2006 SUMMARY REPORT
of
Long Lake

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT

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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 2006 on Long Lake. Similar reports have been written on data collected in 1991, 1996, 2001, and 2005 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

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 19 to 25 feet depending on water level and the samples were analyzed for various water quality parameters (Appendix C).

Long Lake was thermally stratified from May through September. 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 2006, the lake was weakly stratified by May and strongly stratified by June. Stratification remained strong until September, when water temperatures throughout the water column became more uniform. Turnover was beginning during the September sampling, which explains why some of the water quality parameters in the hypolimnion were less than those in August. DO concentrations in the epilimnion did not indicate any significant problems; however the hypolimnion had anoxic conditions (< 1.0 mg/L) from June through September (Appendix B). The anoxic boundary was at its shallowest in July and August (14 ft) and deepest in September, during turnover, 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 2006.

Secchi disk depth (water clarity) averaged 4.52 feet during 2006 (Table 1), which was above the Lake County median of 3.27 feet (Appendix D). This was an increase from 2005 (4.18 feet) and 2001 (4.11 feet). Water clarity is related to the amount of total suspended solids (TSS) in the water column. As the Secchi depth has been increasing over the years, the average TSS has decreased (Figure 2). The 2006 average epilimnetic TSS of 7.2 mg/L was 34% lower than the 2005 average (10.9 m/L) and 26% lower than the 2001 average (9.7 mg/L). The 2006 average epilimnetic TSS was lower than the Lake County median of 7.9 mg/L. Overall, the average epilimnetic TSS has declined significantly since 1991 when the average was 23.6 mg/L (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.

The 2006 seasonal average epilimnetic total phosphorus (TP) concentration of 0.068 mg/L was the lowest since 1991 (0.063 mg/L), but above the county median of 0.060 mg/L. The 2006 seasonal hypolimnetic TP average of 0.345 mg/L was well above the county median of 0.163 mg/l, but was a decrease from the previous monitoring when the hypolimnetic average TP was 0.827 mg/L in 2005 and 0.661 mg/L in 2001. Much of this fluctuation may have been due to environmental affects, such as rain events or water temperature, which influence the thermal stratification and turnover of the lake, and therefore varies between years but the overall decline was probably the result of the increased plants. Phosphorus can be released from sediment 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 30:1 in 2006, which was consistent with previous sampling. This indicates that the lake was phosphorus limited, which means that any addition of phosphorus could result in increases in plant and algae biomass. The trophic state of Long Lake based on phosphorus concentration during 2001, 2005, and 2006 was eutrophic, with TSIp scores of 69.4, 66.6, and 65.0. Long Lake ranked 79th out of 162 lakes in Lake County in 2006 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, swimming, 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 provides *Full* support of aquatic life and *Partial* support of swimming and recreational activities as a result of moderate TP concentrations. The lake provides *Partial* overall use.

Conductivity is a measurement of water's ability to conduct electricity and is positively correlated with chloride (Cl^-) concentration. The Lake County median conductivity for near surface samples was 0.7948 milliSiemens/cm (mS/cm). During 2006, the average epilimnetic conductivity reading for Long Lake was higher (1.1120 mS/cm) and was an increase from the previous monitoring when the average conductivity was 1.0821 mS/cm in 2005 and 0.9430 mS/cm in 2001. The 2006 average Cl^- concentration in Long Lake was above the Lake County median (171 mg/L), with a seasonal average of 187 mg/L. This is down from the 2005 average of 197 mg/L. Water levels on Long Lake rose by more than 5 inches from April to October, which provided more lake volume and could be a reason for the lower 2006 Cl^- values. 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 being a main source. A study done in Canada reported 10% of aquatic species are 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 that Long Lake was being 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, 2006.

Table 1. Water quality data for Long Lake, 2001, 2005, and 2006.

2006	Epilimnion															
DATE	DEPTH	ALK	TKN	NO_2+NO_3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	3	161	1.30	<0.1	1.820	0.044	<0.005	195	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	3	190	1.05	<0.1	0.552	0.051	<0.005	181	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	10.9	683	155	4.18	1.0821	8.28	7.78

2001	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	3	214	0.78	<0.1	0.345	0.059	<0.005	NA	619	8.8	670	193	3.61	0.9992	8.03	7.72
19-Jun	3	210	1.13	<0.1	0.380	0.049	<0.005	NA	608	6.3	677	205	5.61	0.9464	8.11	7.24
24-Jul	3	194	1.66	<0.1	<0.05	0.093	0.007	NA	577	10.5	631	188	3.64	0.9432	8.19	5.64
21-Aug	3	181	1.63	<0.1	<0.05	0.112	0.008	NA	578	11.9	627	188	3.61	0.9083	8.19	8.93
18-Sep	3	182	1.72	<0.1	<0.05	0.146	0.022	NA	550	11.0	573	153	4.10	0.9181	8.02	6.55
	Average	196	1.38	<0.1	0.363[k]	0.092	0.012[k]	NA	586	9.7	636	185	4.11	0.9430	8.11	7.22

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

Table 1. Continued.

2006	Hypolimnion															
DATE	DEPTH	ALK	TKN	NO_2+NO_3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	22	162	1.45	<0.1	1.82	0.045	<0.005	194	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	26	198	1.59	0.531	0.481	0.062	<0.005	189	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	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	NA	8.9	693	148	NA	1.1399	7.22	2.17

2001	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N[*]	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	26	227	2.25	1.120	0.113	0.309	0.163	NA	630	35.0	668	170	NA	1.0160	7.28	0.02
19-Jun	26	225	1.85	0.725	0.121	0.209	0.152	NA	640	4.7	643	168	NA	0.9914	7.26	0.05
24-Jul	25	270	3.52	2.590	<0.05	0.815	0.744	NA	584	6.8	681	183	NA	1.0235	6.77	0.01
21-Aug	26	316	7.10	6.000	<0.05	1.230	1.230	NA	636	9.6	654	219	NA	1.0510	6.55	0.01
18-Sep	26	233	4.45	3.180	<0.05	0.743	0.671	NA	570	10.0	576	167	NA	1.0920	6.35	0.15
	Average	254	3.83	2.723	0.117[k]	0.661	0.592	NA	612	13.2	644	181	NA	1.0348	6.84	0.05

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
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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, 1991-2006.

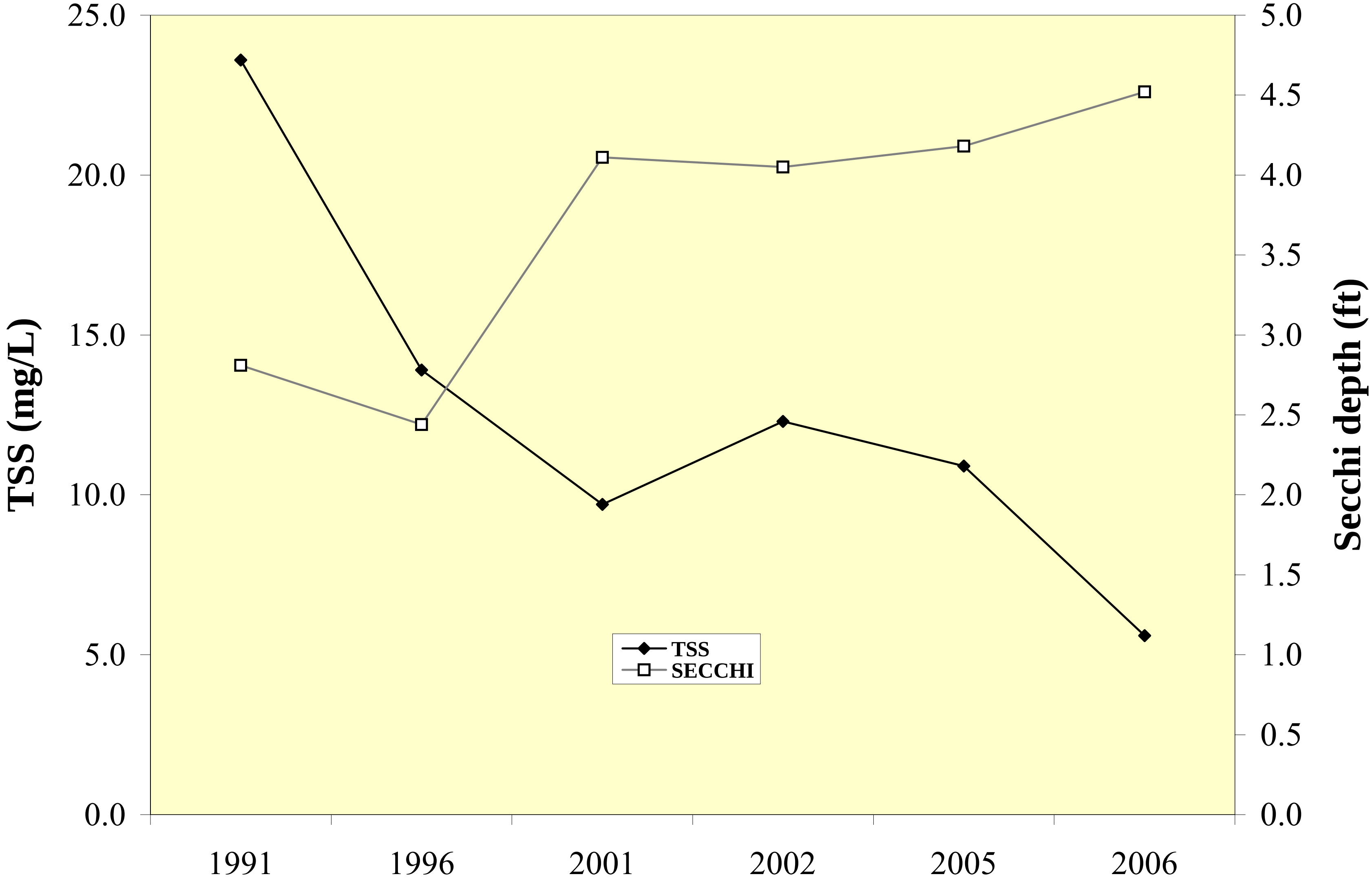

Table 2. Epilimnetic averages of select water quality parameters from previous studies of Long Lake.

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

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

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Table 3. Lake County average TSI phosphorous (TSIp) ranking 2000-2006.

RANK	LAKE NAME	TP AVE	TSIp
1	Cedar Lake	0.0154	43.61
2	Windward Lake	0.0158	43.95
3	Sterling Lake	0.0162	44.31
4	Lake Minear	0.0165	44.57
5	Pulaski Pond	0.0180	45.83
6	Timber Lake	0.0180	45.83
7	Fourth Lake	0.0182	45.99
8	West Loon Lake	0.0182	45.99
9	Lake Carina	0.0193	46.86
10	Independence Grove	0.0194	46.91
11	Lake Kathyrn	0.0200	47.35
12	Lake of the Hollow	0.0200	47.35
13	Banana Pond	0.0202	47.49
14	Bangs Lake	0.0220	48.72
15	Cross Lake	0.0220	48.72
16	Third Lake	0.0221	48.82
17	Dog Pond	0.0222	48.85
18	Sand Pond	0.0230	49.36
19	Stone Quarry Lake	0.0230	49.36
20	Cranberry Lake	0.0240	49.98
21	Deep Lake	0.0240	49.98
22	Druce Lake	0.0244	50.22
23	Little Silver Lake	0.0246	50.33
24	Round Lake	0.0254	50.80
25	Lake Leo	0.0256	50.91
26	Dugdale Lake	0.0274	51.89
27	Peterson Pond	0.0274	51.89
28	Lake Miltmore	0.0276	51.99
29	Ames Pit	0.0278	52.10
30	East Loon Lake	0.0280	52.20
31	Lake Zurich	0.0282	52.30
32	Lake Fairfield	0.0296	53.00
33	Gray's Lake	0.0302	53.29
34	Highland Lake	0.0302	53.29
35	Hook Lake	0.0302	53.29
36	Lake Catherine (Site 1)	0.0308	53.57
37	Lambs Farm Lake	0.0312	53.76
38	Old School Lake	0.0312	53.76
39	Sand Lake	0.0316	53.94
40	Sullivan Lake	0.0320	54.13
41	Lake Linden	0.0326	54.39
42	Gages Lake	0.0338	54.92
43	Hendrick Lake	0.0344	55.17

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	White Lake	0.0408	57.63
47	Sun Lake	0.0410	57.70
48	Potomac Lake	0.0424	58.18
49	Duck Lake	0.0426	58.25
50	Old Oak Lake	0.0428	58.32
51	Wooster Lake	0.0433	58.48
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	Leisure Lake	0.0648	64.30
78	St. Mary's Lake	0.0666	64.70
79	**Long Lake**	**0.0680**	**65.00**
80	Mary Lee Lake	0.0682	65.04
81	Hastings Lake	0.0684	65.08
82	Honey Lake	0.0690	65.21
83	North Tower Lake	0.0718	65.78
84	Lake Fairview	0.0724	65.90
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Countryside Lake	0.0788	67.12
91	Echo Lake	0.0792	67.19
92	Sylvan Lake	0.0794	67.23
93	Big Bear Lake	0.0806	67.45
94	Petite Lake	0.0834	67.94
95	Lake Marie (Site 1)	0.0850	68.21
96	North Churchill Lake	0.0872	68.58
97	Grandwood Park, Site II, Outflow	0.0876	68.65
98	South Churchill Lake	0.0896	68.97
99	Rivershire Pond 2	0.0900	69.04
100	McGreal Lake	0.0914	69.26
101	International Mine and Chemical Lake	0.0948	69.79
102	Eagle Lake (Site I)	0.0950	69.82
103	Dunns Lake	0.0952	69.85
104	Fish Lake	0.0956	69.91
105	Lake Barrington	0.0956	69.91
106	Lochanora Lake	0.0960	69.97
107	Owens Lake	0.0978	70.23
108	Woodland Lake	0.0986	70.35
109	Island Lake	0.0990	70.41
110	McDonald Lake 1	0.0996	70.50
111	Tower Lake	0.1000	70.56
112	Longview Meadow Lake	0.1024	70.90
113	Redwing Slough, Site II, Outflow	0.1072	71.56
114	Lake Forest Pond	0.1074	71.59
115	Bittersweet Golf Course #13	0.1096	71.88
116	Fox Lake (Site 1)	0.1098	71.90
117	Bresen Lake	0.1126	72.27
118	Round Lake Marsh North	0.1126	72.27
119	Timber Lake S	0.1128	72.29
120	Deer Lake Meadow Lake	0.1158	72.67
121	Taylor Lake	0.1184	72.99
122	Grand Avenue Marsh	0.1194	73.11
123	Columbus Park Lake	0.1226	73.49
124	Nippersink Lake (Site 1)	0.1240	73.66
125	Grass Lake (Site 1)	0.1288	74.21
126	Lake Holloway	0.1322	74.58
127	Lakewood Marsh	0.1330	74.67
128	Summerhill Estates Lake	0.1384	75.24
129	Redhead Lake	0.1412	75.53

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
130	Forest Lake	0.1422	75.63
131	Antioch Lake	0.1448	75.89
132	Valley Lake	0.1470	76.11
133	Slocum Lake	0.1496	76.36
134	Drummond Lake	0.1510	76.50
135	Pond-a-Rudy	0.1514	76.54
136	Lake Matthews	0.1516	76.56
137	Buffalo Creek Reservoir	0.1550	76.88
138	Pistakee Lake (Site 1)	0.1592	77.26
139	Salem Lake	0.1650	77.78
140	Half Day Pit	0.1690	78.12
141	Lake Eleanor Site II, Outflow	0.1812	79.13
142	Lake Farmington	0.1848	79.41
143	ADID 127	0.1886	79.71
144	Lake Louise Inlet	0.1938	80.10
145	Grassy Lake	0.1952	80.20
146	Dog Bone Lake	0.1990	80.48
147	Redwing Marsh	0.2072	81.06
148	Stockholm Lake	0.2082	81.13
149	Bishop Lake	0.2156	81.63
150	Hidden Lake	0.2236	82.16
151	Fischer Lake	0.2278	82.43
152	Lake Napa Suwe (Outlet)	0.2304	82.59
153	Patski Pond (outlet)	0.2512	83.84
154	Oak Hills Lake	0.2792	85.36
155	Loch Lomond	0.2954	86.18
156	McDonald Lake 2	0.3254	87.57
157	Fairfield Marsh	0.3264	87.61
158	ADID 182	0.3280	87.69
159	Slough Lake	0.4134	91.02
160	Flint Lake Outlet	0.4996	93.75
161	Rasmussen Lake	0.5025	93.84
162	Albert Lake, Site II, outflow	1.1894	106.26

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in June and August of 2006, with 244 sites sampled in June (Figure 3) and 246 sites sampled in August (Figure 4). The maximum depth plants were found was 8.8 feet in June and 9.8 feet in August. Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. During 2006, the depth of the 1% light level ranged from 5 feet (August and September) to 15 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 57% and 51% of the sampling sites. Coontail was the second most common species found at 46% and 45% of the sampling sites (Table 5a, b). Aquatic plant composition was similar in 2005 with 10 species found and EWM being the most abundant species. Vallisneria was the species found in 2006 and not in 2005. Two exotic aquatic plants, EWM and Curlyleaf Pondweed, were found in Long Lake. Both of these exotics compete with native plants, eventually crowding them out and providing poor natural diversity and limit uses 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 2000-2006 Lake County lakes was 13.6 (Table 6). Long Lake had a FQI of 16.9 in 2006. This is up from 2005 when the FQI was 15.5 and 2000 when the FQI of 13.6 due to an increase in aquatic plant composition.

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 68% (June) and approximately 60% (August) of the sites sampled had aquatic plants (Table 5c). It was calculated that approximately 33% – 38% of the lake bottom was covered by plants.

Figure 3. Aquatic plant sampling grid that illustrates plant density on Long Lake, June 2006.

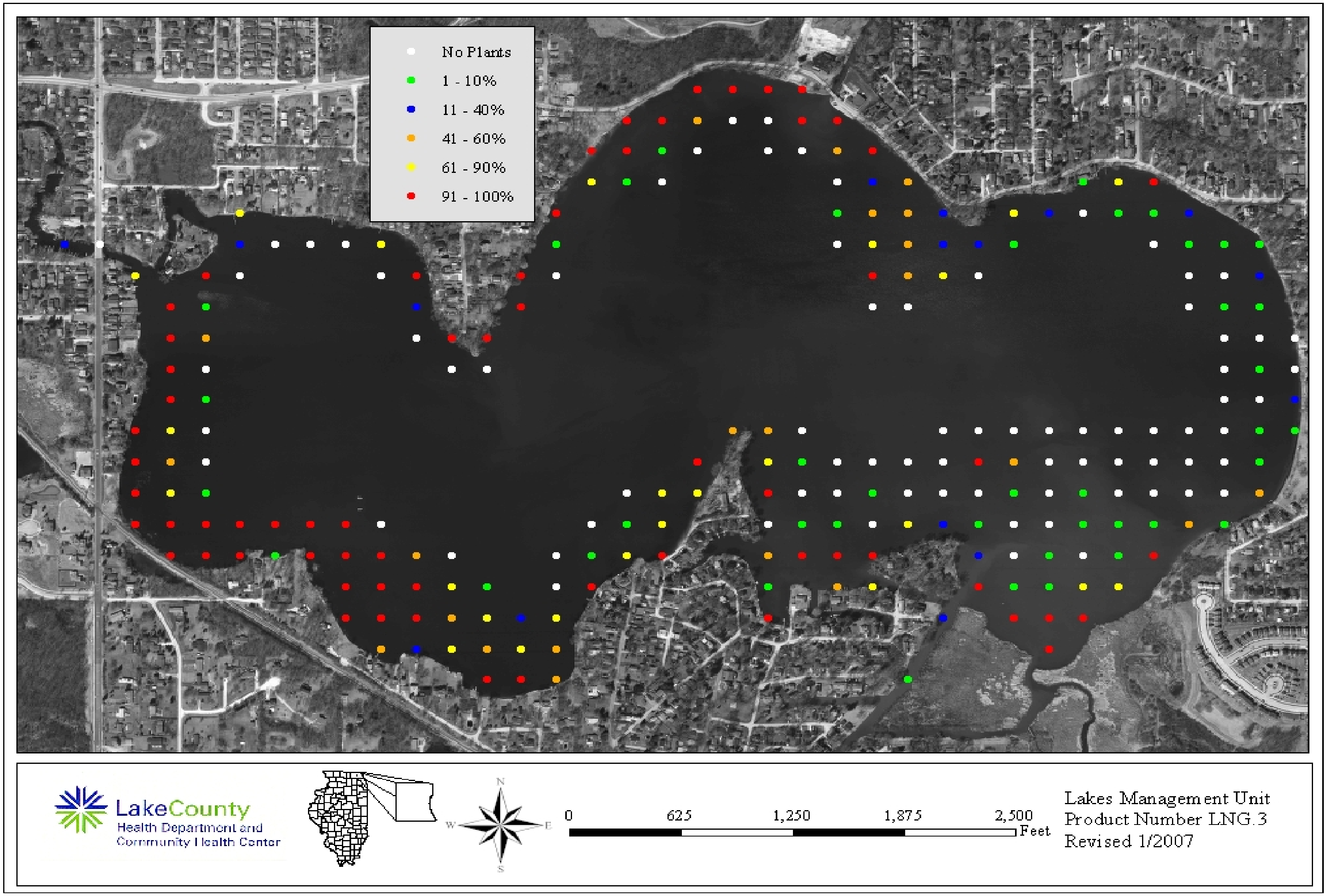

Figure 4. Aquatic plant sampling grid that illustrates plant density on Long Lake, August 2006.

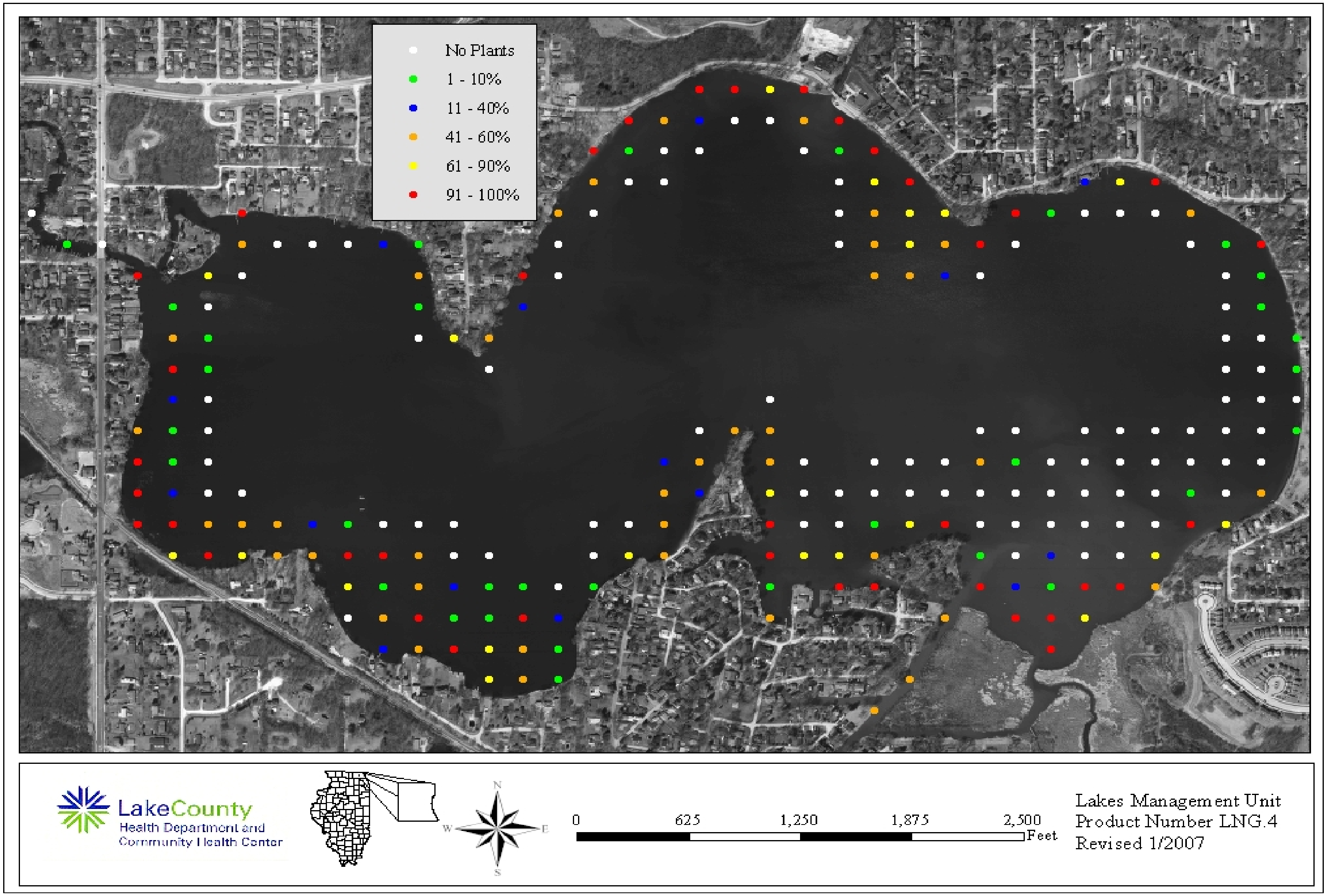

Table 4. Aquatic plant species found in Long Lake in 2006.

Coontail	*Ceratophyllum demersum*
American Elodea	*Elodea canadensis*
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 244 sampling sites on Long Lake in June, 2006. The maximum depth that plants were found was 8.8 feet.

June

Plant Density	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Giant Duckweed	Sago Pondweed	Watermeal	White Water Lily
Absent	132	196	227	242	106	235	237	232	231
Present	38	42	8	2	24	5	5	8	7
Common	34	3	9	0	41	4	1	4	6
Abundant	12	3	0	0	36	0	1	0	0
Dominant	28	0	0	0	37	0	0	0	0
% Plant Occurrence	45.9	19.7	7.0	0.8	56.6	3.7	2.9	4.9	5.3

Table 5b. Aquatic plant species found at the 246 sampling sites on Long Lake in August 2006. The maximum depth that plants were found was 9.8 feet.

August

Plant Density	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Giant Duckweed	Sago Pondweed	Vallisneria	Watermeal	Water Stargrass	White Water Lily
Absent	136	245	225	121	243	240	245	245	244	225
Present	29	1	10	42	3	4	1	1	1	13
Common	26	0	2	29	0	2	0	0	0	3
Abundant	31	0	5	28	0	0	0	0	1	5
Dominant	24	0	4	26	0	0	0	0	0	0
% Plant Occurrence	44.7	0.4	8.5	50.8	1.2	2.4	0.4	0.4	0.8	8.5

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

June

Rake Density (Coverage)	# of Sites	%
No plants	78	32.0%
>0 to 10%	41	16.8%
>10 to 40%	16	6.6%
>40 to 60%	22	9.0%
>60 to 90%	24	9.8%
>90%	63	25.8%
Total Sites with Plants	166	68.0%
Total # of Sites	244	100.0%

August

Rake Density (Coverage)	# of Sites	%
No plants	99	40.6%
>0 to 10%	32	13.1%
>10 to 40%	15	6.1%
>40 to 60%	41	16.8%
>60 to 90%	21	8.6%
>90%	38	15.6%
Total Sites with Plants	147	60.2%
Total # of Sites	246	100.8%

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	35.7	37.9
2	Deep Lake	33.9	35.4
3	Round Lake Marsh North	29.1	29.9
4	East Loon Lake	28.4	29.9
5	Deer Lake	28.2	29.7
6	Sullivan Lake	28.2	29.7
7	Little Silver Lake	27.9	30.0
8	Schreiber Lake	26.8	27.6
9	Cranberry Lake	26.6	28.6
10	Bangs Lake	26.4	28.0
11	West Loon Lake	26.0	27.6
12	Cross Lake	25.2	27.8
13	Lake Zurich	24.0	26.0
14	Lake of the Hollow	23.8	26.2
15	Lakewood Marsh	23.8	24.7
16	Round Lake	23.5	25.9
17	Fourth Lake	23.0	24.8
18	Druce Lake	22.8	25.2
19	Sun Lake	22.7	24.5
20	Countryside Glen Lake	21.9	22.8
21	Sterling Lake	21.8	24.1
22	Butler Lake	21.4	23.1
23	Duck Lake	21.1	22.9
24	Timber Lake (North)	20.8	22.8
25	Broberg Marsh	20.5	21.4
26	Davis Lake	20.5	21.4
27	ADID 203	20.5	20.5
28	McGreal Lake	20.2	22.1
29	Wooster Lake	19.8	22.3
30	Lake Kathryn	19.6	20.7
31	Fish Lake	19.3	21.2
32	Redhead Lake	19.3	21.2
33	Owens Lake	19.3	20.2
34	Lake Minear	18.8	20.6
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	Ames Pit	17.0	18.0
41	Seven Acre Lake	17.0	15.5
42	Gray's Lake	16.9	19.8
43	Grand Avenue Marsh	16.9	18.7

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
44	**Long Lake**	**16.9**	**18.7**
45	Bresen Lake	16.6	17.8
46	Windward Lake	16.3	17.6
47	Lake Barrington	16.3	17.4
48	Diamond Lake	16.3	17.4
49	Lake Napa Suwe	16.3	17.4
50	Dog Bone Lake	15.7	15.7
51	Redwing Slough	15.6	16.6
52	Independence Grove	15.5	16.7
53	Tower Lake	15.2	17.6
54	Heron Pond	15.1	15.1
55	Lake Tranquility (S1)	15.0	17.0
56	North Churchill Lake	15.0	15.0
57	Island Lake	14.7	16.6
58	Dog Training Pond	14.7	15.9
59	Highland Lake	14.5	16.7
60	Lake Fairview	14.3	16.3
61	Taylor Lake	14.3	16.3
62	Third Lake	14.1	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	Hook Lake	13.4	15.5
67	Timber Lake (South)	13.4	15.5
68	Bishop Lake	13.4	15.0
69	Mary Lee Lake	13.1	15.1
70	Old School Lake	13.1	15.1
71	Buffalo Creek Reservoir	13.1	14.3
72	McDonald Lake 2	13.1	14.3
73	Old Oak Lake	12.7	14.7
74	White Lake	12.7	14.7
75	Dunn's Lake	12.7	13.9
76	Echo Lake	12.5	14.8
77	Hastings Lake	12.5	14.8
78	Sand Lake	12.5	14.8
79	Countryside Lake	12.5	14.0
80	Stone Quarry Lake	12.5	12.5
81	Honey Lake	12.1	14.3
82	Lake Leo	12.1	14.3
83	Lambs Farm Lake	12.1	14.3
84	Stockholm Lake	12.1	13.5
85	Pond-A-Rudy	12.1	12.1
86	Lake Matthews	12.0	12.0

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
87	Flint Lake	11.8	13.0
88	Harvey Lake	11.8	13.0
89	Rivershire Pond 2	11.5	13.3
90	Antioch Lake	11.3	13.4
91	Lake Charles	11.3	13.4
92	Lake Linden	11.3	11.3
93	Lake Naomi	11.2	12.5
94	Pulaski Pond	11.2	12.5
95	Redwing Marsh	11.0	11.0
96	West Meadow Lake	11.0	11.0
97	Nielsen Pond	10.7	12.0
98	Lake Holloway	10.6	10.6
99	Lake Carina	10.2	12.5
100	Crooked Lake	10.2	12.5
101	Lake Lakeland Estates	10.0	11.5
102	College Trail Lake	10.0	10.0
103	Werhane Lake	9.8	12.0
104	Big Bear Lake	9.5	11.0
105	Little Bear Lake	9.5	11.0
106	Loch Lomond	9.4	12.1
107	Sand Pond (IDNR)	9.4	12.1
108	Columbus Park Lake	9.2	9.2
109	Sylvan Lake	9.2	9.2
110	Fischer Lake	9.0	11.0
111	Grandwood Park Lake	9.0	11.0
112	Lake Fairfield	9.0	10.4
113	McDonald Lake 1	8.9	10.0
114	East Meadow Lake	8.5	8.5
115	South Churchill 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	Bittersweet Golf Course #13	8.1	8.1
120	Woodland Lake	8.1	9.9
121	Albert Lake	7.5	8.7
122	Lake Eleanor	7.5	8.7
123	Fairfield Marsh	7.5	8.7
124	Lake Louise	7.5	8.7
125	Banana Pond	7.5	9.2
126	Patski Pond	7.1	7.1
127	Rasmussen Lake	7.1	7.1
128	Slough Lake	7.1	7.1
129	Lucky Lake	7.0	7.0

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
130	Lake Forest Pond	6.9	8.5
131	Leisure Lake	6.4	9.0
132	Peterson Pond	6.0	8.5
133	Grassy Lake	5.8	7.1
134	Slocum Lake	5.8	7.1
135	Gages Lake	5.8	10.0
136	Deer Lake Meadow Lake	5.2	6.4
137	ADID 127	5.0	5.0
138	Liberty Lake	5.0	5.0
139	Oak Hills Lake	5.0	5.0
140	Drummond Lake	5.0	7.1
141	IMC Lake	5.0	7.1
142	North Tower Lake	4.9	7.0
143	Forest Lake	3.5	5.0
144	Half Day Pit	2.9	5.0
145	Lochanora Lake	2.5	5.0
146	Hidden Lake	0.0	0.0
147	St. Mary's Lake	0.0	0.0
148	Valley Lake	0.0	0.0
149	Waterford Lake	0.0	0.0
150	Potomac Lake	0.0	0.0
151	Willow Lake	0.0	0.0
	Mean	**13.6**	**14.9**
	Median	**12.5**	**14.3**

SUMMARY OF WILDLIFE AND HABITAT

Wildlife observations were made on a monthly basis during water quality activities. Because the lake is in the middle of a residential setting with the majority of the shoreline composed of riprap, habitat for wildlife was limited. Most of the birds were those common to residential settings. There are healthy populations of mature trees that provide good habitat for a variety of bird species, as well as a few large, dead trees that provide excellent habitat for Double Crested Cormorants, Osprey, and Great Blue Herons. Additionally, there were several shrub areas that provided habitat for smaller bird and mammal species. However, there are several areas in need of habitat improvement on Long Lake. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of native planted shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians.

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 2006.

Long Lake 2006 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 0.34
41106	104627	0.25	0.5	10.04	9.05	82.7	1.1670	7.98	2362	Surface		
41106	104724	1	1.12	10.04	8.94	81.7	1.1670	8.02	2186	Surface	100%	
41106	104816	2	2.08	10.04	8.96	81.9	1.1670	8.03	855	0.33	39%	2.84
41106	104917	3	2.95	9.95	8.93	81.4	1.1680	8.03	582	1.2	27%	0.32
41106	105047	4	4.03	10.01	8.91	81.3	1.1580	8.06	221	2.28	10%	0.42
41106	105146	6	6.06	9.89	8.9	81	1.1580	8.05	190	4.31	9%	0.04
41106	105405	8	8.03	9.85	8.85	80.5	1.1580	8.04	90	6.28	4%	0.12
41106	105519	10	10.03	9.85	8.83	80.3	1.1590	8.04	50	8.28	2%	0.07
41106	105630	12	12.05	9.84	8.77	79.8	1.1590	8.06	22	10.3	1.0%	0.08
41106	105811	14	14.04	9.62	8.57	77.5	1.1600	8.00	12	12.29	0.5%	0.05
41106	105903	16	16.06	9.55	8.5	76.7	1.1590	7.98	6	14.31	0.3%	0.05
41106	110141	18	18.07	9.24	8.28	74.3	1.1590	7.94	3	16.32	0.1%	0.04
41106	110316	20	20.06	8.61	8.04	71	1.1560	7.87	1	18.31	0.05%	0.06
41106	110519	22	21.97	8.11	7.77	67.8	1.1590	7.80	1	20.22	0.05%	0.00
41106	110801	24	24.02	7.65	6.56	56.6	1.1620	7.64	0	22.27		

Long Lake 2006 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 0.38
50906	84603	0.25	0.66	16.74	8.77	93.7	1.1920	8.12	1939	Surface		
50906	84702	1	1.11	16.74	8.82	94.2	1.1930	8.14	1829	Surface	100%	
50906	84805	2	2.02	16.73	8.70	92.9	1.1920	8.15	549	0.27	30%	4.46
50906	84853	3	2.99	16.74	8.80	94.0	1.1920	8.16	416	1.24	23%	0.22
50906	84954	4	3.99	16.73	8.73	93.2	1.1920	8.16	264	2.24	14%	0.20
50906	85052	6	6.02	16.73	8.72	93.1	1.1920	8.16	175	4.27	10%	0.10
50906	85144	8	8.02	16.71	8.77	93.6	1.1920	8.16	102	6.27	6%	0.09
50906	85304	10	10.02	16.51	8.13	86.4	1.1910	8.11	67	8.27	4%	0.05
50906	85418	12	11.95	15.76	7.07	74.0	1.1890	7.96	44	10.2	2%	0.04
50906	85521	14	14.09	15.09	6.35	65.5	1.1890	7.87	24	12.34	1.3%	0.05
50906	85640	16	16.05	14.68	6.00	61.4	1.1870	7.81	15	14.3	0.8%	0.03
50906	85756	18	18.01	14.35	5.16	52.3	1.1870	7.73	8	16.26	0.4%	0.04
50906	85913	20	20.15	14.27	4.75	48.1	1.1880	7.69	5	18.4	0.3%	0.03
50906	90039	22	21.97	14.20	4.42	44.7	1.1870	7.66	3	20.22	0.2%	0.03
50906	90215	24	23.95	13.89	2.89	29.0	1.1860	7.54	1	22.2	0.1%	0.05
50906	90318	26	25.95	13.61	2.07	20.7	1.1870	7.49	1	24.2	0.1%	0.00

Long Lake 2006 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	Extinction Coefficient
											Average	0.45
61306	82605	0.25	0.29	20.58	7.08	80.9	1.146	8.09	3367	Surface		
61306	82800	1	0.99	20.60	6.97	79.6	1.146	8.11	3257	Surface	100%	
61306	82954	2	2.00	20.60	6.81	77.9	1.146	8.13	1102	0.25	34%	4.33
61306	83049	3	3.01	20.58	6.85	78.3	1.146	8.13	710	1.26	22%	0.35
61306	83134	4	4.03	20.56	6.87	78.5	1.146	8.14	551	2.28	17%	0.11
61306	83307	6	6.02	20.51	6.72	76.7	1.146	8.13	258	4.27	8%	0.18
61306	83410	8	8.00	20.50	6.72	76.6	1.146	8.14	161	6.25	5%	0.08
61306	83447	10	10.01	20.45	6.65	75.8	1.146	8.13	75	8.26	2%	0.09
61306	83541	12	11.95	20.25	6.44	73.1	1.147	8.09	34	10.2	1.0%	0.08
61306	83656	14	13.96	19.91	5.91	66.7	1.147	8.01	20	12.21	0.6%	0.04
61306	83758	16	15.99	16.86	0.32	3.4	1.179	7.49	9	14.24	0.3%	0.06
61306	83904	18	17.99	15.41	0.16	1.6	1.185	7.42	5	16.24	0.2%	0.04
61306	83954	20	19.97	15.07	0.14	1.4	1.186	7.39	1	18.22	0.03%	0.09
61306	84029	22	21.97	14.77	0.13	1.3	1.187	7.38	1	20.22	0.03%	0.00
61306	84111	24	23.96	14.55	0.12	1.2	1.188	7.35	0	22.21		
61306	84210	26	25.95	13.96	0.11	1.1	1.198	7.30	0	24.2		

Long Lake 2006 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 0.58
71106	82452	0.25	0.30	24.56	6.83	84.7	1.1200	8.52	1192	Surface		
71106	82547	1	1.00	24.62	6.57	81.5	1.1190	8.54	984	Surface	100%	
71106	82726	2	2.04	24.63	6.52	80.9	1.1190	8.55	327	0.29	33%	3.80
71106	82852	3	2.98	24.63	6.51	80.8	1.1180	8.56	138	1.23	14%	0.70
71106	82935	4	3.98	24.62	6.48	80.4	1.1190	8.56	90	2.23	9%	0.19
71106	83051	6	5.98	24.62	6.52	81.0	1.1190	8.56	48	4.23	5%	0.15
71106	83200	8	8.02	24.63	6.62	82.2	1.1190	8.57	24	6.27	2%	0.11
71106	83254	10	9.98	24.62	6.60	81.9	1.1200	8.57	12	8.23	1.2%	0.08
71106	83422	12	12.01	24.57	6.40	79.4	1.1200	8.54	6	10.26	0.6%	0.07
71106	83548	14	13.99	23.17	0.45	5.5	1.1370	7.77	2	12.24	0.2%	0.09
71106	83701	16	15.97	20.32	0.17	2.0	1.1600	7.49	1	14.22	0.1%	0.05
71106	83827	18	17.99	17.59	0.12	1.3	1.1820	7.35	0	16.24		
71106	83927	20	19.97	16.02	0.10	1.1	1.1940	7.25	0	18.22		
71106	84127	22	22.02	14.99	0.09	1.0	1.2030	7.13	0	20.27		
71106	84346	24	24.04	14.31	0.08	0.8	1.2110	7.00	0	22.29		
71106	84427	26	26.02	14.01	0.07	0.7	1.2150	6.94	0	24.27		

Long Lake 2006 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 0.89
80806	90557	0.25	0.3	26.99	7.35	94.3	1.0920	8.69	2041	Surface		
80806	90702	1	0.97	27	7.08	90.9	1.0920	8.71	1859	Surface	100%	
80806	90814	2	2.1	27.02	7.11	91.2	1.0920	8.71	631	0.35	34%	3.09
80806	90925	3	3.03	27.02	7.01	90	1.0920	8.72	197	1.28	11%	0.91
80806	91213	4	4	27.02	6.95	89.3	1.0910	8.72	43	2.25	2%	0.68
80806	91335	6	5.98	27.02	6.84	87.8	1.0910	8.73	11	4.23	0.6%	0.32
80806	91606	8	7.99	27.02	6.78	87	1.0910	8.73	2	6.24	0.1%	0.27
80806	91752	10	10.04	27.01	6.74	86.5	1.0910	8.72	1	8.29	0.1%	0.08
80806	91854	12	12.02	26.4	2.8	35.6	1.1000	8.29	0	10.27		
80806	92027	14	14.02	24.38	0.15	1.8	1.1390	7.74	0	12.27		
80806	92138	16	15.98	22.49	0.14	1.6	1.1540	7.50	0	14.23		
80806	92236	18	18.03	20.28	0.14	1.6	1.1800	7.34	0	16.28		
80806	92325	20	20	18.17	0.13	1.4	1.1970	7.23	0	18.25		
80806	92423	22	22	16.42	0.13	1.3	1.2140	7.09	0	20.25		
80806	92548	24	24.03	15.85	0.12	1.3	1.2200	7.03	0	22.28		
80806	92627	26	26.01	15.29	0.12	1.2	1.2280	6.97	0	24.26		
80806	92718	28	27.95	15.1	0.11	1.2	1.2290	6.92	0	26.2		

Long Lake 2006 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	Extinction Coefficient
											Average	1.19
91206	83818	0.25	0.29	20.18	3.59	40.9	1.0520	7.88	265	Surface		
91206	83928	1	1.02	20.17	3.46	39.4	1.0520	7.87	202	Surface	100%	
91206	84103	2	2.04	20.17	3.28	37.4	1.0520	7.87	57	0.29	28%	4.36
91206	84214	3	3.05	20.14	3.14	35.8	1.0530	7.86	24	1.3	12%	0.67
91206	84348	4	4.00	20.13	3.01	34.2	1.0530	7.85	11	2.25	5%	0.35
91206	84602	6	6.06	20.1	2.96	33.7	1.0520	7.85	1	4.31	0.5%	0.56
91206	84837	8	7.98	20.07	3.13	35.6	1.0520	7.88	1	6.23	0.5%	0.00
91206	85004	10	10.04	20.06	3.21	36.5	1.0520	7.89	0	8.29		
91206	85132	12	12.04	20.06	3.22	36.6	1.0520	7.89	0	10.29		
91206	85340	14	14.05	20.02	3.27	37.1	1.0510	7.89	0	12.3		
91206	85513	16	15.99	20.00	3.29	37.4	1.0510	7.90	0	14.24		
91206	85636	18	18.01	19.95	2.86	32.4	1.0520	7.85	0	16.26		
91206	85743	20	20.03	19.91	2.69	30.5	1.0510	7.82	0	18.28		
91206	85855	22	22.04	19.81	2.70	30.5	1.0500	7.84	0	20.29		
91206	90012	24	23.99	17.98	0.17	1.8	1.2320	6.91	0	22.24		
91206	90154	26	25.99	15.94	0.09	1.0	1.2830	6.74	0	24.24		

Long Lake 2006 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 0.77
103106	122404	0.25	0.59	7.98	10.76	94.0	1.0170	7.98	3606	Surface		
103106	122450	1	0.77	7.98	10.57	92.4	1.0170	8.05	3840	Surface	100%	
103106	122537	2	2.09	7.96	10.46	91.4	1.0170	8.13	1079	0.34	28%	3.73
103106	122635	3	3.22	7.97	10.41	91.0	1.0170	8.08	459	1.47	12%	0.58
103106	122725	4	3.93	7.97	10.39	90.8	1.0170	8.07	278	2.18	7%	0.23
103106	122813	6	6.12	7.96	10.32	90.2	1.0170	8.06	62	4.37	2%	0.34
103106	122901	8	8.01	7.96	10.31	90.0	1.0170	8.07	20	6.26	0.5%	0.18
103106	122955	10	10.08	7.96	10.27	89.7	1.0170	8.07	6	8.33	0.2%	0.14
103106	123047	12	12.1	7.96	10.29	89.8	1.0170	8.05	1	10.35	0.0%	0.17
103106	123135	14	14.05	7.95	10.22	89.3	1.0170	8.07	0	12.3		
103106	123235	16	16.25	7.94	10.22	89.2	1.0180	8.08	0	14.5		
103106	123332	18	18.16	7.92	10.20	89.0	1.0170	8.08	0	16.41		
103106	123423	20	20.13	7.91	10.26	89.5	1.0170	8.07	0	18.38		
103106	123534	22	21.63	7.93	6.49	56.6	1.0170	7.87	0	19.88		

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 - 2006 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2006			ALKanoxic 2000-2006	
Average	**167.0**		Average	**201**	
Median	**162.0**		Median	**192**	
Minimum	**64.9**	**IMC**	Minimum	**103**	**Heron Pond**
Maximum	**330.0**	**Flint Lake**	Maximum	**470**	**Lake Marie**
STD	**41.8**		STD	**49**	
n =	**798**		n =	**246**	

	Condoxic <=3ft00-2006			Condanoxic 2000-2006	
Average	**0.8834**		Average	**0.9968**	
Median	**0.7948**		Median	**0.8285**	
Minimum	**0.2542**	**Broberg Marsh**	Minimum	**0.3031**	**White Lake**
Maximum	**6.8920**	**IMC**	Maximum	**7.4080**	**IMC**
STD	**0.5389**		STD	**0.7821**	
n =	**797**		n =	**246**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2006			NH3-Nanoxic 2000-2006	
Average	**0.518**		Average	**2.112**	
Median	**0.150**		Median	**1.375**	
Minimum	**<0.05**	***ND**	Minimum	**<0.1**	***ND**
Maximum	**9.670**	**South Churchill Lake**	Maximum	**18.400**	**Taylor Lake**
STD	**1.058**		STD	**2.356**	
n =	**803**		n =	**246**	

*ND = Many lakes had non-detects (71.5%)
Only compare lakes with detectable
concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

*ND = 18.6% Non-detects from 27 different lakes

	pHoxic <=3ft00-2006			pHanoxic 2000-2006	
Average	**8.31**		Average	**7.19**	
Median	**8.31**		Median	**7.18**	
Minimum	**7.06**	**Deer Lake**	Minimum	**6.24**	**Banana Pond**
Maximum	**10.28**	**Round Lake Marsh North**	Maximum	**8.48**	**Heron Pond**
STD	**0.45**		STD	**0.38**	
n =	**792**		n =	**246**	

	All Secchi 2000-2006	
Average	**4.48**	
Median	**3.27**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pond**
Maximum	**29.23**	**Bangs Lake**
STD	**3.69**	
n =	**740**	

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2000 - 2006 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2006	
Average	**1.414**	
Median	**1.220**	
Minimum	**<0.5**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.844**	
n =	**798**	

*ND = 3.6% Non-detects from 14 different lakes

	TKNanoxic 2000-2006	
Average	**2.973**	
Median	**2.270**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.346**	
n =	**246**	

*ND = 3.2% Non-detects from 5 different lakes

	TPoxic <=3ft00-2006	
Average	**0.098**	
Median	**0.060**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**798**	

*ND = 0.1% Non-detects from 5 different lakes
(Carina, Minear,& Stone Quarry)

	TPanoxic 2000-2006	
Average	**0.280**	
Median	**0.163**	
Minimum	**0.012**	**West Loon Lake**
Maximum	**3.800**	**Taylor Lake**
STD	**0.369**	
n =	**246**	

	TSSall <=3ft00-2006	
Average	**15.3**	
Median	**7.9**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**809**	

*ND = 1.3% Non-detects from 10 different lakes

	TVSoxic <=3ft00-2006	
Average	**137.7**	
Median	**134.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**41.2**	
n =	**753**	

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 <=3ft00-2006	
Average	**263**	
Median	**116**	
Minimum	**41**	**Timber Lake (N)**
Maximum	**2390**	**IMC**
STD	**452**	
n =	**78**	

	CLoxic <=3ft00-2006	
Average	**220**	
Median	**171**	
Minimum	**30**	**White Lake**
Maximum	**2760**	**IMC**
STD	**275**	
n =	**318**	

81 of 161 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 1988-2006 (n=3053).

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

Table F1. A list of potential grant opportunities

Grant Program Name	Funding Source	Funding Focus			Cost Share	Typical Award
		Water Quality	Flooding	Habitat		
Challenge Grant Program	USFWS			X	>50%	<$10,000
Chicago Wilderness Small Grants Program	CW			X	None	$15,000
Conservation 2000 (C2000)	IDNR			X	None	$10,000 to $500,000
Conservation Reserve Program	NRCS			X	Land	Variable
Five Star Challenge Grant	NFWF			X	None	$5,000 to $20,000
Flood Mitigation Assistance Program	IEMA		X		25%	$200,000
Habitat Restoration Program for the Fox Watershed	LCSWCD			X	25%	<$1,000K
Illinois Clean Lakes Program (ICLP)	IEPA	X			>50%	$5,000 to $30,000
Illinois Clean Energy Community Foundation	ICECF			X	None	Variable
Lakes Education Assistance Grant Program (LEAP)	IEPA	X			None	$500
Northeast Illinois Wetland Conservation Account	USFWS	X		X	>50%	$600 to $200,000
Partners for Fish and Wildlife Program	USFWS			X	>50%	$3,000
Section 206: Aquatic Ecosystem Restoration	USACE			X	35%	<$1,000,000
Section 319: Non-Point Source Management Program	IEPA	X		X	>40%	Variable
STAG Grants	LCSMC	X			None	Variable
Stream Cleanup And Lakeshore Enhancement (SCALE)	IEPA	X			None	$2,000
Streambank Stabilization and Restoration Program (SSRP)	LCSWCD	X		X	25%	Variable
Unincorporated Lake County Drainage Fund	LCPBD		X		>50%	$5,000 to $10,000
Wildlife Habitat Incentives Program	NRCS			X	Land	Variable
Watershed Management Board	LCSMC	X	X	X	>50%	$5K to $10K
Wetland Reserve Program	NRCS			X	Land	Variable

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
LCPBD = Lake County Planning, Building, and Development Department
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 F2. Grant Contacts

Chicago Wilderness (CW)
Elizabeth McCance, Director of Conservation Programs
Phone: (312) 580-2138
E-mail: emccance@chicagowilderness.org
http://www.chicagowilderness.org/

Illinois Clean Energy Community Foundation (ICECF)
2 N. LaSalle Street
Suite 950
Chicago, IL 60602
Phone: (312) 372-5191
Fax: (312) 372-5190
http://www.illinoiscleanenergy.org/

Illinois Department of Natural Resources (IDNR)
One Natural Resources Way
Springfield, IL 62702-1271
Phone: (217) 782-9740
http://dnr.state.il.us/orep/C2000

Illinois Emergency Management Agency (IEMA)
110 East Adams Street
Springfield, Illinois 62701
Phone: (217) 785-0229
http://www.state.il.us/iema/index.htm

Illinois Environmental Protection Agency (IEPA)
Bureau of Water - Surface Water Section
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276
Telephone: (217) 782-3362
Fax: (217) 785-1225
http://www.epa.state.il.us/water/financial-assistance/non-point.html

Lake County Planning, Building, and Development Department (LCPBD)
18 N. County Street
Waukegan, IL 60085

Phone: (847) 377-2875
Fax: (847) 782-3016

Lake County Soil and Water Conservation District (LCSWCD)
100 N. Atkinson Road
Suite 102A
Grayslake, IL 60030
Phone: (847)-223-1056
Fax: (847)-223-1127
http://www.lakeswcd.org/

Lake County Stormwater Management Commission (LCSMC)
333-B Peterson Road
Libertyville, IL 60048
Phone: (847) 918-5260
Fax: (847) 918-9826
http://www.co.lake.il.us/smc

National Fish and Wildlife Foundation (NFWF)
Attn: Five Star Restoration Program
1120 Connecticut Avenue N.W., Suite 900
Washington, DC 20036
Phone: (202) 857-0166
Fax: (202) 857-0162
http://nfwf.org/programs/5star-rfp.htm

Natural Resources Conservation Service (NRCS)
Wildlife Habitat Incentives Program Coordinator
USDA Natural Resources Conservation Service
1902 Fox Drive
Champaign, IL 61820
Phone: (217) 398-5267
http://www.nrcs.usda.gov/programs/whip/

United States Army Corps of Engineers (USACE)
111 N. Canal Street
Chicago, Illinois 60606-7206
Telephone: (312)-846-5333
Fax: (312)-353-2169

http://www.lrc.usace.army.mil/

United States Fish and Wildlife Service (USFWS)
Chicago Field Office
1250 South Grove Avenue, Suite 103
Barrington, IL 60010
Phone: (847)-381-2253
Fax: (847)-381-2285

Other Related Contacts

Catalog of Federal Funding Sources for Watershed Protection Web Site
http://cfpub.epa.gov/fedfund/

Fox River Ecosystem Partnership (FREP)
http://foxriverecosystem.org/

North American Wetlands Conservation Act Grants Program
http://birdhabitat.fws.gov/NAWCA/grants.htm

North American Wetland Conservation Act Programs
http://birdhabitat.fws.gov/NAWCA/grants.htm

U.S. Fish and Wildlife Foundation
http://www.nfwf.org/