Culver Lake
Mid-Year Report
August 2013

Prepared by:

Princeton Hydro, LLC
1108 Old York Road, Suite 1
P.O. Box 720
Ringoes, New Jersey 08551

The following report provides a mid-year synopsis of the observations and data compiled to date by Princeton Hydro over the course of the 2013 lake monitoring program. The primary purpose of this monitoring program is to utilize the *in-situ*, laboratory water quality, phytoplankton and zooplankton data to guide the Normanoch Association in the management of the lake. These data are especially useful in evaluating those factors affecting short- and long-term water quality conditions and how these changes affect the lake's ecological, aesthetic and recreational properties. Princeton Hydro's efforts continue to be focused on the lake's biology, specifically the management of nuisance, invasive aquatic macrophytes (weeds), and the lake's phytoplankton and zooplankton communities. In keeping with this, in addition to our sampling of the lake, Princeton Hydro stocked the lake with herbivorous zooplankton in both May and June. The purpose of the stocking is to assist in increasing the density of large body, herbivorous zooplankton as a means of controlling the density and composition of the lake's phytoplankton community. We also conducted detailed surveys of the lake's weed community during both of our monitoring events. The weed data are primarily evaluated from the perspective of how invasive non-native plants impact lake use.

To date, monitoring was conducted on 29 May 2013 (late spring) and 16 July 2013 (mid-summer). Both *in-situ* monitoring and discrete water testing of the lake and its inlets (Causeway Cove Brook and Owassa Brook) were conducted during each of these monitoring events. The *in-situ* and discrete data collected during both 2013 monitoring events (May and July) are discussed in this mid-year report. Our final water quality monitoring and zooplankton stocking event will be conducted in mid-September, and will coincide as best as possible with the lake's seasonal turn over.

It should be noted that this report discusses only the data collected to date by Princeton Hydro. Although we have received and have reviewed the *in-situ* data collected by the community volunteers those data are discussed in a limited fashion herein. In November, Princeton Hydro will prepare and present to the Association an End-of-Year report that integrates all the data, including data compiled by Ecosystem Consulting Services (ECS), the volunteers and Aquatic Technologies. That report will detail our findings and conclusions of the lake's condition over the course of the 2013 growing season.

1. WATER QUALITY - TEMPERATURE AND DISSOLVED OXYGEN

During the 29 May 2013 event the lake was already becoming thermally stratified. Specifically, at the time of monitoring, a significant decrease in water temperature was measured from surface to bottom. Additionally, at that time depressed dissolved oxygen (DO) concentrations (<2.0 mg/L) were measured at depths greater than 14 meters. Such conditions are reflective of the late spring/early summer season experienced through mid-May.

During the 16 July event, thermal and DO conditions were different relative to those observed during the 29 May event, with DO concentrations supersaturated (> 9 mg/L) at depths to only 2.0 meters. This was most likely the result of a surficial water algal bloom. DO concentrations in the "habitat zone" of the lake (depths between 4 and 7 meters) were reduced, especially at the 4 to 5 meter interface. As would be expected, between the May and July monitoring events, surface water temperatures had risen, coinciding with the warming ambient air temperatures of the seasonal change. Additionally during the 16 July event, with thermal stratification observed starting at a depth of 4.0 meters, the deeper waters were anoxic throughout, with the measured DO concentrations <1.0 mg/L at depths greater than 10 meters. Based on these observed data, the majority of the lake's deep cold waters did not have enough dissolved oxygen to sustain trout. Optimal cold water fishery habitat conditions were not observed during the 16 July event whatsoever. Recent adjustments to the lake's aeration system seem to have improved deeper water DO concentrations to a depth of 10-12 meters as evidenced by some of the data recently supplied to Princeton Hydro by the Normanoch volunteers; however anoxia remains at the very bottom depths of the lake.

The water temperatures of the inlets were also reflective of the local ambient conditions. The stream temperatures are more susceptible to changes than are the waters of the lake due to flow, size and volume differences between the two. The dissolved oxygen concentrations measured at both inlets stations were at saturations to be expected as based on water temperature. This is most likely the result of increased base flows in conjunction with the cooler spring water temperatures and consistent precipitation events in the spring. All of these factors would increase oxygen saturation of the water and contribute to the higher measured DO concentrations. However, it should be noted that the Causeway Inlet is much more reflective of the temperatures and DO of the lake due to its size and slow-moving flow. For the Causeway Inlet station this is also likely a function of increased biological oxygen demand associated with the decomposition of the organic material in the upgradient wetland areas that drain to this station. As the summer progresses and bacterial respiration increases, declines in DO are to be expected, especially in wetland areas. Although this effect was not yet observed in the DO measured within the lake proper at bottom depths at the Causeway Cove station (Table 2).

The pH of the surface waters of Culver Lake was lowest at 6.90 on 29 May and highest at 8.54 on 16

July. The elevated or alkaline pH values measured on 16 July were most likely due to elevated rates of algal photosynthesis in the surface waters. As rates of photosynthesis increase, the pH of the surrounding waters will increase. The optimal range of pH for most aquatic organisms varies from 6.0 to 9.0. Thus, to date, the pH of Culver Lake was within the optimal range for most aquatic life.

Unlike the lake data, the pH measured at the inlet stations showed less variation between the May and July monitoring dates, but did become more alkaline between the May and July events. These data show that photosynthesis-driven pH changes are typically more pronounced for the lake than for the streams. The data also show that whether due to photosynthesis, changes in surface runoff and groundwater recharge or some other factor the pH of the streams also became more alkaline moving from spring into summer.

2. WATER CLARITY

The clarity goal for Culver Lake is to sustain Secchi depths of at least 1 m (3.3 ft) or greater throughout the course of the growing season (April through September). The lake's Secchi disk clarity, as measured at the mid-lake station, was exceptional in May; 1.8 meters or 5.9 feet. The Secchi clarity measured at the Stehr Tract and Causeway Inlet stations in May also exceeded the 1.0 meter threshold (Table 1). In July the lake's water clarity (as measured at mid-lake) dropped relative to the May measurement, yet remained above the lake's 1.0 meter clarity threshold at 1.2 meters. In addition, Secchi clarity in July remained acceptable at the Stehr Tract (1.1 meters) and at the Causeway Inlet (1.3 meters) stations. To date, the lake's clarity for 2013 has been slightly lower than the May and July 2012 Secchi values. Photos of these respective Secchi depth observations are attached at the end of this report.

3. NUTRIENTS

Princeton Hydro has received the lab results for both the May and July monitoring events. The total phosphorus (TP) concentrations measured in the lake in May 2013 were minimal for the surface and mid-depth samples with concentrations of 0.02 mg/L for both. In addition, the deep sample TP concentration was elevated at 0.12 mg/L. The May 2013 lower TP concentrations are more consistent with Culver Lake's typical long-term spring TP concentrations than has been observed in recent years. TP concentrations equal to or greater than 0.06 mg/L tend to be associated with nuisance algal blooms. Thus the lake's management plan sets the TP threshold at 0.06 mg/L. The spring surface and mid-depth TP concentrations were below this threshold, and in line with long-term averages.

TP concentrations measured in the lake in July 2013 had risen to 0.03 mg/L at the surface, while the mid-depth concentration remained at 0.02 mg/L. The deep sample's TP concentration was also less than that measured in May; 0.06 mg/L. These TP concentrations were consistent with the long-term data base. What is important is that the surface and mid-water TP concentrations measured in July did not deviate that much from the May concentrations and were still below the 0.06 mg/L threshold.

During the May and July monitoring events, the nitrate-N concentrations were minimal (< 0.3 mg/l) at all stations, with the 2013 nitrate data collected to date consistent with the long-term database. Ammonia-N concentration as sampled in the upper portions of the lake's water column was low in both May and July (< 0.10 mg/L). However, the concentration of ammonia-N measured in the deeper portion of the water column was elevated in both May (0.51 mg/L) and July (0.76 mg/L). However, this is not unexpected as deep water ammonia-N concentrations will be higher than surface water concentrations due largely to bacterial decomposition of settled organic material and the lack of any photosynthetic uptake. Bottom water ammonia concentrations are also expected to increase over the course of growing season if the lake's hypolimnion remains anoxic.

TP concentrations were also measured at the two inlet stations. In May, the Causeway Cove TP concentration was 0.03 mg/L, and the concentration of TP measured at the Rt. 206 Inlet was also 0.03 mg/L. In July, the TP concentration in the water entering the lake at Causeway was 0.02 mg/L, less than that measured in May. The July TP concentration measured at the Rt. 206 Inlet was however higher (0.08 mg/L) as compared to the May data. The nitrate-N concentrations measured at the inlets were low during both events; < 0.20 mg/L.

Phosphorus binds well to sediments, so typically as total suspended solids (TSS) concentrations increase so will TP concentrations. Thus tracking TSS concentrations can provide insight into the rate and amount of TP entering the lake from watershed sources. Rainfall in the spring of 2013 was near record levels. We would expect with a greater amount of rainfall an increase in soil erosion and stream bed and bank erosion. This would translate into high in-stream TSS readings. However the TSS concentrations measured in both streams in May were non- detectable at < 2 mg/L. Additionally, the TSS concentrations measured in both streams in July remained low; 2 mg/L at the Causeway Cove Inlet and 5 mg/L at the Route 206 Inlet. The lower concentrations measured this year in May and July probably are a reflection of when our samples were collected relative to the date of the preceding rainfall event.

4. PHYTOPLANKTON AND ZOOPLANKTON

During the 29 May monitoring event the overall density (cell counts) of phytoplankton measured in the water column was relatively low, in non-bloom concentrations. While blue-green algae were the dominant group in May, there was still a diverse assemblage of other algae (green algae, cryptomonads, chrysophytes and diatoms). In fact, in terms of abundance, the green algae were the most abundance group in the mid-depth sample.

In the surface water sample the dominant algae were the blue-green alga *Gloeocapsa*, a genus of blue-green algae that does not tend to produce nuisance blooms or surface scums and the green alga *Chlamydomonas*. Overall the general composition of the phytoplankton community in Culver Lake during the May 2013 sampling event was typical for a meso- to eutrophic temperate lake during the spring season.

In May 2013, mid-depth algal abundance and biomass values were significantly lower than the respective surface water values. Similar to the surface waters, the blue-green algae were the dominant organisms in terms of biomass but the green algae were the dominant algae in terms of abundance.

Finally, it should be noted that the overall phytoplankton composition was generally better in May 2013 relative to May 2012. In May 2012, the lake was experiencing a mild bloom of blue-green alga *Anabaena* in the surface waters, with a mild bloom of the blue-green alga *Aphanizomenon* in the mid-depth waters.

During the 16 July monitoring event, the blue-green were by far the dominant group in the surface waters of Culver Lake in terms of abundance and biomass. While four general species of blue-greens were identified, the dominant genus was *Anabaena*. Other than several green algae, the only other genus identified in the surface waters was a chrysophyte.

Similar to the surface samples, blue-green algae were again the dominant genera identified in the mid-depth sample, with *Pseudoanabaena* being the dominant genus in terms of abundance. However, the mid-depth blue-green abundance and biomass values were lower relative to those in the surface waters. In contrast, more non-blue-green genera (green alga and diatoms) were identified in the mid-depth sample relative to the surface water sample.

Similar to the May 2013 to May 2012 comparison, there were higher amount of algae in the July 2012 surface and mid-depth samples relative to those collected in July 2013. In addition, the magnitude of the blue-green algal bloom in July 2012 was higher, for both surface and mid-depth waters, relative to those experienced in July 2013.

In spite of surface and mid-depth TP concentrations being low during the May and July 2013 sampling events, blue-green algae still persist in Culver Lake. A number of factors (e.g. water temperature, prevailing weather and storms, degree of zooplankton grazing) at least partially contribute to the existing conditions, however, the dominant factor is more than likely the low dissolved inorganic nitrogen to total phosphorus (DIN:TP) ratio, which favors the growth of nitrogen fixing blue-green algae such as *Anabaena* and *Aphanizomenon*. Ratios less than 7 (by weight) tend to favor blue-green algae, while ratios greater than 7 will tend to favor non-blue-green algae. In May 2013 surface and mid-depth DIN:TP ratios were 3.25 and 10.0, respectively, while in July 2013 these ratios were 1.2 and 4.0, respectively. Thus, these data indicate two things. First they reveal that the generally low DIN:TP ratios in Culver Lake allow for blue-green algae to survive and do well in spite of phosphorus concentrations being low. Second, the decline in the DIN:TP ratios from May to July in 2013, along with the increase in seasonal water temperatures, allow the blue-green algae to bloom in Culver Lake. However, as previously mentioned, the blooms in July 2013 were not as severe as those experienced in July 2012.

As discussed above in May surface and mid-depth chlorophyll *a* concentrations were no greater than 14 mg/m^3 (Table 3) and the lake's Secchi depth clarity was 1.8 meters. This is in keeping with the relatively lower phytoplankton densities measured in May, although the lake was dominated in the phytoplankton community by blue-greens. In July, the lake's chlorophyll a concentration, as measured at the lake's surface, was much higher than that measured in May at 26.3 mg/m^3 (Table 3). The lake's clarity was less and the lake had a pronounced green color in July as well. This is consistent with the dominance of the phytoplankton community by blue-green algae, which will tend to concentrate closer to the surface. The higher density of alga cells near the surface impacts the lake's aesthetics and makes the lake look worse. This was reflected in the July chlorophyll a levels. A number of factors (e.g. water temperature, prevailing weather and storms, degree of zooplankton grazing) at least partially contribute to the existing conditions, however, the dominant factor is more than likely the low dissolved inorganic nitrogen to total phosphorus (DIN:TP) ratio, which favors the growth of nitrogen fixing blue-green algae such as *Anabaena* and *Aphanizomenon,* and was discussed in the previous paragraph.

Zooplankton diversity, densities and biomass were moderate during the 29 May 2013 monitoring event. Surface and mid-depth zooplankton biomass values were somewhat similar to each other during the 29 May 2013 monitoring event; however the number of zooplankton per liter was approximately 50% lower at the mid-depth location. Similar to conditions observed in May of 2004 – 2006, herbivorous zooplankton were present in Culver Lake during the May 2013 monitoring event, but at low densities. Only two cladocerans, *Bosmina* and *Chydorus*, were identified in the surface and mid-lake waters. However these species feed mainly on bacteria and detritus. Only one herbivore was identified in the surface waters (*Daphnia*) and one herbivore was identified in the mid-depth waters (*Diaptomus*). Rotifers were the dominant zooplankton in both the surface and mid-depth samples during the May 2013 sapling event.

During the 16 July 2013 monitoring event, three herbivorous zooplankton were identified in the surface and mid-depth waters of Culver Lake, *Daphnia*, *Ceriodaphnia* and *Diaptomus.* In fact, these herbivores made up 17.0% of the total zooplankton abundance at the surface and 20.0% of the abundance in the mid-depth waters. In the surface waters the copepods were the dominant zooplankton group in terms of abundance; with the nauplii (juvenile) the dominant zooplankton in terms of biomass. In the mid-depth waters, the copepods were again the dominant zooplankton group in terms of abundance; with the nauplii were again the dominant zooplankton in terms of biomass. This is a positive trend as herbivores are accounting for a larger portion of the total zooplankton abundance as compared to 2012.

The continued absence of herbivores is more than likely the result of excessive grazing pressure by forage and/or young gamefish. This is especially evident given the amount of grazable algae present in the mid-depth waters in July. The Association may wish to consider reanalyzing the lake's fishery, or conduct an updated fishery survey, followed by aggressive fishery management based on the results of the survey.

To continue long-term efforts to facilitate the development of a zooplankton community dominated by large-bodied herbivorous genera in Culver Lake, Princeton Hydro stocked approximately 87,400 herbivorous zooplankton in Culver Lake during the May 2013 monitoring event. This stocking was repeated in June where 163,400 were stocked. Although we have met our target goal of 250,000 stocked zooplankton, Princeton Hydro will attempt one more stocking event in the Fall of 2013 to continue to help improve the lake's large-bodied herbivorous zooplankton community.

5. AQUATIC MACROPHYTES (PLANTS)

During both the May and July site visits, Princeton Hydro conducted qualitative assessments of the lake's aquatic macrophyte (plant) community. In May a 90/10 mix of Curly-leaf pondweed (*Potamageton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) were the dominant species observed in both the Owassa Lake and Stehr Tract areas. The North Shore area also possessed a light sporadic mix of these two species. Finally, in the Causeway Cove area, a mix of Eurasian watermilfoil, curly-leaf pondweed and coontail (*Ceratophyllum demersum*) were observed, with heavier densities being closer to the Causeway Cove Bridge and at depths greater than 1.5 meters. Similar to the last few seasons, <u>no</u> tape grass (*Vallisneria americana*) was observed in the Stehr Tract, along the North Shore or at the mouth of the Causeway Cove Inlet during the May monitoring event.

In July, overall macrophyte densities in the Stehr Tract were lower relative to those observed in May. Sporadic patches of Eurasian watermilfoil were observed, along with stands of water lilies (*Nymphaea spp.*), which tended to be growing close to the shorelines. The decreased densities of plants in this section of the lake between the May and July monitoring events was due to the mechanical weed harvesting conducted by Aquatic Technologies during June and early July. That harvesting effort reportedly removed 100-125 tons of plant material over the course of 55+ hours of machine operation. Specifically, the harvesting removed Eurasian watermilfoil, coontail, curly-leaf pondweed, elodea, tapegrass and lily species.

Elsewhere in the lake, during the July survey the only visible macrophyte species observed scattered throughout the North Shore areas were sporadic patches of water lilies, Eurasian watermilfoil and Coontail. However in the Causeway Cove section of the lake we observed a plant community similar in species and density to that of the Stehr Tract, which included coontail, Eurasian watermilfoil, secondary growth of curly-leaf pondweed and very minor densities of tapegrass. Given the increase in the occurrence State-wide of water chestnut (*Trapa natans*) the Association should aggressively survey the lake and educate boaters of the ecological dangers that this plant presents. This is a very insidious, invasive plant that is confirmed to be present in large numbers in a number of lakes in the area including private lakes in Sparta, Lake Musconetcong, Clove Acres Lake and Lake Wawayanda. Efforts need to continue to be taken to keep this plant out of Culver Lake.

6. SUMMARY

Monitoring of Culver Lake was conducted in late-spring and mid-summer. To date, the quality of the lake was found to be for the most part consistent with the lake's established water quality thresholds. As noted above, Secchi Disk readings in May were well in excess of the 1 meter threshold value, as was the July mid-lake reading of 1.2 meters. In addition, the July DO data documented a lack of cold water fish habitat in both the metalimnion and hypolimnion of the lake. The DO measured at depths greater than 5 meters was not adequate enough to support trout, in fact no cold water fish habitat was observed during the July monitoring event.

The lake's temperature profiles showed signs of stratification in May, and by July thermal stratification was fully and strongly pronounced. Recent adjustments to the lake's aeration system seem to have improved deeper water DO concentrations to a depth of 10-12 meters as evidenced by some of the data recently supplied to Princeton Hydro by the Normanoch volunteers; however anoxia remains at the very bottom depths of the lake. However, thermal stratification is both expected to occur and is designed to occur by means of the operation of the hypolimnetic aeration system. As such, these conditions are relatively similar to the thermal seasonality and regimes of the lake observed over the past 10-12 years.

The lake's conductivity and pH values were relatively constant from surface to bottom in May, as could be expected given the stratified nature of the lake and the lack of extensive surface water warming. But in July, the pH of the surface waters had increased two orders of magnitude in comparison to the bottom waters. The observed difference was directly a function of increased phytoplankton densities and photosynthetic activity.

The blue-green algae were the dominant surface water algae present in the lake during the May monitoring event, although there was a diverse assemblage of other algal species as well.. This trend continued in July as blue-green algae dominated the phytoplankton community of the lake, especially in the surface waters. This continues to be disturbing due to the various water quality impacts that can be caused by blue-green algae blooms. However, as evidenced by the lake's clarity, although blue green algae were dominant, at least through the July monitoring date they were not creating any significant water quality or aesthetic problems. Based on a review of past weather patterns and the phytoplankton assemblage of the lake, it appears that in years where dry to drought conditions are prevalent through the early to middle parts of the growing seasons, the blue-green algae tend to dominate. Princeton Hydro will continue to examine the relationship between the phytoplankton assemblage and the seasonal weather pattern and will further document this relationship in the 2013 year-end report.

The complete results of the laboratory analyzed water monitoring data are presented in Tables 3 and 4. Clarity is directly a function of algal densities, which can be assessed through the measurement of chlorophyll *a*. As noted above, a decline in water clarity was observed between the May (1.8 meters) and July (1.2 meters) monitoring dates. Even with this reduction in clarity and the noted increase in blue green algae densities, the lake's clarity remained above the prescribed1.0 meter threshold. Consistent with the higher May Secchi readings were relatively low chlorophyll *a* concentrations measured at both the surface (14 mg/m^3) and closer to the thermocline (3.5 mg/m^3) (Table 3). These chlorophyll *a* concentrations had increased to 26.3 mg/m^3 at the surface and 18.4 mg/m^3 at mid-depth in July.

TP concentrations throughout the upper portion and in the middle of the water column of the lake were minimal in May (0.02 mg/L) as well as July (≤0.03 mg/L). However, during both events, a significant increase in TP was measured in the lake's deeper water (0.12 mg/l in May and 0.06 mg/L in July). This is the result of internal recycling resulting from some sediment release as well as the accumulation of phosphorus released from decomposed plant and animal tissue.

In contrast to data collected during the recent monitoring years, the occurrence of herbivorous zooplankton was increased within Culver Lake to date in 2013. However, in May, when this type of zooplankton should be flourishing, the numbers were lower. The low numbers of herbivorous zooplankton is likely a function of a number of factors. First, and most likely, the low herbivorous zooplankton numbers are a sign of overgrazing by forage and/or young game fish, especially given the numbers of preferred green algae species present in the July samples. Second, blue green algae present a very poor food source for herbivorous zooplankton. Third, although zooplankton stocking was conducted in May and June, the densities of introduced zooplankton were less than that needed to supplement or "kick start" the entire lake's native herbivorous zooplankton community. Finally, in-lake habitat conditions may be responsible. However, it appears that ample refuge habitat exists as based on the lake's favorable DO/temperature profiles and the fact that there is ample aquatic vegetation throughout the lake. Of the various factors we feel that the combination of overgrazing by planktivorous forage fish and poor food sources at times are responsible for the observed decline in herbivorous zooplankton densities. Princeton Hydro will continue to observe this trend and attempt to adjust the stocking numbers accordingly. The Association may wish to consider reanalyzing the lake's fishery, or conduct an updated fishery survey, followed by aggressive fishery management based on the results of the survey.

Finally, in keeping with the lake community's commitment to control and limit the spread of invasive aquatic plants, the Normanoch Association must continue to be on guard for water chestnut (*Trapa natans*) and do all that can be done to prevent this plant from getting a foothold in the lake. Information is available through the Rutgers Agricultural Extension Services of Morris County's web site that can be accessed via: http://njaes.rutgers.edu/pubs/publication.asp?pid=FS1119. Given the role of boating in the spread of this plant and the occurrence of water chestnut in a number of lakes in the proximity of Culver Lake, as well as the prime habitat that Culver Lake possesses for this species, continued boater education program should play a key role in the prevention of this plant's introduction in the lake. Princeton Hydro recently sent the Normanoch Association some photographs of this plant which should be utilized in the efforts to locate and identify it, should it be present.

TABLE 1

May 2013 *In-Situ* Data

In-Situ Monitoring for Culver Lake 5/29/13								
Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen	Dissolved Oxygen
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(units)	(mg/L)	(%)
Mid-Lake	14.6	1.8	Surface	16.3	197	7.26	9.77	103.5
			1.0	15.62	196.6	7.39	9.95	104
			2.0	15.55	196.5	7.43	9.94	103.7
			3.0	15.29	197.4	7.44	9.85	102.1
			4.0	14.68	196.7	7.44	9.72	99.5
			5.0	14.41	197.1	7.43	9.38	95.5
			6.0	14.27	196.5	7.41	9.2	93.4
			7.0	13.58	196.6	7.39	9.12	91.1
			8.0	11.67	196.3	7.38	8.97	85.9
			9.0	9.89	195.7	7.34	8.52	78.2
			10.0	9.14	195.9	7.26	7.66	69.1
			11.0	8.6	197.3	7.2	6.88	61.3
			12.0	8.17	199.6	7.13	5.71	50.3
			13.0	7.81	204	7.06	4.56	39.9
			14.0	7.68	205.7	6.95	1.27	11
			14.5	7.66	211	6.9	0.84	7.3
Stehr Tract	1.9	1.9+	Surface	16.78	191.9	7.21	9.33	99.9
			1.0	15.58	184.2	7.4	10.26	107.1
			1.5	15.22	191.8	7.33	9.89	102.4
Causeway Cove	1.8	1.8+	Surface	17.1	199.5	7.06	9.42	101.6
			1.0	16.71	199.7	7.17	9.53	101.9
			1.5	15.38	199	7.17	8.71	90.5
Inlet (RT. 206)	N/A	N/A	Surface	20.61	128.8	6.6	7.46	86.3
Inlet (Causeway)	N/A	N/A	Surface	20.74	206.4	6.88	8.08	93.7

TABLE 2

July 2013 *In-Situ* Data

In-Situ Monitoring for Culver Lake 7/16/13								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(units)**	**(mg/L)**	**(%)**
Mid-Lake	**14.6**	**1.2**	**Surface**	28.19	200	8.43	8.12	108.3
			1.0	27.6	199.6	8.51	8.69	114.7
			2.0	27.36	199.3	8.46	8.71	114.5
			3.0	26.83	198.9	8.2	6.21	80.8
			4.0	22.37	196.5	7.55	5.41	64.8
			5.0	16.36	198.6	7.29	2.28	24.2
			6.0	13.88	197.4	7.26	1.99	20
			7.0	13.43	197.3	7.23	2.12	21.1
			8.0	13.11	197.8	7.2	2.27	22.5
			9.0	12.3	198	7.19	2.34	22.7
			10.0	10.91	198.7	7.18	2.08	19.5
			11.0	10.16	198	7.11	1.15	10.7
			12.0	9.3	201	7.04	0.81	7.4
			13.0	8.57	209.1	6.97	0.15	1.3
			14.0	8.18	228.8	6.87	0.12	1
			14.5	8.18	232.3	6.76	0.05	0.4
Stehr Tract	**2**	**1.1**	**Surface**	28.61	198.3	8.31	8.56	115.1
			1.0	27.81	198	8.53	8.83	117
			2.0	26.08	200.9	7.4	4.76	61.1
Causeway Cove	**1.8**	**1.3**	**Surface**	30.37	202.9	8.54	8.37	116
			1.0	28.3	201	8.5	9.1	121.6
			1.5	27.49	199.8	8.23	8.6	113.2
Inlet (RT. 206)	**N/A**	**N/A**	**Surface**	27.71	142.9	7.4	6.66	88.1
Inlet (Causeway)	**N/A**	**N/A**	**Surface**	31.71	204.9	8.51	8.08	114.5

Table 3 Discrete Water Quality Data Culver Lake - Mid-Lake Monitoring Station 29 May 2013		
SURFACE (0.5 m)	**Chlorophyll *a***	14 mg/m^3
	NH3-N	ND <0.01 mg/L
	NO3-N	0.06 mg/L
	TP	0.02 mg/L
MID (5.0 m)	**Chlorophyll *a***	3.5 mg/m^3
	NH3-N	0.05 mg/L
	NO3-N	0.15 mg/L
	TP	0.02 mg/L
DEEP (13.0 m)	**NH3-N**	0.51 mg/L
	NO3-N	0.13 mg/L
	TP	0.12 mg/L
CAUSEWAY COVE BROOK	**NO3-N**	0.10 mg/L
	TP	0.03 mg/L
	TSS	ND <2mg/L
OWASSA BROOK	**NO3-N**	0.07 mg/L
	TP	0.03 mg/L
	TSS	ND <2 mg/L

Table 4 Discrete Water Quality Data Culver Lake - Mid-Lake Monitoring Station 16 July 2013		
SURFACE (0.5 m)	**Chlorophyll *a***	26.3 mg/m^3
	NH3-N	ND <0.01 mg/L
	NO3-N	0.03 mg/L
	TP	0.03 mg/L
MID (5.0 m)	**Chlorophyll *a***	18.4 mg/m^3
	NH3-N	0.03 mg/L
	NO3-N	0.05 mg/L
	TP	0.02 mg/L
DEEP (13.0 m)	**NH3-N**	0.76 mg/L
	NO3-N	0.06 mg/L
	TP	0.06 mg/L
CAUSEWAY COVE BROOK	**NO3-N**	0.05 mg/L
	TP	0.02 mg/L
	TSS	2 mg/L
OWASSA BROOK	**NO3-N**	0.15 mg/L
	TP	0.08 mg/L
	TSS	5 mg/L

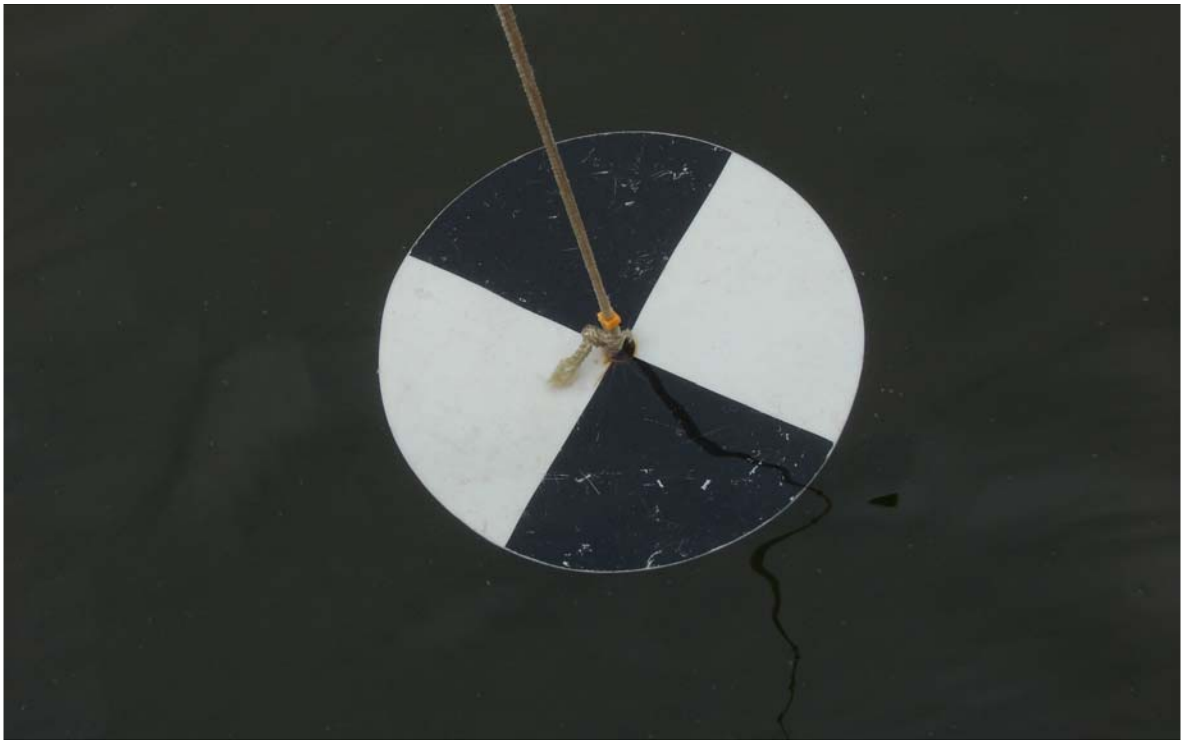

Photo 1: 29 May 2013 surficial view of the secchi disk.

Photo 2: 29 May 2013 view of the secchi disk at a depth of 1 meter.

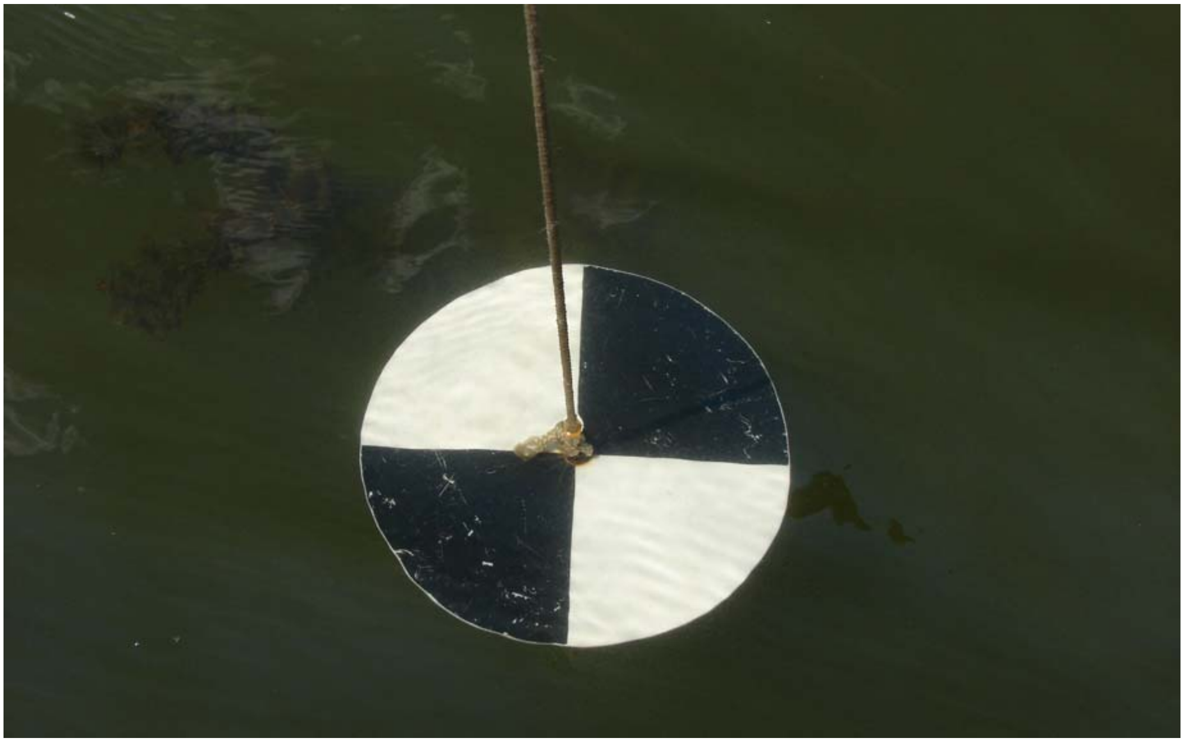

Photo 3: 16 July 2013 surficial view of the secchi disk.

Photo 4: 16 July 2013 view of the secchi disk at a depth of approximately 1.0 meters.