2007 SUMMARY REPORT
of
Lake Minear

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
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EXECUTIVE SUMMARY

Lake Minear was created from filling an abandoned gravel pit in 1951. It is approximately 77.8 acres in size, has a shoreline length of 3.5 miles, and a maximum depth of 22.0 feet. It is available to members for aesthetics, boating, swimming, and fishing.

Water levels were taken at a submerged tree near the water sampling point on the east shore and a total gain of 1.5 feet was recorded from May to September, due to heavy August rains that caused the Des Plaines River to flood into the lake. Lake Minear was stratified May through August with a thermocline forming between 8 and 12 feet. DO concentrations were adequate to support aquatic life (>5 mg/L) in the epilimnion for the entire summer, however the hypolimnion had anoxic conditions (<1 mg/L) June through September.

Lake Minear's water quality was better than most lakes in Lake County. Phosphorus and nitrogen are two important nutrients for algal growth. The average total phosphorus for Lake Minear was 0.020 mg/L compared to the county median of 0.063 mg/L. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN for Lake Minear was 0.67 mg/L, which was lower than the county median of 1.22 mg/L.

Total suspended solid concentrations (TSS) fluctuated throughout the season with maximum concentrations of 4.8 mg/L in July and 4.7 mg/L in August. The average TSS concentration for the season was 3.6 mg/L, which was well below the county median of 8.0 mg/L, but higher than the 2002 average (1.6 mg/L). 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 disk depth with the lowest reading in July (4.27 feet) corresponding to the high TSS value. The average Secchi depth for the season was 7.13 feet, which is greater than the county median (3.28 feet), but lower than the 2002 average of 10.06 feet. The average conductivity reading for Lake Minear was 0.6504 mS/cm, which is well below the county median (0.8038 mS/cm). However, the conductivity has increased by 7% since 2002.

Eighty-eight percent of the sites sampled on Lake Minear had aquatic plants present with six different species found. Eurasian Watermilfoil was the most abundant species found at 72% of the sites and Curlyleaf Pondweed was the second most abundant occurring at 24% of the sites. 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.

In 2007 shoreline erosion was reassessed from the initial 2002 study. There were many areas where erosion has increased, with 39% of the shoreline exhibiting severe erosion. It is recommended that steps are taken to alleviate the problem before it becomes worse.

LAKE FACTS

Lake Name:	Lake Minear
Historical Name:	None
Nearest Municipality:	Libertyville
Location:	T44N, R11E, Sections 15, 16
Elevation:	644.0 feet
Major Tributaries:	None
Watershed:	Des Plaines River
Sub-watershed:	Upper Des Plaines River
Receiving Water body:	None
Surface Area:	77.8 acres
Shoreline Length:	3.5 miles
Maximum Depth:	22.0 feet
Average Depth:	11.9 feet
Lake Volume:	892.5 acre-feet
Lake Type:	Borrow Pit
Watershed Area:	243.1 acres
Major Watershed Land uses:	Single Family, transportation, and public and private open space
Bottom Ownership:	Private
Management Entities:	Lake Minear Conservation Association
Current and Historical uses:	Historically, it was a borrow pit. Currently, it is used for boating, fishing, swimming, and aesthetics.
Description of Access:	No public access, Members only

SUMMARY OF WATER QUALITY

Water samples were collected from May to September in Lake Minear at the deepest point in the east, central 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 Lake Minear (taken from a dead tree stump near the shoreline of the deep point) increased approximately 1.5 feet throughout the season. Initially, the water level went down through July and with the rain in August it rose again through September. It was up enough for the Des Plaines River to overflow into Lake Minear in late August. According the Stormwater Management Commission rain gauge in Libertyville, 5.6 inches of rain was received in July, 10.9 inches in August, and 0.9 inches in September. In order to accurately monitor water levels it is recommended that a staff gauge be installed.

Lake Minear was stratified for most of the sampling season. Stratification occurs 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 May, June, and August the thermocline was around 12 feet, and rose to around 8 feet in July. In September it was still slightly stratified at 12 feet. 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 September (Appendix B). A bathymetric map with volumetric calculations of Lake Minear does not exist, therefore an accurate assessment of the DO conditions cannot be made.

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 Lake Minear was 0.020 mg/L (Table 1) and the county median was 0.063 mg/L (Appendix E). This phosphorus concentration was an increase from 2002 which was 0.017 mg/L when the lake was last sampled by the Lakes Management Unit (LMU). The higher phosphorus concentrations in 2007 may be due to lack of aquatic plant coverage and from stormwater runoff. 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 Lake Minear was 0.67 mg/L, which was lower than the county median of 1.22 mg/L and higher than the concentration in 2002 (0.57 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 indicates 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. Lake Minear had a TN:TP ratio of 26:1 which indicated phosphorus was 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 Lake Minear, 2007.

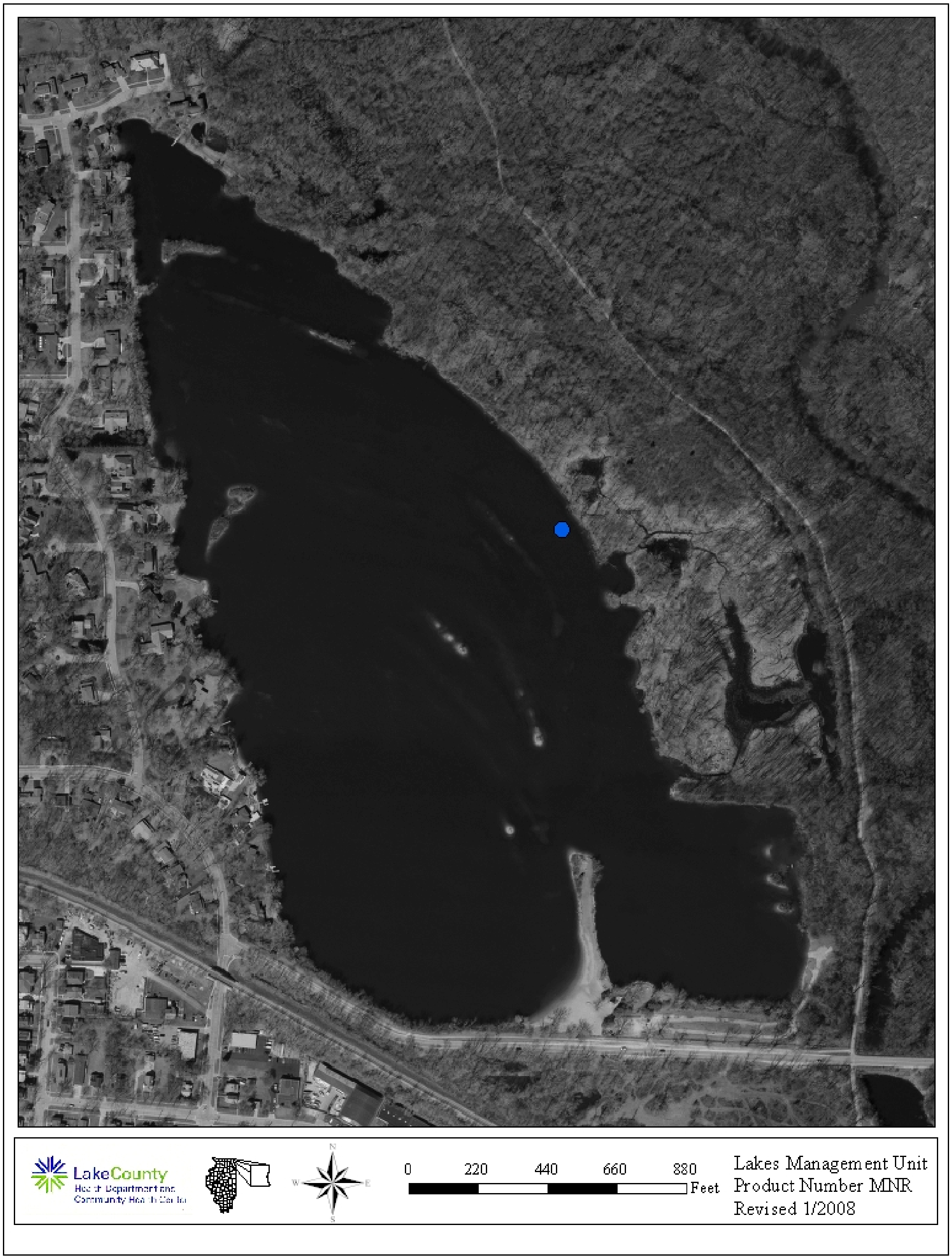

Table 1. Summary of water quality data for Lake Minear, 2007.

2007	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
15-May	3	115	<0.5	<0.1	<0.05	0.019	<0.005	NA	112	1.8	378	83	12.80	0.6600	8.83	9.85
19-Jun	3	102	0.625	<0.1	<0.05	0.022	<0.005	NA	115	2.7	388	109	8.86	0.6390	8.73	7.99
17-Jul	3	111	0.697	<0.1	<0.05	0.020	<0.005	NA	117	4.8	383	101	4.27	0.6720	9.05	8.79
14-Aug	3	111	0.646	<0.1	<0.05	0.013	<0.005	NA	111	4.2	390	112	5.25	0.6450	8.79	7.44
18-Sep	3	135	0.697	<0.1	<0.05	0.028	<0.005	NA	100	4.7	402	117	4.45	0.6360	8.65	11.72
	Average	115	0.666	<0.1	<0.05	0.020	<0.005	NA	111	3.6	388	104	7.13	0.6504	8.81	9.16

2002	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
6-May	3	147	0.572	<0.1	<0.05	0.025	<0.005	354	NA	2.2	372	104	7.97	0.6272	8.35	9.90
10-Jun	3	140	0.548	<0.1	<0.05	0.013	<0.005	348	NA	1.1	390	118	13.55	0.6211	8.48	9.60
15-Jul	3	130	0.540	<0.1	<0.05	<0.01	<0.005	310	NA	1.7	379	109	10.01	0.6205	8.57	8.30
12-Aug	3	115	0.581	<0.1	<0.05	0.010	<0.005	331	NA	1.6	359	105	10.30	0.5997	8.79	8.50
9-Sep	3	99	0.612	<0.1	<0.05	0.018	<0.005	286	NA	1.2	327	88	8.47	0.5602	9.05	10.00
	Average	126	0.571	<0.1	<0.05	0.017[k]	<0.005	326	NA	1.6	365	105	10.06	0.6057	8.65	9.26

Glossary

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

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed

Table 1. Continued.

2007	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
15-May	16	122	0.511	<0.1	<0.05	0.024	<0.005	NA	109	5.4	393	98	NA	0.6700	8.07	7.80
19-Jun	16	145	0.549	<0.1	<0.05	0.034	<0.005	NA	109	2.6	413	113	NA	0.6840	7.61	0.43
17-Jul	15	151	1.130	<0.1	<0.05	0.084	<0.005	NA	111	12.0	401	94	NA	0.7005	8.24	0.37
14-Aug	16	176	1.600	0.719	<0.05	0.093	0.031	NA	112	8.4	409	98	NA	0.7240	7.40	0.12
18-Sep	17	139	0.894	<0.1	<0.05	0.051	<0.005	NA	100	6.8	409	118	NA	0.6510	8.23	0.56
	Average	147	0.937	0.719[k]	<0.05	0.057	0.031[k]	NA	108	7.0	405	104	NA	0.6859	7.91	1.86

2002	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
6-May	16	147	0.622	<0.1	<0.05	0.021	<0.005	359	NA	3.9	374	120	NA	0.6273	8.08	8.30
10-Jun	16	154	0.682	<0.1	<0.05	0.020	<0.005	374	NA	1.4	403	123	NA	0.6411	7.78	5.70
15-Jul	15	156	0.624	<0.1	<0.05	0.026	<0.005	324	NA	4.3	388	106	NA	0.6550	7.71	2.70
12-Aug	14	138	0.732	<0.1	<0.05	0.023	<0.005	336	NA	3.4	371	99	NA	0.6394	7.63	2.00
9-Sep	15	118	1.020	0.103	<0.05	0.041	<0.005	316	NA	4.3	343	92	NA	0.5915	7.86	1.50
	Average	143	0.736	0.103[k]	<0.05	0.026	<0.005	342	NA	3.5	376	108	NA	0.6309	7.8120	4.04

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L
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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 2007, Lake Minear was mesotrophic with a TSIp value of 47.6, which placed it 14th out of 163 lakes in the county (Table 2).

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

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 2007 average TSS concentration for Lake Minear was 3.6 mg/L, which less than the county median (8.0 mg/L). However, the TSS was higher than the 2002 average of 1.6 mg/L. TSS concentrations were highest during July through September, with the highest concentration at 4.8 mg/L in July. July sampling followed a light rain, which could have contributed to the increase in TSS, as well as the wind stirring the bottom sediment up. Boat traffic may also cause the water to be turbid since there were less aquatic plants to hold soil in place due to herbicide treatments. 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 disk depth, with the lowest reading in July (4.27 feet) corresponding to the high TSS value (Figure 2). The average Secchi depth for the season was 7.13 feet, which was greater than the county median (3.28 feet). The Secchi depth decreased since 2002 when the average was 10.06 feet. Lake Minear has been participating in the Volunteer Lake Management Program since 1997, providing valuable information throughout those years and helping to fill in gaps when the LMU was not sampling (Figure 3). The VLMP data had similar Secchi depths in the same years the LMU sampled. The average depth since 1997 was 8.0 feet. Differences between VLMP and LCHD data can be attributed to discrepancies between samplers, as well as date and time samples were taken.

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 Lake Minear was 0.6504 mS/cm, which was below the county median (0.8038 mS/cm). This was a 7% increase from the 2002 average (0.6057 mg/L). The average chloride concentration was 111 mg/L, which was lower than the county median (158 mg/L). A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. It is recommended that the winter road maintenance in the watershed be evaluated as many alternatives to road salt are currently available and being used by several entities in Lake and surrounding counties. While alternatives may contain chloride, they tend to work faster at lower temperatures and therefore require less application to achieve the same result common road salt would achieve.

Table 2. Lake County average TSI phosphorous (TSIp) ranking 2000-2007.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0114	39.24
4	Sand Pond (IDNR)	0.0132	41.36
5	Cedar Lake	0.0157	41.60
6	Windward Lake	0.0158	43.95
7	Pulaski Pond	0.0180	45.83
8	Timber Lake (North)	0.0180	45.83
9	Fourth Lake	0.0182	45.99
10	West Loon Lake	0.0182	45.99
11	Lake Kathyrn	0.0200	47.35
12	Lake of the Hollow	0.0200	47.35
13	Banana Pond	0.0202	47.49
14	**Lake Minear**	**0.0204**	**47.63**
15	Bangs Lake	0.0212	48.17
16	Cross Lake	0.0220	48.72
17	Dog Pond	0.0222	48.85
18	Stone Quarry Lake	0.0230	49.36
19	Cranberry Lake	0.0234	49.61
20	Deep Lake	0.0240	49.98
21	Druce Lake	0.0244	50.22
22	Little Silver Lake	0.0246	50.33
23	Round Lake	0.0254	50.80
24	Lake Leo	0.0256	50.91
25	Dugdale Lake	0.0274	51.89
26	Peterson Pond	0.0274	51.89
27	Lake Miltmore	0.0276	51.99
28	East Loon Lake	0.0280	52.20
29	Lake Zurich	0.0282	52.30
30	Lake Fairfield	0.0296	53.00
31	Gray's Lake	0.0302	53.29
32	Highland Lake	0.0302	53.29
33	Hook Lake	0.0302	53.29
34	Lake Catherine (Site 1)	0.0308	53.57
35	Lambs Farm Lake	0.0312	53.76
36	Old School Lake	0.0312	53.76
37	Sand Lake	0.0316	53.94
38	Sullivan Lake	0.0320	54.13
39	Lake Linden	0.0326	54.39
40	Countryside Lake	0.0332	54.66
41	Gages Lake	0.0338	54.92
42	Hendrick Lake	0.0344	55.17
43	Third Lake	0.0346	55.24
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	Ames Pit	0.0390	56.98

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Sun Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Old Oak Lake	0.0428	58.32
52	Deer Lake	0.0434	58.52
53	Schreiber Lake	0.0434	58.52
54	Nielsen Pond	0.0448	58.98
55	Turner Lake	0.0458	59.30
56	Seven Acre Lake	0.0460	59.36
57	Willow Lake	0.0464	59.48
58	Lucky Lake	0.0476	59.85
59	Davis Lake	0.0476	59.85
60	East Meadow Lake	0.0478	59.91
61	College Trail Lake	0.0496	60.45
62	Lake Lakeland Estates	0.0524	61.24
63	Butler Lake	0.0528	61.35
64	West Meadow Lake	0.0530	61.40
65	Heron Pond	0.0545	61.80
66	Little Bear Lake	0.0550	61.94
67	Lucy Lake	0.0552	61.99
68	Lake Christa	0.0576	62.60
69	Lake Charles	0.0580	62.70
70	Crooked Lake	0.0608	63.38
71	Waterford Lake	0.0610	63.43
72	Lake Naomi	0.0616	63.57
73	Lake Tranquility S1	0.0618	63.62
74	Werhane Lake	0.0630	63.89
75	Liberty Lake	0.0632	63.94
76	Countryside Glen Lake	0.0642	64.17
77	Lake Fairview	0.0648	64.30
78	Leisure Lake	0.0648	64.30
79	Tower Lake	0.0662	64.61
80	Wooster Lake	0.0663	64.63
81	St. Mary's Lake	0.0666	64.70
82	Mary Lee Lake	0.0682	65.04
83	Hastings Lake	0.0684	65.08
84	Honey Lake	0.0690	65.21
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Echo Lake	0.0792	67.19
91	Sylvan Lake	0.0794	67.23
92	Big Bear Lake	0.0806	67.45

Table 2. Continued.

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

Table 2. Continued.

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

Figure 2. Secchi depth vs. total suspended solid (TSS) concentrations in Lake Minear, 2007.

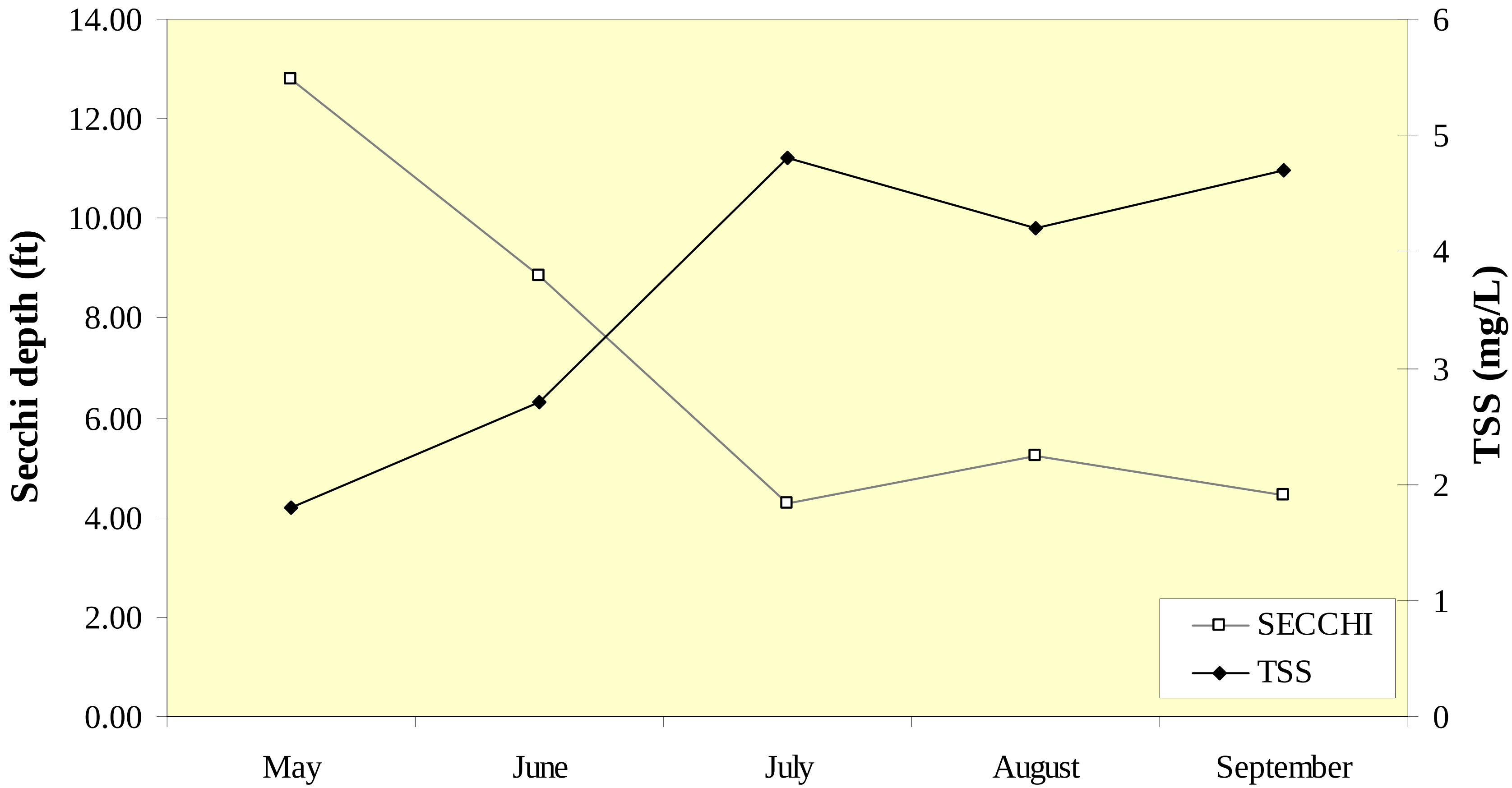
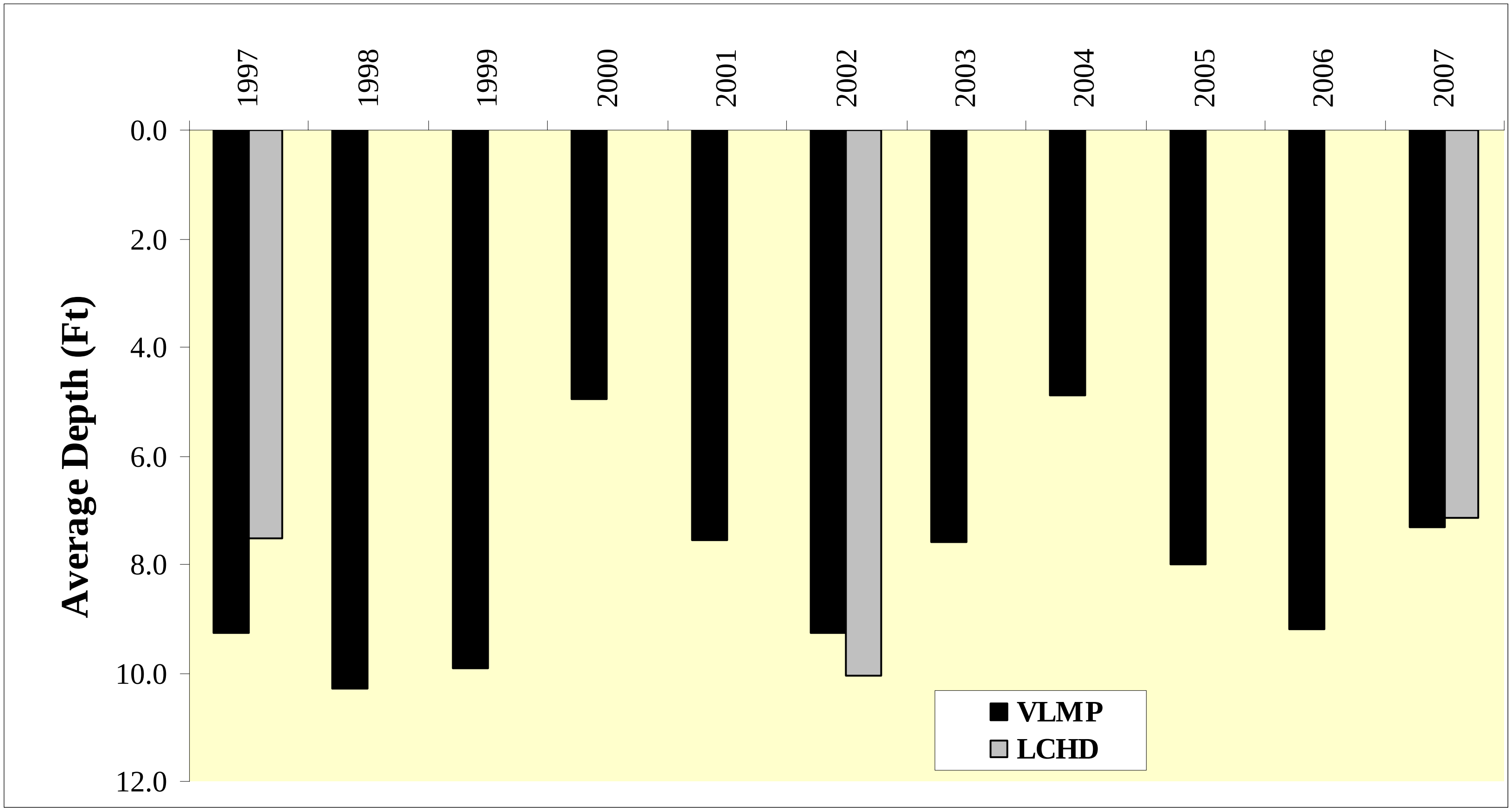


Figure 3. Yearly Secchi depth averages from VLMP and LCHD records for Lake Minear, 1997 to 2007.



The Lake Minear watershed (Figure 4) is approximately 243.1 acres. The area immediately adjacent to the west side of the lake is mostly single family homes (38%), however, the east side of the watershed consists of public and private open space (10%, Figure 5). The single family homes contribute 53% of the estimated runoff in the watershed (Table 3), which could be a reason for the increase in TP. It is recommended that the homeowners association implement a phosphorus free fertilizer ban. Twenty-five percent of runoff comes from transportation (roads) and 12% from retail commercial. The retention time of the lake was calculated as 1.7 years. Lake Minear had one swimming beach (Libertyville Boat Club) the LMU monitored for *E. coli* levels. It was sampled from May to September 2007 with no recommended closings. LMU recommends closing when *E. coli* levels are >235 colony forming units per 100mL. LMU has been monitoring the beach since 1988 and it has had only one closing, which was in 2003.

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted on Lake Minear in June. Seventy-eight points were sampled based on a grid system using ArcGIS with points 60 meters apart (Figure 6). There were six aquatic plant species present (Table 4), and one macro-algae, *Chara* spp. Eurasian Watermilfoil (EWM) was the most abundant species found at 72% of the sites (Table 5) and Curlyleaf Pondweed (CLP) was the second most abundant occurring at 24% of the sites. EWM and CLP are both invasive, exotic species, which crowd out native species and should be kept under control in order for native species to thrive. White Water Crowfoot and American Pondweed were also seen in the lake throughout the summer, but were not found while plant sampling. Duckweed, Flatstem Pondweed, Leafy Pondweed, Small Pondweed, and Watermeal were found in low abundance in 2002, but were not found in 2007. Due to their low abundance they may have been missed during sampling. Herbicide treatments of liquid 2,4D were used on the lake to control EWM in several areas in the center of the lake, as well as areas around private land owner’s docks. Although the plant coverage looked adequate during LMU’s sampling, much of the vegetation was dead or dying. There also appeared to be areas outside of the recommended treatment area that were affected. Granular 2, 4D may be a better solution to avoid any excess drift. Spot treatment of the EWM may also help to eliminate the problem areas, while allowing some of the beneficial native plants to survive to help improve water quality and in-lake habitat.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of the surface light level, plants can no longer photosynthesize. Plants in Lake Minear were found at a maximum depth of 20.0 feet, and the 1% light level was between 12 feet and the bottom of the lake during the season. Plants were growing in all areas of the lake possible. Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each 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 there are a large number of sensitive, high quality plant species or a good

Figure 4. Approximate watershed delineation of Lake Minear, 2007.

Figure 5. Approximate land use within the Lake Minear watershed, 2007.

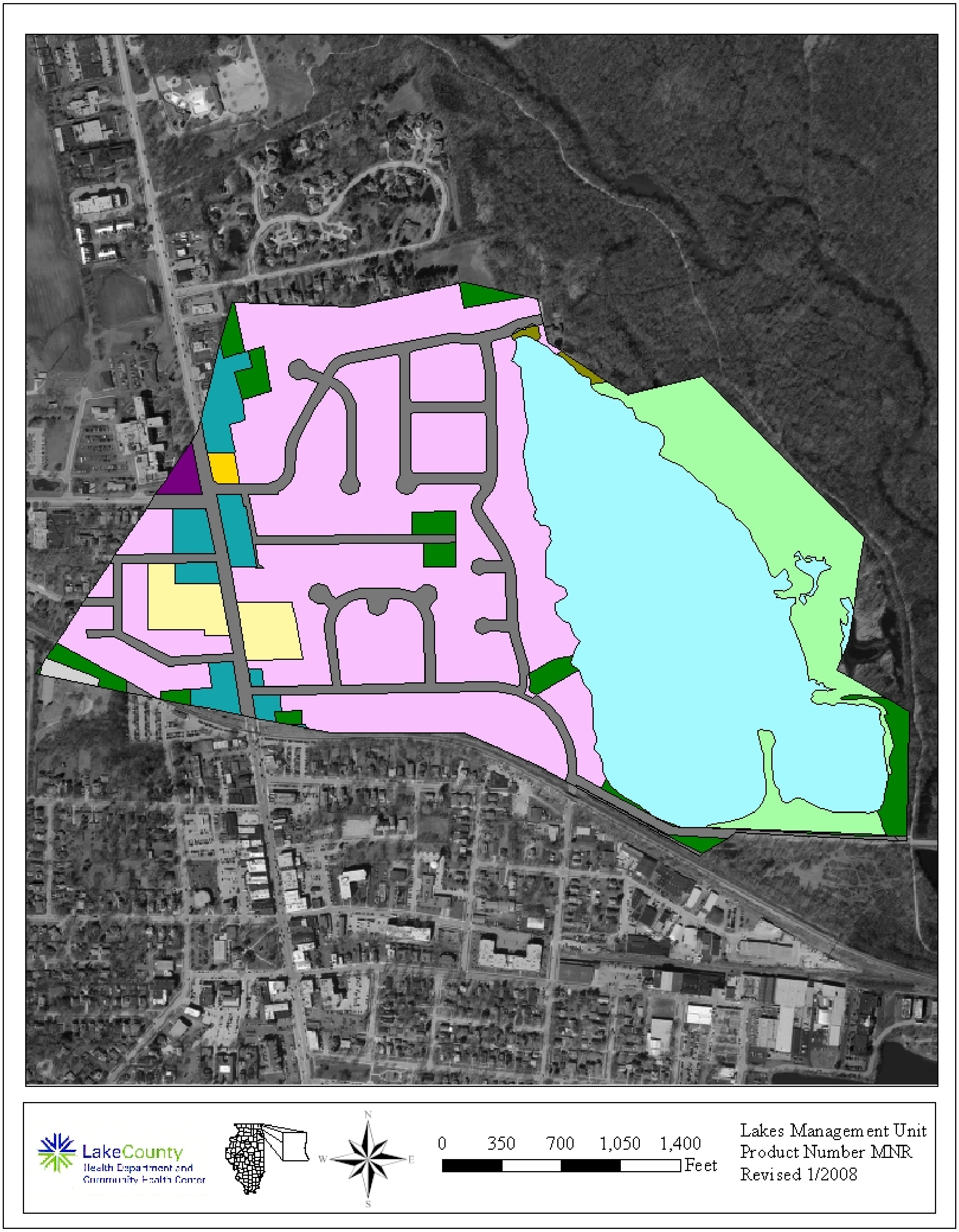


Table 3. Approximate land uses and retention time for Lake Minear, 2007.

Land Use	Acreage	% of Total
Disturbed Land	0.63	0.26%
Forest and Grassland	9.21	3.79%
Government and Institutional	0.99	0.41%
Industrial	0.61	0.25%
Multi Family	5.92	2.44%
Public and Private Open Space	24.67	10.15%
Retail/Commercial	8.31	3.42%
Single Family	92.13	37.91%
Transportation	25.96	10.68%
Water	74.12	30.50%
Wetlands	0.49	0.20%
TOTAL	**243.05**	**100.00%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% total of Estimated Runoff
Disturbed Land	0.63	0.05	0.1	0.06%
Forest and Grassland	9.21	0.05	1.3	0.88%
Govt. & Institution	0.99	0.5	1.4	0.95%
Industrial	0.61	0.3	0.5	0.35%
Multi Family	5.92	0.5	8.1	5.67%
Public & Private Open Space	24.67	0.05	3.4	2.36%
Retail/Commercial	8.31	0.75	17.1	11.93%
Single Family	92.13	0.3	76.0	52.90%
Transportation	25.96	0.5	35.7	24.85%
Water	74.12	0	0.0	0.00%
Wetlands	0.49	0.05	0.1	0.05%
TOTAL	**243.05**		**143.7**	**100.00%**

Lake volume	**243**	**acre-feet**
Retention Time (years)= lake volume/runoff	**1.69**	**years**
	617.37	**days**

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

Figure 6. Aquatic plant sampling grid illustrating plant density on Minear, June 2007.

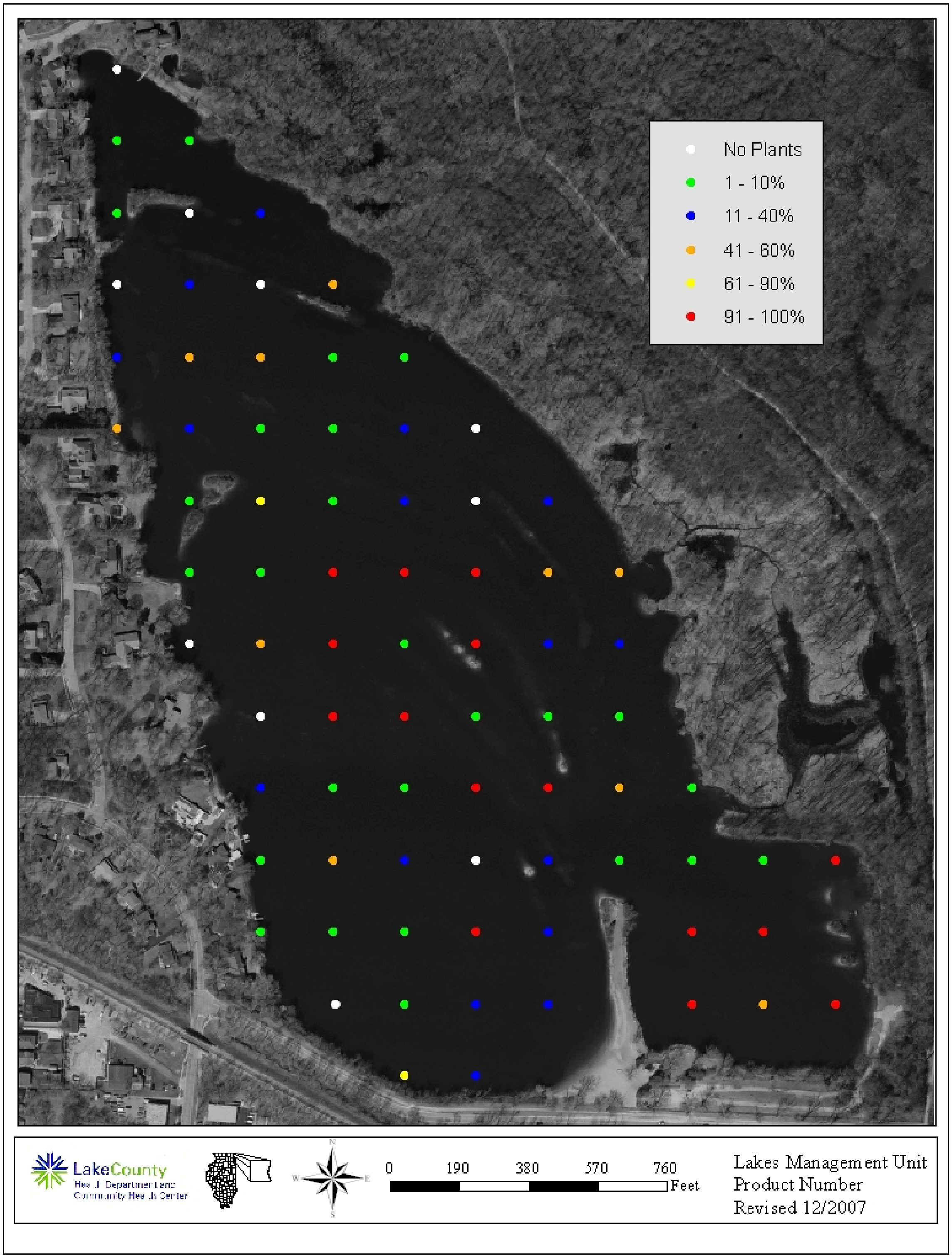


Table 4: Aquatic plant species found in Lake Minear, 2007.

Coontail	*Ceratophyllum demersum*
Chara (Macro algae)	*Chara* spp.
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Slender Naiad	*Najas major*
Spiny Naiad	*Najas marina*
Curlyleaf Pondweed^	*Potamogeton crispus*
Sago Pondweed	*Potamogeton pectinatus*

^ Exotic plant

Table 5a. Aquatic plant species found at the 78 June sampling sites on Lake Minear. The maximum depth plants were found was 20.0 feet.

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Eurasian Watermilfoil	Sago Pondweed	Slender Naiad	Spiny Naiad
Present	5	2	13	20	1	1	1
Common	2	0	4	14	2	0	0
Abundant	1	1	2	5	0	0	0
Dominant	0	0	0	17	0	0	0
% Plant Occurrence	10.3	3.8	24.4	71.8	3.8	1.3	1.3

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

Rake Density (coverage)	# of Sites	% of Sites
No Plants	9	11.5
>0-10%	26	33.3
10-40%	16	20.5
40-60%	10	12.8
60-90%	2	2.6
>90%	15	19.2
Total Sites with Plants	69	88.5
Total # of Sites	78	100.0

diversity of plants present in the lake. Non-native species were counted in the FQI calculations for Lake County Lakes. The average FQI for 2000 – 2007 Lake County lakes was 13.6. The FQI in 2007 for Lake Minear was 11.0, ranking Lake Minear 94th out of 152 lakes (Table 6). This was a decrease from 2002 (18.8).

SUMMARY OF SHORELINE CONDITION

In 2002, approximately 42% of the shoreline of Lake Minear was classified as developed, and several shoreline types were identified. The most common shoreline type was woodland (36%) followed by shrub (18%), beach (15%), riprap (14%), and buffer (6%). The remaining three shoreline types were wetland, lawn, and seawall which made up less than 5% of the shoreline. Erosion was documented on 61% of the shoreline, however most of this was classified as slightly eroding. Approximately 16% of the shoreline was moderately eroding and 14% was severely eroding. All of the severely eroding sections were located on the islands, with the exception of a section along the residential western shoreline.

In 2007, the LMU re-evaluated the shoreline for erosion and noted changes that have occurred since 2002. All the islands are exhibiting severe erosion. There were many areas along the shoreline where erosion had increased, with 39% exhibiting severe erosion (Figure 7). Many areas with erosion had riprap made of broken concrete slabs. This is ineffective at absorbing wave energy, due in part to the flat surfaces of the concrete that actually deflects wave energy into the spaces between the slabs, eventually eroding the bank behind the concrete. It also appears that no filter fabric exists behind the concrete.

Exotic plant species were common along the shoreline of Lake Minear. The most common exotic plants were Common Buckthorn, Honeysuckle, Multiflora Rose, and Reed Canary Grass. Buckthorn and Honeysuckle are particularly problematic as they outcompete native plants and offer little value in terms of shoreline stabilization or wildlife habitat. These plants were the dominant shrub species in the woodland areas along the eastern shoreline. Exotic species should be removed and replaced with native shoreline plants. In addition to shoreline plants, emergent vegetation should be planted or encouraged to grow. These plants (Arrowhead, Bulrushes, Spikerushes, etc.) help stabilize the shoreline by buffering wind and wave action. However, due to the hard rocky substrate along the shoreline and shallow water areas, it may be difficult for emergent plants to become established. Along the shoreline, buffer strips should be installed between the water and manicured lawns to reduce nutrient-rich runoff into the lake. Both emergent vegetation and buffer strips also provide habitat for fish and wildlife that use the lake. There are many grants available to homeowner associations for shoreline restoration, particularly in the common areas of the lake, such as C2000. Appendix F has more information on this grant, as well as other opportunities.

Table 6. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).

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

Table 6. Continued.

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

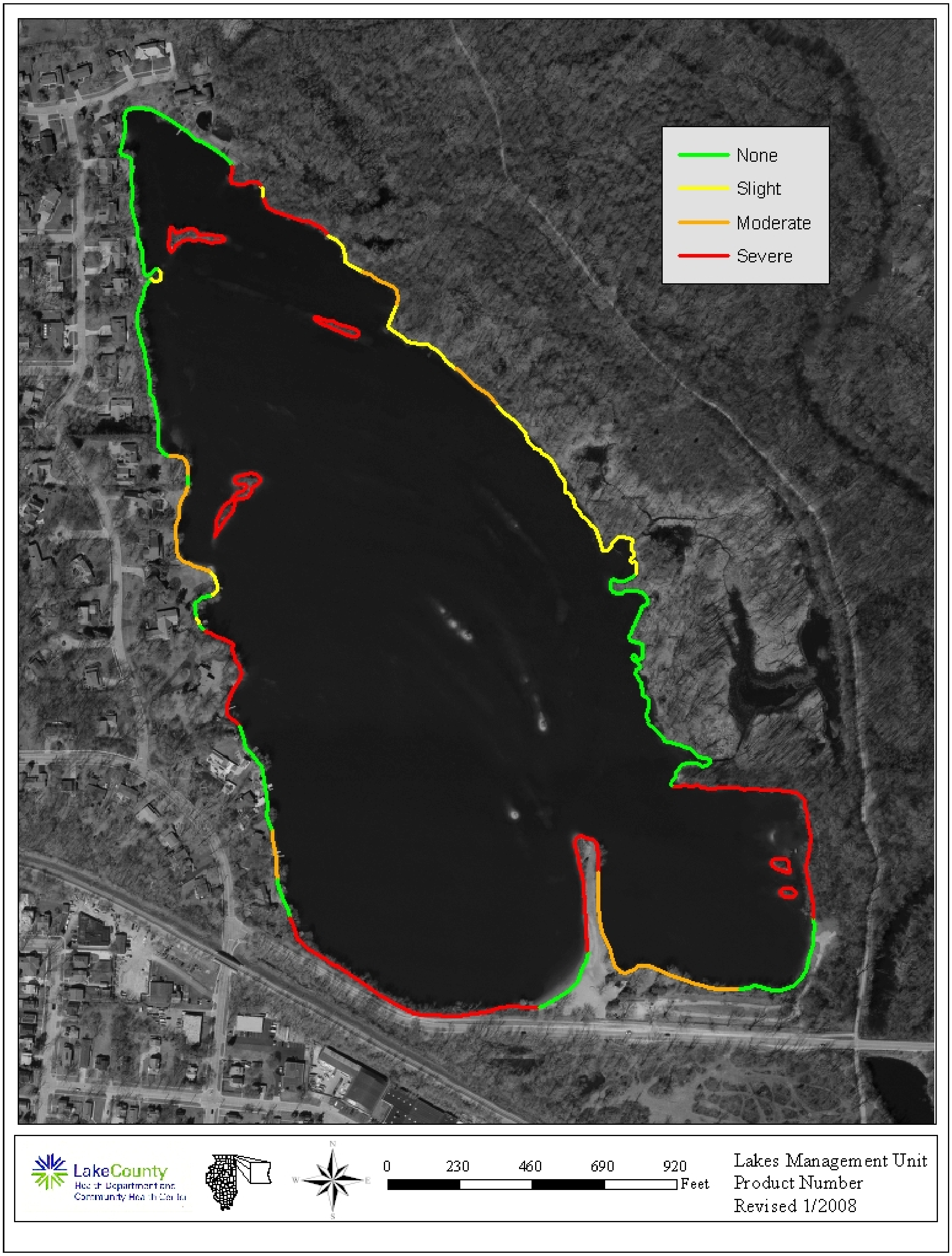
Table 6. Continued.

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

Table 6. Continued.

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

Figure 7. Shoreline erosion on Lake Minear, 2007.



SUMMARY OF WILDLIFE AND HABITAT

Good wildlife populations, primarily birds, were found on and around Lake Minear. Current habitat is fair to good. Many species of wildlife, including many of the bird species were seen along the wooded eastern shorelines.

The IDNR did a fish survey in 1998. At that time the IDNR stated the lake consisted of too many stunted panfish due mostly to the dense stands of EWM. The report concluded the lake had potential to maintain a balanced fishery and recommended management of the EWM, establishing a 15-inch minimum length limit and one per day catch of Largemouth Bass, stocking Largemouth Bass and other predatory fish, and removing carp and Yellow Bass through fishing harvests.

LAKE MANAGEMENT RECOMMENDATIONS

Lake Minear has good water quality, with low TP and TSS concentrations. Although 36% of the shoreline is surrounded by woodlands, 39% of the shoreline is exhibiting severe erosion. Plant diversity was low and included exotic species. There are many grant opportunities available to do improvements around or in the lake (Appendix F).

Creating a Bathymetric Map

Lake Minear 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

Sixty-one percent of Lake Minear's shoreline is eroding, with 39% exhibiting severe erosion. The LMU recommends initiating programs to stop erosion before more of it becomes severe and to fix the public areas with severely eroding shorelines (Appendix D2).

Options for Aquatic Plant Management

Lake Minear Conservation Association, as well as private landowners, treated the lake with liquid 2,4D to control the Eurasian Watermilfoil. Areas outside of the treatment area seemed to be affected as well. Use of granular 2,4D to spot treat Eurasian Watermilfoil may eliminate drift which caused treatment to non-target areas in 2007 (Appendix D3). The Association should also consider reducing the acreage treated to help improve water clarity.

Options to Reduce Conductivity and Chloride Concentrations

The current concentration of chloride in Lake Minear was below the county median, however, it had increased since 2002. This increase is a common trend in most Lake county lakes and steps should be taken to try and reduce conductivity and chloride concentrations. Road salt (sodium chloride) is the most commonly used winter road de-icer and is the major contributor to chloride and conductivity levels (Appendix D4).

Assess Your Lake's Fishery

The last assessment of the fishery was in 1998. An updated of the fishery is recommended to determine the diversity and health of the fish community (Appendix D5).

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.

Shoreline Assessment

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

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

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

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

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

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

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

Lake Minear 2007 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.63
05/16/2007		0.5	0.483	19.05	9.67	104.5	0.660	8.52	4411.8	Surface		
05/16/2007		1	1.081	19.09	9.79	105.9	0.660	8.77	4381.0	Surface	100%	
05/16/2007		2	2.078	19.07	9.85	106.5	0.660	8.81	419.8	0.408	10%	5.75
05/16/2007		3	3.082	19.09	9.85	106.6	0.660	8.83	357.7	1.412	8%	0.11
05/16/2007		4	4.015	19.08	9.85	106.6	0.660	8.84	211.8	2.345	5%	0.22
05/16/2007		6	6.001	19.05	9.89	106.9	0.660	8.85	196.4	4.331	4%	0.02
05/16/2007		8	8.032	19.05	9.92	107.2	0.659	8.85	160.6	6.362	4%	0.03
05/16/2007		10	10.002	19.01	9.96	107.6	0.659	8.85	136.0	8.332	3%	0.02
05/16/2007		12	12.028	14.28	11.79	115.3	0.660	8.64	102.3	10.358	2%	0.03
05/16/2007		14	13.965	11.77	11.12	102.8	0.664	8.40	66.4	12.295	2%	0.04
05/16/2007		16	16.046	10.72	7.80	70.5	0.670	8.07	47.5	14.376	1%	0.02
05/16/2007		18	17.985	10.23	3.83	34.2	0.677	7.79	34.0	16.315	0.8%	0.02

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.32
06/20/2007		0.5	0.535	26.07	7.91	97.8	0.638	8.65	3067.2	Surface		
06/20/2007		1	1.071	26.08	7.92	97.9	0.638	8.69	2672.4	Surface	100%	
06/20/2007		2	2.037	26.05	7.97	98.5	0.639	8.71	1073.7	0.367	40%	2.48
06/20/2007		3	3.044	26.08	7.99	98.8	0.639	8.73	575.6	1.374	22%	0.45
06/20/2007		4	4.040	26.00	8.02	99.0	0.639	8.74	715.8	2.370	27%	-0.09
06/20/2007		6	6.056	25.92	7.93	97.8	0.639	8.74	455.6	4.386	17%	0.10
06/20/2007		8	8.048	25.80	7.79	95.8	0.639	8.72	307.4	6.378	12%	0.06
06/20/2007		10	10.006	25.62	7.17	87.9	0.640	8.61	201.1	8.336	8%	0.05
06/20/2007		12	12.039	20.60	6.82	76.0	0.647	8.20	124.4	10.369	5%	0.05
06/20/2007		14	14.070	16.91	3.26	33.7	0.667	7.78	83.6	12.400	3%	0.03
06/20/2007		16	16.038	14.58	0.43	4.2	0.684	7.61	61.3	14.368	2%	0.02
06/20/2007		18	17.994	13.62	0.14	1.3	0.705	7.49	27.8	16.324	1%	0.05

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.37
07/18/2007		0.5	0.499	26.00	8.80	108.7	0.672	9.06	3396.5	Surface		
07/18/2007		1	0.993	26.00	8.78	108.4	0.655	9.03	3266.5	Surface	100%	
07/18/2007		2	2.066	25.99	8.79	108.5	0.672	9.05	1332.3	0.396	41%	2.26
07/18/2007		3	3.073	25.98	8.79	108.5	0.672	9.05	794.3	1.403	24%	0.37
07/18/2007		4	4.066	25.99	8.80	108.6	0.672	9.06	643.9	2.396	20%	0.09
07/18/2007		6	6.081	25.88	8.73	107.6	0.672	9.06	363.1	4.411	11%	0.13
07/18/2007		8	8.040	25.16	7.49	91.0	0.674	8.96	231.8	6.370	7%	0.07
07/18/2007		10	10.017	24.43	5.12	61.4	0.677	8.78	127.8	8.347	4%	0.07
07/18/2007		12	12.072	22.69	3.36	39.1	0.681	8.53	60.9	10.402	2%	0.07
07/18/2007		14	14.064	20.18	0.50	5.5	0.687	8.35	13.6	12.394	0.4%	0.12
07/18/2007		16	16.016	15.63	0.24	2.4	0.714	8.13	1.5	14.346	0.0%	0.15

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.26
08/15/2007		0.5	0.540	27.50	7.38	93.6	0.645	8.74	756.5	Surface		
08/15/2007		1	1.075	27.52	7.40	93.9	0.645	8.75	465.4	Surface	100%	
08/15/2007		2	2.085	27.52	7.43	94.2	0.645	8.77	265.3	0.415	57%	1.35
08/15/2007		3	3.058	27.51	7.44	94.3	0.645	8.79	82.3	1.388	18%	0.84
08/15/2007		4	4.094	27.52	7.42	94.2	0.627	8.79	145.2	2.424	31%	-0.23
08/15/2007		6	6.050	27.51	7.41	94.1	0.645	8.80	87.8	4.380	19%	0.11
08/15/2007		8	8.055	27.43	7.08	89.7	0.646	8.78	49.4	6.385	11%	0.09
08/15/2007		10	10.096	26.91	5.44	68.2	0.631	8.58	29.5	8.426	6%	0.06
08/15/2007		12	12.121	24.50	1.61	19.3	0.674	8.14	15.3	10.451	3%	0.06
08/15/2007		14	14.041	22.79	0.20	2.3	0.686	7.84	6.5	12.371	1%	0.07
08/15/2007		16	16.004	18.49	0.12	1.3	0.724	7.40	0.9	14.334	0.2%	0.14
08/15/2007		18	18.066	16.19	0.06	0.6	0.765	7.21	0.2	16.396	0.0%	0.09

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.46
09/19/2007		0.5	0.486	20.85	11.86	132.9	0.635	8.82	2992.8	Surface		
09/19/2007		1	1.006	20.84	11.83	132.5	0.636	8.73	2632.3	Surface	100%	
09/19/2007		2	2.010	20.85	11.81	132.3	0.636	8.68	719.3	-0.664	88%	-0.19
09/19/2007		3	3.106	20.84	11.72	131.3	0.636	8.64	510.1	0.340	24%	3.82
09/19/2007		4	4.081	20.83	11.67	130.7	0.635	8.62	334.5	1.436	17%	0.24
09/19/2007		6	6.006	20.81	11.60	129.9	0.636	8.60	157.2	2.411	11%	0.18
09/19/2007		8	7.992	20.79	11.50	128.6	0.636	8.59	71.2	4.336	5%	0.17
09/19/2007		10	10.003	20.79	11.37	127.3	0.636	8.57	36.0	6.322	2%	0.13
09/19/2007		12	12.019	20.20	9.14	101.1	0.638	8.49	18.7	8.333	1%	0.08
09/19/2007		14	14.030	19.32	4.91	53.4	0.636	8.39	8.6	10.349	1%	0.06
09/19/2007		16	16.022	18.63	0.88	9.4	0.637	8.28	4.1	12.360	0.3%	0.06
09/19/2007		18	18.033	18.01	0.24	2.5	0.666	8.17	2.0	14.352	0.1%	0.05

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:

<u>Phosphorus</u>:

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

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

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2005 is 0.063 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2005 was 0.174 mg/L and ranged from a minimum of 0.012 mg/L in West Loon Lake to a maximum of 3.880 mg/L in Taylor Lake.

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

Nitrogen:

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

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

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

Solids:

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County is 7.9 mg/L, ranging from below the 1 mg/L detection limit (10 lakes) to 165 mg/L in Fairfield Marsh.

TVS represents the fraction of total solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TVS values indicate that a large portion of the suspended solids may be made up of algae cells. This is important in determining possible sources of phosphorus to a lake. If much of the suspended material in the water column is determined to be resuspended sediment that is releasing phosphorus, this problem would be addressed differently than if the suspended material was made up of algae cells that were releasing phosphorus. The median TVS value was 132 mg/L, ranging from 34 mg/L in Pulaski Pond to 298 mg/L in Fairfield Marsh.

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

Water Clarity:

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

Common Carp are prolific fish that feed on invertebrates in the sediment. Their feeding activities stir up bottom sediment and can dramatically decrease water clarity in shallow lakes. As mentioned above, lakes with low water clarity are, generally, considered to have poor water quality. This is because the causes and effects of low clarity negatively impact the plant and fish communities, as well as the levels of phosphorus in a lake. The detrimental impacts of low Secchi depth to plants has already been discussed. Fish populations will suffer as water clarity decreases due to a lack of food and decreased ability to successfully hunt for prey. Bluegills are planktivorous fish and feed on invertebrates that inhabit aquatic plants. If low clarity results in the disappearance of plants, this food source will disappear too. Largemouth Bass and Northern Pike are piscivorous fish that feed on other fish and hunt by sight. As the water clarity decreases, these fish species find it more difficult to see and ambush prey and may decline in size as a result. This could eventually lead to an imbalance in the fish community. Phosphorus release from resuspended sediment could increase as water clarity and plant density decrease. This would then result in increased algae blooms, further reducing Secchi depth and aggravating all problems just discussed. The average Secchi depth for Lake County lakes is 3.17 feet. From 2000-2005, Fairfield Marsh and Patski Pond had the lowest Secchi depths (0.33 feet) and Bangs Lake had the highest (29.23 feet). As an example of the difference in Secchi depth based on plant coverage, South Churchill Lake, which had no plant coverage and large numbers of Common Carp in 2003 had an average Secchi depth of 0.73 feet (over four times lower than the county average), while Deep Lake, which had a diverse plant community and few carp had an average 2003 Secchi depth of 12.48 feet (almost four times higher than the county average).

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

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:

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

Conductivity and Chloride:

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

pH:

pH is the measurement of hydrogen ion (H^+) activity in water. The pH of pure water is neutral at 7 and is considered acidic at levels below 7 and basic at levels above 7. Low pH levels of 4-5 are toxic to most aquatic life, while high pH levels (9-10) are not only toxic to aquatic life but may also result in the release of phosphorus from lake sediment. The presence of high plant densities can increase pH levels through photosynthesis, and lakes dominated by a large amount of plants or algae can experience large fluctuations in pH levels from day to night, depending on the rates of photosynthesis and respiration. Few, if any pH problems exist in Lake County lakes. Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes is 8.30, with a minimum of 7.06 in Deer Lake and a maximum of 10.28 in Round Lake Marsh North.

Eutrophication and Trophic State Index:

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

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

Table 1. Trophic State Index (TSI).

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

APPENDIX D. 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^{TM} Echosounder. With this equipment the creation of an accurate bathymetric map of almost any size lake in the county is possible. Costs vary, but can range from $2,000-5,000 depending on lake size.

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 for Aquatic Plant Management

Option 1: Aquatic Herbicides

Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products cannot be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of any negative effects on human health, wildlife, and the environment. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e., low wind speed, DO concentration, temperature).

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Often, aquatic herbicide treatments can be more cost effective in the long run compared to other management techniques. The fisheries and waterfowl populations of the lake would benefit greatly due to an increase in quality habitat and food supply. Dense stands of plants would be thinned out and improve spawning habitat and food source availability for fish. By implementing a good management plan with aquatic herbicides, usage opportunities of the lake would increase.

The most obvious drawback of using aquatic herbicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error can make them unsafe and bring about undesired outcomes. If not properly used, aquatic herbicides can remove too much vegetation from the lake. Another problem associated with removing too much vegetation is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. After the initial removal, there is a possibility for regrowth of vegetation. Upon regrowth, weedy plants such as Eurasian Watermilfoil and Coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiversity. Over-removal, and possible regrowth of nuisance vegetation that may follow will drastically impair recreational use of the lake.

Option 2: Mechanical Harvesting

Mechanical harvesting involves the cutting and removal of nuisance aquatic vegetation by large specialized boats with underwater cutting bars. The total removal or over removal (neither of which should never be the plan of any management entity) of plants by mechanical harvesting should never be attempted. To avoid complete or over removal, the management entity should have a harvesting plan that determines where and how much vegetation is to be removed.

Mechanical harvesting can be a selective means to reduce stands of nuisance vegetation in a lake. Typically, plants cut low enough to restore recreational use and limit or prevent regrowth. This practice normally improves habitat for fish and other aquatic organisms.
High initial investment, extensive maintenance, and high operational costs have led to decreased use. Mechanical harvesters cannot be used in less than 2-4 feet of water (depending on draft of

the harvester) and cannot maneuver well in tight places. The harvested plant material must be disposed of properly to a place that can accommodate large quantities of plants and prevent any from washing back into the lake. Fish, mussels, turtles and other aquatic organisms are commonly caught in the harvester and injured or even removed from the lake in the harvesting process. After the initial removal, there is a possibility for vegetation regrowth. If complete/over removal does occur several problems can result. One problem is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process.

Option 3: Hand Removal

Hand removal of excessive aquatic vegetation is a commonly used management technique. Hand removal is normally used in small ponds/lakes and limited areas for selective vegetation removal. Areas surrounding piers and beaches are commonly targeted areas. Typically tools such as rakes and cutting bars are used to remove vegetation. Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of a large amount of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic.

Option 4: Water Milfoil Weevil

Euhrychiopsis lecontei (*E. lecontei*) is a biological control organism used to control Eurasian Watermilfoil (EWM). *E. lecontei* is a native weevil, which feeds exclusively on milfoil species. It is stocked as a biocontrol and is commonly referred to as the Eurasian Watermilfoil weevil. Currently, the LCHD-Lakes Management Unit has documented weevils in 35 Lake County lakes. Many of these lakes have seen declines in EWM densities in recent years. Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations decline and do not feed on any other aquatic plants. Currently only one company, EnviroScience Inc., has a stocking program (called the MiddFoil® process). The program includes evaluation of EWM densities, of current weevil populations (if any), stocking, monitoring, and restocking as needed.

If control with milfoil weevils were successful, the quality of the lake would be improved. Native plants could start to recolonize, and the fishery of the lake would improve due to more balanced predation and higher quality habitat. Waterfowl would benefit due to increased food sources and availability of prey. Use of milfoil weevils does have some drawbacks. Control using the weevil has been inconsistent in many cases. Also, milfoil control using weevils may not work well on plants in deep water. Furthermore, weevils do not work well in areas where plants are continuously disturbed by activities such as powerboats, swimming, harvesting or herbicide use. One of the most prohibitive aspects to weevil use is price. Typically weevils are stocked to achieve a density of 1-4 weevils per stem. This translates to 500-3000 weevils per acre.

Option 5: Reestablishing Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian Watermilfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. There are few negative impacts to revegetating a lake. One possible drawback is the possibility of new vegetation expanding to nuisance levels and needing control. However, this is an unlikely outcome. Another drawback could be the high costs of extensive revegetation with imported plants.

D4. 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 dolomic lime and acetic acid; can also be made from cheese whey and may have even better ice penetration.
- Benefits: low corrosion rates, safe for concrete, low toxicity and biodegradable, stays on surfaces longer (fewer applications necessary).
- Multi-Purpose: use straight, mix with sodium chloride, sand or as a liquid
- Negatives: slow action at low temperatures, higher cost.

Agricultural Byproducts

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

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

Option 3. Talk to Your Municipality About Using an Alternative

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

D5. Options to Assess Your Lake's Fishery

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

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

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

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

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

2000 - 2007 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2007			ALKanoxic 2000-2007	
Average	**167.3**		Average	**200**	
Median	**162.0**		Median	**193**	
Minimum	**64.9**	**IMC**	Minimum	**103**	**Heron Pond**
Maximum	**330.0**	**Flint Lake**	Maximum	**470**	**Lake Marie**
STD	**42.0**		STD	**48**	
n =	**803**		n =	**253**	

	Condoxic <=3ft00-2007			Condanoxic 2000-2007	
Average	**0.8856**		Average	**1.0035**	
Median	**0.8038**		Median	**0.8340**	
Minimum	**0.2542**	**Broberg Marsh**	Minimum	**0.3210**	**Lake Kathyrn**
Maximum	**6.8920**	**IMC**	Maximum	**7.4080**	**IMC**
STD	**0.5243**		STD	**0.7787**	
n =	**802**		n =	**252**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2007			NH3-Nanoxic 2000-2007	
Average	**0.515**		Average	**2.070**	
Median	**0.150**		Median	**1.340**	
Minimum	**<0.05**	***ND**	Minimum	**<0.1**	***ND**
Maximum	**9.670**	**South Churchill Lake**	Maximum	**18.400**	**Taylor Lake**
STD	**1.082**		STD	**2.296**	
n =	**808**		n =	**252**	

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

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

	pHoxic <=3ft00-2007			pHanoxic 2000-2007	
Average	**8.31**		Average	**7.22**	
Median	**8.31**		Median	**7.21**	
Minimum	**7.07**	**Bittersweet #13**	Minimum	**6.24**	**Banana Pond**
Maximum	**10.28**	**Round Lake Marsh North**	Maximum	**8.48**	**Heron Pond**
STD	**0.44**		STD	**0.41**	
n =	**797**		n =	**252**	

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

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

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

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

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

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

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

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

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

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

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

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

No 2002 IEPA Chain Lakes

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

No 2002 IEPA Chain Lakes.

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

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

77 of 163 lakes had anoxic conditions
Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

Minimums and maximums are based on data from all lakes from 2000-2007 (n=1363).

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

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APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

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

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

Table F1. Continued

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

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