Indian Lake
2025 Water Quality Report

The City *of* Worcester
Department of Sustainability and Resilience
Lakes and Ponds Program

Summary

The following report is presented by the City of Worcester Department of Sustainability and Resilience (DSR), Lakes and Ponds Program (L&P). It details the program's water quality monitoring results, management activities and outreach efforts at Indian Lake in 2025. The "State of the Lake" will be rated "Excellent", "Good", "Fair", or "Poor" based on the results' implications on water quality and recreational value. This report will also outline projects and opportunities the City of Worcester's Lakes and Ponds Program (L&P) intends to implement at Indian Lake in 2026.

Indian Lake is impacted by the urban environment. Indian Lake can face challenges including lake closures due to cyanobacteria and fecal bacteria, high nutrient levels, low water clarity, and excessive plant growth. However, management by community groups and the City of Worcester Lakes and Ponds Program has led to water quality that supports a healthy ecosystem and a wide variety of recreational opportunities. ***In 2025, Indian Lake received a score of "Fair"***. Continue reading to learn more about this rating and L&P's work at Indian Lake.

Background

Originally a natural 100-acre lake called North Pond, Indian Lake was dammed and expanded in the 1800s to 220 acres in order to supply water to the Blackstone Canal until its closure in 1848. More recently, the construction of I-190 reduced the lake's area to its current size of 190 acres. The Commonwealth considers Indian Lake a "Great Pond", as it was larger than 10 acres in its original state and is therefore within the jurisdiction of Chapter 91, a law protecting public rights to access a waterway. Much of the shoreline of the lake is zoned as residential and privately owned, although there are three city parks allowing public access to the water (See Figure 1). I-190 borders the lake on its northeastern shore. Indian Lake's main tributary is Ararat Brook, which enters from the north. The lake empties over a spillway into a culvert on the eastern side of the lake, which eventually flows south into Salisbury Pond. Sears Island is residentially populated and is connected by a causeway to the mainland. To the south is a small pond called Little

Indian Lake, which is connected to the main lake by a small culvert under Grove Street. Indian Lake has a maximum depth of about 17 feet, with the deepest point in the northeastern portion.

Indian Lake is popular for recreation, with two City-maintained beaches, Shore Park and Indian Lake Beach at Clason Road, as well as a City-maintained boat ramp at Morgan Park. The lake supports swimming, fishing, motorized and non-motorized boating, and water skiing. Indian Lake is home to a variety of sport fish including largemouth bass, smallmouth bass, white perch, yellow perch, black crappies, bluegills, pumpkinseeds, carp, and northern pike.

Figure 1 – *View of Indian Lake from Morgan Park.*

As an urban lake, Indian Lake is impacted by the pressures of the city. It is listed on the Massachusetts Impaired Waters 303d List as Category 4a for low dissolved oxygen and non-native plants. It received a Total Maximum Daily Load (TMDL), or a nutrient budget, for phosphorus in 2002. Cyanobacteria have historically been a challenge at the lake, sometimes forming bloom conditions that restrict recreation. However, management by community groups and the Lakes and Ponds Program has led to fewer and shorter lake closures in recent years.

This report details the results of water quality monitoring programs in 2025, as well as the projects the City of Worcester's Lakes and Ponds Program (L&P) intends to implement in 2026. To provide context for the 2025 data, the following paragraph highlights L&P's key findings from 2024.

In 2024, water quality at Indian Lake was rated as "Fair". Cyanobacteria blooms were a significant impediment to recreation and water quality. L&P rated cyanobacteria as "Poor" in 2024 because cyanobacteria bloom conditions necessitated 50 days of lake closure. Although *E. coli* did not cause beach closure in 2024, elevated results at Ararat Brook indicated the need for additional investigation. Although most surface phosphorus results were in ranges considered "Excellent" and "Good", rapid growth of cyanobacteria indicated a nutrient load that is problematic for lake health. Despite low oxygen conditions at the lake bottom during summer months, the top 11 ft of the water column always had suitable oxygen for aquatic life. As in 2023, there were no sightings of invasive Eurasian Milfoil. L&P continued management of the invasive plant *Phragmites australis* in 2024.

To view full reports from all previous seasons, please visit WorcesterMA.gov/bluespace.

Management Summary

Indian Lake has had management plans for cyanobacteria and invasive aquatic plants since the inception of the Lakes and Ponds Program. Given a combination of factors that lead to elevated cyanobacteria growth, preventative lake treatments of aluminum sulfate, or "alum", and copper sulfate have been required to avoid cyanobacteria blooms and keep the lake safe for recreation.

Since Indian Lake was effectively treated with the systemic herbicide ProcellaCOR in 2021, the invasive aquatic plant Eurasian Milfoil has not regrown or required additional treatment. As the target species was no longer present, this required the cessation of a previous permit to draw down the water level in the winter to exclude Milfoil along the shoreline. The absence of Milfoil gave the opportunistic native plants Thinleaf Pondweed (*Potamogeton pusillus*) and Western Waterweed (*Elodea nuttallii)* a chance to grow rapidly. In 2022 and 2023, the Lakes and Ponds Program treated Thinleaf Pondweed with the herbicide diquat dibromide (trade name: Reward) to maintain navigability and recreational access.

Figure 2 – *An aquatic plant harvester was contracted to remove decaying plant matter and reduce the risk of impacts from reduced DO.*

In 2025, the native plant species Western Waterweed (*Elodea nuttallii)* grew in abundance, significantly impeding boating. A low-dose treatment of diquat dibromide was implemented on 30-Jun, causing unexpectedly rapid die-off of *Elodea* throughout the lake. The large amount of decomposing plant matter combined with rising water temperature led to lowered Dissolved Oxygen (DO) and increased populations of cyanobacteria. On 11-Jul a number of dead fish were observed by L&P staff, which had likely succumbed to low oxygen conditions. During regular visits by L&P staff through the end of August no more dead fish were observed. L&P monitored this situation closely and contracted a plant harvester to remove decaying plant matter (see Figure 2), and aeration units to reduce the likelihood of major impacts from low DO. Following conversations between City officials and residents, L&P pursued a permit to resume a winter drawdown of up to 3-ft to reduce plant growth along the shoreline. The drawdown went into effect on 3-Nov, and water levels will be raised in early spring of 2026.

In 2023, L&P began the use of a novel nutrient management strategy, a dosing station at the lake's main inlet (see Figure 3). Ararat Brook is the main tributary to Indian Lake and has many storm drain outfalls that carry phosphorus-laden stormwater into Indian Lake. The dosing station applies polyaluminum chloride (similar to alum) to the mouth of the brook in small doses when it rains, immobilizing phosphorus before it enters the lake. This method aims to reduce the average lake phosphorus concentration while decreasing the total amount of chemical used.

Figure 3 – *L&P operates a dosing station at the lake's main inlet, Ararat Brook. The station applies small doses of polyaluminum chloride to the mouth of the brook when it rains, immobilizing phosphorus before it enters the lake.*

In 2025, above average spring rainfall allowed for regular dosing during storms. This successfully reduced phosphorus inputs to the lake and may have led to increased water clarity early in the season. As the dosing station is not designed to treat in-lake phosphorus, mid-season phosphorus concentrations spiked in response to decaying plant matter, fueling cyanobacteria growth.

Results from weekly cyanobacteria testing contracted by L&P in 2025 ranged between trace amounts and 51,600 cells/mL of cyanobacteria (see Figure 15). Cyanobacteria cell counts remained below the advisory threshold of 70,000 cells/mL throughout the season, never prompting a recreational advisory. However, cyanobacteria activity was visible through reduced clarity and surface scums throughout much of the season. Three copper sulfate treatments were contracted (31-Jul, 14-Aug, and 22-Sep) to avoid bloom conditions and maintain recreational access to Indian Lake.

In late September, patches of the invasive plant *Phragmites australis* were treated with the herbicide glyphosate. The dead patches were later cut to allow for better assessment of regrowth and improved management in the following season.

Sampling Analysis and Overview

Sampling from multiple locations within a waterbody and its watershed leads to better understanding of the water that enters the lake, how it is transformed within, and the water leaving the lake. To account for these changes over space and time, L&P samples at sites in tributaries, at the surface and bottom of mid-lake sites, and the outlet.

Tributaries are streams flowing into a lake or pond. They collect surface runoff from rain or snowmelt along with some groundwater and carry it through the stream channel to the waterbody. In some cases, tributaries make up a large portion of the water going into the lake, and the quality of the water in these tributaries can give insight into where certain impairments in the lake originate. Outlets are the major

exits for water in the lake. Most L&P program water quality parameters are measured at the major natural tributaries and outlets of the lakes.

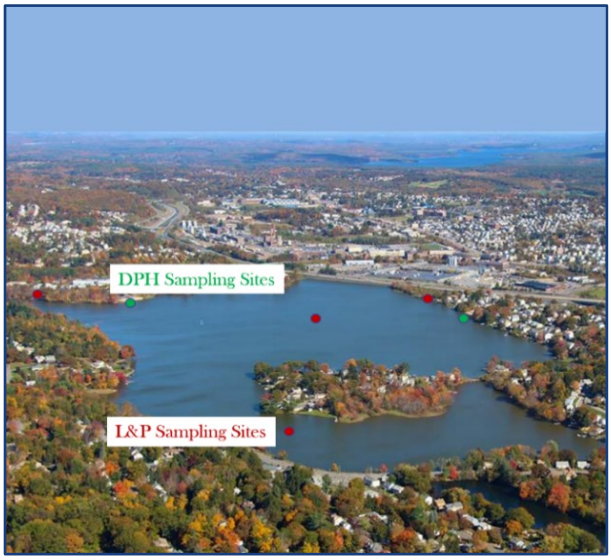


Figure 4 – *Aerial view of Indian Lake and approximate sampling locations.*

Indian Lake was sampled twice monthly from late April through October at four locations: the major aboveground tributary, Ararat Brook; the middle of each of the two basins of the lake (the northern site, which is about 17 feet deep and the southern site, which is about 5 feet deep); and the outlet at the spillway, located in the eastern part of the lake (see Figure 4). At the in-lake locations, probe measurements and water samples were collected one foot below the surface of the water ("surface") and two 2 feet above the bottom of the lake ("bottom"). Parameters evaluated included Secchi disk depth, temperature, dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), and *Escherichia coli* (*E. coli*). Samples were also collected for total suspended solids (TSS), ammonia (NH_3), and nitrate (NO_3) once a month. Altogether, there were 12 sampling events.

Central Massachusetts experienced fluctuating drought conditions during 2025. The year began under Level 2 - Significant drought, worsened to Level 3 - Critical in February - March, and improved through spring, returning to Normal status by early May. Conditions remained Normal through most of the summer monitoring season before drought returned at Level 2 - Significant in September - October and eased to Level 1 - Mild in November - December. Dry conditions in the summer and fall led to low flow conditions at the inlet of Indian Lake. By chance, no sampling days at Indian Lake in 2025 were considered "wet weather" with 24-hour rainfall totals exceeding 0.25 inches.

Samples for cyanobacteria cell density were collected by a contractor as needed. Additionally, City of Worcester Department of Inspectional Services tested for *E. coli* as an indicator of harmful pathogens on a weekly basis during the swimming season at Shore Park Beach and Indian Lake Beach.

Raw data are displayed and explained below. No statistical analysis has been performed. In some cases, results were so low the laboratory equipment could not reliably measure them. This is known as a result below the laboratory reporting limit, and is expressed with the less-than symbol (<) before the reporting limit. For example, an undetected result with a reporting limit of 1.0 mg/L is shown as <1.0 mg/L. Ratings of "Excellent", "Good", "Fair", and "Poor" for reported values are based on the Massachusetts Department of Environmental Protection's SMART Monitoring Watershed Report Card Criteria.

Monitoring Parameters and 2025 Results

Quality Assurance/Quality Control

The Lakes and Ponds Program uses Quality Assurance/Quality Control (QAQC) checks to ensure that data are representative of local conditions and meet precision and accuracy standards. QAQC check results identify data that need to be flagged and/or censored before they are shared and can highlight issues that affect data quality. When data fail to meet acceptable criteria for these checks, they are either flagged as being slightly less robust or are censored entirely. Flagged data points are marked with a red flag and censored data are not included in this report. For more information on L&P's data quality, please contact greenworcester@worcesterma.gov.

Fecal Bacteria

Recreational contact with water contaminated by certain fecal bacteria may cause illness. *Escherichia coli*, or *E. coli* are a type of bacteria found in the digestive tract of warm-blooded animals including geese, pets, and humans. While most strains are harmless, some can cause illness. These bacteria enter the water in many ways, including through direct contact with animal waste, runoff during rainstorms from the shoreline and impervious surfaces like paved roadways, leaking septic tanks, and illicit sewer connections that empty sewage to the stormwater system. The Commonwealth of Massachusetts has strict regulations for bathing beaches, and the City of Worcester Department of Inspectional Services collects samples for *E. coli* weekly at public beaches during the swimming season to ensure that the water is safe for direct contact, closing beaches if the results are above the recreational threshold of 235 *E. coli*/100 mL. L&P also collects *E. coli* samples at Ararat Brook. Water samples collected by L&P and Inspectional Services are analyzed by separate labs for *E. coli* using different techniques with different units. Please note that *E. coli*/100 mL and MPN/100 mL are directly comparable.

Fecal Bacteria at Indian Lake In 2025, Indian Lake Beach on Clason Road was closed on one occasion, 11-Aug, due to a result of 290.9 *E. coli*/100 mL. It was re-opened the following day after re-testing. Results from Shore Park Beach remained below the recreational advisory threshold. Results from beach testing conducted by Inspectional Services ranged between <1 and 290.9, with most results below 24 *E. coli*/100mL, or in the range considered "Excellent" (see Table 2).

E. coli results at Ararat Brook were generally higher than those at the beaches, with results ranging from 45 to 488.44 MPN/100 mL. Five of 9 results were in the range considered "Fair", and six results were considered "Good" (see Table 1).

ARARAT BROOK	
DATE	RESULT
29-Apr	45
13-May	Not Taken
3-Jun	Not Taken
17-Jun	98.67
8-Jul	488.44
22-Jul	488.44
5-Aug	365.4
19-Aug	156.48
2-Sep	Not Taken
17-Sep	107.58
30-Sep	75.41
23-Oct	145.46
Collected by L&P	

	INDIAN LAKE BEACH	SHORE PARK BEACH
DATE	RESULT	RESULT
23-Jun	<1	2
30-Jun	<1	5.2
7-Jul	17.3	4.1
14-Jul	2	33.1
21-Jul	8.5	12.1
28-Jul	19.9	8.6
4-Aug	37.4	81.3
11-Aug	**290.9**	108.6
12-Aug	65.7	N/A
18-Aug	21.1	20.1
25-Aug	24.9	7.4
Collected by COW Inspectional Services		

Excellent	*Good*
Fair	*Poor*
Red Text = Beach Closure	

Tables 1 & 2 *There was only one beach closure at Indian Lake Beach due to fecal bacteria exceedance in 2025.* E. coli *results from Ararat Brook ranged between 45 and 488.44 MPN/100mL, with most results in the ranges considered "Good."*

In 2025, L&P rates Indian Lake as "Good" for fecal bacteria because although there was one day of beach closure, *E. coli* did not significantly affect recreation.

Water Clarity

Water clarity is a measure of the transparency of water. Cyanobacteria and other microorganisms, eroded particles, and re-suspended bottom sediments are some factors that interfere with light penetration and reduce water transparency. Clear water allows sunlight to penetrate to the depths of a waterbody, supporting growth of aquatic plants, which provide food, shelter, and oxygen to aquatic organisms. Clear water is also pleasant to the eye and may be safer for recreational contact. Turbid water, or water filled with particles, absorbs more heat from sunlight. This reduces the water's capacity to hold oxygen, creating favorable conditions for algal and cyanobacteria blooms, which further reduce clarity. Water clarity can be measured with a Secchi disk or by quantifying Total Suspended Solids (TSS). A Secchi disk is a weighted black and white disk on a calibrated line that is lowered into the water until it is no longer visible. Secchi readings are collected on each lake visit by L&P. TSS is a measure of the dry weight of suspended particles in a given amount of water. TSS samples are taken monthly and submitted to a lab for analysis.

Water Clarity at Indian Lake. Water clarity varied widely at Indian Lake in 2025. Between 29-Apr and 8-Jul, Secchi depth ranged between 6.75 and 11.75 ft. The reading of 11.75 ft on 17-Jun is the highest clarity reading recorded at Indian Lake by L&P. From 22-Jul through the end of the season, Secchi depth was 4 ft or below, or in the range considered "Poor" (see Figure 5). Reduced water clarity was largely due to elevated levels of cyanobacteria and decomposing aquatic plants in the water column.

Surface TSS ranged between <1.0 and 16.0 mg/L. Most results were below 10.0 mg/L, or in the range considered "Excellent" (see Figure 6), though several results taken after mid-July were higher. Results in this range are uncommon at Indian Lake and indicate elevated levels of cyanobacteria and decomposing aquatic plants in the water column. Bottom TSS ranged from 2.0 to 16.0 mg/L. As with the surface sites, results taken after mid-July were higher. As expected, TSS increased as Secchi depth decreased.

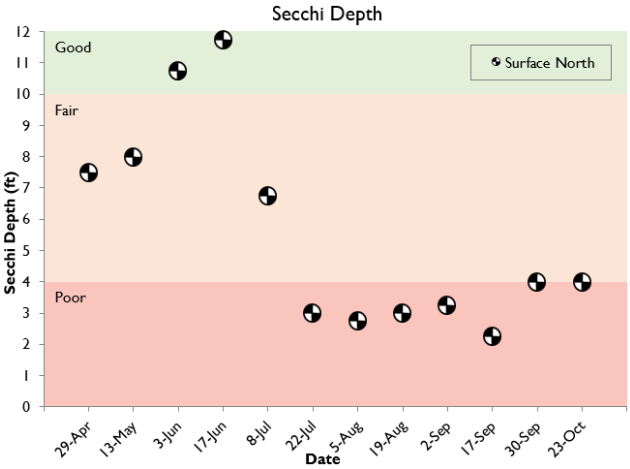


Figure 5 *- Secchi depth was considered "Fair" and "Poor" for most of the season, though two readings were in the range considered "Good". Readings ranged from 2.25-11.75 feet.*

TSS results at the lake outlet were similar to those at the in-lake surface sites, ranging between <1.0 and 15 mg/L, with lower results in May and June and higher results July onward. TSS at Ararat Brook was less consistent, with four results between <0.1 and 1.8 mg/L, and two higher results, 13.0 mg/L and 32.0 mg/L (see Figure 7). These results did not show a clear seasonal distribution, but both days with high results had notes indicating low flow and surface scum.

Despite high water clarity at the beginning of the season, reduced clarity after late July led to an overall rating of "Fair" in 2025.

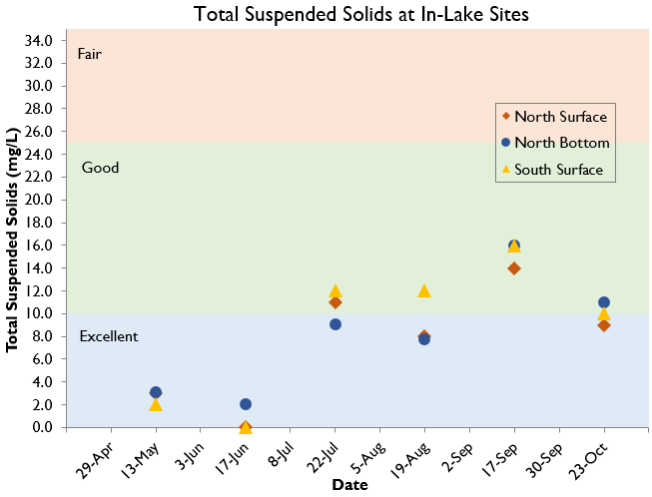


Figure 6 *- In-lake Total Suspended Solids (TSS) ranged between <1.0 and 16.0 mg/L. Most were in the range considered "Excellent" though several results near the end of the season were in the range considered "Good".*

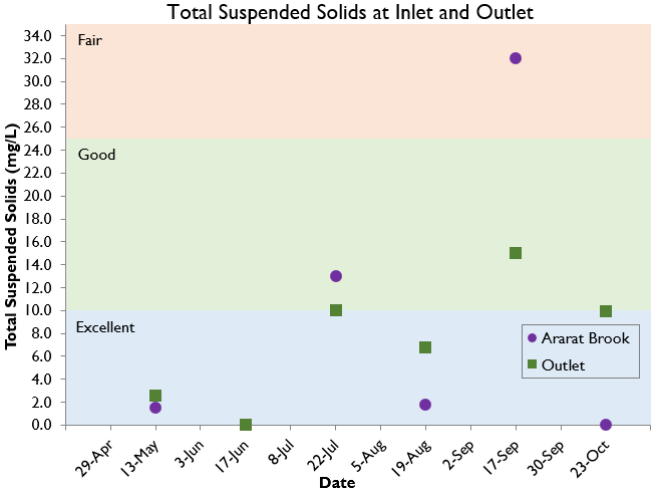


Figure 7 *- Total Suspended Solids (TSS) at the Ararat Brook and the Outlet ranged between <1.0 and 32.0 mg/L with lower results in May and June and higher results July onward.*

Temperature

Water temperature impacts both the biology and chemistry of aquatic ecosystems. Because many organisms prefer to live in a narrow temperature range, understanding temperature across the area and depth of a water body is essential. Temperature also impacts the speed of chemical reactions and the ability of water to hold oxygen. Warmer water can hold less dissolved oxygen than colder water. Temperature dynamics in lakes can also impact the level of mixing experienced throughout the water body, affecting the distribution of oxygen, nutrients, and organic matter. Temperature was measured with a thermometer on a handheld probe at the water's surface at all sites and at the bottom for in-lake sites. To form a more complete picture of how temperature changes through the water column, depth profiles were created by taking measurements at 1-ft increments through the water column.

Temperature at Indian Lake. Surface temperatures at the Northern and Southern Sites were similar to each other throughout the season, ranging between 13.4°C and 27.0°C, following expected seasonal variation (see Figure 8). Surface temperature readings rose at all sites from the beginning of the season through mid-summer, reaching a maximum temperature on 8-Jul before falling for the rest of the season. Bottom temperature at the Northern Site was consistently lower than the surface, ranging between 13.4°C and 21.3°C.

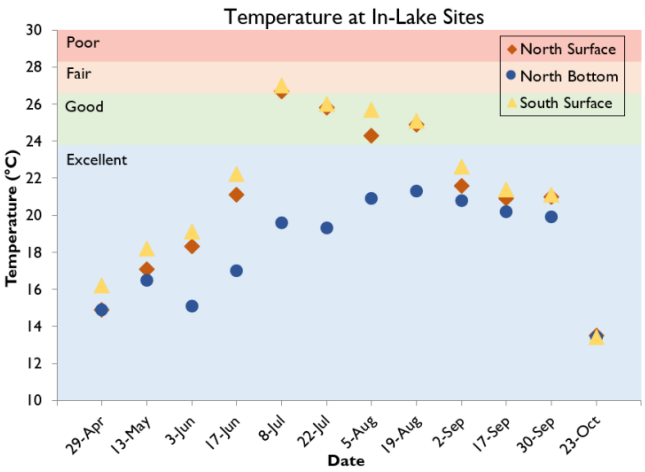


Figure 8 *- Surface water temperature remained in the "Excellent" and "Good" categories for most of the 2025 season, with one instance considered "Fair" at both surface sites. Bottom temperature was considered "Excellent" throughout the season.*

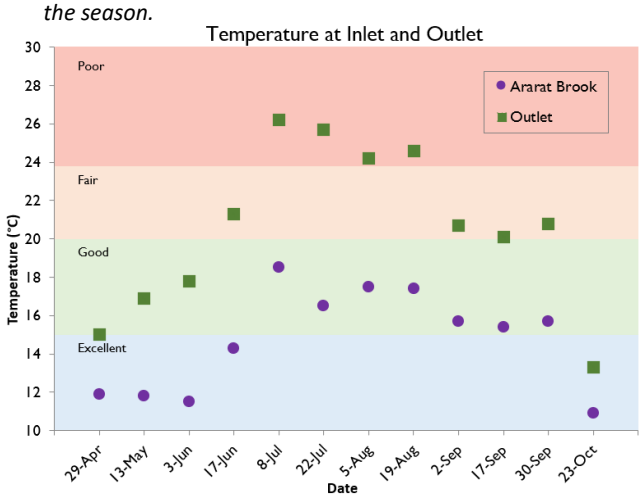


Figure 9 *- Water temperature in Ararat Brook remained in the "Excellent" and "Good" categories for a Coldwater Fish Resource (CFR) for the entire 2025 season. Temperature at the lake outlet was on average 5.9°C higher than in Ararat Brook, demonstrating how much water warms while passing through Indian Lake.*

To determine the extent of warming throughout the entire water column, depth profiles were taken at the Northern Site (see Appendix). During the first two sampling sessions, temperature was relatively consistent throughout the water column. Profiles recorded between 3-Jun and 19-Aug exhibited temperature stratification, with the thermocline between 10 and 14 ft. The maximum temperature difference between the surface and deep water was 6.5° C, indicating relatively mild thermal stratification. After a cooling period in early and mid-September, profiles indicated full water column mixing. The depth

profile on 30-Sep indicated resumed thermal stratification, though the water column was fully mixed during the season's final readings on 17-Oct.

Ararat Brook is the major tributary to Indian Lake. It is a Coldwater Fish Resource (CFR), a special designation given to waterways that support cold water fish species such as trout. These fish require higher quality water than warm water species. The outlet of Indian Lake is the spillway at its northeastern end. Water temperature in Ararat Brook generally remained in the range suitable for cold water fish, with a maximum of 18.5°C. (see Figure 9). All temperature readings were in the ranges considered "Excellent" and "Good". The temperature at the lake outlet was on average 5.9°C higher than in Ararat Brook, demonstrating how much the brook warms while passing through Indian Lake.

L&P rates temperature at Indian Lake as "Good" in 2025.

Dissolved Oxygen

Oxygen dissolved in water is essential to aquatic life. Dissolved Oxygen (DO) is a highly variable parameter that is controlled by many factors, including temperature, pressure, aeration, diffusion, rate of photosynthesis, rate of respiration and more. When water temperature rises, water can hold less dissolved oxygen, potentially stressing aquatic organisms. Thermal stratification, or layering in the water column based on temperature, can also create a barrier to waterbody mixing, creating areas with depleted DO in some deeper portions of waterbodies. Increased algal growth followed by excessive decomposition of organic material can also lead to low oxygen, or hypoxic conditions, potentially causing fish kills. DO was measured using a galvanic DO sensor on a handheld probe at the water's surface, and two feet from the bottom at the in-lake locations. To form a more complete picture of how DO changes through the water column, depth profiles were created by taking measurements at 1-ft increments through the water column.

Dissolved Oxygen at Indian Lake. Though most surface DO readings were above 6 mg/L, or in the range considered "Excellent", several readings between early July and late August were abnormally low (see Figure 10). As seen in past years, bottom DO at the Northern Site was in the "Poor" range for six of 12 readings, with the majority falling between late June and late August.

DO in Ararat Brook ranged between 10.85 and 11.33 mg/L and was mostly in the range considered "Excellent" for a CFR (see Figure 11). At the outlet, DO ranged between 3.19 and 9.72 mg/L, with one reading in the range considered "Poor".

As observed from depth profile data, the water column was sufficiently oxygenated during the first three sampling sessions (see Appendix). At the beginning of June, DO concentration began to drop below 4 mg/L, the lower avoidance limit for fish, in the deepest reaches of the water column. From 17-Jun through 19-Aug, significant oxygen depletion was observed below 10 ft, and on 19-Aug, throughout the entire water column. On 19-Aug, the entire water column exhibited DO below 4 mg/L, or in the range considered "Poor". This was likely caused by unexpectedly rapid die-off following an herbicide treatment on 30-Jun to address overgrowth of the aquatic plant *Elodea*. Higher water temperatures due to normal seasonal variation also contributed to the low oxygen levels. On 11-Jul a moderate number of dead fish were observed by L&P staff, which had likely succumbed to low oxygen conditions. During regular visits by L&P

staff through the end of August no more dead fish were observed. With the exception of 30-Sep, the water column had sufficient DO from the beginning of September through the end of the season.

Plant decomposition led to prolonged low DO conditions at Indian Lake in 2025. Though much of the water column had suitable DO throughout most of the season, L&P recorded several instances where cool and warm water fish would begin to experience stress. A number of dead fish, noted on 11-Jul, was likely caused by low oxygen conditions. Despite many DO results in the "Excellent" category, L&P ranks DO at Indian Lake as "Poor" due to observable impacts of low DO and needed response efforts, which are described in the Plants section of this report.

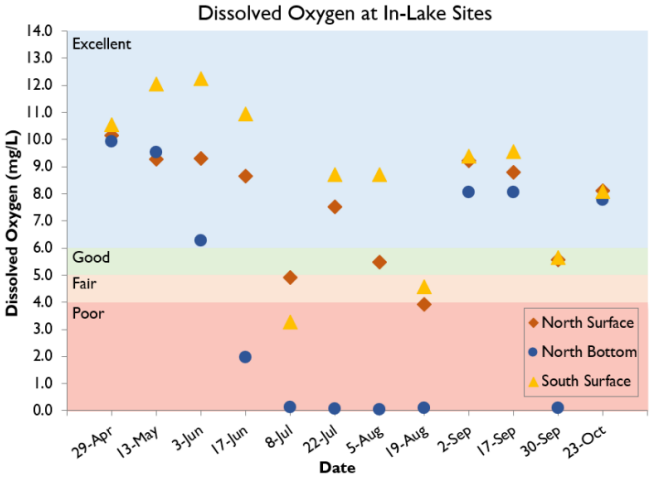


Figure 10 *- Dissolved oxygen was considered "Excellent" at the surface through much of the season, though there were several readings in the "Poor" and "Fair" categories in July and August. Bottom dissolved oxygen readings were in the "Poor" category on six occasions between June and late September.*

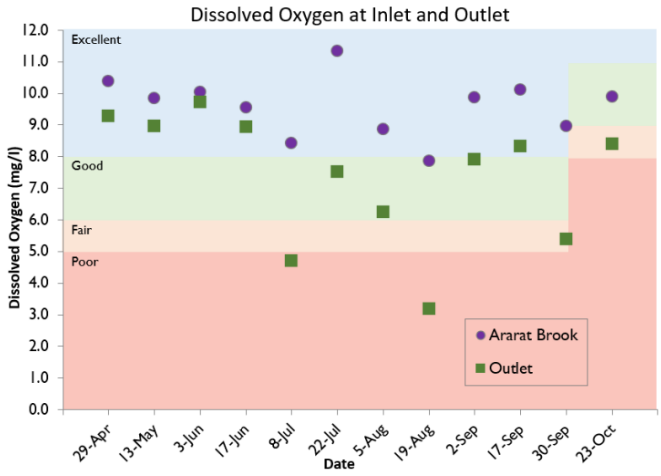


Figure 11 *- Dissolved oxygen in Ararat Brook was in the range considered "Excellent" for all but two readings. At the outlet, dissolved oxygen was consistently lower.*

pH

pH is the concentration of hydrogen ions (H+) in a solution. The more H+ ions that are present, the more acidic the solution. On a scale of 0-14.0 units, 7.0 is a neutral pH. As pH increases from 7.0, the solution is more basic, and as pH decreases from 7.0, it becomes more acidic. In aquatic ecosystems, pH affects most chemical and biological processes including species distribution, growth rate, reproductive success, and nutrient dynamics in lakes. A high pH can promote chemical reactions that release phosphorus from lake sediments. Healthy lakes in our area have a pH between 6.5 and 8.5. pH was measured using an ion-selective electrode

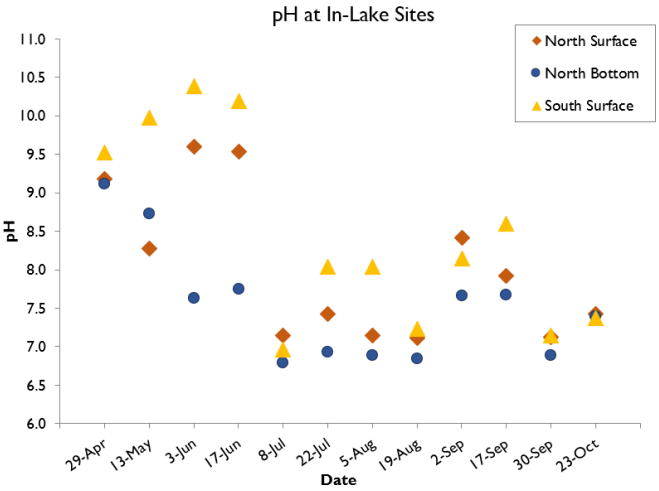


Figure 12 *- Surface pH was generally higher than bottom pH. pH readings dropped in early July, likely due to higher levels of CO_2 caused by increased plant decomposition.*

(ISE) pH sensor on a handheld monitoring probe. Readings are taken at the water's surface and two feet from the bottom.

pH at Indian Lake.

In 2025, pH at the surface of Indian Lake had a wide range of results. At the Northern site, surface pH ranged between 7.11 and 9.60 with the highest reading taken on 3-Jun (see Figure 12). Surface pH in the Southern site had an even wider range of 6.96 to 10.39. Bottom pH at the Northern site ranged from 6.79 to 9.12. Though Indian Lake often exhibits the most basic water of any lake in the program, pH was lower than expected between 8-Jul and 19-Aug. This is likely due to higher levels of CO_2 caused by increased plant decomposition. More acidic conditions, though unexpected, were still in ranges suitable for aquatic life.

At Ararat Brook, pH was less variable than at in-lake sites, ranging from 7.11 to 7.80. At the outlet pH more closely resembled in-lake sites, ranging from 7.02 to 9.66.

Nutrients

Nutrients, primarily nitrogen (N) and phosphorus (P), are food sources for aquatic plants and algae. Although plants and algae are the basis of aquatic food chains and necessary for a healthy lake ecosystem, an overabundance of nutrients can lead to issues such as harmful algal blooms and excessive plant growth. Common nutrient inputs to urban lakes and ponds include fertilizers, pet and goose waste, illicit sewer connections to the stormwater system, and runoff that flows over land into the stormwater system. Additionally, under the right conditions, phosphorus can be released from the sediments at the bottom of the lake, becoming more available for uptake by organisms. To examine the nutrients present in program lakes, L&P collects samples for several compounds and submits them to an external lab for analysis. To measure N, samples are collected for nitrate (NO_3) and ammonia (NH_3) at all sites monthly. To measure P, samples are collected for total phosphorus (TP) twice a month at all sites, and total dissolved phosphorus (TDP) twice a month at all bottom sites. TDP is analyzed to understand how much P is dissolved in the water and available for use by aquatic organisms.

Nutrients at Indian Lake. At the Northern Site, surface TP results ranged from 0.014 to 0.058 mg/L, with four results below 0.025 mg/L or in the range considered "Excellent," two results considered "Good" (0.025 – 0.050 mg/L), and three results considered "Fair" (0.050 – 0.075 mg/L)(see Figure 13). At the Northern Site, most bottom TP results ranged from <0.010 to 0.042 mg/L and were therefore considered "Excellent" and "Good", although two results were considered "Fair" and one was considered "Poor".

In Indian Lake's primary tributary, Ararat Brook, TP ranged between 0.013 and 0.076, with the highest results occurring between 17-Jun and 19-Aug (see Figure 14). Results at the lake outlet generally resembled the in-lake results.

Four of the ten reported TP results were flagged due to quality control challenges caused by a large amount of organic matter in the samples, in addition to TP from the North Bottom on 23-Oct. These results remain informative for understanding general water quality conditions; however, the precision of these results is uncertain and the true concentration of phosphorus during the sampling events may have varied.

As in past years, all in-lake NO_3 results were less than 0.6 mg/L, or in the range considered "Excellent". Results were similar at the lake outlet. As seen in the past, higher NO_3 results were observed at the Ararat Brook inlet, ranging from 0.613 mg/L to 0.996 mg/L. Most of these results were in the range considered "Fair," with two results considered "Good".

NH_3 results at in-lake surface sites ranged between <0.075 and 0.438 mg/L, or in the ranges considered "Excellent", "Good" and "Fair". Results at the Northern bottom site ranged between <0.075 and 0.819 mg/L. All but one result was considered "Excellent" while the high value on 19-August was in the range considered "Poor".

NH_3 results at Ararat Brook, and the outlet were consistently below 0.6 mg/L or in the range considered "Excellent".

L&P rates nutrients in 2025 at Indian Lake as "Fair".

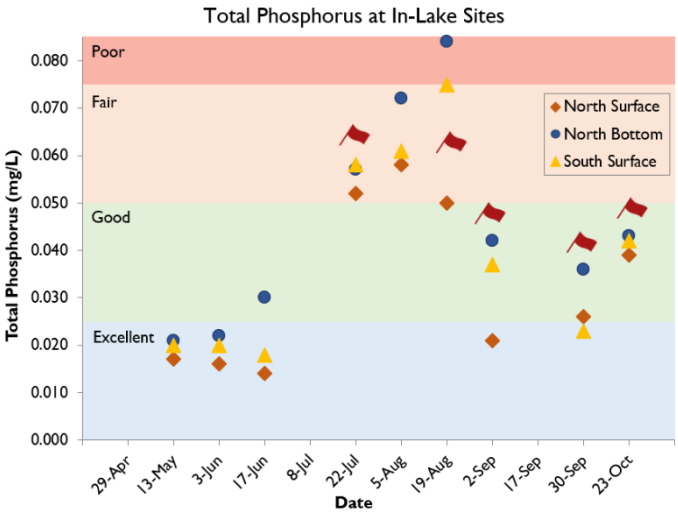


***Figure 13** – In-lake TP ranged widely in 2025. Results were primarily below 0.050 mg/L, or in the ranges considered "Excellent" and "Good". However, between late July and late August most results were in the "Fair" and "Poor" ranges.*

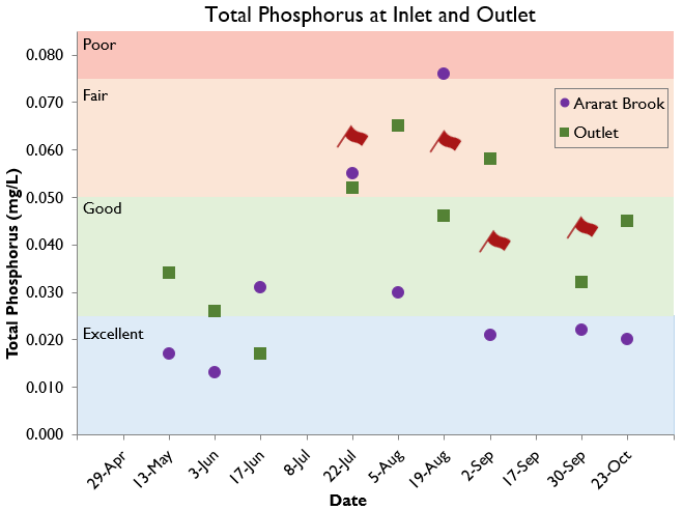


***Figure 14** - Total phosphorus results in Ararat Brook ranged from 0.013 to 0.076 mg/L. At the outlet, results ranged from 0.017 to 0.065 mg/L. The highest results at both sites were in July, August and early September.*

Cyanobacteria

Cyanobacteria are naturally occurring microorganisms in waterbodies. Using sunlight and nutrients such as N and P, cyanobacteria use photosynthesis to gain energy similarly to plants. While normal at low densities in healthy ecosystems, under the right conditions, some species of cyanobacteria can reproduce quickly and cause potentially harmful blooms. In addition to being unsightly and smelly, cyanobacteria blooms can produce toxins that are harmful to humans and pets. Blooms also have the potential to create hypoxic conditions leading to fish kills.

To understand the abundance of cyanobacteria and make decisions regarding lake management and safe access, L&P contracts samples for cyanobacteria cell counts on a regular basis at Indian Lake to determine bloom risk. When results are above the recreational threshold of 70,000 cells/mL, the waterbody must be closed to recreation until cell counts fall. When possible and necessary, L&P uses preventative lake treatments such as algaecide to stop cyanobacteria growth in the early stages of a bloom before cell counts exceed the recreational threshold.

Cyanobacteria at Indian Lake. Indian Lake has favorable conditions for cyanobacteria growth, including warm water, elevated pH, and steady external nutrient inputs through Ararat Brook. L&P has documented cyanobacteria blooms over the past years and developed a management plan which relies on algaecides and flocculants. In 2023, L&P began using a novel nutrient management strategy, an alum dosing station at the inlet of Indian Lake's main tributary Ararat Brook. When the dosing station became operational in early June 2023, it began adding polyaluminum chloride to the lake during rain events to inactivate phosphorus as it enters the lake and reduce cyanobacteria growth potential.

Results from weekly testing contracted by L&P in 2025 ranged between trace amounts and 51,600 cells/mL of cyanobacteria (see Figure 15). Cell counts remained below the advisory threshold of 70,000 cells/mL throughout the season, never prompting a recreational advisory. However, cyanobacteria activity was visible through reduced clarity and surface scums throughout much of the season. Three copper sulfate treatments were contracted (31-Jul, 14-Aug, and 22-Sep) to avoid bloom conditions and maintain recreational access to Indian Lake. As cyanobacteria management effectively maintained recreational access despite consistent population growth, L&P rates cyanobacteria as "Fair" in 2025.

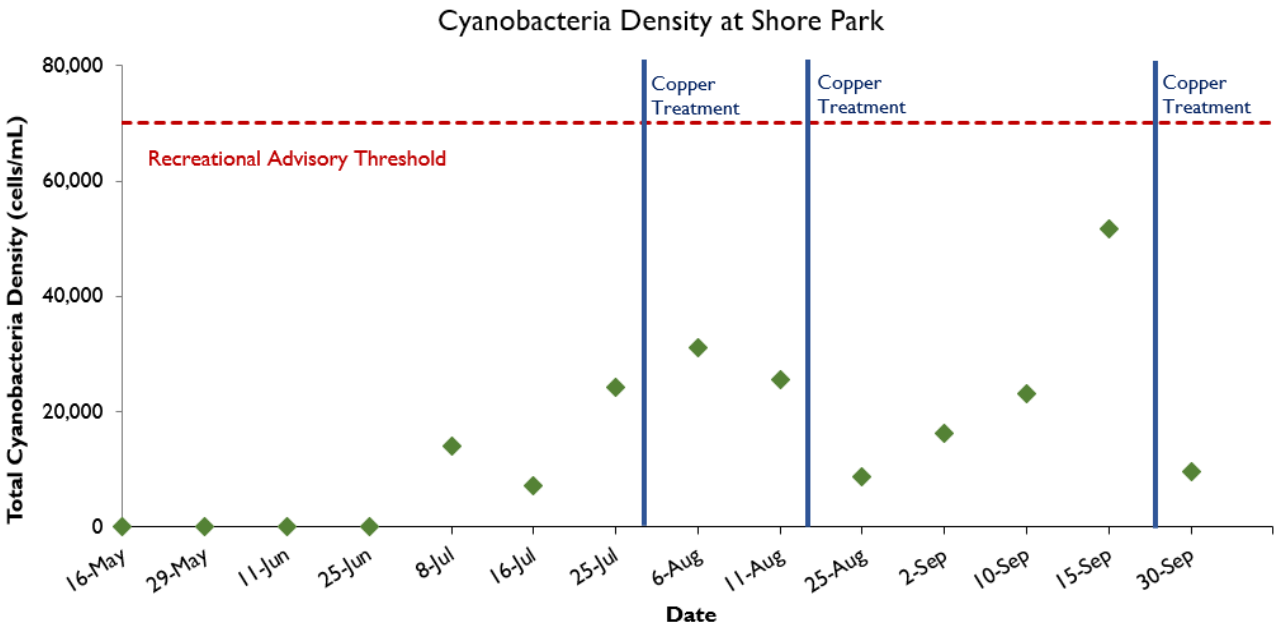


Figure 15 – *In 2025, cyanobacteria density remained below the recreational advisory threshold of 70,000 cells/mL. Three Copper Sulfate algaecide treatments were implemented to avoid bloom conditions. `*

Invasive Aquatic Plants and Animals

An invasive plant or animal is an organism that is not native to the region and outcompetes local flora and fauna. The absence of natural constraints, like predators or environmental limitations, allows invasive plants and animals to reproduce at a rapid rate. When invasive aquatic plants and animals become too numerous or dominant, they can overtake available space, disrupting local ecosystems and making recreation more difficult. Invasive organisms can arrive at new locations by hitching a ride on boats, pets, or boots. Some are released with good intentions as a beautiful addition to a landscape or as a sport

fishing opportunity. Professional surveys and visual inspections from L&P staff are used to make management decisions regarding invasive species.

Invasive Aquatic Plants and Animals at Indian Lake. Historically, Indian Lake has hosted several species of invasive plants, including European Naiad (*Najas minor*), Eurasian Milfoil *(Myriophyllum spicatum*), and Common Reed (*Phragmites australis*), as well as native plants that can become a nuisance for recreation, such as Western Waterweed (*Elodea nuttallii)*, and Thinleaf Pondweed (*Potamogeton pusillus*).

An updated plant survey was contracted in 2025 and carried out in late August (see Figure 16). The survey confirmed that the only invasive plant currently present in Indian Lake is *Phragmites*, an invasive reed which grows along the water's edge in shallow areas and can crowd out native plants and increase sedimentation.

Figure 16 – *A 2025 professional plant survey confirmed that the only invasive plant present in Indian Lake is Phragmites, an invasive reed which grows along the water's edge in shallow areas.*

A wide array of management techniques has been used at Indian Lake to manage invasive and nuisance aquatic plants, including lake drawdown, removal of plants by divers, and herbicide application. Since the eradication of Eurasian Milfoil in 2021, management efforts have focused on addressing *Phragmites* and overgrowth of nuisance native plants Thinleaf Pondweed and *Elodea*. L&P contracted management of *Phragmites* stands with the herbicide glyphosate in September of 2025. Because many of the *Phragmites* stands are established, eradication will likely take multiple years of consistent management. In December, the treated patches were cut to enable assessment of future regrowth.

In 2025, the native plant *Elodea* grew in great abundance, significantly impeding boat access. A low-dose treatment using the herbicide diquat dibromide was implemented on 30-Jun. This caused unexpectedly rapid die-off of *Elodea* throughout the lake, despite the dosage being designed to reduce this likelihood. L&P observed low dissolved oxygen on several occasions, due to a combination of plant decomposition and warm water temperatures. In an effort to address this, L&P contracted harvesting of dying plants throughout the lake and temporarily installed subsurface aerators to reduce the major impacts of low oxygen. Following discussions with residents, L&P secured a permit amendment to conduct a 3-ft winter drawdown for general management of nuisance aquatic plants. As drawdowns can shift ecosystems to favor plants which reproduce via seeds and are not affected by winter exposure, this management technique will be carefully monitored to evaluate effectiveness.

As the drawdown was enacted in November 2025, residents reported the invasive mollusk *Corbicula fluminea* along exposed shorelines. Although it is not known how long it has resided in Indian Lake, it does not appear to currently impede lake health or recreation. L&P will continue to monitor changes in the population of *Corbicula* in Indian Lake in 2026.

Industrial Contaminants

Worcester is a post-industrial urban center and legacy pollutants and emerging contaminants of concern from industrial processes are potential threats to recreational waters. These contaminants may cause negative health and environmental effects. Every three years, L&P tests for a range of these compounds on both a wet and dry weather event. Because most industrial contaminants are legacy pollutants, contamination levels are not expected to change much year to year. In 2022, L&P tested for 74 volatile organic compounds (VOCs), 72 semi volatile organic compounds (SVOCs), 9 polychlorinated biphenyls (PCBs), petroleum hydrocarbons (TPH), 23 perfluoroalkyl substances (PFAS), 21 pesticides, 10 herbicides, and 22 heavy metals. No results of concern were detected. See the 2022 Indian Lake Water Quality Report or contact greenworcester@worcesterma.gov for more information. The follow up monitoring planned for summer 2025 was rescheduled to spring 2026 due to program capacity and greater wet weather sampling opportunities.

State of the Lake

Overall, water quality at Indian Lake was rated as "Fair" in 2025. Excessive growth of nuisance aquatic plants was a significant impediment to recreation and water quality in 2025. Rapid decomposition of plants after a treatment on 30-Jun affected a variety of water quality parameters in Indian Lake. L&P rated DO as "Poor" in 2025 because plant decomposition caused intermittent oxygen stress that likely led to fish mortality. TP was elevated in July and August, likely due to decaying plant matter, fueling cyanobacteria growth. Although Indian Lake was never closed due to cyanobacteria conditions in 2025, consistent growth caused surface scums and prompted three algaecide treatments to maintain recreational access leading to a rating of "Fair". Despite high water clarity at the beginning of the season, reduced clarity after late July led to an overall rating of "Fair" in 2025. Although *E. coli* caused one day of beach closure at Indian Lake Beach, it did not affect recreation otherwise and was rated as "Good". Surface water and tributary temperature mostly remained in the categories considered "Excellent" and "Good" in 2025, leading to a rating of "Good". There were no sightings of invasive Eurasian Milfoil. L&P continued management of the invasive plant *Phragmites australis* in 2025.

Despite impacts to water quality and recreation from excessive growth of nuisance aquatic plants, the lake remained open for the season with minimal public health risk from *E. coli* and cyanobacteria. L&P will continue and improve monitoring and management efforts to preserve the lake's water quality and recreational value into the future.

Ongoing Projects and Plan for 2025

Water Quality Monitoring

In 2026, the Lakes and Ponds Program will continue to monitor Indian Lake to track changes in water quality and implement its cyanobacteria and invasive aquatic plant management plans. L&P will continue to contract cyanobacteria cell counts to better understand cyanobacteria population dynamics and inform management and public health decisions. L&P will continue to closely monitor the efficacy of the dosing station to guide dosing requirements and ensure that the project is attaining its intended goal of removing phosphorus before it enters the lake. In 2026 L&P will also conduct sampling for industrial contaminants.

Figure 17 – *A continuous monitoring buoy was deployed to track cyanobacteria indicators in the northern cove of Indian Lake.*

Since 2022, the Lakes and Ponds Program has seasonally deployed solar powered continuous monitoring buoys in the northern cove of Indian Lake (see Figure 17). These buoys use probes to track the cyanobacteria indicators phycocyanin and chlorophyll, as well as turbidity and temperature. In 2026, L&P will continue to refine its approach to utilizing the data it collects to aid in determining water quality in the cove and efficacy of the dosing station.

Lake Management

The Lakes and Ponds Program has contracted a consultant to develop watershed-based plans to reduce nonpoint source pollution in the City's three main recreational sub-watersheds (see Figure 18). These plans will be based on the U.S. EPA's 9-Element watershed-based planning framework and make future projects aimed at reduction of nonpoint source pollution eligible for state and federal grant funding. A plan is being created for Mill Brook Watershed (including Indian Lake), beginning at the outlet of Worcester's reservoir system. This project will identify pollutant loads and load reduction targets and provide stakeholders with a roadmap to restoration and protection.

Since the project's kickoff in late 2024, the project team has used data collected by L&P and other sources to model stormwater and nutrient dynamics. These models estimate pollutant volumes entering waterbodies, evaluate how the lake ecosystems respond, and establish goals for reducing pollutants and improving water quality.

At public workshops in April 2025, community members provided insight into possible pollutant sources throughout the watershed. This local expertise guided field assessments to identify locations suitable for stormwater control measures, such as bioretention basins, shoreline restoration, erosion prevention, or infrastructure upgrades. High-level conceptual designs were prepared for potential project sites to explore feasibility and cost-effectiveness. More detailed plans will be developed for selected sites to guide implementation. In 2026, the project will review institutional and community practices and recommend initiatives to further reduce nutrient pollution and protect local water resources. The draft plan will be

discussed at an upcoming public meeting prior to revision and finalization based on public input. The City will seek public feedback at an upcoming meeting before finalizing the plans.

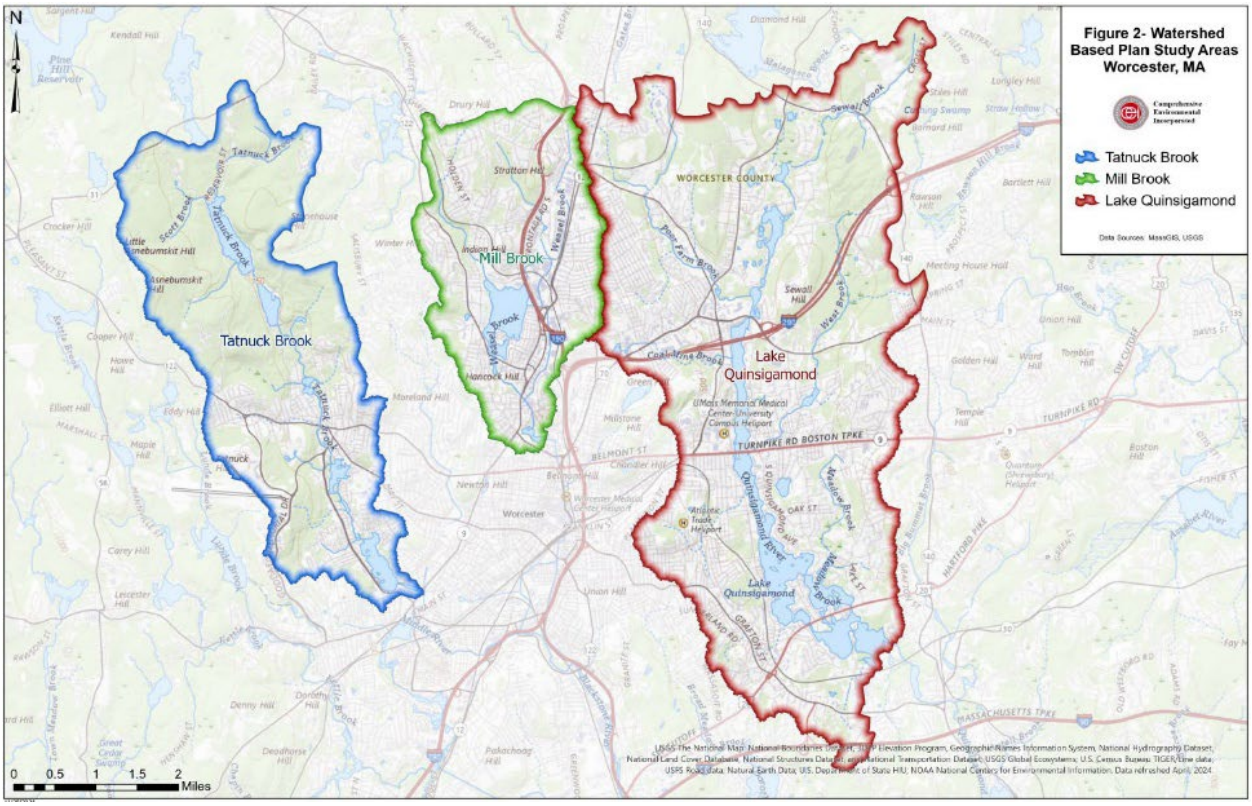


Figure 18 – *The Lakes and Ponds Program has contracted a consultant to develop watershed-based plans to reduce nonpoint source pollution in the City's three main recreational sub-watersheds. This project will identify pollutant loads and load reduction targets and provide stakeholders with a roadmap to restoration and protection. Image credit: Comprehensive Environmental Incorporated (CEI).*

Dosing Station. In 2025, L&P continued to refine operation of the newly constructed dosing station which inactivates phosphorus as it enters Indian Lake (see Figure 19). This system is the second of its kind in the state, and will take multiple seasons to optimize its performance through changing seasonal patterns. In 2026 L&P will continue to hone operational procedures and monitor performance. This project was made possible by advocacy from the Indian Lake Watershed Association (ILWA) and other community partners, and land donations from Bancroft School and the Unitarian Universalist Church.

Figure 19 – *The Indian Lake Dosing Station became operational in early June of 2023.*

Goose Fencing. In 2021, the Lakes and Ponds Program began implementing a goose fencing pilot project that aimed to reduce the number of beach closures at Indian Lake by humanely keeping geese away from the

beach. Geese usually enter the beach from the water and are uncomfortable when there are barriers between the beach and the water as the water is their escape route from land predators. However, Canada geese are intelligent and quickly learn to ignore or avoid many types of deterrents. L&P has worked with lifeguards at City beaches to pilot different fencing methods since 2021 with varied results due to fence design, lifeguard availability, and quick acclimation of geese to the varied approaches. In 2026, L&P will continue to refine the approach to deterring geese from City beaches to reduce the risk of beach closures due to fecal bacteria exceedances.

Education and Outreach

Text Message Alert System. In 2023, the Lakes and Ponds Program launched a text message alert system allowing residents to sign up to receive up-to-date information on lake access to guide upcoming visits. Text messages will alert residents when a beach is closed for fecal bacteria exceedances, or if a boat ramp is closed because a lake is receiving an invasive aquatic plant treatment. To sign up to receive text alerts, visit worcesterma.gov/bluespace.

Educational Programming. Since its inception, the Lakes and Ponds Program has partnered with groups such as local schools, Mass Audubon, the EcoTarium, Worcester JCC, and local watershed associations to provide educational programming in which students learn about water quality issues that affect recreation on our waterways and get hands-on experience in environmental monitoring methods.

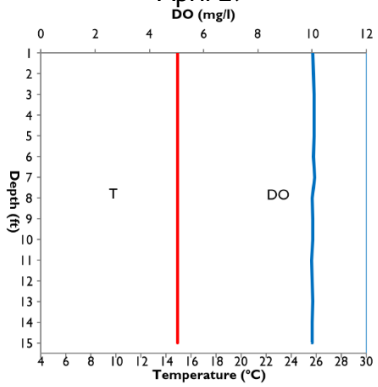
The Lakes and Ponds Program is looking to expand opportunities for educational field trips. If you are affiliated with a school and would like to discuss holding a program together, please email us at greenworcester@worcesterma.gov.

Litter. Inappropriately disposed waste is harmful to the ecological, aesthetic, and recreational value of lakes and ponds. In 2024, DSR began work on a Zero Waste Master Plan that will provide a comprehensive strategy for understanding and mitigating the impact of waste in our community. The Lakes and Ponds Program will collaborate with DSR staff on ways to reduce impact of waste and litter in our lakes and ponds. The Indian Lake Watershed Association has been committed to stewardship of the Indian Lake for many years, including Spring and Fall litter cleanup events. To learn more about their efforts and learn how to get involved, visit them at ilwa.org.

To learn more about Lakes and Ponds Program offerings, please see WorcesterMA.gov/bluespace.

Appendix: Depth Profiles

April 29



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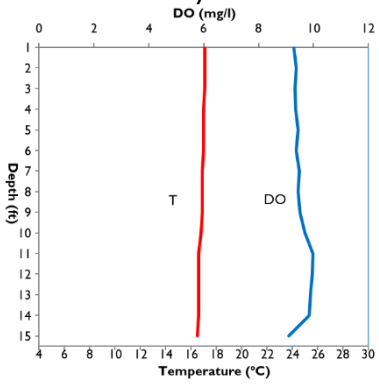

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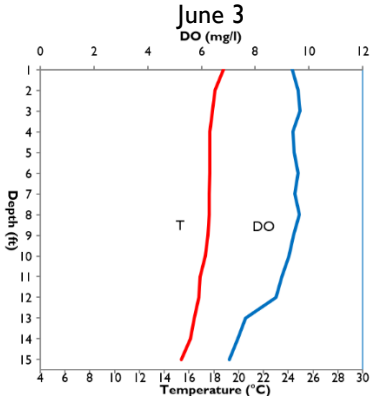

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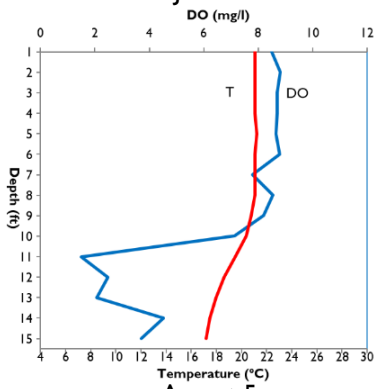

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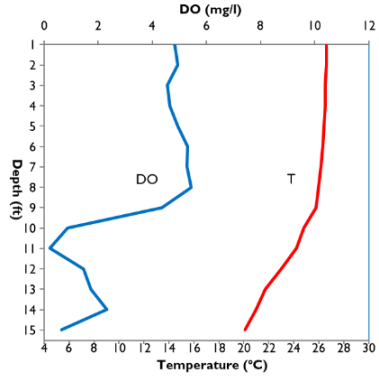

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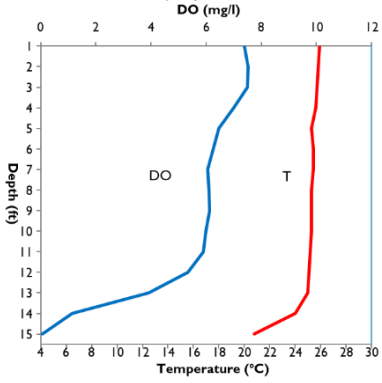

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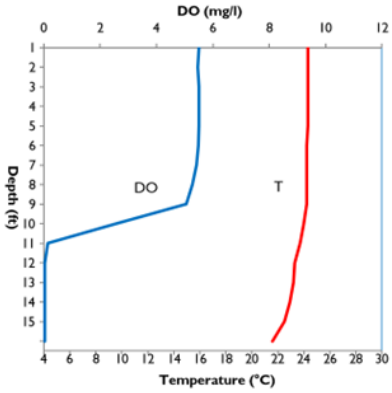

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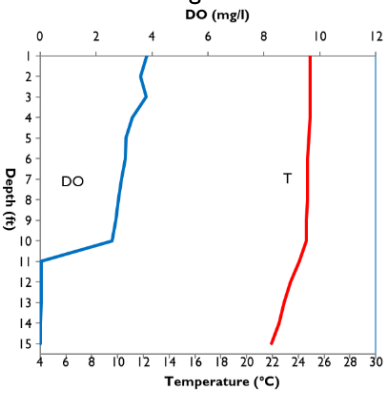

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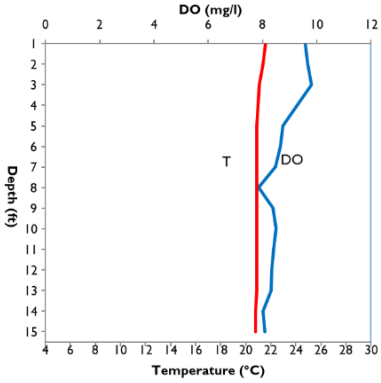

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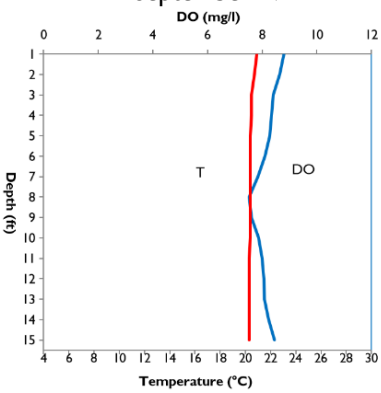

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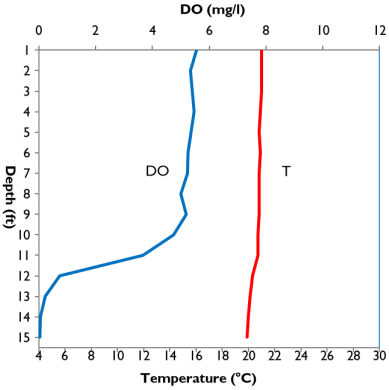

October 23