

**2006 SUMMARY REPORT
of
Crooked Lake**

Lake County, Illinois

Prepared by the

**LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT**

3010 Grand Avenue
Waukegan, Illinois 60085

Adrienne Orr
Michael Adam
Leonard Dane
Shaina Keseley

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EXECUTIVE SUMMARY

Crooked Lake is a 140-acre glacial lake with a maximum depth of 26.5 feet. Water samples were taken from May through September and the lake was stratified for most of the sampling season. Dissolved oxygen levels were adequate to support aquatic life in the epilimnion for the entire summer, however the hypolimnion had anoxic conditions (<1 mg/L) June through August.

The average total phosphorus (TP) concentration in the epilimnion for Crooked Lake was 0.061 mg/L, which was close to the county median (0.060 mg/L). Crooked Lake's phosphorus concentration decreased from 2001 (0.101 mg/L), when the LMU last sampled the lake. Nitrogen is the other nutrient critical for algal growth. The average Total Kjeldahl nitrogen (TKN) concentration for Crooked Lake was 1.62 mg/L, which was higher than the county median of 1.22 mg/L and higher than the concentration in 2001 (1.47 mg/L).

The 2006 average total suspended solids (TSS) concentration for Crooked Lake was 7.7 mg/L, which was equal to the county median and down from the 2001 average of 13.7 mg/L. Water clarity was measured by Secchi depth, with the lowest reading in September (2.78 feet) corresponding to the high TSS value. The average Secchi depth for the 2006 season was 4.4 feet, which was greater than the county median (3.27 feet), and better than the 2001 average (2.51 feet).

Conductivity concentrations, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county. The average conductivity reading for Crooked Lake was 1.1034 mS/cm, which was well above the county median (0.7948 mS/cm). This was a 39% increase from the 2001 average (0.7927 mg/L). The chloride concentration in Crooked Lake in 2006 was 225 mg/L which is well above the county median of 171 mg/L and currently at levels that may have a negative impact on aquatic life.

Plant sampling was conducted on Crooked Lake in July. Six species of plants were present covering approximately 44% of the lake. Eurasian Watermilfoil and Curlyleaf Pondweed were the most two abundant species found at 68% and 23% of the sites, respectively. Both species appear to have increased since 2001.

The shoreline was reevaluated in 2006 in order to assess any changes since the original study conducted in 2001. Overall there is little erosion occurring on the lake due to the good amount of wooded areas and buffered shoreline. However, there were some small areas along the northwest and southeast portions of the lake that are starting to show small signs of erosion and should be taken care of before they get out of hand. The large amount of wooded and buffered areas also offer good habitat for wildlife.

LAKE FACTS

Lake Name:	Crooked Lake
Historical Name:	None
Nearest Municipality:	Lake Villa
Location:	T46N, R10E, Section 34
Elevation:	767 feet
Major Tributaries:	Slough Lake
Watershed:	Des Plaines River
Sub-watershed:	North Mill Creek
Receiving Water body:	Hastings Lake
Surface Area:	140.0 acres
Shoreline Length:	2.7 miles
Maximum Depth:	26.5 feet
Average Depth:	10.8 feet
Lake Volume:	1512.0 acre-feet
Lake Type:	Glacial
Watershed Area:	921.0 acres
Major Watershed Land uses:	Public and Private Open Space, Single Family homes, and Water
Bottom Ownership:	Township and Private
Management Entities:	Township and Crooked Lake Homeowners Association
Current and Historical uses:	Boating, fishing, swimming, and aesthetics
Description of Access:	Homeowners and Subdivision residents

SUMMARY OF WATER QUALITY

Water samples were collected from May to September in Crooked Lake at the deepest point in the northwest portion of the lake (Figure 1). Samples were taken at three feet below the surface and approximately three feet above the lake bottom (Appendix A). Water levels in Crooked Lake (taken from a pier at the Oaks Subdivision launch) decreased approximately 3 inches throughout the season. Initially, the water level went up 4 inches and then dropped again in August. In order to accurately monitor water levels it is recommended that a staff gauge be installed.

Crooked Lake was stratified for most of the sampling season. Stratification is when the 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 becomes anoxic (dissolved oxygen <1 mg/L). The layer between the epilimnion and hypolimnion, where the temperature changes quickly, is the thermocline. In June and July the thermocline was around 20 feet, and dropped to around 22 feet August. A dissolved oxygen (DO) concentration >5.0 mg/L is considered adequate to support a sunfish/bass fishery, since many fish suffer from oxygen stress below this amount. DO levels were adequate to support aquatic life in the epilimnion for the entire summer, however the hypolimnion had anoxic conditions (<1 mg/L) June through August (Appendix B). Based on a bathymetric map produced by the Lake County Health Department (LCHD) in 1986, approximately 14% of the lake volume was affected. This is not an accurate assessment however, due to the age of the map, and it is recommended that a new bathymetric map be created.

Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake would produce algal blooms (Appendix C). The average epilimnetic total phosphorus (TP) concentration for Crooked Lake was 0.061 mg/L (Table 1) and the county median was 0.060 mg/L (Appendix E). This phosphorus concentration was a decrease from 2001 which was 0.101 mg/L when the lake was last sampled by the LMU. The higher phosphorus concentrations in 2001 may have been due to internal loading from the sediment due to carp action. The Illinois Department of Natural Resources has been removing carp from the lake which may be playing a part in the decrease of phosphorus levels. Nitrogen is the other nutrient critical for algal growth. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN concentration for Crooked Lake was 1.62 mg/L, which was higher than the county median of 1.22 mg/L and higher than the concentration in 2001 (1.47 mg/L). The TN:TP (total nitrogen to total phosphorus) ratio looks at which nutrient was limiting plant and algal growth in a lake. Ratios < 10:1 indicate nitrogen was limiting. Ratios of >15:1 indicate phosphorus was limiting. Ratios >10:1, <15:1 indicate there was enough of both nutrients for excessive algal growth. Crooked Lake had a TN:TP ratio of 27:1 which indicated phosphorus was highly limiting.

Another way to look at phosphorus levels and how they affect productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus (TSIp). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). The TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic

Figure 1. Water quality sampling site on Crooked Lake, 2006.



Table 1. Summary of water quality data for Crooked Lake, 2006.

2006	Epilimnion	ALK	TKN	NO ₂ +NO ₃ -N	NO ₃ -N	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	DO
17-May	3	183	1.81	<0.1	<0.05	0.072	<0.005	600	220	5.0	639	153	5.41	1.0980	8.33	9.90
21-Jun	3	175	1.50	<0.1	<0.05	0.062	<0.005	597	217	8.4	650	149	4.26	1.0920	8.46	11.03
19-Jul	3	172	1.55	<0.1	<0.05	0.048	<0.005	590	221	8.2	668	174	4.10	1.0780	8.59	8.19
16-Aug	3	161	1.41	<0.1	<0.05	0.041	<0.005	623	231	6.1	657	168	5.41	1.1440	8.48	7.14
20-Sep	3	155	1.83	<0.1	<0.05	0.081	<0.005	603	237	11.0	647	169	2.78	1.1050	8.30	6.10
Average		169	1.62	<0.1	<0.05	0.061	<0.005	603	225	7.7	652	163	4.39	1.1034	8.43	8.47

2001	Epilimnion	ALK	TKN	NH3	NO ₂ -N*	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	3	163	1.94	<0.1	<0.05	0.145	0.006	488	NA	17.0	536	162	2.10	0.7986	8.55	9.54
20-Jun	3	145	1.18	<0.1	<0.05	0.117	0.015	492	NA	16.0	524	169	2.69	0.7678	8.87	9.94
25-Jul	3	134	1.26	<0.1	<0.05	0.062	<0.005	494	NA	9.4	520	154	2.66	0.7889	8.44	6.63
22-Aug	3	151	1.41	<0.1	<0.05	0.068	<0.005	514	NA	11.0	521	168	2.98	0.7872	8.08	7.35
19-Sep	3	160	1.57	<0.1	<0.05	0.115	0.006	496	NA	15.0	540	182	2.10	0.8210	7.94	6.95
Average		151	1.47	<0.1 ^k	<0.05 ^k	0.101	0.009 ^k	497	NA	13.7	528	167	2.51	0.7927	8.38	8.08

Glossary

ALK = Alkalinity, mg/L CaCO₃
 TKN = Total Kjeldahl nitrogen, mg/L
 NH₃-N = Ammonia nitrogen, mg/L
 NO₂+NO₃-N = Nitrate + Nitrite nitrogen, mg/L
 NO₃-N = Nitrate 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.

2006		Hypolimnion														
DATE	DEPTH	ALK	TKN	NO ₂ +NO ₃ -N	NO ₃ -N	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	DO
17-May	19	184	1.98	0.199	<0.05	0.077	0.006	602	218	8.2	637	148	NA	1.1020	8.17	6.39
21-Jun	20	192	2.56	1.070	<0.05	0.136	0.051	616	215	7.9	681	177	NA	1.1300	7.85	0.50
19-Jul	19	184	2.23	0.750	<0.05	0.070	0.017	599	221	5.5	657	160	NA	1.0960	8.21	0.38
16-Aug	20	185	2.71	1.410	<0.05	0.145	0.061	646	229	5.2	649	151	NA	1.1900	7.14	0.09
20-Sep	18	155	1.86	0.000	<0.05	0.076	<0.005	603	236	10.0	630	150	NA	1.1050	8.23	4.78
Average		189	2.64	1.240	<0.05	0.141	0.056 ^k	631	222	6.6	665	164	NA	0.6447	8.51	2.43

2001		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH ₃	NO ₃ -N [*]	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	20	168	1.49	0.164	<0.05	0.120	0.025	486	NA	12.0	534	156	NA	0.8139	7.94	4.70
20-Jun	21	172	1.20	<0.1	<0.05	0.253	0.109	526	NA	28.0	550	186	NA	0.8188	6.99	0.05
25-Jul	20	242	2.44	0.861	<0.05	0.479	0.352	558	NA	12.0	584	141	NA	0.9255	6.65	0.01
22-Aug	19	161	1.67	0.398	<0.05	0.173	0.040	506	NA	9.6	524	173	NA	0.8908	6.68	0.03
19-Sep	19	164	1.64	0.160	<0.05	0.134	0.009	498	NA	20.0	531	177	NA	0.8209	7.88	6.45
Average		181	1.69	0.396 ^k	<0.05	0.232	0.107	515	NA	16.3	545	167	NA	0.8540	7.23	2.25

Glossary

ALK = Alkalinity, mg/L CaCO₃
TKN = Total Kjeldahl nitrogen, mg/L
NH₃-N = Ammonia nitrogen, mg/L
NO₂+NO₃-N = Nitrate + Nitrite nitrogen, mg/L
NO₃-N = Nitrate 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

(intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich, productive). In 2006, Crooked Lake was eutrophic with a TSI_p value of 63.4, which placed it 70th out of 162 lakes in the county (Table 2).

The Illinois EPA has a use index for assessing lakes for aquatic life, swimming, and recreational use impairment. TSI values along with other water quality parameters are used to make the analyses. According to this index, Crooked Lake provides full support of aquatic life and partial support of swimming and recreational activity. The overall use of the lake is partial.

Total suspended solids (TSS) are composed of nonvolatile suspended solids such as non-organic clay or sediment materials, and volatile suspended solids such as algae and other organic matter. The 2006 average TSS concentration for Crooked Lake was 7.7 mg/L, which was equal to the county median. However, the TSS was lower than the 2001 average of 13.7 mg/L. TSS fluctuated throughout the season with a maximum concentration of 11 mg/L in September. This was due to fall turnover, when phosphorus built up in the hypolimnion during the summer months was released and mixed with the epilimnion. This likely triggered the algal bloom present in September. Water clarity is a direct result of the amount of TSS in the water column, and is usually the first thing people notice about a lake, as it typifies the overall lake quality. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. Water clarity was measured by Secchi depth, with the lowest reading in September (2.78 feet) corresponding to the high TSS value (Figure 2). The average Secchi depth for the season was 4.4 feet, which was greater than the county median (3.27 feet). The Secchi depth has improved since 2001 when the average was 2.51 feet.

Conductivity concentrations, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county. It is believed that road salt is probably the reason for the increase because chloride concentrations detect sodium chloride and calcium chloride which are what most road salt consists of. The average conductivity concentration for Crooked Lake was 1.1034 mS/cm, which was well above the county median (0.7948 mS/cm). This was a 39% increase from the 2001 average (0.7927 mg/L). The average chloride concentration was 225 mg/L, which was greater than the county median (171 mg/L). A study done in Canada reported 10% of aquatic species are harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. At the current levels in Crooked Lake, chloride concentrations may negatively impact aquatic life.

The Crooked watershed (Figure 3) is approximately 921 acres and includes Slough Lake, which flows into Crooked Lake via a stream from the south. The area immediately adjacent to the lake is mostly single family homes however 32% of the watershed consists of public and private open space (Figure 4). The single family homes contribute 37% of the estimated runoff in the watershed (Table 3). Thirty-two percent of runoff comes from transportation (roads) and 28% from public and private open space. The retention time of the lake is 3.5 years. Water quality between Crooked and Slough Lake was quite different. Historically, Slough Lake had a duck farm which contributed to the phosphorus levels in the lake. In 2006 the average total

Table 2. 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 Kathryn	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 2. 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 2. 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 2. 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

Figure 2. Secchi depth vs. total suspended solid (TSS) concentrations in Crooked Lake, 2006.

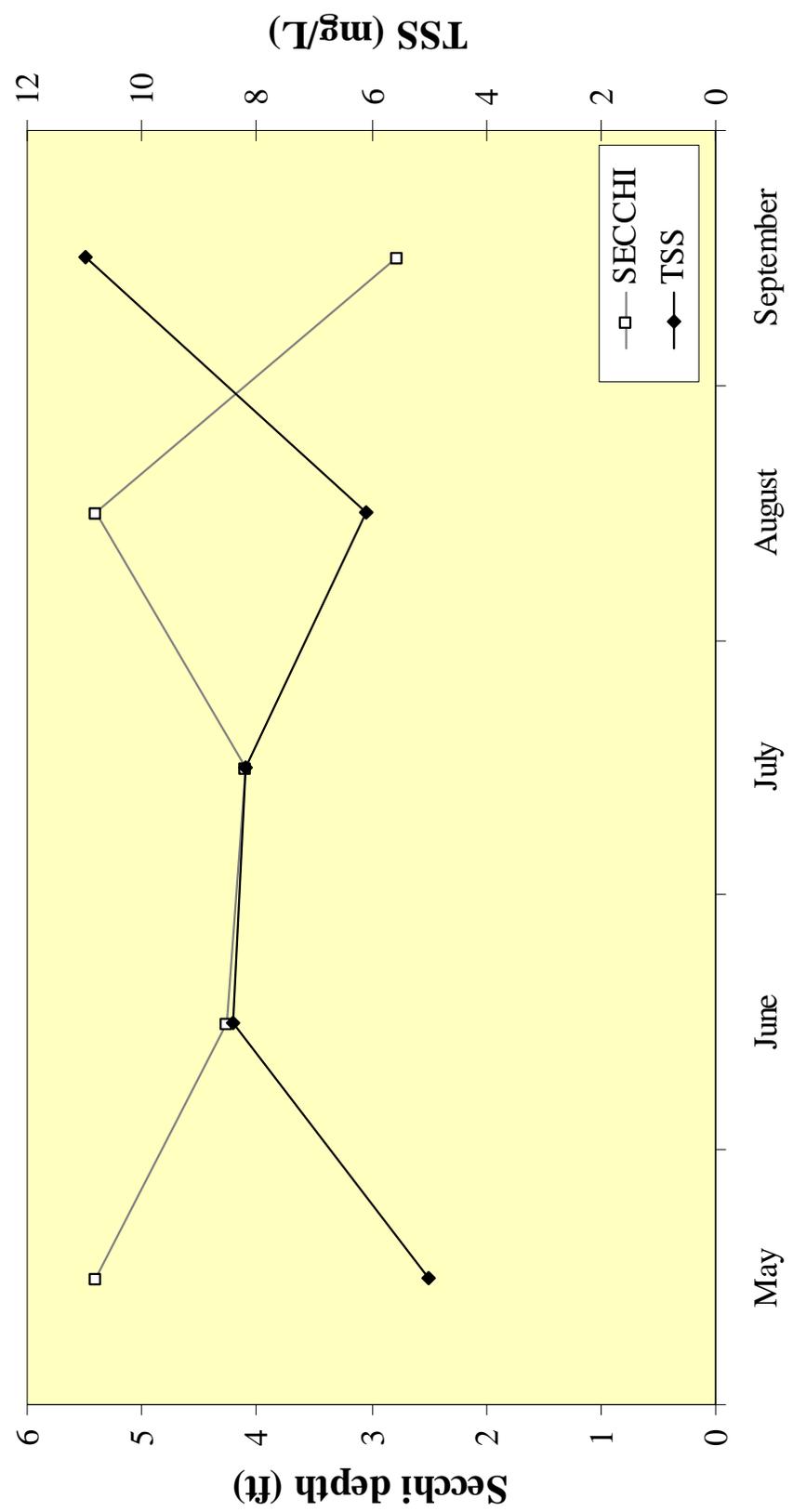


Figure 3. Approximate watershed delineation of Crooked Lake, 2006.

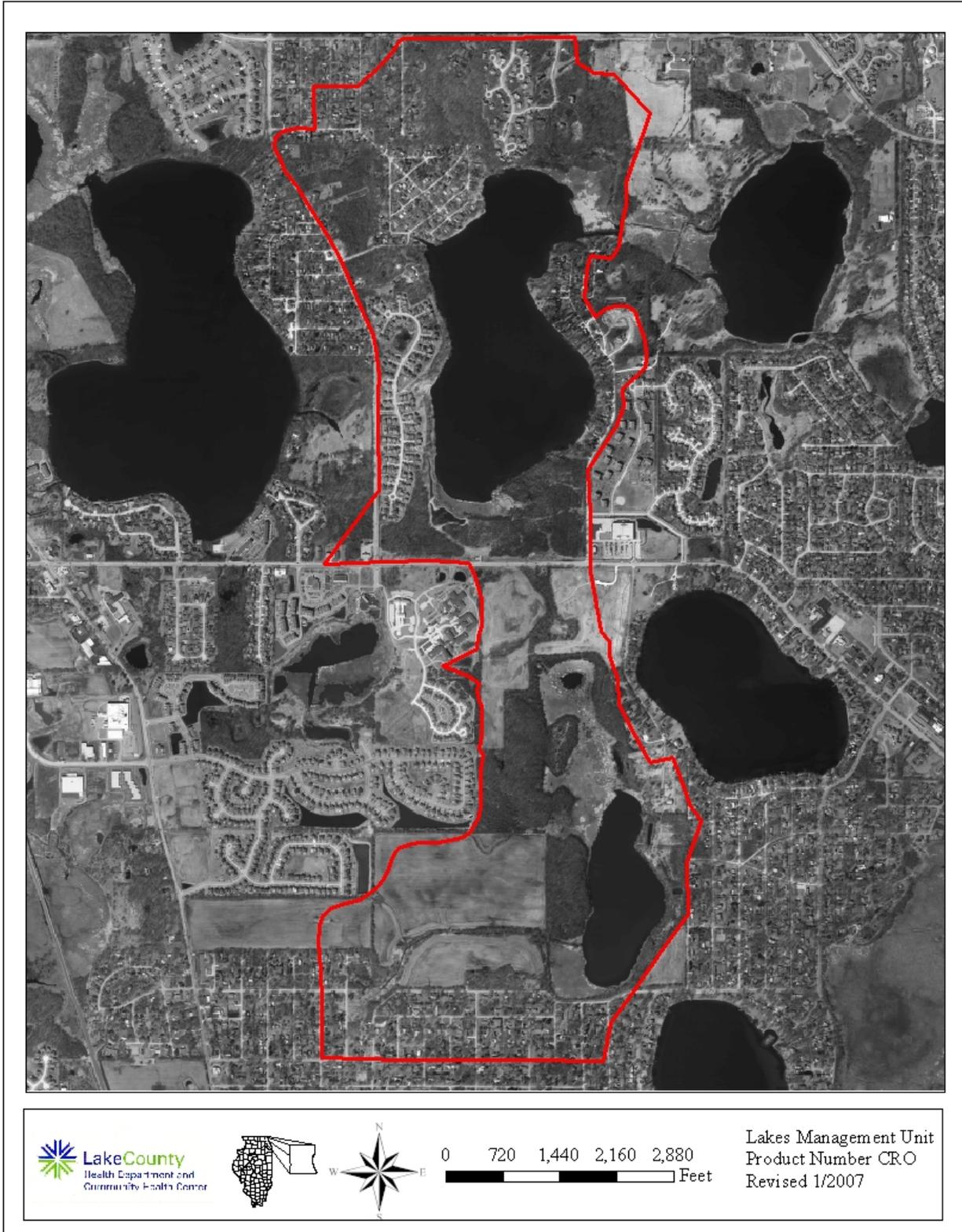


Figure 4. Approximate land use within the Crooked Lake watershed, 2006.

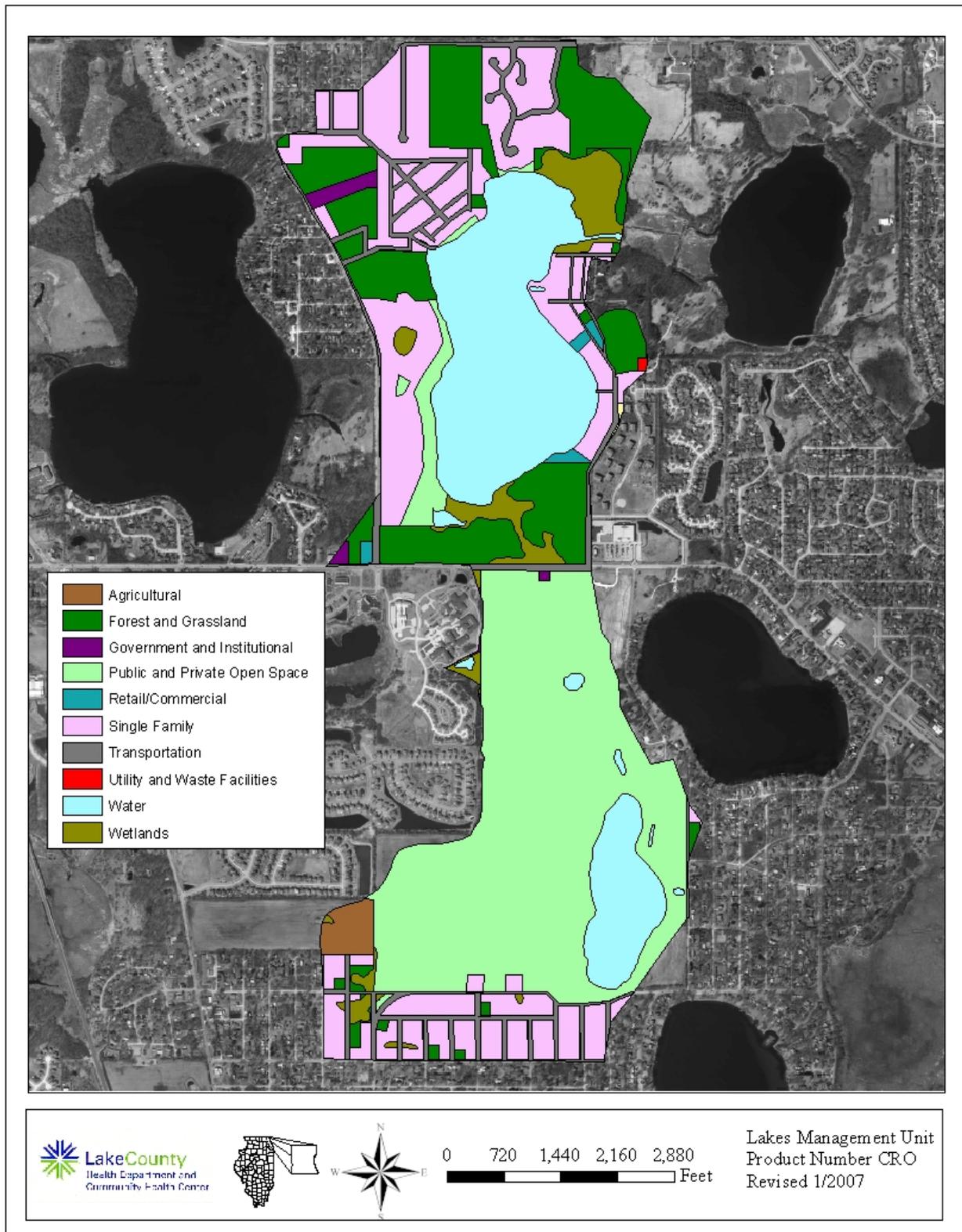


Table 3. Approximate land use within the Crooked Lake watershed, 2006.

LAND USE	ACREAGE	% of Total
Utility & Waste	0.46	0.05%
Agriculture	9.16	1.0%
Forest & Grassland	139.96	15.2%
Govt. & Institution	5.61	0.6%
Multi-Family	0.47	0.1%
Public & Private Open Space	291.97	31.7%
Retail Commercial	3.95	0.4%
Single-Family	193.41	21.0%
Transportation	58.79	6.4%
Water (4.67 non-lake)	180.37	19.6%
Wetlands	37.06	4.0%
TOTAL	921.2	

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	9.16	0.05	1.3	0.3%
Forest and Grassland	139.96	0.05	19.2	4.5%
Government and Institutional	5.61	0.50	7.7	1.8%
Multi Family	0.47	0.30	0.4	0.1%
Public and Private Open Space	291.97	0.15	120.4	27.9%
Retail/Commercial	3.95	0.85	9.2	2.1%
Single Family	193.41	0.30	159.6	36.9%
Transportation	58.79	0.85	137.4	31.8%
Utility and Waste Facilities	0.46	0.30	0.4	0.1%
Water	180.37	0.00	0.0	0.0%
Wetlands	37.06	0.05	5.1	1.2%
	921.21		432.1	100.0%

Lake volume **1512** **acre-feet**
Retention Time (years)= lake
volume/runoff **3.50** **years**
1277.10 **days**

NOTE: Runoff calculations do not include the acreage of lake itself, which is part of the total watershed area.

phosphorus (TP) concentration on Slough Lake (0.413 mg/L) was almost seven times the county median (0.060 mg/L) and almost 7 times the amount of Crooked Lake. The average TKN concentration for Slough Lake was 2.7 mg/L, which was double the county median and greater than Crooked Lake concentrations. The TN:TP ratio for Slough Lake was 6:1 indicating a nitrogen limiting lake. These high levels in Slough Lake may be affecting Crooked Lake because Slough Lake is directly upstream. However, the impact may be minimal due to the area of open space and wetland area the water passes through, filtering out some nutrients before reaching the lake.

Crooked Lake had one swimming beach (Sedgewood Cove) the LCHD monitors for *E. coli* levels. It was sampled from May to September 2006 with no recommended closings. LCHD recommend closing when *E. coli* levels are >235 colony forming unit per 100mL. Camp Peacock has not been sampled since 2004, but had no closing previous to that. Oaks Subdivision beach has not been sampled since 1993.

A plankton sample was collected each month from May through September at the same location water samples were taken. Plankton are microscopic plants and animals that are free-floating within the water column and serve as the base of the food chain. Samples were collected to get a general idea of the types of algae and zooplankton found in the lake. In June there was a bloom of Dinoflagellates (algae) and green algae and large amounts of rotifers present. Phytoplankton then remained relatively stable with a small increase of blue-greens in September. Zooplankton was also stable throughout the rest of the season with Copepods dominating.

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted on Crooked Lake in July. Sixty-nine points were sampled based on a computer generated grid system using ArcGIS with points 60 meters apart (Figure 5). There were 6 species of plants present, (Table 4) which were found at 72% of the sites sampled. Eurasian Watermilfoil was the most abundant species found at 68% of the sites (Table 5) and Curlyleaf Pondweed was the second most abundant occurring at 23% of the sites. Coontail, Sago Pondweed, Spatterdock, and White Water Lily were also present in the lake. Eurasian Watermilfoil and Curlyleaf Pondweed are both invasive, exotic species, which crowd out native species and should be kept under control in order for native species to thrive. Eurasian Watermilfoil seems to have increased in volume since 2001. In 2001, it was recorded at 8% of the sample sites in July, while Curlyleaf Pondweed was recorded at 16% of the sites. Spot treatments of the herbicide 2,4D are being used on the lake to control Eurasian Watermilfoil. The treatments are keeping an adequate amount of vegetative cover on the lake, therefore the LMU does not recommend any further action at this time.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a lake. When the light level in the water column falls below 1% of the surface light level, plants can no longer photosynthesize. Plants in Crooked Lake were found at a maximum depth of 9.9 feet, however the 1% light level was around 12 to 14 feet. Based on this light penetration level, aquatic plants could grow in approximately 52% of the lake. Due to the sampling method used however, some plants may have been missed.

Figure 5. Aquatic plant sampling grid illustrating plant density on Crooked Lake, 2006.

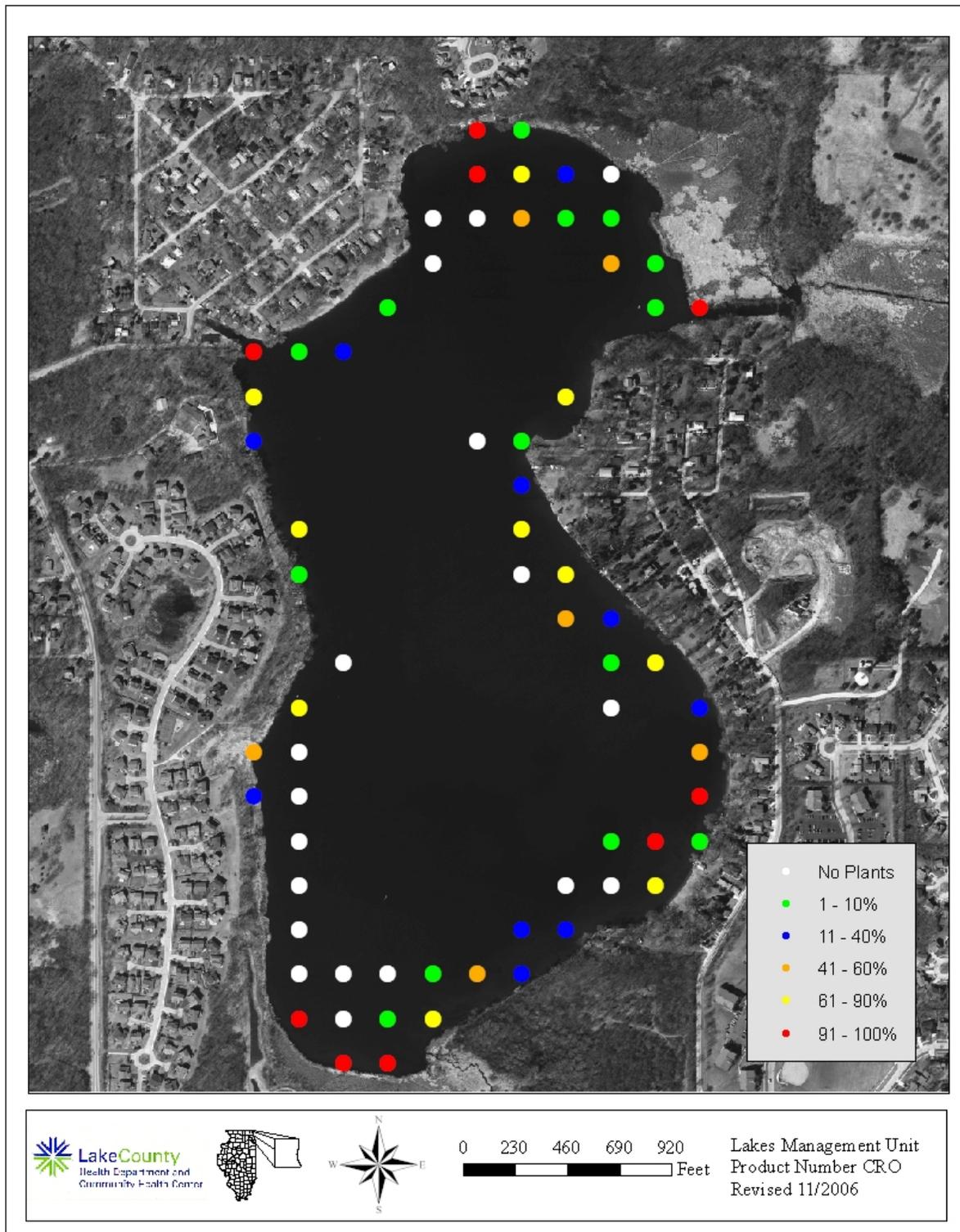


Table 4: Aquatic plant species found in Crooked Lake, 2006.

Coontail	<i>Ceratophyllum demersum</i>
Eurasian Watermilfoil [^]	<i>Myriophyllum spicatum</i>
Spatterdock	<i>Nuphar variegata</i>
White Water Lily	<i>Nymphaea tuberosa</i>
Curlyleaf Pondweed [^]	<i>Potamogeton crispus</i>
Sago Pondweed	<i>Potamogeton pectinatus</i>

[^] Exotic plant

Table 5. Aquatic plant species found at the 69 sampling sites on Crooked Lake, 2006. The maximum depth that plants were found was 9.9 feet.

Plant Density	Coontail	Curlyleaf Pondweed	Eurasian Watermilfoil	Sago Pondweed	Spatterdock	White Water Lily
Absent	60	53	22	67	68	60
Present	3	11	18	1	0	3
Common	3	4	13	1	1	1
Abundant	1	1	4	0	0	0
Dominant	2	0	12	0	0	5
% Plant Occurrence	13.0	23.2	68.1	2.9	1.4	13.0

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

Rake Density (coverage)	# of Sites	% of Sites
No Plants	19	28
>0-10%	15	22
10-40%	10	14
40-60%	6	9
60-90%	10	14
>90%	9	13
Total Sites with Plants	50	72
Total # of Sites	69	100

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species or a good diversity of plants present in the lake. Non-native species were counted in the FQI calculations for Lake County Lakes. The FQI in 2006 for Crooked Lake was 10.2 (Table 6) and the county average was 12.5 ranking 100 out of 151 lakes. This was up slightly from 2001 (9.8), when it ranked 21 out of 64 lakes.

SUMMARY OF SHORELINE CONDITION

In July of 2001 an assessment was conducted to determine the condition of the shoreline at the water/land interface. Approximately 68% of the shoreline was developed, however only 2% was found to be eroding. This was due to the buffered shoreline (47%) and the high quality wooded lots (10% of shoreline). In 2006 the shoreline was reevaluated for erosion. There were a number of areas throughout the lake classified with no erosion in 2001 that were showing signs of slight erosion (Figure 6). The majority of these areas were along the northwest and southeast portions of the lake. Steps should be taken prevent any further erosion and to preserve the shorelines.

In 2001 there were aggressive exotic shoreline plant species found and were still present in 2006. This included such species as Buckthorn, Reed Canary Grass, and Purple Loosestrife. These species are especially detrimental, as they can crowd out native, beneficial plants used by wildlife. Their removal is recommended.

SUMMARY OF WILDLIFE AND HABITAT

The relatively large amount of shoreline classified as buffer and woodland offer good habitat for a variety of wildlife species. Crooked Lake has 10 fish species that were found during the 2003 Illinois Department of Natural Resources (IDNR) survey. Common Carp have been a problem in the lake for some time and were very abundant in 2003. The IDNR also noted that there was an overpopulation of Yellow Bass which may be interfering with Largemouth Bass, Bluegill, and Northern Pike reproduction. All Yellow Bass and carp caught should be harvested.

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

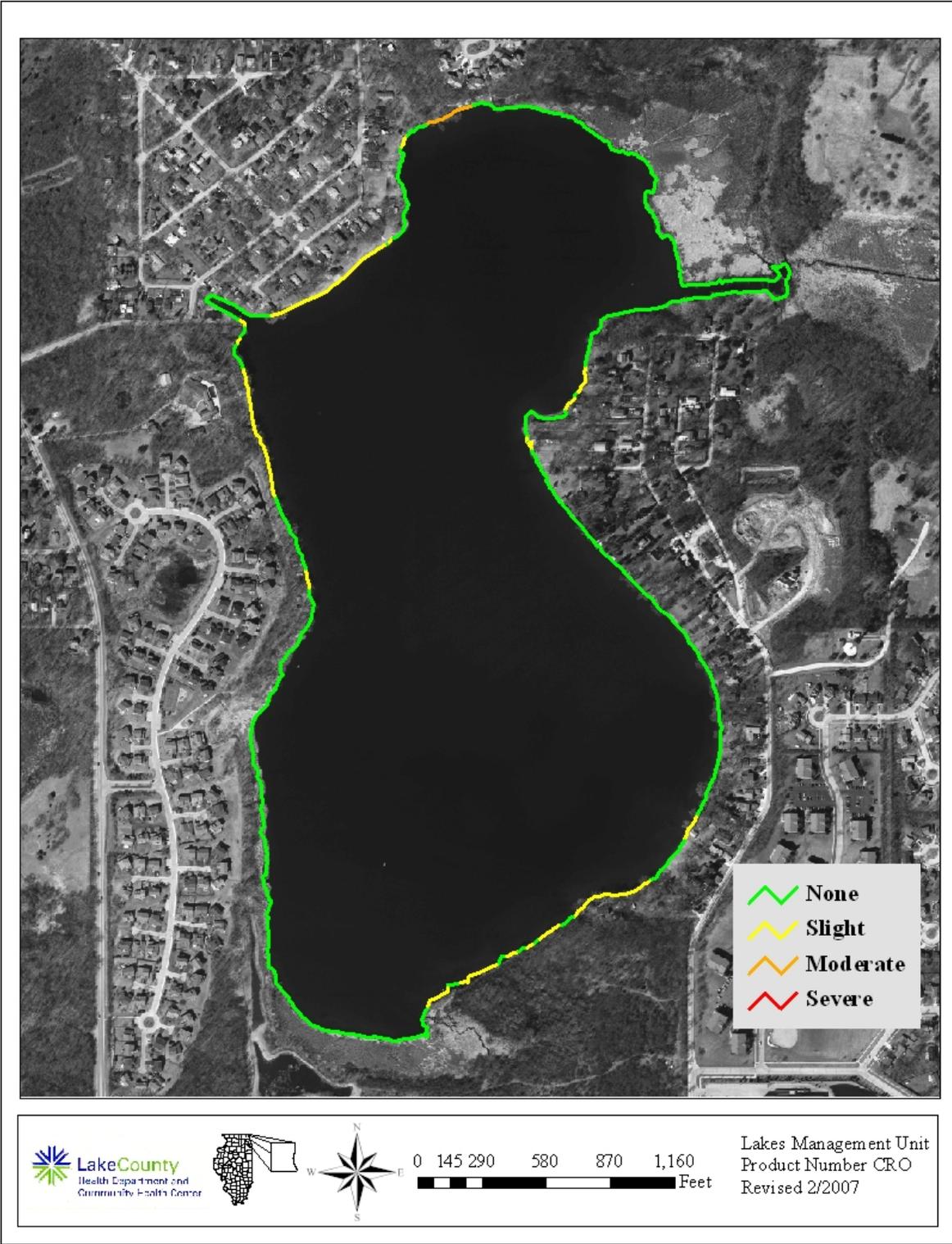
Table 6. Continued.

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
	<i>Mean</i>	13.6	14.9
	<i>Median</i>	12.5	14.3

Figure 6. Shoreline erosion on Crooked Lake, 2006.



LAKE MANAGEMENT RECOMMENDATIONS

Water quality on Crooked Lake has improved since 2001. Nearly 47% of the watershed surrounded by public and private open space and forest and grassland which provide good habitat for wildlife. However, there are some small areas on the shoreline starting to exhibit erosion. Although plant coverage on the lake was good, plant diversity was not and included exotic species. There are many grant opportunities available to do improvements around or in the lake (Appendix F).

✦ Creating a Bathymetric Map

Crooked Lake does not have a current bathymetric (depth contour) map which is an essential tool in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management practices, such as aquatic herbicide use or fish stocking were part of the overall lake management plan (Appendix D1).

✦ Lakes with Shoreline Erosion

Areas of erosion are starting to appear around the shoreline of Crooked Lake. The LMU recommends initiating programs to stop erosion before it becomes severe (Appendix D2).

✦ Eliminate or Control Exotic Species

In 2001 and 2006 aggressive, exotic shoreline plant species were found. These species are especially detrimental, as they can crowd out native, beneficial plants used by wildlife. Their removal is recommended (Appendix D3).

✦ Increased participation in the Volunteer Lake Management Program

Data is collected by a lake resident and helps the LMU as well as the state in obtaining data when either entity is not able to get out to the lake (Appendix D4).

✦ Options for Lakes with High Carp Populations

Removal of carp may help to reduce TSS and phosphorus concentrations in Crooked Lake. The IDNR has previously done carp removal and further coordination with them should continue to occur (Appendix D5)

✦ Options to Reduce Conductivity and Chloride Concentrations

The current concentration of chloride in Crooked Lake has the potential to negatively impact aquatic life, from plants to fish. Road salt (sodium chloride) is the most commonly used winter road de-icer and is the major contributor to chloride and conductivity levels (Appendix D6).

**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.

Plankton Sampling

Plankton were sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a or YSI 6600 Sonde® 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 63µm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton were collected within a small cup on the bottom of the tow. The collected sample was then emptied into a pre-labeled brown plastic bottle. The net was rinsed with deionized water into the bottle in order to ensure all the plankton were collected. The sample was then transferred to a graduated cylinder to measure the amount of milliliters (mL) that the sample was. The sample was then returned to the bottle and preserved with Lugol's iodine solution (5 drops/mL). The sample bottle was then closed and stored in a cooler until returning

to the lab, where it was transferred to the refrigerator until enumeration. Enumeration was performed within three months, but ideally within one month, under a microscope. Prior to sub-sample being removed for enumeration, the sample bottle was inverted several times to ensure proper homogenization. An automated pipette was used to retrieve 1 mL of sample, which was then placed in a Sedgewick Rafter slide. This is a microscope slide on which a rectangular chamber has been constructed, measuring 50 mm x 20 mm in area and 1 mm deep. The slide was then placed under the microscope and counted at a 20X magnification (phytoplankton) or 10X magnification (zooplankton). For phytoplankton, twenty fields of view were randomly counted with all species within each field counted. Due to their larger size, zooplankton were counted throughout the entire slide. Through calculations, it was determined how many of each species were in 1 mL of lake water.

Shoreline Assessment

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

None – Includes man-made erosion control such as beach, rip-rap and sea wall.

Slight – Minimal or no observable erosion; generally considered stable; no erosion control practices will be recommended with the possible exception of small problem areas noted within an area otherwise designated as “slight”.

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

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

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

<i>Parameter</i>	<i>Method</i>
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 18 th ed. Electrode method, #4500 NH ₃ -F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18 th 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 18 th ed, Method #2540B
Total suspended solids	SM 18 th ed, Method #2540D Detection Limit = 0.5 mg/L
Chloride	SM 18 th ed, Method #4500C1-D
Total volatile solids	SM 18 th ed, Method #2540E, from total solids
Alkalinity	SM 18 th ed, Method #2320B, potentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18 th ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18 th 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 CROOKED LAKE IN
2006**

Date	Text	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light	% Light	Extinction
MMDDYY		feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	Transmission	Coefficient
										feet	Average	0.25
05/09/2006		0.5	0.982	16.93	10.01	103.7	1.098	8.39	3181.6	Surface		
05/09/2006		1	1.007	16.93	9.98	103.5	1.098	8.34	1937.1	Surface	100%	
05/09/2006		2	2.013	16.93	9.98	103.4	1.098	8.33	1052.2	0.343	54%	1.78
05/09/2006		3	3.059	16.91	9.90	102.5	1.098	8.33	755.9	1.389	39%	0.24
05/09/2006		4	4.043	16.89	9.84	102.0	1.098	8.32	316.3	2.373	16%	0.37
05/09/2006		6	6.016	16.83	9.68	100.1	1.099	8.31	264.7	4.346	14%	0.04
05/09/2006		8	8.033	16.78	9.62	99.4	1.099	8.30	139.2	6.363	7%	0.10
05/09/2006		10	10.011	16.75	9.45	97.5	1.098	8.30	73.1	8.341	4%	0.08
05/09/2006		12	12.050	16.71	9.28	95.7	1.098	8.29	20.3	10.380	1%	0.12
05/09/2006		14	13.993	16.68	9.13	94.1	1.099	8.28	10.5	12.323	1%	0.05
05/09/2006		16	16.024	16.66	9.03	93.0	1.098	8.28	5.1	14.354	0%	0.05
05/09/2006		18	18.037	16.11	7.60	77.5	1.101	8.22	2.7	16.367	0%	0.04
05/09/2006		20	20.034	15.27	5.18	51.8	1.103	8.11	1.5	18.364	0%	0.03
05/09/2006		22	22.050	14.07	1.79	17.5	1.089	7.83	0.1	20.380	0%	0.13

Date	Text	Depth	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light	% Light	Extinction
MMDDYY		feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	Transmission	Coefficient
		feet							feet	Average	0.33
06/13/2006		0.5	21.20	10.94	123.5	1.093	8.32	3300.1	Surface		
06/13/2006		1	21.19	11.01	124.4	1.092	8.40	2952.3	Surface	100%	
06/13/2006		2	21.05	11.04	124.3	1.092	8.44	1031.8	0.378	35%	2.78
06/13/2006		3	20.96	11.03	124.0	1.092	8.46	687.1	1.422	23%	0.29
06/13/2006		4	20.76	10.99	123.0	1.091	8.48	475.6	2.300	16%	0.16
06/13/2006		6	20.54	10.61	118.4	1.092	8.48	229.0	4.325	8%	0.17
06/13/2006		8	20.44	10.06	111.9	1.092	8.47	104.6	6.320	4%	0.12
06/13/2006		10	20.38	9.53	105.9	1.094	8.45	50.4	8.267	2%	0.09
06/13/2006		12	20.32	9.39	104.2	1.094	8.45	19.8	10.406	1%	0.09
06/13/2006		14	20.11	7.43	82.2	1.099	8.36	9.8	12.370	0%	0.06
06/13/2006		16	19.85	5.53	60.8	1.102	8.26	5.2	14.246	0%	0.04
06/13/2006		18	19.54	3.17	34.7	1.106	8.05	2.3	16.393	0%	0.05
06/13/2006		20	16.72	0.50	5.1	1.130	7.85	1.1	18.289	0%	0.04
06/13/2006		22	14.60	0.14	1.4	1.149	7.53	0.6	20.363	0%	0.03

Date	Text	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light	% Light	Extinction
MMDDYY		feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	Transmission	Coefficient
										feet	Average	0.39
07/11/2006		0.5	0.495	24.78	8.32	100.6	1.078	8.51	426.2	Surface		
07/11/2006		1	1.090	24.79	8.24	99.7	1.078	8.55	428.0	Surface	100%	
07/11/2006		2	2.095	24.80	8.21	99.2	1.078	8.58	99.2	0.425	23%	3.44
07/11/2006		3	3.024	24.79	8.19	99.0	1.078	8.59	32.1	1.354	8%	0.83
07/11/2006		4	4.063	24.79	8.13	98.4	1.079	8.61	34.0	2.393	8%	-0.02
07/11/2006		6	6.048	24.73	8.08	97.5	1.078	8.62	30.1	4.378	7%	0.03
07/11/2006		8	8.042	24.72	8.04	97.1	1.079	8.63	17.4	6.372	4%	0.09
07/11/2006		10	10.052	24.70	8.08	97.6	1.079	8.64	9.8	8.382	2%	0.07
07/11/2006		12	12.046	24.67	7.83	94.5	1.079	8.64	6.7	10.376	2%	0.04
07/11/2006		14	14.024	24.01	2.96	35.3	1.088	8.44	3.7	12.354	1%	0.05
07/11/2006		16	15.981	23.82	1.05	12.4	1.091	8.29	2.3	14.311	1%	0.03
07/11/2006		18	18.022	23.28	0.52	6.2	1.096	8.21	1.2	16.352	0%	0.04
07/11/2006		20	19.952	21.61	0.23	2.7	1.111	8.06	0.8	18.282	0%	0.02
07/11/2006		22	22.054	18.71	0.12	1.3	1.153	7.78	0.5	20.384	0%	0.02

Date	Text	Depth	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light	% Light	Extinction
MMDDYY		feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	Transmission	Coefficient
		feet							feet	Average	NA
08/08/2006		0.5	27.40	7.47	94.7	1.142	8.47	NA	Surface		
08/08/2006		1	27.41	7.37	93.4	1.144	8.47	NA	Surface	NA	
08/08/2006		2	27.41	7.39	93.7	1.144	8.48	NA	0.411	NA	NA
08/08/2006		3	27.41	7.41	94.0	1.144	8.48	NA	1.383	NA	NA
08/08/2006		4	27.40	7.42	94.1	1.144	8.49	NA	2.410	NA	NA
08/08/2006		6	27.37	7.42	94.0	1.144	8.49	NA	4.377	NA	NA
08/08/2006		8	27.32	7.35	93.0	1.144	8.48	NA	6.413	NA	NA
08/08/2006		10	27.29	7.42	93.9	1.143	8.49	NA	8.350	NA	NA
08/08/2006		12	27.24	7.86	99.4	1.143	8.52	NA	10.369	NA	NA
08/08/2006		14	27.08	8.29	104.5	1.142	8.55	NA	12.367	NA	NA
08/08/2006		16	26.85	3.87	48.6	1.152	8.01	NA	14.421	NA	NA
08/08/2006		18	26.14	0.15	1.8	1.168	7.43	NA	16.357	NA	NA
08/08/2006		20	24.80	0.09	1.0	1.190	7.14	NA	18.354	NA	NA
08/08/2006		22	21.42	0.06	0.6	1.293	6.75	NA	20.335	NA	NA
08/08/2006		23.375	20.73	0.05	0.5	1.366	6.57	NA	21.705	NA	

Date	Text	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light	% Light	Extinction
MMDDYY		feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	Transmission	Coefficient
										feet	Average	NA
09/12/2006		0.5	0.498	20.70	6.33	70.8	1.103	8.34	NA	Surface		
09/12/2006		1	0.986	20.70	8.20	91.7	1.104	8.36	NA	Surface	NA	
09/12/2006		2	2.082	20.61	7.08	79.1	1.105	8.34	NA	0.412	NA	NA
09/12/2006		3	2.958	20.52	6.10	68.0	1.105	8.30	NA	1.288	NA	NA
09/12/2006		4	4.042	20.52	5.45	60.7	1.104	8.29	NA	2.372	NA	NA
09/12/2006		6	5.979	20.50	5.60	62.4	1.105	8.28	NA	4.309	NA	NA
09/12/2006		8	8.023	20.50	5.81	64.7	1.104	8.27	NA	6.353	NA	NA
09/12/2006		10	10.071	20.49	5.04	56.1	1.104	8.26	NA	8.401	NA	NA
09/12/2006		12	12.038	20.49	5.21	58.1	1.105	8.26	NA	10.368	NA	NA
09/12/2006		14	14.062	20.48	6.03	67.2	1.105	8.25	NA	12.392	NA	NA
09/12/2006		16	16.041	20.48	5.01	55.8	1.104	8.23	NA	14.371	NA	NA
09/12/2006		18	18.038	20.47	4.78	53.3	1.105	8.23	NA	16.368	NA	NA
09/12/2006		20	20.033	20.44	6.05	67.3	1.103	8.26	NA	18.363	NA	NA

**APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY
DATA**

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

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2005 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	$\geq 40 < 50$	$> 0.012 \leq 0.024$	$\geq 6.56 < 13.12$
Eutrophic	$\geq 50 < 70$	$> 0.024 \leq 0.096$	$\geq 1.64 < 6.56$
Hypereutrophic	≥ 70	> 0.096	< 1.64

APPENDIX D. LAKE MANAGEMENT OPTIONS

D1. Option for Creating a Bathymetric Map

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

D2. Options for Lakes with Shoreline Erosion

Option 1: Install a Seawall

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

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

Option 2: Install Rock Rip-Rap or Gabions

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

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

Option 3: Create a Buffer Strip

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

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

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

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

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

Option 5: Install A-Jacks®

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone.

The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® cannot be seen. A disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site.

Option 6: Establish a “No Wake” Zone or No Motor Area

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

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

D3. Options to Eliminate or Control Exotic Species

Option 1: Biological Control

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.

Control of exotics by a natural mechanism is preferable to chemical treatments, however there are few exotics that can be controlled by biological means. Insects, being part of the same ecological system as the exotic plant (i.e., the beetles and weevils with Purple Loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. Bio-control can also be expensive and labor intensive.

Option 2: Control by Hand

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as Purple Loosestrife and Reed Canary Grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored since regrowth of the removed species is common. Many exotic species, such as Purple Loosestrife, Buckthorn, and Garlic Mustard are proficient at colonizing disturbed sites. This method can be labor intensive but costs are low.

Option 3: Herbicide Treatment

Chemical treatments can be effective at controlling exotic plant species, and works best on individual plants or small areas already infested with the plant. In some areas where individual spot treatments are prohibitive or impractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option because in order to chemically treat the area, a broadcast application would be needed. Because many of the herbicides are not selective, meaning they kill all plants they contact, this may be unacceptable if native plants are found in the proposed treatment area.

Herbicides are commonly used to control nuisance shoreline vegetation by applying it to green foliage or cut stems. They provide a fast and effective way to control or eliminate nuisance vegetation by killing the root of the plant, preventing regrowth. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. It is best to apply herbicides when plants are actively growing, such as in the late

spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

D4. Participate in the Volunteer Lake Monitoring Program

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

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

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

For information, please contact:

VLMP Regional Coordinator:
Holly Hudson
Chicago Metropolitan Agency for Planning
233 S. Wacker Drive, Suite 880
Chicago, IL 60606
(312) 386-8700

D5. Option for Lakes with a High Carp Population

Rotenone is a piscicide that is naturally derived from the stems and roots of several tropical plants, making it biodegradable. It kills fish by chemically inhibiting the use of oxygen in biochemical pathways, therefore adult fish are much more susceptible than fish eggs. In the aquatic environment, fish come into contact with the rotenone by a different method than other organisms. With fish, the rotenone comes into direct contact with the exposed respiratory surfaces (gills), which is the route of entry. In other organisms this type of contact is minimal.

Rotenone has varying levels of toxicity on different fish species. Some species of fish can detoxify rotenone quicker than it can build up in their systems. Unfortunately, concentrations to remove undesirable fish, such as carp, bullhead and Green Sunfish, are high enough to kill more desirable species such as bass, Bluegill, crappie, Walleye, and Northern Pike. Rotenone is most effectively used when waters are cooling down (fall) not warming up (spring) and is most effective when water temperatures are <50°F. To use rotenone in a body of water over 6 acres a *Permit to Remove Undesirable Fish* must be obtained from the Illinois Department of Natural Resources (IDNR), Natural Heritage Division, Endangered and Threatened Species Program. Furthermore, only an IDNR fisheries biologist licensed to apply aquatic pesticides can apply rotenone in the state of Illinois, as it is a restricted use pesticide.

Rotenone is one of the only ways to effectively remove undesirable fish species, however it can be expensive. It allows for rehabilitation of the lake's fishery, which will allow for improvement of the aquatic plant community, and overall water quality. There are some negative impacts that may also occur with the use of rotenone. In the process of removing carp with rotenone, other desirable fish species will also be removed. The fishery can be replenished with restocking and quality sport fishing normally returns within 2-3 years. The IDNR will not approve application of rotenone to waters known to contain threatened and endangered fish species.

As with most intensive lake management techniques, a good bathymetric map is needed so that an accurate lake volume can be determined. To achieve a concentration of 6 ppm, which is the rate needed for most total rehabilitation projects (remove carp, bullhead and Green Sunfish), 2.022 gal/AF is required. In waters with high turbidity and/or planktonic algal blooms, the ppm may have to be higher. An IDNR fisheries biologist will be able to determine if higher concentrations will be needed.

D6. Options to Reduce Conductivity and Chloride Concentrations

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

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

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

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

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

Option 1. Proper Use on Your Property

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

Option 2. Examples of Alternatives

While alternatives may contain chloride, they tend to work faster at lower temperatures and therefore require less application to achieve the same result that common road salt would.

Calcium, Magnesium or Potassium Chloride

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

Calcium Magnesium Acetate (CMA)

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

Agricultural Byproducts

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

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

Option 3. Talk to Your Municipality About Using an Alternative

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

APPENDIX E. WATER QUALITY STATISTICS FOR ALL LAKE COUNTY LAKES

2000 - 2006 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2006		ALKanoxic 2000-2006		
Average	167.2		Average	201	
Median	162.0		Median	191	
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 =	247	

	Condoxic <=3ft00-2006		Condanoxic 2000-2006		
Average	0.8838		Average	0.9949	
Median	0.7954		Median	0.8276	
Minimum	0.2542	Broberg Marsh	Minimum	0.3210	Lake Kathryn
Maximum	6.8920	IMC	Maximum	7.4080	IMC
STD	0.5391		STD	0.7811	
n =	796		n =	247	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2006		NH3-Nanoxic 2000-2006		
Average	0.521		Average	2.103	
Median	0.153		Median	1.350	
Minimum	<0.05	*ND	Minimum	<0.1	*ND
Maximum	9.670	South Churchill Lake	Maximum	18.400	Taylor Lake
STD	1.060		STD	2.354	
n =	803		n =	247	

*ND = Many lakes had non-detects (71.5%)

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

Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	pHoxic <=3ft00-2006		pHanoxic 2000-2006		
Average	8.30		Average	7.20	
Median	8.30		Median	7.18	
Minimum	5.21	Redwing Slough	Minimum	6.24	Banana Pond
Maximum	10.28	Round Lake Marsh North	Maximum	8.48	Heron Pond
STD	0.48		STD	0.39	
n =	796		n =	247	

	All Secchi 2000-2006		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
Average	4.48		
Median	3.27		
Minimum	0.33	Fairfield Marsh, Patski Pond	
Maximum	21.82	Bangs Lake	
STD	3.69		
n =	740		

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

	TKNoxic ≤3ft00-2006		TKNanoxic 2000-2006		
Average	1.481		Average	2.971	
Median	1.260		Median	2.270	
Minimum	<0.5	*ND	Minimum	<0.5	*ND
Maximum	10.300	Fairfield Marsh	Maximum	21.000	Taylor Lake
STD	0.828		STD	2.341	
n =	798		n =	247	
*ND = 3.6% Non-detects from 14 different lakes			*ND = 3.2% Non-detects from 5 different lakes		

	TPoxic ≤3ft00-2006		TPanoxic 2000-2006		
Average	0.101		Average	0.279	
Median	0.061		Median	0.162	
Minimum	<0.01	*ND	Minimum	0.012	West Loon Lake
Maximum	3.880	Albert Lake	Maximum	3.800	Taylor Lake
STD	0.179		STD	0.369	
n =	798		n =	247	
*ND = 0.1% Non-detects from 5 different lakes (Carina, Minear, & Stone Quarry)					

	TSSall ≤3ft00-2006		TVSoxic ≤3ft00-2006		
Average	15.4		Average	137.7	
Median	7.9		Median	134.0	
Minimum	<0.1	*ND	Minimum	34.0	Pulaski Pond
Maximum	165.0	Fairfield Marsh	Maximum	298.0	Fairfield Marsh
STD	20.5		STD	41.2	
n =	810		n =	752	
*ND = 1.3% Non-detects from 10 different lakes			No 2002 IEPA Chain Lakes		

	TDSoxic ≤3ft00-2004		CLanoxic ≤3ft00-2006		
Average	470		Average	261	
Median	454		Median	116	
Minimum	150	Lake Kathryn, White	Minimum	41	Timber Lake (N)
Maximum	1340	IMC	Maximum	2390	IMC
STD	169		STD	450	
n =	745		n =	79	
No 2002 IEPA Chain Lakes.					

	CLOxic ≤3ft00-2006	
Average	220	
Median	171	
Minimum	30	White Lake
Maximum	2760	IMC
STD	275	
n =	317	



APPENDIX F. 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>

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