2009 SUMMARY REPORT
of
Sullivan Lake

Lake County, Illinois

Prepared by the

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TABLE OF CONTENTS

APPENDICES

EXECUTIVE SUMMARY

Sullivan Lake is a slough of glacial origin located in the village of Lakemoor within Grant Township. The lake has a surface area of 53.27 acres and a mean depth of 2.10 feet. The Lakemoor Golf Course surrounds the lake on three sides and owns nearly all of the lake. The golf course uses the lake for aesthetics and water hazards, and is in control of any lake management conducted on the lake. Access to Sullivan Lake, is open only to lakeshore residents on the north and west sides of the lake through their own properties

Sullivan 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.

Sullivan Lake receives water from Volo bog and its 1423.77 acre watershed and drains into the Lily Lake Drain through a creek located on the west side of the lake which enters the Fox River. The primary land use within the Sullivan Lake watershed was public and private open space (34%); which is unique characteristic as Lake County only has 13% of land preserved as public and private open space.

Sullivan Lake is a high quality waterbody in Lake County. The 2009 water quality of Sullivan Lake was above average for Lake County lakes with many parameters above the county medians. Total phosphorus in Sullivan Lake averaged 0.037 mg/L and the median for the county was 0.063 mg/L. Total suspended solid concentrations averaged 3.3 mg/L which was more than two times lower than the county average of 7.9 mg/L; this was correlated with water clarity as shown by the average Secchi depth readings reaching the bottom of the lake throughout the season. The average conductivity for Sullivan Lake was 0.6048 mS/cm and average Cl- concentration was 59 mg/L. These parameters were below the county median of 0.7910 mS/cm and 145 mg/L; however conductivity has increased 26% since 2002.

The aquatic plant community has shifted in overall composition since 2002. White Water Lily was the dominant aquatic plant species; however the most dramatic change was the density of Common Bladderwort that was not documented in 1995 and assessed at relatively low populations in 2002. Among the most desirable aquatic plants within the community were American Lotus and Small Bladderwort. These plants are rare in Lake County; Sullivan Lake is the only lake outside of the Chain of Lakes to have American Lotus. In addition Small Bladderwort is endangered in Illinois.

Based on the 2009 assessment, there was a significant increase in shoreline erosion with approximately 59% of the shoreline having some degree of erosion. Overall, 41% of the shoreline had no erosion, 38% had slight erosion, 21% had moderate. The areas of moderate erosion should be addressed soon. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion.

Sullivan Lake can support a variety of aquatic and terrestrial wildlife, due to the low amount of residential shoreline around the lake and the presence of wetland buffers around most of the shore provided high quality habitat for birds, amphibians and reptiles. Additionally, the high quality aquatic plant community provides habitat for fish which include the state endangered species, Blackchin Shiner (*Notropis heterodon*) and Iowa Darter (*Etheosoma exile*).

LAKE FACTS

Lake Name:	Sullivan Lake
Historical Name:	None
Nearest Municipality:	Lakemoor
Location:	T 45N, R 9E, Sections 28, 33
Elevation:	750.0 feet mean sea level
Major Tributaries:	Volo Bog
Watershed:	Fox River
Sub-watershed:	Lower Fox River
Receiving Water body:	Lily Lake Drain
Surface Area:	58.3 acres
Shoreline Length:	2.6 miles
Maximum Depth:	10.5 feet
Average Depth:	2.1 feet
Lake Volume:	122.4 acre-feet
Lake Type:	Glacial
Watershed Area:	1423.8 acres
Major Watershed Land uses:	Public and Private Open Space, agriculture, and wetlands
Bottom Ownership:	Lakemoor Golf Course
Management Entities:	Lakemoor Golf Course
Current and Historical uses:	Fishing, water hazard and aesthetics
Description of Access:	Lakemoor Golf Course and lakeshore residents

SUMMARY OF WATER QUALITY

Water samples were collected from May through September in Sullivan Lake at the deepest point in the main body located near the center of the lake in an effort to represent the water quality of the majority of the lake. (Figure 1). Samples were taken at the surface or at 3 feet and analyzed for various water quality parameters (Appendix A). Water level was taken from a stake located on the north side of the lake each month during sampling. Sullivan Lake is within the Lower Fox River watershed which includes Pistakee Lake, Redhead Lake, Lake Matthews, Seven Acre Lake, Lake of the Hollow (Brandenburg Lake), and Volo Bog in Lake County. In 2009 the Lakes Management Unit (LMU) also sampled Lake of the Hollow.

Sullivan Lake had oxygenated conditions throughout the water column in May and June. Low dissolved oxygen conditions existed in the surface waters of Sullivan Lake July through September ranging from 1.07 mg/L in August to 2.36 mg/L in July (Appendix B). The Illinois Environmental Protection Agency's applicable standard for dissolved oxygen is 5.0 mg/L. This concentration is required to maintain a healthy fishery. Anoxic conditions (<1.0 mg/L) were exhibited at the 1-3 foot contours of the lake in August and September. The lowest dissolved oxygen concentration documented was in August at the 2 foot depth (0.40 mg/L). The volume of water in Sullivan Lake that was anoxic during the sampling season could not be calculated due to the absence of a bathymetric map.

Sullivan Lake had above average water quality for Lake County lakes in 2009. The presence of dense aquatic plant communities influenced a variety of water quality parameters in 2002 as well as in 2009. Many water quality parameters remained below county medians in 2009. The total suspended solid (TSS) concentration (turbidity) is composed of nonvolatile suspended solids (NVSS), non-organic clay or sediment materials, and total volatile solids (TVS) (algae and other organic matter). The TSS concentration averaged 3.3 mg/L (Table 1), which was lower than the county median of 7.9 mg/L (Appendix E). 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 increase in TSS concentration (7.8 mg/L) that correlated with an increase in TVS (156 mg/L) accounting for 65% of the TSS in August. The presence of organic detritus and algae coupled with dense aquatic plant communities can negatively affect dissolved oxygen levels. As noted by the anoxic conditions that also occurred in August, aquatic plants and algae produce oxygen during the day as they photosynthesize however during the night the production of oxygen stops and the consumption of oxygen begins as the process of respiration continues. Secchi disk measurement could not be statistically analyzed because measurements were obstructed from aquatic plants and the bottom of the lake. Lake of the Hollow had the deepest average Secchi depth (8.74 ft.) and lowest average TSS (2.0 mg/L) concentration within the Lake County portion of the Lower Fox River watershed (Table 2). Sullivan Lake and Seven Acre Lake also had below county median TSS concentrations of 3.3 mg/L and 6.3 mg/L, respectively. However Redhead Lake and Lake Matthews, both within the Chain of Lakes, had significantly higher TSS concentrations of 36.8 mg/L and 21.2 mg/L, respectively in 2002. These values were influenced by the location of the lakes within the Lower Fox River watershed. Lake of the Hollow, Sullivan Lake, and Seven Acre Lake have small drainage areas and diverse aquatic plant populations that contribute

Figure 1. Water quality sampling site on Sullivan Lake, 2009.

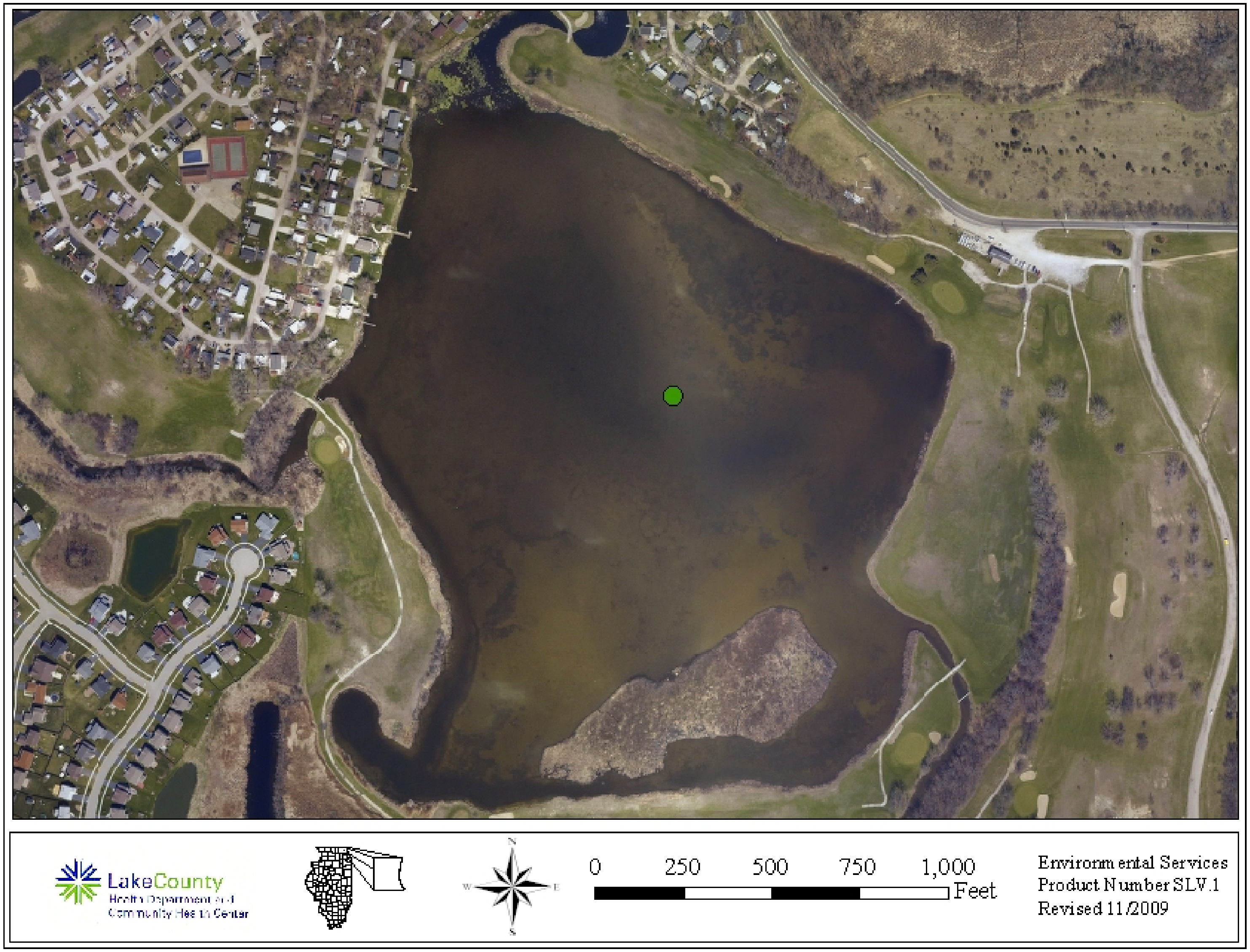


Table 2. Water quality data for Sullivan Lake, 2002 and 2009.

2009	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
19-May	3	200	1.16	<0.1	<0.05	0.037	<0.005	NA	54	3.2	352	93	0.0[a]	0.5338	7.97	10.14
16-Jun	0	183	0.97	<0.1	<0.05	0.022	<0.005	NA	35	1.5	311	97	0.0[a]	0.4700	7.88	8.50
21-Jul	3	210	1.01	<0.1	<0.05	0.023	<0.005	NA	52	1.5	380	127	0.0[a]	0.6310	7.60	2.36
18-Aug	0	215	1.37	<0.1	<0.05	0.042	<0.005	NA	77	7.8	452	156	0.0[a]	0.6969	7.82	1.07
22-Sep	0	227	1.20	<0.1	<0.05	0.061	<0.005	NA	77	2.7	438	127	0.0[a]	0.6922	8.17	1.15
	Average	207	1.14	<0.1	<0.05	0.037	<0.005	NA	59	3.3	387	120	N/A	0.6048	7.89	4.64

2002	Epilimnion															
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
13-May	0	177	1.29	<0.1	<0.05	0.029	<0.005	278	NA	2.9	284	116	0.0[a]	0.4543	8.19	9.57
17-Jun	0	149	1.49	0.1	<0.05	0.029	<0.005	240	NA	3.3	277	110	0.0[a]	0.4036	8.79	8.33
22-Jul	0	161	1.94	<0.1	<0.05	0.03	<0.005	286	NA	5.9	331	138	0.0[a]	0.4768	8.55	3.61
19-Aug	0	189	1.95	<0.1	<0.05	0.040	<0.005	292	NA	9.7	367	156	0.0[a]	0.5234	8.12	4.75
16-Sep	0	211	1.56	<0.1	<0.05	0.032	<0.005	308	NA	4.4	340	132	0.0[a]	0.5332	7.91	5.70
	Average	177	1.65	<0.1	<0.05	0.032	<0.05	281	NA	5.2	320	130	N/A	0.4783	8.31	6.39

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 disk depth was obstructed by the bottom

Table 2. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity within the Lower Fox River watershed.

	Lake of the Hollow	Lake of the Hollow	Redhead Lake
Year	**2000**	**2009**	**2002**
Secchi (feet)	9.28	8.74	1.27
TSS (mg/L)	1.8	2.0	36.8
TP (mg/L)	0.020	0.023	0.141
Conductivity (milliSiemens/cm)	0.4794	0.5771	0.6744

	Volo Bog	Sullivan Lake	Sullivan Lake
Year	**NA**	**2002**	**2009**
Secchi (feet)	NA	NA	NA
TSS (mg/L)	NA	5.2	3.3
TP (mg/L)	NA	0.032	0.037
Conductivity (milliSiemens/cm)	NA	0.4783	0.6048

	Seven Acre Lake
Year	**2003**
Secchi (feet)	4.18
TSS (mg/L)	6.3
TP (mg/L)	0.046
Conductivity (milliSiemens/cm)	0.5838

	Lake Matthews
Year	**2002**
Secchi (feet)	1.41
TSS (mg/L)	21.2
TP (mg/L)	0.152
Conductivity (milliSiemens/cm)	0.7135

Direction of Watershed Flow to the Lower Fox River

to water quality. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity.

Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake could produce algal blooms. The total phosphorus (TP) in Sullivan Lake averaged 0.037 mg/L in 2009 which was a slight increase from the 2002 value of 0.032 mg/L and almost two times lower than the county median of 0.063 mg/L. The same watershed trend of TSS and Secchi depth occurred with TP. Lake of the Hollow had the lowest average TP concentration (0.023 mg/L) in the Lake County portion of the Lower Fox River watershed and Lake Mathews had the highest TP concentration (0.152 mg/L, 2002). Lakes with phosphorus concentrations 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. There were external sources of TP affecting Sullivan Lake such as stormwater from the 1423.77 acres within its watershed as well (Figure 2). 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. Public and private open space (34%) and agriculture (22%) were the major land uses within the watershed (Figure 3). Thirty-four percent of public and private space within a watershed was valuable characteristic of the watershed as Lake County only has 13% of land preserved as open space. For Sullivan Lake public and private open space (30%), single family (15%) and both transportation and multi family (15%) were the land uses contributing the highest percentages of estimated runoff (Table 3). 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. This is especially true of the single family land use; and transportation. When applying lawn fertilizers near lakes it is important to remember that one pound of phosphorus can produce 300-500 pounds of algae (Figure 4). 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 67 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 Sullivan Lake watershed single family homes and the Lakemoor Golfcourse are a major land uses contributing to runoff, applying lawn fertilizers containing zero phosphorus would be an effective way to reduce phosphorus within the watershed.

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 Sullivan Lake was 1.14 mg/L, which was slightly below the county median (1.18 mg/L) and a 31% decrease from the 2002 average (1.65 mg/L). Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means that one of the nutrients is in short supply and any addition of that nutrient to the lake will result in an increase of plant and/or algal growth. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting, ratios greater than or equal to 15:1 indicate phosphorus is limiting, and ratios greater than 10:1, but less than 15:1 indicate there is enough of both nutrients to facilitate excess algae or plant growth. In

Figure 2. Approximate watershed delineation for Sullivan Lake, 2009.

Figure 3. Approximate land use within the Sullivan Lake watershed, 2009.

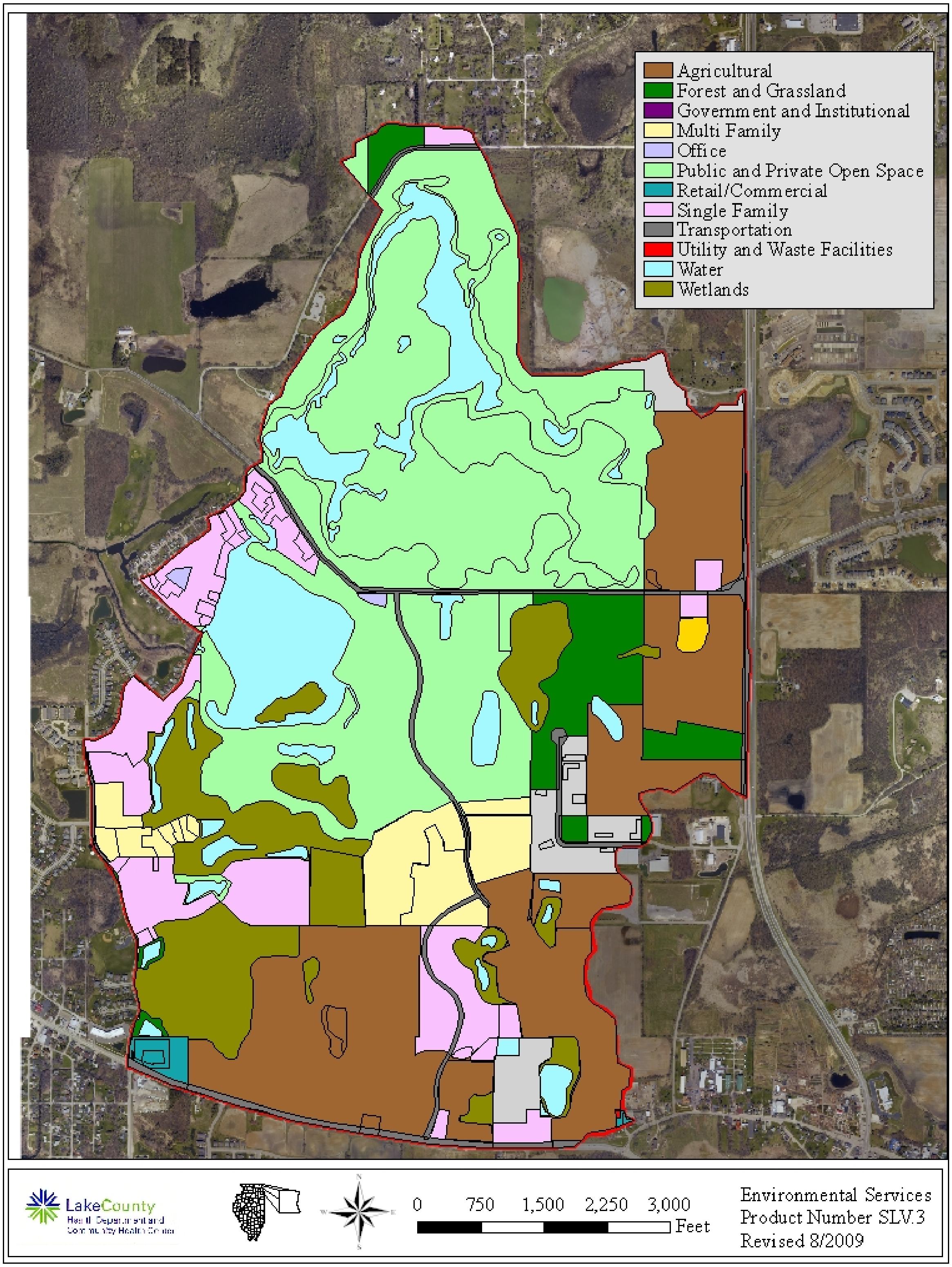


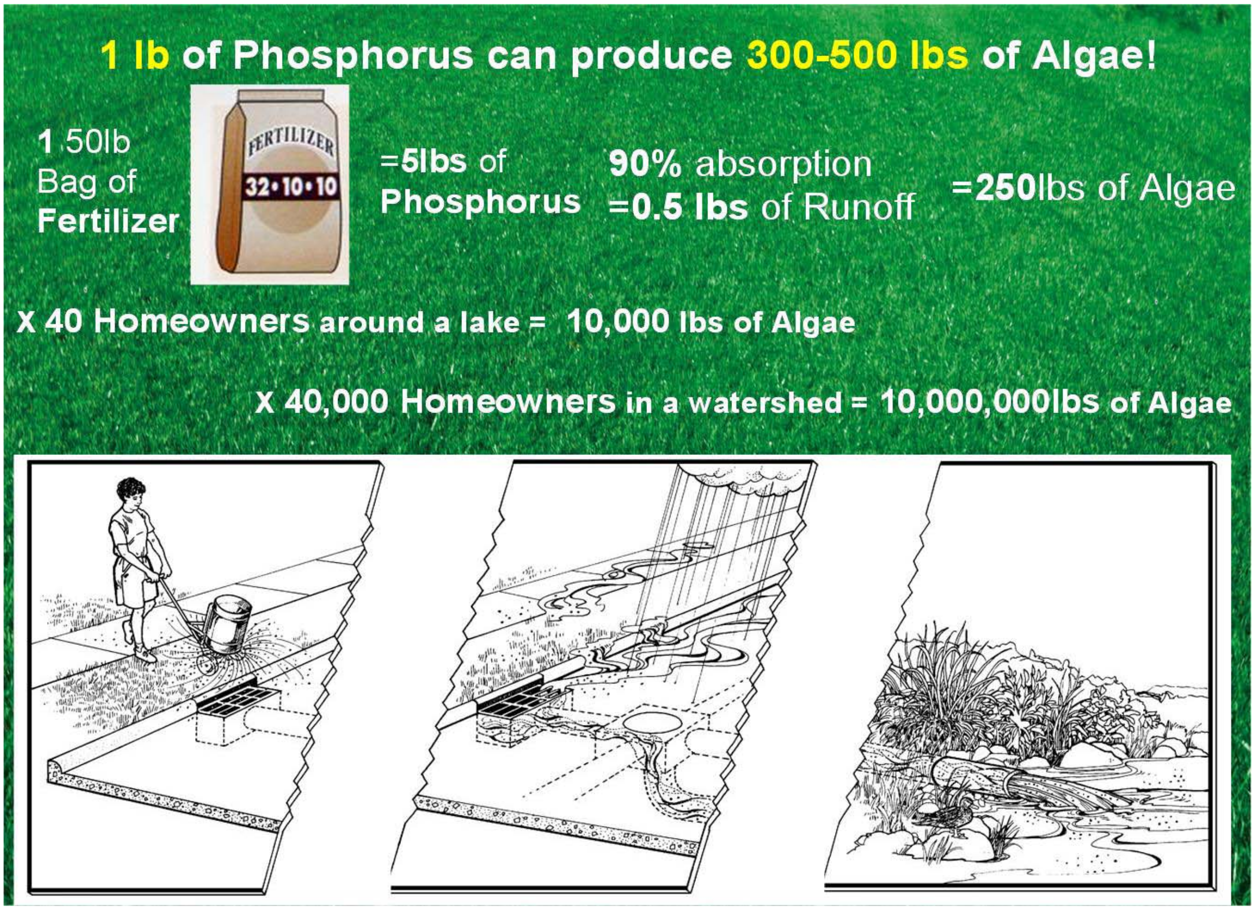
Table 3. Approximate land uses and retention time for Sullivan Lake, 2009.

Land Use	Acreage	% of Total
Agricultural	309.82	21.8%
Disturbed Land	2.98	0.2%
Forest and Grassland	60.66	4.3%
Industrial	40.75	2.9%
Multi Family	67.14	4.7%
Office	2.03	0.1%
Public and Private Open Space	480.44	33.7%
Retail/Commercial	7.02	0.5%
Single Family	125.13	8.8%
Transportation	39.47	2.8%
Utility and Waste Facilities	0.25	0.0%
Water	139.39	9.8%
Wetlands	148.69	10.4%
Total Acres	**1423.77**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	309.82	0.05	42.6	6.4%
Disturbed Land	2.98	0.05	0.4	0.1%
Forest and Grassland	60.66	0.05	8.3	1.2%
Industrial	40.75	0.80	89.7	13.4%
Multi Family	67.14	0.50	92.3	13.8%
Office	2.03	0.85	4.8	0.7%
Public and Private Open Space	480.44	0.15	198.2	29.6%
Retail/Commercial	7.02	0.85	16.4	2.5%
Single Family	125.13	0.30	103.2	15.4%
Transportation	39.47	0.85	92.3	13.8%
Utility and Waste Facilities	0.25	0.30	0.2	0.0%
Water	139.39	0.00	0.0	0.0%
Wetlands	148.69	0.05	20.4	3.1%
TOTAL	**1423.77**		**668.8**	100.0%

Lake volume	**122.40**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.18**	**years**
	66.80	**days**

Figure 4. Illustration of how phosphorus from lawn fertilizers enters a watershed.



2002 Sullivan Lake was strongly phosphorus limited (TN:TP ratio of 51:1) and in 2009 the TN:TP ratio was 31:1 indicating that phosphorus was still the limiting nutrient in the lake. 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 2002 Sullivan Lake was slightly eutrophic with a TSIp value of 51.4 with aquatic life having full support and recreational use scoring partial support. In 2009 Sullivan Lake remained slightly eutrophic with a TSIp value of 56.2 ranking 42nd out of 165 in the county (Table 4). The impairment indices determined that Sullivan Lake maintained full support for aquatic life and partial support for recreational use do to substantial macrophyte impairment.

Conductivity readings, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county (Figure 5). 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 Sullivan Lake was 0.6048 mS/cm. This was lower than the county median of 0.7910 mS/cm but a 26% increase since 2002 (0.4783 mS/cm). The chloride concentration averaged 59 mg/L for the season and was considerably 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 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. Chlorides are not utilized in a lake ecosystem and often persist in a lake until they are diluted from seasonal rain events. 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.

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted on Sullivan Lake in July 2009. There were 62 points generated based on a computer grid system with points 60 meters apart (Figure 6). Aquatic plants existed at all 62 of the sites (Figure 7) that included 19 aquatic plant species and one macro-algae; the only exotic invasive species documented was Curlyleaf Pondweed (Table 5). While the aquatic plant community was diverse, there was a change in the overall composition of aquatic plants present in 2009 when compared to 2002. The 2002 aquatic plant assessments included: Floatingleaf Pondweed, American Pondweed, Small Pondweed, White Water Crowfoot, and Grass-leaved Arrowhead. These species were not documented in 2009; however Giant Duckweed, Star Duckweed and Small Bladderwort were added to the community in the 2009 assessment. Among the most desirable aquatic plants within the community were American Lotus (2%) and Small Bladderwort (18%). These plants are rare in Lake County; Sullivan Lake is the only lake outside of the Chain of Lakes to have American Lotus (Figure 8). In addition

Table 4. 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 4. 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 4. 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 4. 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 5. Chloride (Cl^-) concentration vs. conductivity for Sullivan Lake, 2009.

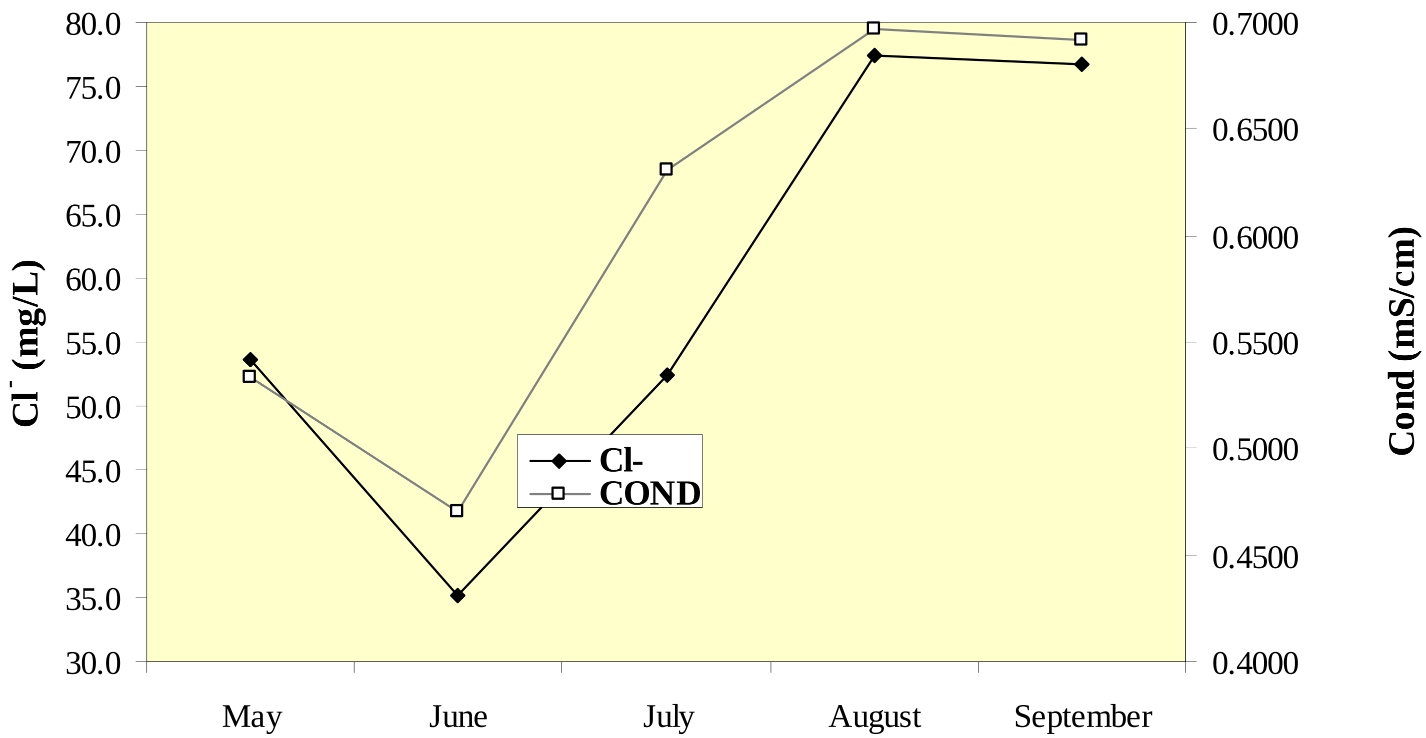


Figure 6. Aquatic plant sampling grid for Sullivan Lake, July 2009.

Figure 7. Aquatic plant sampling grid that illustrates plant density on Sullivan Lake, July 2009.

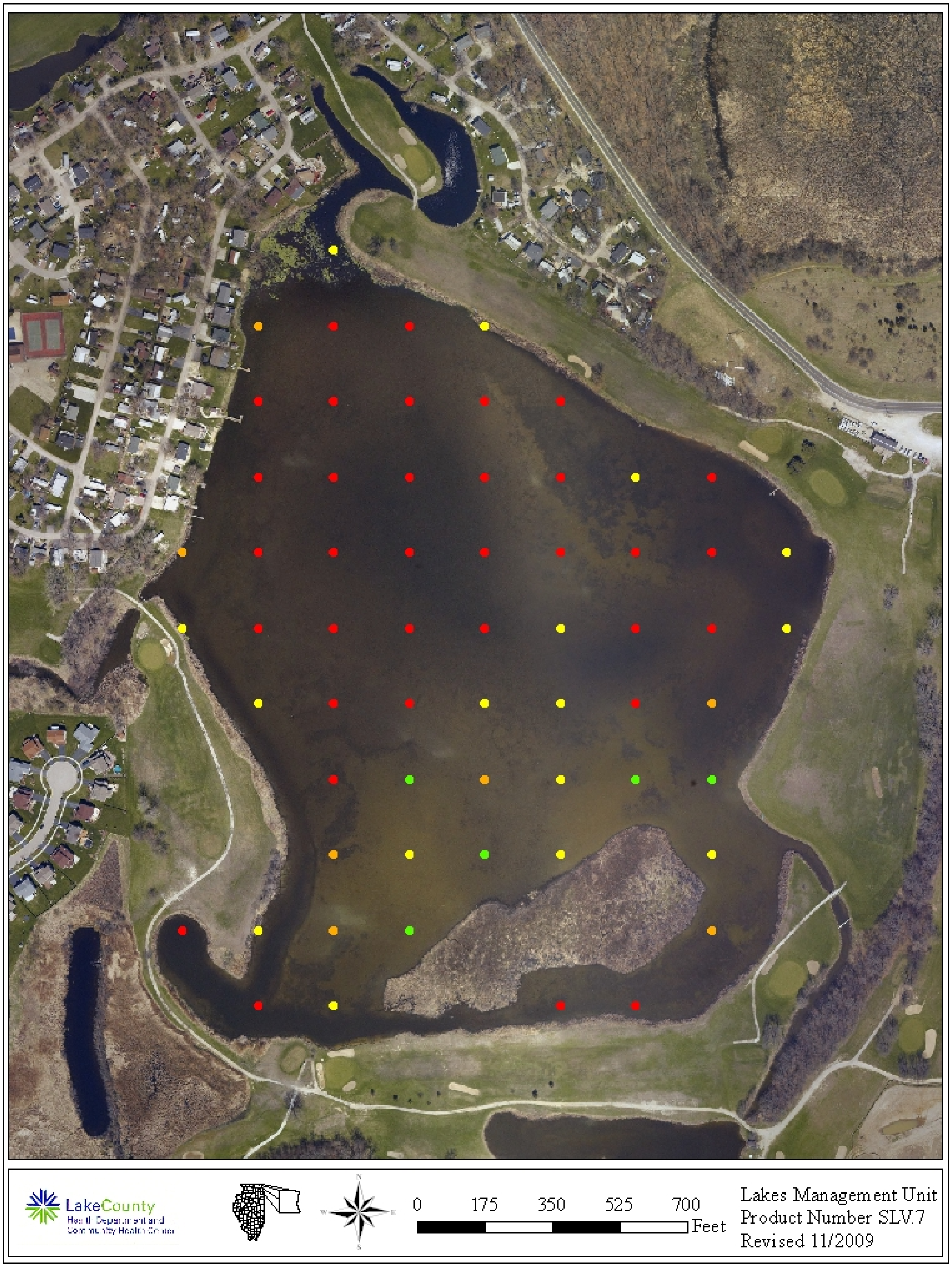


Table 5a. Aquatic plant species found at the 62 sampled sites on Sullivan Lake, June 2009. Maximum depth that plants were found was 5.8 feet

Plant Density	American Lotus	Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Flatstem Pondweed	Giant Duckweed	Illinois Pondweed
Absent	61	9	20	45	61	36	61	33	51	54
Present	1	12	8	7	1	23	1	22	11	5
Common	0	23	13	1	0	2	0	5	0	3
Abundant	0	15	9	1	0	1	0	1	0	0
Dominant	0	3	12	8	0	0	0	1	0	0
% Plant Occurrence	1.6	85.5	67.7	27.4	1.6	41.9	1.6	46.8	17.7	12.9

Plant Density	Northern Watermilfoil	Sago Pondweed	Small Bladderwort	Slender Naiad	Spattordock	Spiny Naiad	Star Duckweed	Watermeal	White Waterlily
Absent	57	50	51	57	61	53	52	58	8
Present	5	12	10	5	1	9	10	1	6
Common	0	0	1	0	0	0	0	1	10
Abundant	0	0	0	0	0	0	0	2	11
Dominant	0	0	0	0	0	0	0	0	27
% Plant Occurrence	8.1	19.4	17.7	8.1	1.6	14.5	16.1	6.5	87.1

Table 5b. Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	0	0.0
>0-10%	0	0.0
10-40%	5	8.1
40-60%	7	11.3
60-90%	16	25.8
>90%	34	54.8
Total Sites with Plants	62	100.0
Total # of Sites	62	100.0

Figure 8. Aquatic plant sampling grid that illustrates plant density for Lotus, on Sullivan Lake, June 2009.

Small Bladderwort is endangered in Illinois. A difference in the plant sampling technique from 2002 to 2009 may account for some of the variation. In 2002 plant sampling was conducted once a month May-September, which could potentially document early and late plant species. The 2009 survey utilized a grid system that encompassed the entire lake to reduce biases; the 2002 survey used a meandering survey technique.

The 2002 aquatic plant community was dominated by White Water Lily (73%) followed by Chara (macro-algae, 59%) and Sago Pondweed (47%). In 2009 White Water Lily still had the highest aquatic plant density in Sullivan Lake at 87% of the sites. However in 2009 the plant community was co-dominated by the floating aquatic plant White Water Lily and the submerged aquatic plant Common Bladderwort that was found at 86% of all the sampling sites. The density of Common Bladderwort in Sullivan Lake in 2009 was unexpected since the 1995 aquatic plant survey did not document Common Bladderwort and the 2002 survey it was found at 8% of the sites from May to September. Other abundant aquatic plants in 2009 included Chara (68%) and Flatstem Pondweed (47%). Curlyleaf Pondweed, the only exotic plant found in 2002 and 2009, was observed only at one site and does not currently pose a threat of reaching nuisance levels in Sullivan Lake. 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 Pondweed plants usually die back which is typically followed by an increase in phosphorus availability that may fuel nuisance algal blooms. However due to the diversity and density of aquatic plants in Sullivan Lake, Curlyleaf Pondweed has not been able to establish a vigorous population and was found at 2% of sites in 2009 and 3% of sites in 2002.

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 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 Sullivan Lake reached to the bottom throughout the sampling season May - September. Plants were found at 100% of the sampling sites. Most of the lake had aquatic plant density greater than 90% with the exception being on the north side of the island. 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 score for Lake County lakes from 2000-2009 was 13.7. Sullivan Lake had a FQI

Table 5. Aquatic plant species found in Sullivan Lake, 2009.

American Lotus	*Nelumbo lutea*
Coontail	*Ceratophyllum demersum*
Chara (Macro alga)	*Chara spp.*
American Elodea	*Elodea canadensis*
Small Duckweed	*Lemna minor*
Star Duckweed	*Lemna trisulca*
Curlyleaf Pondweed	*Potamogeton crispus*
Illinois Pondweed	*Potamogeton illinoensis*
Sago Pondweed	*Potamogeton pectinatus*
Flatstem Pondweed	*Potamogeton zosteriformis*
Northern Watermilfoil	*Myriophyllum sibiricum*
Slender Naiad	*Najas flexilis*
Spiny Naiad	*Najas marina*
Spatterdock	*Nuphar variegata*
White Water Lily	*Nymphaea tuberosa*
Giant Duckweed	*Spirodella polyrhiza*
Small Bladderwort*****	*Utricularia minor*
Common Bladderwort	*Utricularia vulgaris*
Watermeal	*Wolffia columbiana*

*** Endangered in Illinois**

Table 7. 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 7. 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 7. 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 7. 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**

score of 26.9 in 2009 which was a slight decrease from the 2002 value of 28.2. However the 2009 value indicates a diverse aquatic plant community that contains more desirable species than most Lake County lakes ranking Sullivan Lake 9th out of 154 lakes (Table 6).

SUMMARY OF SHORELINE CONDITION

Lakes with stable water levels potentially have less shoreline erosion problems. The water level fluctuations on the lake were relatively stable. There was little monthly change from May to August. These types of slight water level fluctuations can have a reduced impact on shoreline erosion when compared to significant fluctuations. The most significant water level fluctuation occurred as a decrease in water level from August to September of 4.5 inches. 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. 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).

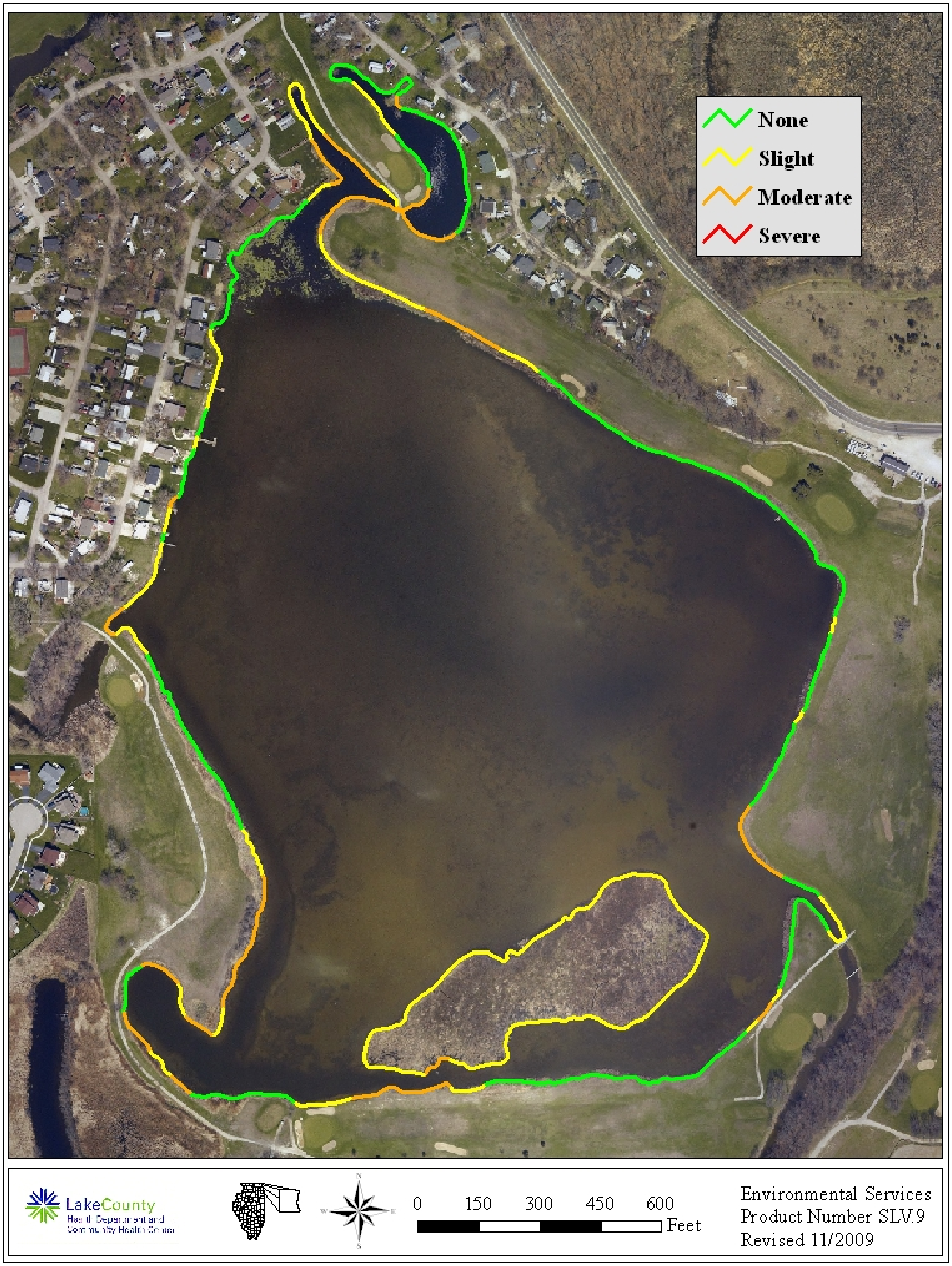
A shoreline assessment was conducted at Sullivan Lake on September 18, 2002. The shoreline was assessed for a variety of criteria, and based on these assessments; several important generalizations could be made. Sullivan Lake's shoreline was made up of only three different types: buffer (66%), wetland (22%) and lawn (12%). Approximately 82% of the shoreline is developed and the majority of this developed shoreline is comprised of buffer (81%). The remainder of the developed shoreline consists of lawn (14%) and wetland (6%). The undeveloped portions of the lake are made up entirely of wetland. 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. On the other hand, buffer and wetland are ideal shoreline types because they typically prevent shoreline erosion, as well as provide wildlife habitat. Wetland and buffered shorelines should be maintained as much as possible and manicured lawns should be replaced with 10-30 feet of buffer strip made up of native vegetation in order to reduce or eliminate erosion.

The shoreline was reassessed in 2009 for significant changes in erosion since 2002. Based on the 2009 assessment, there was an increase in shoreline erosion with approximately 59% of the shoreline having some degree of erosion (Figure 9). Overall, 41% of the shoreline had no erosion, 38% had slight erosion, 21% had moderate. The areas of moderate erosion mostly 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 activities on Sullivan Lake. Waterfowl and song birds typical of residential areas were noted throughout the sampling

Figure 9. Shoreline erosion on Sullivan Lake, 2009.



season. Some residential areas offered good habitat with mature trees and naturalized areas. Residences with manicured lawns mowed to the water's edge offered the least habitat on the lake. Downed trees (deadfall) in the water offer good habitat for fish, turtles and wading birds. Deadfall should be left in the water. Sullivan Lake has been noted as encompassing some quality habitats for a variety of aquatic and terrestrial wildlife. In the past, state threatened fish species, blackchin shiner (*Notropis heterodon*) and Iowa Darter (*Etheosoma exile*), were also found in Sullivan Lake. The maintenance of wetland, wooded and buffered shorelines, and the establishment of additional buffer strips especially along the shoreline of developed areas is very important and strongly recommended to continue to provide the quality and diversity of habitat for birds and other animals in the future.

LAKE MANAGEMENT RECOMMEDATIONS

Sullivan Lake management is administered by the Lakemoor Golf Course. Sullivan Lake is a high quality waterbody in Lake County, due to good water quality and the presence of the dense and diverse aquatic plant community. It is recommended that minimal in-lake management be conducted on the lake. Due to the shallow nature and poor dissolved oxygen conditions, the lake is not a good candidate for a game fishery. To improve the overall quality of Sullivan Lake, the LMU has the following recommendations:

- **Reduce Conductivity and Chloride Concentrations**

  The 2009 average conductivity reading for Sullivan Lake was 0.6048mS/cm; which is lower than the county median of 0.7910 mS/cm. However, this is still a 26% increase from the 2002 value of 0.4783 m/S. Chloride concentrations averaged 59 mg/L for the season and the county median was 166 mg/L. Lake County medians are high due to the use of road salts for winter road management that is a major contributor to chloride concentrations and conductivity. Proper application procedures and alternative methods can be used to keep these concentrations under control before they reach levels that could harm plant and wildlife populations (Appendix D1).

- **Volunteer Lakes Management Program**

  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 D2). In addition to the VMLP, a staff gauge should be installed to monitor the lake level each month. The establishment of a VLMP on Sullivan 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.

- **Lakes with shoreline erosion**

  Based on the 2009 assessment, there was a significant increase in shoreline erosion with approximately 59% of the shoreline having some degree of erosion. Overall, 41% of the shoreline had no erosion, 38% had slight erosion, 21% had moderate. The areas of moderate erosion should be addressed soon. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion (Appendix D3).

- **Creating a Bathymetric Map**

  Sullivan Lake has no documentation of a bathymetric map. Creating an updated bathymetric map can help with improvements to Sullivan Lake. A bathymetric map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, fish stocking, etc.) are part of the lake's overall management (Appendix D5).

- **Proper Disposal of Unused and Expired Medication**

  Wastewater treatment plants and septic systems are generally not designed to treat pharmaceutical waste and this practice has led to medications being found in surface and ground water, both of which are sources of drinking water. Research has shown that trace amounts of pharmaceuticals and personal care products (PPCPs) can cause ecological harm. If you have unused PPCPs you should save them for an IEPA-sponsored household hazardous waste collection (Appendix D6).

- **Become a Member of Illinois Lakes Management Association**

  It is recommended that the Lakemoor Golf Club and private homeowners become a member of Illinois Lake Management Association (ILMA). ILMA is a group of professional and citizens with interests in lakes management. There is an annual conference where ideas are exchanged and questions can be answered. In addition, you will receive a membership directory with contact information if you have questions between conferences.

- **Grant program opportunities**

  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

Sullivan 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 2.21
51909	0	0.71	16.29	10.09	105.1	0.5326	7.97	4971	Surface		
51909	1	1.05	16.29	10.12	105.4	0.5329	7.92	4772	Surface	100%	
51909	2	2.04	16.29	10.11	105.3	0.5335	7.96	1492	0.29	30%	4.009
51909	3	2.81	16.31	10.14	105.7	0.5338	7.97	960	1.06	19%	0.416

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 4.38
61609	0	0.48	21.30	8.49	98.6	0.4700	7.88	3080	Surface		
61609	1	1.08	21.28	8.50	98.8	0.4696	7.88	2813	Surface	100%	
61609	2	2.03	21.21	8.74	101.4	0.4681	7.88	308	0.28	11%	7.900
61609	3	2.80	21.21	8.82	102.3	0.4683	7.87	125	1.05	4%	0.859

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 3.26
72109	0	0.29	20.17	3.97	45.1	0.6285	8.05	3776	Surface		
72109	1	1.05	19.83	2.57	28.9	0.6281	7.77	3794	Surface	100%	
72109	2	2.11	19.62	2.39	26.8	0.6280	7.66	738	0.36	19%	4.548
72109	3	2.90	19.66	2.36	26.5	0.6310	7.60	76	1.15	2%	1.977

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 10.07
81809	0	0.29	23.33	1.07	13.0	0.6969	7.82	3578	Surface		
81809	1	1.00	23.11	0.77	9.3	0.6950	7.65	3803	Surface	100%	
81809	2	2.00	22.69	0.40	4.8	0.7009	7.56	307	0.25	8%	10.067

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
										Average	15.40
92209	0	0.32	18.95	1.15	12.8	0.6922	8.17	509	Surface		
92209	1	1.03	18.53	0.50	5.5	0.6938	8.00	524	Surface	100%	
92209	2	1.99	18.37	0.42	4.6	0.6954	7.98	13	0.24	2%	15.402

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:

<u>Phosphorus</u>:

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. Options to Reduce Conductivity and Chloride Concentrations

Road salt (sodium chloride) is the most commonly used winter road de-icer. While recent advances in the technology of salt spreaders have increased the efficiency to allow more even distribution, the effect to the surrounding environment has come into question. Whether it is used on highways for public safety or on your sidewalk and driveway to ensure your own safety, the main reason for road salt's popularity is that it is a low cost option. However, it could end up costing you more in the long run from the damages that result from its application.

Excess salt can effect soil and in turn plant growth. This can lead to the die-off of beneficial native plant species that cannot tolerate high salt levels, and lead to the increase of non-native, and/or invasive species that can.

Road salts end up in waterways either directly or through groundwater percolation. The problem is that animals do not use chloride and therefore it builds up in a system. This can lead to decreases in dissolved oxygen, which can lead to a loss of biodiversity.

The Environmental Services monitors the levels of salts in surface waters in the county by measuring conductivity and chloride concentrations (which are correlated to each other). There has been an overall increase in salt levels that has been occurring over the past couple of decades. These increases could have detrimental effects on plants, fish and animals living and using the water.

What can you do to help maintain or reduce chloride levels?

Option 1. Proper Use on Your Property

Ultimately, the less you use of any product, the better. Physically removing as much snow and ice as possible before applying a de-icing agent is the most important step. Adding more products before removing what has already melted can result in over application, meaning unnecessary chemicals ending up in run-off to near by streams and lakes.

<u>**Option 2. Examples of Alternatives**</u>

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 would.

Calcium, Magnesium or Potassium Chloride

- Aided by the intense heat evolved during its dissolution, these are used as ice-melting compounds.

<u>Calcium Magnesium Acetate (CMA)</u>

- Mixture of dolomic lime and acetic acid; can also be made from cheese whey and may have even better ice penetration.
- Benefits: low corrosion rates, safe for concrete, low toxicity and biodegradable, stays on surfaces longer (fewer applications necessary).
- Multi-Purpose: use straight, mix with sodium chloride, sand or as a liquid

- Negatives: slow action at low temperatures, higher cost.

Agricultural Byproducts

- Usually mixed with calcium chloride to provide anti-corrosion properties.
- Lower the freezing point of the salt they are added to.
- as a pre-wetting (anti-ice) agent, it's like a Teflon treatment to which ice and snow will not stick.

Local hardware and home improvement stores should carry at least one salt alternative. Some names to look for: Zero Ice Melt Jug, Vaporizer, Ice Away, and many others. Check labels or ask a sales associate before you buy in order to ensure you are purchasing a salt alternative.

Option 3. Talk to Your Municipality About Using an Alternative

Many municipalities are testing or already using alternative products to keep the roads safe. Check with your municipality and encourage the use of these products.

D2. 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:

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Lake County Health Department – Environmental Services
500 W. Winchester Unit 102
Libertyville, IL 60048
(847) 377-8030

D3. 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.

D4. Option for Creating a Bathymetric Map

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Maps can be created by the Lake County Health Department – Environmental Services (ES). ES purchased a BioSonics DT-X^{TM} Echosounder. With this equipment the creation of an accurate bathymetric map of almost any size lake in the county is possible. Costs vary, but can range from $2,000-5,000 depending on lake size.

D5. Options for the proper disposal of unused and expired medication

What do you do with your unused prescription drugs? Most people would say "flush them down the toilet." Well, the age-old advice of flushing pharmaceuticals down the toilet is now considered to be the least desirable of all alternatives. Many households and businesses have gotten into the habit of flushing waste pharmaceuticals down the toilet or pouring them down the drain because it was low cost and the simplest way to prevent unintended use. However, wastewater treatment plants and septic systems are generally not designed to treat pharmaceutical waste and this practice has led to medications being found in surface and ground water, both of which are sources of drinking water. Research has shown that trace amounts of pharmaceuticals and personal care products (PPCPs) can cause ecological harm. The PPCPs have probably been present in water and the environment for as long as humans have been using them since they are added to the environment through the elimination of waste from the body, bathing, and disposal of unwanted medications into sewers and trash.

So if you have expired or unused medications don't flush/pour them down the drain because they'll contaminate the water supply. Burning them is a bad idea because the release of dioxins will pollute the air. Instead, the IEPA offers the following recommendations for disposing of outdated pharmaceuticals:

- Reduce pharmaceutical waste when possible by taking all doses of prescribed antibiotics and by buying only as much aspirin or other medicine as can be used before the expiration date.
- Take unused pharmaceuticals to a designated pharmaceutical-collection program or to an IEPA-sponsored household hazardous waste collection event, if possible.
- Throw old medicines in the trash. First, remove all labels. Next, make the medicines less appealing to children or thieves by dissolving pills in a small amount of water or alcohol, or by grinding them into pieces and mixing them into cat litter or coffee grounds. Finally, place them in a plastic bag or similar container and hide them with other trash.

For more information, go to www.epa.state.il.us and click on the box labeled "Medication Disposal."

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**	

LakeCounty
Health Department and
Community Health Center

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

	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

	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

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

	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

	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

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

No 2002 IEPA Chain Lakes.

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

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

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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

APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

Grant Program Name	Funding Source	Contact Information	Funding Focus: Water Quality/ Wetland	Funding Focus: Habitat	Funding Focus: Erosion	Funding Focus: 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
NRCS = Natural Resources Conservation Service
USACE = United States Army Corps of Engineers
USFWS = United States Fish and Wildlife Service