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MEMORANDUM

To:	Lake Hopatcong Commission
From:	F.S. Lubnow, Ph.D., Princeton Hydro, LLC
cc:	The Lake Hopatcong Foundation
	NJDEP
Date:	15 September 2014
Subject:	**Interim 2014 water quality monitoring for Lake Hopatcong**
# of Pages:	six

This memorandum is a brief summary of some of the water quality data collected at Lake Hopatcong in 2014. To date, four of the five water quality monitoring events were conducted: 21 May, 24 June, 17 July and 15 August 2014. The last sampling event is scheduled for 16 September 2014.

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 is a summary of Secchi depth measurements (water clarity) from the mid-lake sampling station (#2) and the River Styx / Crescent Cove (#3) sampling station. First, it should be noted that the water clarity in River Styx was relatively high in May of both 2013 and 2014 but continued to remain high (greater than 2 meters) well into June in 2014. This higher water clarity from spring into summer explains why aquatic plant growth was so much higher in the early growing season of 2014 relative to 2013. 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 is typically preferred over frequent and intense blue-green algae blooms. This is why we focus on controlling the nutrient loads (particularly phosphorus) entering the lake from the watershed.

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

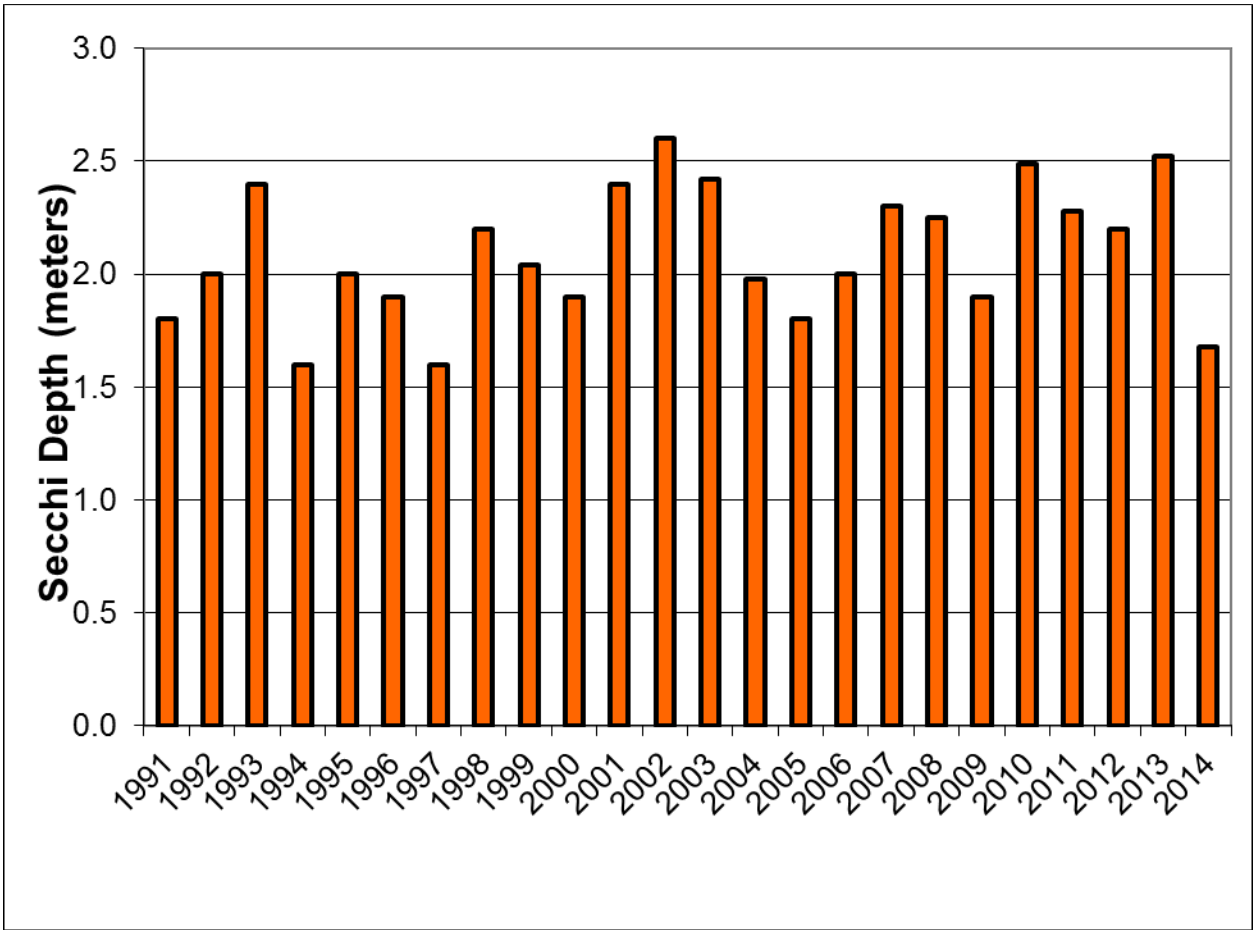
Station	2013 Mid-lake (#2) (meters)	2013 River Styx (#3) (meters)	2014 Mid-lake (#2) (meters)	2014 River Styx (#3) (meters)
May	2.9	2.1b	1.9	2.0
June	2.6	1.7	1.8	2.1b
July	2.9	1.2	1.8	0.9
August	2.0	0.6	1.2	0.6
September	2.2	1.2	NS	NS
Mean	**2.5**	**1.4**	**1.7**	**1.4**

b stands for "to bottom of lake"

NS = not sampled (scheduled for 16 September 2014)

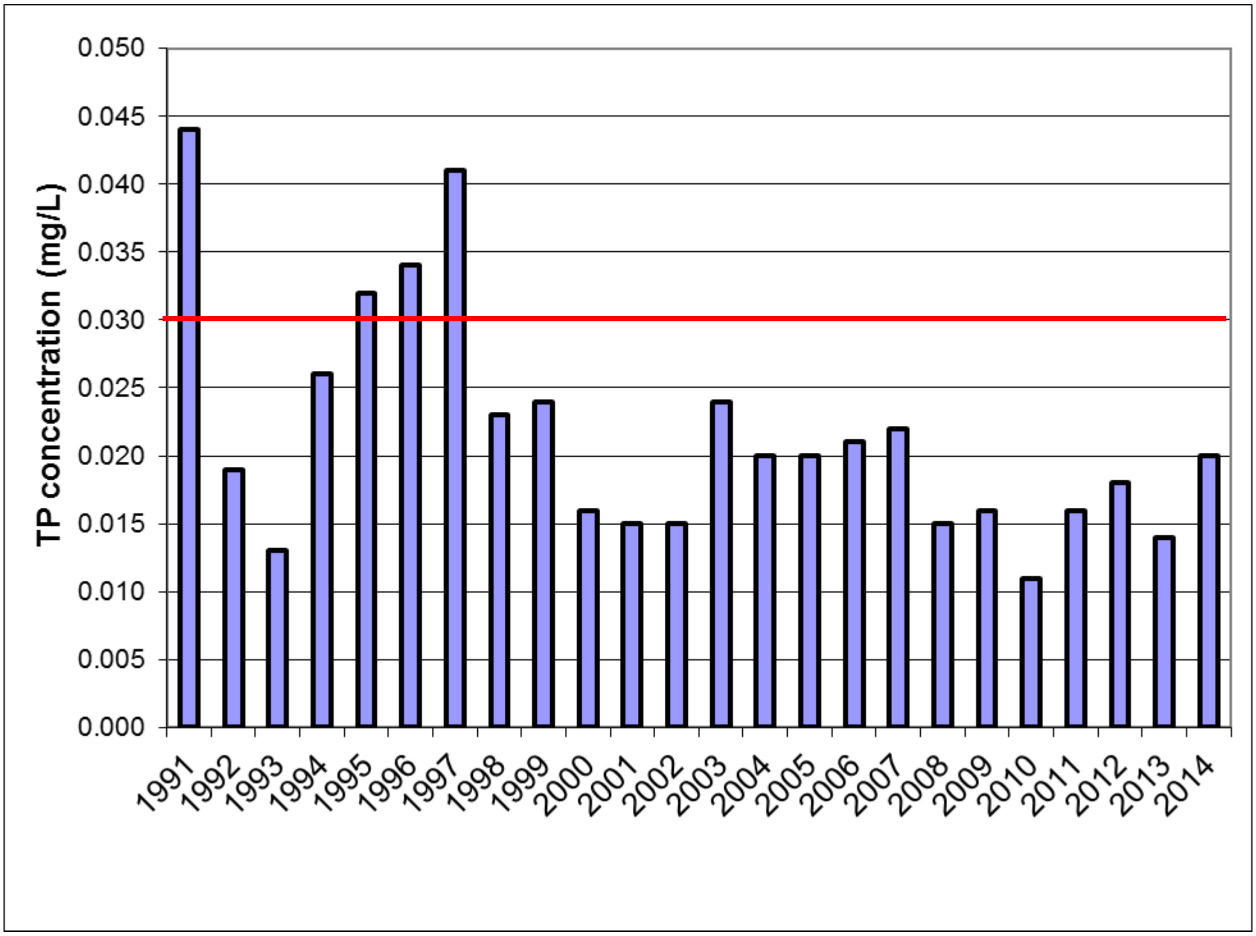
In contrast to the higher water clarity in the first half of the 2014 growing season in River Styx, the 2014 water clarity measurements at the mid-lake sampling station were consistently below what was observed in 2013 and well as the last few years. As shown below in Figure 1 the mean Secchi depth at Station #2 has been greater than 2 meters since 2007 with one exception (2009). In fact, the 2014 mean Secchi depth (to date; does not include the September value) is the lowest mean since 1997. Typically, once the Secchi depth falls below 1 meter (3.3 feet) that lake is perceived by a layperson as being "dirty", "scummy" or aesthetically unattractive.

Figure 1 – Long-Term Mean Secchi depth in Meters at the Mid-Lake Sampling Station (#2) at Lake Hopatcong



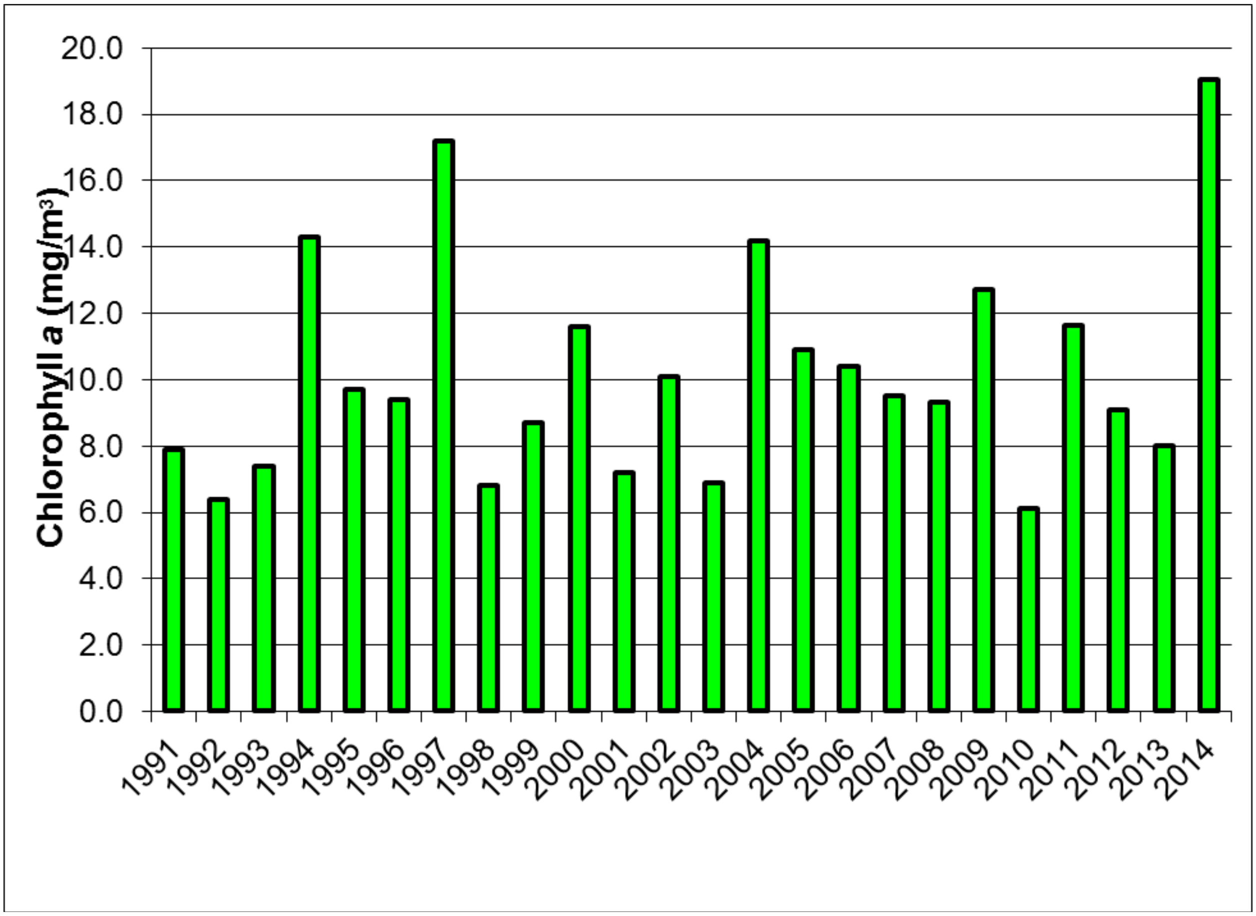
Shown below are the mean annual total phosphorus (TP) concentrations at the mid-lake sampling station (Station #2). The 2014 mean TP concentration is 0.020 mg/L (to date; does not include the September value), which is the highest mean value since 2007. While the 2014 mean concentration was elevated relative to recent years, it was still below the targeted mean TP concentration identified in the lake's TMDL (0.03 mg/L).

Figure 2 – Long-Term Mean Total Phosphorus Concentrations at the Mid-Lake Sampling Station (#2) at Lake Hopatcong



Shown below are the mean chlorophyll *a* concentrations at the mid-lake sampling station (Station #2). The 2014 mean chlorophyll *a* concentration was 19.0 mg/m^3 (to date; does not include the September value), which is the highest mean concentration over the entire 1991 – 2014 dataset.

Figure 3 – Long-Term Mean Chlorophyll *a* Concentrations at the Mid-Lake Sampling Station (#2) at Lake Hopatcong



In addition, as a result of some complaints regarding near-shore algal blooms over the summer, Princeton Hydro conducted an additional sampling event on 6 August 2014. Two near-shore locations were sampled for the identification of phytoplankton. The first site was in the Township of Jefferson (75 Shore Road, Woodport), while the second site was in the Borough of Hopatcong (227 Hudson Avenue).

Lake Hopatcong - Woodport at 75 Shore Road (Jefferson)

A wide variety of algae were identified in these near-shore samples including some green algae, diatoms (such as *Fragilaria*) and a few blue-green algae (*Aphanocapsa* and *Microcystis*). While the two identified blue-green algae have the potential to generate cyanotoxins they were not present in bloom-like densities at this site. The dominant algae were two genera of filamentous green algae (*Oedogonium* and *Cladophora*). These genera produce the nuisance, "cotton candy-like" mats seen in lakes and ponds but they do not produce cyanotoxins.

Lake Hopatcong – 227 Hudson Avenue

Again, a wide variety of algae were found at this site including green algae (such as *Staurastrum*), chrysophytes (*Mallomonas*), cryptomonads (*Cryptomonas*), dinoflagellates (*Peridinium*), and euglenoids (*Trachelomonas*). However, the dominant algal group was by far the blue-green algae. At least five genera of blue-green algae were identified in this sample, which included *Anabaena*, *Coelosphaerium*, *Microcystis* (the dominant genera), as well as *Aphanizomenon* and *Phormidium*. *Anabaena*, *Microcystis* and *Aphanizomenon* are well known to produce cyanotoxins. In addition, some dead / decaying *Anabaena*, *Microcystis* and *Coelosphaerium* were identified in the surface waters at this site. As these algae decay and their cells lyse (burst open) the cyanotoxins that are stored in their cells are released into the environment. However, the fact that the bloom is decomposing is a good sign that cyanotoxin concentrations were on the decline.

Finally, it should be noted that NJDEP also conducted some sampling within the River Styx / Crescent Cove section of Lake Hopatcong on 5 August 2014. This sampling included the collection of samples for the analysis of the cyanotoxin microcystin. Six samples were collected throughout the River Styx / Crescent Cove section of the lake. Four of the six samples had microcystin concentrations less than 20 ug/L, which is a generally recognized threshold for recreational waters. However, the two near-shore sites had concentrations greater than the 20 ug/L threshold. These elevated concentrations were along the wind-blown western shoreline, where blue-green algal cells accumulate. Most blue-green algae quickly die off as water temperatures decline so cyanotoxin concentrations are probably below the threshold at this time. However, it should also be noted that blue-green algae tend to dominant lakes that have elevated phosphorus concentrations. Again, this is why the focus of the long-term restoration of Lake Hopatcong, and its TMDL, focuses on reducing its annual, watershed-based phosphorus load.