2007 SUMMARY REPORT
of
Long Lake

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT

3010 Grand Avenue
Waukegan, Illinois 60085

Leonard Dane
Michael Adam
Shaina Keseley
Adrienne Orr

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LAKE FACTS

Lake Name:	Long Lake
Historical Name:	None
Nearest Municipality:	Round Lake Beach
Location:	T44N, R10E, Sections 26,27,34,35
Elevation:	738.0 feet
Major Tributaries:	Eagle Creek, Round Lake Drain, Squaw Creek
Watershed:	Fox River
Sub-watershed:	Squaw Creek
Receiving Waterbody:	Fox Lake
Surface Area:	392.6 acres
Shoreline Length:	7.7 miles
Maximum Depth:	30.0 feet
Average Depth:	13.1 feet
Lake Volume:	4400.0 acre-feet
Lake Type:	Glacial
Watershed Area:	25441.0 acres
Major Watershed Land Uses:	Agriculture, Single Family, and Public and Private Open Space
Bottom Ownership:	Village of Round Lake Beach, Forest Preserve, State, and Private
Management Entities:	Long Lake Improvement and Sanitation Association
Current and Historical Uses:	Fishing, boating, swimming
Description of Access:	Private (public may launch with fee)

In 2005, Long Lake was chosen to be one of seven "sentinel" lakes in the county that the Lakes Management Unit (LMU) will monitor annually for five years, beginning with the 2005 season. This report summarizes the water quality sampling results and aquatic plant surveys conducted in 2007 on Long Lake. Similar reports have been written on data collected in 1991, 1996, 2001, 2005, and 2006 and are available from the LMU. The following report does not cover lake history and discussion of the watershed, as other reports have.

SUMMARY OF WATER QUALITY

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

Water samples were collected monthly from April through October at the deepest point in the lake (Figure 1; Appendix A). Long Lake was sampled at depths of three feet and 23 to 26 feet depending on water level, and the samples were analyzed for various water quality parameters (Appendix C). The water level in Long Lake fluctuated in 2007. The seawall at the Squaw Subdivision boat launch was used to measure the water level each month. Between the April and May sampling the water level decreased 5.9 inches. The water level then increased 2.1 inches from May to June. The water level decreased again from June to July by 3.0 inches. In August the water level increased by 12.3 inches and in September the level decreased 10.3 inches. The water level continued to drop in October for a seasonal decrease of 7.0 inches. This change in water level was a result of large rains that fell across Lake County during 2007. A total of 27.9 inches of rain was recorded at the Stormwater Management Commission's rain gauge in Round Lake Beach between the May and October sampling.

Thermal stratification occurs when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically experiences anoxic conditions (where dissolved oxygen (DO) concentrations drop below 1 mg/L) by mid-summer. In 2007, the lake was weakly stratified from June through September. Turnover was completed by October when water temperatures throughout the water column became more uniform.

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support a sunfish/bass fishery, since these fish can suffer oxygen stress below this amount. DO concentrations in the epilimnion did drop below 5.0 mg/L during June through September (Appendix B). This was likely due to a planktonic algae bloom. Algae release oxygen during the day and consume oxygen at night. The sampling occurred during morning hours and the DO level had not come back up yet. The hypolimnion had anoxic conditions (DO < 1.0 mg/L) from June through September. The anoxic boundary was at its shallowest in July (10 ft) and deepest in September at approximately 24 feet. Since an accurate bathymetric map with volumetric calculations does not exist for Long Lake it was impossible to determine the volume of the lake that was anoxic during 2007.

Secchi disk depth (water clarity) averaged 3.24 feet during 2007 (Table 1), which was similar to the Lake County median of 3.28 feet (Appendix D). This was a decrease from 2006 (4.52 feet)

and 2005 (4.18 feet). Water clarity is related to the amount of total suspended solids (TSS) in the water column. In general the average Secchi depth has increased over the years, and the average TSS had decreased (Figure 2). The 2007 average epilimnetic TSS of 11.1 mg/L was 35% higher than the 2006 average (7.2 m/L) and 2% higher than the 2005 average (10.9 mg/L). The 2007 average epilimnetic TSS was above the Lake County median of 8.0 mg/L. The average epilimnetic TSS had declined significantly from 1991 (23.6 mg/L) to 2006 (Table 2). The decline in TSS in Long Lake was likely due to the increase in aquatic plant densities. Aquatic plants improve water clarity by stabilizing bottom sediments, buffering wave action, and utilizing nutrients that would otherwise be used by algae. However, in 2007 the average TSS increased, algae blooms were common, and the plant community declined. This was likely the result of runoff washing excess phosphorous and sediment it the lake. The phosphorous was utilized by the algae causing the frequent blooms, increasing the TSS, and limiting the light penetration so plants could not grow.

In 2007 Long Lake had its highest recorded average epilimnetic total phosphorus (TP) concentration (0.103 mg/L) since 1991. The county TP epilimnetic median was 0.063 mg/L. The TP concentrations tripled from May (0.044 mg/L) to June (0.133 mg/L) and remained high for the rest of the season. This could be related to the rain that fell across the watershed this summer. Long Lake has a large watershed with many potential sources of nutrients and pollutants. Run-off from the rain could also have washed excess phosphorus applied to lawns into the lake. It is recommended that the Long Lake Improvement and Sanitation Association (LLISA) encourage a phosphorus lawn fertilizer ban. Several communities and lake associations within the county have already enacted such policies. In addition, the aquatic plant community in Long Lake was less dense in 2007 than 2006. Aquatic plants utilize phosphorus during their growing season. The 2007 seasonal hypolimnetic TP average of 0.672 mg/L was well above the county median of 0.163 mg/l, and was an increase from 2006 (0.345 mg/L) but a decrease from 2005 (0.827 mg/L). Phosphorus can be released from sediment under anoxic conditions through biological or mechanical processes, or from plant or algae as they die. This explains why the TP concentrations were higher in the hypolimnion. Long Lake had a TN:TP ratio of 17:1 in 2007, which was consistent with previous sampling. This indicated that the lake was phosphorus limited, which means any addition of phosphorus could result in increases in plant and algae biomass. Long Lake experienced problematic algae blooms in 2007. The trophic state of Long Lake based on phosphorus concentration during 2005 and 2006 was eutrophic, with TSIp scores of 66.6 and 65.0, respectively. In 2007 Long Lake was hypereutrophic with a score of 71.0 and ranked 114th out of 163 lakes in Lake County based on average TP concentrations (Table 3).

The Illinois Environmental Protection Agency (IEPA) has assessment indices to classify Illinois lakes for their ability to support aquatic life and recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations (TSIp), and aquatic plant coverage. According to this index, Long Lake provided *Full* support of aquatic life and *Partial* support of recreational activities as a result of moderate TP and TSS concentrations. The lake provided *Partial* overall use.

Conductivity is a measurement of water's ability to conduct electricity and is positively correlated with chloride (Cl^-) concentration. During 2007, the average epilimnetic conductivity

reading for Long Lake was 0.9068 milliSiemens/cm (mS/cm) which was above the Lake County median of 0.8038 mS/cm. However, this was a decrease from the previous monitoring when the average conductivity was 1.0821 mS/cm in 2005 and 1.1120 mS/cm in 2006. The 2007 average Cl^- concentration in Long Lake was below the Lake County median (158 mg/L), with a seasonal average of 145 mg/L. This was also down from the 2005 and 2006 averages of 197 mg/L and 187 mg/L. The increase in rainfall during 2007 likely caused the flushing of the Cl^- from the lake and also caused the remaining Cl^- to become more diluted. This can be seen by the decrease in Cl^- and conductivity as the summer progressed. Stormwater runoff from impervious surfaces such as roads and parking lots can deliver high concentrations of this Cl^- to nearby lakes and ponds, with road salts used in winter road maintenance being a main source. A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to Cl^- concentrations greater than 220 mg/L. Additionally, shifts in algal populations were associated with Cl^- concentrations as low as 12 mg/l. Therefore, it was likely Long Lake was negatively impacted by the high Cl^- concentrations and it is important to keep the use of road salts to a minimum and look into road salt alternatives within the watershed.

Figure 1. Water quality sampling site on Long Lake, 2007.

Table 1. Water quality data for Long Lake, 2005, 2006, and 2007.

2007	Epilimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-Apr	3	184	1.22	<0.1	0.612	0.048	<0.005	181	8.4	645	119	3.28	1.0440	8.15	13.61
08-May	3	199	1.10	<0.1	0.368	0.044	<0.005	180	5.2	652	135	5.58	1.0860	8.02	8.70
12-Jun	3	186	1.86	<0.1	0.128	0.133	0.008	167	17.0	628	157	2.30	0.9830	8.65	13.36
10-Jul	3	178	2.17	<0.1	<0.05	0.144	<0.005	159	17.8	604	152	2.79	0.9560	8.60	6.24
07-Aug	3	177	1.95	<0.1	<0.05	0.098	<0.005	152	11.5	550	118	2.33	0.8812	8.67	6.37
11-Sep	3	187	1.64	<0.1	<0.05	0.137	0.055	82	6.9	415	94	3.28	0.6690	7.68	4.28
23-Oct	3	200	1.50	0.227	<0.05	0.116	0.041	93	11.0	463	100	3.12	0.7283	7.72	5.94
	Average	187	1.63	0.227[k]	0.369[k]	0.103	0.035[k]	145	11.1	565	125	3.24	0.9068	8.21	8.36

2006	Epilimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	3	161	1.30	<0.1	1.820	0.044	<0.005	195	5.2	718	142	4.59	1.1660	8.03	8.93
09-May	3	174	1.27	<0.1	1.060	0.034	<0.005	197	2.1	756	163	11.32	1.1920	8.16	8.80
13-Jun	3	184	1.19	0.105	0.389	0.040	<0.005	183	2.7	728	164	5.94	1.1460	8.13	6.85
11-Jul	3	175	1.29	<0.1	<0.05	0.060	<0.005	187	7.7	765	206	4.23	1.1180	8.56	6.51
08-Aug	3	146	2.14	<0.1	<0.05	0.087	<0.005	195	13.0	722	200	1.60	1.0920	8.72	7.01
12-Sep	3	148	2.18	0.288	<0.05	0.143	0.017	189	10.0	665	154	2.03	1.0530	7.86	3.14
31-Oct	3	179	1.59	0.177	0.272	0.068	0.008	162	10.0	652	147	1.94	1.0170	8.07	10.41
	Average	167	1.57	0.197[k]	1.090[k]	0.068	0.013[k]	187	7.2	715	168	4.52	1.1120	8.22	7.38

2005	Epilimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	3	190	1.05	<0.1	0.552	0.051	<0.005	181	12.0	682	147	6.14	1.0680	8.17	12.12
11-May	3	196	1.10	<0.1	0.088	0.051	<0.005	191	8.1	682	126	6.10	1.1000	7.91	8.78
15-Jun	3	185	1.32	<0.1	<0.05	0.052	<0.005	189	6.8	671	127	4.04	1.0980	7.89	6.68
13-Jul	3	172	1.21	<0.1	<0.05	0.051	<0.005	198	7.8	700	170	3.94	1.1180	7.99	7.27
10-Aug	3	154	1.38	<0.1	<0.05	0.071	<0.005	205	8.2	721	204	4.43	1.0720	9.11	9.04
14-Sep	3	143	2.08	<0.1	<0.05	0.148	0.008	207	16.8	680	170	2.30	1.0530	8.66	3.78
18-Oct	3	152	1.87	<0.1	<0.05	0.109	0.012	208	16.7	647	140	2.29	1.0660	8.22	6.81
	Average	170	1.43	<0.1	0.320[k]	0.076	0.010[k]	197	10.9	683	155	4.18	1.0821	8.28	7.78

Glossary

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

Table 1. Continued.

2007	Hypolimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-Apr	23	185	1.22	<0.1	0.610	0.044	<0.005	180	8.4	641	115	NA	1.0550	8.03	12.46
08-May	23	202	1.07	0.152	0.358	0.045	0.007	179	8.6	655	133	NA	1.0875	7.80	6.43
12-Jun	24	230	2.11	1.170	<0.05	0.492	0.449	181	7.9	698	161	NA	1.1140	7.40	0.13
10-Jul	26	259	3.88	2.930	<0.05	1.080	1.040	177	11	685	167	NA	1.1370	7.12	0.09
07-Aug	25	277	6.05	4.700	<0.05	1.330	1.260	176	5.5	662	139	NA	1.1330	6.99	0.10
11-Sep	25	241	5.84	5.010	<0.05	1.590	1.270	124	9.0	508	116	NA	0.9937	6.81	0.09
23-Oct	22	203	1.76	0.228	<0.05	0.124	0.041	93.6	11.0	454	96	NA	0.7292	7.74	5.83
	Average	228	3.13	2.365[k]	0.484[k]	0.672	0.390[k]	159	8.8	615	132	NA	1.0356	7.41	3.59

2006	Hypolimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	22	162	1.45	<0.1	1.82	0.045	<0.005	194	4.9	720	146	NA	1.1600	7.80	7.77
09-May	24	174	1.32	<0.1	1.05	0.023	<0.005	198	1.8	736	155	NA	1.1860	7.54	2.89
13-Jun	24	199	1.83	0.858	0.15	0.280	0.176	191	7.0	764	177	NA	1.1880	7.35	0.12
11-Jul	24	211	2.22	0.965	<0.05	0.309	0.250	188	6.5	770	191	NA	1.2110	7.00	0.08
08-Aug	25	280	5.20	4.060	<0.05	1.230	1.190	197	2.9	740	160	NA	1.2280	7.03	0.12
12-Sep	24	175	3.39	1.670	<0.05	0.457	0.329	189	16.0	675	156	NA	1.0500	7.84	0.17
31-Oct	19	179	1.56	0.177	0.281	0.070	0.007	161	11.3	654	148	NA	1.0165	8.08	10.23
	Average	197	2.42	1.546[k]	0.825[k]	0.345	0.390[k]	188	7.2	723	162	NA	1.1485	7.52	3.05

2005	Hypolimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	26	198	1.59	0.531	0.481	0.062	<0.005	189	6.4	687	147	NA	1.1000	7.47	4.06
11-May	24	200	1.33	0.258	0.077	0.071	<0.005	191	8.6	676	122	NA	1.1020	7.45	3.73
15-Jun	26	232	3.64	2.250	<0.05	1.050	0.793	185	11.0	685	123	NA	1.1310	6.92	0.08
13-Jul	26	271	5.10	4.110	<0.05	1.150	1.080	186	8.4	730	187	NA	1.1790	6.63	0.09
10-Aug	24	292	6.69	4.850	<0.05	1.340	1.240	191	4.4	725	175	NA	1.1780	6.82	0.11
14-Sep	24	310	10.90	8.680	<0.05	2.010	1.920	194	7.2	706	145	NA	1.2230	6.86	0.25
18-Oct	23	151	2.06	<0.1	<0.05	0.104	0.012	205	16.0	641	135	NA	1.0660	8.40	6.84
	Average	236	4.47	3.447[k]	0.279[k]	0.827	1.009	192	8.9	693	148	NA	1.1399	7.22	2.17

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

Figure 2. Total suspended solid (TSS) concentrations vs. Secchi depth for Long Lake, 1991-2007.

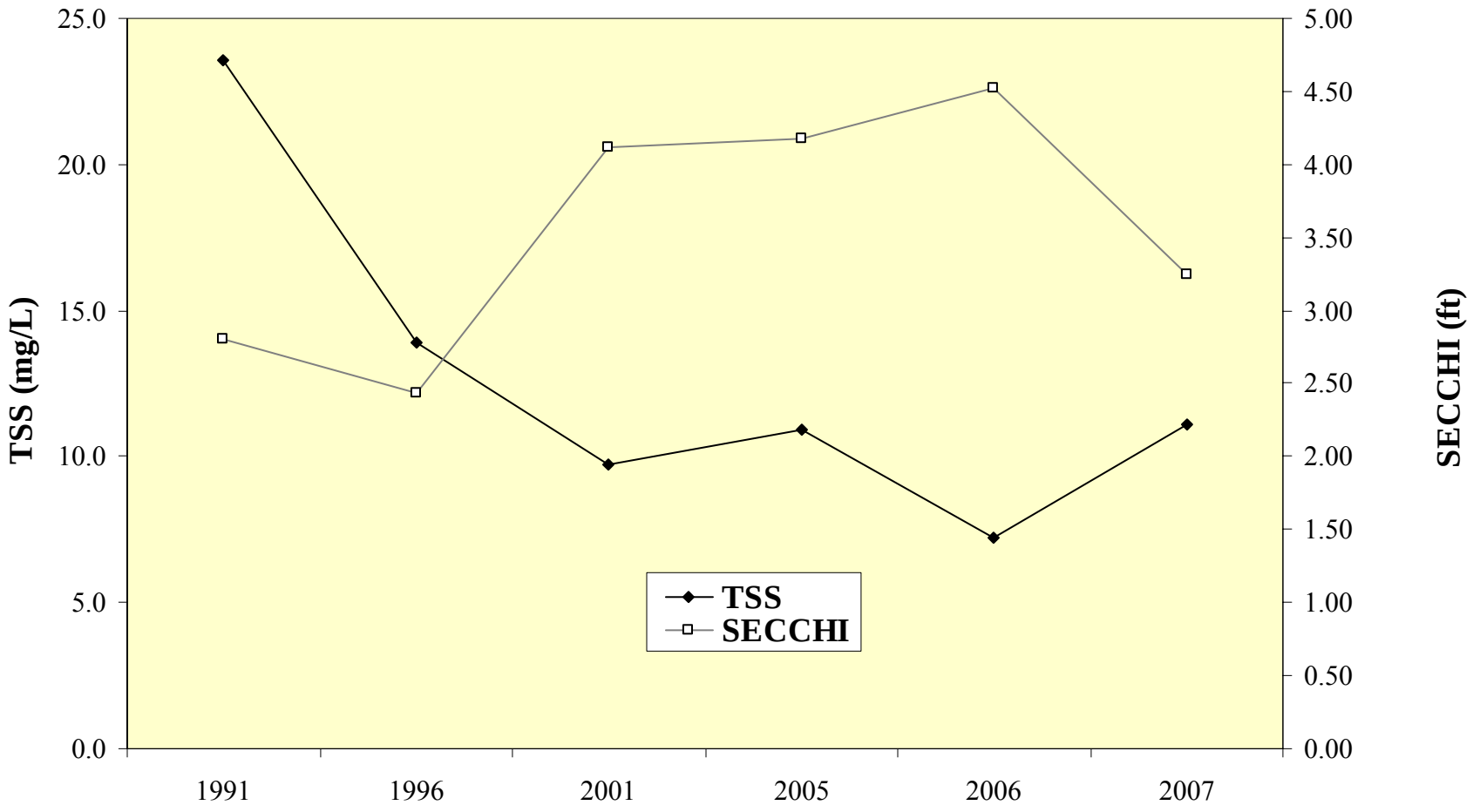

Table 2. Epilimnetic averages of select water quality parameters from previous studies of Long Lake.

YEAR	TKN	TP	TSS	SECCHI	COND
1991	1.21	0.063	23.6	2.81	NA
1996	1.42	0.086	13.9	2.44	0.5222
2001	1.38	0.092	9.7	4.11	0.9430
2005	1.43	0.076	10.9	4.18	1.0821
2006	1.57	0.068	7.2	4.52	1.1120
2007	1.63	0.103	11.1	3.24	0.9066

Glossary

TKN = Total Kjeldahl nitrogen, mg/L
TP = Total phosphorus, mg/L
TSS = Total suspended solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm

Table 3. Lake County average TSI phosphorous (TSIp) ranking 2000-2007.

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	Sand Pond (IDNR)	0.0165	41.36
5	Cedar Lake	0.0157	41.60
6	Windward Lake	0.0158	43.95
7	Pulaski Pond	0.0180	45.83
8	Timber Lake (North)	0.0180	45.83
9	Fourth Lake	0.0182	45.99
10	West Loon Lake	0.0182	45.99
11	Lake Kathyrn	0.0200	47.35
12	Lake of the Hollow	0.0200	47.35
13	Banana Pond	0.0202	47.49
14	Lake Minear	0.0204	47.63
15	Bangs Lake	0.0212	48.17
16	Cross Lake	0.0220	48.72
17	Dog Pond	0.0222	48.85
18	Stone Quarry Lake	0.0230	49.36
19	Cranberry Lake	0.0234	49.61
20	Deep Lake	0.0240	49.98
21	Druce Lake	0.0244	50.22
22	Little Silver Lake	0.0246	50.33
23	Round Lake	0.0254	50.80
24	Lake Leo	0.0256	50.91
25	Dugdale Lake	0.0274	51.89
26	Peterson Pond	0.0274	51.89
27	Lake Miltmore	0.0276	51.99
28	East Loon Lake	0.0280	52.20
29	Lake Zurich	0.0282	52.30
30	Lake Fairfield	0.0296	53.00
31	Gray's Lake	0.0302	53.29
32	Highland Lake	0.0302	53.29
33	Hook Lake	0.0302	53.29
34	Lake Catherine (Site 1)	0.0308	53.57
35	Lambs Farm Lake	0.0312	53.76
36	Old School Lake	0.0312	53.76
37	Sand Lake	0.0316	53.94
38	Sullivan Lake	0.0320	54.13
39	Lake Linden	0.0326	54.39
40	Countryside Lake	0.0332	54.66
41	Gages Lake	0.0338	54.92
42	Hendrick Lake	0.0344	55.17
43	Third Lake	0.0346	55.24
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	Ames Pit	0.0390	56.98

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Sun Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Old Oak Lake	0.0428	58.32
52	Deer Lake	0.0434	58.52
53	Schreiber Lake	0.0434	58.52
54	Nielsen Pond	0.0448	58.98
55	Turner Lake	0.0458	59.30
56	Seven Acre Lake	0.0460	59.36
57	Willow Lake	0.0464	59.48
58	Lucky Lake	0.0476	59.85
59	Davis Lake	0.0476	59.85
60	East Meadow Lake	0.0478	59.91
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 Christa	0.0576	62.60
69	Lake Charles	0.0580	62.70
70	Crooked Lake	0.0608	63.38
71	Waterford Lake	0.0610	63.43
72	Lake Naomi	0.0616	63.57
73	Lake Tranquility S1	0.0618	63.62
74	Werhane Lake	0.0630	63.89
75	Liberty Lake	0.0632	63.94
76	Countryside Glen Lake	0.0642	64.17
77	Lake Fairview	0.0648	64.30
78	Leisure Lake	0.0648	64.30
79	Tower Lake	0.0662	64.61
80	Wooster Lake	0.0663	64.63
81	St. Mary's Lake	0.0666	64.70
82	Mary Lee Lake	0.0682	65.04
83	Hastings Lake	0.0684	65.08
84	Honey Lake	0.0690	65.21
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Echo Lake	0.0792	67.19
91	Sylvan Lake	0.0794	67.23
92	Big Bear Lake	0.0806	67.45

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Petite Lake	0.0834	67.94
94	Timber Lake (South)	0.0848	68.18
95	Lake Marie (Site 1)	0.0850	68.21
96	North Churchill Lake	0.0872	68.58
97	Grand Avenue Marsh	0.0874	68.61
98	Grandwood Park, Site II, Outflow	0.0876	68.65
99	North Tower Lake	0.0878	68.68
100	South Churchill Lake	0.0896	68.97
101	Rivershire Pond 2	0.0900	69.04
102	McGreal Lake	0.0914	69.26
103	International Mine and Chemical Lake	0.0948	69.79
104	Eagle Lake (Site I)	0.0950	69.82
105	Valley Lake	0.0950	69.82
106	Dunns Lake	0.0952	69.85
107	Fish Lake	0.0956	69.91
108	Lochanora Lake	0.0960	69.97
109	Owens Lake	0.0978	70.23
110	Woodland Lake	0.0986	70.35
111	Island Lake	0.0990	70.41
112	McDonald Lake 1	0.0996	70.50
113	Longview Meadow Lake	0.1024	70.90
114	**Long Lake**	**0.1029**	**70.96**
115	Lake Barrington	0.1053	71.31
116	Redwing Slough, Site II, Outflow	0.1072	71.56
117	Lake Forest Pond	0.1074	71.59
118	Bittersweet Golf Course #13	0.1096	71.88
119	Fox Lake (Site 1)	0.1098	71.90
120	Osprey Lake	0.1108	72.04
121	Bresen Lake	0.1126	72.27
122	Round Lake Marsh North	0.1126	72.27
123	Deer Lake Meadow Lake	0.1158	72.67
124	Taylor Lake	0.1184	72.99
125	Columbus Park Lake	0.1226	73.49
126	Nippersink Lake (Site 1)	0.1240	73.66
127	Grass Lake (Site 1)	0.1288	74.21
128	Lake Holloway	0.1322	74.58
129	Lakewood Marsh	0.1330	74.67
130	Summerhill Estates Lake	0.1384	75.24
131	Redhead Lake	0.1412	75.53
132	Forest Lake	0.1422	75.63
133	Antioch Lake	0.1448	75.89
134	Slocum Lake	0.1496	76.36
135	Drummond Lake	0.1510	76.50
136	Pond-a-Rudy	0.1514	76.54
137	Lake Matthews	0.1516	76.56
138	Buffalo Creek Reservoir	0.1550	76.88

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Pistakee Lake (Site 1)	0.1592	77.26
140	Salem Lake	0.1650	77.78
141	Half Day Pit	0.1690	78.12
142	Lake Eleanor Site II, Outflow	0.1812	79.13
143	Lake Farmington	0.1848	79.41
144	ADID 127	0.1886	79.71
145	Lake Louise Inlet	0.1938	80.10
146	Grassy Lake	0.1952	80.20
147	Dog Bone Lake	0.1990	80.48
148	Redwing Marsh	0.2072	81.06
149	Stockholm Lake	0.2082	81.13
150	Bishop Lake	0.2156	81.63
151	Hidden Lake	0.2236	82.16
152	Fischer Lake	0.2278	82.43
153	Lake Napa Suwe (Outlet)	0.2304	82.59
154	Patski Pond (outlet)	0.2512	83.84
155	Oak Hills Lake	0.2792	85.36
156	Loch Lomond	0.2954	86.18
157	McDonald Lake 2	0.3254	87.57
158	Fairfield Marsh	0.3264	87.61
159	ADID 182	0.3280	87.69
160	Slough Lake	0.4134	91.02
161	Flint Lake Outlet	0.4996	93.75
162	Rasmussen Lake	0.5025	93.84
163	Albert Lake, Site II, outflow	1.1894	106.3

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in May and July of 2007, with 188 sites sampled in May (Figure 3) and 164 sites sampled in July (Figure 4). The maximum depth plants were found was 6.5 feet in May and 7.7 feet in July. Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. During 2007, the depth of the 1% light level ranged from 6 feet (June through September) to 10 feet (May). There was a total of ten aquatic plant species found between the two sampling events (Table 4). Eurasian Watermilfoil (EWM) was the most dominant species found at 58% (May) and 38% (July) of the sampling sites. Coontail was the second most common species found at 57% (May) and 22% (July) of the sampling sites (Table 5a, b). Aquatic plant composition was similar in 2006 (10 species) and 2005 (9 species) with EWM being the most abundant species both years. However, the density of plants and the depth at which they were found was greater in 2006. The abundance of the two exotics, EWM and Curlyleaf Pondweed, in Long Lake did not significantly change over the three sampling years. Both of these exotics compete with native plants, eventually crowding them out and providing poor natural diversity and limit use by wildlife. Removal or control of exotic species is recommended.

Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. A high FQI number indicates there is a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2007 Lake County lakes was 13.6 (Table 6). Long Lake had a FQI of 16.1 in 2007. This was up from 2005 when the FQI was 15.5 and down 2006 when the FQI of 16.9. This fluctuation in values correlates with the differences in aquatic plant composition each year. While the FQI was similar all three years, the densities and overall health of the aquatic plant populations in 2007 was poor.

To maintain a healthy sunfish/bass fishery, the Illinois Department of Natural Resources (IDNR) recommends plant coverage be 30% to 40% across the lake bottom. These surveys found approximately 72% (May) and approximately 52% (July) of the sites sampled had aquatic plants (Table 5c). It was calculated that approximately 19% (July) – 31% (May) of the lake bottom was covered by plants. Several landowners had treated the aquatic plants near their property with herbicide pellets.

Figure 3. Aquatic plant sampling grid that illustrates plant density on Long Lake, May 2007.

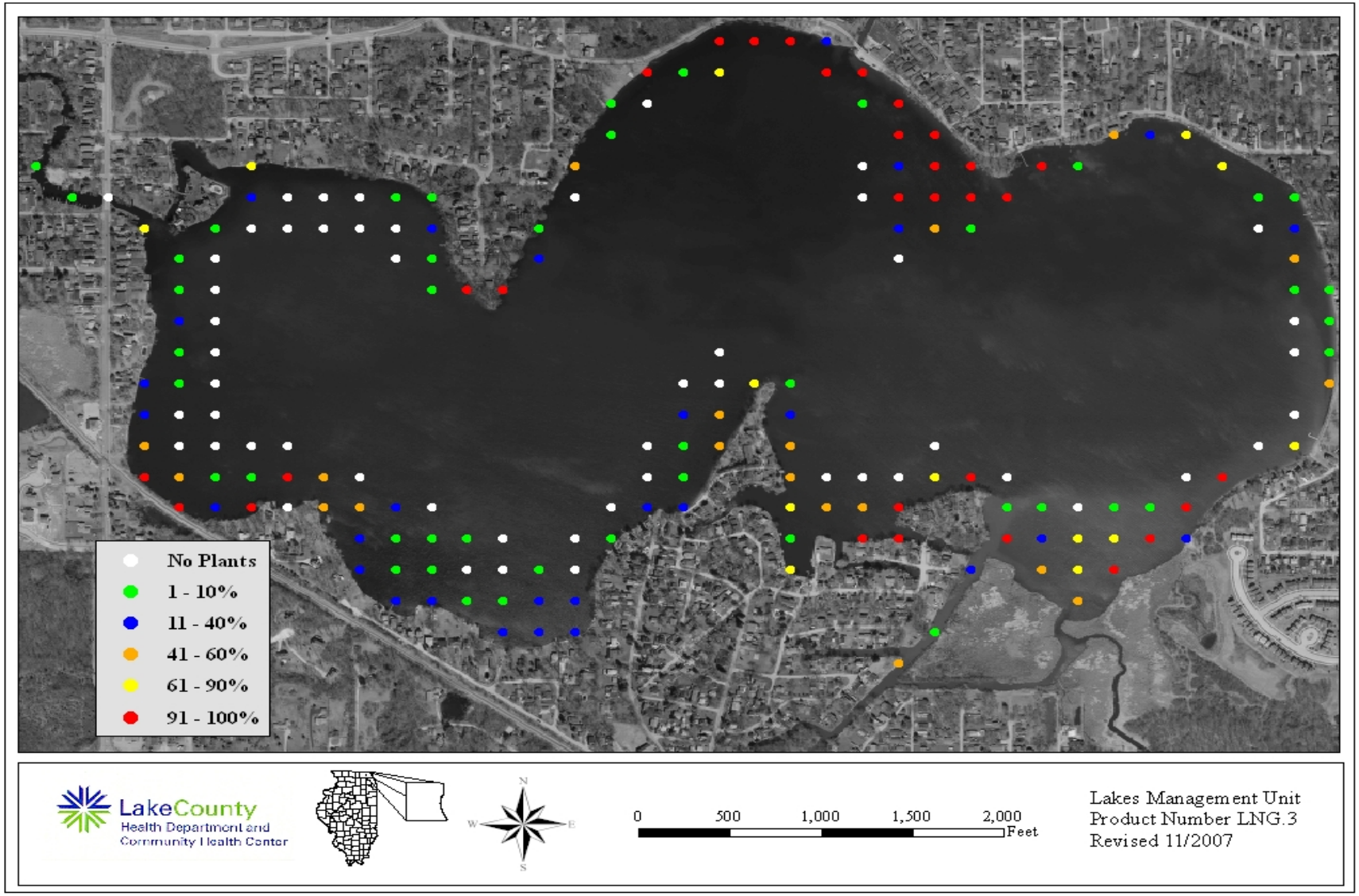

Figure 4. Aquatic plant sampling grid that illustrates plant density on Long Lake, July 2007.

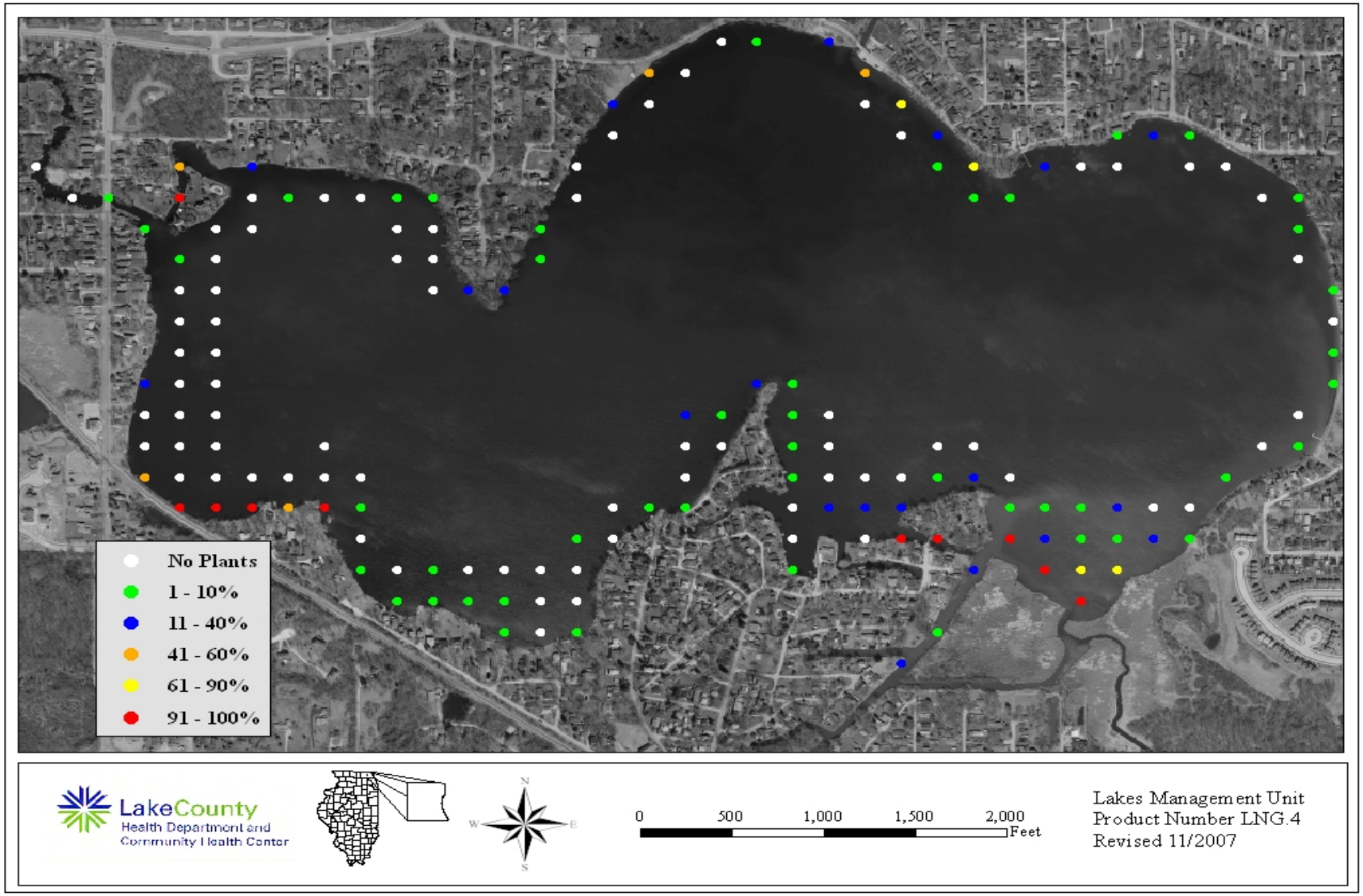

Table 4. Aquatic plant species found in Long Lake in 2007.

Coontail	*Ceratophyllum demersum*
Vallisneria (eel grass)	*Vallisneria americana*
Water Stargrass	*Heteranthera dubia*
Small Duckweed	*Lemna minor*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed^	*Potamogeton crispus*
Sago Pondweed	*Potamogeton pectinatus*
Giant Duckweed	*Spirodella polyrhiza*
Watermeal	*Wolffia columbiana*

^ Exotic plant

Table 5a. Aquatic plant species found at the 188 sampling sites on Long Lake in May, 2007. The maximum depth that plants were found was 6.5 feet.

May								
Plant Density	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Sago Pondweed	Vallisneria	Watermeal	White Water Lily
Absent	80	168	187	79	178	186	187	173
Present	54	18	1	54	10	2	1	12
Common	28	2	0	24	0	0	0	3
Abundant	11	0	0	10	0	0	0	0
Dominant	15	0	0	21	0	0	0	0
% Plant Occurrence	57.4	10.6	0.5	58.0	5.3	1.1	0.5	8.0

Table 5b. Aquatic plant species found at the 164 sampling sites on Long Lake in July 2006. The maximum depth that plants were found was 7.7 feet.

July								
Plant Density	Coontail	Duckweed	Eurasian Watermilfoil	Giant Duckweed	Sago Pondweed	Watermeal	Water Stargrass	White Water Lily
Absent	128	145	101	159	161	161	162	149
Present	18	14	37	4	3	0	2	8
Common	5	4	20	0	0	2	0	4
Abundant	4	0	4	0	0	1	0	2
Dominant	9	1	2	1	0	0	0	1
% Plant Occurrence	22.0	11.6	38.4	3.0	1.8	1.8	1.2	9.1

Table 5c. Distribution of rake density across all sampled sites on Long Lake.

May		
Rake Density (Coverage)	# of Sites	%
No plants	52	27.7%
>0 to 10%	44	23.4%
>10 to 40%	29	15.4%
>40 to 60%	19	10.1%
>60 to 90%	13	6.9%
>90%	31	16.5%
Total Sites with Plants	136	72.3%
Total # of Sites	188	100.0%

July		
Rake Density (Coverage)	# of Sites	%
No plants	78	41.5%
>0 to 10%	47	25.0%
>10 to 40%	20	10.6%
>40 to 60%	5	2.7%
>60 to 90%	4	2.1%
>90%	10	5.3%
Total Sites with Plants	86	45.7%
Total # of Sites	164	87.2%

Table 6. 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	35.1	37.3
2	Deep Lake	33.9	35.4
3	Cranberry Lake	30.1	31.0
4	Round Lake Marsh North	29.1	29.9
5	East Loon Lake	28.4	29.9
6	Deer Lake	28.2	29.7
7	Sullivan Lake	28.2	29.7
8	Little Silver Lake	27.9	30.0
9	Schreiber Lake	26.8	27.6
10	West Loon Lake	26.0	27.6
11	Cross Lake	25.2	27.8
12	Independence Grove	24.6	27.5
13	Sterling Lake	24.5	26.9
14	Bangs Lake	24.5	26.2
15	Lake Zurich	24.0	26.0
16	Lake of the Hollow	23.8	26.2
17	Lakewood Marsh	23.8	24.7
18	Round Lake	23.5	25.9
19	Fourth Lake	23.0	24.8
20	Druce Lake	22.8	25.2
21	Sun Lake	22.7	24.5
22	Countryside Glen Lake	21.9	22.8
23	Butler Lake	21.4	23.1
24	Duck Lake	21.1	22.9
25	Timber Lake (North)	20.8	22.8
26	Wooster Lake	20.8	22.6
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	ADID 203	20.5	20.5
30	McGreal Lake	20.2	22.1
31	Lake Kathryn	19.6	20.7
32	Fish Lake	19.3	21.2
33	Redhead Lake	19.3	21.2
34	Owens Lake	19.3	20.2
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Hendrick Lake	17.7	17.7
39	Summerhill Estates Lake	17.1	18.0
40	Seven Acre Lake	17.0	15.5
41	Gray's Lake	16.9	19.8
42	Lake Barrington	16.7	17.7
43	Bresen Lake	16.6	17.8
44	Windward Lake	16.3	17.6

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
45	Diamond Lake	16.3	17.4
46	Lake Napa Suwe	16.3	17.4
47	**Long Lake**	**16.1**	**18.0**
48	Dog Bone Lake	15.7	15.7
49	Redwing Slough	15.6	16.6
50	Osprey Lake	15.5	17.3
51	Lake Fairview	15.2	16.3
52	Heron Pond	15.1	15.1
53	Lake Tranquility (S1)	15.0	17.0
54	North Churchill Lake	15.0	15.0
55	Island Lake	14.7	16.6
56	Dog Training Pond	14.7	15.9
57	Highland Lake	14.5	16.7
58	Grand Avenue Marsh	14.3	16.3
59	Taylor Lake	14.3	16.3
60	Dugdale Lake	14.0	15.1
61	Eagle Lake (S1)	14.0	15.1
62	Longview Meadow Lake	13.9	13.9
63	Ames Pit	13.4	15.5
64	Hook Lake	13.4	15.5
65	Third Lake	13.4	15.5
66	Bishop Lake	13.4	15.0
67	Mary Lee Lake	13.1	15.1
68	Old School Lake	13.1	15.1
69	Buffalo Creek Reservoir	13.1	14.3
70	McDonald Lake 2	13.1	14.3
71	Old Oak Lake	12.7	14.7
72	Timber Lake (South)	12.7	14.7
73	White Lake	12.7	14.7
74	Dunn's Lake	12.7	13.9
75	Echo Lake	12.5	14.8
76	Hastings Lake	12.5	14.8
77	Sand Lake	12.5	14.8
78	Stone Quarry Lake	12.5	12.5
79	Honey Lake	12.1	14.3
80	Lake Carina	12.1	14.3
81	Lake Leo	12.1	14.3
82	Lambs Farm Lake	12.1	14.3
83	Stockholm Lake	12.1	13.5
84	Pond-A-Rudy	12.1	12.1
85	Lake Matthews	12.0	12.0
86	Flint Lake	11.8	13.0
87	Harvey Lake	11.8	13.0
88	Rivershire Pond 2	11.5	13.3
89	Antioch Lake	11.3	13.4
90	Lake Charles	11.3	13.4

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
91	Lake Linden	11.3	11.3
92	Lake Naomi	11.2	12.5
93	Pulaski Pond	11.2	12.5
94	Lake Minear	11.0	13.9
95	Redwing Marsh	11.0	11.0
96	Tower Lake	11.0	11.0
97	West Meadow Lake	11.0	11.0
98	Nielsen Pond	10.7	12.0
99	Lake Holloway	10.6	10.6
100	Countryside Lake	10.5	12.1
101	Crooked Lake	10.2	12.5
102	College Trail Lake	10.0	10.0
103	Lake Lakeland Estates	10.0	11.5
104	Valley Lake	9.9	9.9
105	Werhane Lake	9.8	12.0
106	Big Bear Lake	9.5	11.0
107	Little Bear Lake	9.5	11.0
108	Loch Lomond	9.4	12.1
109	Columbus Park Lake	9.2	9.2
110	Sylvan Lake	9.2	9.2
111	Fischer Lake	9.0	11.0
112	Grandwood Park Lake	9.0	11.0
113	Lake Fairfield	9.0	10.4
114	McDonald Lake 1	8.9	10.0
115	East Meadow Lake	8.5	8.5
116	Lake Christa	8.5	9.8
117	Lake Farmington	8.5	9.8
118	Lucy Lake	8.5	9.8
119	South Churchill Lake	8.5	8.5
120	Bittersweet Golf Course #13	8.1	8.1
121	Woodland Lake	8.1	9.9
122	Albert Lake	7.5	8.7
123	Banana Pond	7.5	9.2
124	Fairfield Marsh	7.5	8.7
125	Lake Eleanor	7.5	8.7
126	Lake Louise	7.5	8.7
127	Patski Pond	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Slough Lake	7.1	7.1
130	Lucky Lake	7.0	7.0
131	Lake Forest Pond	6.9	8.5
132	Leisure Lake	6.4	9.0
133	Peterson Pond	6.0	8.5
134	Gages Lake	5.8	10.0
135	Grassy Lake	5.8	7.1
136	Slocum Lake	5.8	7.1

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
137	Deer Lake Meadow Lake	5.2	6.4
138	Drummond Lake	5.0	7.1
139	IMC Lake	5.0	7.1
140	ADID 127	5.0	5.0
141	Liberty Lake	5.0	5.0
142	Oak Hills Lake	5.0	5.0
143	Forest Lake	3.5	5.0
144	Sand Pond (IDNR)	3.5	5.0
145	Half Day Pit	2.9	5.0
146	Lochanora Lake	2.5	5.0
147	Hidden Lake	0.0	0.0
148	North Tower Lake	0.0	0.0
149	Potomac Lake	0.0	0.0
150	St. Mary's Lake	0.0	0.0
151	Waterford Lake	0.0	0.0
152	Willow Lake	0.0	0.0
	Mean	**13.6**	**14.9**
	Median	**12.5**	**14.3**

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 9.1) overlaid a grid pattern onto a 2006 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.

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

APPENDIX B. MULTI-PARAMETER DATA FOR LONG LAKE IN 2007.

Long Lake 2007 Multiparameter data

Date MMDDYY	Time HHMMSS	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 0.78
41607	80117	0	0.25	6.80	13.19	111.3	1.0370	8.12	3368	Surface		
41607	80323	1	1.00	6.44	13.48	112.7	1.0440	8.13	3493	Surface	100%	
41607	80416	2	2.00	6.43	13.63	113.9	1.0450	8.13	1102	0.25	33%	4.615
41607	80522	3	2.96	6.43	13.61	113.7	1.0440	8.15	553	1.21	16%	0.570
41607	80650	4	3.97	6.39	13.74	114.7	1.0450	8.16	321	2.22	10%	0.245
41607	80834	6	5.90	6.38	13.68	114.2	1.0470	8.19	108	4.15	3%	0.262
41607	80951	8	8.08	6.36	13.63	113.7	1.0460	8.16	34	6.33	1.0%	0.183
41607	81100	10	9.93	6.36	13.54	113	1.0470	8.22	13	8.18	0.4%	0.118
41607	81227	12	11.99	6.35	13.57	113.2	1.0470	8.16	5	10.24	0.1%	0.093
41607	81324	14	13.99	6.31	13.33	111.1	1.0480	8.12	1	12.24	0.03%	0.131
41607	81505	16	16.07	6.32	13.31	111.0	1.0490	8.11	0	14.32	0%	
41607	81552	18	17.94	6.24	13.03	108.4	1.0520	8.09	0	16.19	0%	
41607	81641	20	20.00	5.91	12.77	105.3	1.0520	8.06	0	18.25	0%	
41607	81726	22	22.00	5.80	12.59	103.6	1.0540	8.05	0	20.25	0%	
41607	81840	24	24.05	5.72	12.33	101.2	1.0550	8.01	0	22.3	0%	
41607	82119	26	26.02	5.66	11.57	94.9	1.0570	7.96	0	24.27	0%	

Date MMDDYY	Time HHMMSS	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 0.63
50807	72417	0	0.26	16.09	8.90	93.0	1.0870	8.00	1541	Surface		
50807	72538	1	0.95	16.18	9.00	94.2	1.0870	8.02	1368	Surface	100%	
50807	72636	2	1.98	15.93	8.85	92.2	1.0860	8.02	442	0.23	32%	4.912
50807	72727	3	3.01	15.84	8.70	90.4	1.0860	8.02	196	1.26	14%	0.645
50807	72811	4	4.00	15.81	8.59	89.2	1.0860	8.02	123	2.25	9%	0.207
50807	73001	6	6.01	15.72	8.15	84.4	1.0880	7.99	75	4.26	5%	0.116
50807	73127	8	8.00	15.47	7.80	80.4	1.0870	7.96	35	6.25	3%	0.122
50807	73224	10	10.05	15.21	7.70	78.9	1.0870	7.95	16	8.3	1.2%	0.094

50807	73404	12	12.02	14.92	7.46	76.0	1.0870	7.91	8	10.27	0.6%	0.067
50807	73516	14	14.00	14.49	7.24	73.1	1.0870	7.89	4	12.25	0.3%	0.057
50807	73618	16	16.05	14.38	7.10	71.5	1.0870	7.86	1	14.3	0.1%	0.097
50807	73818	18	17.98	14.22	6.70	67.3	1.0860	7.82	1	16.23	0.1%	0.000
50807	73912	20	20.03	14.13	6.54	65.5	1.0870	7.81	0	18.28	0%	
50807	74256	22	21.98	14.01	6.56	65.5	1.0870	7.81	0	20.23	0%	
50807	74441	24	23.99	13.94	6.29	62.8	1.0880	7.79	0	22.24	0%	
50807	74550	26	25.99	13.83	5.46	54.3	1.0900	7.72	0	24.24	0%	

Long Date MMDDYY	Time HHMMSS	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 0.84
61207	74233	0	0.25	22.70	13.79	163.6	1.0110	8.60	3167	Surface		
61207	74341	1	1.00	23.75	13.21	159.8	0.9874	8.61	3167	Surface	100%	
61207	74457	2	2.02	23.76	13.38	162	0.9895	8.64	1083	0.27	79%	3.974
61207	74616	3	3.06	23.54	13.36	161.1	0.9837	8.65	471	1.31	34%	0.636
61207	74729	4	4.04	23.43	13.4	161.2	0.9765	8.65	197	2.29	14%	0.381
61207	74844	6	6.04	22.11	7.45	87.4	0.9397	8.10	32	4.29	2%	0.424
61207	74953	8	8.07	21.45	4.64	53.8	0.9615	7.86	7	6.32	0.5%	0.240
61207	75137	10	10.01	21.23	3.22	37.1	0.9878	7.77	2	8.26	0.1%	0.152
61207	75255	12	11.98	20.99	2.73	31.4	0.9948	7.72	1	10.23	0.1%	0.068
61207	75422	14	14.04	20.81	2.45	28.1	1.0150	7.70	0	12.29	0%	
61207	75530	16	16.02	20.51	1.90	21.6	1.0360	7.68	0	14.27	0%	
61207	75649	18	18.05	19.56	0.53	5.9	1.0900	7.63	0	16.3	0%	
61207	75836	20	19.99	18.62	0.18	1.9	1.1030	7.60	0	18.24	0%	
61207	75953	22	21.99	16.19	0.15	1.6	1.1100	7.49	0	20.24	0%	
61207	80154	24	23.99	15.08	0.13	1.3	1.1140	7.40	0	22.24	0%	
61207	80259	26	26.01	14.19	0.12	1.1	1.1180	7.33	0	24.26	0%	

Long Date MMDDYY	Time HHMMSS	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 0.93
71007	74232	0	0.30	26.78	6.65	82.3	0.9544	8.56	3276	Surface		

71007	74352	1	1.03	26.79	6.64	82.1	0.9568	8.58	3070	Surface	100%	
71007	74455	2	2.04	26.8	6.58	81.4	0.9569	8.59	846	0.29	62%	4.445
71007	74716	3	3.02	26.78	6.24	77.2	0.956	8.6	304	1.27	22%	0.806
71007	74831	4	4.02	26.77	5.94	73.5	0.9557	8.59	119	2.27	9%	0.413
71007	74959	6	6.03	26.7	5.15	63.7	0.9592	8.53	23	4.28	1.7%	0.384
71007	75104	8	8.01	26.59	3.98	49.1	0.9623	8.44	5	6.26	0.4%	0.244
71007	75304	10	10.00	25.81	0.71	8.7	0.9736	8.11	1	8.25	0.1%	0.195
71007	75519	12	11.99	25.21	0.15	1.8	0.9809	8.02	1	10.24	0.1%	0.000
71007	75627	14	14.01	22.64	0.14	1.5	1.0020	7.84	0	12.26	0%	
71007	75821	16	16.03	21.06	0.12	1.4	1.0310	7.67	0	14.28	0%	
71007	75938	18	18.00	19.83	0.11	1.2	1.0590	7.55	0	16.25	0%	
71007	80103	20	20.06	18.66	0.11	1.2	1.0850	7.45	0	18.31	0%	
71007	80242	22	21.98	17.50	0.09	1.0	1.1040	7.32	0	20.23	0%	
71007	80437	24	24.01	16.26	0.09	0.9	1.1290	7.18	0	22.26	0%	
71007	80559	26	25.98	15.83	0.09	0.9	1.1370	7.12	0	24.23	0%	
71007	80711	28	28.02	15.58	0.09	0.9	1.1420	7.08	0	26.27	0%	

Date MMDDYY	Time HHMMSS	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 0.27
80707	75214	0	0.25	26.46	6.84	84.2	0.8832	8.38	1236	Surface		
80707	75414	1	1.03	26.48	6.84	84.3	0.8832	8.69	1052	Surface	100%	
80707	75507	2	2.07	26.43	6.5	80.0	0.8828	8.68	239	1.26	23%	0.645
80707	75601	3	3.01	26.41	6.37	78.4	0.8812	8.67	106	2.32	10%	0.275
80707	75728	4	4.07	26.34	6.12	75.2	0.8801	8.64	56	4.26	5%	0.343
80707	75841	6	6.01	26.28	5.95	73.0	0.8775	8.61	13	6.24	1.2%	0.189
80707	80011	8	7.99	26.22	5.23	64.1	0.8782	8.54	4	8.32	0.4%	0.167
80707	80200	10	10.07	25.82	3.05	37.1	0.8694	8.23	1	10.29	0.1%	0.000
80707	80303	12	12.04	24.8	0.49	5.8	0.8996	7.94	1	12.3	0.1%	
80707	80441	14	14.05	24.04	0.16	1.9	0.9591	7.84	0	14.32	0%	
80707	80600	16	16.07	23.19	0.12	1.4	0.9763	7.69	0	16.29	0%	
80707	80650	18	18.04	22.78	0.12	1.4	0.9878	7.62	0	18.28	0%	
80707	80800	20	20.03	21.61	0.10	1.2	1.0130	7.46	0	20.32	0%	
80707	81036	22	22.07	20.33	0.09	1.0	1.0440	7.30	0	22.29	0%	

80707	81234	24	24.04	17.58	0.09	1.0	1.1240	7.03	0	24.25	0%
80707	81332	26	26.00	16.75	0.09	0.9	1.1420	6.94	0	26.28	0%
80707	81433	28	28.03	16.48	0.10	1.0	1.1480	6.90	0		

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 1.07
91107	74353	0	0.34	21.88	4.58	51.5	0.6686	7.76	3369	Surface		
91107	74545	1	0.97	21.90	4.41	49.7	0.6683	7.70	3345	Surface	100%	
91107	74707	2	2.05	21.90	4.28	48.3	0.669	7.68	596	0.3	18%	5.750
91107	74824	3	2.98	21.90	4.28	48.2	0.669	7.68	288	1.23	9%	0.591
91107	74915	4	4.07	21.90	4.28	48.2	0.6692	7.68	117	2.32	3%	0.388
91107	75022	6	5.95	21.90	4.19	47.1	0.6699	7.67	26	4.2	0.78%	0.358
91107	75208	8	8.03	21.91	4.15	46.8	0.6696	7.67	8	6.28	0.24%	0.188
91107	75305	10	10.00	21.90	4.23	47.6	0.6716	7.66	2	8.25	0.06%	0.168
91107	75417	12	12.05	21.87	4.01	45.1	0.6727	7.66	1	10.3	0.03%	0.067
91107	75613	14	14.09	21.87	3.99	45.0	0.6723	7.67	0	12.34		
91107	75730	16	16.08	21.81	4.01	45.0	0.6736	7.67	0	14.33		
91107	75843	18	18.06	21.77	3.87	43.5	0.6747	7.67	0	16.31		
91107	75941	20	20.06	21.24	2.05	22.8	0.7035	7.45	0	18.31		
91107	80116	22	21.99	19.85	0.11	1.2	0.8071	7.07	0	20.24		
91107	80227	24	24.05	18.72	0.09	0.9	0.9293	6.88	0	22.3		
91107	80324	26	26.09	17.87	0.08	0.9	1.0580	6.74	0	24.34		
91107	80401	28	28.04	17.36	0.08	0.8	1.1130	6.67	0	26.29		

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 1.02
102307	74701	0	0.37	14.79	6.14	62.5	0.7293	7.75	876	Surface		
102307	74751	1	1.03	14.78	6.07	61.8	0.7288	7.74	971	Surface	100%	
102307	74907	2	2.2	14.78	6.05	61.6	0.7289	7.73	126	0.45	13%	4.538
102307	75137	3	2.98	14.78	5.94	60.4	0.7283	7.72	73	1.23	8%	0.444

102307	75237	4	4.04	14.77	5.92	60.3	0.7283	7.72	21	2.29	2%	0.544
102307	75323	6	5.93	14.77	5.95	60.5	0.7288	7.71	5	4.18	0.5%	0.343
102307	75428	8	7.98	14.77	5.89	60.0	0.7284	7.71	2	6.23	0.2%	0.147
102307	75731	10	9.97	14.77	5.83	59.3	0.7288	7.72	1	8.22	0.1%	0.084
102307	75930	12	12.00	14.77	5.83	59.4	0.7292	7.72	0	10.25		
102307	80048	14	13.91	14.75	5.81	59.1	0.7289	7.73	0	12.16		
102307	80208	16	16.01	14.74	5.85	59.5	0.7295	7.73	0	14.26		
102307	80323	18	18.03	14.72	5.78	58.7	0.7295	7.73	0	16.28		
102307	80445	20	20.00	14.69	5.81	59.0	0.7292	7.75	0	18.25		
102307	80530	22	22.01	14.68	5.83	59.2	0.7292	7.74	0	20.26		
102307	80640	24	24.01	14.63	5.72	58.0	0.7295	7.73	0	22.26		

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 2000-2005 will be used in the following discussion.

Temperature and Dissolved Oxygen:

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

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if

this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

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

Nutrients:

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

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

it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2005 is 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 2000-2005 was 0.174 mg/L and ranged from a minimum of 0.012 mg/L in West Loon 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 is 7.9 mg/L, ranging from below the 1 mg/L detection limit (10 lakes) 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 mg/L, ranging from 34 mg/L in Pulaski Pond to 298 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 3.17 feet. From 2000-2005, Fairfield Marsh and Patski Pond had the lowest Secchi depths (0.33 feet) and Bangs Lake had the highest (29.23 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 is 8.30, with a minimum of 7.06 in Deer Lake and a maximum of 10.28 in Round Lake Marsh North.

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. WATER QUALITY STATISTICS FOR ALL LAKE COUNTY LAKES.

2000 - 2007 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2007	
Average	**167.3**	
Median	**162.0**	
Minimum	**64.9**	**IMC**
Maximum	**330.0**	**Flint Lake**
STD	**42.0**	
n =	**803**	

	ALKanoxic 2000-2007	
Average	**200**	
Median	**193**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**48**	
n =	**253**	

	Condoxic <=3ft00-2007	
Average	**0.8856**	
Median	**0.8038**	
Minimum	**0.2542**	**Broberg Marsh**
Maximum	**6.8920**	**IMC**
STD	**0.5243**	
n =	**802**	

	Condanoxic 2000-2007	
Average	**1.0035**	
Median	**0.8340**	
Minimum	**0.3210**	**Lake Kathyrn**
Maximum	**7.4080**	**IMC**
STD	**0.7787**	
n =	**252**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2007	
Average	**0.515**	
Median	**0.150**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.082**	
n =	**808**	

*ND = Many lakes had non-detects (74.5%)
Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2007	
Average	**2.070**	
Median	**1.340**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.296**	
n =	**252**	

*ND = 19.8% Non-detects from 28 different lakes

	pHoxic <=3ft00-2007	
Average	**8.31**	
Median	**8.31**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.44**	
n =	**797**	

	pHanoxic 2000-2007	
Average	**7.22**	
Median	**7.21**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.41**	
n =	**252**	

	All Secchi 2000-2007	
Average	**4.57**	
Median	**3.28**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pond**
Maximum	**21.33**	**Bangs Lake**
STD	**3.81**	
n =	**750**	

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2000 - 2007 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2007	
Average	**1.457**	
Median	**1.220**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.830**	
n =	**808**	

*ND = 4.5% Non-detects from 16 different lakes

	TKNanoxic 2000-2007	
Average	**2.910**	
Median	**2.320**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.272**	
n =	**252**	

*ND = 2.8% Non-detects from 4 different lakes

	TPoxic <=3ft00-2007	
Average	**0.100**	
Median	**0.063**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**808**	

*ND = 2.4% Non-detects from 7 different lakes
(Carina, Minear,& Stone Quarry)

	TPanoxic 2000-2007	
Average	**0.294**	
Median	**0.177**	
Minimum	**0.012**	**Indep. Grove and W. Loon Lake**
Maximum	**3.800**	**Taylor Lake**
STD	**0.380**	
n =	**252**	

	TSSall <=3ft00-2007	
Average	**15.5**	
Median	**8.0**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**814**	

*ND = 1.8% Non-detects from 11 different lakes

	TVSoxic <=3ft00-2007	
Average	**135.3**	
Median	**132.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.9**	
n =	**758**	

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 <=3ft00-2007	
Average	**232**	
Median	**119**	
Minimum	**41**	**Timber Lake (N)**
Maximum	**2390**	**IMC**
STD	**400**	
n =	**102**	

	CLoxic <=3ft00-2007	
Average	**211**	
Median	**158**	
Minimum	**30**	**White Lake**
Maximum	**2760**	**IMC**
STD	**247**	
n =	**411**	

77 of 163 lakes had anoxic conditions
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 2000-2007 (n=1363).

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

LCHD Lakes Management Unit ~ 12/17/2007

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APPENDIX E. GRANT PROGRAM OPPORTUNITES.

Table E1. Potential Grant Opportunities

Grant Program Name	Funding Source	Contact Information	Funding Focus				Cost Share
			Water Quality/ Wetland	Habitat	Erosion	Flooding	
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 E1. 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/nonpoint.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
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