2009 SUMMARY REPORT
of
Summerhill Estates Lake

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Summerhill Estates Lake is a glacial lake located in unincorporated Lake County and Fremont Township. The lake has a surface area of 54.0 acres and a mean depth of 2.8 feet. The Lake County Forest Preserve District manages the undeveloped property along the north and east of the lake allowing the public recreational hiking opportunities. The homeowners located on the south side of the lake utilize the lake for aesthetics, boating, and swimming.

Summerhill Estates Lake is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency. This indicates that the lake and surrounding natural environments have potential to have high quality aquatic resources based on water quality and hydrology values.

Summerhill Estates Lake receives water from its 290.78 acre watershed and drains into Mud Lake through a creek located on the north side of the Lake which enters Squaw Creek and eventually the Fox River. The primary land use within the Summerhill Estates Lake watershed was public and private open space (65%); which is unique characteristic as Lake County only has 13% of land preserved as public and private open space.

The 2009 water quality in Summerhill Estates Lake was poor with multiple parameters above the county medians. Total phosphorus (TP) concentration in Summerhill Estates Lake averaged 0.199 mg/L and the median for the county was 0.063 mg/L. Summerhill Estates Lake had the highest level of phosphorus in the entire Squaw Creek watershed in 2009. The presence of organic detritus and algae led to a decrease in water clarity and an increase in Total Suspended Solids (TSS) over the course of the summer ranging from 4.4 mg/L in June to 15.0 mg/L in August. A total nitrogen to total phosphorus (TN:TP) ratio of 6:1 in Summerhill Estates Lake means nitrogen was limiting; the majority of lakes in Lake County and the Midwest are phosphorus limiting. Also using phosphorus as an indicator, the trophic state index (TSIp) ranked Summerhill Estates Lake as hypereutrophic with a TSIp value of 80.5. The average conductivity reading for Summerhill Estates Lake was 0.5552 mS/cm and average Cl- concentrations were 87 mg/L. Conductivity is positively correlated with chloride (Cl-) concentrations. These parameters were below the county median of 0.7910 mS/cm and 145 mg/L for conductivity and chloride, respectively.

Diversity of aquatic plants has decreased in Summerhill Estates Lake from nine in 2004 to six in 2009. Summerhill Estates Lake aquatic plant community had seasonal dominance where Curlyleaf Pondweed was abundant April through May and Coontail was the most abundant in July. This will require various management strategies to achieve a healthy balance. Curlyleaf Pondweed dominated the plant community in May and June, while Coontail, Duckweed and Watermeal dominated throughout the remainder of the summer.

Based on the 2009 assessment, there was an increase in shoreline erosion with approximately 20% of the shoreline having some degree of erosion. Overall, 80 of the shoreline had no erosion, 11% had slight erosion, 5% had moderate, and 4% had severe erosion. The areas of moderate and severe erosion should be addressed soon. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion.

LAKE FACTS

Lake Name:	Summerhill Estates Lake
Historical Name:	Developers Marsh
Nearest Municipality:	Wauconda
Location:	T 44N, R 10E, Sections 19, 20
Elevation:	808.5 feet mean sea level
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Squaw Creek
Receiving Water body:	Mud Lake
Surface Area:	54.0 acres
Shoreline Length:	2.2 miles
Maximum Depth:	6.9 feet
Average Depth:	2.8 feet
Lake Volume:	152.6 acre-feet
Lake Type:	Glacial
Watershed Area:	290.8 acres
Major Watershed Land uses:	Public and Private Open Space, Water, and Single Family
Bottom Ownership:	Lake County Forest Preserve District and Private
Management Entities:	Lake County Forest Preserve District and Private
Current and Historical uses:	Fishing, swimming, boating, and aesthetics
Description of Access:	Private – Summerhill Estates Lake residents only

SUMMARY OF WATER QUALITY

Water samples were collected from May through September in Summerhill Estates Lake at the deepest point located on the west side of the lake (Figure 1). Samples were taken at 3 feet below in the surface in May, July, August, and September samples were taken at the surface in June due to excessive macrophyte coverage. These samples were analyzed for various water quality parameters (Appendix A). Water level was taken from a piling on the south west side of the lake each month during sampling. Due to the small watershed area of Summerhill Estates Lake, the lake was more susceptible to water level fluctuations. A decrease in lake water levels was observed during the sampling season. Data from the Stormwater Management Commission's Wauconda rain gauge indicated steady rainfall throughout the sampling season at approximately 4 inches of rainfall between sampling events; indicating no correlation between rain events and decreased water levels due to the small size of the watershed. The most notable decrease in lake level in 2009 occurred in July when the lake level decreased 7.5 inches between June and July sampling events. Water level from the beginning to the end of the summer decreased 9.0 inches in Summerhill Estates Lake. In order to accurately monitor water levels it is recommended that a staff gauge be installed and levels measured and recorded frequently (daily or weekly). Summerhill Estates Lake is within the Squaw Creek watershed which the Lakes Management Unit (LMU) sampled in 2009. The head water of Squaw Creek includes the lakes Old Oak, Schreiber, Owens, and Davis. As Squaw Creek flows north several tributaries enter Squaw Creek from the east and west. Summerhill Estates Lake drains into the Squaw Creek by a creek from the bay located on the north end of the lake and flows into Mud Lake before entering Squaw Creek. As Squaw Creek flows north the LMU sampled additional lakes downstream of Summerhill Estates Lake including: Lake Helen, Lake Nippersink, Patski Pond, Hook Lake, Cranberry Lake, Highland Lake, Round Lake, and Long Lake (Figure 2).

Summerhill Estates Lake had oxic conditions (>1 mg/L dissolved oxygen) throughout the lake only experiencing low dissolved oxygen (DO) conditions at the six foot depth contour June through August ranging from 2.60 mg/L in August to 4.90 mg/L in July (Appendix B). The Illinois Environmental Protection Agency's applicable standard for DO is 5.0 mg/L. This concentration is required to maintain a healthy fishery. The volume of water in Summerhill Estates Lake above this standard was 99.9% June through August and 100.0% in May and September based on a bathymetric map created by the LMU in 2009 (Table 1) (Figure3).

Historically Summerhill Estates Lake had poor water quality for Lake County lakes; the glacial lake had high phosphorus levels and an aquatic plant community that influenced a variety of water quality parameters in 2004. Many water quality parameters remained above county medians in 2009. The total suspended solid (TSS) concentrations averaged 9.1 mg/L (Table 2), which was higher than the county median of 7.9 mg/L (Appendix E). TSS is composed of nonvolatile suspended solids, non-organic clay or sediment materials, and volatile suspended solids, algae and other organic matter. High TSS values are typically correlated with poor water clarity (Secchi disk depth) and can be detrimental to many aspects of the lake ecosystem including the plant and fish communities. In August there was a notable decrease in the Secchi depth corresponding to an increase in TSS (Figure 4). The TSS values for Summerhill Estates Lake were below the county median in May, June, and September. The presence of organic detritus and algae led to a decrease in water clarity and an increase in TSS during July and August. Summerhill Estates Lake had a lower TSS value than Nippersink Lake, Patski Pond and

Figure 1. Water quality sampling site on Summerhill Estates Lake, 2009.

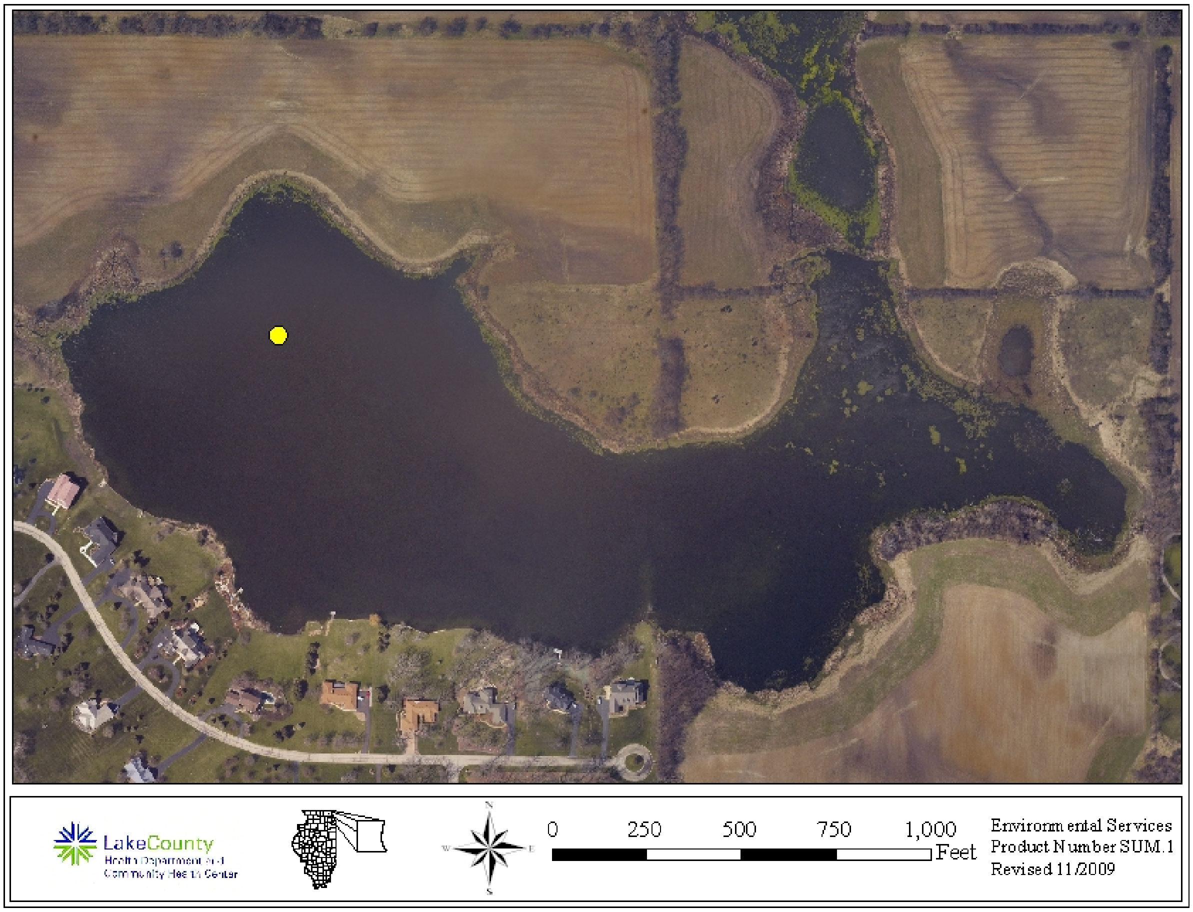

Figure 2. Lakes sampled in the Squaw Creek Watershed, 2009.

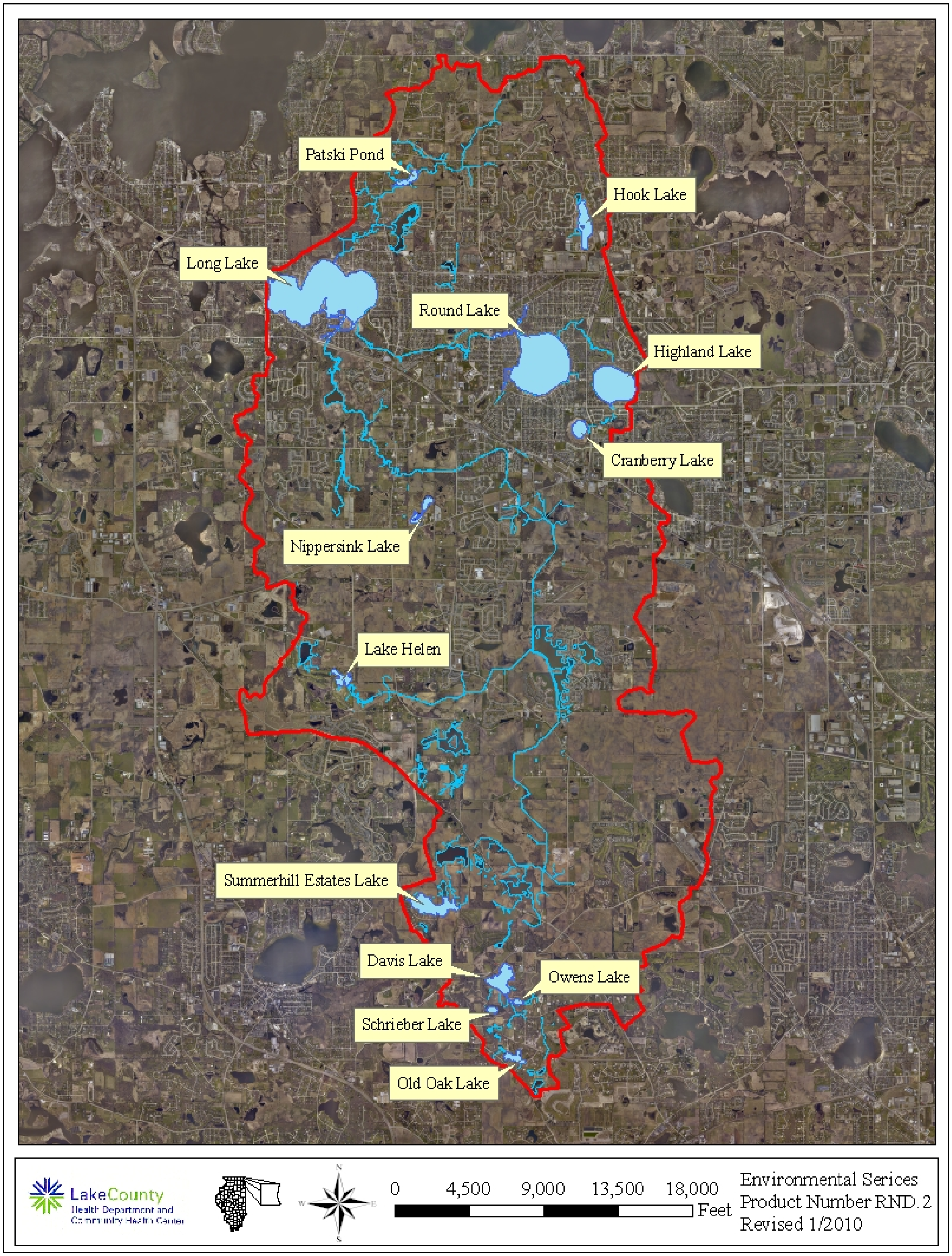

Table 1. Morphometric features of Summerhill Estates Lake, 2009.

Data From the April 29, 2009 Bathymetric Survey, LCHD Environmental Services

Contour (Feet)	Area Enclosed (Acres)	Percent of Total Acres	Volume (Acre-Feet)	Depth Zone (Feet)	Area (Acres)	Percent Depth Zone To Total Acres	Percent Acre-Feet To Total Volume
0	53.95	100.0%	46.18	0 - 1	15.13	28.0%	30.3%
1	38.82	72.0%	35.85	1 - 2	5.86	10.9%	23.5%
2	32.96	61.1%	30.24	2 - 3	5.37	9.9%	19.8%
3	27.59	51.1%	23.78	3 - 4	7.43	13.8%	15.6%
4	20.16	37.4%	13.59	4 - 5	12.22	22.6%	8.9%
5	7.95	14.7%	2.93	5 - 6	7.87	14.6%	1.9%
6	0.07	0.1%	0.12	6+	0.07	0.1%	0.1%
			152.56		53.95	100%	100%

Maximum Depth of Lake: 6.89 Feet
Average Depth of Lake: 2.82 Feet
Volume of Lake: 152.56 Acre-Feet

Area of Lake: 53.95 Acres
Shoreline Length: 2.20 Miles
Water Elevation at 808.50 Feet Above Mean Sea Level

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Figure 3. Bathymetric map of Summerhill Estates Lake, 2009.

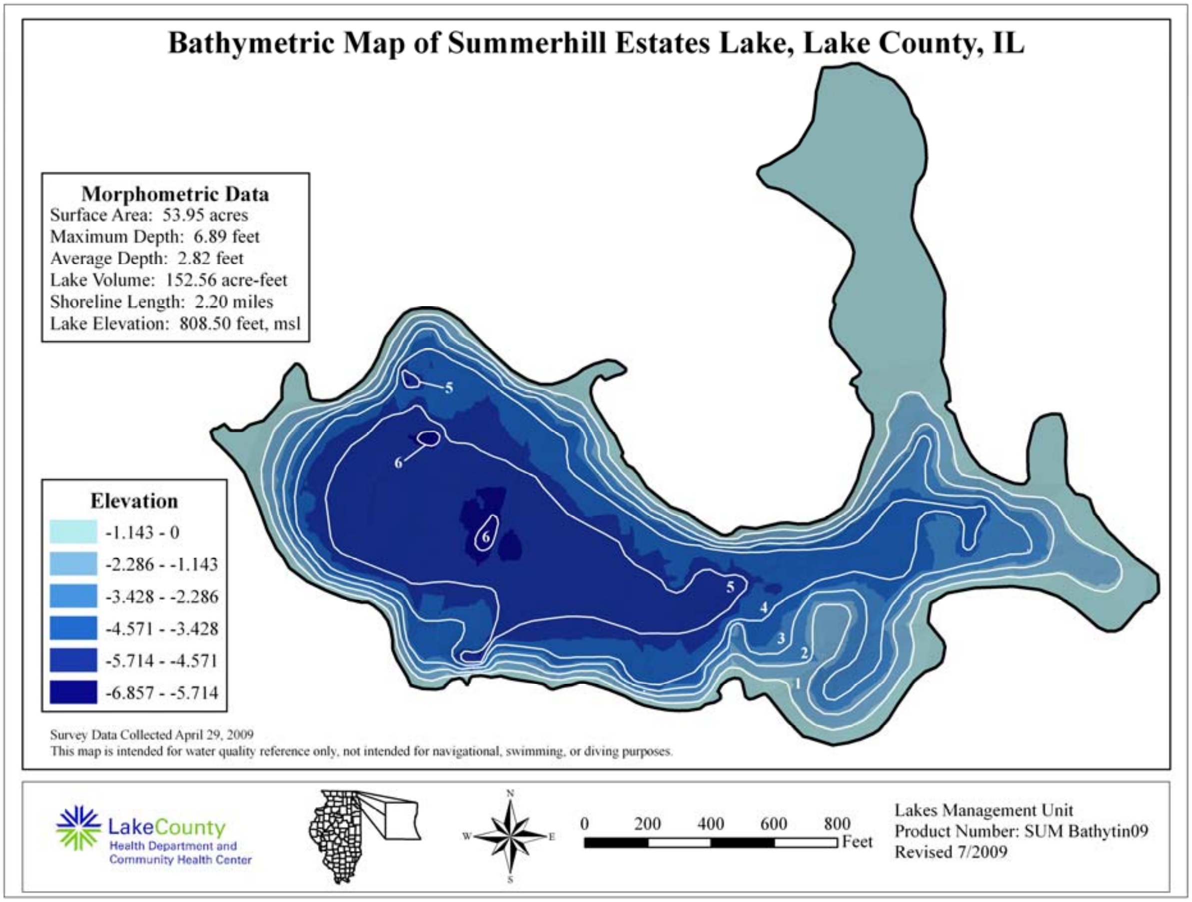


Table 2. Water quality data for Summerhill Estates Lake, 2004 and 2009.

2009	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
12-May	3	92	0.85	<0.1	<0.05	0.056	0.009	87	NA	6.1	275	78	6.07	0.4720	10.40	10.18
9-Jun	0	124	1.22	<0.1	<0.05	0.287	0.184	85	NA	4.4	323	84	4.36	0.5250	8.96	6.11
14-Jul	3	159	1.36	<0.1	<0.05	0.311	0.110	87	NA	14.0	362	96	2.72	0.5960	8.44	8.29
11-Aug	3	162	1.53	<0.1	<0.05	0.241	0.075	87	NA	15.0	371	98	1.47	0.6020	8.63	9.59
15-Sep	3	153	1.33	<0.1	<0.05	0.102	0.021	88	NA	7.3	353	88	1.75	0.5810	8.71	8.87
	Average	138	1.26	<0.1	<0.05	0.199	0.080	87	NA	9.4	337	89	3.27	0.5552	9.03	8.61

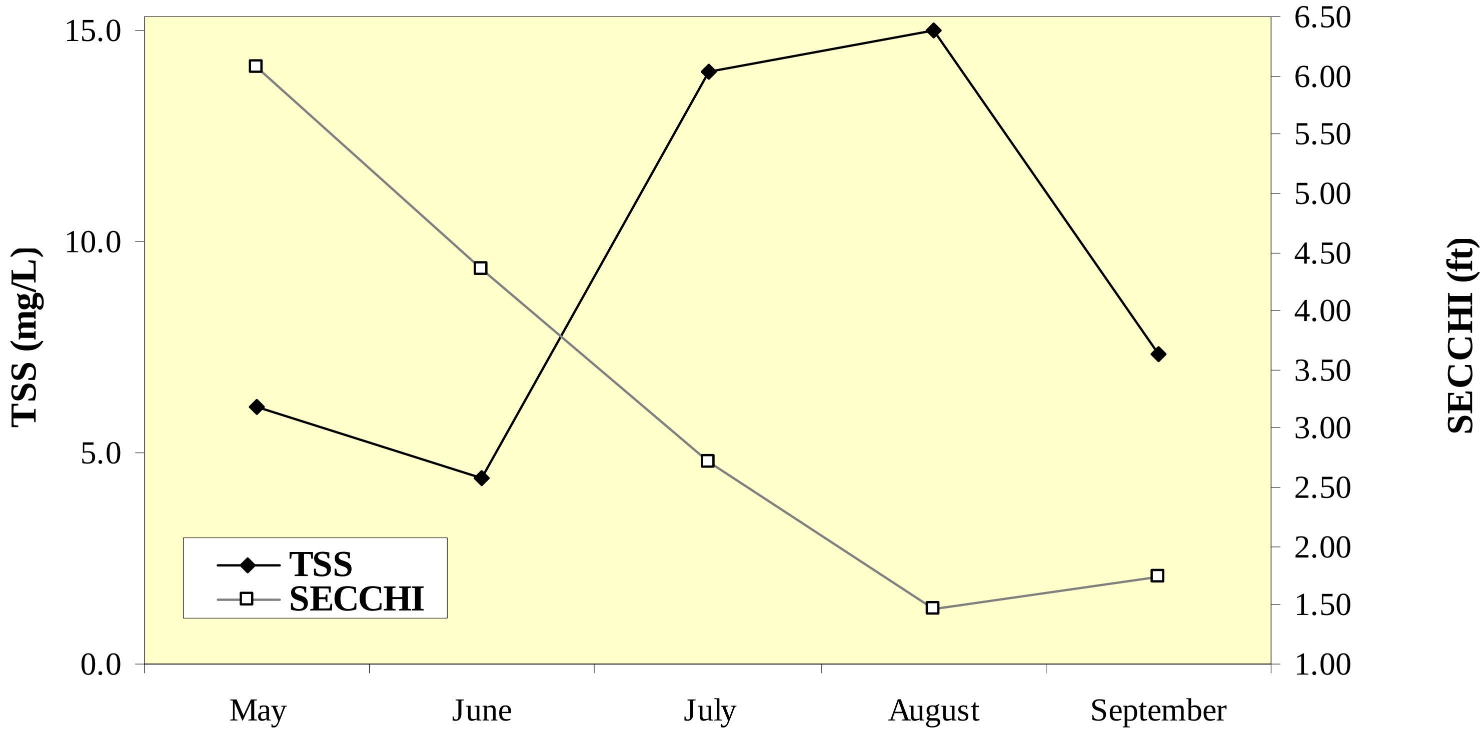
2004	Epilimnion															
DATE	DEPTH	ALK	TKN	NH3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
19-May	3	100	1.16	<0.1	<0.05	0.113	0.046	NA	274	3.4	305	89	0.00[a]	0.5250	9.85	5.05
16-Jun	3	122	1.51	<0.1	0.150	0.143	0.058	NA	302	2.7	327	103	4.63	0.5430	8.88	1.38
21-Jul	3	166	1.68	<0.1	<0.05	0.198	0.041	NA	306	6.1	359	108	4.4	0.6200	7.95	5.38
18-Aug	3	167	1.87	<0.1	<0.05	0.132	0.011	NA	356	8.5	390	126	3	0.6230	8.15	7.67
22-Sep	3	161	1.88	<0.1	<0.05	0.106	<0.005	NA	332	10.0	387	124	2.56	0.6180	8.30	8.74
	Average	143	1.62	<0.1	0.150[k]	0.138	0.039[k]	NA	314	6.1	354	110	3.65[b]	0.5858	8.63	5.64

Glossary

ALK = Alkalinity, mg/L $CaCO_3$	TDS = Total dissolved solids, mg/L
TKN = Total Kjeldahl nitrogen, mg/L	TSS = Total suspended solids, mg/L
NH_3-N = Ammonia nitrogen, mg/L	TS = Total solids, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L	TVS = Total volatile solids, mg/L
NO_3-N = Nitrate + Nitrite nitrogen, mg/L	SECCHI = Secchi disk depth, ft.
TP = Total phosphorus, mg/L	COND = Conductivity, milliSiemens/cm
SRP = Soluble reactive phosphorus, mg/L	DO = Dissolved oxygen, mg/L
Cl^- = Chloride, mg/L	

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed
a = Secchi depth was obstructed by plants
b = Secchi disk depth average does not include data from when Secchi disk was obstructed by plants

Figure 4. Total suspended solid (TSS) concentrations vs. Secchi depth for Summerhill Estates Lake, 2009.



Long Lake, but greater than Old Oak, Schreiber, Owens, Davis, Hook, Cranberry, Highland and Round Lake. Davis Lake, which is near the top of the watershed, had the highest average Secchi depth (9.65 feet) and lowest average TSS (2.6 mg/L), however, these values are also influenced by the presence diverse aquatic plant populations that contribute to the high water quality (Table 3).

Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake could produce algal blooms. Total phosphorus (TP) concentration in Summerhill Estates Lake averaged 0.199 mg/L which is three times the county median of 0.063 mg/L and a slight increase from the 2004 value of 0.138 mg/L. The lowest TP concentrations occurred in May (0.056 mg/L) during the peak growing cycle of Curlyleaf Pondweed; after the Curlyleaf Pondweed died back in June the phosphorus level increased five times to 0.287 mg/L. The same watershed trend of TSS and Secchi disk occurred with TP. Summerhill Estates Lake had the highest TP concentration in the entire Squaw Creek watershed and Highland Lake had the lowest TP concentration (0.020 mg/L). Lakes with phosphorus levels greater than 0.050 mg/L are considered impaired as they may support nuisance algae and/or abundant aquatic plant growth. Phosphorus can enter a lake either internally (typically linked to sediment) or externally (point or non-point sources). Point source pollution can be from storm pipes or wastewater discharge and non-point source pollution is from groundwater runoff, which picks up phosphorus from agricultural fields, septic systems, lawns, or impervious surfaces. Internal sources within Summerhill Estates Lake were the decomposition of large densities of algae that continued to recycle phosphorus and sediments that are stirred up by carp and wind. Also, historically this was drained and farmed. There were external sources of TP affecting Summerhill Estates Lake such as stormwater from the 290.78 acres within its watershed as well (Figure 5). Public and private open space (65%) and single family (15%) were the major land uses within the watershed (Figure 4). Sixty-five percent of public and private space within a watershed was a unique and valuable characteristic as Lake County only has 13% of land preserved as open space. For Summerhill Estates Lake public and private open space (58%), single family (27%) and transportation (15%) were the land uses contributing the highest percentages of estimated runoff (Figure 6/Table 4). It is important to keep in mind that although the amount of estimated runoff from certain areas may be low, they can still deliver high concentrations of TSS and TP. When applying lawn fertilizers near lakes it is important to remember that one pound of phosphorus can produce 300-500 pounds of algae (Figure 7). The retention time (the amount of time it takes for water entering a lake to flow out of it again) was calculated to be approximately 410 days. A watershed is an area of land that drains into a body of water, everyone lives in a watershed and the land management directly affects the water quality. In the Summerhill Estates Lake watershed where single family homes are a major land use contributing to runoff, applying lawn fertilizers containing zero phosphorus would be an effective way to reduce phosphorus within the watershed.

Alkalinity is a lake's buffer against acid rain and can be influenced by the type of minerals in the soils and watershed bedrock, and by how much the lake water comes into contact with these minerals. The average 2009 Alkalinity ($CaCO_3$) concentrations were 138 mg/L which is below the county median of 161 mg/L. The lowest concentration was in May with a concentration of 92 mg/L. Alkalinity acts to buffer lakes from the effects of acid rain by neutralizing hydrogen ions from the acid inputs. The buffering occurs when excess hydrogen ions ($H+$) are removed from

Table 3. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity within the Squaw Creek watershed.

	Cranberry Lake	Cranberry Lake	Cranberry Lake	Cranberry Lake	Cranberry Lake	Cranberry Lake	Highland Lake	Highland Lake	Highland Lake	Highland Lake
Year	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**1991**	**1996**	**2001**	**2009**
Secchi (feet)	10.96	10.52	9.33	9.06	9.63	8.56	7.08	7.98	6.58	6.97
TSS (mg/L)	1.2	1.5	1.6	1.8	2.2	3.7	3.4	2.4	3.3	4.8
TP (mg/L)	0.024	0.024	0.024	0.023	0.027	0.036	0.039	0.023	0.030	0.020
Conductivity (milliSiemens/cm)	0.3809	0.5625	0.6019	0.5138	0.5070	0.4262	NA	0.4076	0.5560	0.5834

	Round Lake	Round Lake	Round Lake	Round Lake	Round Lake	Round Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake
Year	**1989**	**1991**	**1995**	**1999**	**2003**	**2009**	**1996**	**2001**	**2005**	**2006**	**2007**	**2008**	**2009**
Secchi (feet)	7.07	5.20	7.44	10.32	6.25	7.01	2.44	4.11	4.18	4.52	3.24	2.69	4.16
TSS (mg/L)	4.4	5.4	3.4	2.7	3.5	3.0	13.9	9.7	10.9	7.2	11.1	11.6	10.2
TP (mg/L)	0.100	0.031	0.024	0.015	0.025	0.023	0.086	0.092	0.076	0.068	0.103	0.117	0.092
Conductivity (milliSiemens/cm)	NA	NA	0.6290	0.8364	1.0730	1.2292	0.5222	0.9430	1.0821	1.112	0.9066	0.8722	0.7587

	Old Oak Lake	Old Oak Lake	Schreiber Lake	Schreiber Lake	Owens Lake	Owens Lake	Davis Lake	Davis Lake	Summerhill Estates Lake	Summerhill Estates Lake	Lake Helen	Lake Nippersink
Year	**2003**	**2009**	**2003**	**2009**	**2000**	**2009**	**2000**	**2009**	**2004**	**2009**	**2009**	**2009**
Secchi (feet)	5.08	4.85	9.59	7.25	4.38	5.30	8.14	9.65	3.65	3.27	6.43	1.73
TSS (mg/L)	3.6	4.9	3.1	2.8	11.0	3.5	2.1	2.6	6.1	9.4	4.1	18.9
TP (mg/L)	0.043	0.049	0.043	0.040	0.124	0.058	0.048	0.065	0.138	0.199	0.072	0.100
Conductivity (milliSiemens/cm)	0.7240	0.7700	0.2882	0.2582	0.5395	0.5274	0.5143	0.6306	0.5858	0.5552	0.4742	0.4588

	Patski Pond	Patski Pond	Hook Lake	Hook Lake
Year	**2004**	**2009**	**2004**	**2009**
Secchi (feet)	NA	NA	5.03	3.95
TSS (mg/L)	52.7	33.7	5.1	6.5
TP (mg/L)	0.251	0.197	0.030	0.041
Conductivity (milliSiemens/cm)	0.8194	0.8994	1.1067	1.4690

Direction of Watershed Flow →

Figure 5. Approximate watershed delineation for Summerhill Estates Lake, 2009.

Figure 6. Approximate land use within the Summerhill Estates Lake watershed, 2009.

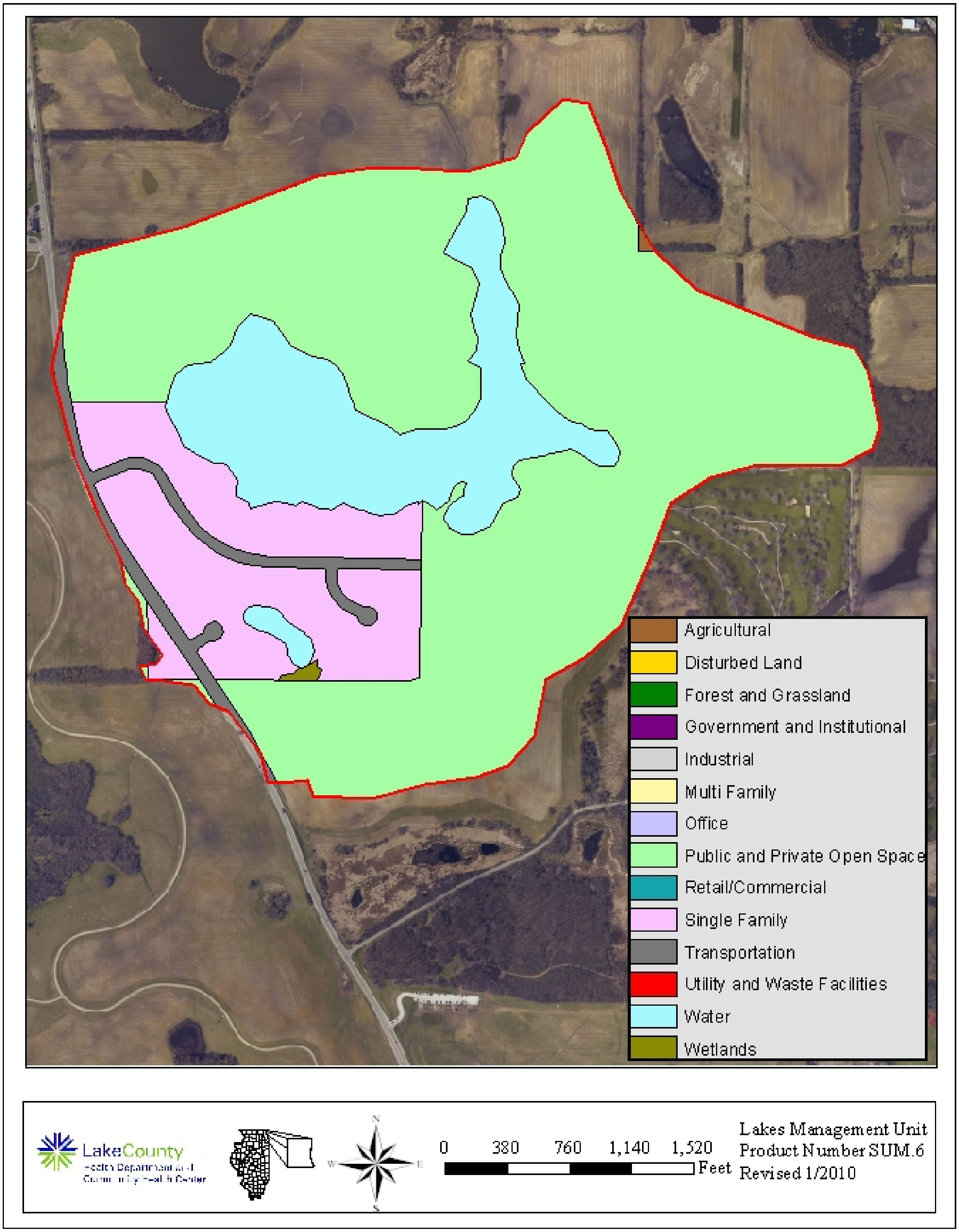


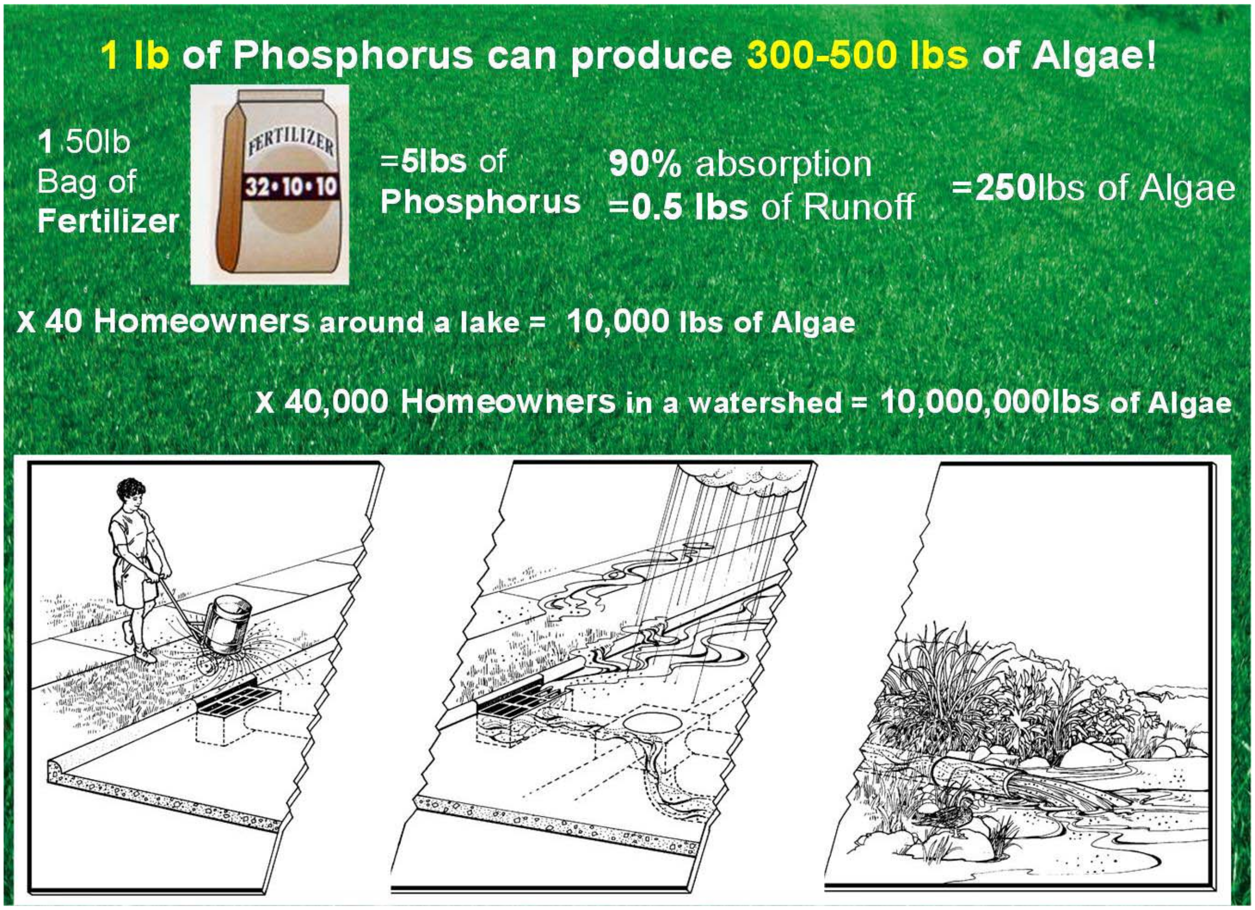
Table 4. Approximate land uses and retention time for Summerhill Estates Lake, 2009.

Land Use	Acreage	% of Total
Agricultural	0.18	0.1%
Public and Private Open Space	189.59	65.2%
Single Family	44.33	15.2%
Transportation	8.97	3.1%
Water	47.35	16.3%
Wetlands	0.37	0.1%
Total Acres	**290.78**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	0.18	0.05	0.0	0.0%
Public and Private Open Space	189.59	0.15	78.2	57.6%
Single Family	44.33	0.30	36.6	26.9%
Transportation	8.97	0.85	21.0	15.4%
Water	47.35	0.00	0.0	0.0%
Wetlands	0.37	0.05	0.1	0.0%
TOTAL	**290.78**		**135.8**	100.0%

Lake volume	**152.56**	**acre-feet**
Retention Time (years)= lake volume/runoff	**1.12**	**years**
	410.02	**days**

Figure 7. Illustration of how phosphorus from lawn fertilizers enters a watershed.



the water. As the hydrogen ions are removed, pH goes up. This was documented by the high pH value of 10.40 in May which was the highest value recorded in Lake County since 2000. This was influenced by the large populations of Curlyleaf Pondweed. As aquatic plants under go the photosynthesis pH is raised because the process consumes protons (H+). The median pH value for the county was 8.35.   Aquatic organisms need the pH of their water body to be within a certain range for optimal growth and survival. Although each organism has an ideal pH, most aquatic organisms prefer pH of 6.5 – 8.0. Outside of this range, organisms become physiologically stressed. Reproduction can be impacted by out-of-range pH, and organisms may even die if the pH gets too far from their optimal range.

Nitrogen is also critical for the growth of plants and algae. Nitrogen sources vary from fertilizer to human waste and sewage treatment plants, to groundwater, air, and rainfall. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN for Summerhill Estates Lake was 1.26 mg/L, which was slightly above the county median (1.18 mg/L) and a decrease from the 2004 average (1.62 mg/L). The TN:TP (total nitrogen to total phosphorus) ratio looks at which nutrient is limiting plant and algal growth in a lake. Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate there is enough of both nutrients for excessive algal growth. Summerhill Estates Lake had a TN:TP ratio of 6:1 which means that nitrogen was the limiting nutrient. This was supported by the ammonia (NH3-N) and nitrate/nitrite (NO2+NO3-N) parameters on Summerhill Estates Lake having non-detect values as those forms of nitrogen are readily available for aquatic plant and algal use. Most lakes in Lake County and the Midwest are phosphorus limiting; due to the fact that phosphorus is the nutrient needed in the smallest quantity for plant growth while nitrogen is needed in the largest amount. Due to the low TN:TP ratio Summerhill Estates Lake was susceptible to blue-green algae blooms. Blue green algae can fix nitrogen from the atmosphere when nitrogen supplies are low. Blue green algae may release cyanotoxins under certain conditions as they die that can poison mammals, fish, and invertebrates that directly ingest the algae or the infected water.

Conductivity readings, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county. Road salts used in winter road maintenance consist of sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanides which are detected when chlorides are analyzed. The 2009 average conductivity reading for Summerhill Estates Lake was 0.5552 mS/cm. This is lower than the county median of 0.7910 mS/cm and was a slight increase since 2004 (0.5858 mS/cm). Chloride concentrations averaged 87 mg/L for the season and were also less than the county median of 145 mg/L. A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations were associated with chloride concentrations as low as 12 mg/l. (potentially shifts from green algae to blue-green algae). It appears that the road salt is compounding in many lakes in the county. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years. Round Lake which is located upstream had higher conductivity levels than Summerhill Estates Lake and experienced a 95% increase from 1995 (0.6290 mS/cm) to 2009 (1.2292). Alternatives to road salt should be considered. While alternatives may contain chloride, they tend to work faster at lower temperatures and therefore require less application to achieve the same result that common road salt.

The Illinois EPA has indices used for assessing lakes for aquatic life and recreational use impairment. The indices are calculated using the mean trophic state index (TSI), percent macrophyte coverage, and the median nonvolatile suspended solids concentration. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich and productive). This index can be calculated using TP values obtained at or near the surface. In 2004 Summerhill Estates Lake was hypereutrophic with a TSIp value of 75.7 with aquatic life having full support and recreational use scoring partial support. In 2009 Summerhill Estates was again hypereutrophic with a TSIp value of 80.5 ranking the lake 149 out of 165 in the county (Table 4). The impairment indices determined that Summerhill Estates Lake had full support for aquatic life and non-support for recreational use do to substantial macrophyte impairment, substantial phosphorus levels and high pH. (The IEPA discontinued calculating the Swimming Use Index in 2007).

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted on Summerhill Estates Lake in July 2009. There were 58 points generated based on a computer grid system with points 30 meters apart (Figure 8). Aquatic plants existed at 35 of the 58 of the sites (60.3%) with 6 aquatic plant species found with the only exotic being Curlyleaf Pondweed (Figure 9). This is a significant decrease in plant diversity from 2004 where 9 species where found including Elodea, Small Pondweed and Flatstem Pondweed. In 2009 the plant community had a seasonal variation in dominant species. In May 80% of the lake was observed to have topped out Curlyleaf Pondweed. By July only 12% of the sampling points had Curlyleaf Pondweed. This exotic plant has a tolerance for low light and low water temperatures that allow it to get a head start and outcompete native plants in the spring. Curlyleaf Pondweed can form dense mats that may interfere with boating and other recreational uses. Large populations of Curlyleaf Pondweed also can cause changes in nutrient availability. In midsummer, Curlyleaf plants usually die back which is typically followed by an increase in phosphorus availability that may fuel nuisance algal blooms. Removal or control of exotic species is recommended. Coontail (53.4% of sample sites), Duckweed (37.9%), and Watermeal (37.9%) were the most abundant species found in July, 2009 (Table 6a, b). In 2004 the plant community contained the same dominant plants as 2009 (Coontail, Duckweed, and Watermeal). Duckweed and Watermeal are very tiny floating leaf plants that can spread throughout an entire lake very quickly. They typically appear in highly nutrient enriched lakes and once they are present, it is very difficult to eradicate them. Like Curlyleaf Pondweed, they can contribute to low DO conditions when they decompose and they can also shade out other plant species below the surface. However, Duckweed and Watermeal differ from CLP in that they will persist throughout the summer, continuing to die, decompose and reproduce long after CLP has disappeared.

The diversity and health of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which

Table 5. Lake County average TSI phosphorous (TSIp) ranking 2000-2009.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0135	39.24
4	Lake Zurich	0.0130	41.14
5	Sand Pond (IDNR)	0.0165	41.36
6	West Loon Lake	0.0140	42.21
7	Windward Lake	0.0158	43.95
8	Cedar Lake	0.0170	45.00
9	Pulaski Pond	0.0180	45.83
10	Timber Lake	0.0180	45.83
11	Fourth Lake	0.0182	45.99
12	Lake Kathryn	0.0200	47.35
13	Highland Lake	0.0200	47.35
14	Banana Pond	0.0202	47.49
15	Lake Minear	0.0204	47.63
16	Cross Lake	0.0220	48.72
17	Sun Lake	0.0220	48.72
18	Dog Pond	0.0222	48.85
19	Lake of the Hollow	0.0230	49.36
20	Stone Quarry Lake	0.0230	49.36
21	Round Lake	0.0230	49.36
22	Deep Lake	0.0234	49.61
23	Bangs Lake	0.0240	49.98
24	Druce Lake	0.0244	50.22
25	Little Silver	0.0250	50.57
26	Lake Leo	0.0256	50.91
27	Dugdale Lake	0.0274	51.89
28	Peterson Pond	0.0274	51.89
29	Lake Miltmore	0.0276	51.99
30	Lake Fairfield	0.0296	53.00
31	Third Lake	0.0300	53.20
32	Gray's Lake	0.0302	53.29
33	Lake Catherine (Site 1)	0.0308	53.57
34	Lambs Farm Lake	0.0312	53.76
35	Old School Lake	0.0312	53.76
36	Sand Lake	0.0316	53.94
37	Lake Linden	0.0326	54.39
38	Gages Lake	0.0338	54.92
39	Honey Lake	0.0340	55.00
40	Hendrick Lake	0.0344	55.17
41	Cranberry Lake	0.0360	55.82
42	Sullivan Lake	0.0370	56.22
43	Diamond Lake	0.0372	56.30
44	Channel Lake (Site 1)	0.0380	56.60
45	Ames Pit	0.0390	56.98
46	Schreiber Lake	0.0400	57.34

Table 5. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Hook Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Deer Lake	0.0434	58.52
52	Nielsen Pond	0.0448	58.98
53	Turner Lake	0.0458	59.30
54	Seven Acre Lake	0.0460	59.36
55	Willow Lake	0.0464	59.48
56	Lucky Lake	0.0476	59.85
57	East Meadow Lake	0.0478	59.91
58	Old Oak Lake	0.0490	60.27
59	East Loon Lake	0.0490	60.27
60	Countryside Lake	0.0490	60.27
61	College Trail Lake	0.0496	60.45
62	Lake Lakeland Estates	0.0524	61.24
63	Butler Lake	0.0528	61.35
64	West Meadow Lake	0.0530	61.40
65	Heron Pond	0.0545	61.80
66	Little Bear Lake	0.0550	61.94
67	Lucy Lake	0.0552	61.99
68	Lake Napa Suwe (Outlet)	0.0570	62.45
69	Lake Christa	0.0576	62.60
70	Lake Charles	0.0580	62.70
71	Owens Lake	0.0580	62.70
72	Crooked Lake	0.0608	63.38
73	Waterford Lake	0.0610	63.43
74	Wooster Lake	0.0610	63.43
75	Lake Naomi	0.0616	63.57
76	Lake Tranquility S1	0.0618	63.62
77	Werhane Lake	0.0630	63.89
78	Liberty Lake	0.0632	63.94
79	Countryside Glen Lake	0.0642	64.17
80	Lake Fairview	0.0648	64.30
81	Leisure Lake	0.0648	64.30
82	Davis Lake	0.0650	64.34
83	Tower Lake	0.0662	64.61
84	St. Mary's Lake	0.0666	64.70
85	Mary Lee Lake	0.0682	65.04
86	Hastings Lake	0.0684	65.08
87	Lake Helen	0.0720	65.82
88	Spring Lake	0.0726	65.94
89	ADID 203	0.0730	66.02
90	Bluff Lake	0.0734	66.10
91	Harvey Lake	0.0766	66.71
92	Broberg Marsh	0.0782	67.01

Table 5. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Sylvan Lake	0.0794	67.23
94	Big Bear Lake	0.0806	67.45
95	Petite Lake	0.0834	67.94
96	Timber Lake (South)	0.0848	68.18
97	Lake Marie (Site 1)	0.0850	68.21
98	North Churchill Lake	0.0872	68.58
99	Grand Avenue Marsh	0.0874	68.61
100	Grandwood Park, Site II, Outflow	0.0876	68.65
101	North Tower Lake	0.0878	68.68
102	South Churchill Lake	0.0896	68.97
103	Rivershire Pond 2	0.0900	69.04
104	McGreal Lake	0.0914	69.26
105	Long Lake	0.0920	69.35
106	International Mine and Chemical Lake	0.0948	69.79
107	Eagle Lake (Site I)	0.0950	69.82
108	Valley Lake	0.0950	69.82
109	Dunns Lake	0.0952	69.85
110	Fish Lake	0.0956	69.91
111	Lochanora Lake	0.0960	69.97
112	Woodland Lake	0.0986	70.35
113	Island Lake	0.0990	70.41
114	McDonald Lake 1	0.0996	70.50
115	Nippersink Lake	0.1000	70.56
116	Longview Meadow Lake	0.1024	70.90
117	Lake Barrington	0.1053	71.30
118	Redwing Slough, Site II, Outflow	0.1072	71.56
119	Lake Forest Pond	0.1074	71.59
120	Bittersweet Golf Course #13	0.1096	71.88
121	Fox Lake (Site 1)	0.1098	71.90
122	Osprey Lake	0.1108	72.04
123	Bresen Lake	0.1126	72.27
124	Round Lake Marsh North	0.1126	72.27
125	Deer Lake Meadow Lake	0.1158	72.67
126	Taylor Lake	0.1184	72.99
127	Columbus Park Lake	0.1226	73.49
128	Nippersink Lake (Site 1)	0.1240	73.66
129	Echo Lake	0.1250	73.77
130	Grass Lake (Site 1)	0.1288	74.21
131	Lake Holloway	0.1322	74.58
132	Lakewood Marsh	0.1330	74.67
133	Redhead Lake	0.1412	75.53
134	Forest Lake	0.1422	75.63
135	Antioch Lake	0.1448	75.89
136	Slocum Lake	0.1496	76.36
137	Pond-a-Rudy	0.1514	76.54
138	Lake Matthews	0.1516	76.56

Table 5. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Buffalo Creek Reservoir	0.1550	76.88
140	Pistakee Lake (Site 1)	0.1592	77.26
141	Grassy Lake	0.1610	77.42
142	Salem Lake	0.1650	77.78
143	Half Day Pit	0.1690	78.12
144	Lake Eleanor Site II, Outflow	0.1812	79.13
145	Lake Farmington	0.1848	79.41
146	Lake Louise	0.1850	79.43
147	ADID 127	0.1886	79.71
148	Patski Pond (outlet)	0.1970	80.33
149	**Summerhill Estates Lake**	**0.1990**	**80.48**
150	Dog Bone Lake	0.1990	80.48
151	Redwing Marsh	0.2072	81.06
152	Stockholm Lake	0.2082	81.13
153	Bishop Lake	0.2156	81.63
154	Ozaukee Lake	0.2200	81.93
155	Hidden Lake	0.2236	82.16
156	Fischer Lake	0.2278	82.43
157	Oak Hills Lake	0.2792	85.36
158	Loch Lomond	0.2954	86.18
159	McDonald Lake 2	0.3254	87.57
160	Fairfield Marsh	0.3264	87.61
161	ADID 182	0.3280	87.69
162	Slough Lake	0.4134	91.02
163	Flint Lake Outlet	0.4996	93.75
164	Rasmussen Lake	0.5025	93.84
165	Albert Lake, Site II, outflow	1.1894	106.26

Figure 8. Aquatic plant sampling grid on Summerhill Estates Lake, June 2009.

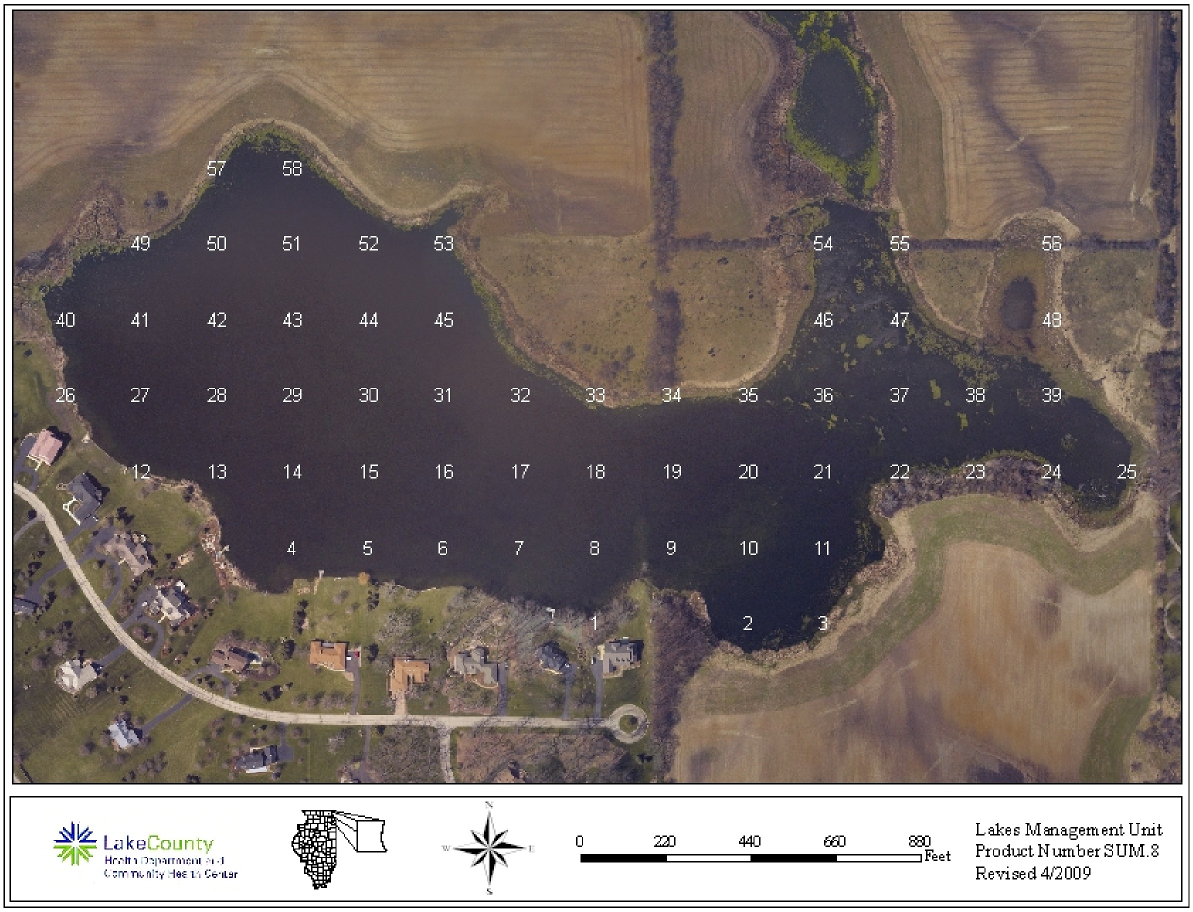


Figure 9. Aquatic plant sampling grid that illustrates plant density on Summerhill Estates Lake, June 2009.

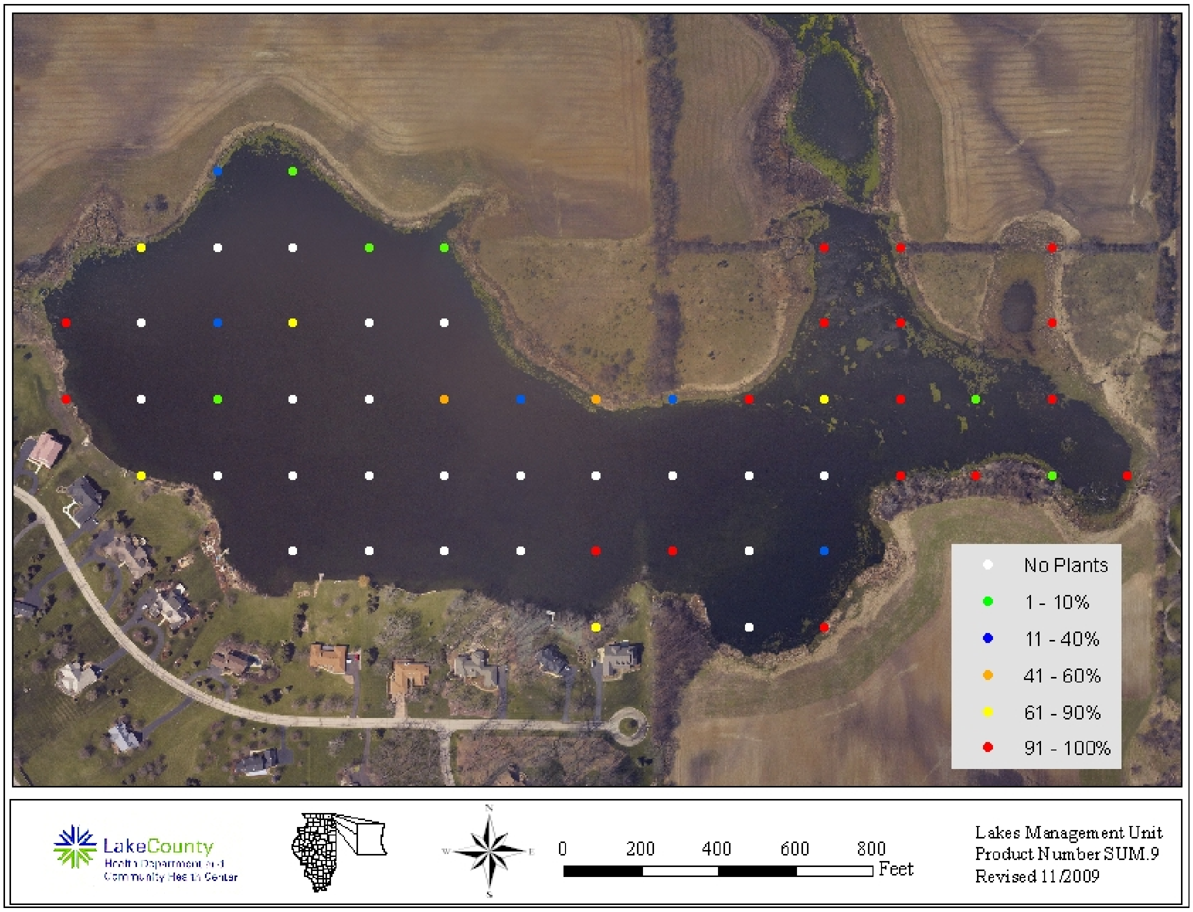


Table 6a. Aquatic plant species found at the 58 sampling sites on Summerhill Estates Lake, July 2009. Maximum depth that plants were found was 6.5 feet.

Plant Density	Coontail	Curlyleaf Pondweed	Duckweed	Sago Pondweed	Star Duckweed	Watermeal
Absent	27	51	36	50	43	36
Present	6	1	4	1	8	6
Common	5	5	7	2	5	3
Abundant	7	1	5	3	2	6
Dominant	13	0	6	2	0	7
% Plant Occurrence	53.4	12.1	37.9	13.8	25.9	37.9

Table 6b. Distribution of rake density across all sampled sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	23	39.7
>0-10%	5	8.6
10-40%	6	10.3
40-60%	5	8.6
60-90%	2	3.4
>90%	17	29.3
Total Sites with Plants	35	60.3
Total # of Sites	58	100.0

Table 7. Aquatic plant species found in Summerhill Estates Lake in 2009.

Coontail	*Ceratophyllum demersum*
Duckweed	*Lemna* spp.
Star Ducweed	*Lemna trisulca*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Curlyleaf Pondweed^	*Potamogeton crispus*^
Sago Pondweed	*Potamogeton pectinatus*
Watermeal	*Wolffia columbiana*

^ Exotic plant

aquatic plants will grow. When the light level in the water column falls below 1% of the surface light level, plants can no longer photosynthesize. The 1% light level in Summerhill Estates Lake reached to 6 foot depth (bottom) for the entire sampling season. Plants were found at a maximum depth of 6.5 feet. The morphology of Summerhill Estates Lake is relatively shallow with the average depth being 2.82 feet. The shallow nature, availability of light and high nutrients makes Summerhill Estates Lake likely to experience 100% aquatic plant cover. A healthy aquatic plant population typically only covers 30 to 40% of the lake bottom. Aquatic vegetation is critical to good lake health and provides important wildlife habitat and food sources. Additionally, aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available resources.

Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicate that there were large numbers of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for Lake County lakes from 2000-2009 was 15.0. Summerhill Estates Lake has a FQI of 12.7. Summerhill Estates Lake was just below the average, by Lake County standards ranking 74th of 154 lakes (Table 8).

In August 2009, a meander survey was conducted on shoreline vegetation, the species encountered were documented. The shoreline vegetation was dominated by cattails and sandbar willow. Other species encountered were common wetland species. There were occurrences of common reed, reed canary grass, and purple loosestrife along the shoreline areas. On the east side of the lake, the wetland fringe was dominated by cattail and reed canary grass and had a septic odor as infiltrated cattails. A complete list of vegetation is given in Table 9. An FQI was calculated to include shoreline vegetation. The FQI for the shoreline plant community was 14.6. The shoreline and lake vegetation had a combined FQI of 17.8.

SUMMARY OF SHORELINE CONDITION

A shoreline assessment was conducted at Summerhill Estates Lake on July 28, 2004. The shoreline was assessed for a variety of criteria, and based on this assessment, several important generalizations were made. Approximately 47% of Summerhill Estates Lake's shoreline was developed. The developed shoreline was dominated by a combination of buffer (50.6%), prairie (20.3%) and lawn (20.7%), while woodland and rip rap made up a small part of the remainder. The undeveloped shoreline consisted entirely of wetland buffer. Wetland buffer and prairie are very desirable shoreline types, providing wildlife habitat and, typically, protecting the shore from excessive erosion. Manicured lawn is considered undesirable because it provides a poor shoreline-water interface due to the poor root structure of turf grasses. These grasses are incapable of stabilizing the shoreline and typically lead to erosion. As a result of the dominance of buffer and prairie shoreline types, the 2004 report concluded that virtually none of Summerhill

Table 8. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native)

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.2	40.2
2	Cranberry Lake	32.5	33.3
3	East Loon Lake	30.6	32.7
4	Deep Lake	29.7	31.2
5	Little Silver	29.6	31.6
6	Bangs Lake	29.5	31.0
7	Round Lake Marsh North	29.1	29.9
8	Deer Lake	28.2	29.7
9	Sullivan Lake	26.9	28.5
10	West Loon Lake	25.7	27.3
11	Cross Lake	25.2	27.8
12	Wooster Lake	25.0	26.6
13	Independence Grove	24.6	27.5
14	Sterling Lake	24.5	26.9
15	Lake Zurich	24.3	27.1
16	Sun Lake	24.3	26.1
17	Schreiber Lake	23.9	24.8
18	Lakewood Marsh	23.8	24.7
19	Round Lake	23.5	25.9
20	Honey Lake	23.3	25.1
21	Fourth Lake	23.0	24.8
22	Lake of the Hollow	23.0	24.8
23	Druce Lake	22.8	25.2
24	Countryside Glen Lake	21.9	22.8
25	Butler Lake	21.4	23.1
26	Davis Lake	21.4	21.4
27	Duck Lake	21.1	22.9
28	Timber Lake (North)	20.8	22.8
29	ADID 203	20.5	20.5
30	Broberg Marsh	20.5	21.4
31	McGreal Lake	20.2	22.1
32	Lake Kathryn	19.6	20.7
33	Fish Lake	19.3	21.2
34	Redhead Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Lake Helen	18.0	18.0
39	Old Oak Lake	18.0	19.1
40	Hendrick Lake	17.7	17.7
41	Long Lake	17.2	19.0
42	Seven Acre Lake	17.0	15.5
43	Gray's Lake	16.9	19.8
44	Owens Lake	16.3	17.3

Table 8. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
45	Countryside Lake	16.7	17.7
46	Highland Lake	16.7	18.9
47	Lake Barrington	16.7	17.7
48	Bresen Lake	16.6	17.8
49	Diamond Lake	16.3	17.4
50	Windward Lake	16.3	17.6
51	Dog Bone Lake	15.7	15.7
52	Redwing Slough	15.6	16.6
53	Osprey Lake	15.5	17.3
54	Lake Fairview	15.2	16.3
55	Heron Pond	15.1	15.1
56	Lake Tranquility (S1)	15.0	17.0
57	North Churchill Lake	15.0	15.0
58	Dog Training Pond	14.7	15.9
59	Island Lake	14.7	16.6
60	Grand Avenue Marsh	14.3	16.3
61	Lake Nippersink	14.3	16.3
62	Taylor Lake	14.3	16.3
63	Dugdale Lake	14.0	15.1
64	Eagle Lake (S1)	14.0	15.1
65	Longview Meadow Lake	13.9	13.9
66	Third Lake	13.9	16.6
67	Ames Pit	13.4	15.5
68	Bishop Lake	13.4	15.0
69	Buffalo Creek Reservoir	13.1	14.3
70	Mary Lee Lake	13.1	15.1
71	McDonald Lake 2	13.1	14.3
72	Old School Lake	13.1	15.1
73	Dunn's Lake	12.7	13.9
74	**Summerhill Estates Lake**	**12.7**	**13.9**
75	Timber Lake (South)	12.7	14.7
76	White Lake	12.7	14.7
77	Hastings Lake	12.5	14.8
78	Sand Lake	12.5	14.8
79	Stone Quarry Lake	12.5	12.5
80	Lake Carina	12.1	14.3
81	Lake Leo	12.1	14.3
82	Lambs Farm Lake	12.1	14.3
83	Pond-A-Rudy	12.1	12.1
84	Stockholm Lake	12.1	13.5
85	Grassy Lake	12.0	12.0
86	Lake Matthews	12.0	12.0
87	Flint Lake	11.8	13.0
88	Harvey Lake	11.8	13.0
89	Lake Napa Suwe	11.7	13.9
90	Rivershire Pond 2	11.5	13.3

Table 8. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
91	Antioch Lake	11.3	13.4
92	Hook Lake	11.3	13.4
93	Lake Charles	11.3	13.4
94	Lake Linden	11.3	11.3
95	Lake Naomi	11.2	12.5
96	Pulaski Pond	11.2	12.5
97	Lake Minear	11.0	13.9
98	Redwing Marsh	11.0	11.0
99	Tower Lake	11.0	11.0
100	West Meadow Lake	11.0	11.0
101	Nielsen Pond	10.7	12.0
102	Lake Holloway	10.6	10.6
103	Crooked Lake	10.2	12.5
104	College Trail Lake	10.0	10.0
105	Lake Lakeland Estates	10.0	11.5
106	Valley Lake	9.9	9.9
107	Werhane Lake	9.8	12.0
108	Big Bear Lake	9.5	11.0
109	Little Bear Lake	9.5	11.0
110	Loch Lomond	9.4	12.1
111	Columbus Park Lake	9.2	9.2
112	Sylvan Lake	9.2	9.2
113	Fischer Lake	9.0	11.0
114	Grandwood Park Lake	9.0	11.0
115	Lake Fairfield	9.0	10.4
116	Lake Louise	9	10.4
117	McDonald Lake 1	8.9	10.0
118	East Meadow Lake	8.5	8.5
119	Lake Christa	8.5	9.8
120	Lake Farmington	8.5	9.8
121	Lucy Lake	8.5	9.8
122	South Churchill Lake	8.5	8.5
123	Bittersweet Golf Course #13	8.1	8.1
124	Woodland Lake	8.1	9.9
125	Albert Lake	7.5	8.7
126	Banana Pond	7.5	9.2
127	Fairfield Marsh	7.5	8.7
128	Lake Eleanor	7.5	8.7
129	Patski Pond	7.1	7.1
130	Rasmussen Lake	7.1	7.1
131	Slough Lake	7.1	7.1
132	Lucky Lake	7.0	7.0
133	Lake Forest Pond	6.9	8.5
134	Ozaukee Lake	6.7	8.7
135	Leisure Lake	6.4	9.0
136	Peterson Pond	6.0	8.5

Table 8. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
137	Gages Lake	5.8	10.0
138	Slocum Lake	5.8	7.1
139	Deer Lake Meadow Lake	5.2	6.4
140	ADID 127	5.0	5.0
141	IMC Lake	5.0	7.1
142	Liberty Lake	5.0	5.0
143	Oak Hills Lake	5.0	5.0
144	Forest Lake	3.5	5.0
145	Sand Pond (IDNR)	3.5	5.0
146	Half Day Pit	2.9	5.0
147	Lochanora Lake	2.5	5.0
148	Echo Lake	0.0	0.0
149	Hidden Lake	0.0	0.0
150	North Tower Lake	0.0	0.0
151	Potomac Lake	0.0	0.0
152	St. Mary's Lake	0.0	0.0
153	Waterford Lake	0.0	0.0
154	Willow Lake	0.0	0.0
	Mean	**13.7**	**15.0**
	Median	**12.5**	**14.3**

Table 9. Aquatic plant species found in Summerhill Estates in 2009.

Swamp Milkweed	*Asclepias incarnata*
Water Hemlock	*Cicuta maculata*
Field Thistle ^	*Cirsium arvense*
Rusty Nut Hedge	*Cyperus ferruginescens*
Cinnamon Willow Herb	*Epilobium coloratum*
Wild Strawberry	*Fragaria virginiana*
Wood Avens	*Geum canadense*
Sawtooth Sunflower	*Helianthus grosseserratus*
Rice Cut Grass	*Leersia oryzoides*
Purple Loosestrife ^	*Lythrum salicaria*
Virginia Creeper	Parthenocissus quinquefolia
Reed Canary Grass ^	*Phalaris arundinacea*
Common Reed ^	*Phragmites australis*
Clearweed	*Pilea pumila*
Lawn Prunella ^	*Prunella vulgaris*
Swamp Buttercup	*Ranunculus septentrionalis*
Multiflora Rose ^	*Rosa multiflora*
Common Arrowhead	*Sagittaria latifolia*
Sandbar Willow	*Salix interior*
Dark Green Rush	*Scirpus atrovirens*
Wool Grass	*Scirpus cyperinus*
Great Bulrush	*Scirpus validus creber*
Mad-dog Skullcap	*Scutellaria lateriflora*
Tall Goldenrod	*Solidago altissima*
Late Goldenrod	*Solidago gigantea*
Common Grass-leaved Golden Rod	*Solidago graminifolia*
Narrow-leaved Cattail ^	*Typha angustifolia*
Hybrid Cattail ^	*Typha X glauca*
Blue Vervain	*Verbena hastata*
Hoary Vervain	Verbena stricta

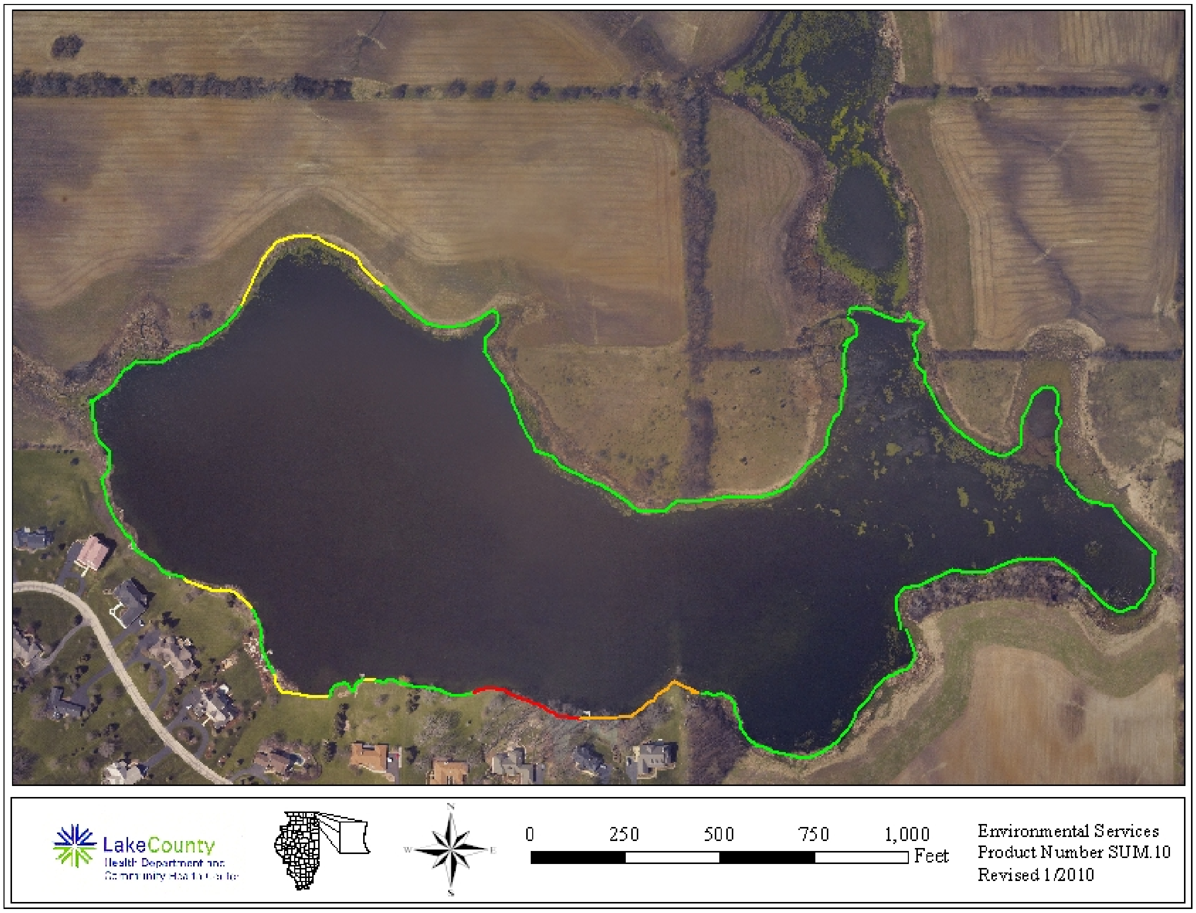
^ Exotic plant

Estates Lake's shoreline exhibited erosion. The shoreline was reassessed in 2009 for significant changes in erosion since 2004. Based on the 2009 assessment, there was an increase in shoreline erosion with approximately 20% of the shoreline having some degree of erosion (Figure 10). Overall, 80% of the shoreline had no erosion, 11% had slight erosion, 5% had moderate, and 4% had severe erosion. The areas of moderate and severe erosion should be addressed soon. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits can be three-fold. First, the erosion is repaired and the new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds habitat for wildlife to a shoreline that is otherwise limited in habitat. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and keep geese and gulls from congregating, as it is not desirable habitat for them.

OBSERVATIONS OF WILDLIFE AND HABITAT

Wildlife observations were made on a monthly basis during water quality and plant sampling activities. All observations were either visual or audible and a variety of birds, mammals, and reptiles were observed over the course of the study. Wildlife habitat in the form of wetland buffer, prairie and other buffered shorelines were abundant. Summerhill Estates Lake offers uncommon opportunities for wildlife due to the fact that its watershed is primarily composed of public and private open space and contains a variety of habitats that can support a diversity of wildlife including fish, reptiles, mammals and birds. Therefore it is very important that the natural areas be maintained to provide the appropriate habitat for all wildlife species in the future.

Figure 10. Shoreline erosion on Summerhill Estates Lake, 2009.



LAKE MANAGEMENT RECOMMENDATIONS

- **Participate in the volunteer lake monitoring program (VLMP)**

  To track future water quality trends, it is recommended the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the Secchi disk readings on a bimonthly basis from April to October (Appendix D1). In addition to the VMLP, a staff gauge should be installed to monitor the lake level each month. The establishment of a VLMP on Summerhill Estates Lake would provide valuable historical data and enable lake managers to create baseline information to evaluate the improvement or decline of lake water quality over time.

- **Aquatic Plant Management**

  Summerhill Estates Lake aquatic plant community has seasonal dominance and will require various management strategies to achieve a healthy balance. Curlyleaf pondweed dominated the plant community in May and June, while Coontail, Duckweed and Watermeal dominated throughout the remainder of the summer. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake (Appendix D2).

- **Watershed nutrient reduction**

  Summerhill Estates Lake had the highest level of phosphorus in the entire Squaw Creek watershed despite its upstream location. Nutrient sources include internal and external sources, to successfully mitigate nutrient loads both avenues will have to be addressed. The internal sources are primarily the decomposition of large densities of plant matter; management of specific aquatic plant species is recommended. Reduction of external nutrient load from single family homes a major land use can be accomplished by following lake friendly lawn and garden care practices (Appendix D3).

- **Nuisance algae management**

  Mild algae blooms occurred on Summerhill Estates Lake throughout the summer, but did not dominate the lake due to a high density of aquatic plants. The blooms largely consisted of planktonic algae and were caused by high phosphorus concentrations. These high concentrations make the lake susceptible to blue-green algae blooms. Blue green algae can fix nitrogen from the atmosphere when nitrogen supplies are low. Blue green algae may release cyanotoxins under certain conditions as they die that can poison mammals, fish, and invertebrates that directly ingest the algae or the infected water.Chemical algae treatments often require multiple applications as the treated algae decompose and release nutrients to fuel another algae bloom. The best management plan to combat nuisance algae should include nutrient reduction (Appendix D4).

- **<u>Lakes with shoreline erosion</u>**

Based on the 2009 assessment, there was an increase in shoreline erosion with approximately 20% of the shoreline having some degree of erosion. Overall, 80% of the shoreline had no erosion, 11% had slight erosion, 5% had moderate, and 4% had severe erosion. The areas of moderate and severe erosion should be addressed soon. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion (Appendix D5).

- **<u>Assess your lake's fishery</u>**

Based on the LMU's records Summerhill Estates Lake's fish community has not been documented. Regular fisheries assessments should be conducted to determine the diversity and health of the fish community (Appendix D6).

- **<u>Grant program opportunities</u>**

There are opportunities to receive grants to help accomplish some of the management recommendations listed above (Appendix F).

APPENDIX A. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were at the deepest point in the lake (see sample site map), three feet below the surface, and 3 feet above the bottom. Samples were collected with a horizontal Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. Analytical methods for the parameters are listed in Table A1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every two feet until reaching the bottom.

Plant Sampling

In order to randomly sample each lake, mapping software (ArcMap 9.3) overlaid a grid pattern onto an aerial photo of Lake County and placed points 60 or 30 meters apart, depending on lake size. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation.

Shoreline Assessment

In previous years a complete assessment of the shoreline was done. However, this year we did a visual estimate to determine changes in the shoreline. The degree of shoreline erosion was categorically defined as none, slight, moderate, or severe. Below are brief descriptions of each category.

> None – Includes man-made erosion control such as beach, rip-rap and sea wall.
>
> Slight – Minimal or no observable erosion; generally considered stable; no erosion control practices will be recommended with the possible exception of small problem areas noted within an area otherwise designated as “slight”.

Moderate – Recession is characterized by past or recently eroded banks; area may exhibit some exposed roots, fallen vegetation or minor slumping of soil material; erosion control practices may be recommended although the section is not deemed to warrant immediate remedial action.

Severe – Recession is characterized by eroding of exposed soil on nearly vertical banks, exposed roots, fallen vegetation or extensive slumping of bank material, undercutting, washouts or fence posts exhibiting realignment; erosion control practices are recommended and immediate remedial action may be warranted.

Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal.
Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

Table A1. Analytical methods used for water quality parameters.

Parameter	***Method***
Temperature	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Dissolved oxygen	Hydrolab DataSonde ®4a or YSI 6600 Sonde®
Nitrate and Nitrite nitrogen	USEPA 353.2 rev. 2.0 EPA-600/R-93/100 Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18th ed. Electrode method, #4500 NH_3-F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18th ed, 4500-N_{org} C Semi-Micro Kjeldahl, plus 4500 NH_3-F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18th ed, Method #2540B
Total suspended solids	SM 18th ed, Method #2540D Detection Limit = 0.5 mg/L
Chloride	SM 18th ed, Method #4500C1-D
Total volatile solids	SM 18th ed, Method #2540E, from total solids
Alkalinity	SM 18th ed, Method #2320B, patentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18th ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18th ed, Methods #4500-P B 1 and #4500-P E Detection Limit = 0.005 mg/L
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a or YSI 6600 Sonde®, LI-COR® 192 Spherical Sensor

Summerhill Estates Lake 2009 Multiparameter data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 1.64
5/12/2009	0	0.51	15.63	12.15	122.3	0.4820	10.39	3209	Surface		
5/12/2009	1	1.00	14.40	11.81	115.8	0.4780	10.46	3522	Surface	100%	
5/12/2009	2	2.01	13.96	10.96	106.4	0.4740	10.44	1114	0.262	35%	4.394
5/12/2009	3	2.93	13.78	10.18	98.4	0.4720	10.40	164	1.183	5%	1.621
5/12/2009	4	4.00	13.70	9.83	94.9	0.4710	10.40	92	2.249	3%	0.259
5/12/2009	5	5.01	13.59	6.27	60.4	0.4770	10.15	35	3.261	1.1%	0.291

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 1.46
6/9/2009	0	0.51	18.55	6.11	65.3	0.5250	8.96	524	Surface		
6/9/2009	1	1.04	18.56	5.27	56.3	0.5250	8.96	542	Surface	100%	
6/9/2009	2	1.97	18.56	4.92	52.6	0.5250	9.05	129	-0.714	103%	0.047
6/9/2009	3	2.94	18.54	4.72	50.4	0.5250	9.05	100	0.217	25%	6.619
6/9/2009	4	3.97	18.52	4.62	49.4	0.5240	9.08	56	1.192	19%	0.213
6/9/2009	5	4.97	18.46	4.48	47.8	0.5260	9.05	33	2.219	11%	0.265
6/9/2009	6	5.58	18.25	2.81	29.8	0.5430	8.78	20	3.218	6%	0.158

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 1.57
7/14/2009	0	0.49	24.38	7.95	95.2	0.5950	8.55	2529	Surface		
7/14/2009	1	1.04	24.38	8.29	99.4	0.5960	8.47	2414	Surface	100%	
7/14/2009	2	1.94	24.36	8.29	99.3	0.5960	8.45	620	-0.714	95%	-0.065
7/14/2009	3	3.04	24.36	8.19	98.1	0.5960	8.44	320	0.194	25%	7.008
7/14/2009	4	4.00	24.35	8.15	97.6	0.5960	8.43	191	1.29	13%	0.512
7/14/2009	5	5.05	24.19	7.82	93.3	0.5980	8.36	109	2.247	8%	0.230
7/14/2009	6	6.06	24.04	7.00	83.3	0.5990	8.22	51	3.295	4.3%	0.170

7/14/2009	7	7.02	23.22	4.19	49.1	0.6150	7.79	27	4.312	2.0%	0.177

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
8/11/2009	0	0.51	24.22	9.47	112.9	0.0040	8.00	639		Average	2.23
8/11/2009	1	1.01	25.80	10.43	128.3	0.6190	8.69	3953	Surface		
8/11/2009	2	2.00	25.71	10.37	127.3	0.6010	8.68	609	Surface	156%	
8/11/2009	3	2.99	25.60	9.59	117.6	0.6020	8.63	204	0.25	24%	7.481
8/11/2009	4	4.00	25.39	7.36	89.8	0.6060	8.44	109	1.242	8%	0.880
8/11/2009	5	4.99	25.17	4.38	53.3	0.6110	8.20	45	2.252	4%	0.278
8/11/2009	6	6.00	24.91	2.60	31.5	0.6140	7.91	19	3.242	1.8%	0.272

Date **MMDDYY**	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
40071	0	0.495	23.85	8.57	101.7	0.582	8.67	NA		Average	NA
40071	1	1.00	23.79	8.81	104.4	0.5810	8.69	NA	Surface		
40071	2	1.99	23.45	8.97	105.7	0.5800	8.71	NA	Surface	NA	
40071	3	3.00	23.3	8.87	104.2	0.5810	8.71	NA	0.243	NA	NA
40071	4	4.00	23.21	8.23	96.5	0.5820	8.67	NA	1.249	NA	NA
40071	5	5.01	23.2	7.90	92.6	0.5820	8.65	NA	2.251	NA	NA
40071	6	6.00	23.19	7.62	89.2	0.5830	8.63	NA	3.257	NA	NA
40071	7	7.00	23.19	7.23	84.8	0.5820	8.61	NA	4.248	NA	NA

APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY DATA

Lakes possess a unique set of physical and chemical characteristics that will change over time. These in-lake water quality characteristics, or parameters, are used to describe and measure the quality of lakes, and they relate to one another in very distinct ways. As a result, it is virtually impossible to change any one component in or around a lake without affecting several other components, and it is important to understand how these components are linked.

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2009 will be used in the following discussion.

Temperature and Dissolved Oxygen:

Water temperature fluctuations will occur in response to changes in air temperatures, and can have dramatic impacts on several parameters in the lake. In the spring and fall, lakes tend to have uniform, well-mixed conditions throughout the water column (surface to the lake bottom). However, during the summer, deeper lakes will separate into distinct water layers. As surface water temperatures increase with increasing air temperatures, a large density difference will form between the heated surface water and colder bottom water. Once this difference is large enough, these two water layers will separate and generally will not mix again until the fall. At this time the lake is thermally stratified. The warm upper water layer is called the ***epilimnion***, while the cold bottom water layer is called the ***hypolimnion***. In some shallow lakes, stratification and destratification can occur several times during the summer. If this occurs the lake is described as polymictic. Thermal stratification also occurs to a lesser extent during the winter, when warmer bottom water becomes separated from ice-forming water at the surface until mixing occurs during spring ice-out.

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

External pollution in the form of oxygen-demanding organic matter (i.e., sewage, lawn clippings, soil from shoreline erosion, and agricultural runoff) or nutrients that stimulate the growth of excessive organic matter (i.e., algae and plants) can reduce average DO concentrations in the lake by increasing oxygen consumption. This can have a detrimental impact on the fish community, which may be squeezed into a very small volume of water as a result of high temperatures in the epilimnion and low DO levels in the hypolimnion.

Nutrients:

Phosphorus:
For most Lake County lakes, phosphorus is the nutrient that limits plant and algae growth. This means that any addition of phosphorus to a lake will typically result in algae blooms or high plant densities during the summer. The source of phosphorus to a lake can be external or internal (or both). External sources of phosphorus enter a lake through point (i.e., storm pipes and wastewater discharge) and non-point runoff (i.e., overland water flow). This runoff can pick up large amounts of phosphorus from agricultural fields, septic systems or impervious surfaces before it empties into the lake.

Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. In lakes with high oxygen levels (oxic), phosphorus can be released from the sediment through plants or sediment resuspension. Plants take up sediment-bound phosphorus through their roots, releasing it in small amounts to the water column throughout their life cycles, and in large amounts once they die and begin to decompose. Sediment resuspension can occur through biological or mechanical means. Bottom-feeding fish, such as common carp and black bullhead can release phosphorus by stirring up bottom sediment during feeding activities and can add phosphorus to a lake through their fecal matter. Sediment resuspension, and subsequent phosphorus release, can also occur via wind/wave action or through the use of artificial aerators, especially in shallow lakes. In lakes that thermally stratify, internal phosphorus release can occur from the sediment through chemical means. Once oxygen is depleted (anoxia) in the hypolimnion, chemical reactions occur in which phosphorus bound to iron complexes in the sediment becomes soluble and is released into the water column. This phosphorus is trapped in the hypolimnion and is unavailable to algae until fall turnover, and can cause algae blooms once it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2009 was 0.063 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2009 was 0.167 mg/L and ranged from a minimum of 0.012 mg/L in Independence Grove Lake to a maximum of 3.880 mg/L in Taylor Lake.

The analysis of phosphorus also included soluble reactive phosphorus (SRP), a dissolved form of phosphorus that is readily available for plant and algae growth. SRP is not discussed in great detail in most of the water quality reports because SRP concentrations vary throughout the season depending on how plants and algae absorb and release it. It gives an indication of how much phosphorus is available for uptake, but, because it does not take all forms of phosphorus into account, it does not indicate how much phosphorus is truly present in the water column. TP is considered a better indicator of a lake's nutrient status because its concentrations remain more stable than soluble reactive phosphorus. However, elevated SRP levels are a strong indicator of nutrient problems in a lake.

Nitrogen:
Nitrogen is also an important nutrient for plant and algae growth. Sources of nitrogen to a lake vary widely, ranging from fertilizer and animal wastes, to human waste from sewage treatment plants or failing septic systems, to groundwater, air and rainfall. As a result, it is very difficult to control or reduce nitrogen inputs to a lake. Different forms of nitrogen are present in a lake under different oxic conditions. NH_4^+ (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If NH_4^+ comes into contact with oxygen, it is immediately converted to NO_2 (nitrite) which is then oxidized to NO_3^- (nitrate). Therefore, in a thermally stratified lake, levels of NH_4^+ would only be elevated in the hypolimnion and levels of NO_3^- would only be elevated in the epilimnion. Both NH_4^+ and NO_3^- can be used as a nitrogen source by aquatic plants and algae. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. Adding the concentrations of TKN and nitrate together gives an indication of the amount of total nitrogen present in the water column. If inorganic nitrogen (NO_3^-, NO_2^-, NH_4^+) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee limited algae growth the way low phosphorus levels do. Nitrogen gas in the air can dissolve in lake water and blue-green algae can "fix" atmospheric nitrogen, converting it into a usable form. Since other types of algae do not have the ability to do this, nuisance blue-green algae blooms are typically associated with lakes that are nitrogen limited (i.e., have low nitrogen levels).

The ratio of TKN plus nitrate nitrogen to total phosphorus (TN:TP) can indicate whether plant/algae growth in a lake is limited by nitrogen or phosphorus. Ratios of less than 10:1

suggest a system limited by nitrogen, while lakes with ratios greater than 20:1 are limited by phosphorus. It is important to know if a lake is limited by nitrogen or phosphorus because any addition of the limiting nutrient to the lake will, likely, result in algae blooms or an increase in plant density.

Solids:

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County was 7.9 mg/L, ranging from below the 0.1 mg/L detection limit to 165 mg/L in Fairfield Marsh.

TVS represents the fraction of total solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TVS values indicate that a large portion of the suspended solids may be made up of algae cells. This is important in determining possible sources of phosphorus to a lake. If much of the suspended material in the water column is determined to be resuspended sediment that is releasing phosphorus, this problem would be addressed differently than if the suspended material was made up of algae cells that were releasing phosphorus. The median TVS value was 132.8 mg/L, ranging from 34.0 mg/L in Pulaski Pond to 298.0 mg/L in Fairfield Marsh.

Total dissolved solids (TDS) are the amount of dissolved substances, such as salts or minerals, remaining in water after evaporation. These dissolved solids are discussed in further detail in the *Alkalinity* and *Conductivity* sections of this document. TDS concentrations were measured in Lake County lakes prior to 2004, but was discontinued due to the strong correlation of TDS to conductivity and chloride concentrations.

Water Clarity:

Water clarity (transparency) is not a chemical property of lake water, but is often an indicator of a lake's overall water quality. It is affected by a lake's water color, which is a reflection of the amount of total suspended solids and dissolved organic chemicals. Thus, transparency is a measure of particle concentration and is measured with a Secchi disk. Generally, the lower the clarity or Secchi depth, the poorer the water quality. A decrease in Secchi depth during the summer occurs as the result of an increase in suspended solids (algae or sediment) in the water column. Aquatic plants play an important role in the level of water clarity and can, in turn, be negatively affected by low clarity levels. Plants increase clarity by competing with algae for resources and by stabilizing sediments to prevent sediment resuspension. A lake with a healthy plant community will almost always have higher water clarity than a lake without plants. Additionally, if the plants in a lake are removed (through herbicide treatment or the stocking of grass carp), the lake will probably become dominated by algae and Secchi depth will decrease. This makes it very difficult for plants to become re-established due to the lack of available sunlight and the lake will, most likely, remain turbid. Turbidity will be accelerated if the lake is very shallow and/or common carp are present. Shallow lakes are more susceptible to sediment resuspension through wind/wave action and are more likely to experience clarity problems if plants are not present to stabilize bottom sediment.

Common Carp are prolific fish that feed on invertebrates in the sediment. Their feeding activities stir up bottom sediment and can dramatically decrease water clarity in shallow lakes. As mentioned above, lakes with low water clarity are, generally, considered to have poor water quality. This is because the causes and effects of low clarity negatively impact the plant and fish communities, as well as the levels of phosphorus in a lake. The detrimental impacts of low Secchi depth to plants has already been discussed. Fish populations will suffer as water clarity decreases due to a lack of food and decreased ability to successfully hunt for prey. Bluegills are planktivorous fish and feed on invertebrates that inhabit aquatic plants. If low clarity results in the disappearance of plants, this food source will disappear too. Largemouth Bass and Northern Pike are piscivorous fish that feed on other fish and hunt by sight. As the water clarity decreases, these fish species find it more difficult to see and ambush prey and may decline in size as a result. This could eventually lead to an imbalance in the fish community. Phosphorus release from resuspended sediment could increase as water clarity and plant density decrease. This would then result in increased algae blooms, further reducing Secchi depth and aggravating all problems just discussed. The average Secchi depth for Lake County lakes is 3.12 feet. From 2000-2009, Ozaukee Lake had the lowest Secchi depths (0.25 feet) and West Loon Lake had the highest (24.77 feet). As an example of the difference in Secchi depth based on plant coverage, South Churchill Lake, which had no plant coverage and large numbers of Common Carp in 2003 had an average Secchi depth of 0.73 feet (over four times lower than the county average), while Deep Lake, which had a diverse plant community and few carp had an average 2003 Secchi depth of 12.48 feet (almost four times higher than the county average).

Another measure of clarity is the use of a light meter. The light meter measures the amount of light at the surface of the lake and the amount of light at each depth in the water column. The amount of attenuation and absorption (decreases) of light by the water column are major factors controlling temperature and potential photosynthesis. Light intensity at the lake surface varies seasonally and with cloud cover, and decreases with depth. The deeper into the water column light penetrates, the deeper potential plant growth. The maximum depth at which algae and plants can grow underwater is usually at the depth where the amount of light available is reduced to 0.5%-1% of the amount of light available at the lake surface. This is called the euphotic (sunlit) zone. A general rule of thumb in Lake County is that the 1% light level is about 1 to 3 times the Secchi disk depth.

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:

Alkalinity is the measurement of the amount of acid necessary to neutralize carbonate ($CO_3^=$) and bicarbonate (HCO_3^-) ions in the water, and represents the buffering capacity of a body of water. The alkalinity of lake water depends on the types of minerals in the surrounding soils and in the bedrock. It also depends on how often the lake water comes in contact with these minerals. If a lake gets groundwater from aquifers containing limestone minerals such as calcium carbonate ($CaCO_3$) or dolomite ($CaMgCO_3$), alkalinity will be high. The median alkalinity in Lake County lakes (162 mg/L) is considered moderately hard according to the hardness classification scale of Brown, Skougstad and Fishman (1970). Because hard water (alkaline) lakes often have watersheds with fertile soils that add nutrients to the water, they usually produce more fish and aquatic plants than soft water lakes. Since the majority of Lake County lakes have a high alkalinity they are able to buffer the adverse effects of acid rain.

Conductivity and Chloride:

Conductivity is the inverse measure of the resistance of lake water to an electric flow. This means that the higher the conductivity, the more easily an electric current is able to flow through water. Since electric currents travel along ions in water, the more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. Accordingly, conductivity has been correlated to total dissolved solids and chloride ions. The amount of dissolved solids or conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Many Lake County lakes have elevated conductivity levels in May, but not during any other month. This was because chloride, in the form of road salt, was washing into the lakes with spring rains, increasing conductivity. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. Beginning in 2004, chloride concentrations are one of the parameters measured during the lake studies. Increased chloride concentrations may have a negative impact on aquatic organisms. Conductivity changes occur seasonally and with depth. For example, in stratified lakes the conductivity normally increases in the hypolimnion as bacterial decomposition converts organic materials to bicarbonate and carbonate ions depending on the pH of the water. These newly created ions increase the conductivity and total dissolved solids. Over the long term, conductivity is a good indicator of potential watershed or lake problems if an increasing trend is noted over a period of years. It is also important to know the conductivity of the water when fishery assessments are conducted, as electroshocking requires a high enough conductivity to properly stun the fish, but not too high as to cause injury or death.

pH:

pH is the measurement of hydrogen ion (H^+) activity in water. The pH of pure water is neutral at 7 and is considered acidic at levels below 7 and basic at levels above 7. Low pH levels of 4-5 are toxic to most aquatic life, while high pH levels (9-10) are not only toxic to aquatic life but may also result in the release of phosphorus from lake sediment. The presence of high plant densities can increase pH levels through photosynthesis, and lakes dominated by a large amount of plants or algae can experience large fluctuations in pH levels from day to night, depending on the rates of photosynthesis and respiration. Few, if any pH problems exist in Lake County lakes. Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes was 8.34, with a minimum of 7.07 in Bittersweet #13 Lake and a maximum of 10.40 in Summerhill Estates Lake.

Eutrophication and Trophic State Index:

The word *eutrophication* comes from a Greek word meaning "well nourished." This also describes the process in which a lake becomes enriched with nutrients. Over time, this is a lake's natural aging process, as it slowly fills in with eroded materials from the surrounding watershed and with decaying plants. If no human impacts disturb the watershed or the lake, natural eutrophication can take thousands of years. However, human activities on a lake or in the watershed accelerate this process by resulting in rapid soil erosion and heavy phosphorus inputs. This accelerated aging process on a lake is referred to as cultural eutrophication. The term trophic state refers to the amount of nutrient enrichment within a lake system. *Oligotrophic* lakes are usually deep and clear with low nutrient levels, little plant growth and a limited fishery. *Mesotrophic* lakes are more biologically productive than oligotrophic lakes and have moderate nutrient levels and more plant growth. A lake labeled as *eutrophic* is high in nutrients and can support high plant densities and large fish populations. Water clarity is typically poorer than oligotrophic or mesotrophic lakes and dissolved oxygen problems may be present. A *hypereutrophic* lake has excessive nutrients, resulting in nuisance plant or algae growth. These lakes are often pea-soup green, with poor water clarity. Low dissolved oxygen may also be a problem, with fish kills occurring in shallow, hypereutrophic lakes more often than less enriched lakes. As a result, rough fish (tolerant of low dissolved oxygen levels) dominate the fish community of many hypereutrophic lakes. The categorization of a lake into a certain trophic state should not be viewed as a "good to bad" categorization, as most lake residents rate their lake based on desired usage. For example, a fisherman would consider a plant-dominated, clear lake to be desirable, while a water-skier might prefer a turbid lake devoid of plants. Most lakes in Lake County are eutrophic or hypereutrophic. This is primarily as a result of cultural eutrophication. However, due to the fertile soil in this area, many lakes (especially man-made) may have started out under eutrophic conditions and will never attain even mesotrophic conditions, regardless of any amount of money put into the management options. This is not an excuse to allow a lake to continue to deteriorate, but may serve as a reality check for lake owners attempting to create unrealistic conditions in their lakes.

The Trophic State Index (TSI) is an index which attaches a score to a lake based on its average total phosphorus concentration, its average Secchi depth (water transparency) and/or its average chlorophyll *a* concentration (which represent algae biomass). It is based on the principle that as phosphorus levels increase, chlorophyll *a* concentrations increase and Secchi depth decreases. The higher the TSI score, the more nutrient-rich a lake is, and once a score is obtained, the lake can then be designated as oligotrophic, mesotrophic or eutrophic. Table 1 (below) illustrates the Trophic State Index using phosphorus concentration and Secchi depth.

Table 1. Trophic State Index (TSI).

Trophic State	TSI score	Total Phosphorus (mg/L)	Secchi Depth (feet)
Oligotrophic	<40	≤ 0.012	>13.12
Mesotrophic	≥40<50	>0.012 ≤ 0.024	≥6.56<13.12
Eutrophic	≥50<70	>0.024 ≤ 0.096	≥1.64<6.56
Hypereutrophic	≥70	>0.096	< 1.64

APPENDIX D. LAKE MANAGEMENT OPTIONS.

D1. Participate in the Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection Agency (Illinois EPA) to gather fundamental information on Illinois' inland lakes, and to provide an educational program for citizens. Approximately 165 lakes (of 3,041 lakes in Illinois) are sampled annually by approximately 300 volunteers. The volunteers are lakeshore residents, lake owners/managers, members of environmental groups, public water supply personnel, and/or citizens with interest in a particular lake.

The VLMP relies on volunteers to gather a variety of information on their chosen lake. The primary measurement is Secchi disk depth. Analysis of the Secchi disk measurement provides an indication of the general water quality condition of the lake, as well as the amount of usable habitat available for fish and other aquatic life.

Microscopic plants and animals, water color, and suspended sediments are factors that interfere with light penetration through the water column and lessen the Secchi disk depth. As a rule, one to three times the Secchi depth is considered the lighted zone of the lake. In this region of the lake there is enough light to allow plants to grow and produce oxygen. Water below the lighted zone can be expected to have little or no dissolved oxygen. Other observations such as water color, suspended algae and sediment, aquatic plants, and odor are also recorded. The sampling season is May through October with volunteer measurements taken twice a month. After volunteers have completed one year of the basic monitoring program, they are qualified to participate in the Expanded Monitoring Program. In the expanded program, volunteers are trained to collect water samples that are shipped to the Illinois EPA laboratory for analysis of total and volatile suspended solids, total phosphorus, nitrate-nitrite nitrogen and ammonia nitrogen. Other parameters that are part of the expanded program include dissolved oxygen, temperature, and zebra mussel monitoring. Additionally, chlorophyll *a* monitoring has been added to the regiment for selected lakes.

For information, please contact:

VLMP Regional Coordinator: Mike Adam
Lake County Health Department – Environmental Services
500 W. Winchester Unit 102
Libertyville, IL 60048
(847) 377-8030

D3. Options for Watershed Nutrient Reduction

The two key nutrients for plant and algae growth are nitrogen and phosphorus. Fertilizers used for lawn and garden care have significant amounts of both. The three numbers on the fertilizer bag identify the percent of nitrogen, phosphorus and potash in the fertilizer mixture. For example, a fertilizer with the numbers 5-10-5 has 5% nitrogen, 10% phosphorus and 5% potash. Fertilizers considered low in phosphorus (the second number) have a number of 5 or lower. A lower concentration of phosphorus applied to a lawn will result in a smaller concentration of phosphorus in stormwater runoff. An established lawn will not be negatively affected by a lower phosphorus rate. However, for areas with new seeding or new sod, the homeowner would still want to use a fertilizer formulated for encouraging growth until the lawn is established. A simple soil test can determine the correct type and amount of fertilizer needed for the soil. Knowing this, homeowners can avoid applying the wrong type or amount of fertilizer.

Option 1. Buffer Strips

Buffer strips of unmowed native vegetation at least 25 feet wide along the shoreline can slow nutrient laden runoff from entering a lake. It can help prevent shoreline erosion and provide habitat beneficial for wildlife. Different plant mixes can be chosen to allow for more aesthetically pleasing buffer strips and tall species can be used to deter waterfowl from congregating along the shore. Initially the cost of plants can be expensive, however, over time less maintenance is required for the upkeep of a buffer strip.

Option 2. Lake Friendly Lawn and Garden Care Practices – Phosphorus Reduction

a. Compost yard waste instead of burning. Ashes from yard waste contain nutrients and are easily washed into a lake.

b. Avoid dumping yard waste along or into a ditch, pond, lake, or stream. As yard waste decomposes, the nutrients are released directly into the water, or flushed to the lake via the ditch.

c. Avoid applying fertilizer up to the water's edge. Leave a buffer strip of at least 25 feet of unfertilized yard before the shoreline.

d. ***Avoid applying fertilizers when heavy rains are expected, or over-watering the ground after applying fertilizer.***

e. When landscaping, keep site disturbance to a minimum, especially the removal of vegetation and exposure of bare soil. Exposed soil can easily erode.

f. When landscaping, seed or plant exposed soil and cover it with mulch as soon as possible to minimize erosion and runoff.

g. Use lawn and garden chemicals sparingly, or do not use them at all.

e. Most lawns in Lake County do not need additional phosphorus for sufficient plant growth. Consider using a phosphorus-free fertilizer.

Option 3. Street Sweeping

Street sweeping has been used in communities to help prevent debris from clogging stormsewer drains, but it also benefits lakes by removing excess phosphorus, sand, silt and other pollutants. Leftover sand and salt applied to streets has been found to contain higher concentrations of silt, phosphorus and trace metals than new sand and salt mixes. If a municipality does not manage the lake, the lake management entity may be able to offer the village or city extra payment for sweeping streets closest to the lake.

Option 4: Reduce Stormwater Volume from Impervious Surfaces

The quality and quantity of runoff directly affects the lake's water quality. With continued growth and development in Lake County, more impervious surfaces such as parking lots and buildings contribute to the volume of stormwater runoff. Runoff picks up pollutants such as nutrients and sediment as it moves over land or down gutters. A faster flow rate and higher volume can result in erosion and scouring, adding sediment and nutrients to the runoff.

Roof downspouts should be pointed away from driveways and foundations and toward lawns or planting beds where water can soak into the soil. A splash block directly below downspouts helps prevent soil erosion. If erosion still occurs, a flexible perforated plastic tubing attached to the downspout can dissipate the water flow.

Option 5: Required Practices for Construction

Follow the requirements in the Watershed Development Ordinance (WDO) concerning buffer strips. Buffer strips can slow the velocity of runoff and trap sediment and attached nutrients. Setbacks, buffer strips and erosion control features, when done properly, will help protect the lake from excessive runoff and associated pollutants. Information about the contents of the ordinance can be obtained through Lake County Planning and Development, (847) 360-6330.

Option 6. Organize a Local Watershed Organization

A watershed organization can be instrumental in circulating educational information about watersheds and how to care for them. Often a galvanized organization can be a stronger working unit and a stronger voice than a few individuals. Watershed residents are the first to notice problems in the area, such as a lack of erosion control at construction sites. This organization would be an advocate for the watershed, and members could voice their concerns about future development impacts to local officials. This organization could educate the community about how phosphorus (and other pollutants) affect lakes and can help people implement watershed controls. Several types of educational outreaches can be used together for best results. These include: community newsletters, newspaper articles, local cable and radio station announcements. In some cases fundraising may be utilized to secure more funding for a project.

Option 7. Motor Boat Restrictions for Shallow Lakes

To reduce resuspension of phosphorus from the sediment, communities that have a shallow lake or large shallow areas in their lake may want to restrict motorized boating. The action of a spinning prop in shallow areas can disturb the sediment. Flocculent sediment particles can release loosely attached phosphorus into the water. Restrictions could include a ban of motorized traffic in certain areas or ban the use of motors entirely, however this could be hard to enforce without hiring law enforcement personnel. This would work best for lakes with shallow areas that have a large phosphorus source in the sediment.

Option 8. Discourage Waterfowl from Congregating

Waterfowl droppings (feces) can be a source of phosphorus (and bacteria) to the water, especially if they are congregating in large numbers along beaches and/or other nearshore areas. The annual nutrient load from two Canada Geese can be greater than the annual nutrient load from residential areas (Gremlin and Malone, 1986). These birds prefer habitat with short plants or no plants, such as lawns mowed to the water's edge and beaches. Waterfowl avoid areas with tall, dense vegetation through which they are unable to see predators. Tactics to discourage waterfowl from congregating in large groups include scare devices, a buffer strip of tall plants along the shoreline, and discouraging people from feeding geese and ducks. Signage could be erected at public parks/beaches discouraging people from feeding waterfowl. A template is available from Environmental Services.

D4. Options for Nuisance Algae Management

Option 1: Algaecides

Algaecides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algaecides in use. There is also a non-copper based algaecide on the market called GreenClean™ from BIOsafe Systems, which contains the active ingredient sodium carbonate peroxyhydrate. Regardless of active ingredient, all forms act as contact killers. This means that the product has to come into contact with the algae to be effective. Algaecides come in two forms: granular and liquid. Granular algaecides are mainly used on filamentous algae where they are spread over their mats. Liquid algaecides are mixed with a known amount of water to achieve a known concentration and sprayed onto/into the water. Liquid forms are used on both filamentous and planktonic algae. When applying an algaecide it is important that the label is completely read and followed. If too much of the lake is treated, an oxygen crash caused by the decomposition of treated algae may cause fish kills. Additionally, treatments should never be applied when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections depending on the size of the lake, (larger lakes will need to be divided into more sections), and then treat the lake one section at a time allowing at least two weeks between treatments. Furthermore, application of algaecides should never be done in extremely hot weather (>90^oF) or when dissolved oxygen concentrations are low. It is best to treat in spring or when the blooms/mats start to appear.

A properly implemented plan can often provide season long control with minimal applications. The fishery and waterfowl populations of the lake would also benefit due to a decrease in nuisance algal blooms, which would increase water clarity. This in turn would allow the native aquatic plants to return to the lake. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would also benefit from increases in quality food sources. By implementing a good management plan, usage opportunities for the lake would increase. Activities such as boating and swimming would improve due to the removal of thick blooms and/or mats of algae.

The most obvious drawback of using algaecides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error and overuse can make them unsafe and bring about undesired outcomes. As the algae are continuously exposed to copper, some species are becoming more and more tolerant. This results in the use of higher concentrations in order to achieve adequate control, which can be unhealthy for the lake. In other instances, by eliminating one type of algae, lake managers are finding that other species that are even more problematic are showing up. These species can often be more difficult to control due to an inherent resistance to copper products. Additionally, excessive use of copper products can lead to a build up of copper in lake sediment. This can cause problems for activities such as dredging. Due to a large amount of copper in the sediment, special permits and disposal methods would have to be utilized.

Option 2: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom making it unavailable, thus reducing algal growth. This flocculent layer can then prevent sediment bound phosphorus from entering the water column. Alum treatments typically last 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio benefit more quickly from alum applications, while lakes with high mean depth to surface area ratio (thermally stratified lakes) will see more longevity from an alum application due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited.

Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. This makes alum more cost effective in the long-term compared to continual treatment with algaecides. Effects of alum treatments can be seen in as little as a few days. The increase in clarity can have many positive effects on the lakes ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food/habitat sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations.

There are also several drawbacks to alum. In order for alum to provide long-term effectiveness, external nutrient inputs must also be reduced or eliminated. With larger watersheds this could prove to be physically and financially difficult. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long term control due to disruption of the flocculent layer. If alum is not properly applied, toxicity problems may occur. Due to these concerns, it is recommended that a lake management professional plans and administers the alum treatment.

Option 3: Revegetation With Native Aquatic Plants

A healthy native plant population can reduce algal growth. Many lakes with long-standing algal problems have a sparse to non-existent plant population. This is due to reduction in light penetration by excessive algal blooms and/or mats. Revegetation should only be done when existing nuisance algal blooms are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. Planting depth light levels must be greater than 1-5% of the surface light levels for plant growth. If aquatic herbicides are being used to control existing vegetation, their use should be scaled back or abandoned all together. This will allow the vegetation to grow back, which will help in controlling the algae in addition to other positive impacts associated with a healthy plant population.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake should be allowed to naturally expand into adjacent areas filling the niche left by the nuisance algae. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with each other to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire should be erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. A list can be obtained from the Lake Management Unit that lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc).

By revegetating opened areas, the lake will benefit in several ways. Once established, native plant populations will help to control growth of nuisance algae by shading and competition for resources. This provides a more natural approach as compared to other management options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also improve due to the improvement in water quality and the suppression of weedy species.

One drawback is the possibility of new vegetation expanding to nuisance levels and needing control. Another drawback could be high costs if extensive revegetation is needed using imported plants. If a consultant were used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

D5. Options for Lakes with Shoreline Erosion

Option 1: Install a Seawall

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). A new type of construction material being used is vinyl or PVC. Vinyl seawalls will not rust over time.

If installed properly and in the appropriate areas (i.e., shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last many years and have relatively low maintenance. However, seawalls are disadvantageous for several reasons. One of the main disadvantages is that they are expensive, since a professional contractor and heavy equipment are needed for installation. Also, if any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling of another portion. Permits and surveys are needed whether replacing old seawall or installing a new one. Seawalls also provide little habitat for fish or wildlife. Because there is no structure for fish, wildlife, or their prey, few animals use shorelines with seawalls. In addition, poor water clarity that may be caused by resuspension of sediment from deflected wave action contributes to poor fish and wildlife habitat, since sight feeding fish and birds (i.e., bass, herons, and kingfishers) are less successful at catching prey. This may contribute to a lake's poor fishery (i.e., stunted fish populations).

Option 2: Install Rock Rip-Rap or Gabions

Rip-rap is the procedure of using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. Gabions are wire cages or baskets filled with rock. They provide similar protection as rip-rap, but are less prone to displacement. They can be stacked, like blocks, to provide erosion control for extremely steep slopes.

Rip-rap and gabions can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the rip-rap and subsequent shoreline. Fish and wildlife habitat can also be provided if large (not small) boulders are used. A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning.

Option 3: Create a Buffer Strip

Another effective, more natural method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Stabilizing the shoreline with vegetation is most effective on slopes less than 2:1 to 3:1, horizontal to vertical, or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with severe erosion problems.

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Buffer strips may slow the velocity of floodwaters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. In addition, many wildlife species prefer the native shoreline vegetation habitat and various species are even dependent on native shoreline vegetation for their existence. In addition to the benefits of increased wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

There are few disadvantages to native shoreline vegetation. Certain species (i.e., cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

Option 4: Install Biolog, Fiber Roll, or Straw Blanket with Plantings

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from watershed sources. They are most effective in areas where plantings alone are not effective due to existing erosion.

Option 5: Install A-Jacks®

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone.
The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® cannot be seen. A disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site.

Option 6: Establish a "No Wake" Zone or No Motor Area

Establishing a "no wake" zone or no motor area will not solve erosion problems by itself. However, since shoreline erosion is generally not caused by one specific factor, these techniques can be effective if used in combination with one or more of the techniques described above. Limiting boat activity, particularly near shorelines or in shallow areas, may also have an additional benefit by improving water quality since less sediment may be disturbed and resuspended in the water column. Less motorboat disturbance will also benefit wildlife and may encourage many species to use the lake both during spring and fall migration and for summer residence. This may add to the lake's aesthetics and increasing recreational opportunities for some lake users.

Enforcement and public education are the primary obstacles with the "no wake" techniques. Public resistance to any regulation change may be strong, particularly if the lake is open to the public and has had no similar regulations in the past. Depending on the regulations implemented, there may be some loss of recreational use for some users, particularly powerboating. However, if the lake is large enough, certain parts of the lake (i.e., the middle or deepest) may be used for this activity without negatively influencing other uses.

D6. Options to Assess Your Lake's Fishery

Many lakes have a fish-stocking program in which fish are stocked every year or two to supplement fish species already occurring in the lake or to introduce additional fish species into the system. However, few lakes that participate in stocking check the progress or success of these programs with regular fish surveys. Lake managers should have information about whether or not funds delegated to fish stocking are being well spent, and it is difficult to determine how stocked fish species are surviving and reproducing or how they are affecting the rest of the fish community without a comprehensive fish assessment.

A simple, inexpensive way to collect information on the status of a fishery is to sample anglers actively involved in recreational fishing on the lake and evaluate the types, numbers and sizes of fish caught. Such information provides insight on the status of fish populations in the lake, as well as a direct measure of the quality of fishing and the fishing experience. However, the numbers and types of fish sampled by anglers are limited, focusing on game and catchable-sized fish. Thus, in order to obtain a comprehensive assessment of the fish community, including non-game fish species, more quantitative methods such as gill netting, trap netting, seining, trawling, angling (hook and line fishing) and electroshocking must be employed. Each method has its advantages and limitations, and frequently multiple gears are employed. The best gear and sampling methods depend on the target species and life stage, the types of information desired, and the environment to be sampled.

It is best to monitor fish populations annually. The best time of year depends on the sampling method, the target fish species, and the types of data to be collected. In many lakes and regions, the best time to sample fish is during the fall turnover period after thermal stratification breaks down and the lake is completely mixed because: (1) young-of-year (YOY) and age 1+ (one year or older) fish of most target species should be present and vulnerable to most standard collection gear, including seines, trap nets and electroshockers; (2) species that dwell in the hypolimnion during the summer may be more vulnerable to capture during fall overturn; and (3) lower water temperatures in the fall can help reduce sampling-related mortality. Sampling locations are also species, life stage, and gear dependent. As with sampling methods and time, locations should be selected to maximize capture efficiency for the target species of interest and provide the greatest gain in information for the least amount of sampling effort.

The Illinois Department of Natural Resources (IDNR) will perform a fish survey at no charge on most public and some private water bodies. In order to determine if your lake is eligible for a survey by the IDNR, contact Frank Jakubecik, Fisheries Biologist, at (815) 675-2319. If a lake is not eligible for an IDNR fish survey or if a more comprehensive survey is desired, contact the Environmental Services for a list of consultants.

APPENDIX E. WATER QUALITY STATISTICS FOR ALL LAKE COUNTY LAKES.

2000 - 2009 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2009	
Average	**166**	
Median	**161**	
Minimum	**65**	**IMC**
Maximum	**330**	**Flint Lake**
STD	**42**	
n =	**819**	

	ALKanoxic 2000-2009	
Average	**198**	
Median	**189**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**49**	
n =	**251**	

	Condoxic <=3ft00-2009	
Average	**0.8846**	
Median	**0.7910**	
Minimum	**0.2260**	**Schreiber Lake**
Maximum	**6.8920**	**IMC**
STD	**0.5217**	
n =	**823**	

	Condanoxic 2000-2009	
Average	**1.0121**	
Median	**0.8431**	
Minimum	**0.3210**	**Lake Kathyrn, Schreiber Lake**
Maximum	**7.4080**	**IMC**
STD	**0.7784**	
n =	**251**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2009	
Average	**0.514**	
Median	**0.160**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.087**	
n =	**824**	

*ND = Many lakes had non-detects (76.5%)
Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2009	
Average	**2.134**	
Median	**1.430**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.325**	
n =	**251**	

*ND = 20.3% Non-detects from 32 different lakes

	pHoxic <=3ft00-2009	
Average	**8.35**	
Median	**8.34**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.40**	**Summerhill Estates**
STD	**0.46**	
n =	**818**	

	pHanoxic 2000-2009	
Average	**7.31**	
Median	**7.33**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.41**	
n =	**251**	

	All Secchi 2000-2009	
Average	**4.56**	
Median	**3.15**	
Minimum	**0.25**	**Ozaukee Lake**
Maximum	**24.77**	**West Loon Lake**
STD	**3.80**	
n =	**763**	

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2000 - 2009 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2009	
Average	**1.418**	
Median	**1.180**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.826**	
n =	**824**	

*ND = 3.8% Non-detects from 15 different lakes

	TPoxic <=3ft00-2009	
Average	**0.099**	
Median	**0.063**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**824**	

*ND = 2.4% Non-detects from 8 different lakes

	TSSall <=3ft00-2009	
Average	**15.3**	
Median	**7.9**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**830**	

*ND = 1.3% Non-detects from 8 different lakes

	TDSoxic <=3ft00-2004	
Average	**470**	
Median	**454**	
Minimum	**150**	**Lake Kathryn, White**
Maximum	**1340**	**IMC**
STD	**169**	
n =	**745**	

No 2002 IEPA Chain Lakes.

	CLoxic <=3ft00-2009	
Average	**191**	
Median	**145**	
Minimum	**2.7**	**Schreiber Lake**
Maximum	**2760**	**IMC**
STD	**220**	
n =	**561**	

	TKNanoxic 2000-2009	
Average	**2.883**	
Median	**2.235**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.300**	
n =	**251**	

*ND = 2.9% Non-detects from 4 different lakes

	TPanoxic 2000-2009	
Average	**0.311**	
Median	**0.167**	
Minimum	**0.012**	**Independ. Grove**
Maximum	**3.800**	**Taylor Lake**
STD	**0.417**	
n =	**251**	

	TVSoxic <=3ft00-2009	
Average	**129.7**	
Median	**125.5**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.8**	
n =	**774**	

No 2002 IEPA Chain Lakes

	CLanoxic <=3ft00-2009	
Average	**198**	
Median	**117**	
Minimum	**3.5**	**Schreiber Lake**
Maximum	**2390**	**IMC**
STD	**327**	
n =	**159**	

Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

Minimums and maximums are based on data from all lakes from 2000-2009 (n=1378).

Average, median and STD are based on data from the most recent water quality sampling year for each lake.

LCHD Lakes Management Unit ~ 12/9/2009

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APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

			Funding Focus				
Grant Program Name	**Funding Source**	**Contact Information**	**Water Quality/ Wetland**	**Habitat**	**Erosion**	**Flooding**	**Cost Share**
Challenge Grant Program	USFWS	847-381-2253 or 309-793-5800		X	X		
Chicago Wilderness Small Grants	CW	312-346-8166 ext. 30					None
Partners in Conservation (formerly C2000)	IDNR	http://dnr.state.il.us/orep/c2000/		X			None
Conservation Reserve Program	NRCS	http://www.nrcs.usda.gov/programs/crp/		X			Land
Ecosystems Program	IDNR	http://dnr.state.il.us/orep/c2000/ecosystem/		X			None
Emergency Watershed Protection	NRCS	http://www.nrcs.usda.gov/programs/ewp/			X	X	None
Five Star Challenge	NFWF	http://www.nfwf.org/AM/Template.cfm		X			None
Illinois Flood Mitigation Assistance Program	IEMA	http://www.state.il.us/iema/construction.htm				X	None
Great Lakes Basin Program	GLBP	http://www.glc.org/basin/stateproj.html?st=il	X		X		None
Illinois Clean Energy Community Foundation	ICECF	http://www.illinoiscleanenergy.org/		X			
Illinois Clean Lakes Program	IEPA	http://www.epa.state.il.us/water/financial-assistance/index.html					None
Lake Education Assistance Program (LEAP)	IEPA	http://www.epa.state.il.us/water/conservation-2000/leap/index.html	X				$500

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
IEMA = Illinois Emergency Management Agency
IEPA = Illinois Environmental Protection Agency
IDNR = Illinois Department of Natural Resources
IDOA = Illinois Department of Agriculture
LCSMC = Lake County Stormwater Management Commission
LCSWCD = Lake County Soil and Water Conservation District
NFWF = National Fish and Wildlife Foundation
NRCS = Natural Resources Conservation Service
USACE = United States Army Corps of Engineers
USFWS = United States Fish and Wildlife Service

Table F1. Continued

Grant Program Name	Funding Source	Contact Information	Funding Focus: Water Quality/ Wetland	Funding Focus: Habitat	Funding Focus: Erosion	Funding Focus: Flooding	Cost Share
Northeast Illinois Wetland Conservation Account	USFWF	847-381-2253	X				
Partners for Fish and Wildlife	USFWS	http://ecos.fws.gov/partners/		X			> 50%
River Network's Watershed Assistance Grants Program	River Network	http://www.rivernetwork.org	X	X	X		na
Section 206: Aquatic Ecosystems Restoration	USACE	312-353-6400, 309-794-5590 or 314-331-8404		X			35%
Section 319: Non-Point Source Management Program	IEPA	http://www.epa.state.il.us/water/financial-assistance/non point.html	X	X			>40%
Section 1135: Project Modifications for the Improvement of the Environment	USACE	312-353-6400, 309-794-5590 or 314-331-8404		X			25%
Stream Cleanup And Lakeshore Enhancement (SCALE)	IEPA	http://www.epa.state.il.us/water/watershed/scale.html	X	X			None
Streambank Stabilization & Restoration (SSRP)	IDOA/ LCSWCD	http://www.agr.state.il.us/Environment/conserv/ or call LCSWCD at (847) 223-1056		X	X		25%
Watershed Management Boards	LCSMC	http://www.co.lake.il.us/smc/projects/wmb/default.asp	X		X	X	50%
Wetlands Reserve Program	NRCS	http://www.nrcs.usda.gov/programs/wrp/	X	X			Land
Wildlife Habitat Incentive Program	NRCS	http://www.nrcs.usda.gov/programs/whip/		X			Land

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
IEMA = Illinois Emergency Management Agency
IEPA = Illinois Environmental Protection Agency
IDNR = Illinois Department of Natural Resources
IDOA = Illinois Department of Agriculture
LCSMC = Lake County Stormwater Management Commission
LCSWCD = Lake County Soil and Water Conservation District
NFWF = National Fish and Wildlife Foundation
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USACE = United States Army Corps of Engineers
USFWS = United States Fish and Wildlife Service