LAKE HOPATCONG – 2024 WATER QUALITY REPORT

MORRIS AND SUSSEX COUNTIES, NEW JERSEY

JANUARY 2025

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1.0 INTRODUCTION

Lake Hopatcong is the largest lake in New Jersey, with a surface area of 2,686 acres and approximately 39 miles of shoreline. With a maximum depth of 16.7 meters and a mean depth of 5.6 meters, the lake is dimictic and stably stratifies during the growing season each year. Lake Hopatcong is a highly valued resource for the state and has a substantial impact on the local economy.

Princeton Hydro, LLC conducted general water quality monitoring of Lake Hopatcong during the 2024 growing season. This monitoring program represents a continuation of the long-term monitoring program of Lake Hopatcong. While the 2010 through 2012 water quality monitoring programs were conducted with funds awarded to the Lake Hopatcong Commission by the New Jersey Department of Environmental Protection (NJDEP) through the Non-Point Source (319(h) of the Clean Water Act) grant program (Project Grant RP10-087), the water quality monitoring program of 2013 was funded through the Lake Hopatcong Foundation as a monetary match toward the grant. Remaining funds in the 319(h) grant were made available for the 2014, 2015, and 2016 water quality monitoring programs. The annual water quality monitoring program was funded by the Lake Hopatcong Commission from 2018 through 2024.

The current water quality monitoring program is a modified version of the program that was originally initiated in the Phase I Diagnostic / Feasibility Study of Lake Hopatcong and continued through the Phase II Implementation Projects. Both the Phase I and Phase II projects were funded by the US EPA Clean Lakes (314) Program. The modified monitoring program also continued through the development, revision, and approval of the Total Maximum Daily Load (TMDL)-based Restoration Plan, as well as through the installation of a series of watershed projects funded through three NJDEP 319 grants and a US EPA Targeted Watershed grant. Some additional monitoring was conducted during each sampling event in 2020, 2021, and 2022 as part of the HAB grant awarded in 2020 as well as a 319 grant (*WQR-2019-LHC00130)* awarded in 2021. The recent 319 grant involved modeling efforts to better quantify the internal phosphorus load on a seasonal and monthly basis under varying hydraulic conditions and will also involve the implementation of various in-lake and watershed-based projects to reduce nutrient loading to the waterbody. Finally, additional *in-situ* monitoring was conducted in July and August of the 2022, 2023, and 2024 seasons as part of a Highlands Council funded project to better characterize carryover brown trout (*Salmo trutta*) habitat during the peak summer months. This grant allowed for weekly *in-situ* sampling during the summer months, providing invaluable high-frequency data.

The current water quality monitoring program is valuable in terms of continuing to assess the overall "health" of the lake on an annual basis, identifying long-term trends or changes in water quality, and quantifying and objectively assessing the success and potential impacts of restoration efforts. In addition, the in-lake water quality monitoring program continues to be an important component in the evaluation of the long-term success of the implementation of the phosphorus TMDL-based Restoration Plan, which was approved by NJDEP in April of 2006. The monitoring program also provides the data necessary to support the Foundation's and Commission's requests for grant funding to implement both watershed-based and in-lake projects to improve the water quality of Lake Hopatcong. Also, much of the data collected in 2024 will be used to assess the relative effectiveness of in-lake and watershed-based projects, designed to prevent or minimize the impacts of harmful algal blooms (HABs) in Lake Hopatcong. Finally, it should be noted that the 2006 Restoration Plan was recently updated with funds provided by the NJ Highlands Council in 2021 into a Watershed Implementation Plan (WIP) and is being used to select, design and implement additional watershed-based projects.

2.0 MATERIALS AND METHODS

In-lake water quality monitoring was conducted at the following twelve locations in Lake Hopatcong (Appendix I) during the 2024 study period:

Station Number	Location
1	Woodport Bay
2	Mid-Lake
3	Crescent Cove/River Styx
4	Point Pleasant/King Cove
5	Outlet
6	Henderson Cove
7	Inlet from Lake Shawnee
8*	Great Cove
9*	Byram Cove
10	Northern Woodport Bay
11	Jefferson Canals
12	Landing Channel

* *In-situ* monitoring only

During the 2024 season, standard water quality sampling was conducted on 14 May, 13 June, 9 July, 6 August, and 18 September. Additional *in-situ* monitoring events that were included as part of the trout study were conducted on 2 July, 16 July, 23 July, 30 July, 13 August, and 21 August. An Aqua TROLL 500 multi-probe unit was used to monitor the *in-situ* parameters dissolved oxygen (DO), temperature, pH, specific conductance, and chlorophyll *a* during each sampling event. Data were recorded at 1.0 m increments starting at 0.1- 0.2 m below the water's surface and continued to within 0.5 m of the lake sediments at each station. In addition, water clarity was measured at each sampling station with a Secchi disk. A Turner FluoroSense handheld fluorometer was also used to measure *in-situ* phycocyanin and chlorophyll *a* concentrations at the surface of each station.

Discrete water quality samples were collected with a Van Dorn sampling device 0.5 m below the lake surface at each station, with the exception of Stations 8 and 9, as well as mid-depth and 0.5 m above the sediment at the mid-lake sampling site (Station 2). Discrete water samples were appropriately preserved, stored on ice, and transported to a State-certified laboratory for the analysis of the following parameters:

- Total suspended solids
- Total phosphorus-P
- Soluble reactive phosphorus-P
- Nitrate-N
- Ammonia-N
- Chlorophyll *a*

During each sampling event, phytoplankton and zooplankton samples were collected at the surface and mid-depth of the deep sampling station (Station 2). Phytoplankton samples were collected at the surface and mid-depth utilizing a Van Dorn sampling device and quantitatively assessed, while zooplankton samples were collected utilizing a Schindler sampling device and qualitatively assessed. Phytoplankton grab samples were also collected at the surface of Station 3, Station 10, and Station 12 for the quantitative assessment of cyanobacteria.

3.0 RESULTS AND DISCUSSION

All *in-situ* data collected in 2024 is presented Appendix II, discrete data in Appendix III, and plankton data in Appendix IV.

3.1 IN-SITU PARAMETERS

TEMPERATURE

Summer thermal stratification results when increasing solar radiation and air temperatures, aided by a few days of little wind activity, combine to thermally stratify the water column. Thermal stratification consists of a relatively warm upper water layer (epilimnion), a transition zone (metalimnion or thermocline), and a cold, deep water layer (hypolimnion). The density differences imparted through thermal stratification serve to inhibit wind driven mixing of the water column thereby effectively sealing off the hypolimnetic layer from contact with the atmosphere. This phenomenon has important implications in that bottom waters of thermally stratified systems may become devoid of oxygen due to excessive bacterial decomposition of organic matter and a lack of atmospheric replenishment of dissolved oxygen through diffusion. Resultant conditions of hypolimnetic anoxia include internal sediment release of metals and phosphorus, and reduced fish habitat.

In the late summer and early fall, declining air temperatures result in a negative heat income to the lake, and a loss of heat exceeds inputs from solar radiation. Surface waters are thus cooled and induce convection currents which serve to erode the metalimnion of the lake until the water column exhibits a uniform temperature and therefore uniform density. At this point the lake experiences fall turnover. The transition from the final stages of weak summer thermal stratification to fall turnover are often times abrupt, and can occur over a period of a few hours, especially if associated with the high wind velocities of a storm.

Surface water temperatures measured at Station 2 were coolest in May and September, with respective temperatures of 15.79 °C and 21.93 °C. The lake was already thermally stratified on 14 May, with an epilimnion present in the upper 5.0 m and a thermocline present from approximately 5.0 m to 9.0 m. By mid-June, surface temperatures at Station 2 had increased by over 7.0 °C relative to the 14 May event. The thermal stratification pattern remained similar between monitoring events, with the persistence of an epilimnion in the upper 5.0 m. The epilimnion shrunk significantly by 9 July due to the rapid heating at the surface, only present in the upper 2.0 m, and a large thermocline established from 2.0 m to 9.0 m.

Surface temperatures at Station 2 increased to a seasonal maximum of 29.02 °C on 16 July; this data was collected during one of the trout habitat monitoring events. This was the first time that the surface water temperature at Station 2 exceeded 29.0 °C during one of Princeton Hydro's monitoring events. Elevated water temperatures increase the risk of HABs, particularly at the mid-lake station where the internal phosphorus load is abundant. Surface temperatures cooled slightly by 6 August but still remained elevated at 27.45 °C. The lake remained stratified in September as temperatures cooled, with an expanded epilimnion present in the upper 8.0 m.

Water temperatures were often higher at the other stations throughout the lake as a result of the shallower depths. It takes less energy from the sun to heat the other stations since the mixing zone is much shallower. Surface water temperatures exceeded 28.50 °C at all stations on 9 July and exceeded 30.0 °C at Stations 7 and 10.

The long-term surface water temperatures from Station 2 during the month of July have been graphed and are shown below in Figure 1. This analysis was conducted to assess the potential impacts of climate change on Lake Hopatcong. The Station 2, mid-lake data were used because there was no chance of shading from near-shore trees or structures at this location. The July data were used since it is typically the warmest month of the year in the Mid-Atlantic States.

As shown in Figure 1, there has been a statistically significant increase in July surface water temperatures at Lake Hopatcong over the past 35 years. Additionally, the July 2024 surface water temperature at Station 2 was the highest recorded. It should be noted that each year from 2019 to 2022 were in the top six of the highest recorded July surface water temperatures dating back to 1988. These data provide evidence that climatic change is impacting Lake Hopatcong. In turn, increasing water temperatures makes the lake more favorable for larger and more frequent HABs.

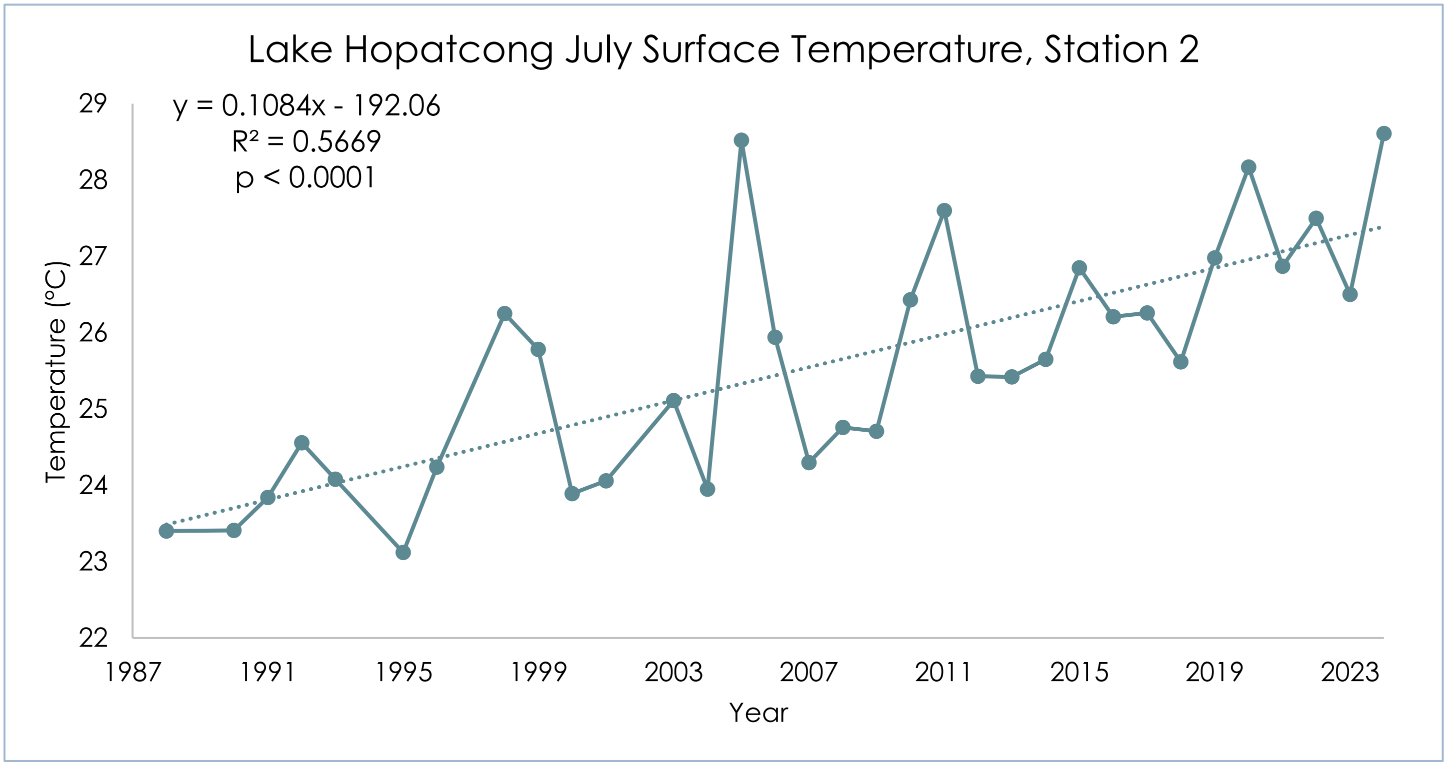


Figure 1: Long-term, July surface water temperatures at the mid-lake sampling station at Lake Hopatcong

DISSOLVED OXYGEN

DO is crucial to almost all biochemical reactions occurring in freshwater ecosystems. The primary sources of DO in a lake are diffusion from the atmosphere and photosynthesis. Biological respiration and bacterial decomposition of organic matter are the primary sources of consumption; these processes are often classified as water oxygen demand (WOD) and sediment oxygen demand (SOD) in limnology. The abundance and distribution of DO in a lake system is predicated on the relative rates of these producers and consumers; producers include aquatic macrophytes and phytoplankton. As the producers photosynthesize, they utilize water, carbon dioxide, and sunlight to create oxygen and glucose. This process increases DO concentrations in the sun-lit zone of a lake; this active area of the lake is known as the photic zone. As such, DO concentrations are generally higher in photic zone and lower in the deeper water, where a lack of photosynthetic activity in conjunction with organism respiration results in a decrease. DO is also influenced by the thermal properties of the water column. This includes both lake stratification and the varying degree of oxygen retention capacity of water at different temperatures; colder water holds more oxygen than warmer water.

When lakes thermally stratify, there is generally a correlated stratification of DO levels. The hypolimnion usually has lower DO concentrations, as this water cannot mix with the epilimnion, whereby DO concentrations would be replenished with atmospheric sources. In highly productive lakes, the hypolimnion may become devoid of oxygen due to bacterial decomposition of excessive inputs of organic material. The source of this material may either be from excessive phytoplankton production in the upper water layers that then sink to the bottom when they die (autochthonous), from excessive watershed derived sediment loading (allochthonous), or more likely a mixture of the two. Also, as DO concentrations are generally measured during the daytime when concentrations are highest, concentrations are lower at night when photosynthesis ceases but respiration continues.

An important consequence of anoxic (DO < 1.0 mg/L) conditions in the hypolimnion includes both reduced fish habitat and the release of metals and phosphorus, a process termed internal loading. Internal loading occurs when tightly bound iron and phosphate sediment complexes are reduced, thereby dissociating phosphorus from iron, and making it available for diffusion into the water column. This process has been documented to contribute to the overall eutrophication of many lakes, as this internal source of phosphorus is pulsed into the photic zone during strong storm events whereby it may serve as fuel for excessive algal growth. A general guideline for DO concentrations in lakes is that a concentration of greater than 1.0 mg/L is needed to preclude internal nutrient and metal release while concentrations of 4.0 mg/L and greater should be kept in order to sustain proper warm-water fisheries habitat.

DO concentrations remained above 5.0 mg/L in the upper 10.0 m at Station 2 on 14 May before slowly declining to anoxic (DO < 1.0 mg/L) conditions at 14.0 m. As the surface water warmed in June and the lake developed a more defined thermal stratification pattern, DO concentrations began to decline rapidly below the epilimnion; this trend continued through the last monitoring event on 18 September. On 13 June, 9 July, and 6 August, DO concentrations fell below the 5.0 mg/L threshold at depths of approximately 4.8 m, 4.2 m, and 4.6 m, respectively. Due to the high oxygen demand in Lake Hopatcong, DO concentrations fell to anoxic concentrations shortly below the above-mentioned depths; a large portion of the water column was void of oxygen in June, July, and August. As water temperatures cooled in September and the epilimnion expanded, anoxia was pushed down in the water column slightly; however, the hypolimnion still remained anoxic below a depth of 7.0 m.

During the 14 May event, DO concentrations at all remaining stations were above 5.0 mg/L throughout the water column, with the exception of the bottom 2.0 m at the deeper (8.0 m) Station 9. On 13 June, all other sampling stations had DO concentrations that were above 5.0 mg/L, with the exception of the bottom few meters at the deeper Stations 8 and 9. DO concentrations began to decrease slightly at the shallower stations as the water temperatures increased in July and August; however, only the bottom of Stations 8 and 9 were anoxic. On 18 September, all other sampling stations had DO concentrations that were above 5.0 mg/L, with the exception of the bottom few meters at Stations 8 and 9.

To better illustrate the relationship between thermal stratification and DO concentrations across the growing season, isopleth figures are presented below (Figures 2 and 3).

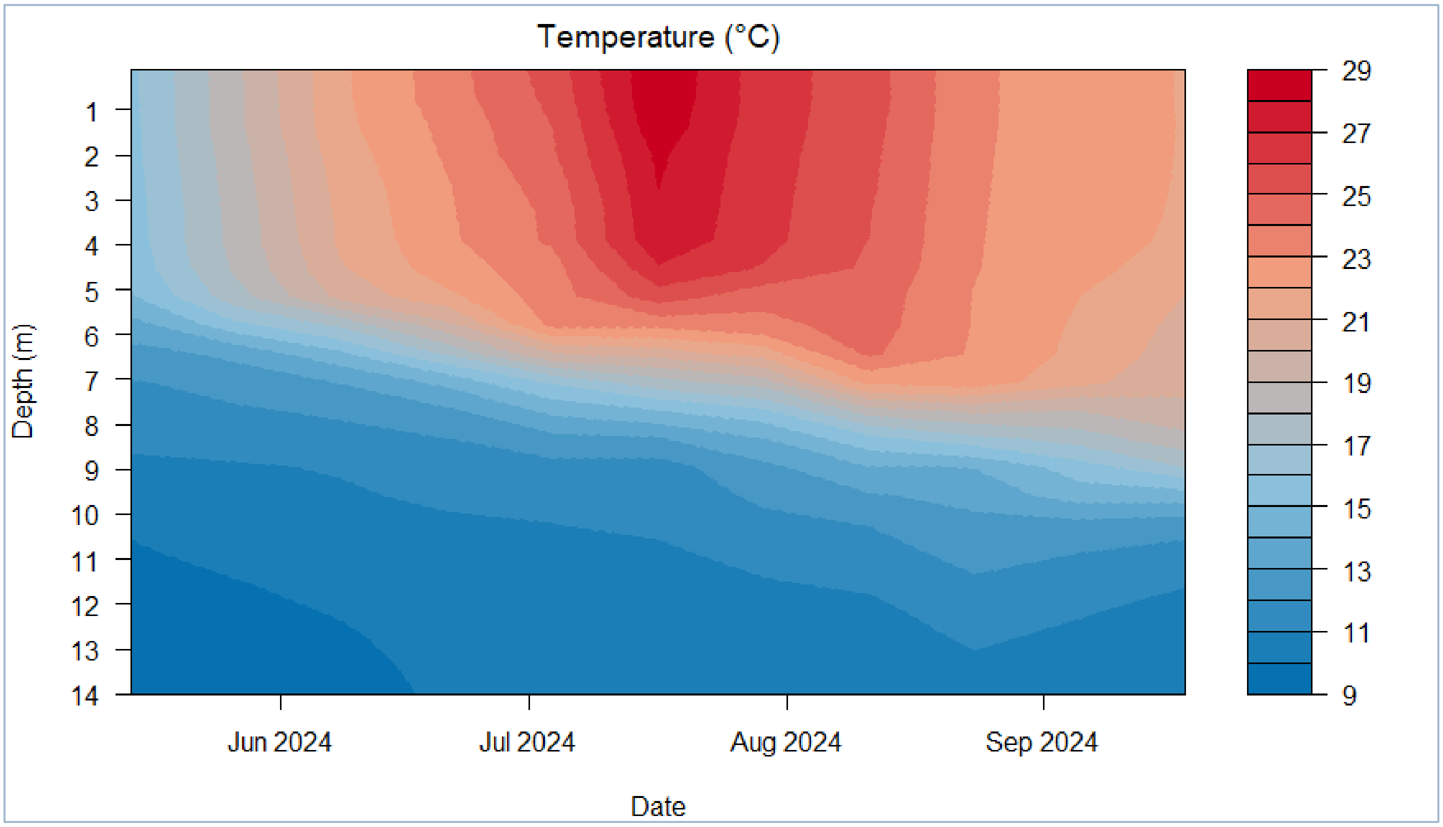


Figure 2: Temperature isopleths at Station 2 throughout the 2024 season

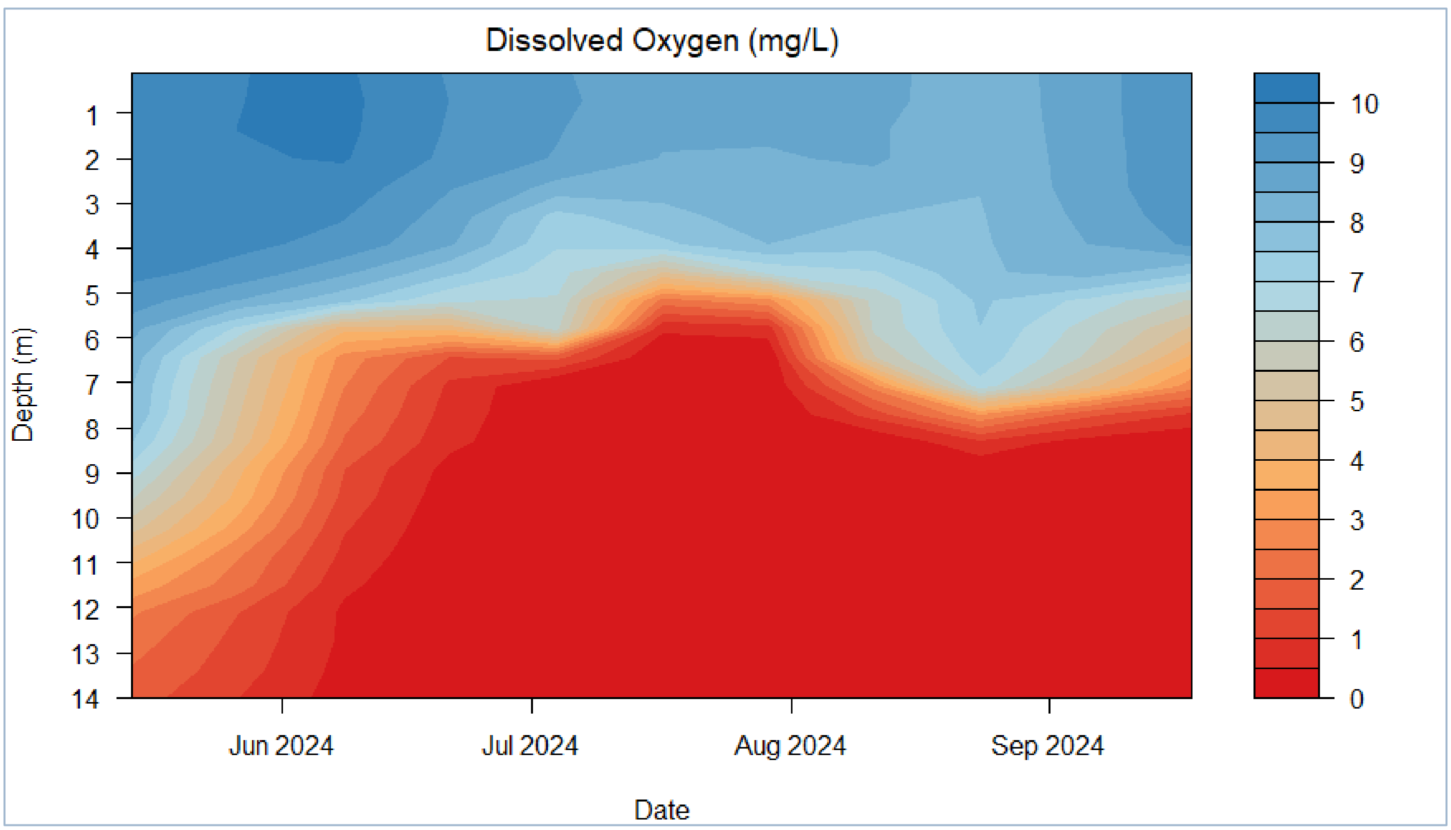


Figure 3: Dissolved oxygen isopleths at Station 2 throughout the 2024 season

PH

pH is a unitless measurement of the hydrogen ion concentration in water. Expressed on a negative logarithmic scale from 0 to 14, every change of 1 pH unit represents a 10-fold change in hydrogen ion concentration. The pH of pure water is 7 and is termed neutral. Any value less than 7 is termed acidic, while any value greater than 7 is termed basic. Baseline pH values in aquatic systems are primarily determined by the ionic constituency of the surrounding geology. Watersheds draining soils of easily erodible anionic constituents are generally well buffered, and as such have runoff waters with basic pH values (pH above 7). Spatial variations in pH throughout the water column are largely due to relative rates of photosynthesis versus respiration. As plants and algae photosynthesize and carbon dioxide is removed from the water, pH values increase. Conversely, respiration releases carbon dioxide into the environment which results in a reduction in pH. Given these relationships, pH values may differ substantially in the epilimnion and hypolimnion. The New Jersey Surface Water Quality Standard for pH is between 6.5 -8.5.

Surface pH values ranged between 7.5 – 9.3 on 13 May, with two stations exceeding the upper threshold of the New Jersey Surface Water Quality Standard. The two stations that exceeded the upper limit of 8.5 were the shallow Stations 5 and 12, which was likely due to early season plant growth. On 13 June, surface pH values ranged between 7.6 – 8.6 throughout the lake, mostly remaining within the optimal range. pH values often decrease with depth as a result of decreasing rates of photosynthesis, although pH values at all depths remained above 6.5 during each sampling event. Surface pH values remained similar to the June values in July and August, with a few stations exceeding 8.5 but remaining below 9.0. Surface values again remained within the optimal range of 6.5 – 8.5 in September. In summary, pH values exceeded the upper recommended threshold at a few stations but remained at acceptable ecological values.

WATER CLARITY

Transparency in lakes is generally determined through the use of a Secchi disk. The Secchi disk is a contrasting white and black disk that is lowered into the lake until no longer visible then retrieved until visible again. The average of those two lengths is termed the Secchi depth. This depth may be influenced by algal density, suspended inorganic particles, organic acid staining of the water or more commonly a combination of all three. This parameter is often times used to calculate the trophic status (productivity) of a lake and as such is a critical tool in lake evaluation. Secchi depths less than 1.0 m are generally associated with reduced water quality due to high concentrations of algae or suspended inorganic sediments and as such is generally associated with impaired quality.

Water clarity was measured at each in-lake monitoring station throughout the 2024 season. Based on Princeton Hydro's in-house, long-term database of lakes in northern New Jersey, water clarity is considered acceptable for recreational activities when the Secchi depth is equal to or greater than 1.0 m (3.3 ft).

Water clarity was variable throughout the lake during each sampling event. In May, all stations had Secchi depths that met the 1.0 m threshold, ranging from 1.0 m at Station 10 up to 1.8 m at Station 2. Clarity decreased throughout the lake on 13 June, ranging from a minimum of 0.9 m at Station 3 up to 1.3 m at Station 8. Water clarity continued to decrease throughout the lake on 9 July, with a minimum of 0.8 m at Stations 1, 3, 9, 10, and 12 and a maximum of 1.2 m at Station 11. On 6 August, clarity ranged from 0.6 m at Stations 1, 3, and 6 to 1.2 m at Station 11. Water clarity improved slightly at all stations on 18 September, ranging from 0.8 m at Station 3 to 1.6 m at Station 2. Similar to recent years, water clarity was consistently poor at Stations 3 and 10, located in Crescent Cove and Woodport Bay, respectively. Water clarity has consistently been decreasing throughout Lake Hopatcong in recent years, which is a concerning trend. The mean Secchi depth of 1.1 at Station 2 was the lowest on record for the second consecutive year dating back to 1991.

3.2 DISCRETE PARAMETERS

AMMONIA-NITROGEN (NH_3-N)

In lakes, ammonia is naturally produced and broken down by bacterial processes while also serving as an important nutrient in plant growth. In a process termed ammonification, bacteria break down organically bound nitrogen to form NH_4^+. In aerobic systems bacteria then break down excess ammonia to nitrate (NO_3^-) in a process termed nitrification. These processes provide fuel for bacteria and are generally kept in balance to prevent accumulation of any one nitrogen compound.

Ammonia is generally present in low concentrations in oxygenated epilimnetic layers of lakes due to the rapid conversion of the ammonium ion to nitrate. In addition, most plants and algae prefer the reduced ammonium ion to the oxidized nitrate ion for growth and therefore further contribute to reduced concentrations of ammonia in the upper water layer. In the anoxic hypolimnion of lakes ammonia tends to accumulate due to increased bacterial decomposition of organic material and lack of oxygen which would otherwise serve to oxidize this molecule to nitrate.

Increased surface water concentrations of ammonia may be indicative of excessive non-point source pollution from the associated watershed. The ammonium ion, unlike that of nitrate, may easily bind to soil particles whereby it may be transported to the lake during storm events. Another likely source of excessive ammonia in suburban watersheds is runoff from lawn fertilizer which is often highly rich in nitrogenous species. Increases in ammonia concentrations in the hypolimnion of lakes are generally associated with thermal stratification and subsequent dissolved oxygen depletion. Once stratification breaks down a pulse of ammonia rich water may be mixed throughout the entire water column whereby it will cause undue stress to aquatic organisms, as well as possible toxicity.

Toxicity of ammonia to aquatic species generally increases with increasing pH (>8.5) and decreasing temperature (<5°C). The general guideline issued by the EPA is that ammonia should not exceed a range of 0.02 mg/L to 2.0 mg/L, dependent upon water temperature and pH, to preclude toxicity to aquatic organisms.

Surface ammonia-N concentrations remained relatively low throughout Lake Hopatcong in 2024, ranging between 0.01 mg/L and 0.06 mg/L. Surface ammonia-N concentrations were consistently higher at Station 3, with values of 0.06 and 0.08 mg/L in May and July, respectively.

Mid-depth samples collected at Station 2 were also low throughout the season, ranging between 0.02 mg/L and 0.06 mg/L from July through September. Deep samples at Station 2 were elevated throughout the season, ranging between 0.56 mg/L in May, June, and August and 1.11 mg/L in September. As mentioned above, ammonia often accumulates in the anoxic hypolimnion due to the lack of oxygen which would otherwise oxidize the molecule and convert it to nitrate. These elevated ammonia-N concentrations coincide with elevated TP concentrations, indicating a large internal load in the hypolimnion that is available for depth-regulating cyanobacteria.

NITRATE-NITROGEN (NO_3-N)

Nitrate is the most abundant form of inorganic nitrogen in freshwater ecosystems. Common sources of nitrate in freshwater ecosystems are derived from bacterial facilitated oxidation of ammonia and through groundwater inputs. The molecular structure of nitrate lends it poor ability to bind to soil particles but excellent mobility in groundwater.

Nitrate is often utilized by algae, although to a lesser extent than ammonia, for growth. Nitrate distribution is highly dependent on algal abundance and the spatial distribution of dissolved oxygen concentrations. In many eutrophic lake systems nitrate concentrations show temporal and spatial variability due to algal productivity and relative concentrations of dissolved oxygen.

Excessively high concentrations of nitrate are primarily attributable to either wastewater inputs or excessive organic matter decomposition in oxygenated hypolimnion. Typically, lakes with concentrations above 0.30 mg/L indicates nitrogen-loading; however, concentrations below 0.50 mg/L are still considered acceptable surface water quality.

Surface nitrate-N concentrations were low to moderate in May, ranging between 0.05 mg/L at Stations 5 and 12 and 0.19 mg/L at Station 3. Surface nitrate-N concentrations exceeded 0.10 mg/L at Stations 3, 7, and 10. Surface nitrate-N concentrations decreased throughout the lake in June, with concentrations below the lab detection limit of 0.05 mg/L at all stations except for 7 and 11, with respective concentrations of 0.05 mg/L and 0.09 mg/L. Surface concentrations increased slightly at most stations in July but remained low, with a maximum concentration of 0.07 mg/L at Station 11. Surface nitrate-N concentrations remained low for the remainder of the season and never exceeded 0.06 mg/L.

Mid-depth samples collected at Station 2 were low throughout most of the season and peaked at 0.13 mg/L in May; all other samples were below the lab detection limit of 0.05 mg/L. Deep samples varied between below the lab detection limit of 0.05 mg/L in June to 0.13 mg/L in May.

In summary, Surface nitrate-N concentrations remained low in 2024 with no isolated elevated concentrations as was observed in 2023; Station 3 had an elevated concentration of 0.52 mg/L in May 2023 and Station 10 had an elevated concentration of 0.26 mg/L in August 2023. It should be noted that the Borough of Hopatcong (Station 3) is partially sewered, while the Township of Jefferson (Station 10) is not sewered. Thus, these elevated nitrate-N concentrations in these sections of the lake can be at least partially attributed to leachate from near-shore septic leachfields. However, the Borough has been in the process of sewering some of their neighborhoods. In addition, the Township is currently working with a number of stakeholders, including the US Army Corps of Engineers, to design and conduct a sewering project for the residents in this part of the watershed.

TOTAL PHOSPHORUS (TP)

Phosphorus is often the limiting nutrient in lake ecosystems, or the nutrient in which abundance is lowest relative to demand by plants and algae. As a result, phosphorus is often the primary nutrient driving excessive plant and algal growth. Given this nutrient limitation, only relatively small increases in phosphorus concentration can fuel algal blooms and excessive macrophyte production. By monitoring total phosphorus concentrations, the current trophic status of the lake can be determined and future trends in productivity may be predicted. It is important to note that total phosphorus concentrations account for all species of phosphorus, including organic, inorganic, soluble, and insoluble. Therefore, this measure accounts not only for those dissolved, inorganic species of phosphorus that are readily available for algal assimilation, but also for those species of phosphorus either tightly bound to soil particles or contained as cellular constituents of aquatic organisms which are generally unavailable for algal assimilation.

The State's Surface Water Quality Standard (SWQS, N.J.A.C. 7:9B – 1.14(c) 5) for TP in the surface waters of a freshwater lake or impoundment is 0.05 mg/L. This established TP concentration is for any freshwater lake or impoundment in New Jersey that does not have an established TMDL. Lake Hopatcong has established a phosphorus TMDL, which was revised and approved by NJDEP in June 2006. Based on its refined phosphorus TMDL, the long-term management goal is to maintain an average growing season TP concentration of 0.03 mg/L or less within the surface waters of Lake Hopatcong. Based on Princeton Hydro's in-house database on northern

New Jersey lakes, TP concentrations equal to or greater than 0.03 mg/L increases the likelihood of nuisance algal growth and/or HABs.

Surface TP concentrations were low to moderate in May, with concentrations of 0.04 mg/L at Stations 3, 7, 10, and 12; all other stations had concentrations below 0.04 mg/L. Surface TP concentrations did increase around the lake on 13 June and exceeded the 0.03 mg/L recommended threshold at seven stations. Stations 3, 5, and 7 had concentrations of 0.04 mg/L, and Stations 2, 10, and 11 had concentrations of 0.05 mg/L. Surface TP concentrations were similar in July, exceeding 0.03 mg/L at six stations. Stations 1, 10, 11, and 12 had concentrations of 0.04 mg/L, Station 3 had a concentration of 0.05 mg/L, and Station 7 had a concentration of 0.06 mg/L. Surface TP concentrations remained slightly elevated in August and exceeded 0.03 mg/L at six stations again; Station 3 and 10 had the highest concentrations at 0.06 mg/L. Surface TP concentrations decreased around the lake in September and did not exceed 0.03 mg/L at any station.

TP concentrations were consistently elevated at Stations 3 and 10, continuing a trend that's been observed in recent years. Station 10 is located north of Brady Bridge in a shallow section of the lake that is consistently turbid. Station 3 is located in Crescent Cove and consistently has the highest cyanobacteria concentrations during the summer months.

Mid-depth TP concentrations at Station 2, which were collected from the middle of the thermocline, were low throughout the season and did not exceed 0.03 mg/L. This indicates that little to no TP that was building up in the anoxic hypolimnion throughout the season was mixed with the surface water and likely explains why TP concentrations were generally low at the surface of Station 2 throughout the season. Deep TP concentrations collected from approximately 0.5 m above the sediment increased as the season progressed and anoxic conditions persisted, reaching a maximum TP concentration of 0.21 mg/L on 18 September.

The mean TP concentration was calculated for each surface water sampling station and compared with the TMDL threshold concentration of 0.03 mg/L. Of the ten long-term water quality monitoring stations, seven stations were compliant with this TMDL in 2024. Stations 3, 10, and 12 had seasonal mean concentrations of 0.04 mg/L. Stations 3, 10, and 12 were the three stations that exceeded the 0.03 mg/L threshold in 2023, all with a concentration of 0.04 mg/L.

SOLUBLE REACTIVE PHOSPHORUS (SRP)

Soluble reactive phosphorus (SRP) represents the dissolved inorganic portion of the total phosphorus metric. This species of phosphorus is readily available for assimilation by all algal forms for growth and is therefore normally present in limited concentrations except in eutrophic lakes. Princeton Hydro recommends concentrations to not exceed 0.005 mg/L to prevent nuisance algal blooms.

Surface SRP concentrations were low throughout the lake for most of the 2024 growing season. Surface concentrations did not exceed 0.003 mg/L in May. In June, surface concentrations exceeded 0.003 mg/L at Stations 7 and 11, with respective concentrations of 0.004 mg/L and 0.009 mg/L. Only one sample from Station 1 exceeded 0.003 mg/L in July and August, with a concentration of 0.007 mg/L on 9 July. Surface SRP concentrations remained low at all stations in September, with maximum concentrations of 0.003 mg/L at Stations 3 and 12.

Mid-depth SRP concentrations at Station 2 were below the lab detection limit of 0.003 mg/L from May through August before increasing to 0.004 mg/L in September. Deep SRP concentrations at Station 2 were low in May with a concentration of 0.002 mg/L but increased in June with a concentration of 0.008 mg/L. Deep SRP concentrations were extremely elevated from July – September, with concentrations ranging between 0.049 mg/L in August and 0.085 mg/L in September. These concentrations are much higher than the deep SRP concentrations measured over the past 2 years. In 2022, the maximum deep SRP concentration was 0.005 mg/L and in 2023, the maximum deep SRP concentration was 0.020 mg/L. These elevated concentrations are a direct result of the internal release of phosphorus from the anoxic sediments and serve as a source of fuel for depth-regulating cyanobacteria.

CHLOROPHYLL *A*

Chlorophyll *a* is a pigment possessed by all algal groups, used in the process of photosynthesis. Its measurement is an excellent means of quantifying algal biomass. In general, an algal bloom is typically perceived as a problem by the layperson when chlorophyll-*a* concentrations are equal to or greater than 25.0 to 30.0 µg/L. In contrast, the targeted average and maximum chlorophyll-*a* concentrations, once Lake Hopatcong is in complete compliance with the TMDL, are predicted to be 8.0 and 14.0 µg/L, respectively.

Chlorophyll *a* was elevated at station 7 in May, with a concentration of 22.0 µg/L; all other stations had concentrations below 14.0 µg/L. On 13 June, surface chlorophyll *a* concentrations exceeded the 14.0 µg/L threshold at four stations, ranging from 15.0 µg/L at Stations 10 and 12 up to 18.0 µg/L at Station 3. In July, five stations had chlorophyll *a* concentrations above 14.0 µg/L, ranging from 15.0 µg/L at Station 6 up to 21.0 µg/L at Station 12. Concentrations were more variable in early August, and only three stations exceeded the 14.0 µg/L threshold; however, Station 3 had an elevated concentration of 37.0 µg/L. Only two stations exceeded the 14.0 µg/L threshold in September; Station 1 had a concentration of 15.0 µg/L and Station 3 had a concentration of 22.0 µg/L.

Lakewide average surface chlorophyll *a* concentrations were calculated for each month and compared with the targeted goal of 8.0 µg/L. Average surface chlorophyll *a* concentrations exceeded the targeted goal of 8.0 µg/L during each sampling event in 2024, ranging from 8.3 µg/L in May up to 14.9 µg/L in July; these were both lower than the minimum and maximum average chlorophyll *a* concentrations in 2023. Station 11 was the only site that had a growing season average at or below the targeted threshold of 8.0 g/L. All other stations exceeded this threshold, ranging from a seasonal average of 10.2 µg/L at Station 6 up to a maximum of 20.6 µg/L at Station 3. This is the third year in a row that Station 3 had the highest seasonal average chlorophyll *a* concentration. However, Stations 1 and 10, both located north of Brady Bridge, had much lower seasonal average concentrations than the past two years, with respective averages of 11.6 µg/L and 12.8 µg/L.

TOTAL SUSPENDED SOLIDS (TSS)

The concentration of suspended particles in a waterbody that will cause turbid or "muddy" conditions, total suspended solids is often a useful indicator of sediment erosion and stormwater inputs into a waterbody. Because suspended solids within the water column reduce light penetration through reflectance and absorbance of light waves and particles, suspended solids tend to reduce the active photic zone of a lake while contributing a "muddy" appearance at values over 25 mg/L. Total suspended solids measures include suspended inorganic sediment, algal particles, and zooplankton particles.

Surface TSS concentrations were low throughout most of the lake in May, ranging from below the lab detection limit of 2 mg/L at Stations 4 and 5 to 9 mg/L at Station 1. TSS concentrations remained low at many stations in June but were moderately elevated at Stations 6, 7, and 10, with respective concentrations of 16 mg/L, 33 mg/L, and 14 mg/L. TSS concentrations decreased throughout the lake on 24 July, with concentrations ranging between 2 mg/L at Station 11 and 11 mg/L at Station 7. TSS concentrations were variable in August, ranging between 2 mg/L at Station 11 and 19 mg/L at Station 3. TSS concentrations remained relatively low in September, ranging from below the lab detection limit of 2 mg/L at Station 2 and 11 mg/L at Station 10. Mid-depth and deep TSS concentrations at Station 2 were low to moderate all season and never exceeded 12 mg/L.

3.3 BIOLOGICAL PARAMETERS

PHYTOPLANKTON

Phytoplankton are algae that are freely floating in the open waters of a lake or pond. These algae are vital to supporting a healthy ecosystem since they are the base of the aquatic food web. However, high densities of phytoplankton can produce nuisance conditions. The majority of nuisance algal blooms in freshwater ecosystems are the result of cyanobacteria, also known as blue-green algae. Some of the more common water quality problems created by blue-green algae include bright green surface scums, taste and odor problems, and the generation of cyanotoxins. Phytoplankton samples were collected from the surface and mid-depth of Station 2 during the 2024 season and were quantitatively assessed for comparison with the NJDEP HAB Alert Levels. Surface samples were also collected at Stations 3 and 10 for quantitative analysis during each event; Princeton Hydro also began collecting plankton samples at Station 12 in June. New Jersey implemented advanced harmful algal bloom (HAB) screening and response protocols in 2020, and these HAB standards are provided below in Figure 4.

Surface and mid-depth grab samples collected at Station 2 during the 14 May sampling event yielded a diverse plankton community, with 21 genera identified at the surface and 17 genera identified at mid-depth. Similar to recent years, the green algae and diatom communities were the most diverse in May, with a total of 13 genera identified at the surface and 11 genera identified at mid-depth. Also similar to 2023, the cyanobacteria community was already moderately abundant at this time, with a total cyanobacteria cell count of 22,472 cells/mL at the surface and 20,573 cells/mL at mid-depth; *Aphanizomenon* was the dominant genera which is often the case early in the season. The phytoplankton community remained diverse on 13 June, with 21 genera identified at the surface and 19 genera identified at mid-depth. The green algae community was again the most diverse, yielding 9 genera at the surface and 6 genera at mid-depth. The cyanobacteria community increased in abundance over the following month, with cyanobacteria densities of 37,494 cells/mL at the surface and 27,220 cells/mL at mid-depth; *Aphanizomenon* was the dominant genus again at both depths. Although higher than desired, these were lower than the June 2023 samples, with respective cell counts of 59,697 cells/mL and 63,254 cells/mL.

As the season progressed into July, cyanobacteria densities increased around the lake, with HABs manifesting in certain areas. The cyanobacteria cell count at the surface was exceptionally high at 317,293 cells/mL while the cell count at mid-depth increased to 58,090 cells/mL. In addition to *Aphanizomenon*, *Raphidiopsis raciborskii* (previously named *Cylindrospermopsis raciborskii*) densities were also very high and exceeded 100,000 cells/mL at the surface of Station 2. In addition to the mid-lake section of Lake Hopatcong, HABs were also observed near the State Park and in Byram Cove. *Raphidiopsis* is a subtropical cyanobacteria genus that has been blooming in Lake Hopatcong, as well as other temperate waterbodies, in increasing numbers in recent years. Based on the last four years of data, this subtropical cyanobacteria tends to appear at Station 3 at the heigh of the summer season and has increasingly been present at Station 2 and other areas of the lake.

Cyanobacteria densities decreased in August but the surface sample from Station 2 remained very high with a cell count of 151,585 cells/mL. The cyanobacteria community was not diverse in August, and *Aphanizomenon* and *Raphidiopsis* were the only genera present. 42 cyanobacteria akinetes/mL were identified in the surface sample; akinetes are a type of overwintering cyanobacteria cells or “resting spores,” and akinete densities can reveal the potential for cyanobacteria growth.

The phytoplankton community at Station 2 remained moderately diverse in September, with 15 genera identified at the surface and 16 genera identified at mid-depth. Cyanobacteria densities decreased in September but still remained elevated with surface and mid-depth densities of 41,567 cells/mL and 28,826 cells/mL. Akinete densities at Station 2 increased substantially in September, with respective surface and mid-depth concentrations of 1,537 akinetes/mL and 797 akinetes/mL, primarily on *Raphidiopsis* filaments. Cyanobacteria tend to increase akinete production later in the season, as temperatures begin to cool and the duration of sunlight decreases, as they prepare to overwinter in the sediments. Princeton Hydro only began consistently monitoring akinete production in recent years, but the increased production of *Raphidiopsis* akinetes towards the end of the season provides insight into the elevated *Raphidiopsis* densities that have been observed over the past few years.

Surface grabs were also collected at Station 3 during each sampling event. The sample collected at Station 3 during the 14 May sampling event yielded a diverse plankton community, with 20 different genera identified. The green algae and diatom community was the richest in May, with 10 genera identified between the two groups. The cyanobacteria cell count was only 11,637 cells/mL in May. The plankton community at Station 3 increased considerably in richness and abundance on 13 June, with 23 genera identified, and there was a very diverse green algae community comprised of 11 genera. The cyanobacteria community also increased in richness and abundance in June, with a total of 5 genera identified and a cyanobacteria cell count of 49,686 cells/mL; *Aphanizomenon* was the dominant genus.

23 total genera were identified in the sample collected at Station 3 on 9 July; however, cyanobacteria densities increased significantly. The total cyanobacteria count was 287,224 cells/mL and was dominated by *Aphanizomenon* and *Raphidiopsis*. This coincided with elevated cell counts at Station 2, near the State Park and Byram Cove. Cyanobacteria densities remained elevated in August, with a total cyanobacteria cell count of 182,783 cells/mL. *Raphidiopsis* replaced *Aphanizomenon* as the dominant genera in August. Cyanobacteria densities remained high in September, with a total cell count of 141,818 cells/mL, primarily comprised of *Raphidiopsis*. Additionally, 897 akinetes/mL were identified in this sample, which is indicative of cyanobacteria preparing to overwinter in the sediments until environmental conditions become more favorable the following season.

Cyanobacteria densities in samples collected at Stations 2, 3, 10 and 12, are provided in Figure 5 below.

In addition to the cyanobacteria cell counts at Station 2, Turner FluoroSense handheld fluorometers were utilized to measure phycocyanin at the surface during these main water quality sampling events. Phycocyanin is a pigment that is produced almost exclusively by cyanobacteria and is currently being assessed by NJDEP in terms of monitoring for HABs. It's important to note that the model of meter has different ranges and requires a separate correlation. A correlation was calculated by NJDEP for the Turner handheld meter used by Princeton Hydro, with a value of 12 µg/L correlating with an estimated cyanobacteria cell count of 20,000 cells/mL and a value of 44 µg/L correlating with an estimated cyanobacteria cell count of 80,000 cells/mL.

Phycocyanin measurements were taken at the surface of all stations in 2024. Phycocyanin concentrations remained low at most stations in May, ranging from 1 µg/L at Stations 5, 7, 11, and 12 up to 15 µg/L at Station 4. Concentrations increased at most stations on 13 June, exceeding 12 µg/L at Stations 2, 3, and 6; Stations 3 had the highest phycocyanin concentration at 19 µg/L. Phycocyanin concentrations continued to increase in July and exceeded 12 µg/L at stations besides Stations 7, 10 and 11. Phycocyanin concentrations exceeded 25 µg/L at Stations 3, 5, 6, and 8, with respective concentrations of 32, 30, 27, and 27 µg/L. Phycocyanin concentrations continued to rise in August, exceeding 12 µg/L everywhere besides Station 7 and 11; concentrations exceeded 40 µg/L at Stations 2 and 9. Phycocyanin concentrations finally began to decrease in September, but still exceeded 12 µg/L at Stations 2 and 10.

HAB Alert Level	Criteria	Recommendations
HAB Not Present	**HAB reported and investigated. No HAB present.**	**None**
WATCH *Suspected or confirmed HAB with potential for allergenic or irritative health effects*	Suspected HAB based on field survey **OR** Confirmed cell counts ≥20K - <80K cells/mL **AND** No known toxins above public health thresholds	**Public Bathing Beaches Open** Waterbody Accessible: Use caution during **primary contact (e.g. swimming) and secondary (e.g. non-contact boating)** activities Do not ingest water (people/pets/livestock) Do not consume fish
ADVISORY *Confirmed HAB with moderate risk of adverse health effects and increased potential for toxins above public health thresholds*	Lab testing for toxins Microcystins: ≥2 µg/L Cylindrospermopsin: ≥5 µg/L Anatoxin-a: ≥15 µg/L Saxitoxin: ≥0.6 µg/L **OR** Confirmed cell counts ≥80K cells/mL	**Public Bathing Beaches Closed** Waterbody Remains Accessible: Avoid primary contact recreation Use caution for secondary contact recreation Do not ingest water (people/pets/livestock) Do not consume fish
WARNING *Confirmed HAB with high risk of adverse health effects due to high toxin levels*	Toxin (microcystins) ≥20 - <2000 µg/L	**Public Bathing Beaches Closed** Cautions as above May recommend against secondary contact recreation.
DANGER *Confirmed HAB with very high risk of adverse health effects due to very high toxin levels*	Toxin (microcystins) ≥2000 µg/L	**Public Bathing Beaches Closed** Cautions as above. Possible closure of all or portions of waterbody and possible restrictions access to shoreline.

Figure 4: NJDEP HAB Response Guidelines

The NJDEP modified their HAB alert level classifications for 2020 and beyond. Cell counts between 20,000 – 80,000 cells/mL fall under the classification of "Watch." Under this classifications, public health beaches can remain open, depending on local health authority evaluation and assessment, but monitoring under these classifications should increase. As cell counts exceed 80,000 cells/mL, the alert levels progress into "Advisory," "Warning," and "Danger" depending on cyanotoxin concentrations; however, public bathing beaches would be closed under any of these elevated classifications. Cyanobacteria cell counts throughout the 2024 season can be found in Figure 5.

Cyanobacteria cell counts at the surface of Station 2 fell under the "Watch" level in May, June, and September, and the "Advisory" level in July and August. Cyanobacteria cell counts at mid-depth of Station 2 fell under the "Watch" level during each monitoring event. Cyanobacteria cell counts at Station 3 fell under the "Watch" level in June before progressing into the "Advisory" level for the remainder of the season. Cyanobacteria cell counts at Station 10 fell under the "Watch" level from July and September, and the "Advisory" level in August. Finally, cyanobacteria cell counts at Station 12 fell under the "Watch" level in June and September and the "Advisory" level in July and August.

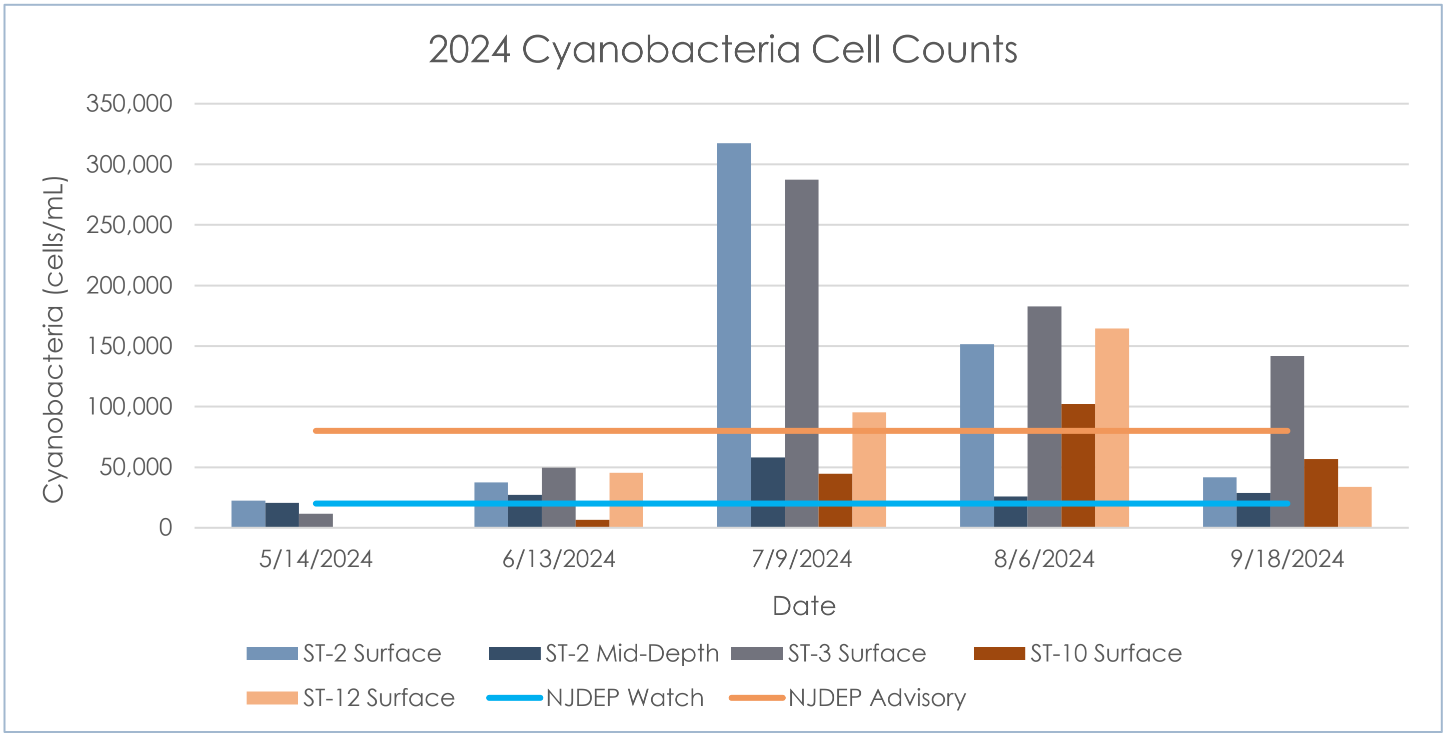


Figure 5: Cyanobacteria cell counts in Lake Hopatcong throughout the 2024 season

ZOOPLANKTON

Zooplankton are the micro-animals that live in the open waters of a lake or pond. Some large-bodied zooplankton are a source of food for forage and/or young gamefish. In addition, many of these large-bodied zooplankton are also herbivorous (i.e. algae eating) and can function as a natural means of controlling excessive algal biomass. Given the important role zooplankton serve in the aquatic food web of lakes and ponds, samples for these organisms were collected at the surface and mid-depths of Station 2 during each monitoring event.

The Cladoceran genera *Bosmina*, as well as a diversity of rotifer genera, were common at Station 2 in May. In total, there were 9 zooplankton genera identified at the surface and 10 genera identified at mid-depth, with representation from the three major groups: Cladocerans, copepods, and rotifers. The rotifer genus *Keratella* was abundant at both depths. Zooplankton richness increased slightly in June, with a total of 10 genera identified at the surface and 12 genera identified at mid-depth. The larger herbivorous Cladocerans increased in diversity as well, with two genera identified at the surface and four genera identified at mid-depth; the Cladoceran genus *Bosmina* was common in the surface sample.

Zooplankton genera richness continued to increase in July, with a total of 14 genera identified in both the surface and mid-depth samples. The increase in genera richness was primarily attributed to the smaller rotifers, although the Cladocerans were still present in low densities. At least three Cladoceran genera were identified in each sample.

Zooplankton genera richness decreased in the surface sample in August, with 7 genera identified in the surface sample and 14 genera identified in the mid-depth sample. There were no Cladoceran genera identified at the surface and only a low abundance of *Bosmina* was identified in the mid-depth sample. Rotifers dominated the zooplankton community again in September, with *Polyartha* being the most abundant genus.

3.4 RECREATIONAL FISHERY AND POTENTIAL BROWN TROUT HABITAT

Of the recreational gamefish that reside or are stocked in Lake Hopatcong, trout are the most sensitive in terms of water quality. For their sustained management, all species of trout require DO concentrations of at least 4.0 mg/L or greater. However, the State's designated water quality criteria to sustain a healthy, aquatic ecosystem is a DO concentration of at least 5.0 mg/L.

While all trout are designated as cold-water fish, trout species display varying levels of thermal tolerance. Brown trout (*Salmo trutta*) have an <u>optimal</u> summer water temperature range of 18.0 to 24.0 °C (65.0 to 75.0 °F). However, these fish can survive in waters as warm as 26.0 °C (79.0 °F) (Scott and Crossman, 1973), defined here as acceptable habitat. The 2024 temperature and DO data for Lake Hopatcong were examined to identify the presence of optimal and acceptable brown trout habitat. As with previous monitoring reports, this analysis focused primarily on *in-situ* data collected at the mid-lake sampling station (Station 2).

For the sake of this analysis, sections of the lake that had DO concentrations equal to or greater than 5.0 mg/L and water temperatures less than 24.0 °C were considered optimal habitat for brown trout. In contrast, sections of the lake that had DO concentrations equal to or greater than 5.0 mg/L and water temperatures between 24.0 and 26.0 °C were considered acceptable or carry over habitat for brown trout.

A separate brown trout study was also conducted over the course of the 2024 season for the third consecutive year. This study involved the stocking of 1,000 tagged trout, larger than the trout stocked by the state, to determine if the increase in mass and fat reserves gives them an advantage in holding over through the hot summer months. The stocking of the tagged trout was funded by the Lake Hopatcong Commission, Foundation, and the Knee-Deep Club. Additionally, the Highlands Council funded the study to collect additional, high-frequency water quality data to better define carryover habitat in the lake. The Highlands Council grant also includes the analysis of trout data garnered from tag data and creel surveys and a report that synthesizes those elements to manage the trout fishery and trout carryover habitat of Lake Hopatcong. A separate report will be submitted that includes all of these elements.

Optimal brown trout habitat was present in the upper 10.0 m of the lake on 14 May. By mid-June, optimal brown trout habitat was reduced to the upper 5.50 m of the water column at Station 2 due to anoxic conditions present in the hypolimnion. Carryover habitat was available at these same depth intervals in May and June because the limiting factor was low DO in the hypolimnion rather than elevated temperatures near the surface.

In-situ sampling conducted on 2 July as part of the trout study revealed limited optimal brown trout habitat throughout the lake as a result of increasing temperatures in the epilimnion as well as anoxic conditions creeping upwards in the water column. *In-situ* sampling was conducted at approximately 1.0 ft intervals through the thermocline during the summer to accurately define trout habitat. As such, there was approximately 5.20 m of optimal trout habitat at Station 2 on 2 July. However, there was carryover trout habitat present in the upper 6.40 m during this event.

Weekly sampling through 13 August revealed that there was no optimal trout habitat present on any of the days that Princeton Hydro monitored the lake. However, carryover habitat was available at times later into the season; however, this was dynamic on a weekly basis and there were sampling events in July and early August with no carryover habitat.

On 9 July, there was only 0.80 m of carryover habitat at Station 2, from a depth of 3.40 m to 4.20 m. There was no carryover habitat in Lake Hopatcong on 16 July as surface water temperatures exceeded 29.0 °C at Station 2. Water temperatures cooled over the following week; however, temperatures in the epilimnion remained over 26.0 °C and there was no carryover habitat. There was a limited amount of carryover habitat (0.70 m) in the lower epilimnion on 30 July, but surface temperatures remained over 26.0 °C. Surface temperatures exceeded 27.0 °C on 6 August resulting in the loss of carryover habitat in the lake. Water temperatures began to cool over the following week which resulted in an expansion of the epilimnion and the presence of carryover habitat in the upper 6.80 m on 13 August.

As water temperatures in the epilimnion continued to decrease over the following week, optimal trout habitat was present at Station 2 for the first time since 5 July. On 21 August, there was approximately 7.40 m of optimal and carryover trout habitat. Optimal and carryover habitat was present in the upper 5.50 m on 18 September.

3.5 MECHANICAL WEED HARVESTING PROGRAM

Many of the shallower sections of Lake Hopatcong are susceptible to the proliferation of nuisance densities of rooted aquatic plants. Given the size of Lake Hopatcong, the composition of its aquatic plant community, and its heavy and diverse recreational use, mechanical weed harvesting is the most cost effective and ecologically sound method of controlling nuisance weed densities. Thus, the weed harvesting program has been in operation at Lake Hopatcong since the mid-1980's with varying levels of success. However, one consistent advantage mechanical weed harvesting has over other management techniques, such as the application of aquatic herbicides, is that phosphorus is removed from the lake along with the weed biomass. In fact, based on a plant biomass study conducted at Lake Hopatcong in 2006 and the plant harvesting records from 2006 to 2008, approximately 6-8% of the total phosphorus load targeted for reduction under the established TMDL was removed through the mechanical weed harvesting program.

In sharp contrast to the 2006 – 2008 harvesting years, only 1.2% of the phosphorus load targeted for reduction under the TMDL was removed through mechanical weed harvesting during the 2009 growing season. This substantial reduction in the amount of plant biomass and phosphorus removed in 2009 was due to severe budgetary cuts that resulted in laying off the Commission's full time Operation Staff, as well as initiating the harvesting program later in the growing season. However, the 2010 harvesting season resulted in the estimated removal of approximately 6% of the phosphorus load targeted for reduction under the TMDL, similar to the percentages removed in 2006 – 2008.

In contrast to the 2012 growing season, the mechanical weed harvesting program ran longer from 2013 through 2016. This was primarily due to the fact that the program was initiated earlier in these years relative to 2012. NJDEP has directly overseen the operation of the weed harvesting program for the last seven years and each year displays a higher rate of removal, which was attributed to hired staff becoming more familiar with the operations and lake-specific conditions. In addition, the operations staff has been excellent at maximizing high rates of efficiency during harvesting operations.

Due to an extremely unfortunate accident at the initiation of the 2020 harvesting season, the harvesting of aquatic vegetation at Lake Hopatcong was largely postponed over the 2020 growing season. The removal of only 35 cubic yards (16 tons) of plant biomass from Lake Hopatcong in 2020 resulted in the removal of only 3 kgs (6 lbs) of TP from the lake. This was less than 0.1% of the TP load targeted for removal under the TMDL.

Mechanical weed harvested was not conducted over the 2021 growing season. However, the harvesting program resumed in 2022, resulting in the removal of 1,178 cubic yards (531 tons) of plant biomass. This resulted in the removal of approximately 86 kgs (189 lbs) of TP, which has the potential to produce approximately 208,200 lbs of wet algae biomass. The 189 lbs of TP accounts for 2.6% of the TP targeted for removal under the lake's TMDL.

Approximately 704 cubic yards (317 tons) of plant biomass was removed from Lake Hopatcong in 2024, representing the lowest rate of removal over a full growing season in many years. This resulted in the removal of approximately 51 kgs (113 lbs) of TP, which has the potential to produce approximately 124,426 lbs of wet algae biomass. The 113 lbs of TP accounts for 1.6% of the TP targeted for removal under the lake's TMDL.

3.6 INTERANNUAL ANALYSIS OF WATER QUALITY DATA

Annual mean values of Secchi depth, chlorophyll *a*, and TP concentrations were calculated for the years 1991 through 2024. The annual mean values for Station 2 were graphed, along with the long-term mean for the lake, and can be found in Appendix I.

The 2024 mean Secchi depth at Station 2 was 1.10 m. Although this is above the targeted threshold of 1.0 m, this is the lowest mean Secchi depth at the mid-lake station for the second consecutive year. This is a concerning trend and may be contributing to the decrease in submerged aquatic vegetation that was observed in 2024.

The mean chlorophyll *a* concentration at Station 2 was 12.8 µg/L, which is higher than the targeted mean value of 8.0 µg/L. However, the mean concentration of 12.0 µg/L was 3.0 µg/L lower than the 2023 mean value. The long-term seasonal chlorophyll *a* average at Station 2 is 10.9 µg/L.

The 2024 mean TP concentration at Station 2 was .028 mg/L, remaining below the targeted threshold of 0.030 mg/L as per the TMDL. The 2024 mean TP concentration is the highest since 1997, which is mostly the result of the elevated June concentration of 0.50 mg/L. The long-term mean TP concentration at the surface of Station 2 is 0.021 mg/L.

3.7 WATER QUALITY IMPAIRMENTS, ESTABLISHED TMDL CRITERIA AND EVALUATION

As identified in N.J.A.C. 7:9B-1.5(g)2, "Except as due to natural condition, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation or otherwise render the waters unsuitable for the designated uses." For Lake Hopatcong, these objectionable conditions specifically include both algal blooms and nuisance densities of aquatic vegetation.

As described in detail in the Lake Hopatcong TMDL Restoration Plan, a targeted mean TP concentration, as well as mean and maximum chlorophyll-*a* ecological endpoint, was established to identify compliance with the TMDL. For the sake of this 2024 analysis, the mid-lake (Station 2), Crescent Cove / River Styx (Station 3) and Northern Woodport Bay (Station 10) monitoring stations were reviewed. To provide guidance for this review, the criteria developed under Lake Hopatcong's TMDL are provided below:

TMDL Criteria for Lake Hopatcong

Targeted mean TP concentration	0.03 mg/L
Targeted mean chlorophyll *a* concentration endpoint	8 µg/L
Targeted maximum chlorophyll *a* concentration endpoint	14 µg/L

The 2024 mean TP concentration at Station 2 was 0.028 mg/L, remaining below the targeted threshold of 0.030 mg/L as per the TMDL. Surface TP concentrations at Station 2 ranged between 0.02 mg/L and 0.05 mg/L. The 2024 seasonal mean chlorophyll *a* concentration at Station 2 was 12.8 µg/L. Thus, the 2024 average exceeded the targeted mean chlorophyll *a* concentration of 8.0 µg/L. This was largely due to increased chlorophyll *a* concentrations in July and August. Chlorophyll concentrations ultimately ranged from 8.0 µg/L on 14 May to 19.0 µg/L on 9 July. The July and August sampling events exceeded the targeted maximum chlorophyll *a* concentration endpoint of 14.0 µg/L during the 2024 season, with respective concentrations of 19.0 and 16.0 µg/L.

Chlorophyll *a* and TP concentrations were elevated at Station 3 relative to other stations throughout most of the 2024 season. The 2024 mean TP concentration was 0.04 mg/L, exceeding the targeted mean of 0.03 mg/L. 2024 concentrations ranged between 0.03 mg/L and 0.06 mg/L, exceeding 0.03 mg/L from May through August. The seasonal mean chlorophyll *a* concentration at Station 3 was the highest compared to the other sampling stations for the third consecutive year, with an average of 20.6 µg/L; this mean concentration is significantly higher than the targeted mean concentration of 8.0 µg/L. Overall, chlorophyll concentrations ranged from 13.0 µg/L to 37.0 µg/L.

At Station 10, the seasonal TP average was 0.04 mg/L, exceeding the targeted mean. TP concentrations at Station 10 ranged from 0.03 mg/L in September up to 0.06 mg/L in August. Chlorophyll *a* concentrations were variable throughout the 2024 season, ranging between 9.8 µg/L in September and 15.0 µg/L in June and August. The 2024 seasonal average exceeded the 8.0 µg/L targeted mean, yielding a concentration of 12.8 µg/L.

4.0 SUMMARY

This section provides a summary of the 2024 water quality conditions, as well as recommendations on how to preserve the highly valued aquatic resources of Lake Hopatcong.

1. The water column was thermally stratified from May through September at Station 2. DO declined with depth, ultimately declining below the 5.0 mg/L threshold below the epilimnion during each event. From June through September, DO concentrations dropped below 5.0 mg/L at the top of the thermocline as a result of the high oxygen demand during the summer months. By June, anoxic conditions were present above the sediment and remained this way through the last sampling event in September. Anoxic conditions were present in at least the bottom 6.0 m of the water column. The persistent and widespread anoxia in the hypolimnion results in the release of bioavailable phosphorus from the sediments, as seen in the elevated deep TP and SRP concentrations at Station 2.

2. While the previous long-term water quality database had value, the HABs experienced in 2019 identified the need to slightly expand the monitoring program. Specifically, soluble reactive phosphorus was added to the monitoring program at each sampling station. The plankton monitoring was adjusted, including phytoplankton counts (in particular with the cyanobacteria) at surface and mid-depth. Finally, additional vertical sampling of discrete parameters at Station 2 to cover surface, mid-depth, and deep-water samples were added to the program in 2020. This increased sampling scope continued during through the 2024 season which allowed for a more detailed analysis of nutrient concentrations throughout the lake and how they may be affecting cyanobacteria densities. An additional station located in Landing Channel was added in 2023. Sampling this station is important in tracking any future improvements in Landing Channel resulting from potential additional PhosLock applications or any dredging that may occur. This increased scope should be continued for future sampling years to continue to bolster the historic database for Lake Hopatcong.

3. It has been well documented that phosphorus is the primary limiting nutrient in Lake Hopatcong. That is, a slight increase in phosphorus will result in a substantial increase in the amount of algal and/or aquatic plant biomass. TP concentrations in the surface water were variable throughout the lake, ranging between 0.02 mg/L and 0.06 mg/L. Elevated TP concentrations at surface stations were observed in some of the shallow, near-shore stations, such as Stations 3, 7, 10, and 11; all of these stations had a seasonal mean concentration of 0.04 mg/L. Surface and mid-depth TP concentrations were low for most of the season at Station 2; however, there was one elevated surface sample with a concentration of 0.05 mg/L in June. According to the precipitation data from the Jefferson Twp 4.4 SW CoCoRaHS station, there was less than 0.03 inches of rain over the five days leading up to the June monitoring event, so it is unlikely the elevated surface concentration was a direct result of a recent stormwater event.

   Deep water TP concentrations were elevated from July through September as anoxic conditions persisted, reaching a maximum of 0.21 mg/L on 18 September. Elevated TP in the deep waters is attributed to extended periods of anoxia which results in the internal loading of phosphorus from the sediment. Of particular concern was the elevated deep SRP concentrations, which exceeded 0.045 mg/L from July through September and reached a maximum of 0.085 mg/L in September. SRP is the bioavailable form of phosphorus that is rapidly utilized by cyanobacteria.

4. The 2024 growing season, from April through September, saw 29.68 inches of precipitation, per the Jefferson Twp 4.4 SW CoCoRaHS station; this is very close to the 30-year average, from 1991 – 2020, of 30.47 inches of rain. However, April, May, and August experienced a lot of rain, while the other months were very dry. June, September, and October were extremely dry, with respective precipitation totals of 1.31 inches, 1.47 inches, and 0.01 inches. There were 10.62 inches of precipitation in August, more than double the long-term average. The variability in precipitation events can lead to conditions that favor

algal blooms, especially short but intense storms that drop a lot of rain followed by extended periods of dry, hot weather.

5. There were no lake-wide HABs in 2024 similar to the HAB in 2019; however, there were localized HABs during the summer months in different areas of the lake. In July, HABs were observed near the State Park and in Byram Cove. Cyanobacteria cell counts were also elevated at Station 2 and Station 3 (Crescent Cove), exceeding the NJDEP Advisory level, in July and August; cyanobacteria densities remained above the Advisory level at Station 3 in September.

6. Akinetes, which are a type of overwintering cyanobacteria cells or “resting spores,” were quantified in the plankton samples in 2024. Elevated akinete densities can reveal the potential for cyanobacteria growth. The akinetes will lie dormant in the sediment during the colder months before forming vegetative cells that will become planktonic cyanobacteria when environmental conditions improve, primarily through light and temperature. Akinete densities increased as the season progressed, with maximum densities at most stations observed in September. Cyanobacteria tend to increase akinete production later in the season, as temperatures begin to cool and the duration of sunlight decreases, as they prepare to overwinter in the sediments. Princeton Hydro only began consistently monitoring akinete production in recent years, but the increased production of *Raphidiopsis* akinetes towards the end of the season provides insight into the elevated *Raphidiopsis* densities that have been observed over the past few years. The work that Princeton Hydro will be doing in 2025 funded by the Army Corps of Engineers, Engineer Research and Development Center (ERDC) grant will be implementing and analyzing innovative strategies to proactively target akinete growth.

7. Based on the *in-situ* conditions, optimal brown trout habitat was present in the upper 10.00 m of Station 2 in May, the upper 5.50 m of the lake in June, 5.20 m on 2 July, the upper 7.40 m on 21 August, and the upper 5.50 m on 18 September. Optimal brown trout habitat was extremely limited for most of July and August. However, carryover brown trout habitat was present in varying degrees throughout the entire season, but there were three sampling events with no carryover habitat. Brown trout habitat became limited during the peak summer months as a result of low DO concentrations creeping upwards and warm temperatures creeping down. Surface water temperatures exceeded 29.0 °C at Station 2 for the first time in 34 years during one or Princeton Hydro’s monitoring events.

8. A mechanical weed harvesting program has been in operation at Lake Hopatcong since the early 1980s. Over the 2024 growing season approximately 704 cubic yards (317 tons) of plant biomass was removed. This resulted in the removal of approximately 113 lbs of TP, which has the potential to produce approximately 124,426 lbs of wet algae biomass. The 113 lbs of TP accounts for 1.6% of the TP targeted for removal under the lake’s TMDL. Princeton Hydro recommends an updated submerged aquatic vegetation survey in 2025 to compare the data with historical records.

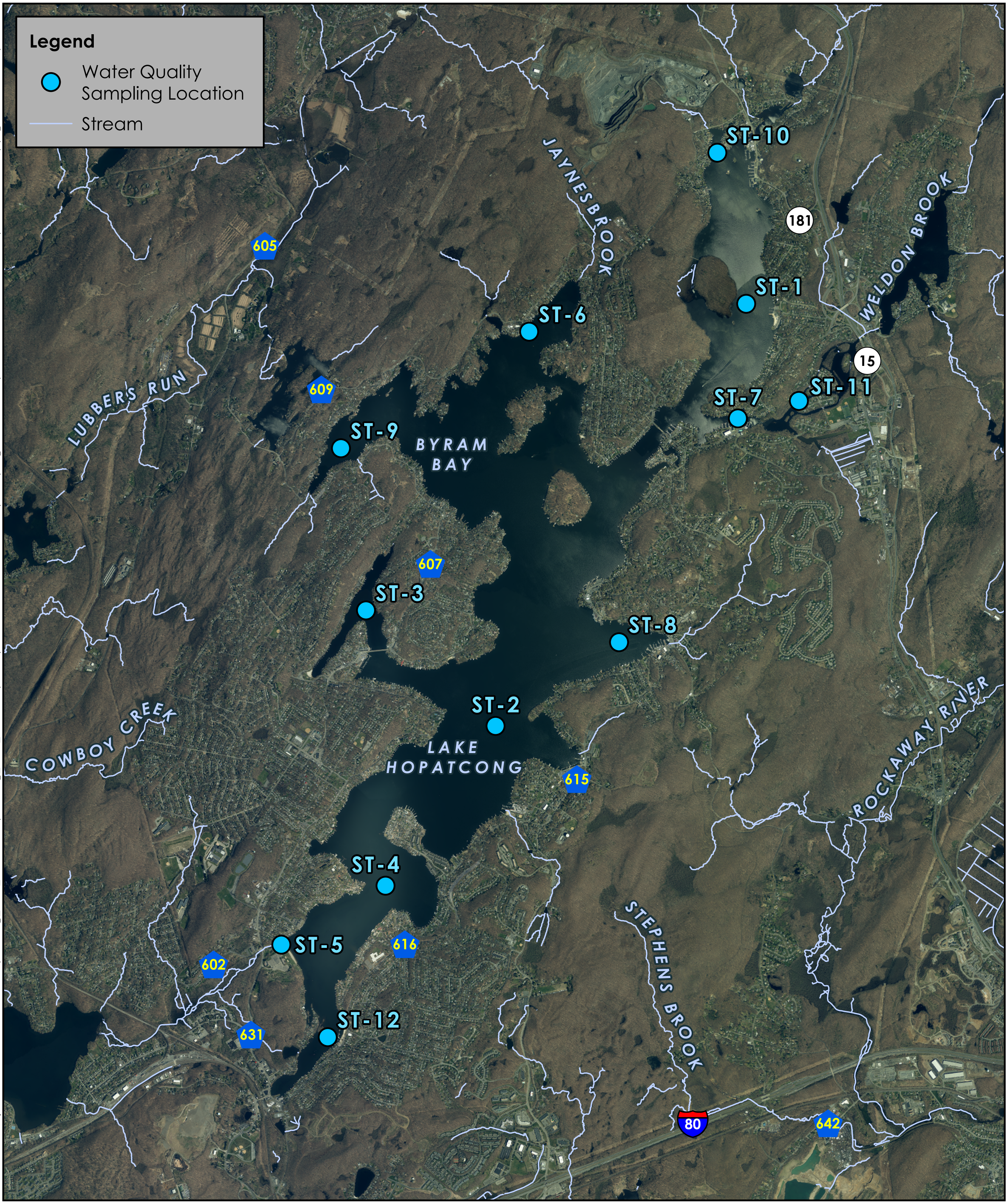
9. While the 2024 mean surface water, mid-lake TP concentration remained in compliance with the targeted concentration under the lake’s TMDL, other near-shore stations had higher mean values. In addition, the mean 2024 Secchi depth at the mid-lake station was the lowest recorded for the consecutive year (Appendix A). This is a concerning trend and likely contributed to the lower amounts of submerged aquatic vegetation that were observed in 2024.

10. It should be noted that *Raphidiopsis raciborskii* (previously named *Cylindrospermopsis raciborskii*) was present in high numbers from July through September (Appendix IV). Similar to the past few years, *Raphidiopsis* was abundant in the shallow Crescent Cove, but also the surface of Station 2. Based on these observations as well as those made over the last few years, this pattern of growth and distribution for *Raphidiopsis* is typical since it was identified in Lake Hopatcong a few years ago. Such observations indicate that this genus typically resides along the sediment / water interface in the shallow sections of

the lake where nutrient availability is higher than in the open waters. The increased production of *Raphidiopsis* akinetes towards the end of the season provides insight into these elevated *Raphidiopsis* densities that have been observed over the past few years. The work that Princeton Hydro will be doing in 2025 funded by the Army Corps of Engineers, Engineer Research and Development Center (ERDC) grant will be implementing and analyzing innovative strategies to proactively target akinete growth.

11. Finally, the alum treatment funded by the Lake Restoration Grant was successfully completed over a period of 7 days from 23 October – 29 October. A total of 112,240 gallons of alum were treated over an area of 976 acres, resulting in the target dosage rate of 115 gallons/acre. Princeton Hydro was on site on 23 October, 26 October, and 29 October conducting visual and water quality monitoring before, during, and after each daily treatment. Additional monitoring will be conducted during the 2025 growing season to quantify the reduction in the phosphorus load.

APPENDIX I: FIGURES



File: P:\0783\Projects\0783003\GIS\APRX\Hopatcong_Trout_Habitat\Hopatcong_Trout_Habitat.aprx, Layout: Standard Water Quality Sampling Locations, Exported: 2/27/2024, Drawn by tsrinivasan, Copyright Princeton Hydro, LLC.

NOTES:
1. Sampling locations are approximate
2. Streams obtained from the United States Geological Survey's (USGS) National Hydrography Dataset (NHD).
3. 2020 orthoimagery obtained from the NJ Geographic Information Network (NJGIN) Open Data portal: https://njgin.nj.gov/

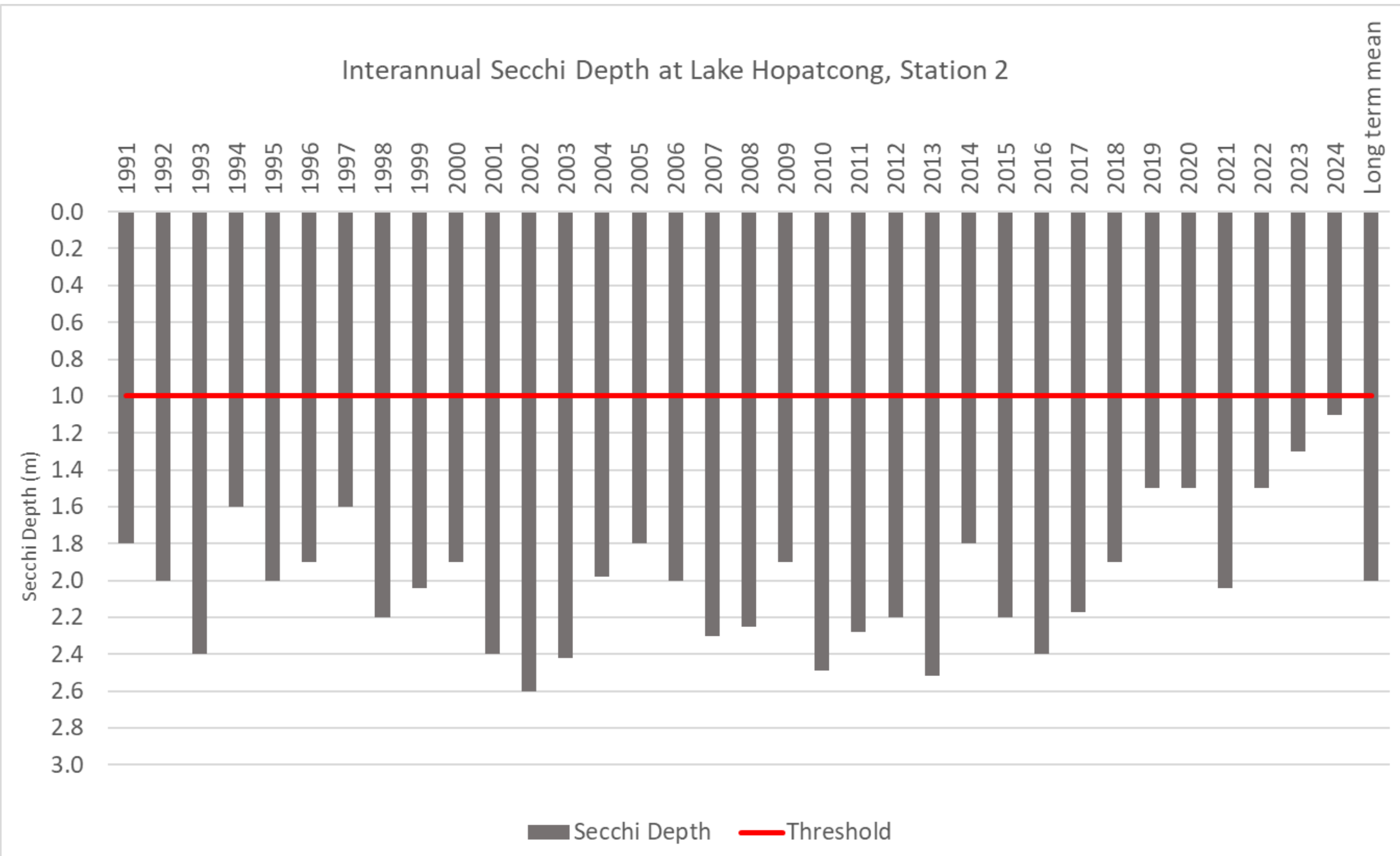
0 2,000 4,000 Feet

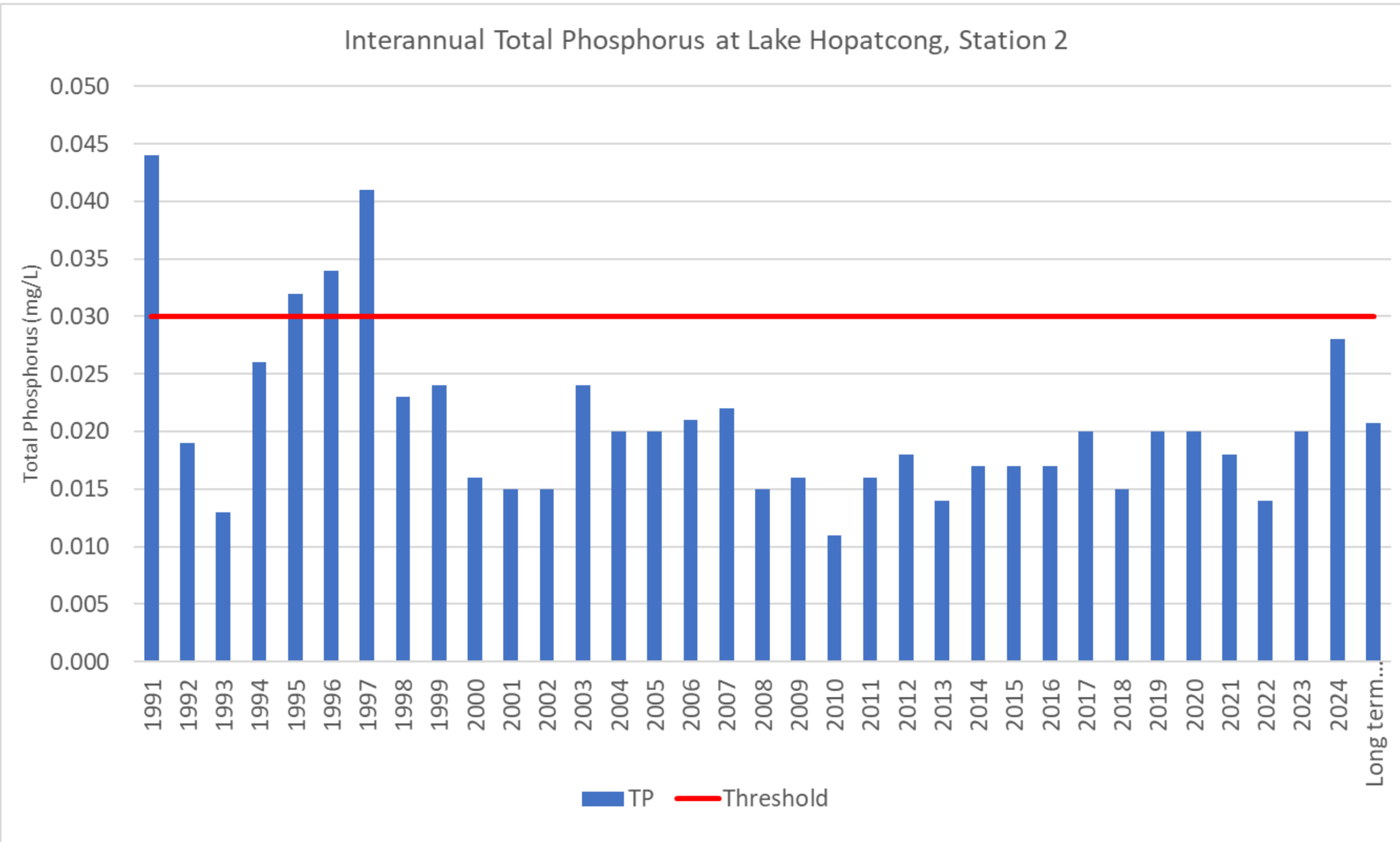
Spatial Reference: NAD 1983 StatePlane New Jersey FIPS 2900 Feet

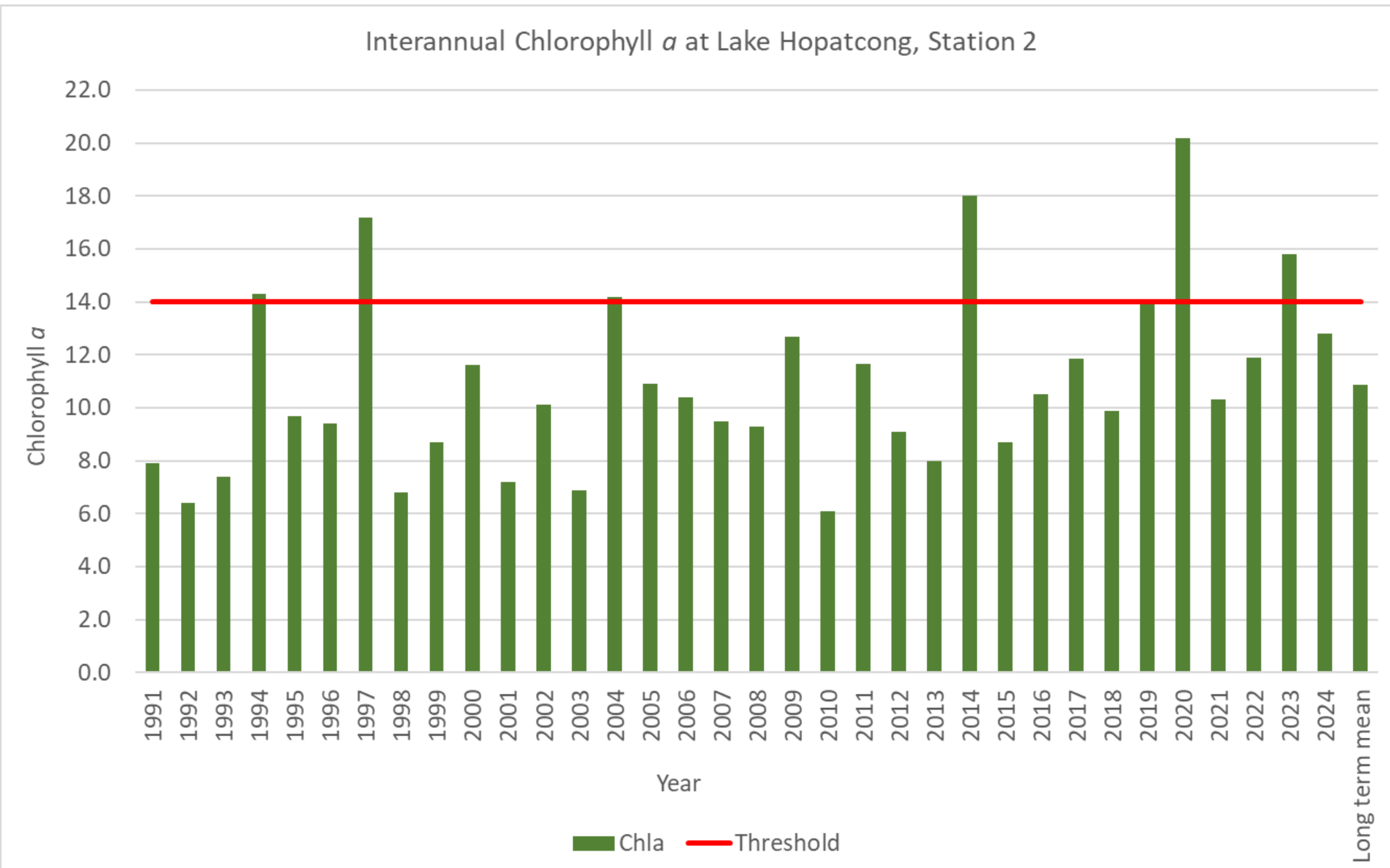
STANDARD WATER QUALITY SAMPLING LOCATIONS

LAKE HOPATCONG
LAKE HOPATCONG COMMISSION
SUSSEX AND MORRIS COUNTIES, NEW JERSEY

PRINCETON HYDRO
SCIENCE DESIGN ENGINEERING
www.PrincetonHydro.com


Interannual Secchi Depth at Lake Hopatcong, Station 2
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Long term mean
Secchi Depth (m)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
Secchi Depth
Threshold


Interannual Total Phosphorus at Lake Hopatcong, Station 2
Total Phosphorus (mg/L)
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Long term...
TP
Threshold


Interannual Chlorophyll *a* at Lake Hopatcong, Station 2
Chlorophyll *a*
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Long term mean
Year
Chla
Threshold

APPENDIX II: IN-SITU DATA

In-Situ Monitoring for Lake Hopatcong 5/14/2024									
Station	Depth (meters)			Temperature	Specific Conductance	Dissolved Oxygen		pH	Chlorophyll *a*
	Total	Secchi	Sample	°C	µS/cm	mg/L	% Sat.	S.U.	RFU
STA-1	2.30	1.10	0.1	16.78	264.9	8.49	90.0	7.43	0.435
			1.0	16.16	264.5	8.38	89.3	7.34	0.846
			2.0	15.97	267.7	7.10	74.1	7.28	0.748
STA-2	14.20	1.80	0.1	15.79	341.3	9.90	102.8	8.06	0.024
			1.0	15.74	341.3	9.89	102.7	8.02	0.034
			2.0	15.68	341.3	9.87	102.6	7.96	0.041
			3.0	15.55	341.3	9.86	102.0	7.98	0.038
			4.0	15.55	340.9	9.87	102.1	8.06	0.047
			5.0	15.21	341.4	9.41	96.8	8.26	0.063
			6.0	13.10	338.8	8.44	81.9	8.23	0.126
			7.0	11.93	341.1	8.01	76.4	8.22	0.396
			8.0	11.51	340.7	7.87	74.2	8.25	0.583
			9.0	10.72	342.2	6.70	62.1	8.21	0.752
			10.0	10.13	343.7	5.50	51.1	8.20	0.295
			11.0	9.90	345.9	4.00	36.0	8.10	0.036
			12.0	9.74	347.9	2.62	23.7	8.04	0.034
			13.0	9.60	348.9	2.10	18.6	7.90	0.026
			14.0	9.49	349.5	1.73	15.6	7.88	0.028
			15.0	9.44	351.4	0.53	4.8	7.83	0.030
STA-3	2.30	1.30	0.1	16.95	554.5	9.14	97.7	7.70	0.339
			1.0	16.83	584.7	9.05	95.8	7.71	1.014
			2.0	16.49	598.3	8.51	89.8	7.64	1.219
STA-4	3.20	1.60	0.1	15.85	340.6	10.01	104.3	8.43	0.025
			1.0	15.58	340.6	10.06	104.1	8.31	0.025
			2.0	14.95	340.4	10.03	102.3	8.23	0.032
			3.0	14.27	343.6	7.55	75.9	8.05	0.839
STA-5	2.30	1.70	0.1	16.44	352.7	10.27	108.4	9.15	0.020
			1.0	16.41	351.9	10.30	107.7	9.13	0.023
			2.0	15.86	350.7	9.54	99.1	8.80	0.024
STA-6	3.30	1.60	0.1	17.14	337.3	9.92	106.1	7.80	0.027
			1.0	17.10	337.1	9.90	105.9	7.79	0.032
			2.0	16.90	337.2	9.89	105.4	7.78	0.038
			3.0	15.99	336.1	9.50	99.2	7.81	0.184
STA-7	1.40	1.20	0.1	17.27	215.9	8.80	94.2	7.66	0.860
			1.0	16.77	216.6	8.37	88.6	7.52	1.103
STA-8	8.20	1.70	0.1	16.27	333.8	9.93	103.9	7.94	0.024
			1.0	16.01	334.7	9.93	103.8	7.87	0.026
			2.0	15.90	335.6	9.91	103.3	7.82	0.038
			3.0	15.89	336.9	9.87	102.7	7.85	0.036
			4.0	15.85	337.6	9.78	101.8	7.94	0.122
			5.0	15.78	338.2	9.68	100.6	8.08	0.139
			6.0	14.95	340.7	8.61	88.1	8.22	0.132
			7.0	11.86	337.9	7.14	67.9	8.18	0.271
			8.0	11.13	339.6	6.80	65.7	8.17	0.574
STA-9	8.30	1.60	0.1	16.46	339.9	9.76	103.2	7.78	0.029
			1.0	16.46	340.5	9.77	103.2	7.82	0.033
			2.0	16.34	339.9	9.78	102.9	7.83	0.036
			3.0	16.06	339.7	9.74	101.9	7.90	0.042
			4.0	15.68	338.4	9.43	97.8	8.00	0.119
			5.0	14.58	340.2	8.60	87.0	8.10	0.107
			6.0	12.34	342.3	5.64	54.4	8.09	0.033
			7.0	11.42	343.5	4.87	45.2	8.10	0.031
			8.0	10.74	345.4	3.82	35.5	8.13	0.034
STA-10	1.30	1.00	0.1	17.98	272.1	8.90	96.9	7.52	0.581
			1.0	17.88	272.9	8.88	96.6	7.51	0.736
STA-11	1.20	1.10	0.1	16.51	142.4	8.18	86.3	7.56	0.004
			1.0	15.90	144.5	7.89	82.6	7.27	0.027
STA-12	2.00	1.30	0.1	16.72	403.8	11.80	124.8	9.32	0.027
			1.0	16.19	404.3	11.87	124.4	9.26	0.029
			1.7	15.98	403.2	12.19	127.8	9.23	0.023

***In-Situ* Monitoring for Lake Hopatcong 6/13/2024**									
Station	**Depth (meters)**			**Temperature**	**Specific Conductance**	**Dissolved Oxygen**		**pH**	**Chlorophyll *a***
	Total	**Secchi**	**Sample**	**°C**	**µS/cm**	**mg/L**	**% Sat.**	**S.U.**	**RFU**
STA-1	2.30	1.10	0.1	23.88	276.4	9.92	120.7	8.26	2.035
			1.0	23.29	276.5	9.56	115.6	8.08	2.880
			2.0	22.51	276.9	8.79	104.4	7.83	3.562
STA-2	14.20	1.10	0.1	22.94	354.7	10.11	121.3	8.63	0.524
			1.0	22.93	354.7	10.17	121.8	8.65	0.869
			2.0	22.61	353.8	10.07	120.3	8.57	1.155
			3.0	22.29	353.1	9.51	112.6	8.40	1.287
			4.0	22.18	353.2	9.20	108.6	8.34	1.090
			5.0	21.65	352.1	7.52	87.9	8.10	0.720
			6.0	16.84	347.3	1.93	20.6	7.78	0.040
			7.0	13.33	345.8	1.54	15.2	7.74	0.032
			8.0	12.00	347.9	1.10	10.5	7.52	0.023
			9.0	11.08	350.2	0.46	4.3	7.51	0.021
			10.0	10.86	356.8	0.32	3.0	7.40	0.020
			11.0	10.45	353.8	0.00	0.0	7.39	0.020
			12.0	10.12	358.3	0.00	0.0	7.40	0.020
			13.0	9.95	361.2	0.00	0.0	7.38	0.028
			14.0	9.88	363.4	0.00	0.0	7.39	0.026
STA-3	2.30	0.90	0.1	23.39	458.6	9.53	115.4	8.11	1.488
			1.0	22.58	459.1	9.25	110.5	7.97	2.308
			2.0	22.13	454.4	8.81	104.2	7.80	2.747
STA-4	3.20	1.00	0.1	23.42	360.4	9.36	113.4	8.10	0.161
			1.0	22.95	360.0	9.34	111.8	8.06	1.214
			2.0	22.20	357.2	7.89	93.6	7.79	1.416
			3.0	21.79	362.1	4.84	57.3	7.57	1.486
STA-5	2.30	1.00	0.1	22.30	364.7	9.20	109.5	7.86	1.644
			1.0	22.23	364.5	9.17	108.5	7.87	1.383
			2.0	22.08	364.2	9.05	106.9	7.81	1.919
STA-6	3.30	1.10	0.1	23.36	351.8	9.91	119.8	8.39	0.387
			1.0	23.33	351.4	9.89	119.7	8.32	0.605
			2.0	23.24	351.4	9.79	118.2	8.23	0.967
			3.0	22.17	351.9	7.41	87.2	7.81	2.010
STA-7	1.40	1.00	0.1	24.24	238.6	8.38	103.0	7.56	1.124
			1.0	24.18	237.7	8.38	102.2	7.59	1.304
STA-8	7.50	1.30	0.1	23.21	352.3	10.20	123.2	8.64	0.215
			1.0	23.10	351.9	10.27	122.5	8.58	0.880
			2.0	22.89	351.7	10.11	121.1	8.50	0.963
			3.0	22.76	351.4	9.98	119.4	8.49	1.074
			4.0	22.47	351.8	9.81	116.6	8.49	1.151
			5.0	22.10	355.8	8.47	100.0	8.30	0.986
			6.0	16.08	345.5	1.93	20.2	8.06	0.038
			7.0	13.70	349.0	1.26	12.5	7.90	0.050
STA-9	8.30	1.00	0.1	23.08	352.9	9.85	118.5	8.44	0.174
			1.0	23.06	352.2	9.83	118.4	8.43	0.595
			2.0	22.17	350.9	9.61	113.7	8.29	1.018
			3.0	21.75	349.7	8.77	102.9	8.08	1.206
			4.0	21.58	351.6	7.76	90.6	8.00	1.048
			5.0	21.31	351.8	6.12	71.1	7.95	0.601
			6.0	16.33	342.7	1.95	19.7	7.93	0.038
			7.0	12.74	349.3	0.00	0.0	7.83	0.029
			8.0	11.84	359.5	0.00	0.0	7.81	0.028
STA-10	1.30	1.00	0.1	24.61	283.4	10.41	128.8	8.49	1.519
			1.0	23.69	361.2	10.56	128.8	8.41	2.413
STA-11	1.20	1.10	0.1	22.11	177.8	7.50	88.7	7.43	1.018
			1.0	21.25	186.0	7.24	83.9	7.15	0.915
STA-12	2.00	1.00	0.1	23.70	380.0	7.44	90.5	7.49	0.613
			1.0	22.60	373.5	7.71	91.3	7.42	1.652
			1.7	22.35	379.2	7.38	87.5	7.34	1.499

***In-Situ* Monitoring for Lake Hopatcong 7/9/2024**									
Station	**Depth (meters)**			**Temperature**	**Specific Conductance**	**Dissolved Oxygen**		**pH**	**Chlorophyll *a***
	Total	**Secchi**	**Sample**	**°C**	**µS/cm**	**mg/L**	**% Sat.**	**S.U.**	**RFU**
STA-1	2.30	0.80	0.1	29.97	283.7	7.95	108.3	7.28	1.715
			1.0	29.24	286.2	7.46	100.6	7.31	2.307
			2.0	28.00	287.9	4.81	63.9	7.12	3.184
STA-2	14.20	1.00	0.1	28.61	362.4	10.52	140.2	8.81	0.642
			1.0	28.45	363.2	10.75	142.1	8.83	0.717
			2.0	27.97	362.1	10.45	137.7	8.75	1.159
			3.0	26.55	360.3	8.62	110.8	8.09	1.313
			4.0	24.81	360.4	5.62	69.9	7.34	0.663
			5.0	23.55	358.9	4.36	59.0	7.22	0.665
			6.0	21.67	355.5	1.47	17.2	7.00	0.377
			7.0	17.44	352.4	0.00	0.0	6.89	0.111
			8.0	13.65	352.0	0.00	0.0	6.88	0.032
			9.0	11.69	352.6	0.00	0.0	6.88	0.022
			10.0	11.14	355.6	0.00	0.0	6.86	0.022
			11.0	10.63	358.4	0.00	0.0	6.86	0.022
			12.0	10.34	362.6	0.00	0.0	6.86	0.015
			13.0	10.20	368.9	0.00	0.0	6.88	0.017
			14.0	9.95	373.1	0.00	0.0	6.80	0.018
STA-3	2.30	0.80	0.1	29.50	395.1	9.89	133.9	8.69	1.575
			1.0	29.01	396.5	9.34	125.3	8.53	2.409
			2.0	28.43	397.8	7.50	100.4	8.00	3.030
STA-4	3.20	0.90	0.1	29.05	363.4	9.65	129.6	8.44	0.717
			1.0	28.18	363.1	10.17	134.5	8.60	1.286
			2.0	27.03	360.9	8.77	113.5	7.99	1.480
			3.0	25.95	363.0	3.25	41.3	7.35	1.339
STA-5	3.00	1.00	0.1	28.97	366.0	9.31	121.9	8.25	0.578
			1.0	28.87	366.5	8.87	118.3	8.10	1.192
			2.0	27.64	364.2	7.38	96.6	7.69	2.789
			2.7	26.78	367.8	4.23	54.5	7.32	3.898
STA-6	3.30	0.90	0.1	29.67	359.5	10.04	136.5	8.56	0.656
			1.0	29.58	360.9	10.14	137.6	8.50	1.015
			2.0	28.97	360.4	8.99	120.7	8.02	1.431
			3.0	28.11	361.8	5.84	74.5	7.57	0.700
STA-7	1.40	0.90	0.1	30.21	302.9	7.81	107.0	7.48	1.381
			1.0	30.10	303.0	7.69	105.1	7.43	1.344
STA-8	7.50	0.90	0.1	28.93	364.0	10.72	143.7	8.84	0.588
			1.0	28.78	363.4	10.82	144.6	8.90	0.932
			2.0	28.18	362.4	10.55	139.5	8.79	1.206
			3.0	26.95	360.9	9.06	117.3	8.12	1.158
			4.0	25.62	362.2	4.52	57.1	7.34	1.028
			5.0	23.62	358.4	4.23	51.4	7.26	0.496
			6.0	21.64	354.6	1.52	17.9	7.14	0.072
			7.0	17.71	351.7	0.00	0.0	7.04	0.157
STA-9	7.30	0.80	0.1	29.73	364.4	10.84	147.5	8.82	0.627
			1.0	29.67	364.2	10.88	147.8	8.84	0.662
			2.0	28.40	361.7	10.45	138.8	8.63	1.305
			3.0	27.61	361.4	9.91	130.2	8.43	1.375
			4.0	25.71	359.0	6.08	76.9	7.53	0.951
			5.0	23.71	358.4	3.89	47.5	7.17	0.460
			6.0	22.22	354.8	1.61	19.0	7.00	0.840
			7.0	19.99	350.9	0.00	0.0	6.90	0.137
STA-10	1.30	0.80	0.1	30.26	303.8	9.02	123.7	7.90	1.291
			1.0	30.26	304.0	9.02	123.7	7.87	1.660
STA-11	1.20	1.20+	0.1	29.44	243.2	6.11	83.4	7.10	0.023
			1.0	28.28	247.7	4.39	57.5	6.96	0.037
STA-12	2.00	0.80	0.1	29.11	369.2	8.28	111.3	7.60	1.771
			1.0	27.97	367.4	7.75	102.1	7.56	3.022
			1.7	27.32	369.8	2.85	37.1	7.15	4.984

***In-Situ* Monitoring for Lake Hopatcong 8/6/2024**									
Station	**Depth (meters)**			**Temperature**	**Specific Conductance**	**Dissolved Oxygen**		**pH**	**Chlorophyll *a***
	Total	**Secchi**	**Sample**	**°C**	**µS/cm**	**mg/L**	**% Sat.**	**S.U.**	**RFU**
STA-1	2.30	0.60	0.1	28.04	306.3	8.00	105.7	7.64	1.502
			1.0	28.14	306.3	8.13	107.5	7.70	2.044
			2.0	27.78	305.8	7.68	100.9	7.62	3.605
STA-2	14.50	0.90	0.1	27.45	362.6	8.99	117.7	8.53	0.693
			1.0	27.21	362.1	8.58	111.6	8.34	0.981
			2.0	26.92	362.0	8.62	111.3	8.26	1.313
			3.0	26.72	361.6	8.20	105.8	8.05	1.281
			4.0	26.69	361.8	8.06	103.9	7.93	1.258
			5.0	25.44	360.2	2.91	36.6	7.19	0.216
			6.0	24.41	346.4	0.59	7.3	6.80	0.218
			7.0	19.83	377.5	0.00	0.0	7.09	0.055
			8.0	15.16	261.6	0.00	0.0	7.04	0.031
			9.0	13.35	357.3	0.00	0.0	7.03	0.025
			10.0	11.82	358.5	0.00	0.0	7.02	0.022
			11.0	11.10	361.5	0.00	0.0	7.05	0.021
			12.0	10.74	361.6	0.00	0.0	7.08	0.022
			13.0	10.40	370.3	0.00	0.0	7.07	0.030
			14.0	10.35	370.9	0.00	0.0	7.06	0.031
STA-3	2.20	0.60	0.1	27.88	386.7	9.27	121.9	8.69	4.612
			1.0	27.57	381.6	8.56	112.3	8.42	4.645
			2.0	27.16	374.5	6.54	84.6	7.88	6.079
STA-4	3.00	0.80	0.1	28.52	363.8	9.76	130.1	8.67	1.275
			1.0	27.60	362.3	9.56	125.5	8.55	3.020
			2.0	26.83	362.2	7.66	99.1	7.95	3.108
			2.7	26.55	362.5	6.62	85.2	7.71	2.075
STA-5	3.00	0.80	0.1	27.58	362.4	8.58	112.5	8.10	2.088
			1.0	27.28	362.3	8.66	112.8	8.09	3.313
			2.0	27.08	363.8	7.30	94.9	7.77	4.790
			2.7	26.71	364.9	3.26	42.1	7.20	6.303
STA-6	3.00	0.60	0.1	28.40	359.6	8.84	117.5	8.17	1.252
			1.0	27.87	359.1	8.67	114.0	8.09	1.770
			2.0	27.75	359.2	8.21	107.4	7.89	2.040
			2.7	27.54	360.4	5.95	77.6	7.58	2.143
STA-7	1.30	0.70	0.1	29.71	297.8	8.25	111.0	7.64	0.965
			1.0	27.97	308.3	7.80	102.7	7.39	1.325
STA-8	8.00	0.90	0.1	29.06	364.9	9.65	129.9	8.64	0.637
			1.0	28.26	363.6	9.85	130.8	8.75	0.821
			2.0	27.57	362.5	9.43	127.6	8.62	1.211
			3.0	27.10	361.9	8.52	110.7	8.23	1.388
			4.0	26.76	361.4	6.99	90.2	7.80	1.018
			5.0	25.63	359.5	3.28	41.5	7.10	0.282
			6.0	23.82	342.3	0.00	0.0	6.80	0.099
			7.0	19.16	374.6	0.00	0.0	6.92	0.111
			7.8	18.12	378.6	0.00	0.0	7.07	0.170
STA-9	8.30	1.00	0.1	28.62	362.9	9.66	127.4	8.68	0.220
			1.0	27.72	362.7	9.82	129.0	8.70	0.827
			2.0	27.32	362.3	9.55	124.5	8.62	1.265
			3.0	27.13	362.9	9.29	120.4	8.48	1.377
			4.0	26.96	361.9	7.76	100.6	7.93	1.534
			5.0	26.25	366.7	4.75	60.8	7.40	0.851
			6.0	21.62	370.2	0.00	0.0	7.15	0.243
			7.0	17.87	380.1	0.00	0.0	7.19	0.034
			8.0	13.77	369.9	0.00	0.0	7.13	0.221
STA-10	1.20	0.70	0.1	29.00	320.7	9.40	126.3	8.35	1.266
			1.0	28.04	314.2	8.82	116.5	8.19	2.964
STA-11	1.20	1.20+	0.1	27.65	266.2	6.02	86.7	7.38	0.575
			1.0	26.88	265.8	5.77	74.2	7.16	0.455
STA-12	2.00	0.80	0.1	29.24	365.9	9.69	130.1	8.61	1.214
			1.0	28.54	364.3	9.66	127.8	8.48	2.661
			1.5	27.76	364.4	7.53	100.4	7.98	5.264

***In-Situ* Monitoring for Lake Hopatcong 9/18/2024**									
Station	**Depth (meters)**			**Temperature**	**Specific Conductance**	**Dissolved Oxygen**		**pH**	**Chlorophyll *a***
	Total	**Secchi**	**Sample**	**°C**	**µS/cm**	**mg/L**	**% Sat.**	**S.U.**	**RFU**
STA-1	2.30	0.90	0.1	22.10	308.6	8.84	104.3	7.63	1.734
			1.0	22.10	308.7	8.80	103.7	7.65	2.317
			2.0	22.08	308.8	7.74	103.0	7.69	2.229
STA-2	14.50	1.60	0.1	21.93	351.5	9.42	110.7	8.00	0.135
			1.0	21.94	353.6	9.42	110.6	8.01	0.421
			2.0	21.94	353.6	9.41	110.4	8.01	0.485
			3.0	21.91	353.6	9.40	110.3	8.04	0.601
			4.0	21.79	353.6	9.05	105.9	7.91	0.819
			5.0	21.05	350.8	6.17	71.2	7.55	0.545
			6.0	20.64	350.2	4.57	52.3	7.38	0.668
			7.0	20.29	350.4	2.92	33.2	7.24	0.362
			8.0	19.54	340.0	0.00	0.0	6.89	0.439
			9.0	16.89	399.1	0.00	0.0	7.23	0.589
			10.0	12.80	389.8	0.00	0.0	7.31	0.039
			11.0	11.35	379.0	0.00	0.0	7.12	0.030
			12.0	10.79	382.9	0.00	0.0	7.05	0.026
			13.0	10.45	289.6	0.00	0.0	7.01	0.034
			14.0	10.26	391.5	0.00	0.0	6.99	0.032
STA-3	2.20	0.80	0.1	22.32	406.7	8.13	94.7	7.46	2.206
			1.0	22.57	405.5	7.42	88.3	7.47	2.518
			2.0	22.54	406.7	6.83	81.1	7.43	3.569
STA-4	3.30	1.30	0.1	22.20	355.8	8.16	96.3	7.57	0.689
			1.0	22.19	356.1	8.13	95.9	7.58	1.137
			2.0	22.16	356.3	8.02	94.6	7.56	1.473
			3.0	22.13	356.6	7.71	90.6	7.53	3.428
STA-5	2.50	1.00	0.1	22.60	358.4	7.81	92.4	7.52	1.280
			1.0	22.60	358.3	7.79	92.8	7.53	1.704
			2.0	22.58	358.2	7.78	92.6	7.50	1.971
STA-6	3.30	1.20	0.1	22.16	344.2	9.14	107.9	7.70	0.165
			1.0	22.18	345.5	9.12	107.7	7.79	0.581
			2.0	21.82	344.7	8.02	93.2	7.70	1.237
			3.0	21.46	344.4	6.92	80.6	7.61	1.771
STA-7	1.30	1.10	0.1	21.51	320.9	8.18	95.3	7.38	1.253
			1.0	21.40	322.2	7.92	90.1	7.39	0.995
STA-8	7.50	1.30	0.1	21.82	354.2	9.31	109.1	7.81	0.360
			1.0	21.88	354.6	9.28	108.9	7.84	0.605
			2.0	21.85	354.3	9.27	108.7	7.87	0.775
			3.0	21.56	352.9	8.23	95.2	7.74	0.718
			4.0	21.02	351.7	6.21	71.7	7.50	0.688
			5.0	20.81	350.4	5.54	63.6	7.44	0.468
			6.0	20.50	350.1	3.96	45.3	7.32	0.434
			7.0	19.70	336.8	0.47	5.3	6.97	0.452
STA-9	8.50	1.30	0.1	22.49	349.6	9.58	113.8	8.24	0.410
			1.0	22.49	349.8	9.56	113.6	8.24	0.545
			2.0	22.49	350.1	9.56	113.6	8.26	0.532
			3.0	22.47	350.2	9.55	113.1	8.23	0.579
			4.0	22.32	350.7	9.14	107.8	8.13	0.845
			5.0	21.42	348.2	6.72	78.1	7.75	0.685
			6.0	20.79	348.5	4.76	54.7	7.61	0.853
			7.0	20.16	399.7	0.79	8.9	7.32	0.535
			8.0	18.78	369.7	0.00	0.0	7.20	0.028
STA-10	1.20	0.90	0.1	22.46	315.9	10.17	120.7	8.42	3.378
			1.0	22..45	315.9	10.17	120.7	8.46	2.109
STA-11	1.10	1.10+	0.1	20.33	300.5	8.12	92.4	7.44	0.040
			1.0	20.11	311.4	8.28	93.9	7.39	1.698
STA-12	1.80	0.90	0.1	22.30	360.1	7.82	92.6	7.59	2.049
			1.0	22.33	362.1	7.57	89.6	7.53	1.847
			1.5	22.27	362.4	7.53	89.0	7.54	2.693

APPENDIX III: DISCRETE DATA

Discrete Data 5/14/2024						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	6.0	0.02	0.09	0.002	0.03	9
ST-2 SURFACE	8.0	0.01	0.08	0.002	0.02	2
ST-2 MID	5.7	0.02	0.13	0.001	0.02	2
ST-2 DEEP		0.56	0.12	0.002	0.06	3
ST-3	13.0	0.06	0.19	0.001	0.04	2
ST-4	6.8	0.02	0.08	0.002	0.02	ND<2
ST-5	2.0	0.01	0.05	0.001	0.02	ND<2
ST-6	6.6	0.01	0.08	0.001	0.02	2
ST-7	22.0	0.01	0.12	0.002	0.04	6
ST-10	11.0	0.03	0.15	ND<0.001	0.04	7
ST-11	2.7	0.02	0.09	0.003	0.03	4
ST-12	4.4	0.01	0.05	0.003	0.04	3
Surface Mean	**8.3**	**0.02**	**0.10**	**0.002**	**0.03**	**4**

Discrete Data 6/13/2024						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	14.0	0.02	ND<0.05	0.003	0.03	6
ST-2 SURFACE	12.0	0.03	ND<0.05	0.003	0.05	5
ST-2 MID	8.9	0.04	ND<0.05	0.003	0.02	4
ST-2 DEEP		0.56	ND<0.05	0.009	0.07	7
ST-3	18.0	0.04	ND<0.05	0.002	0.04	9
ST-4	12.0	0.04	ND<0.05	0.002	0.03	4
ST-5	17.0	0.04	ND<0.05	0.002	0.04	10
ST-6	13.0	0.04	ND<0.05	0.002	0.03	16
ST-7	9.9	0.04	0.05	0.004	0.04	33
ST-10	15.0	0.03	ND<0.05	0.002	0.05	14
ST-11	13.0	0.03	0.09	0.009	0.05	9
ST-12	15.0	0.02	ND<0.05	0.002	0.04	9
Surface Mean	**13.9**	**0.03**	**0.03**	**0.003**	**0.04**	**12**

Discrete Data 7/9/2024						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	12.0	0.03	0.06	0.007	0.04	7
ST-2 SURFACE	19.0	0.06	ND<0.05	0.001	0.02	4
ST-2 MID	10.0	0.06	ND<0.05	0.001	0.03	4
ST-2 DEEP		0.86	0.13	0.076	0.20	8
ST-3	13.0	0.08	0.05	0.001	0.05	8
ST-4	19.0	0.03	ND<0.05	0.001	0.03	7
ST-5	17.0	0.02	ND<0.05	0.001	0.03	6
ST-6	15.0	0.02	0.05	0.001	0.03	4
ST-7	14.0	0.03	0.06	0.001	0.06	11
ST-10	13.0	0.02	0.05	0.002	0.04	8
ST-11	6.2	0.04	0.07	0.002	0.04	2
ST-12	21.0	0.04	0.05	0.001	0.04	8
Surface Mean	**14.9**	**0.04**	**0.05**	**0.002**	**0.04**	**7**

Discrete Data 8/6/2024						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	11.0	0.04	ND<0.05	0.001	0.04	10
ST-2 SURFACE	16.0	0.02	ND<0.05	0.002	0.03	5
ST-2 MID	4.7	0.06	ND<0.05	0.003	0.03	9
ST-2 DEEP		0.56	0.05	0.049	0.13	10
ST-3	37.0	0.05	ND<0.05	0.002	0.06	19
ST-4	14.0	0.06	ND<0.05	0.001	0.04	11
ST-5	12.0	0.02	ND<0.05	0.001	0.03	9
ST-6	9.4	0.03	ND<0.05	0.002	0.03	7
ST-7	11.0	0.02	0.06	0.002	0.04	7
ST-10	15.0	0.02	0.05	0.002	0.06	11
ST-11	8.0	0.03	0.06	0.002	0.05	2
ST-12	11.0	0.02	ND<0.05	0.001	0.03	4
Surface Mean	**14.4**	**0.03**	**0.03**	**0.002**	**0.04**	**9**

Discrete Data 9/18/2024						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	15.0	0.02	ND<0.05	0.001	0.03	10
ST-2 SURFACE	9.0	0.01	ND<0.05	0.001	0.02	ND>2
ST-2 MID	6.8	0.06	ND<0.05	0.002	0.02	6
ST-2 DEEP		1.11	0.08	0.085	0.21	12
ST-3	22.0	0.02	ND<0.05	0.003	0.03	9
ST-4	9.0	0.01	ND<0.05	0.001	0.02	6
ST-5	13.0	0.02	ND<0.05	0.001	0.02	8
ST-6	6.8	0.01	ND<0.05	0.001	0.02	5
ST-7	7.1	0.01	ND<0.05	0.001	0.03	5
ST-10	9.8	0.01	ND<0.05	0.001	0.03	11
ST-11	11.0	0.01	ND<0.05	0.001	0.03	8
ST-12	6.0	0.01	ND<0.05	0.003	0.02	4
Surface Mean	**10.9**	**0.01**	**0.03**	**0.001**	**0.03**	**7**

APPENDIX IV: PLANKTON DATA

Phytoplankton Community Composition Analysis

Sampling Location: Lake Mohawk | Sampling Date: 2024.05.14 | Examination Date: 2024.05.28

Site A: ST-2 Surface Phyto | Site B: ST-2 Mid- Depth Phyto | Site C: ST-3 Surface Phyto | Site D: ST-10 Surface Phyto | Site E: ST-2 Surface Zoop | Site F: ST-2 Deep Zoop

Phytoplankton

Diatoms	A	B	C	D	E	F	Chlorophytes	A	B	C	D	E	F	Cyanophytes	A	B	C	D	E	F
Amphipora				R			*Actinastrum*							*Anabaena*						
Asterionella	P	P	C	C			*Ankistrodesmus*	P	P	P	A			*Aphanizomenon*	15,575	13,715	4,107			
Cocconeis							*Brachiomonas*	R						*Aphanocapsa*						
Cyclotella							*Chlamydomonas*							*Chroococcus*						
Cymbella							*Chlorella*				P			*Coelosphaerium*			6,846			
Diatoma							*Closterium*			R	P			*Cylindrospermopsis*						
Fragilaria	P	C	C	C			*Cosmarium*				P			*Dolichospermum*			171	200		
Frustulia							*Crucigenia*							*Gloeocapsa*						
Gomphonema							*Dictyosphaerium*		R					*Lyngbya*						
Gyrosigma							*Eudorina*	P						*Merismopedia*						
Melosira			P	P			*Franceia*							*Microcystis*						
Navicula							*Gloeococcus*							*Oscillatoria*	2,447					
Nitzschia			C	P			*Gloeomonas*	C	C		R			*Planktothrix*						
Pinnularia							*Golenkinia*							*Pseudanabaena*	4,450	6,858	513			
Rhoicosphernia							*Kirchneriella*							*Synechococcus*						
Stauroneis							*Koliella*	P		P				*Woronichinia*						
Stephanodiscus	P	C					*Lagerheimia*							Akinetes						
Synedra	P	C					*Nannochloris*		C											
Tabellaria	C	C					*Oocystis*							**Euglenoids**	**A**	**B**	**C**	**D**	**E**	**F**
							Pandorina							*Euglena*						
							Pediastrum	R	R	P	P			*Phacus*						
							Platydorina							*Trachelomonas*	C	C	C			
Chrysophytes	**A**	**B**	**C**	**D**	**E**	**F**	*Scenedesmus*	P	C	C	P									
Chromulina							*Selenastrum*							**Dinoflagellates**	**A**	**B**	**C**	**D**	**E**	**F**
Dinobryon	P	P	R				*Sphaerocystis*				P			*Ceratium*			R			
Mallomonas							*Spinoclosterium*							*Gymnodinium*	P	P	R			
Synura							*Spondylosium*							*Peridinium*						
							Staurastrum	R		P	P									
Xanthophytes	**A**	**B**	**C**	**D**	**E**	**F**	*Teilingia*							**Cryptophytes**	**A**	**B**	**C**	**D**	**E**	**F**
Isthmochloron							*Tetraselmis*							*Chroomonas*	P		C	C		
							Treubaria							*Cryptomonas*	C	C	A	A		
							Ulothrix													
							Zygnema													

Zooplankton

Cladocera	A	B	C	D	E	F	Copepoda	A	B	C	D	E	F	Rotifera	A	B	C	D	E	F
Bosmina					C	P	*Diaptomus*							*Ascomorpha*					A	P
Chydorus					P	P	*Microcyclops*					R	C	*Asplanchna*					P	R
							Nauplii					R	P	*Conochilus*					P	R
														Kellicottia						R
														Keratella					A	A
														Polyartha					C	P

Sites:	A	B	C	D	E	F
Cyanobacteria Count (cells/mL)	22,472	20,573	11,637	200		
Phytoplankton Genera Richness	21	17	20	17		
Zooplankton Genera Richness					9	10

A = Abundant, C = Common, P = Present, R = Rare

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Phytoplankton Community Composition Analysis

Sampling Location: Lake Hopatcong | **Sampling Date: 2024.06.13** | **Examination Date: 2024.06.14**

Site A: ST-2 Surface Phyto | **Site B: ST-2 Mid- Depth Phyto** | **Site C: ST-3 Surface Phyto** | **Site D: ST-10 Surface Phyto** | **Site E: ST-12 Surface Phyto** | **Site F: ST-2 Surface Zoop** | **Site G: ST-2 Deep Zoop**

Phytoplankton

Diatoms	A	B	C	D	E	F	G
Amphipora							
Asterionella		P	P	P	P		
Cocconeis		P		P			
Cyclotella							
Cymbella							
Diatoma					R		
Fragilaria	R	R	P	P			
Frustulia				P			
Gomphonema							
Gyrosigma							
Melosira	P	P	C	C	C		
Navicula				P			
Nitzschia		P		P			
Pinnularia							
Rhoicosphernia							
Stauroneis							
Stephanodiscus							
Synedra	P			A	C		
Tabellaria	P	C	C	P	P		

Chrysophytes	A	B	C	D	E	F	G
Chromulina							
Dinobryon							
Mallomonas							
Synura							

Xanthophytes	A	B	C	D	E	F	G
Isthmochloron							

Chlorophytes	A	B	C	D	E	F	G
Actinastrum							
Ankistrodesmus	P	P	C	C	C		
Brachiomonas	P	P	C	C	C		
Chlamydomonas	P		C	P			
Chlorella	P	P	C	C	C		
Closterium				P			
Coelastrum		P	P	P			
Cosmarium	R		P	P	P		
Crucigenia				P			
Dictyosphaerium			R				
Eudorina							
Franceia			P	P			
Gloeococcus							
Gloeomonas				P			
Golenkinia	R						
Kirchneriella				P			
Koliella				P			
Nannochloris				P			
Oocystis							
Pandorina					P		
Pediastrum	P	P	C	P			
Platydorina							
Scenedesmus	P	P	P	A	C		
Selenastrum							
Sphaerocystis							
Spinoclosterium							
Spondylosium							
Staurastrum	P		P	C	P		
Teilingia							
Tetraselmis							
Treubaria							
Ulothrix							
Zygnema							

Cyanophytes	A	B	C	D	E	F	G
Anabaena							
Aphanizomenon	32,253	27,023	37,736	661	36,174		
Aphanocapsa				1,586			
Chroococcus							
Coelosphaerium			4,193				
Cylindrospermopsis							
Dolichospermum	1,209	197		132	1,233		
Eucapsis				1,480			
Lyngbya							
Merismopedia							
Microcystis			629	1,057	411		
Oscillatoria			1,258				
Planktothrix							
Pseudanabaena	4,032		5,870		1,439		
Synechococcus							
Woronichinia				1,586	6,166		
Akinetes	40						

Euglenoids	A	B	C	D	E	F	G
Euglena		P		R	P		
Phacus		R	R		P		
Trachelomonas	P	P	P	P	C		

Dinoflagellates	A	B	C	D	E	F	G
Ceratium							
Gymnodinium	P		P	R	P		
Peridinium							

Cryptophytes	A	B	C	D	E	F	G
Chroomonas	P	P			P		
Cryptomonas	P	C		C	C		

Zooplankton

Cladocera	A	B	C	D	E	F	G
Bosmina						C	P
Ceriodaphnia						P	R
Chydorus							R
Daphnia							R

Copepoda	A	B	C	D	E	F	G
Diaptomus							
Microcyclops						P	P
Nauplii						P	P

Rotifera	A	B	C	D	E	F	G
Asplanchna						R	R
Conochilus						P	C
Gastropus							P
Keratella						C	
Polyartha						C	C
Pompholyx						R	R
Trichocerca						P	P

Sites:	A	B	C	D	E	F	G
Cyanobacteria Count (cells/mL)	37,494	27,220	49,686	6,502	45,423		
Phytoplankton Genera Richness	21	19	23	35	23		
Zooplankton Genera Richness						10	12

Comments: A = Abundant, C = Common, P = Present, R = Rare

Princeton Hydro, LLC
35 Clark Street, Trenton, NJ 08611; Phone (908) 237-5660

Phytoplankton Community Composition Analysis

Sampling Location: Lake Hopatcong | **Sampling Date: 2024.07.09** | **Examination Date: 2024.07.11**

Site A: ST-2 Surface Phyto | **Site B: ST-2 Mid- Depth Phyto** | **Site C: ST-3 Surface Phyto** | **Site D: ST-10 Surface Phyto** | **Site E: ST-12 Surface Phyto** | **Site F: ST-2 Surface Zoop** | **Site G: ST-2 Deep Zoop**

Phytoplankton

Diatoms	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Chlorophytes**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Cyanophytes**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Amphipora								*Actinastrum*					R			*Anabaena*							
Asterionella								*Ankistrodesmus*	250	P	750		P			*Aphanizomenon*	186,025	24,585	147,770	17,329	64,080		
Cocconeis				P	P			*Brachiomonas*		R		P	P			*Aphanocapsa*					1,602		
Cyclotella		R		R	P			*Chlamydomonas*	1,250	P	1,000		P			*Chroococcus*		114		1,405	534		
Cymbella								*Chlorella*		P		C				*Coelosphaerium*	750		4,751				
Diatoma								*Closterium*								*Cylindrospermopsis*							
Fragilaria		P	1,750	P	P			*Coelastrum*		R		R	P			*Dolichospermum*	2,500	229		3,747	2,937		
Frustulia				P				*Cosmarium*					R			*Eucapsis*							
Gomphonema								*Crucigenia*		P		P	P			*Lyngbya*							
Gyrosigma								*Dictyosphaerium*								*Merismopedia*	4,001		1,000				
Melosira		P	7,751	C	C			*Elakatothrix*			1,250					*Microcystis*			34,941	10,304	5,340		
Navicula								*Franceia*		R						*Oscillatoria*							
Nitzschia		P		P				*Gloeococcus*								*Planktothrix*		6,861			2,136		
Pinnularia								*Gloeomonas*								*Pseudanabaena*		9,148		5,620			
Rhoicosphernia								*Golenkinia*								*Raphidiopsis*	124,017	17,153	98,763	6,089	18,690		
Stauroneis								*Kirchneriella*								*Woronichinia*							
Stephanodiscus			250					*Koliella*								Akinetes							
Synedra	1,500		750		P			*Nannochloris*					P										
Tabellaria		P	750	P	P			*Oocystis*	250							**Euglenoids**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
								Pandorina								*Euglena*				P			
								Pediastrum		P		P	P			*Phacus*				R	R		
								Quadrigula					R			*Trachelomonas*		P		P	C		
Chrysophytes	**A**	**B**	**C**	**D**	**E**	**F**	**G**	*Scenedesmus*		P	1,000	P	C										
Chromulina								*Selenastrum*					R			**Dinoflagellates**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Dinobryon				R	P			*Sphaerocystis*								*Ceratium*					R		
Mallomonas								*Spinoclosterium*								*Gymnodinium*							
Synura								*Spondylosium*			500					*Peridinium*							
								Staurastrum	500	P	250	P	P										
Xanthophytes	**A**	**B**	**C**	**D**	**E**	**F**	**G**	*Teilingia*								**Cryptophytes**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Isthmochloron								*Tetrastrum*					R			*Chroomonas*	1000	P			P		
								Treubaria				P				*Cryptomonas*	4001	P	250	C	P		
								Ulothrix															
								Zygnema															

Zooplankton

Cladocera	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Copepoda**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Rotifera**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Bosmina						P	P	*Diaptomus*								*Anuraeopsis*							R
Ceriodaphnia						P	R	*Microcyclops*						P	C	*Ascomorpha*						P	P
Chydorus						R	R	Nauplii						C	C	*Asplanchna*						R	R
																Brachionus						P	P
																Conochilus						C	C
																Hexartha						R	
Other Arthropods																*Keratella*						C	C
Ostracoda						R	R									*Monostyla*						R	
																Polyartha						C	C
																Trichocerca							R

Sites:	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Cyanobacteria Count (cells/mL)	317,293	58,090	287,224	44,494	95,319		
Phytoplankton Genera Richness	12	24	17	26	33		
Zooplankton Genera Richness						14	14

Comments: A = Abundant, C = Common, P = Present, R = Rare

Princeton Hydro, LLC
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Phytoplankton Community Composition Analysis

Sampling Location: Lake Hopatcong | **Sampling Date: 2024.08.06** | **Examination Date: 2024.08.07**

Site A: ST-2 Surface Phyto | **Site B: ST-2 Mid- Depth Phyto** | **Site C: ST-3 Surface Phyto** | **Site D: ST-10 Surface Phyto** | **Site E: ST-12 Surface Phyto** | **Site F: ST-2 Surface Zoop** | **Site G: ST-2 Deep Zoop**

Phytoplankton

Diatoms	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Amphipora							
Asterionella							
Cocconeis			P				
Cyclotella			P	P	R		
Cymbella							
Diatoma							
Fragilaria	P	P		P			
Frustulia				P			
Gomphonema							
Gyrosigma							
Melosira	P	P	A	C	C		
Navicula							
Nitzschia		P					
Pinnularia							
Rhoicosphernia							
Stauroneis							
Stephanodiscus							
Synedra		C	P	P	P		
Tabellaria	R	P			R		
Chrysophytes	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Chromulina							
Dinobryon							
Mallomonas							
Synura					R		
Xanthophytes	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Isthmochloron							

Chlorophytes	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Actinastrum			R				
Ankistrodesmus				P			
Brachiomonas					P		
Chlamydomonas							
Chlorella		P					
Closterium							
Coelastrum			R		R		
Cosmarium							
Crucigenia				P	P		
Dictyosphaerium							
Eudorina		R					
Franceia							
Gloeococcus							
Gloeomonas					P		
Golenkinia				R			
Kirchneriella							
Koliella							
Nannochloris							
Oocystis							
Pandorina	P						
Pediastrum	P	R	C	C	C		
Quadrigula							
Scenedesmus	R		C	C	P		
Selenastrum							
Sphaerocystis							
Spinoclosterium							
Spondylosium							
Staurastrum	P	P	P	C	P		
Teilingia							
Tetrastrum				P			
Treubaria			R				
Ulothrix							
Zygnema							

Cyanophytes	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Anabaena							
Aphanizomenon	82,891	15,044	35,377	7,559	76,197		
Aphanocapsa							
Chroococcus							
Coelosphaerium							
Cylindrospermopsis							
Dolichospermum							
Eucapsis							
Lyngbya							
Merismopedia							
Microcystis							
Oscillatoria							
Planktothrix							
Pseudanabaena							
Raphidiopsis	68,694	10,676	147,406	94,491	88,171		
Woronichinia							
Akinetes	42		197	216	223		
Euglenoids	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Euglena				P			
Phacus							
Trachelomonas	C	P	P	C	P		
Dinoflagellates	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Ceratium	P		R				
Gymnodinium	R		R				
Peridinium							
Cryptophytes	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Chroomonas			P				
Cryptomonas	P	P	P	C	P		

Zooplankton

Cladocera	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Bosmina							P
Other Arthropods							

Copepoda	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Diaptomus							
Microcyclops						P	P
Nauplii						R	P

Rotifera	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Ascomorpha							P
Asplanchna							P
Conochilus						R	P
Gastropus							C
Hexartha							R
Keratella						P	P
Lepadella							P
Ploesma							C
Polyartha						P	P
Pompholyx						P	P
Trichocerca						P	P

Sites:	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Cyanobacteria Count (cells/mL)	151,585	25,720	182,783	102,050	164,368		
Phytoplankton Genera Richness	14	13	18	18	17		
Zooplankton Genera Richness						7	14

Comments: A = Abundant, C = Common, P = Present, R = Rare

Princeton Hydro, LLC
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Phytoplankton Community Composition Analysis

Sampling Location: Lake Hopatcong | **Sampling Date:** 2024.09.18 | **Examination Date:** 2024.09.25

Site A: ST-2 Surface Phyto | Site B: ST-2 Mid- Depth Phyto | Site C: ST-3 Surface Phyto | Site D: ST-10 Surface Phyto | Site E: ST-12 Surface Phyto | Site F: ST-2 Surface Zoop | Site G: ST-2 Deep Zoop

Phytoplankton

Diatoms	A	B	C	D	E	F	G
Amphipora							
Asterionella							
Cocconeis							
Cyclotella	P		C				
Cymbella							
Diatoma							
Fragilaria							
Frustulia							
Gomphonema							
Gyrosigma				P			
Melosira		P	C	C	C		
Navicula				P			
Nitzschia	C	A	P	C	C		
Pinnularia							
Rhoicosphernia							
Stauroneis							
Stephanodiscus							
Synedra		P	P		P		
Tabellaria		P		P			

Chrysophytes	A	B	C	D	E	F	G
Chromulina							
Dinobryon	R		P	P	P		
Mallomonas							
Synura							

Xanthophytes	A	B	C	D	E	F	G
Isthmochloron							

Chlorophytes	A	B	C	D	E	F	G
Actinastrum							
Ankistrodesmus				P			
Brachiomonas	C	P	P	P			
Chlamydomonas							
Chlorella	P	P	P		P		
Closterium		P					
Coelastrum	R		P				
Cosmarium							
Crucigenia	P	P	P	P	P		
Dictyosphaerium							
Eudorina							
Franceia							
Gloeococcus							
Gloeomonas							
Golenkinia							
Kirchneriella							
Koliella							
Nannochloris							
Oocystis							
Pandorina							
Pediastrum		R	C	P	C		
Quadrigula							
Scenedesmus	P	P	C	P	C		
Selenastrum							
Sphaerocystis							
Spinoclosterium							
Spondylosium							
Staurastrum	P	P	P	P	P		
Teilingia							
Tetrastrum							
Treubaria				P			
Ulothrix							
Zygnema							

Cyanophytes	A	B	C	D	E	F	G
Anabaena							
Aphanizomenon	4,574	1,572	6,166	14,537	8,844		
Aphanocapsa							
Chroococcus							
Coelosphaerium							
Cylindrospermopsis							
Dolichospermum							
Eucapsis							
Lyngbya							
Merismopedia				5,316			
Microcystis				1,661			
Oscillatoria							
Planktothrix							
Pseudanabaena							
Raphidiopsis	36,993	27,254	135,652	35,303	25,059		
Woronichinia							
Akinetes	1,537	797	897	374	835		

Euglenoids	A	B	C	D	E	F	G
Euglena				P			
Phacus				R	R		
Trachelomonas	C	C	C	P	P		

Dinoflagellates	A	B	C	D	E	F	G
Ceratium			P	P			
Gymnodinium	R		R	P	P		
Peridinium							

Cryptophytes	A	B	C	D	E	F	G
Chroomonas							
Cryptomonas	P	C	C	C	P		

Zooplankton

Cladocera	A	B	C	D	E	F	G
Bosmina						P	P

Other Arthropods	A	B	C	D	E	F	G
Ostracoda							

Copepoda	A	B	C	D	E	F	G
Microcyclops						R	R
Nauplii						R	P

Rotifera	A	B	C	D	E	F	G
Asplanchna						P	P
Brachionus						R	
Keratella						C	C
Polyartha						A	C
Pompholyx						C	C
Trichocerca						P	P

Sites:	A	B	C	D	E	F	G
Cyanobacteria Count (cells/mL)	41,567	28,826	141,818	56,817	33,903		
Phytoplankton Genera Richness	15	16	19	24	16		
Zooplankton Genera Richness						9	8

Comments: A = Abundant, C = Common, P = Present, R = Rare

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