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MEMORANDUM

To: Lake Hopatcong Foundation
Lake Hopatcong Commission
From: F.S. Lubnow, Ph.D., Princeton Hydro, LLC
Date: 8 September 2017
Subject: **Interim 2017 water quality monitoring for Lake Hopatcong**
# of Pages: four

This memorandum is a brief summary of some of the water quality data collected at Lake Hopatcong in 2017. To date, four of the five water quality monitoring events were conducted: 2 May, 6 June, 17 July and 21 August 2017. The last sampling event is scheduled for some time in September 2017. This report focuses on the May through July sampling events.

For the Lake Hopatcong monitoring program, a variety of physical, chemical, and biological data were collected from 11 sampling stations throughout the lake:

Station	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

* *In-situ* data only

It should be noted that all field protocol and laboratory methodology have been described in detail and have been accepted by NJDEP through an approved QAPP. Also, Princeton Hydro is State-certified for the collection of *in-situ* data and discrete samples (State ID # 10006).

A calibrated Eureka Amphibian with Manta multi-probe or similar instrument was used to collect *in-situ* data from all 11 stations and included dissolved oxygen (DO), pH, conductivity, and temperature. The *in-situ* data were collected at 0.5 to 1.0-meter intervals from surface to bottom. In addition, sub-surface discrete water samples were collected and analyzed for ammonia-N, nitrate-N, total phosphorus (TP), total suspended solids (TSS), and chlorophyll *a*. Vertical net tows were conducted for phytoplankton (free-floating algae) and zooplankton (micro-animals, some of which feed on phytoplankton) at the mid-lake sampling station (Station #2).

Shown below in Table 1 is a summary of Secchi depth measurements (water clarity) from the mid-lake sampling station (#2), the River Styx / Crescent Cove (#3) sampling station, Woodport Bay (#1) and Northern Woodport Bay (#10). Typically, once the Secchi depth falls below 1 meter (3.3 feet) the lake is perceived by a layperson as being "dirty", "scummy" or aesthetically unattractive. It should be noted that the water clarity in River Styx was relatively high in May and June, which contributes to the high amounts of rooted aquatic plants in the first half of the growing season. By early June Station #3 was heavily inundated with large amounts of submerged vegetation and while there was a delay in the initiation of mechanical weed harvesting program in 2017, by July a large proportion of the plant and algal mat biomass was harvested and removed.

Typically, a higher water clarity, with more plant growth is preferred over the more turbid conditions associated with nuisance algal blooms (particularly blue-green algae) and the potential problems such blooms can cause such as unpleasant surface scums, high turbidity, unpleasant taste and odors and the production of cyanotoxins. Thus, while high densities of aquatic vegetation can be problematic, managing such conditions are typically preferred over frequent and intense blue-green algae blooms. This is why we focus on controlling the nutrient loads (particularly phosphorus) entering Lake Hopatcong from the watershed.

Table 1 - Secchi depth in meters (1 meter = 3.3 feet) at Four of the Long-Term Water Quality Monitoring Stations at Lake Hopatcong in 2017

Station	Mid-lake (#2) (meters)	River Styx (#3) (meters)	Woodport Bay (#1) (meters)	Northern Woodport Bay (#10) (meters)
May	2.0	1.5	1.9	1.4
June	2.6	1.0	2.0	1.2
July	2.2	1.5	1.3	1.3b
Mean	**2.3**	**1.3**	**1.7**	**1.3**

b stands for "to bottom of lake"

Overall, Secchi depths from May through July were generally acceptable at the four monitoring stations sited above. However, the lower Secchi depths were typically found in the River Styx / Crescent Cove and the Northern Woodport Bay sampling stations.

Table 2 displays the total phosphorus (TP) concentrations for Lake Hopatcong for the same four monitoring stations and sampling events as outlined in Table 1. Based on the lake's TMDL Lake Hopatcong's average growing season TP concentration should be 0.03 mg/L or lower. The State's criteria for any specific TP concentration measured in a lake should be 0.05 mg/L or lower. As TP concentrations increase, there is an increased probability of the lake experiencing nuisance algal blooms in frequency, duration and magnitude.

Table 2 – TP concentrations (mg/L) at Four of the Long-Term Water Quality Monitoring Stations at Lake Hopatcong in 2017

Station	Mid-lake (#2)	River Styx (#3)	Woodport Bay (#1)	Northern Woodport Bay (#10)
May	0.02	0.03	0.03	0.04
June	0.03	0.05	0.03	0.05
July	0.02	0.04	0.04	0.04
Mean	**0.023**	**0.04**	**0.033**	**0.043**

As shown above, of the four sampling stations, the only one in compliance with the TMDL (a mean TP concentration of 0.03 mg/L or less) was the mid-lake station, although statistically the mean TP for Woodport Bay can be considered in compliance. In contrast, both the River Styx and the Northern Woodport Bay stations were out of compliance with the TMDL. Also, in each of these stations the June TP concentrations reached the NJDEP threshold for TP in lakes (0.05 mg/L).

Table 3 displays the chlorophyll *a* concentrations for Lake Hopatcong for the same four monitoring stations and sampling events as outlined in Table 1. Chlorophyll *a* is a measurement of a photosynthetic pigment all algae possess and therefore is a means of quantifying algal biomass in lakes and ponds.

Table 3 – Chlorophyll *a* Concentrations (mg/m^3) at Four of the Long-Term Water Quality Monitoring Stations at Lake Hopatcong in 2017

Station	Mid-lake (#2)	River Styx (#3)	Woodport Bay (#1)	Northern Woodport Bay (#10)
May	14.0	10.0	9.8	11.0
June	9.2	16.0	8.6	22.0
July	11.0	15.0	21.0	23.0
Mean	**11.4**	**13.7**	**13.1**	**18.6**

The targeted maximum chlorophyll *a* concentration under the TMDL is 14 mg/m3. The mid-lake station is the only one identified in Table 3 where this maximum threshold was not exceeded. For the River Styx and Northern Woodport Bay stations this threshold was exceeded in two of the three sampling events, while in Woodport Bay the threshold was exceeded once.

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 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 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 optimal summer water temperature range of 18 to 24^{o}C (65 to 75^{o}F) (USEPA, 1994). However, these fish can survive in waters as warm as 26^{o}C (79^{o}F) (Scott and Crossman, 1973), defined here as acceptable habitat. In early May 2017, the entire water column of Lake Hopatcong could be considered as optimal habitat conditions for brown trout. By early June 2017, optimal brown trout habitat was found from the surface to a depth of 7 meters (23.1 feet). By late July 2017, there was no optimal brown trout habitat but carry-over habitat was found between depths of 4 and 5 meters (13.2 and 16.5 feet).

Finally, a few notes on the aquatic vegetation. While initially submerged plant growth appeared to be severe in May and June, particularly in the River Styx / Crescent Cove by July, once the mechanical weed harvesters were up and running, plant densities were acceptable.

In conclusion, while mid-lake water quality conditions in Lake Hopatcong were generally acceptable, lower conditions were identified in the River Styx / Crescent Cove and the Northern Woodport Bay stations. In addition, while submerged plant and mat algae densities attained nuisance conditions in the early part of the growing season, such conditions improved once the mechanical weed harvesting program was initiated in June. After the September 2017 sampling event is complete Princeton Hydro will complete the final year-end report, which should be submitted to the Foundation and Commission sometime in November 2017.