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MEMORANDUM

To: The Lake Hopatcong Commission
From: F.S. Lubnow, Ph.D., Princeton Hydro, LLC
Date: 20 August 2012
Subject: **Mid-year 2012 water quality monitoring for Lake Hopatcong**
# of Pages: five

This memorandum is a concise summary of the water quality conditions of Lake Hopatcong during the 23 May, 19 June and 24 July 2012 monitoring events. A more comprehensive analysis of the 2012 water quality database will be conducted in the year-end report, after the September sampling event is completed and all of the laboratory results have been received.

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).

The table below provides data on water clarity, as measured with a Secchi disk, for Lake Hopatcong during the May through July 2012 sampling events. Typically, a lake is perceived by a layperson as being "dirty" or "scummy" when the Secchi depth is less than 1.0 meter (3.3 feet). Please note that a "b" after a Secchi value indicates that the disk reached the bottom. It should also be noted that most Secchi depths were equal to or greater than the 1.0 meter threshold during all three in-lake monitoring events. The exceptions were to this were the Secchi depth value at Station #11 in June, and the Secchi values at Stations #1 and #3 in July. These lower Secchi depths were attributed to the unusually mild winter, followed by the particularly dry and hot spring / summer seasons. Such conditions favored the development of high concentrations of phytoplankton (free-floating algae).

Station	May 2012 Secchi depth (meters)	June 2012 Secchi depth (meters)	July 2012 Secchi depth (meters)
1	1.9b	1.2	0.95
2	2.5	2.2	1.7
3	1.5b	1.5	0.8
4	2.5	1.7	1.5
5	2.8	1.7	Not measured
6	2.2b	1.5	1.2
7	1.3	1.0	1.6b
8	2.5	2.0	1.75
9	2.5	2.1	1.8
10	1.5b	1.3	1.0
11	1.0b	0.9	1.0b

b stands for "to bottom of lake"

Temperature changes greater than $1^{o}C$ over 1 meter (3.3 feet) through the water column indicate that the lake is thermally stratified, which has a profound impact on the physical, chemical, and biological components of a lake ecosystem. Based on the collected *in-situ* data, the deep, mid-section of the lake (Station #2) was strongly thermally stratified during the May through July sampling events.

Lake Hopatcong was well oxygenated (DO > 5 mg/L) from the surface to 9 m (30 ft) during the May 2012 monitoring event but was still oxygenated (DO > 2 mg/L) from 9 m to the bottom. In June 2012, the lake was well oxygenated from the surface to 8 m (26.4 ft), and anoxic (DO < 1 mg/L) immediate over the sediments at 13 m (43 ft). In July 2012, the lake was well oxygenated

from the surface to 6 m (20 ft) and was anoxic from 10 m (33 ft) to the bottom. Again, the mild winter, followed by the particularly dry and hot spring / summer, resulted in a strong degree of thermal stratification in Lake Hopatcong and a large anoxic zone in the deeper sections of the lake.

During the May 2012 monitoring event, pH values typically varied from the mid 7.0's to the mid 8.0's. The exception to this was the elevated pH values (> 9.0) measured at Station #3, which is indicative of excessive amount of photosynthesis. In contrast, pH values during the June 2012 monitoring event varied between the upper 6.0's and the mid-8.0's. Similar to June, the July 2012 monitoring event had pH values that varied between the upper 6.0's and the mid-8.0's. Since the optimum range for pH for most aquatic organisms is between 6.0 and 8.5, the water quality of Lake Hopatcong was generally acceptable relative to pH, with the exception being pH values measured at Station #3 during the May 2012 monitoring event.

During the 23 May 2012 sampling event, the total phosphorus (TP) concentration at 7 of the 9 stations was 0.02 mg/L. The exceptions to this were Stations #6 and #11 where the TP concentrations were 0.03 and 0.05 mg/L, respectively. During the 19 June 2012 sampling event TP concentrations varied from 0.01 to 0.04 mg/L with a mean of 0.03 mg/L. The highest June TP and NO_3-N concentrations were measured in Station #3 as well as in the Canal sampling stations (#7 and #11). During the 24 July 2012 sampling event, TP concentrations varied between 0.02 and 0.06 mg/L, with the highest concentration measured at Station #3. In contrast, the highest NO_3-N concentration during the July 2012 event was measured at Station #11.

The targeted average in-lake TP concentration is 0.03 mg/L, as stated in the TMDL Restoration Plan for Lake Hopatcong. Thus, all of the in-lake and watershed-based projects that are and will be implemented at Lake Hopatcong are designed to attain this targeted in-lake TP concentration. During the May 2012 sampling event, the surface water TP concentrations were at or below 0.03 mg/L for all collected samples, with the exception of Station #11, where the TP concentration was 0.05 mg/L.

In contrast to May 2012, during the June 2012 event, 2 of the 9 collected samples (22%) were above the targeted in-lake TP threshold of 0.03 mg/L. These two slightly elevated TP concentrations, both at 0.04 mg/L, were measures in River Styx / Crescent Cove and one of the Canal sampling stations. Elevated NO3-N concentrations were also measured at these two sampling stations during the June 2012 sampling event. It should be noted that the Canal stations are located in the Township of Jefferson section of the watershed; the Township is the only municipality within the Lake Hopatcong watershed that is not sewered. Thus, more than likely these elevated nutrient concentrations in the Canals are attributed to leachate moving from the septic system leachfields into the receiving waterway.

Similar to the June 2012 sampling event, 2 of the 9 collected samples (22%) were above the targeted in-lake TP threshold of 0.03 mg/L during the July 2012 event. The two elevated TP concentrations were measured at Station #3 (0.06 mg/L) and Station #10 (0.04 mg/L).

TSS is essentially a measurement of the amount of particulate matter or "dirt" in the water. For most lakes and ponds, TSS concentrations during baseline (non-storm event) conditions are

typically less than 25 mg/L. Thus, TSS concentrations greater than 25 mg/L are usually perceived by the layperson as being "dirty" or "muddy". During the May 2012 sampling event most of the TSS concentrations were less than 3 mg/L and all were low, the exception being at Station #11 (the Canals) where the TSS concentration was 22 mg/L. In contrast, TSS concentrations were generally low during the June 2012 sampling event, where concentrations varied between < 3 and 6 mg/L. TSS concentrations during the July 2012 sampling event were low to moderate, varying between < 3 mg/L (four of the nine stations) and 10 mg/L (at Station #1). It should be noted that Station #1 (Woodport Bay) tended to have the higher or highest TSS concentrations of the nine monitoring stations.

Measuring the amount of chlorophyll *a* in is an excellent means of measuring algal biomass. Based on our in-house database of Mid-Atlantic waterbodies, when chlorophyll *a* concentrations exceed 30 mg/m^3, the general perception by the layperson is that the water is "scummy" or "dirty" relative to recreational use. The chlorophyll *a* concentrations in eight of the nine stations measured during the May 2012 sampling event varied between 1.2 and 6.8 mg/m^3; however, a substantially higher chlorophyll *a* concentration was measured at Station #11 (58.2 mg/m^3). The June 2012 chlorophyll *a* concentrations were generally higher, varying between 8.3 and 22.7 mg/m^3; concentrations exceeding 20 mg/m^3 were measured at Stations #7 and #11 (the Canal stations) during the June 2012 sampling event.

The July 2012 chlorophyll *a* concentrations varied widely throughout the lake, with concentrations between 4.3 and 67.7 mg/m^3. Station #3 had the chlorophyll *a* concentration of 67.7 mg/m^3, while Stations #1, #4, #5 and #10 all had concentrations near or greater than 20 mg/m^3.

In May 2012 the diatoms, "brown" algae, *Tabellaria* and *Fragilaria* were the dominant algae. The chrysophyte *Dinobryon*, the blue-green algae *Oscillatoria* and *Coelosphaerium*, and a number of green algae were also identified in the May sample. Zooplankton abundance was high and the dominant zooplankton genus was the small-bodied cladoceran *Bosmina*.

From May to June 2012, the dominant algae shifted from diatoms to the blue-green alga *Anabaena*. However, the diatom *Fragilaria* and the green alga *Pediastrum* were also relatively common at this time. Other blue-green algae, a variety of green algae and a few other diatoms and dinoflagellates were also identified. A "bloom" of the small-bodied cladoceran *Bosmina* was also identified in the lake during the June 2012 sampling event.

By July 2012, both phyto- and zooplankton densities were moderate with the blue-green alga *Anabaena* being the most common alga. Not one genus dominated the zooplankton; however, several herbivorous (algae-eating) genera were present.

Near-shore, Non-Point Source (NPS) Monitoring Stations

In addition to the baseline in-lake monitoring stations, there are an additional five in-lake stations to monitor near-shore conditions adjacent to watershed sites where stormwater BMPs have been or will be installed. These sites include:

1. The southern end of Crescent Cove in the Borough of Hopatcong (NPS-1).
2. Along the eastern shoreline of the lake, in the Township of Jefferson, just south of Brady's Bridge (NPS-2).
3. Ashley Cove in the Township of Jefferson (NPS-3).
4. King Cove in the Township of Roxbury (NPS-4).
5. Southern end of the public beach at the Hopatcong State Park (NPS-5).

Details on these near-shore sampling stations will be provided in the year-end sampling report. However, it should be cited that TP concentrations at all five NPS sampling stations varied between low and moderate, while the TSS concentrations were low during the May through July 2012 sampling events. Again, more details on these near-shore sampling stations will be provided in the year-end report.

As always, if you have any questions or comments, please feel free to contact Princeton Hydro at 610-524-4220 or by e-mail (flubnow@princetonhydro.com). Thank you for your time.