a maximum depth of 24 meters. In addition to the Silver Lake Provincial Park, which can be found in the south-east corner of the lake near its outlet, there is also an MTO rest stop with public boat launch accessible from Highway 7. Silver Lake is known to support populations of the cold-water sensitive lake trout, as well as warm water sport fish such as small and large mouth bass, northern pike, black crappie and yellow perch.

In the four years of sampling, Silver Lake has maintained an oligotrophic status with total phosphorus levels generally below 10 µg/L (Figure 13). The 2022 Secchi depth and total phosphorus results are summarized in Table 10. While the July sample showed a higher than average total phosphorus concentration (25 µg/L) the remainder of the Secchi depth and phosphorus results support the classification of the lake as oligotrophic.

Water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 10: 2022 sampling summary for Silver Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)	Calcium (Ca2+) (mg/L)
Main Basin	5/18/2022	6	<2	<2	56
Main Basin	7/15/2022	6	25	25	
Main Basin	9/9/2022	5.5	8	6	

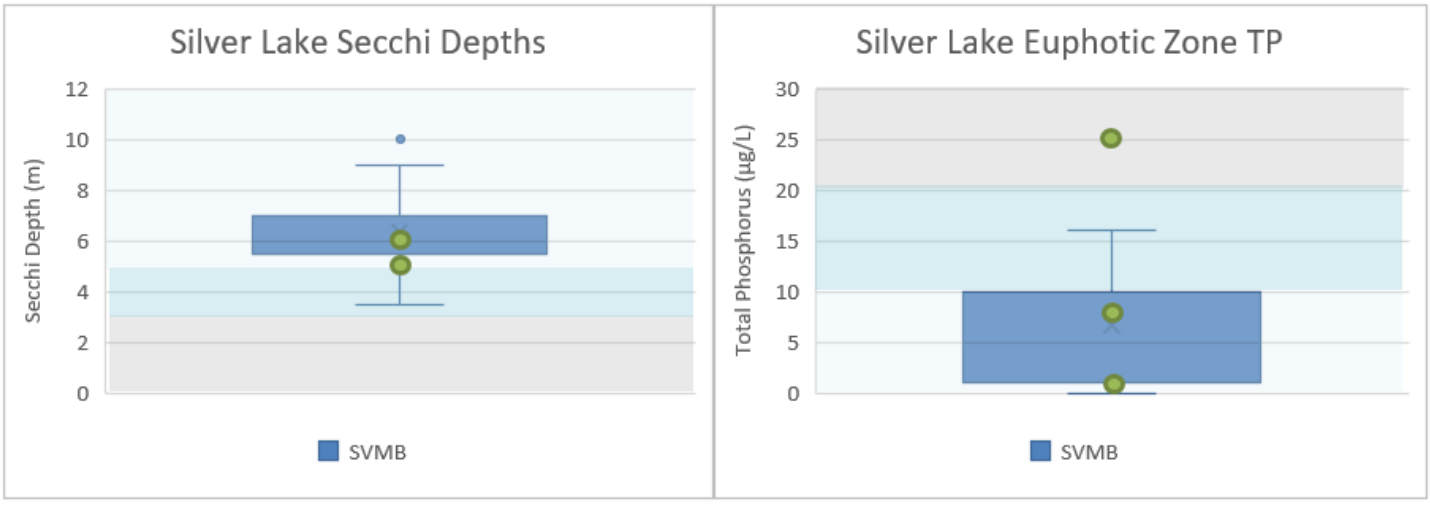


Figure 13: Secchi Depth and Euphotic Zone Total Phosphorus results from five sampling years for the main basin of Clayton Lake. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours.

Bennett Lake

Bennett Lake is a shallow warm water lake located in the Fall River subwatershed, southwest of the village of Lanark. It is the last lake on the system before it outlets into the Mississippi River. The lake is 10 m deep in the south basin, and supports a warm water fishery of small and largemouth bass, northern pike, walleye and yellow perch.

Due to its shallow depth, we expect Bennett Lake to lie in the mesotrophic to eutrophic range. Five years of Secchi depth, and total phosphorus concentration results supports this classification (Figure 14). The results from the 2022 season are summarized in Table 11. It is possible that the extremely high results from the south basin bottom samples are due to hitting the substrate with the sampling equipment. The remainder of the results support the classification of the lake as meso-eutrophic.

Water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 11: 2022 sampling summary for Bennett Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)	Calcium (Ca2+) (mg/L)
North Basin	06/02/2022	5	<2	2	40
North Basin	08/03/2022	3	16	10	
North Basin	09/20/2022	2	13	5	
South Basin	06/02/2022	3.5	10		40
South Basin	08/03/2022	4	2	272	
South Basin	09/20/2022	3	30	435	

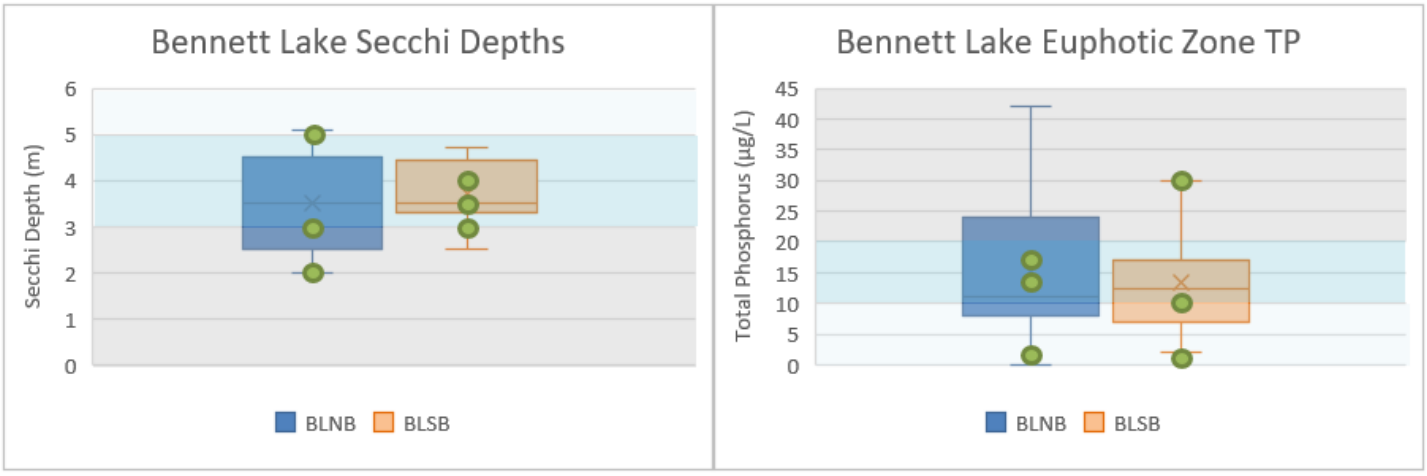
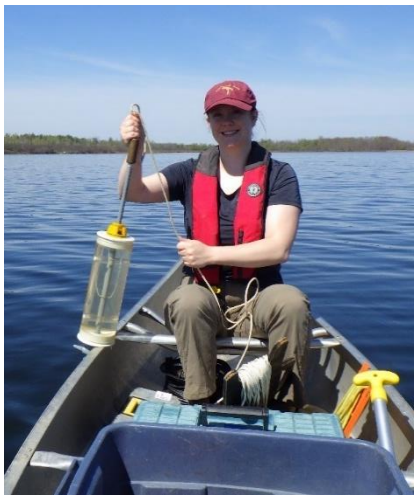


Figure 14: Secchi Depth and Euphotic Zone Total Phosphorus results from five sampling years for both basins in Bennett Lake. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours.

Ottawa River Subwatershed



Constance Lake

Constance Lake is a warm water lake in the City of Ottawa that flows north through Constance Creek to outlet into the Ottawa River at Constance Bay. It has a maximum depth of 3 meters and supports a warm water fishery of largemouth bass, northern pike and yellow perch. Constance Lake differs from most of our monitored lakes as it has a large shoreline wetland ecosystem which has been classified as a Provincially Significant Wetland.

The results from the 2022 season are shown in Table 12 and are compared to past years results in Figure 15. Based on Secchi depths and average euphotic zone total phosphorus results from three sampling seasons the lake is classified as eutrophic. While the July result (40 µg/L) seems high, it is similar to past year's mid-season results. Additionally, similar to past years, the September result is reduced and much closer to the euphotic-mesotrophic classification threshold.

The high total phosphorus results seem reasonable given the highly productive wetland ecosystem that the lake is part of. Longer term monitoring will help increase our understanding of the seasonal variation in results at this site.

The water temperature and dissolved oxygen profile data from the 2022 sampling events are available in Appendix A.

Table 12: 2022 sampling summary for Constance Lake.

Site	Date	Secchi Depth (m)	Total P – Euphotic Zone (µg/L)	Total P – Bottom Sample (µg/L)	Calcium (Ca2+) (mg/L)
Main Basin	5/10/2022	3	15	16	56
Main Basin	7/11/2022	2.5	40	41	
Main Basin	9/6/2022	2.5	22	-	

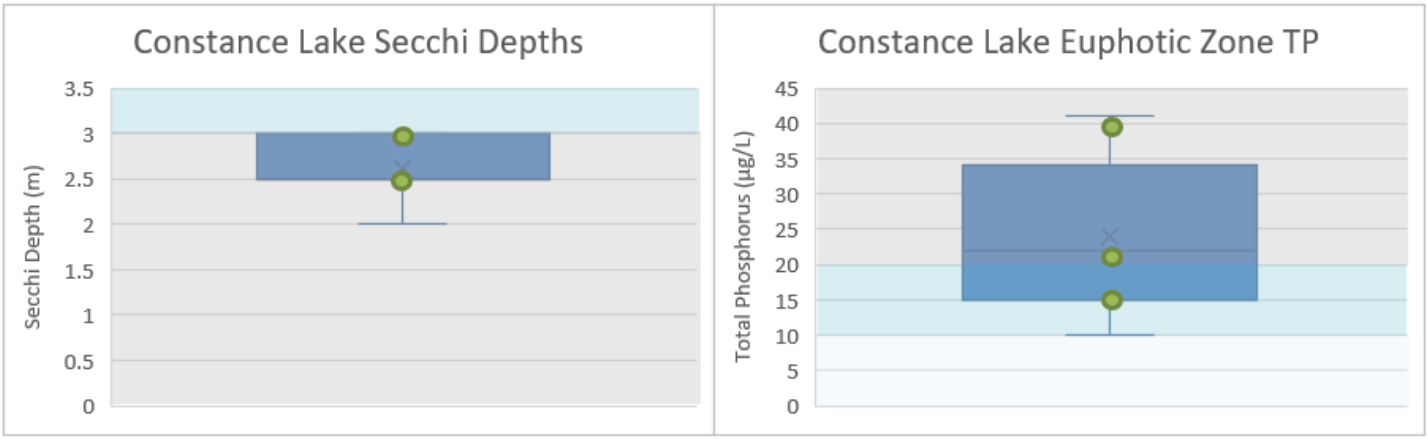


Figure 15: Secchi Depth and Euphotic Zone Total Phosphorus results from three sampling years for the main basin of Constance Lake. The 2022 results are shown with a green dot, and the trophic level classifications are shown with the blue to grey background colours.

Stream Monitoring Program

Summary

While the lake monitoring program focusses efforts on particular subwatershed(s) each year on a rotational basis, stream sampling is also conducted at select additional sites throughout the Mississippi River watershed to help expand MVCA's knowledge of these smaller systems. Due to the Covid-19 pandemic only temperature monitoring data was collected from our streams in 2022. Figure 16 illustrates the locations of these sites across the Mississippi River watershed and Tables 13a and 13b summarizes the stream site thermal results for 2022.

Brook Trout

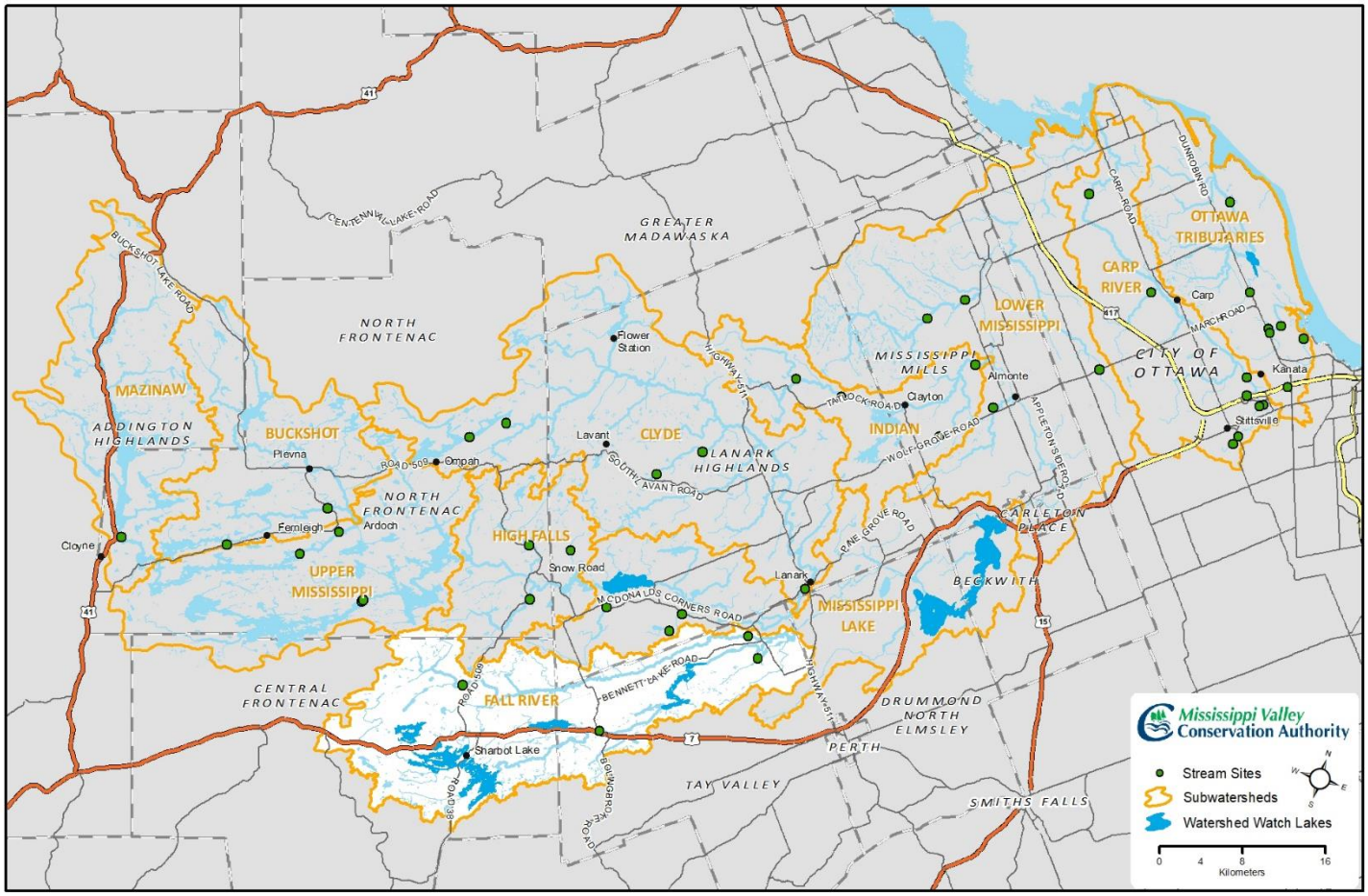


Figure 16: 2022 stream sampling site locations.

Temperature Monitoring

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes, and stream shading from riparian vegetation. The natural year to year variations of water temperatures can be influenced by many factors, (duration and frequency of rain events, flow rates from springs, changes in stream shading, etc.) and can have many impacts on the stress levels and success rates of the cold to cool water fish species that are found in the creek. Water temperature is used along with the maximum air temperature (using the revised Stoneman and Jones method by Cindy Chu *et al, 2009*) to classify a watercourse as either cold, cold-cool, cool, cool-warm, or warm water. Refer to Tables 13a and 13b for a summary of the thermal classification results from the 2022 season.

Deploying a temperature logger

Temperature loggers were launched at 21 stream sites in the Mississippi River watershed, and 1 site in the Constance Creek watershed, to investigate thermal habitat availability and to continue monitoring known cold to cool water streams for potential variations due to changes in annual climate. As discussed further in the Water Quantity Summary, the 2022 had average rainfall for both April and May that, coupled with the spring melt, resulted in average flows as the season moved into June. Rainfall for June, July and August was above average, eliminating any concerns about a drought occurring this year.

Analysis of the temperature logger data indicates that the July and August rain events contributed water to the system that likely resulted in the majority of the sites either maintaining past thermal classifications or cooled the site by a classification level. There is a need for continued monitoring at stations prone to fluctuate between categories to determine if the observed thermal fluctuations are an ongoing trend or a temporary result due to the conditions experienced in the dryer vs wetter summers.

Ten of the sites monitored in 2022 recorded a cooling change of thermal regime by one catigory compared to last year's analysis. The presence of this variability in the long-term sites shows the short-term sensitivity of each catchment to seasonal weather patterns and the need for long term monitoring to understand the potential for longer term shifts in climate impacts.

Water temperature in Paul's Creek has now been monitored for seven consecutive ice-free seasons. In 2017 the creek was classified as cool, however in 2018 the system warmed to a cool-warm system and has stayed within that range until it was again classified as cool in 2022.

Not far from Paul's Creek, the downstream reach of Long Sault Creek held a cool status from 2017-2020 and then cooled to cold-cool status in 2021 which was maintained in 2022.

MVCA has monitored the downstream reach of Bolton Creek for six summer seasons and like Paul's Creek it had a similar warming and then cooling pattern over those years. It has gone from a cool-warm classification in 2017 to a warm classification from 2018-2021, and then was classified as cool-warm again in 2022. In addition to the long-term monitoring near the creek's outlet, this year MVCA also launched a logger in the upper reach of Bolton Creek where it crosses Burkes Settlement Road and was able to classify that reach as cool water habitat. This is a very long creek that

flows through a diverse landscape of wetlands and forests and it is beneficial to be able to learn more about its varied character through our monitoring efforts.

Mosquito Creek has been monitored for five consecutive years now and results have shown it to fluctuate between being a cool to a cold-cool habitat, with its most recent classification being in the cold-cool range.

Despite the either stability, or cooling of the majority of our monitoring sites in 2022, six of the sites were found to of warmed by a level. It's possible this may be linked to the loggers ending up out of water for a portion of the summer, or it could be associated with other variability in the local conditions. This reinforces the importance of creating robust long-term data sets.

Table 13a: A summary of the Mississippi River watershed stream sites sampled in 2022 with their thermal classification results. *Note, it may take many years of classification analysis to account for annual weather influences.

Subwatershed	Stream Name	2022 Thermal Classification	Number of Years Monitored	Thermal Trend Direction*
Buckshot Creek	Swamp Creek	Warm	2	Up
Clyde River	Easton's Creek - Black Creek Rd	Cool-Warm	2	Up
Clyde River	Easton's Creek - Dalhousie 2nd Conc.	Cool-Warm	3	Stable
Constance Creek	Harwood Creek	Cold-Cool	3	Stable
Fall River	Bolton – Hunter Sd road	Cool-Warm	6	Down
Fall River	Bolton – Burkes Settlement Rd	Cool	1	
Fall River	Fall River at Maberly	Cool-Warm	1	
Fall River	Limekiln Creek	Cool	3	Down
High Falls	Antoine Creek	Cold-Cool	3	Down
High Falls	Mosquito Creek	Cold-Cool	5	Down
Indian River	Indian River at stream gauge	Cool-Warm	2	Down
Indian River	Indian River at Tatlock Ed	Cool-Warm	1	
Indian River	Indian River at trail off Darling 7th	Warm	2	Up
Indian River	Union Hall Creek	Cool	2	Stable
Lower Mississippi	Cody Creek	Cool	3	Stable
Lower Mississippi	Indian Creek - Pakenham 9th Conc	Cool	2	Down
Lower Mississippi	Indian Creek - Sugar Bush Rd	Cool-Warm	2	Down
Lower Mississippi	Wolf Grove Creek	n/a		
Mississippi Lakes	Black Creek	n/a		
Mississippi Lakes	Long Sault - DS – Milton's Rd	Cold-Cool	7	Stable
Mississippi Lakes	Long Sault US – Dalhousie 9th Con A	Warm	2	Stable
Mississippi Lakes	Paul's Creek	Cool	7	Down
Upper Mississippi	Gull Creek	Cold-Cool	2	Down

Table 13b: A summary of the Carp River and Ottawa Tributaries stream sites sampled in 2022 with their thermal classification results. *Note, it may take many years of classification analysis to account for annual weather influences.

Subwatershed	Stream Name	2022 Thermal Classification	Number of Years Monitored	Thermal Trend Direction*
Carp River	Carp River at John Shaw Road	Cool-Warm	2	Up
Carp River	Corkery Creek (downstream)	Cool	3	Small up
Carp River	Corkery Creek (upstream)	Cool	2	Down
Carp River	Feedmill Creek	Cool-Warm	2	Up
Carp River	Poole Creek (downstream)	Cool-Warm	4	Stable
Carp River	Poole Creek (midstream)	Cold-Cool	3	Stable
Carp River	Poole Creek (upstream)	n/a		
Ottawa Tributaries	Constance Creek	n/a		
Ottawa Tributaries	Harwood Creek	Cold-Cool	2	Stable
Ottawa Tributaries	Shirley's Brook (downstream)	Cool-Warm	3	Stable
Ottawa Tributaries	Shirley's Brook (midstream)	Cool	1	
Ottawa Tributaries	Watt's Creek (downstream)	n/a		
Ottawa Tributaries	Watt's Creek (upstream)	Cold-Cool	1	

Rainbow Trout

Shoreline Stewardship

MVCA's Tree Planting Programs

Shoreline tree planting is an effective way to protect water quality, combat erosion, clean the water, and create healthy habitat for fish, birds, pollinators and other wildlife.

MVCA administers a small-scale shoreline planting program where MVCA staff conduct a site visit then work with the property owners to design a shoreline planting plan that will suit their property's needs. MVCA then orders, delivers and installs the plants according to the agreed upon plan. In 2022, this program resulted in 280 trees and shrubs being planted across 8 properties.

For the past six years, MVCA has been working with a select number of lake associations on a rotational basis to pilot a tree day event, where property owners are offered up to 15 shoreline plants per property. In 2022, MVCA partnered with the Mazinaw Lake Association, the Silver Lake Association, and the Bennett and Fagan Lakes Association to distribute 916 plants to 59 properties. Due to the continued success of this program within the lake community, MVCA will be working with Palmerston Lake, Canonto Lake, and the Malcolm and Ardoch Lake Associations in 2023.

Lake Planning

2022 Activity Summary

MVCA has a mandated role to address natural hazard issues, such as flooding and erosion in the review of planning applications under the Planning Act. Additionally, in an advisory role, applications are reviewed within the context of Natural Heritage values such as wetlands, wildlife and fish habitat; as well as water quality and quantity. MVCA also administers Ontario Regulation 153/06. The purpose of this regulation is to prevent loss of life and property due to flooding and erosion, and to conserve and enhance natural resources. In MVCA regulated areas (floodplains, shorelines and wetlands), permission is required from MVCA for development, interference with wetlands, and alterations to shorelines and watercourses.

In 2022, MVCA planning and regulations staff reviewed 35 permit applications on the lakes monitored in 2022. This represents 17% of the total permits issued in 2022.

Having reliable information about the health of a lake is essential for providing appropriate and effective recommendations on development applications. The monitoring information is often used in the review of planning applications and may assist in developing mitigation recommendations so impacts of development are minimized.

Monitoring of our lakes also informs shoreline residents, both seasonal and permanent, of the lake health which encourages them to become stewards of their lake by taking an active role in restoring and enhancing their shoreline. Stewardship initiatives that protect and enhance water quality include temporarily storing water (eg. rain barrels), directing runoff away from the lake (e.g. installing properly working eavestroughs), creating or enhancing surfaces to allow more water to infiltrate rather than run off along the surface (e.g. rain gardens), and planting trees and shrubs along the shoreline.

Appendix A: Water Temperature and Dissolved Oxygen Profile Details

The results from the 2022 temperature and dissolved oxygen profiles from all the lake sampling events are presented below in alphabetical order. For the lakes with appropriate cool to cold water conditions, a colour code has been applied to the table representing optimal cold-water habitat conditions (in blue) and the fringe vital conditions for survival (in pink) as defined in Table A-1. Some of the warm water lakes may be shown to have these conditions periodically but they do not last throughout the season and thus the lake only supports a warm water fishery.

Table A-2 summarizes the thermal classifications for the lakes sampled in 2022. Some of the cold-water lakes may no longer support certain cold-water fish species (such as lake trout) due to historical stocking activities or water level management efforts.

Table A-1: Optimal and vital habitat conditions for cold water fish species such as Lake Trout.

	Optimal Habitat for Cold Water Fisheries (Trout) = DO > 6 mg/L at < 10°C
	Vital Habitat for Cold Water Fisheries (Trout) = DO > 4 mg/L at < 15.5°C

Table A-2: List of cold water and warm water lakes monitored in 2021.

Cold Water Lakes	**Warm Water Lakes**
Sharbot Lake (west)	Sharbot Lake (east)
White Lake	Bennett Lake
Black Lake	Dalhousie Lake
Silver Lake	Mississippi Lake
	Constance Lake

Bennett Lake

South Basin

	2-Jun-22		2-Aug-22		20-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	20.90	8.73	24.10	8.58	19.60	9.33
1	21.00	8.68	24.10	8.56	19.70	9.28
2	21.00	8.67	24.10	8.53	19.70	9.25
3	20.80	9.08	24.10	8.51	19.70	9.21
4	18.90	8.67	24.10	8.47	19.70	9.18
5	15.00	8.26	23.50	7.28	19.70	9.15
6	13.10	8.06	18.00	0.78	19.70	9.02
7	11.50	6.55	14.40	0.68	16.60	0.91
8	10.10	5.39	11.70	0.95	12.40	0.74
9	9.50	4.11	10.30	0.65	10.40	0.67
10	9.10	2.85	9.60	0.58	9.70	0.65
11	8.90	2.27				
12	8.80	1.86				

North Basin

	2-Jun-22		2-Aug-22		20-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	20.60	9.13	23.90	8.83	19.60	8.86
1	20.60	9.11	24.20	8.75	19.70	8.80
2	20.60	9.00	24.20	8.66	19.80	8.68
3	20.50	9.06	24.30	8.51	19.80	8.57
4	20.40	8.83	24.30	8.46	19.80	8.54
5	9.20	8.08	24.30	8.45	19.80	8.51
6	17.30	6.73	24.10	1.60	19.80	8.49

Black Lake

Main Basin

	24-May-22		5-Aug-22		25-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	18.10	9.76	25.20	8.45	17.90	9.55
1	18.00	9.77	25.00	8.43	18.00	9.52
2	18.00	9.72	24.60	8.40	18.00	9.50
3	17.90	9.66	24.50	8.36	18.00	9.48
4	13.50	12.36	24.50	8.39	18.00	9.46
5	11.10	13.55	23.50	8.88	18.00	9.45
6	9.60	13.15	16.00	12.64	17.70	9.41
7	8.30	12.34	12.80	12.55	17.20	9.51
8	7.00	10.80	10.00	11.84	11.80	10.22
9	6.20	9.47	8.90	11.00	9.70	7.80
10	5.80	8.00	7.90	8.35	8.60	5.74
11	5.50	7.31	6.80	4.51	7.60	3.56
12	5.40	6.76	6.40	2.62	7.10	1.50
13	5.30	6.45	6.00	1.70	6.40	0.90
14	5.20	6.21	5.70	0.92	6.10	0.73
15	5.10	6.01	5.60	0.75	5.90	0.67
16	5.10	3.14	5.40	0.70		
17			5.40	0.67		
18			5.30	0.64		
19			5.30	0.62		
20			5.20	0.58		

Constance Lake

Main Basin

	10-May-22		11-Jun-22		6-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	16.80	10.22	23.90	11.80	21.50	9.20
1	16.50	10.29	23.80	11.85	21.50	9.21
2	16.30	10.26	23.70	11.78	21.40	9.36
3	15.60	5.70			21.40	9.14

Dalhousie Lake

Main Basin

	6-May-22		2-Aug-22		15-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	12.00	11.08	23.90	8.59	20.50	8.78
1	11.90	11.12	23.90	8.58	20.60	8.75
2	11.90	11.09	23.90	8.51	20.60	8.71
3	11.80	11.10	23.90	8.45	20.60	8.69
4	11.80	11.09	23.90	8.40	20.70	8.65
5	11.80	11.06	23.80	8.28	20.70	8.63
6	11.80	11.05	23.80	8.20	20.70	8.63
7	11.80	11.01	21.10	3.44	20.60	8.62
8	11.70	9.51	17.30	0.85	20.00	6.40
9					18.30	1.59
10					14.40	0.68

Mississippi Lake

Inlet

	11-May-22		13-Jul-22		8-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	16.90	10.02	24.40	8.55	20.90	9.13
1	16.80	10.04	24.10	8.55	20.50	9.11
2	16.70	10.02	23.80	8.53	20.30	9.03
3	16.50	9.94	23.70	8.48	202.00	8.90
4	16.50	9.89	23.60	8.26	20.20	8.86
5	16.40	9.92	22.40	5.45	20.10	8.90
6	16.30	9.85	22.30	5.34	20.10	8.84
7	16.00	9.81	21.70	8.80	20.00	8.70
8	15.70	9.66	19.20	0.72	19.50	6.23
9			17.30	0.64	16.70	1.10
10					15.20	0.75

Burnt Island

	11-May-22		13-Jul-22		8-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	17.00	10.44	24.10	8.62	22.30	9.40
1	16.80	10.45	23.40	8.53	21.40	9.50
2	16.50	10.53	23.00	8.53	21.10	9.75
3	14.70	10.92	22.90	8.48	20.90	9.40
4	13.60	10.64	22.80	8.44	20.80	9.36
5	13.30	10.24	22.80	8.40	20.70	9.32
6	13.00	10.22	22.80	8.35	20.70	9.27
7	12.90	10.17	22.70	8.25	20.60	9.18
8			22.70	8.25		
9			22.60	8.22		

Pretties Island

	11-May-22		13-Jul-22		8-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	16.60	10.95	24.30	8.65	22.10	9.55
1	15.60	10.99	24.00	8.66	21.70	9.48
2	14.60	10.97	23.70	8.62	21.20	9.41
3	13.50	10.82	23.40	8.45	21.00	9.36
4	13.00	10.54	23.30	8.35	20.90	9.32
5	12.80	10.38	23.20	8.18	24.90	9.31
6	12.60	8.65	23.00	8.13	20.60	8.80
7			23.00	8.09		

Outlet

	11-May-22		13-Jul-22		8-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	17.60	11.12	25.10	8.57	22.00	9.87
1	17.10	11.21	24.10	8.39	20.70	10.76
2	16.80	11.23	23.30	9.78	20.50	10.98

Sharbot Lake

South West Basin

	12-May-22		7-Jul-22		7-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	19.70	10.24	24.00	8.72	20.80	9.15
1	18.40	10.35	23.40	8.78	20.70	9.13
2	13.80	11.49	23.10	8.81	20.70	9.11
3	11.80	11.46	22.90	8.81	20.70	9.06
4	10.60	11.39	22.40	8.60	20.60	9.04
5	10.00	11.21	20.90	8.13	20.60	9.01
6	9.60	11.11	15.70	7.14	20.60	8.95
7	9.00	10.98	11.60	6.56	17.10	2.73
8	8.60	10.78	10.20	5.66	12.70	1.15
9	8.30	10.52	9.40	4.25	11.20	0.77
10	7.90	10.22	9.00	3.22	10.40	0.68
11	7.60	9.83			9.60	0.61

Main West

	12-May-22		7-Jul-22		7-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	19.60	10.90	23.70	8.64	20.90	9.35
1	16.70	11.25	22.80	8.73	20.90	9.32
2	13.80	11.76	22.50	8.71	20.80	9.32
3	11.80	11.93	22.40	8.69	20.80	9.29
4	10.10	11.93	22.20	8.38	20.80	9.25
5	9.50	11.78	20.40	8.08	20.70	9.22
6	9.20	11.69	16.10	8.25	20.70	9.18
7	8.80	11.55	12.50	8.31	17.60	6.61
8	8.50	11.45	10.60	8.47	13.70	7.04
9	8.30	11.35	9.60	8.56	11.40	7.21
10	7.90	11.27	8.60	8.63	9.90	7.32
11	7.60	11.21	8.10	8.71	9.00	7.48
12	7.10	11.10	7.70	8.72	8.40	7.61
13	6.60	11.01	7.20	8.67	7.80	7.56
14	6.40	10.92	6.90	8.63	7.20	7.40
15	6.20	10.89	6.70	8.60	6.80	7.67
16	6.20	10.85	6.40	8.66	6.60	7.72
17	6.10	10.80	6.20	8.56	6.40	7.74
18	6.00	10.77	6.10	8.48	6.30	7.11
19	5.90	10.73	6.00	8.39	6.20	7.04
20	5.80	10.68	5.90	8.26	6.10	6.92
21	5.70	10.60	5.80	8.12	6.00	6.86
22	5.70	10.53	5.80	7.84	5.90	6.68
23	5.60	10.51	5.70	7.73	5.90	5.97
24	5.60	10.44	5.70	7.55	5.80	5.62
25	5.60	10.37	5.70	7.35	5.80	5.32
26	5.50	10.35	5.60	6.50	5.70	4.84
27	5.50	10.27	5.60	6.37	5.70	4.21
28	5.50	10.17	5.60	6.10	5.70	3.71
29	5.40	10.07	5.60	2.90		
30	5.40	9.92				
31	5.30	9.12				

North West

	12-May-22		7-Jul-22		7-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	18.70	10.61	23.80	8.67	20.90	9.30
1	16.70	10.98	23.40	8.70	20.90	9.28
2	15.00	11.51	22.80	8.76	20.80	9.27
3	12.70	11.75	22.60	8.73	20.80	9.25
4	11.00	11.86	22.10	8.52	20.80	9.21
5	10.30	11.83	20.10	8.25	20.80	9.16
6	9.60	11.66	16.60	8.10	20.70	9.13
7	9.20	11.52	13.30	8.09	20.70	9.10
8	8.90	11.29	10.90	8.37	13.90	7.00
9	8.20	11.15	9.60	8.36	11.30	7.15
10	7.60	11.06	8.60	8.39	9.90	7.09
11	7.10	10.96	8.00	8.39	8.90	7.04
12	6.70	10.87	7.70	8.38	8.40	7.00
13	6.50	10.84	7.30	8.31	7.90	6.89
14	6.30	10.77	7.00	8.14	7.40	6.43
15	6.20	10.72	6.90	8.07	7.20	6.24
16	6.10	10.69	6.70	7.76	7.00	6.06
17	6.00	10.63	6.60	7.62	6.90	5.73
18	6.00	10.61	6.50	7.49	6.80	5.55
19	5.90	10.57	6.50	7.42	6.80	5.35
20	5.90	10.50	6.50	7.31	6.80	5.06
21	5.80	10.46	6.50	7.23	6.70	4.94
22	5.80	10.40	6.40	7.19	6.70	4.75
23	5.80	10.37	6.40	7.12	6.70	4.58
24	5.80	10.35	6.40	7.10	6.60	4.45
25	5.80	10.33	6.40	6.95		
26	5.70	10.20	6.40	6.91		
27	5.60	10.10	6.40	6.85		
28			6.40	6.79		
29			6.40	6.67		

East Basin

	12-May-22		7-Jul-22		7-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	19.10	10.39	25.00	8.54	21.00	9.04
1	16.40	11.19	23.70	8.65	21.00	9.02
2	14.60	11.51	23.00	8.74	21.00	8.97
3	13.50	11.49	22.80	8.67	20.90	8.91
4	11.80	11.52	22.70	8.62	20.90	8.88
5	10.80	11.36	22.50	8.42	20.90	8.88
6	10.20	11.21	21.10	6.56	20.80	8.93
7	9.80	11.08	17.50	5.63	20.80	8.92
8	9.50	11.02	14.00	5.83	19.90	5.77
9	9.30	10.96	12.10	6.55	14.30	1.41
10	9.00	10.88	10.60	6.56	11.40	1.78
11	8.70	10.85	9.90	6.71	10.60	1.77
12	8.40	10.82	9.40	6.86	9.90	1.68
13	8.30	10.81	9.00	7.05	9.50	2.38
14	8.00	10.81	8.80	7.17	9.30	2.72
15	7.80	10.78	8.50	7.22	9.00	3.23
16	7.70	10.72	8.30	7.31	8.70	3.62
17	7.60	10.71	8.00	7.38	8.40	3.89
18	7.50	10.68	7.90	7.29	8.20	4.01
19	7.30	10.62	7.80	7.30	7.80	3.93
20	7.20	10.51	7.70	7.30	7.70	3.81
21	11.10	10.47	7.50	7.20	7.60	3.68
22	7.00	10.42	7.50	7.12	7.60	3.69
23	6.90	10.35	7.40	7.05	7.60	3.57
24	6.90	10.29	7.40	7.00	7.60	3.42
25	6.80	10.22	7.40	6.85	7.50	3.33
26	6.60	10.13	7.30	6.71	7.50	3.12
27	6.50	10.02	7.30	6.60	7.50	2.65
28	6.50	9.97	7.20	6.39	7.40	2.29
29	6.30	9.75	7.20	6.15	7.40	2.20
30	6.20	2.70				

Silver Lake

Main Basin

	18-May-22		15-Jul-22		9-Sep-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	17.50	9.80	23.80	8.67	21.70	9.01
1	17.50	9.78	23.40	8.72	21.60	9.00
2	16.20	9.94	23.30	8.70	21.40	9.05
3	15.30	10.60	23.20	8.66	21.20	9.05
4	14.60	10.99	23.10	8.62	21.10	9.00
5	11.50	11.77	22.80	8.59	21.10	8.93
6	10.30	11.69	21.40	8.93	21.00	8.90
7	9.50	11.49	16.00	10.31	20.50	8.66
8	9.10	11.37	12.40	10.48	16.70	9.56
9	8.60	11.22	10.90	10.45	13.00	9.64
10	7.90	11.00	9.70	10.26	10.50	9.02
11	7.60	10.86	8.80	9.55	9.40	8.63
12	7.30	10.75	8.20	9.45	8.70	8.35
13	7.20	10.70	7.80	9.36	8.10	8.10
14	7.10	10.65	7.50	9.02	7.60	7.48
15	6.90	10.57	7.20	8.71	7.20	7.04
16	6.70	10.44	6.90	8.46	7.00	7.76
17	6.50	10.34	6.80	8.19	6.80	6.49
18	6.40	10.24	6.60	8.06	6.70	5.85
19	6.30	10.18	6.50	7.85	6.60	5.45
20	6.30	10.08	6.40	7.50	6.50	4.94
21	6.20	9.98	6.40	7.11	6.40	3.82
22	6.10	9.76	6.30	6.07	6.30	3.43
23			6.20	5.72	6.30	2.54
24			6.20	5.31	6.20	0.83

White Lake

Main Basin

	9-May-22		4-Jul-22		29-Aug-22	
Depth (m)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)	Temp (°C)	D.O. (mg/L)
0.1	13.40	11.17	23.10	9.53	24.10	8.52
1	13.10	11.19	22.80	9.74	24.00	8.54
2	12.30	11.36	22.50	9.57	23.80	8.59
3	12.20	11.37	22.40	9.53	23.70	8.58
4	12.00	11.37	22.40	9.46	23.50	8.52
5	11.30	11.48	22.30	9.43	23.50	8.47
6	10.30	11.69	21.90	9.69	23.40	8.41
7	10.20	11.70	17.20	12.09	22.80	8.37
8	9.80	11.66	12.60	12.57	18.60	10.47
9	9.00	11.56	11.30	12.25	14.50	10.28
10	8.30	11.28	10.40	11.40	12.40	9.61
11	7.70	10.94	9.20	10.24	10.80	7.91
12	7.40	10.63	8.70	9.25	10.00	6.65
13	7.10	10.57	8.10	7.89	8.90	3.91
14	6.80	10.28	7.80	7.11	8.20	3.05
15	6.50	9.84	7.30	5.95	7.70	1.31
16	6.20	9.50	7.00	5.00	7.40	0.89
17	6.10	9.38	6.70	4.65	7.20	0.77
18	6.00	9.31	6.50	4.20	6.80	0.71
19	6.00	9.22	6.40	3.40	6.50	0.68
20	5.90	9.21	6.30	3.22	6.30	0.66
21	5.80	9.12	6.20	2.98	6.30	0.64
22	5.70	8.92	6.10	2.73	6.20	0.63
23	5.70	8.78	6.00	2.19	6.10	0.61
24	5.70	8.62	5.90	1.77	6.10	0.60
25	5.60	8.02	5.90	1.15	6.00	0.58
26	5.60	7.77	5.70	0.80		
27			5.70	0.67		