LAKE HOPATCONG
WATER QUALITY MONITORING
ANNUAL REPORT 2004

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1.0 INTRODUCTION

Princeton Hydro, LLC conducted general water quality monitoring of Lake Hopatcong during the 2004 growing season (May through September). This monitoring program represents a continuation of the long-term monitoring program of Lake Hopatcong. 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 (PAS, 1983) and continued through the Phase II Implementation Project. Both the Phase I and Phase II projects were funded by the US EPA Clean Lakes (314) Program.

The current water quality monitoring program is important in terms of continuing the baseline database of the lake, identifying long-term trends in water quality, and quantifying and objectively assessing the success and potential impacts of restoration efforts.

2.0 MATERIALS AND METHODS

In-lake water quality monitoring was conducted at the following eleven (11) locations in Lake Hopatcong (Figure 1 in Appendix A) during the 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

* *In-situ* monitoring only

The 2004 sampling dates were 26 May, 16 June, 30 July, 31 August and 30 September. A Eureka Amphibian with Manta multi-probe unit was used to monitor the *in-situ* parameters dissolved oxygen (DO), temperature, pH, and conductivity during each sampling event. Data were recorded at 1.0 m increments starting at 0.5 m below the water's surface and continued to within 0.5 m of the lake sediments at each station during each sampling date. In addition, water clarity was measured at each sampling station with a Secchi disk.

Discrete water quality samples were collected with a Van Dorn sampling device at 0.5 m below the lake surface and 0.5 m above the sediments at the mid-lake sampling site (Station #2). Discrete samples were collected from a mid-depth position at the remaining six (6) original sampling stations (Stations #1, 3, 4, 5, 6 and 7) and at the Jefferson Canals site (Station #11) on each date. Discrete water samples were appropriately preserved, stored on ice, and returned to a State-certified laboratory for the analysis of the following parameters:

total suspended solids
total phosphorous-P
nitrate-N
ammonia-N
chlorophyll *a*

All laboratory analyses were performed in accordance with *Standard Methods for the Examination of Water and Wastewater, 18th Edition* (American Public Health Association, 1992). Monitoring at the remaining three locations, Great Cove (Station #8), Byram Cove (Station #9) and Northern Woodport Bay (Station #10) consisted solely of *in-situ* and Secchi disk data collection.

During each sampling event, vertical plankton tows were conducted at the deep sampling station (Station #2). A 50-um mesh plankton net was used to sample the phytoplankton, while a 150-um mesh plankton net was used to sample the zooplankton. The vertical tows were deployed starting immediately above the anoxic zone and conducted through the water column to the surface.

3.0 RESULTS AND DISCUSSION

Thermal Stratification

Thermal stratification is a condition where the warmer surface waters (called the epilimnion) are separated from the cooler bottom waters (called the hypolimnion) through differences in density, and hence, temperature. Thermal stratification separates the bottom waters from the surface waters with a layer of water that displays a sharp decline in temperature with depth (called the metalimnion or thermocline). In turn, this separation of the water layers can have a substantial impact on the ecological processes of a lake (for details see below). Thermal stratification tends to be most pronounced in the deeper portions of a lake. Thus, for convenience, the discussion on thermal stratification in Lake Hopatcong focuses primarily on the deep, mid-lake (Station #2) sampling station.

In-situ measurements during the 2004 growing season were generally consistent with values recorded in previous years' monitoring programs. However, through the 2004 sampling season the presence of an established thermocline or metalimnion was narrow and less distinct. This can be attributed to the above-average rainfall totals for the 2004 growing season. Individual rain events lead toward a temporary erosion of the upper thermocline, promoting significant mixing and dilution with the epiliminion. In addition, an abnormally wet season can limit the establishment of a pronounced thermocline.

On 26 May 2004, Lake Hopatcong was in the very early stages of seasonal thermal stratification, demonstrating a very narrow thermocline at a depth between and 4 and 5 meters. From surface to bottom (14 meters), the temperature decreased from 22.0^{o}C at the surface to 10.93 ^{o}C at the bottom (Appendix B).

By 16 June 2004, thermal stratification was apparent at the mid-Lake Station. The epilimnion was located from the surface to 5 meters (16.4 ft). The metalimnion was located between 6 and 8 meters (19.7 and 26.5 ft), while the hypolimnion began at depths below 8 meters.

During the 30 July 2004 and 31 August 2004 sampling events, the epilimnion was located from the surface to 6 meters and 7 meters, respectively. The thermocline was quite narrow and was located between 7 and 8 meters (23 and 26.2 ft), with the hypolimnion being below 8 meters.

Although water temperatures in the epiliminion were dramatically cooler, a thermally stratified condition remained during the 30 September 2004 sampling event while the thermocline remained narrow, between 8 and 9 meters.

The only sampling areas that were stratified from May through September were Stations #2 (mid-lake) and #9 (Byram Cove). The other moderately deep sampling station (> 5 meters), Station #8 (Great Cove), was stratified from June through August. The remaining eight (8) sampling stations were well mixed through the entire sampling season. These well-mixed conditions were the result of relatively shallow water depths (< 3 meters) and abnormally high seasonal rainfall. In general, areas of Lake Hopatcong less than 2 to 3 meters (6.6 to 9.9 feet) in depth remain well mixed through the course of the summer (Appendix B).

Thermal stratification can effectively "seal off" the bottom waters from the surface, which can result in a depletion of dissolved oxygen (DO) in the bottom waters. With the exception of a few groups of bacteria, all aquatic organisms require measurable amounts of DO (> 1 mg/L) to exist. Thus, once the bottom waters of a lake are depleted of DO, a condition termed anoxic, that portion of the lake is no longer available as viable habitat.

Dissolved Oxygen

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in the water. Atmospheric oxygen enters water by diffusion from the surrounding air, by aeration (rapid movement), and as a by-product of photosynthesis. Adequate dissolved oxygen (DO) is necessary for good water quality. Oxygen is a necessary element to almost all forms of life. As dissolved oxygen concentrations fall below 5.0 mg/L, aquatic life is put under stress. DO levels that remain below 1.0 – 2.0 mg/L for a few hours can result in large fish kills and loss of other aquatic life. Although many aquatic organisms require a minimum of 1.0 mg/L of DO to survive, the NJDEP State criteria for DO concentrations in surface waters is 5.0 mg/L or greater, for a healthy aquatic ecosystem.

In addition to a temporary loss of bottom habitat, anoxic conditions can produce chemical reactions that result in a release of phosphorus from the sediments and into the overlying water. In turn, once the lake is mixed, this phosphorus can be transported to surface waters and stimulate additional algal growth. This process is called internal phosphorus loading. Given the temporary loss of bottom water habitat and the increase in the internal phosphorus load, anoxic conditions are generally considered undesirable in a lake.

During the 26 May 2004 sampling event, DO concentrations were above the 5.0 mg/L threshold throughout most of Lake Hopatcong. The deep waters (> 12 meters) of Station #2 (mid-Lake) and the bottom waters of Station #4 (3 meters) had depressed levels of DO (< 4.0 mg/L). The surface waters of Lake Hopatcong were generally well oxygenated (> 5.0 mg/L) during the 16 June 2004 sampling event. Anoxic conditions (DO concentrations < 1 mg/L) were identified at depths greater than 8 meters.

During the 30 July 2004 sampling event, Lake Hopatcong was well oxygenated from the surface to a depth of about 6 meters. Anoxic conditions were identified at depths between 8 and 14 meters during the late July sampling event. During the 31 August 2004 sampling event, from the surface to 7 meters the lake was well oxygenated. Typically, anoxic conditions persist through the summer season in Lake Hopatcong, however, the unusually high frequency of storm events during the late summer of 2004 resulted in a high degree of mixing through the water column. Such conditions can eliminate anoxic conditions by transferring oxygenated water to the deeper sections of the lake.

By 30 September 2004, anoxic conditions were re-established at depths greater than 10 meters. In contrast, from the surface to about 9 meters, Lake Hopatcong was well oxygenated, with DO concentrations typically being greater than 6.0 mg/L (Appendix B).

pH

The optimal range of pH for most freshwater organisms is between 6.0 and 9.0. The pH throughout the water column of Lake Hopatcong was within this optimal range. Normally, temporarily elevated pH values in the surface waters can be attributed to high rates of algal and/or aquatic plant photosynthesis. As algae and plants photosynthesize, they produce DO as a by-product, as well as increase the pH of their immediate environment. In any event, the pH of Lake Hopatcong through the 2004 growing season was within the optimal range for most aquatic organisms.

Water Clarity (as measured with a Secchi disk)

Water clarity or transparency, as measured with a Secchi disk, was generally acceptable at all of the sampling stations during the 2004 sampling 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). Thus, Secchi depth measurements throughout almost all of Lake Hopatcong were greater than 1.0 meter. For example, at the mid-Lake sampling station (Station #2), the Secchi depth varied from 1.5 to 2.8 meters (5.0 to 9.2 ft) through the course of the 2004 sampling season. The exception to these acceptable water clarity measurements was the Crescent Cove / River Styx (Station #3) sampling station, where Secchi depth fell below the 1.0 meter threshold during the July and August sampling events (Figure 2).

Of the eleven sampling stations, the Station #3 sampling station historically tends to have the lowest water clarity, especially during July and August. During these months, Secchi depths are typically below the 1.0 m threshold. Such conditions were certainly observed during the 2004 sampling season. Secchi depths at Station #3 averaged 0.55 meters from July through September in 2004. Over this same time period, TSS (total suspended solids) concentrations were moderate (between 8 and 13 mg/L) relative to high chlorophyll-*a* concentrations (between 56.3 and 79.2 mg/m^3). These observed conditions indicate that the sub-optimal July and August Secchi depths at Station #3 were primarily due to algal blooms. Annually, Station #3 has the lowest Secchi depths relative to the other sampling stations of the lake; both algal blooms and excessive densities of aquatic plants typically plague this section of the lake during the summer season.

Ammonia-Nitrogen (NH_4-N)

Surface water NH_4-N concentrations above 0.05 mg/L tend to stimulate elevated rates of algal growth. Over the 2004 season, surface water NH_4-N concentrations throughout Lake Hopatcong varied between <0.02 mg/L and 0.10 mg/L. Two stations had NH_4-N concentrations equal to or greater than the 0.05 mg/L threshold in May. This number dropped to one (1) station in June, one (1) in July and zero (0) in August and September. NH_4-N concentrations measured during the last several monitoring years have been slightly to moderately higher than those of past monitoring years (1992 through 1999).

Bottom water NH_4-N concentrations are monitored seasonally at the mid-lake sampling site (Station #2). As in 2003, bottom water NH_4-N concentrations remained above the 0.05 mg/L threshold from May through September. However, bottom water NH_4-N concentrations are typically elevated during summer months, as a result of a depletion of dissolved oxygen. Under such conditions, bacterial decomposition of organic matter results in an accumulation of NH_4-N. The severe limitation of light in the bottom waters results in negligible uptake of NH_4-N by algae, which also contributes toward its accumulation. Such a seasonal accumulation of NH_4-N is common occurrence in Lake Hopatcong.

Nitrate-Nitrogen (NO_3-N)

With one exception, NO_3-N concentrations throughout the 2004 sampling season of Lake Hopatcong varied between <0.02 mg/L and 0.16 mg/L. During the May sampling event, NO_3-N concentrations were below the analytical limit of detection at Station #7. In contrast, NO_3-N concentrations at the remaining Stations were all equal to or greater than 0.03 mg/L.

While there was a considerable amount of variation both among the sampling stations and between sampling events, the NO_3-N concentrations measured in June were generally lower relative to the May concentrations. Stations #1 through #7 had NO_3-N concentrations less than or equal to 0.03 mg/L. Only Station #11 had a higher NO_3-N concentration at 0.05 mg/L. During the July sampling event, all NO_3-N concentrations were less than or equal to 0.06 mg/L.

On 31 August 2004, the NO_3-N concentrations at all of the sampling stations were less than or equal to 0.05 mg/L. In contrast, the deep Stations #2 sample had a NO_3-N concentration of 0.10 mg/L. On 30 September 2004 NO_3-N concentrations at Stations #3, #7 and #11 were greater than 0.10 mg/L, while concentrations at the remaining stations varied between 0.02 and 0.03 mg/L.

The consistently elevated NO_3-N concentrations at Stations #7 and #11, located in the shallow northeastern Canal area of the lake, strongly support the contention that septic systems continue to exert a negative impact on the water quality of Lake Hopatcong. Such impacts need to be addressed either through an aggressive septic management program and/or the sewering of this section of the watershed. The high frequency of storm events experienced during 2004 exacerbated the leaching of nitrate and other pollutants from septic leachfields, through the sub-soils and into the receiving waterways of Lake Hopatcong.

The refined phosphorus TMDL was recently completed for Lake Hopatcong and in response to this, the Township of Jefferson is developing a septic management program. It should be emphasized that this septic management program is being implemented as a temporary means of addressing the septic-related pollutant inputs until funds are available for the installation of community-based sewage system within the Township of Jefferson.

Total Phosphorous

Phosphorus has been identified as the primary limiting nutrient for algae and aquatic plants in Lake Hopatcong. In other words, a small increase in the phosphorus load will stimulate a substantial increase in algal and aquatic plant growth. For example, one pound of phosphorus can generate as much as 1,100 lbs of wet algae. This fact demonstrates the continued need to reduce the annual phosphorus load entering Lake Hopatcong as much as possible.

Studies have shown that TP concentrations as low as 0.03 mg/L can stimulate high rates of algal growth that are quantified as eutrophic or highly productive. Based on Princeton Hydro's in-house database on northern New Jersey lakes, TP concentrations equal to or greater than 0.06 mg/L will typically result in the development of algal blooms / mats that are perceived as a recreational nuisance by the layperson. Based on the recently completed refined phosphorus TMDL, the long-term management goal is to maintain a <u>mean</u> growing season TP concentration of 0.028 mg/L within the surface waters of Lake Hopatcong.

During the May sampling event, TP concentrations throughout the lake generally varied between <0.02 and 0.03 mg/L. Exceptions were a TP concentration of 0.04 mg/L at Station #5 (the Outlet) and 0.05 mg/L at Station #7 (Inlet from Lake Shawnee). The lake at this time had a greenish hue, which was more than likely the result of a moderate spring algal bloom (see Section on phytoplankton for details). Spring storm events transport phosphorus from the watershed and into the lake, resulting in an increase spring algal blooms.

During the June 2004 sampling event, TP concentrations throughout Lake Hopatcong varied between < 0.02 and 0.03 mg/L. Surface water TP concentrations during the 30 July 2004 sampling event were within a similar range with one exception. During the July 2004 sampling event, the TP concentration at Station #3 (River Styx / Crescent Cove) was 0.06 mg/L, which is the threshold when algal blooms are typically experienced in a Mid-Atlantic waterbody.

During the 30 August 2004 sampling event, TP concentrations in the surface waters again generally varied between < 0.02 and 0.03 mg/L, with two exceptions. The TP concentration at Station #3 was 0.07 mg/L, while the concentration at Station #7 was 0.04 mg/L (Appendix C). Finally, during the September 2004 sampling event, surface water TP concentrations again varied between < 0.02 and 0.03 mg/L, with the Station #3 concentration being 0.04 mg/L.

In general, TP concentrations in Lake Hopatcong were moderate in the spring but were generally low through the summer. The exception to the general pattern was the Crescent Cove / River Styx (Station #3) sampling station, where July and August TP concentrations were near or greater than the 0.06 mg/L bloom threshold. As previously identified such elevated TP concentrations in this section of the lake is a re-occurring condition. The elevated summer TP concentrations at Station #3 are the result of the land use and activities within the surrounding sub-watersheds (Borough of Hopatcong), as well as the minimal amount of hydrologic flushing. Combined, these factors provide the opportunity for algae and aquatic plants to assimilate available phosphorus, producing the blooms and large stands of rooted aquatic plants that are typically observed in the Crescent Cove / River Styx portion of the lake.

Similar to previous monitoring years (pre 2003), the TP concentrations at the mid-lake, deep sampling station (Station #2) were elevated in mid-summer, varying from 0.04 to 0.18 mg/L between July and September 2004 (Appendix C). During previous monitoring events, TP concentrations as high as 0.33 mg/L were measured in the deep waters of Station #2. Such elevated TP concentrations in the deep waters are attributed to the establishment of anoxic conditions (DO < 1 mg/L) during the summer months. The low bottom water TP concentrations, relative to past monitoring years, were attributed to the high frequency of storm events. Wet growing seasons tend to erode the density difference between the epilimnion and hypolimnion and can transport deep water TP to the surface.

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 30.0 mg/m^3. Based on the findings of the refined TMDL, the mean seasonal chlorophyll *a* concentration under existing conditions is 15 mg/m^3, while the maximum seasonal value is 26 mg/m^3. In contrast, the targeted mean and maximum chlorophyll *a* concentrations, once Lake Hopatcong is in complete compliance with the TMDL, are 8 and 14 mg/m^3, respectively.

The mean chlorophyll *a* concentrations for May, June and September 2004 were below the existing mean concentration of 15 mg/m^3. In contrast, the July and August 2004 mean chlorophyll *a* concentrations were 20 and 24 mg/m^3, respectively, both greater than the existing mean of 15 mg/m^3. In addition, July and August 2004 chlorophyll *a* concentrations at Station #3 also exceeded the maximum seasonal value of 26 mg/m^3. These elevated chlorophyll *a* concentrations in July and August indicate that algal blooms were experienced in Lake Hopatcong during the mid-summer season. While the majority of the 2004 concentrations did not attain the 30 mg/m^3 threshold, the measured concentrations in conjunction with some select shoreline observations made during the summer season (for details see below), were indicative of nuisance conditions. These results indicate that efforts must continue in complying with the targeted TP and chlorophyll *a* concentrations for Lake Hopatcong.

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 result in nuisance conditions. The majority of nuisance algal blooms in freshwater ecosystems is 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 cyanotoxins.

Table 1 lists the dominant phytoplankton identified in Lake Hopatcong during each 2004 water quality monitoring event. In May 2004, the phytoplankton community was similar to what has been observed in Lake Hopatcong in previous spring monitoring events. A bloom of the chrysophyte *Dinobryon* was observed in May 2004. This alga can give the water a brown, turbid appearance, although it tends to be found in deeper waters, within the thermocline. Other chrysophytes, and a variety of diatoms and green algae were also identified in the May 2004 sample (Table 1).

From May to June 2004, overall phytoplankton diversity increased and not one particular genus or group was dominant. One significant difference between the May and June samples was that four genera of blue-green algae were identified in the June 2004 sample (Table 1).

By late July 2004, Lake Hopatcong was experiencing a moderate bloom of the blue-green algae *Microcystis*, *Coelosphaerium*, *Anabaena*. Additional samples were collected by the Commission on 28 July 2004 along the shore of Van Every Cove (also known as Lee's Park Cove). A heavy surface scum was observed along this shoreline. An examination of the sample revealed that the surface scum was composed of the same three blue-greens identified at Station #2, as well as *Oscillatoria*, a blue-green that prefers to exist in the low light, mid-depth waters.

Table 1

Phytoplankton in Lake Hopatcong during the 2004 Growing Season

Sampling Date	Phytoplankton
26 May 2004	A bloom of the chrysophyte *Dinobryon*. Other chrysophytes (*Synura*) variety of diatoms (*Melosira*, *Fragilaria*, *Asterionella*, *Tabellaria*), green algae (*Chlorella*, *Pandorina*, *Gloeocystis*) and the dinoflagellate *Ceratium* were also identified.
16 June 2004	A variety of algae were identified in the sample. Community diversity attained its highest level in June. The green algae were the most diverse group (*Pediastrum*, *Scenedesmus*, *Gloeocystis*, *Sphaeriocystis*, *Cosmarium*, *Staurastrum*). Diatoms (*Melosira*, *Fragilaria*, *Stephanodiscus*, *Tabellaria*) and blue-green algae (*Oscillatoria*, *Microcystis*, *Coelosphaerium*, *Anabaena*) were also identified in the sample.
30 July 2004	A bloom of a variety of blue-green algae, including *Microcystis*, *Coelosphaerium*, *Anabaena*. The blue-green *Oscillatoria* was also identified in the sample along with a variety of green algae (*Staurastrum*, *Pediastrum*, *Cosmarium*) and a few chrysophytes, diatoms on the dinoflagellate *Ceratium*.
31 August 2004	Essentially the same community composition as identified in the 30 July 2004 sample; blue-green algae were the dominant forms and occurred in bloom densities.
30 September 2004	The dominant algae were several blue-greens (*Coelosphaerium* and *Anabaena*) and the diatoms *Melosira*. A variety of chrysophytes, diatoms and green algae were also identified.

The dominance of the phytoplankton community in Lake Hopatcong by blue-green algae continued through August. In fact, the structure of the late August 2004 phytoplankton community was extremely similar to the late July 2004 community. The dominant genera identified in the 31 August 2004 sample were *Anabaena* and *Coelosphaerium* (Table 1).

By late September 2004, the dominance of the blue-green algae was beginning to decline, although two of the three dominant algae were still blue-greens (*Anabaena* and *Coelosphaerium*). The third dominant alga was the diatom *Melosira*. Other diatoms and green algae increased in their relative contribution to the phytoplankton community in Lake Hopatcong from August to September 2004.

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 Station #2 during each monitoring event. The results of these samples are provided in Table 2.

The zooplankton community of Lake Hopatcong was dominated by either small-bodied cladocerans such as *Bosmina* and *Chydorus* or one of a variety of rotifers through the course of the 2004 monitoring season. These types of zooplankton tend to feed on bacteria, detritus and in some cases each other. None of the dominant zooplankton are highly herbivorous; that is, they feed primarily on algae.

Three genera of herbivorous zooplankton were identified in Lake Hopatcong during the 2004 growing season and include the cladocerans *Daphnia* and *Ceriodaphnia* and the copepod *Diaptomus*. None of these algae-eating zooplankton were common in Lake Hopatcong and *Daphnia* was only identified in the May 2004 sample.

The dominance of non-herbivorous zooplankton and the general absence of particularly large-bodied, herbivorous zooplankton such as *Daphnia* have been documented during past monitoring years in Lake Hopatcong. These low abundance of large-bodied, herbivorous zooplankton is more than likely the result of the presence of high densities of small, zooplankton-feeding fish such as alewives, golden shiners, and young white perch. However, site specific data on the lake's existing fishery community would need to be collected to verify this hypothesis.

Table 2

Zooplankton in Lake Hopatcong during the 2004 Growing Season

Sampling Date	Zooplankton
26 May 2004	Small-bodied cladocerans (*Bosmina* and *Chydrous*), and the colonial rotifer *Conochilus* were the dominant zooplankton. A few herbivorous (algae-eating) zooplankton were identified and included the cladoceran *Daphnia* and the copepod *Diaptomus*.
16 June 2004	The small-bodied cladoceran *Bosmia* was the dominant zooplankter. A few rotifers and two herbivorous zooplankton (the cladoceran *Ceriodaphnia* and the copepod *Diaptomus*) were also identified in the sample.
30 July 2004	Overall zooplankton abundance declined from June to July and the dominant zooplankter was the rotifer *Keratella*. A few rotifers, *Ceriodaphnia* and *Diaptomus* were also identified.
31 August 2004	The rotifers *Polyarthra* and *Keratella* were the dominant zooplankton in this sample. A few small-bodied cladocerans and copepods were identified, as well as *Ceriodaphnia*.
30 September 2004	The small-bodied cladocerans (*Bosmina* and *Chydrous*) were the dominant zooplankton. A few rotifers and copepods, including the herbivorous copepod *Diaptomus*, were also identified in the sample.

Recreational Fishery and Potential Brown Trout Habitat

Of the recreational game fish 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 criterion to sustain a healthy, aquatic ecosystem is a DO concentration of at least 5mg/L.

While all trout are designated as coldwater 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). The 2004 temperature and DO data for Lake Hopatcong were examined to identify the present of optimal or acceptable brown trout habitat.

An examination of the 2004 DO and temperature data indicates that acceptable conditions existed for brown trout from the surface to 9 meters in May and from the surface to 6 meters in June. By July this acceptable "zone" for brown trout existed from the surface to 5 meters and was compressed to between 6 and 7 meters in late August. By late September 2004, the acceptable zone for brown trout was identified between surface waters and 9 meters. Based on these data acceptable brown trout habitat persisted through the entire growing season.

Mechanical Weed Harvesting Program

Many of the more shallow 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 weed harvesting has over other management techniques, such as the application of herbicides, is that phosphorus is removed from the lake along with the weed biomass. In fact, between 8 and 12% of the total annual phosphorus load of Lake Hopatcong can be removed through mechanical weed harvesting.

During the last three growing seasons, since the State designated Lake Hopatcong Commission has been operating the mechanical weed harvesting program, an average of 1,526 tons of aquatic vegetation is removed from the lake per year. This roughly equates to 3.05 million pounds of plant biomass removed from Lake Hopatcong per year.

Inter-annual Analysis of Water Quality Data

Annual mean values of Secchi depth, chlorophyll *a* and total phosphorus concentrations were calculated for the years 1991 through 2004. The annual mean values for Station #2 were graphed, along with the long-term, "running mean" for the lake.

The mean 2004 Secchi depth at Station #2 was 2.0 meters, which was the lowest mean Secchi depth recorded at Lake Hopatcong since 2000 (Figure 3). While the mean Secchi depth was above the 1.0 meter threshold for recreational waterbodies, it is lower than annual means for 2001 through 2003. The 2004 growing season was extremely wet, with a high frequency of storm events, transporting nonpoint source pollution, including phosphorus, to the lake. In turn, an elevated phosphorus load stimulates algal growth.

As cited above, based on Princeton Hydro's in-house database, Secchi depths greater than 1 m (3.3 ft) are considered acceptable for recreational waterbodies; Secchi depths less than 1 m are perceived as "dirty" or "cloudy" to the layperson. Thus, while the 2004 mean Secchi depth was lower than what has been measured in previous years, Lake Hopatcong's water clarity remained acceptable in terms of recreational use.

One of the major factors responsible for the observed water clarity of a lake is the amount of algal biomass in the water. In other words, the less algae in the water, the higher the water clarity. An effective way of quantifying algae biomass is to measure the amount of chlorophyll *a*. Chlorophyll *a* is a photosynthetic pigment all algae possess, so measuring chlorophyll *a* provides a measurement of the amount of algae biomass in the open waters of a lake.

The relatively low mean Secchi depth in 2004 correlated well with the relatively high mean chlorophyll *a* concentration. The 2004 annual mean chlorophyll *a* concentration for Station #2 was 14.2 mg/m^3 (Figure 4). This is the highest mean chlorophyll *a* concentration in Lake Hopatcong since 1997 and tied for being the second highest mean in the entire 1991 – 2004 database. More than likely, these elevated amounts of algal biomass in Lake Hopatcong were attributed to in increase in phosphorus loading, as a result of a high frequency of storm events through the growing season. Such conditions emphasis the need for watershed-based control measured to reduce the existing phosphorus loads entering Lake Hopatcong.

While the 2004 mean chlorophyll *a* concentration was the highest it has been since 1997, it was still below the 30 mg/m^3 threshold, when laypeople perceive water quality problems (i.e. algal blooms) in terms of recreational use. Neither the 2004 chlorophyll *a* mean, nor any of the actual concentrations measured at the mid-lake, deep water station (Station #2) were equal to or greater than 30 mg/m^3. However, some single chlorophyll *a* measurements, particularly at Station #3 during the mid-summer months, did exceed the 30 mg/m^3 threshold.

For most waterbodies in the northeastern portion of the United States, phosphorus is the primary nutrient limiting algal growth. This means that higher amounts of phosphorus entering a lake or pond, typically translates into more algae being produced. Past studies have demonstrated that phosphorus is the primary limiting nutrient for algae in Lake Hopatcong. The data collected during the 2004 monitoring program continues to support this hypothesis.

The 2004 annual mean TP concentration was 0.02 mg/L, slightly lower than the 2003 mean of 0.024 mg/L (Figure 5). However, the 2004 TP mean was the second highest measured in Lake Hopatcong over the last five years (Figure 5). Again, a high frequency of storm events experienced through the 2004 growing season, increased the watershed-based phosphorus load entering Lake Hopatcong.

4.0 SUMMARY AND RECOMMENDATIONS

This report documents the findings of the 2004 Lake Hopatcong water quality monitoring program. This section provides a summary of the 2004 water quality conditions, as well as recommendations on how to preserve the highly valued aquatic resources of Lake Hopatcong.

1. Based on the 2004 water quality database, and similar to past monitoring years, the water quality conditions of Lake Hopatcong were generally consistent with those of a meso- to slightly eutrophic ecosystem.

2. Lake Hopatcong was thermally stratified from late May through mid-September 2004. The strength of this thermal stratification was its strongest during July and August.

3. Overall, the surface waters (to approximately 5 meters) of Lake Hopatcong remained well oxygenated (dissolved oxygen concentrations > 4 mg/L) throughout the monitoring season. An anoxic zone (waters with DO concentrations less than 1 mg/L) developed along the lake's bottom by late June. This is in contrast to past monitoring years, when anoxic is typically first detected in May. By late July, this layer of anoxic water had reached a depth of 8 meters from the surface.

4. Nitrate-N concentrations were variable during the 2004 monitoring program. However, the consistently elevated concentrations in the shallower portions of the lake (i.e. Stations #7 and #11), indicate that both surface runoff and near-shore septic systems continue to have a direct impact on the water quality of the lake.

5. It has been well-documented that phosphorus is the primary limiting nutrient in Lake Hopatcong. That is, an increase in the amount of phosphorus will result in an increase in the amount of algal and/or aquatic plant biomass. TP concentrations in the surface waters of Lake Hopatcong typically varied between < 0.02 and 0.03 mg/L. However, elevated concentrations were measured in certain sections of the lake, particularly during the summer months.

6. While the mid-lake chlorophyll *a* concentrations were not excessive at the mid-lake sampling station, other sections of the lake experienced nuisance algal blooms. As is typical each year, Station #3 (Crescent Cove / River Styx) experienced nuisance algal blooms through the summer months. However, in addition to the blooms at Station #3, the coves and shoreline along the eastern side of the lake, to the south of the Jefferson Canals, also experienced nuisance algal surface scums. The high frequency of storm events transporting phosphorus to the lake, and possibly mixing deep water algal blooms and internal phosphorus with the surface waters, were identified as the cause for these blooms.

7. Based on the *in-situ* conditions, summer holdover brown trout habitat was available throughout the entire 2004 growing season. As previously suggested, the data continue to indicate that holdover brown trout habitat exists in Lake Hopatcong through the growing season.

8. The annual mean Secchi depth at the mid-lake sampling station was 2.0 meters. While this Secchi depth is acceptable for a recreational waterbody, it is the lower mean in Lake Hopatcong over the last four years.

9. Similar to Secchi depth, the mean chlorophyll *a* concentration for 2004 was acceptable for a recreational waterbody, however, relative to past monitoring years, it was one of the high values measured in Lake Hopatcong. This elevated chlorophyll *a* mean was attributed to an elevated phosphorus load as a result of the high frequency of storm events in 2004.

10. Over the last three growing seasons, an average of approximately 1,526 tons of aquatic plant biomass was harvested from Lake Hopatcong per year. The mechanical weed harvesting program, increases the recreational and ecological value of Lake Hopatcong, as well as remove a minor amount of phosphorus from the lake.

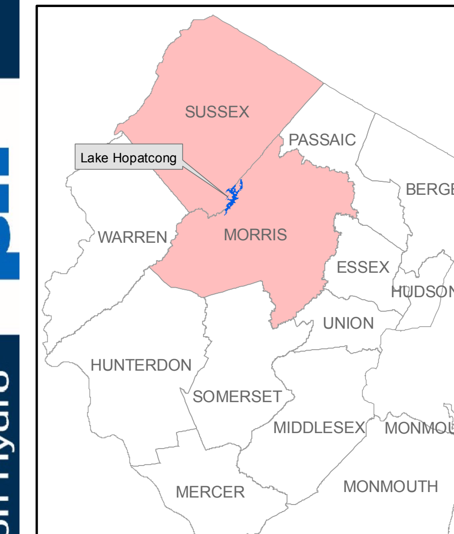
APPENDIX A

FIGURES

File: P:\0412\Projects\0412001\GIS\pfiles\Hopatcong-WaterSamp.mxd Jan 17, 2005 4:21:53 PM, Copyright Princeton Hydro, LLC.

Princeton Hydro

NEW JERSEY COUNTY MAP



PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551

0 650 1,300 2,600 Feet

1 inch equals 2,500 feet

SOURCES:

1. Data accuracies are limited to the accuracy and scales of the original data sources.
2. USGS Quadrangle of Stanhope and Dover, NJ.

FIGURE 1: WATER SAMPLING LOCATIONS

LAKE HOPATCONG
WATER QUALITY SAMPLING
MORRIS & SUSSEX CO., NJ

LEGEND

● Sampling Locations

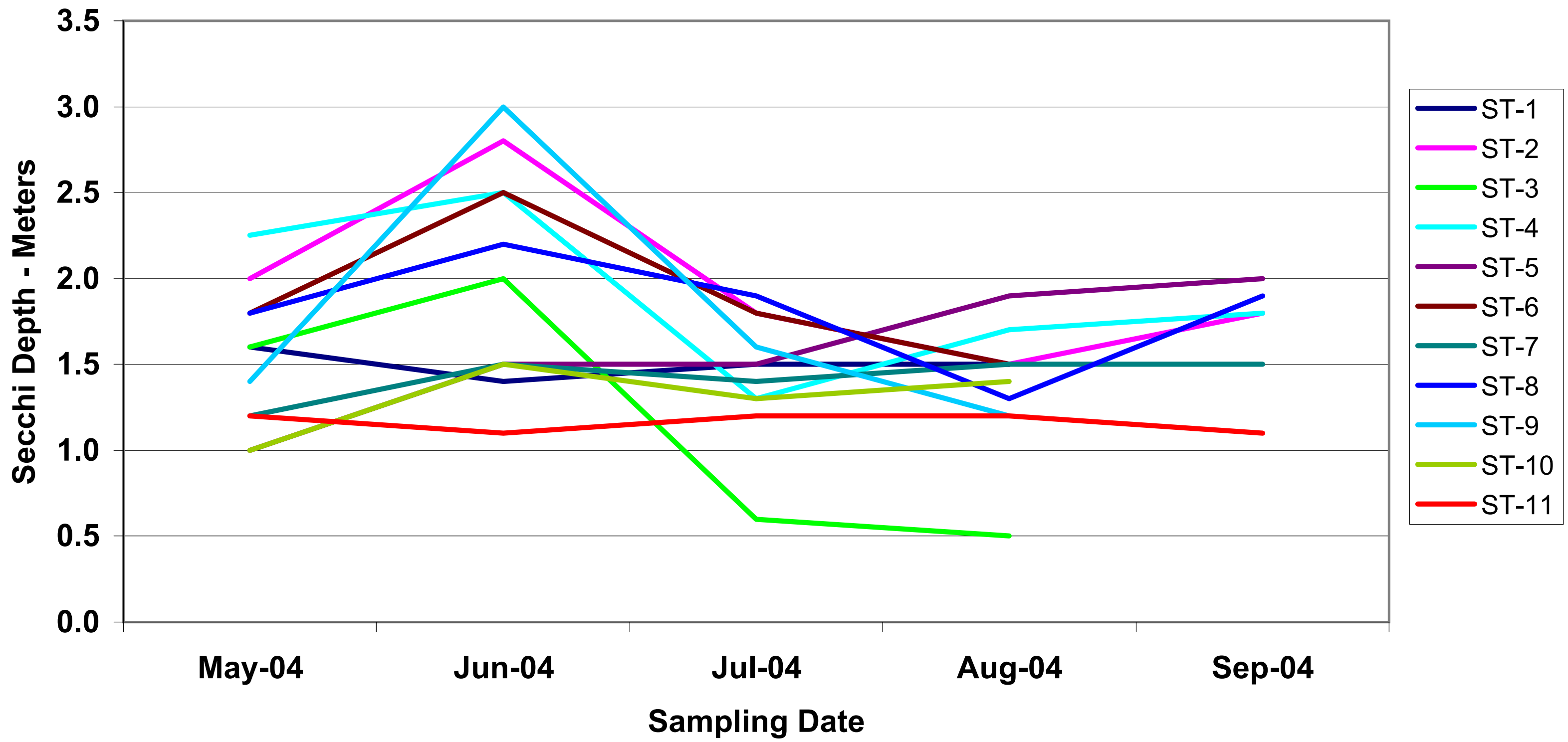


Figure 2 - Lake Hopatcong 2004 Secchi depth values

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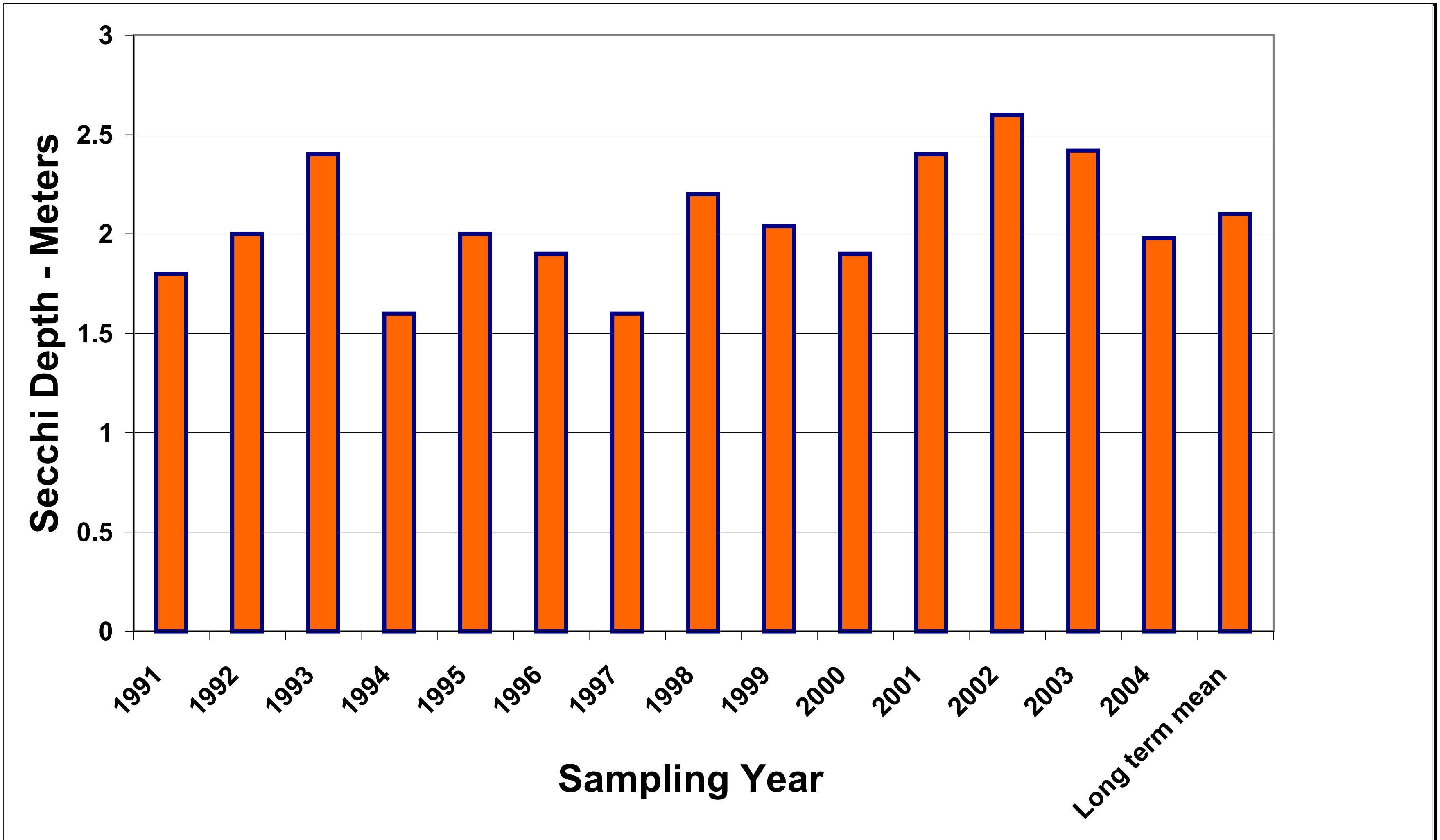

Figure 3 - Lake Hopatcong Long Term Secchi Depth Values at Station #2

pH
Princeton Hydro, L.L.C.
1108 Old York Road
Ringoes, N. J. 08551

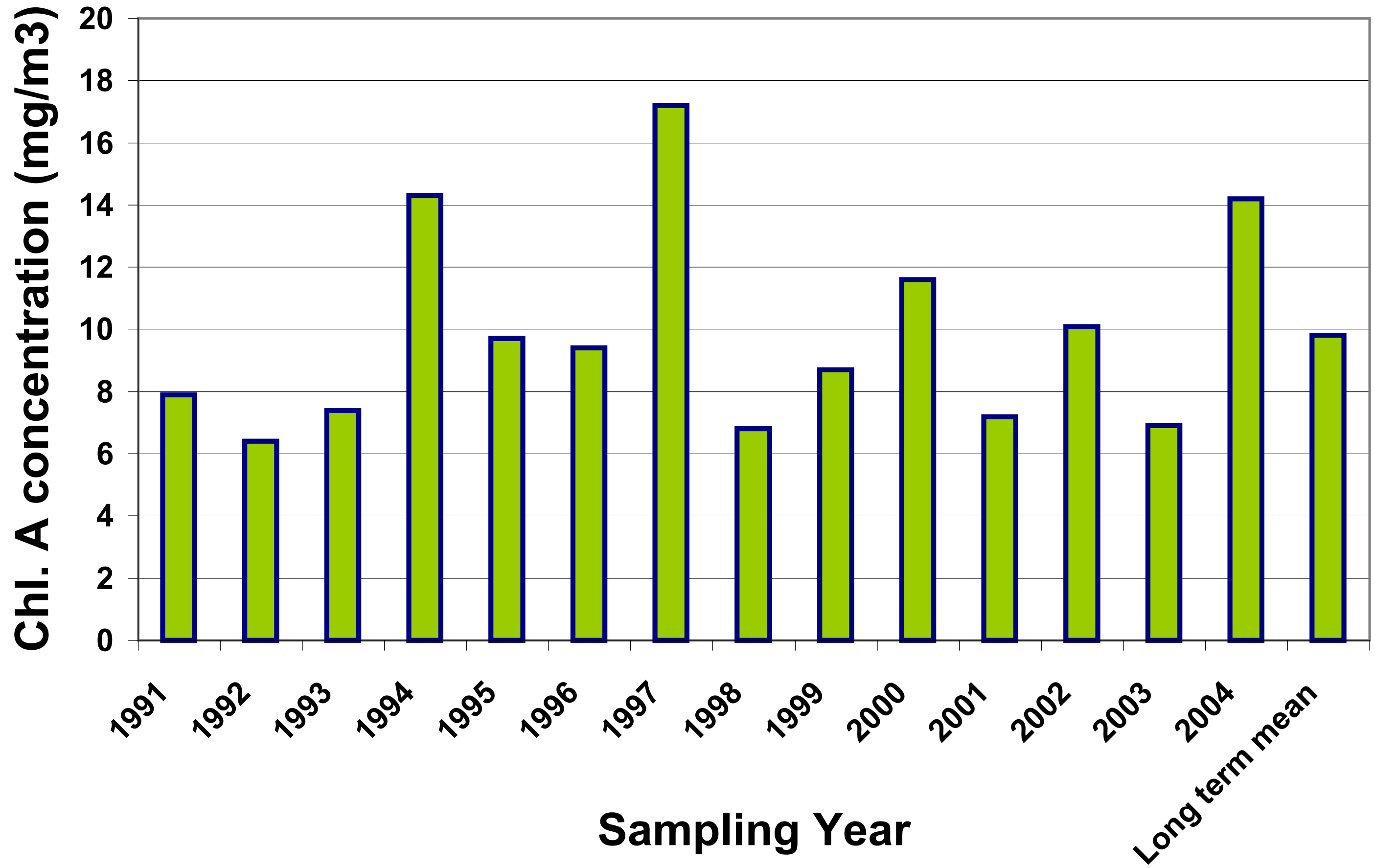

Figure 4 - Lake Hopatcong Long Term Chl A concentrations at Station #2

pH

Princeton Hydro, L.L.C.
1108 Old York Road
Ringoes, N. J. 08551

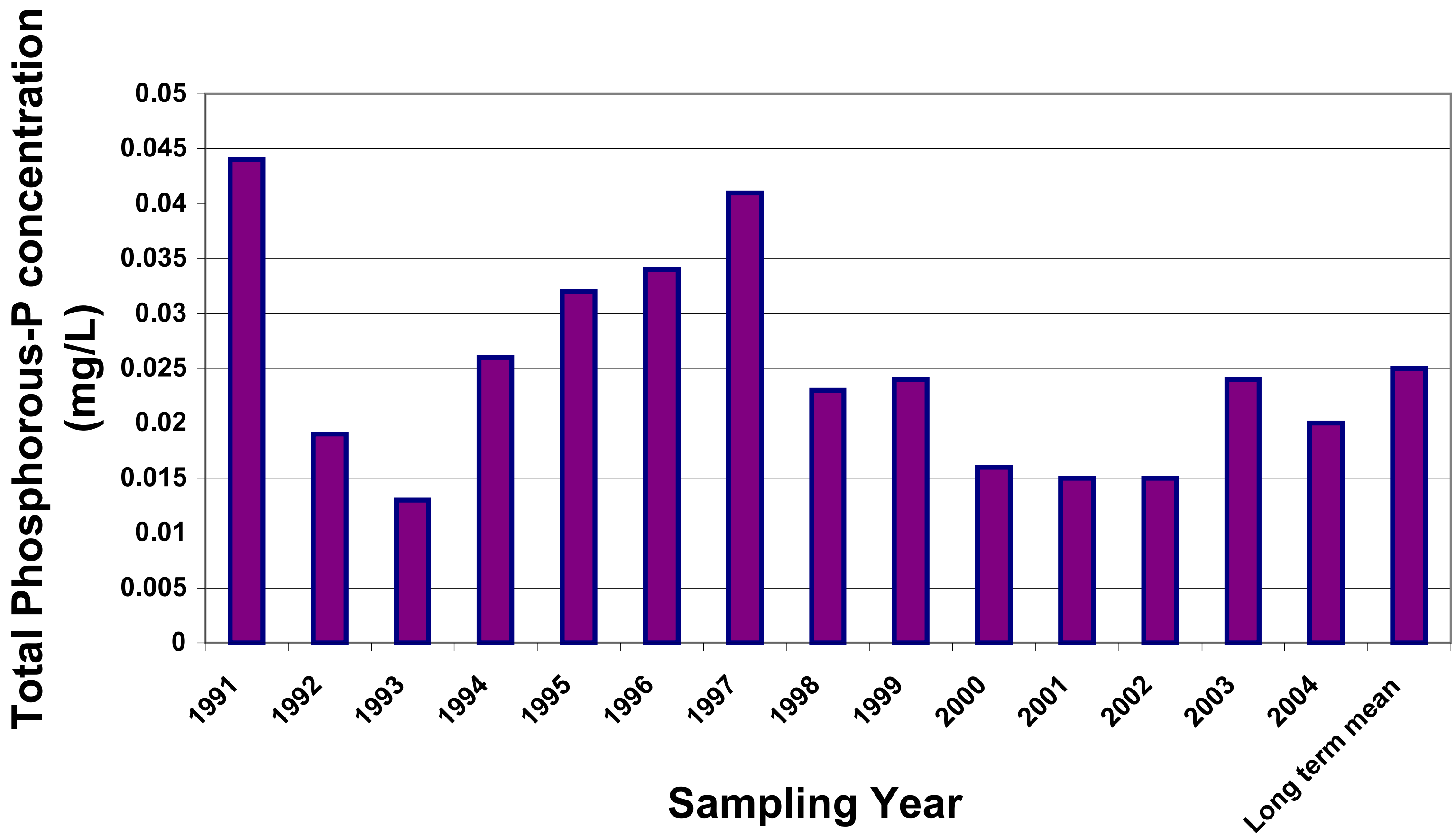

Figure 5 - Lake Hopatcong Long Term TP concentrations at Station #2

Princeton Hydro, L.L.C.
1108 Old York Road
Ringoes, N. J. 08551

APPENDIX B

TABLES

In-Situ Monitoring for Lake Hopatcong 5/26/04							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(units)**	**(mg/L)**
ST-1	**2**	**1.6**	**Surface**	22.36	0.0384	7.21	7.32
			1.0	22.69	0.312	7.21	7.03
			2.0	22.7	0.312	7.25	6.9
ST-2	**13.8**	**2**	**Surface**	22	0.293	7.53	8.27
			1.0	21.98	0.293	7.55	8.19
			2.0	21.94	0.293	7.57	8.21
			3.0	21.78	0.293	7.46	7.92
			4.0	20.79	0.293	7.26	7.25
			5.0	16.81	0.289	7.11	6.61
			6.0	15.09	0.289	6.98	6.57
			7.0	14.14	0.289	6.88	6.26
			8.0	13.72	0.289	6.82	6
			9.0	12.89	0.289	6.71	5.11
			10.0	12.35	0.289	6.65	4.48
			11.0	11.94	0.289	6.61	4.3
			12.0	11.55	0.291	6.55	3.16
			13.0	10.93	0.294	6.53	1.5
ST-3	**2.2**	**1.6**	**Surface**	22.71	0.412	8.68	10.61
			1.0	22.75	0.414	8.73	10.52
			2.0	22.76	0.414	8.71	9.86
ST-4	**3.2**	**2.25**	**Surface**	21.94	0.296	8.05	8.6
			1.0	21.94	0.298	8.05	8.47
			2.0	21.94	0.296	8.06	8.44
			3.0	20.32	0.294	6.78	2.96
ST-5	**1**	**1**	**Surface**	22.11	0.3	8.77	9.36
			1.0	22.11	0.3	8.76	9.27
ST-6	**2.5**	**1.8**	**Surface**	23.37	0.286	7.26	7.3
			1.0	23.44	0.286	7.28	7.11
			2.0	23.45	0.286	7.3	7.07
ST-7	**1.5**	**1.2**	**Surface**	22.94	0.1743	6.71	6.23
			1.0	22.92	0.173	6.69	6.07
ST-8	**7.5**	**1.8**	**Surface**	22.04	0.291	7.57	8.71
			1.0	22.06	0.291	7.59	8.21
			2.0	22.05	0.291	7.59	8.21
			3.0	22.04	0.291	7.55	8.02
			4.0	19.67	0.291	7.28	7.11
			5.0	16.02	0.289	6.92	6.05
			6.0	14.76	0.289	6.82	5.71
			7.0	13.94	0.289	6.73	5.28
ST-9	**8.1**	**1.4**	**Surface**	22.88	0.287	7.63	8.88
			1.0	22.93	0.287	7.67	8.28
			2.0	22.92	0.289	7.65	8.32
			3.0	22.9	0.287	7.63	8.31
			4.0	22.77	0.287	7.59	8.1
			5.0	19.29	0.289	7.19	6.32
			6.0	14.89	0.289	7.01	6.03
			7.0	13.59	0.291	6.84	4.8
			8.0	13.23	0.293	6.67	3.22
ST-10	**1.6**	**1**	**Surface**	21.87	0.0015	7.09	7.88
			1.0	22.87	0.323	7.17	7.23
ST-11	**1.2**	**1.2**	**Surface**	22.17	0.1498	6.61	6.13
			1.0	22.13	0.1511	6.57	5.86

In-Situ Monitoring for Lake Hopatcong 6/16/04							
Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(units)	(mg/L)
ST-1	1.7	1.4	Surface	24.75	0.263	7.5	8.63
			1.0	24.43	0.264	7.44	8.39
			2.0	23.65	0.266	7.07	6.73
ST-2	13.8	2.8	Surface	23.44	0.254	8.17	9.38
			1.0	23.07	0.254	8.18	9.46
			2.0	22.45	0.254	8.23	9.52
			3.0	21.92	0.254	8	9.17
			4.0	21.32	0.254	7.96	9.3
			5.0	21.04	0.252	7.82	9.15
			6.0	19.46	0.25	7.03	6.71
			7.0	14.98	0.248	6.59	1.66
			8.0	13.59	0.247	6.53	1.5
			9.0	12.92	0.247	6.46	0.93
			10.0	12.42	0.247	6.42	0.46
			11.0	12.06	0.248	6.4	0.2
			12.0	11.63	0.248	6.38	0.27
			13.0	11.31	0.25	6.38	0.2
ST-3	2.3	2	Surface	25.76	0.351	8.31	10.13
			1.0	24.04	0.354	8.14	9.27
			2.0	22.19	0.307	8.13	9.57
ST-4	2.8	2.5	Surface	23.56	0.263	7.8	9.25
			1.0	23.2	0.261	7.82	8.96
			2.0	21.11	0.254	7.21	7.11
ST-5	1.5	1.5	Surface	23.4	0.263	7.67	8.55
			1.0	22.9	0.261	7.73	8.84
ST-6	2.5	2.5	Surface	25.62	0.254	8.52	9.81
			1.0	23.98	0.254	8.35	9.71
			2.0	22.32	0.252	8.53	10.39
ST-7	1.9	1.5	Surface	25.2	0.1917	7.44	9.43
			1.0	24.68	0.202	7.3	8.88
ST-8	7.5	2.2	Surface	23.37	0.254	8.27	9.64
			1.0	22.5	0.256	8.19	9.61
			2.0	22.01	0.254	7.92	9.27
			3.0	21.03	0.252	7.82	9.18
			4.0	20.55	0.252	7.46	8.72
			5.0	20.12	0.252	7.23	8.05
			6.0	19.94	0.252	7.09	7.63
			7.0	18.71	0.25	6.84	5.76
ST-9	8	3	Surface	23.45	0.252	8.36	10.03
			1.0	23.2	0.252	8.39	9.69
			2.0	22.76	0.252	8.43	9.81
			3.0	22.45	0.252	8.38	9.68
			4.0	22.2	0.252	8.28	9.67
			5.0	20.95	0.252	7.73	8.61
			6.0	17.93	0.248	7.09	4.8
			7.0	15.21	0.25	6.69	1.32

			8.0	14.56	0.25	6.59	0.66
ST-10	**1.5**	**1.5**	**Surface**	25.44	0.279	8.38	9.92
			1.0	24.87	0.28	8.64	10.56
ST-11	**1.1**	**1.1**	**Surface**	24.85	0.1694	7.42	9.64
			1.0	23.76	0.1676	7.34	9.31

In-Situ Monitoring for Lake Hopatcong 7/30/04							
Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(units)	(mg/L)
ST-1	2	1.5	Surface	24.62	0.338	7.14	7.27
			1.0	24.44	0.338	7.1	7.22
			2.0	24.29	0.338	7	6.75
ST-2	13.9	1.8	Surface	23.95	0.32	8.42	8.6
			1.0	23.9	0.32	8.42	8.6
			2.0	23.86	0.32	8.25	8.32
			3.0	23.17	0.321	8.17	8.16
			4.0	22.94	0.321	7.52	7.22
			5.0	22.73	0.322	7.02	6.4
			6.0	22.08	0.323	6.79	4.45
			7.0	20.94	0.323	6.56	2.15
			8.0	17.62	0.324	6.38	0.77
			9.0	14.72	0.328	6.45	1
			10.0	13.19	0.329	6.48	1.02
			11.0	12.34	0.331	6.53	1.13
			12.0	11.82	0.335	6.58	1.24
			13.0	11.3	0.344	6.67	1.41
			13.5	11.12	0.351	6.7	1.55
ST-3	2.1	0.6	Surface	24.26	0.36	8.63	9.73
			1.0	23.87	0.363	8.3	8.11
			2.0	22.95	0.381	6.9	2.55
ST-4	2.8	1.3	Surface	24.04	0.321	8.38	8.81
			1.0	24.04	0.321	8.39	8.59
			2.0	23.98	0.323	8.26	8.67
			2.5	23.27	0.322	7.53	7.7
ST-5	1.5	1.5	Surface	23.85	0.321	8.78	8.23
			1.0	23.75	0.321	8.85	8.61
ST-6	2.6	1.8	Surface	24.3	0.32	7.94	8.43
			1.0	24.27	0.32	7.9	8.21
			2.0	23.71	0.321	7.66	8.07
ST-7	1.4	1.4	Surface	24.15	0.239	7.01	7.44
			1.0	23.88	0.23	7.18	8.25
ST-8	7.5	1.9	Surface	24	0.32	8.03	8.4
			1.0	24	0.32	8.02	8.06
			2.0	23.35	0.321	7.88	8.04
			3.0	23.09	0.321	7.46	7.28
			4.0	22.94	0.321	7.2	6.89
			5.0	22.84	0.322	7.07	6.83
			6.0	22.47	0.324	6.85	5.73
			7.0	21.17	0.324	6.65	2.78
ST-9	8.1	1.6	Surface	24.03	0.321	8.24	8.61
			1.0	24	0.321	8.23	8.46
			2.0	23.86	0.322	8.17	8.31
			3.0	23.77	0.324	7.96	8.09
			4.0	23.59	0.323	7.93	7.95
			5.0	23.04	0.322	7	6.4

			6.0	22.6	0.326	6.67	4.64
			7.0	21.2	0.325	6.46	1.8
			8.0	19.07	0.327	6.54	1.1
ST-10	**1.5**	**1.3**	**Surface**	24.09	0.344	7.35	7.83
			1.0	24.02	0.347	7.39	7.67
ST-11	**1.2**	**1.2**	**Surface**	24.2	0.194	6.94	7.98
			1.0	23.79	0.193	6.95	8.02

In-Situ Monitoring for Lake Hopatcong 8/31/04							
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(units)
ST-1	4.5	1.5	Surface	25.01	0.34	7.3	7.46
			1.0	25.01	0.339	7.26	7.46
			2.0	25	0.339	7.24	7.45
			3.0	24.99	0.339	7.22	7.45
			4.0	24.98	0.339	7.04	7.48
ST-2	15	1.5	Surface	24.36	0.321	8.42	8.1
			1.0	24.35	0.321	8.4	8.07
			2.0	24.35	0.321	8.33	8.03
			3.0	24.32	0.321	8.25	7.43
			4.0	24.23	0.321	8.12	7.84
			5.0	24.1	0.321	7.93	7.73
			6.0	23.95	0.322	7.44	7.41
			7.0	23.08	0.323	6.27	7.25
			8.0	20.69	0.314	0.67	6.68
			9.0	14.43	0.326	0.6	6.73
			10.0	14.37	0.337	0.78	6.76
			11.0	14.22	0.339	0.85	6.73
			12.0	12.83	0.338	0.93	6.73
			13.0	11.52	0.348	1.1	6.82
			14.0	11.05	0.35	1.23	6.86
ST-3	2.2	0.5	Surface	25.5	0.357	8.64	8.63
			1.0	25.45	0.358	8.57	8.51
			2.0	24.18	0.352	7.01	7.59
ST-4	3.1	1.7	Surface	25.11	0.322	8.27	8.21
			1.0	25.15	0.322	8.17	8.2
			2.0	25	0.322	8.34	8.22
			3.0	24.67	0.322	5.69	7.76
ST-5	3.2	1.9	Surface	26.13	0.323	7.84	8.23
			1.0	25.53	0.322	7.81	8.14
			2.0	25.35	0.323	8	7.39
			3.0	24.12	0.325	1.65	6.97
ST-6	2.5	1.5	Surface	25.43	0.321	7.89	7.91
			1.0	25.3	0.321	7.62	7.83
			2.0	24.24	0.319	7.33	7.58
ST-7	1.5	1.5	Surface	25.68	0.189	7.28	7.15
			1.0	25.55	0.189	7.33	7.17
			1.5	25.31	0.186	6.98	7.18
ST-8	8.2	1.3	Surface	24.56	0.321	8.51	8.39
			1.0	24.56	0.322	8.61	8.37
			2.0	24.46	0.322	8.46	8.28
			3.0	24.34	0.322	8.27	8.27
			4.0	24.27	0.322	8.07	7.85
			5.0	23.82	0.321	7.15	7.34
			6.0	23.38	0.322	6.38	7.19
			7.0	23.75	0.323	5.44	6.995
			8.0	19.82	0.329	0.69	6.71

ST-9	**8.2**	**1.2**	**Surface**	25.39	0.322	8.71	8.7
			1.0	25.32	0.322	8.69	8.66
			2.0	25.23	0.325	8.21	8.47
			3.0	23.37	0.325	5.9	7.19
			4.0	23.01	0.322	5.39	7.05
			5.0	22.26	0.321	3.16	6.73
			6.0	21.85	0.32	1.52	6.62
			7.0	21.25	0.314	0.68	6.54
			8.0	20.04	0.326	0.76	6.71
ST-10	**1.5**	**1.4**	**Surface**	25.39	0.364	9	8.76
			1.0	25.38	0.362	8.73	8.66
			1.5	25.4	0.362	8.4	8.83
ST-11	**1.2**	**1.2**	**Surface**	25.07	0.189	6.83	7.05
			1.0	25.03	0.19	6.82	7.12

In-Situ Monitoring for Lake Hopatcong 9/30/04							
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(units)
ST-1			Surface				
			1.0				
			2.0				
			3.0				
			4.0				
ST-2	14	1.8	Surface	19.51	0.34	7.21	7.08
			1.0	19.5	0.34	7.18	7.09
			2.0	19.49	0.34	7.19	7.09
			3.0	19.49	0.34	7.2	7.09
			4.0	19.49	0.34	7.18	7.1
			5.0	19.49	0.34	7.33	7.08
			6.0	19.49	0.34	7.28	7.07
			7.0	19.48	0.34	7.13	7.07
			8.0	19.46	0.34	7.08	7.07
			9.0	19.34	0.34	6.1	7.01
			10.0	18.17	0.34	0.95	6.79
			11.0	17.01	0.35	0.43	6.94
			12.0	13.1	0.37	0.55	7.05
			13.0	12.01	0.38	0.6	7.13
			14.0	11.47	0.47	0.67	7.15
ST-3			Surface				
			1.0				
			2.0				
ST-4	2.7	1.8	Surface	18.93	0.33	8.02	7.32
			1.0	18.93	0.33	7.98	7.3
			2.0	18.92	0.33	7.93	7.29
			3.0	18.91	0.33	7.83	7.29
ST-5	3.7	2	Surface	18.87	0.33	7.72	7.26
			1.0	18.87	0.33	7.66	7.23
			2.0	18.89	0.33	7.62	7.2
			3.0	18.88	0.33	7.56	7.2
			4.0	18.88	0.33	7.6	7.22
ST-6			Surface				
			1.0				
			2.0				
ST-7	1.5	1.5	Surface	17.68	0.12	6.25	6.41
			1.0	17.55	0.12	6.21	6.37
			1.5	17.21	0.12	5.04	6.4
ST-8	6.7	1.9	Surface	19.41	0.34	7.11	7.05
			1.0	19.39	0.34	6.94	7.06
			2.0	19.39	0.34	6.67	7.06
			3.0	19.38	0.34	6.94	7.04
			4.0	19.37	0.34	6.7	7.02
			5.0	19.31	0.34	6.69	7
			6.0	19.07	0.34	6.64	6.96
			7.0	18.36	0.33	6.01	6.85

ST-9			**Surface**				
			1.0				
			2.0				
			3.0				
			4.0				
			5.0				
			6.0				
			7.0				
			8.0				
ST-10			**Surface**				
			1.0				
			1.5				
ST-11	**1.4**	**1.1**	**Surface**	17.19	0.1	7.37	6.49
			1.0	17.17	0.1	7.33	6.42

APPENDIX C

LABORATORY DATA SHEETS

HOPATCONG

5/26/2004

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	13.1	0.03	0.03	0.03	3
ST-2	6.8	0.04	0.07	0.02	<3
ST-3	10.7	0.07	0.38	<0.02	3
ST-4	3.3	0.03	0.08	0.03	<3
ST-5	3.1	0.04	0.07	0.04	3
ST-6	4	0.06	0.15	0.03	<3
ST-7	9.5	<0.02	0.14	0.05	3
ST-11	4.9	0.02	0.16	0.03	<3
ST-2 DEEP		0.14	0.07	0.03	<3
MEAN		0.05	0.13	0.03	1.33

6/16/2004

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	13.1	<0.02	<0.02	0.03	<3
ST-2	7.3	<0.02	0.02	0.02	<3
ST-3	5.3	<0.02	<0.02	0.03	<3
ST-4	5.5	<0.02	<0.02	0.02	4
ST-5	3.6	0.02	<0.02	0.03	3
ST-6	4.6	0.03	0.03	0.03	<3
ST-7	6.3	0.03	0.02	0.03	4
ST-11	7.7	0.1	0.05	0.03	4
ST-2 DEEP		0.1	0.1	<0.02	3
MEAN	6.68	0.06	0.04	0.03	3.60

7/30/2004

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	9.7	0.04	0.03	0.02	5
ST-2	17.4	0.04	<0.02	<0.02	<3
ST-3	56.3	0.04	0.04	0.06	8
ST-4	26.4	0.04	0.02	0.03	<3
ST-5	24.9	0.04	<0.02	0.03	<3
ST-6	10.8	0.06	<0.02	0.02	<3
ST-7	7.5	0.05	0.05	0.02	3
ST-11	6.1	0.04	0.06	0.02	<3
ST-2 DEEP		0.1	0.04	0.04	5
MEAN	19.89	0.05	0.04	0.03	5.25

8/31/2004

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	11.3	<0.02	0.03	<0.02	5
ST-2	23.9	<0.02	0.03	0.03	5
ST-3	79.2	<0.02	0.04	0.07	13
ST-4	20.5	<0.02	<0.02	0.03	4
ST-5	12.7	<0.02	0.05	0.03	5
ST-6	17.8	<0.02	0.02	0.02	4
ST-7	15.4	<0.02	0.04	0.04	3
ST-11	11.2	<0.02	0.04	0.03	4
ST-2 DEEP		0.07	0.13	0.18	6
MEAN	24.00	0.07	0.05	0.05	5.44

9/30/2004

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	12.7	<0.02	0.03	0.02	<3
ST-2	15.8	<0.02	<0.02	0.02	<3
ST-3	17.8	<0.02	0.15	0.04	6
ST-4	17.4	<0.02	<0.02	0.03	<3
ST-5	14.2	<0.02	<0.02	<0.02	<3
ST-6	17.8	0.03	<0.02	<0.02	<3
ST-7	9	0.03	0.1	0.03	<3
ST-11	9	0.03	0.11	0.02	<3
ST-2 DEEP		0.15	0.1	0.07	3
MEAN	14.21	0.06	0.10	0.03	4.50