2005 SUMMARY REPORT
of
Butler Lake

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Butler Lake is a 55.19 acre natural glacial slough lake located in the Village of Libertyville. The lake is publicly owned and managed by the Village of Libertyville Parks and Recreation Department (LPRD). It is part of the Bull Creek drainage of the Des Plaines River Watershed. Two lakes, St. Mary's Lake and Loch Lomond, are located upstream. A third lake within Butler Lake's watershed is IMC Lake, which drains into St. Mary's Lake. Water enters Butler Lake from Bull Creek on the west end of the lake and leaves at the north end, eventually draining into the Des Plaines River.

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

Several studies have been conducted on Butler Lake in the past. The Illinois Department of Natural Resources conducted several fish surveys for Butler Lake. The Lake County Health Department – Lake Management Unit (LMU) completed a water quality study on Butler Lake in 1995, 2001, and 2005. Finally, the U.S. Army Corps of Engineers conducted an environmental assessment for a rehabilitation project that consists of restoration of a native prairie, buffer zones, riffle creation, bank stabilization, and dredging the lake.

Water clarity was best in May (5.95 feet) and poorest in June (3.61 feet), averaging 4.35 feet in 2005, which is down from the 2001 average of 6.65 feet. Dissolved oxygen concentrations of at least 5.0 mg/L were recorded in Butler Lake from the water's surface down to the lake bottom during May, June, and September during 2005. In July and August the lake's DO was <5.0 mg/L below 6 feet.

High conductivity readings and high chloride concentrations were found during the 2005 season. Conductivity readings were up from 2001. Road salt may be a reason for the high levels of these two parameters. Total phosphorus concentrations in Butler Lake in 2005 (average = 0.053 mg/L in the epilimnion) have increased slightly since last sampled in 2001 (average = 0.044 mg/L).

Fourteen aquatic plant species and one macro-algae were found in the lake. Coontail and White Water Lily were the dominant aquatic plant species. Two exotic aquatic plants, Eurasian Water Milfoil and Curlyleaf Pondweed, were found in Butler Lake.

LAKE FACTS

Lake Name:	Butler Lake
Historical Name:	None
Nearest Municipality:	Village of Libertyville
Location:	T44N, R11E, Section 16,17
Elevation:	692.00 feet
Major Tributaries:	Bull Creek
Watershed:	Des Plaines River
Sub-watershed:	Bull Creek
Receiving Waterbody:	Des Plaines River
Surface Area:	55.19 acres
Shoreline Length:	2.48 miles
Maximum Depth:	9.0 feet
Average Depth:	4.1 feet
Lake Volume:	230.38 acre-feet
Lake Type:	Impoundment
Watershed Area:	3919.36 acres
Major Watershed Land Uses:	Single Family, Public/Private Open Space, and Forest and Grassland
Bottom Ownership:	Village of Libertyville
Management Entities:	Village of Libertyville Parks and Recreation Department (LPRD)
Current and Historical Uses:	Fishing ($2.00 fee), non-motorized boating, and ice-skating
Description of Access:	Crawford Warming House, Butler Lake Park

SUMMARY OF WATER QUALITY

Water samples were collected monthly from May through September at the deepest point in the lake (Figure 1, See Appendix A for water sampling methods). Butler Lake was sampled at 3 feet and 5 or 6 feet (depending on water level). Butler Lake was also sampled in 1995 and 2001 by the Lake County Health Department – Lake Management Unit (LMU) and the results will be compared to the 2005 data (See Table 1 for the water quality data). Appendix C explains the various water quality parameters measured, how these parameters relate to each other, and why the measurement of each parameter is important.

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support a sunfish/bass fishery, since these fish can suffer oxygen stress below this level. Concentrations of at least 5.0 mg/L were recorded in Butler Lake from the water's surface down to the lake bottom during May, June, and September in 2005 (Appendix B). In July and August the lake's DO was <5.0 mg/L below 6 feet and only experienced anoxic conditions (< 1.0 mg/L) below 8 feet in July (1.2% of the lake volume). Butler Lake only weakly stratified near the 7-foot depth in July, but was well mixed throughout the rest of the season. This is the result of Butler Lake being a small, shallow lake. During the winter of 2000 Butler Lake had experienced a fish kill. Decomposition from the fish kill consumed oxygen likely causing the DO to be low during the 2001 study. The 2001 DO readings were <3 mg/L throughout the water column in June and < 4 mg/L in August. DO levels were <2 mg/L below four feet in July. In 1995 DO concentrations in the epilimnion were adequate throughout the season. As a result of the 2000 fishkill, an aeration system was installed in the fall of 2001 to help keep the lake oxygenated during the winter and is not needed to destratify the lake during the summer. The system consists of a 1 horsepower compressor and 3 diffusers (one in the main lake and two in the lagoon). Generally, the aerator is turned on in mid November and runs through March.

The Village of Libertyville and the US Army Corps of Engineers (USACOE) are currently funding a dredging project on Butler Lake. An area near the middle of the lake will be dredged to 8 feet deep, with hopes to allow fish to over winter and allow a predator/prey self-sustaining fish population. This past fall a sediment dewatering facility was installed with dredging expected to start in Spring 2006.

Secchi disk readings averaged 4.35 feet during 2005 and 6.65 feet during 2001. Both of these values are above the Lake County median of 3.17 feet (Appendix E). The decrease in Secchi depth from 2001 to 2005 correlates with an increase in total suspended solids (TSS). In 2005 the average TSS was 6.3 mg/L while in 2001 it averaged 2.1 mg/L. Both values are below the county median of 7.9 mg/L. TSS is composed of nonvolatile suspended solids, non-organic clay or sediment materials, and volatile suspended solids, algae and other organic matter. The increase in TSS from 2001 to 2005 may have been caused by the fact that the days sampled were windy causing the bottom to be stirred up due to the shallow nature of the lake. The lakes in the Bull Creek watershed were all sampled during 2005 and include Loch Lomond Lake, IMC Lake, St. Mary's Lake, and Butler Lake (Table 2). Loch Lomond Lake had the lowest average Secchi depth and highest average TSS, while Butler Lake had the highest average Secchi depth and lowest average TSS. This is unusual since lakes on the top of a watershed generally have better

Figure 1. Water quality sampling site on Butler Lake, 2005.

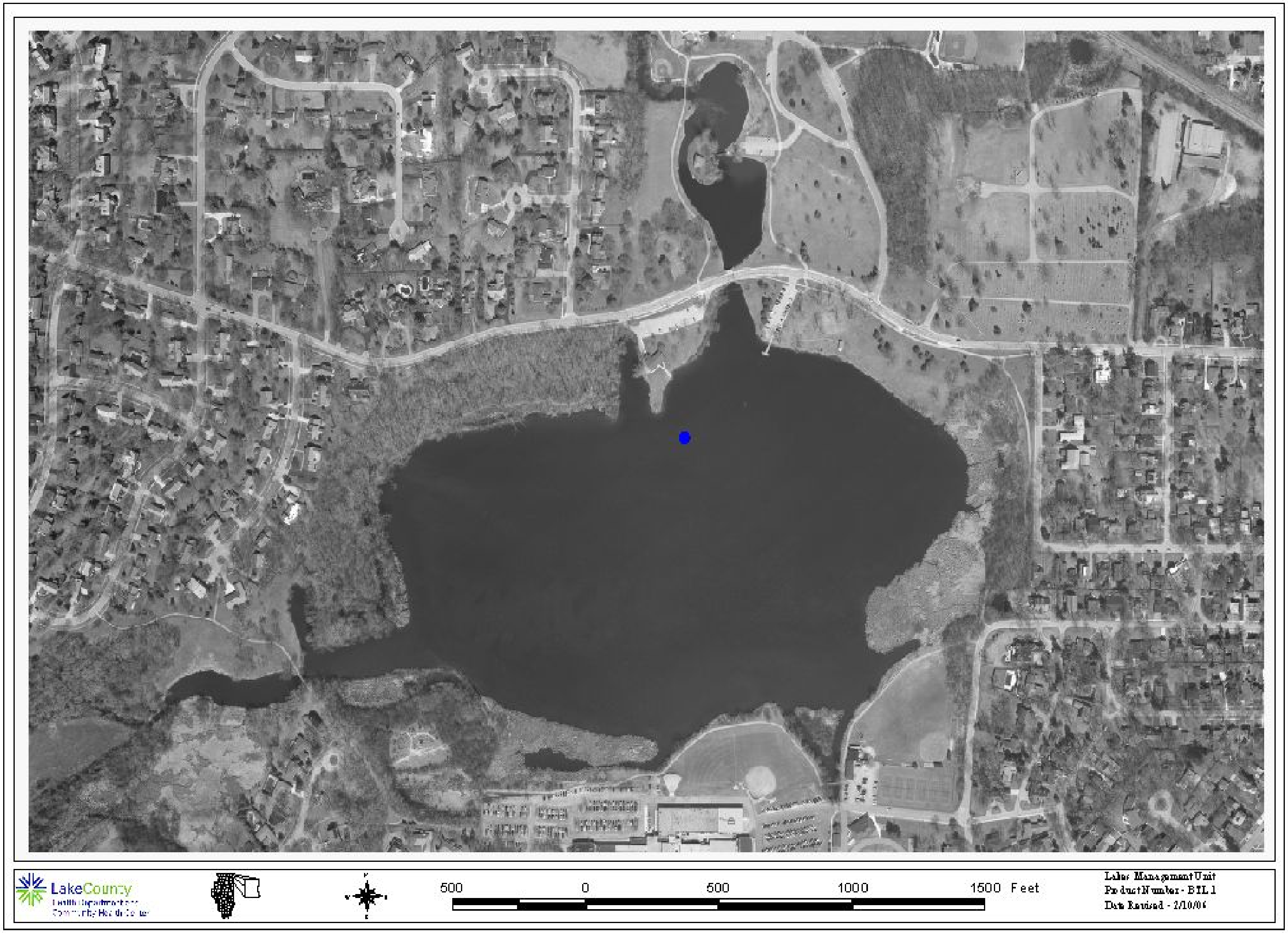

Table 1. Water quality data for Butler Lake, 2001 and 2005.

2005	**Epilimnion**														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	3	166	1.00	<0.1	<0.05	0.037	<0.005	232	NA	4.8	649	106	5.95	1.1580	8.08	9.61
14-Jun	3	121	1.38	<0.1	<0.05	0.066	0.007	234	NA	10.8	646	132	3.61	1.1010	8.28	6.74
12-Jul	3	121	1.35	<0.1	<0.05	0.068	<0.005	248	NA	5.8	668	135	3.74	1.1300	8.29	6.10
9-Aug	3	145	1.30	<0.1	<0.05	0.052	<0.005	250	NA	5.1	693	154	3.71	1.1710	7.89	7.40
13-Sep	3	161	1.32	<0.1	<0.05	0.041	<0.005	254	NA	5.1	717	150	4.76	1.2410	7.78	5.78
	Average	143	1.27	<0.1	<0.05	0.053	0.007[k]	244	NA	6.3	675	135	4.35	1.1602	8.06	7.13

2001	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
30-Apr	3	163	<0.5	<0.1	<0.05	0.029	<0.005	NA	566	2.1	637	155	9.02[a]	0.9922	8.10	9.44
4-Jun	3	173	1.320	0.496	0.084	0.051	0.015	NA	636	1.9	655	159	7.60	1.0070	7.23	2.57
9-Jul	3	143	0.995	<0.1	<0.05	0.059	0.009	NA	618	2.5	669	170	5.38	1.0710	7.63	4.24
6-Aug	3	146	0.820	<0.1	<0.05	0.052	0.010	NA	634	2.0	755	220	6.43	1.1700	7.43	3.61
4-Sep	3	145	0.989	<0.1	<0.05	0.029	<0.005	NA	612	2.0	651	121	7.19	1.1090	7.83	6.79
	Average	152	1.03[k]	0.496[k]	0.084[k]	0.048	0.011[k]	NA	625	2.1	683	168	6.65[b]	1.0893	7.53	4.30

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia 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

a = Secchi depth was obstructed by the bottom
b = Secchi disk depth average does not include data from May because Secchi disk was on the bottom and therefore the reading could have been deeper
k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable

Table 1. Continued.

2005	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	6	166	1.06	<0.1	<0.05	0.04	<0.005	232	NA	5.0	645	91	NA	1.1590	8.10	9.58
14-Jun	6	120	1.25	<0.1	<0.05	0.056	0.009	234	NA	11.4	661	148	NA	1.1010	8.28	6.68
12-Jul	5	120	1.32	<0.1	<0.05	0.073	<0.005	247	NA	6.9	678	140	NA	1.1290	8.29	6.05
9-Aug	6	145	1.59	<0.1	<0.05	0.082	<0.005	250	NA	7.5	716	168	NA	1.1700	7.81	5.72
	Average	138	1.31	<0.1	<0.05	0.063	0.009[k]	241	NA	7.7	675	137	NA	1.1398	8.12	7.01

2001	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
30-Apr	6	163	0.52	<0.1	<0.05	0.052	<0.005	NA	576	2.5	611	155	NA	0.9922	8.11	9.63
4-Jun	6	172	1.40	0.502	0.091	0.052	0.016	NA	638	2.7	648	140	NA	1.0080	7.24	2.68
9-Jul	6	148	0.92	<0.1	<0.05	0.074	0.025	NA	634	3.1	682	163	NA	1.0730	7.24	1.67
6-Aug	6	150	0.88	<0.1	<0.05	0.057	0.011	NA	666	2.2	748	224	NA	1.1630	7.20	1.31
4-Sep	6	145	0.98	<0.1	<0.05	0.030	<0.005	NA	600	1.8	636	107	NA	1.1150	7.28	2.43
	Average	156	0.94	0.502[k]	0.091[k]	0.053	0.017[k]	NA	623	2.5	665	158	NA	1.0702	7.42	3.54

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl 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

Table 2. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity readings in the Bull Creek watershed (Loch Lomond Lake, St. Mary's Lake, and Butler Lake).

	Loch Lomond Lake	Loch Lomond Lake	Loch Lomond Lake	IMC Lake	IMC Lake	St. Mary's Lake	St. Mary's Lake	St. Mary's Lake	Butler Lake	Butler Lake	Butler Lake
Year	**1999**	**2004**	**2005**	**2003**	**2005**	**1995**	**2002**	**2005**	**1995**	**2001**	**2005**
Secchi (feet)	1.89	3.27	2.17	4.96	3.08	2.26	2.68	2.79	5.83	6.65	4.35
TSS (mg/L)	19.2	13.2	13.1	4.4	9.7	12.2	11.8	10.8	3.1	2.1	6.3
TP (mg/L)	0.235	0.245	0.295	0.039	0.095	0.065	0.075	0.067	0.031	0.048	0.053
Conductivity (milliSiemens/cm)	0.7076	0.8232	1.3298	1.9958	6.1436	0.5958	1.0272	1.1774	0.5852	1.0893	1.1602

Direction of Watershed Flow →

water quality, but may be explained by the lack of aquatic plants and extensive algal growth in Loch Lomond Lake and St. Mary's Lake.

Another aspect of water quality is the nutrients within a water column, especially nitrogen (N) and phosphorus (P). These are the two nutrients that can limit plant and algae growth. Carbon and light are the other factors that control plant and algae growth, but these are not normally limiting. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate that phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate that there are enough of both nutrients to facilitate excess algae or plant growth. Butler Lake had a TN:TP ratio of 24:1 in 2005 and 23:1 in 2001. This indicates the lake was phosphorus limited, which means that any addition of phosphorus could result in increases in plant and algae biomass. Most lakes in Lake County are phosphorus limited. Butler Lake had a 2005 seasonal average total phosphorus (TP) concentration of 0.053 mg/L, which was below the county median of 0.063 mg/L. This was an increase from the 1995 and 2001 surveys when the average TP concentration was 0.031 mg/L and 0.048 mg/L, respectively. Phosphorus can be released from sediment through biological or mechanical processes, or from plant or algae as they die. This typically occurs in lakes like Butler Lake that do not stratify, therefore phosphorus attached to bottom sediment or released from dying algae/plants can be easily distributed throughout the water column.

Butler Lake also has external sources from the various land uses within its 3919 acre watershed (Figure 2), which includes Loch Lomond Lake, IMC Lake, and St. Mary's Lake. The four largest land uses within the watershed were single family (29%), public and private open space (17%), forest and grassland (13%), and transportation (8%)(Figure 3). Land uses within the watershed can contribute to external phosphorus loading (Table 3). For Butler Lake, the land uses contributing the highest percentages of estimated runoff are single family and transportation (i.e., road), which are 32% and 26%, respectively. The retention time for the lake was calculated to be approximately 29 days.

TP can be used for the trophic state index (TSIp), which classifies lakes according to the overall level of nutrient enrichment. The TSIp score falls within one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Hypereutrophic lakes are those that have excessive nutrients, with nuisance algae growth reminiscent of "pea soup" and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae. Mesotrophic and oligotrophic lakes are those with lower nutrient levels. These are very clear lakes, with little algae growth. Most lakes in Lake County are eutrophic. The trophic state of Butler Lake in terms of its phosphorus concentration during 2001 was eutrophic, with a TSIp score of 57.5. In 2005 it was still eutrophic with a TSIp score of 61.3. Butler Lake ranked 62nd out of 162 lakes in Lake County based on average TP concentrations (Table 4). Loch Lomond Lake ranked 157th, IMC Lake ranked 100th, and St. Mary's Lake ranked 78th.

The IEPA has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, or recreational uses. The guidelines consider several aspects, such as water clarity,

Figure 2. Approximate watershed delineation for Butler Lake, 2005.

Figure 3. Approximate land use within the Butler Lake watershed, 2005.

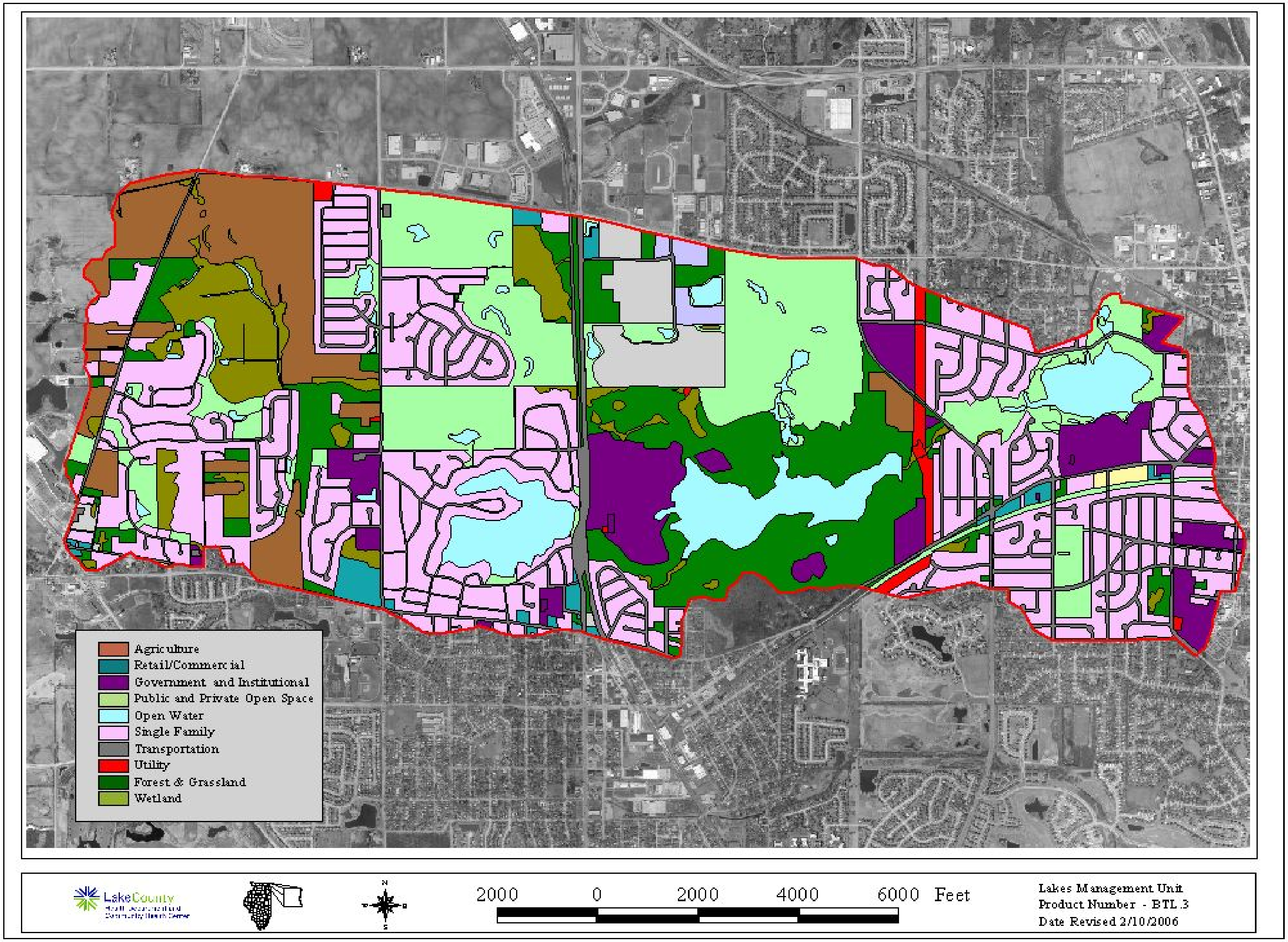

Table 3. Approximate land uses and retention time for Butler Lake, 2005.

Land Use	Acreage	% of Total
Agricultural	310.7	7.9
Forest and Grassland	500.0	12.8
Government and Institutional	259.7	6.6
Industrial	119.1	3.0
Multi Family	7.3	0.2
Office	21.9	0.6
Public and Private Open Space	656.6	16.8
Retail/Commercial	47.2	1.2
Single Family	1145.0	29.2
Transportation	326.6	8.3
Utility and Waste Facilities	36.2	0.9
Water	280.5	7.2
Wetlands	209.0	5.3
Total Acres	**3919.7**	**100.0**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agriculture	310.7	0.05	42.7	1.4%
Commercial	47.2	0.85	110.3	3.7%
Forest & Grassland	500.0	0.05	68.8	2.3%
Govt. & Institution	259.7	0.50	357.1	12.1%
Industrial	119.1	0.85	278.3	9.4%
Multi Family	7.3	0.50	10.1	0.3%
Public & Private Open Space	656.6	0.15	270.8	9.2%
Office	21.9	0.85	51.1	1.7%
Open water	280.5	0.00	0.0	0.0%
Single-Family	1145.0	0.30	944.6	32.0%
Transportation	326.6	0.85	763.3	25.8%
Utility & Waste	36.2	0.30	29.9	1.0%
Wetlands	209.0	0.05	28.7	1.0%
TOTAL	**3919.7**		**2955.7**	**100.0%**

Lake volume **230.38 acre-feet**

Retention Time (years)= lake volume/runoff **0.08 years**

28.45 days

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

Table 4. Lake County average TSI phosphorous (TSIp) ranking 2000-2005.

RANK	LAKE NAME	TP AVE	TSIp
1	Windward Lake	0.0158	43.9
2	Sterling Lake	0.0162	44.3
3	Lake Minear	0.0165	44.6
4	Pulaski Pond	0.0180	45.8
5	Fourth Lake	0.0182	46.0
6	West Loon Lake	0.0182	46.0
7	Cedar Lake	0.0183	46.1
8	Third Lake	0.0190	46.6
9	Lake Carina	0.0193	46.9
10	Independence Grove	0.0194	46.9
11	Lake Kathyrn	0.0200	47.3
12	Lake of the Hollow	0.0200	47.3
13	Banana Pond	0.0202	47.5
14	Cross Lake	0.0220	48.7
15	Dog Pond	0.0222	48.9
16	Sand Pond	0.0230	49.4
17	Stone Quarry Lake	0.0230	49.4
18	Bangs Lake	0.0233	49.6
19	Cranberry Lake	0.0236	49.7
20	Deep Lake	0.0240	50.0
21	Druce Lake	0.0244	50.2
22	Little Silver Lake	0.0246	50.3
23	Round Lake	0.0254	50.8
24	Lake Leo	0.0256	50.9
25	Timber Lake	0.0270	51.7
26	Dugdale Lake	0.0274	51.9
27	Peterson Pond	0.0274	51.9
28	Lake Miltmore	0.0276	52.0
29	Ames Pit	0.0278	52.1
30	East Loon Lake	0.0280	52.2
31	Lake Zurich	0.0282	52.3
32	Lake Fairfield	0.0296	53.0
33	Gray's Lake	0.0302	53.3
34	Highland Lake	0.0302	53.3
35	Hook Lake	0.0302	53.3
36	Lake Catherine (Site 1)	0.0308	53.6
37	Lambs Farm Lake	0.0312	53.8
38	Old School Lake	0.0312	53.8
39	Sand Lake	0.0316	53.9
40	Waterford Lake	0.0318	54.0
41	Potomac Lake	0.0318	54.0
42	Sullivan Lake	0.0320	54.1

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
43	Wooster Lake	0.0324	54.3
44	Gages Lake	0.0338	54.9
45	Hendrick Lake	0.0356	55.7
46	Diamond Lake	0.0372	56.3
47	Channel Lake (Site 1)	0.0380	56.6
48	Sun Lake	0.0410	57.7
49	Lake Linden	0.0420	58.0
50	Old Oak Lake	0.0428	58.3
51	Schreiber Lake	0.0434	58.5
52	Nielsen Pond	0.0448	59.0
53	Turner Lake	0.0458	59.3
54	Seven Acre Lake	0.0460	59.4
55	Willow Lake	0.0464	59.5
56	Lucky Lake	0.0476	59.9
57	Davis Lake	0.0476	59.9
58	East Meadow Lake	0.0478	59.9
59	College Trail Lake	0.0496	60.4
60	Countryside Lake	0.0512	60.9
61	Lake Lakeland Estates	0.0524	61.2
62	**Butler Lake**	**0.0528**	**61.3**
63	Lake Christa	0.0530	61.4
64	West Meadow Lake	0.0530	61.4
65	Deer Lake	0.0542	61.7
66	Heron Pond	0.0545	61.8
67	Little Bear Lake	0.0550	61.9
68	Lucy Lake	0.0552	62.0
69	Lake Charles	0.0580	62.7
70	White Lake	0.0588	62.9
71	Lake Naomi	0.0616	63.6
72	Lake Tranquility S1	0.0618	63.6
73	Werhane Lake	0.0630	63.9
74	Liberty Lake	0.0632	63.9
75	Countryside Glen Lake	0.0642	64.2
76	Leisure Lake	0.0648	64.3
77	Hastings Lake	0.0664	64.7
78	St. Mary's Lake	0.0666	64.7
79	Mary Lee Lake	0.0682	65.0
80	Honey Lake	0.0690	65.2
81	Redwing Slough, Site II, Outflow	0.0718	65.8
82	North Tower Lake	0.0718	65.8
83	Lake Fairview	0.0724	65.9
84	Spring Lake	0.0726	65.9
85	ADID 203	0.0730	66.0
86	Bluff Lake	0.0734	66.1

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
87	Long Lake	0.0761	66.6
88	Harvey Lake	0.0766	66.7
89	Broberg Marsh	0.0782	67.0
90	Echo Lake	0.0792	67.2
91	Sylvan Lake	0.0794	67.2
92	Big Bear Lake	0.0806	67.4
93	Petite Lake	0.0834	67.9
94	Lake Marie (Site 1)	0.0850	68.2
95	North Churchill Lake	0.0872	68.6
96	Grandwood Park, Site II, Outflow	0.0876	68.6
97	South Churchill Lake	0.0896	69.0
98	Rivershire Pond 2	0.0900	69.0
99	McGreal Lake	0.0914	69.3
100	International Mine and Chemical Lake	0.0948	69.8
101	Eagle Lake (Site I)	0.0950	69.8
102	Dunns Lake	0.0952	69.8
103	Lake Barrington	0.0956	69.9
104	Lochanora Lake	0.0960	70.0
105	Owens Lake	0.0978	70.2
106	Woodland Lake	0.0986	70.4
107	Island Lake	0.0990	70.4
108	Duck Lake	0.0996	70.5
109	Tower Lake	0.1000	70.6
110	Crooked Lake	0.1014	70.8
111	Fish Lake	0.1022	70.9
112	Longview Meadow Lake	0.1024	70.9
113	Lake Forest Pond	0.1074	71.6
114	Bittersweet Golf Course #13	0.1096	71.9
115	Fox Lake (Site 1)	0.1098	71.9
116	Bresen Lake	0.1126	72.3
117	Round Lake Marsh North	0.1126	72.3
118	Timber Lake S	0.1128	72.3
119	Deer Lake Meadow Lake	0.1158	72.7
120	Taylor Lake	0.1184	73.0
121	Grand Avenue Marsh	0.1194	73.1
122	Columbus Park Lake	0.1226	73.5
123	Nippersink Lake (Site 1)	0.1240	73.7
124	Grass Lake (Site 1)	0.1288	74.2
125	Lake Holloway	0.1322	74.6
126	Lakewood Marsh	0.1330	74.7
127	Summerhill Estates Lake	0.1384	75.2
128	Redhead Lake	0.1412	75.5

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
129	Antioch Lake	0.1448	75.9
130	Forest Lake	0.1470	76.1
131	Valley Lake	0.1470	76.1
132	Slocum Lake	0.1496	76.4
133	Drummond Lake	0.1510	76.5
134	Pond-a-Rudy	0.1514	76.5
135	Lake Matthews	0.1516	76.6
136	Buffalo Creek Reservoir	0.1550	76.9
137	Pistakee Lake (Site 1)	0.1592	77.3
138	Salem Lake	0.1650	77.8
139	Half Day Pit	0.1690	78.1
140	McDonald Lake 1	0.1722	78.4
141	Lake Eleanor Site II, Outflow	0.1812	79.1
142	Lake Farmington	0.1848	79.4
143	ADID 127	0.1886	79.7
144	Lake Louise Inlet	0.1938	80.1
145	Grassy Lake	0.1952	80.2
146	Fischer Lake	0.1978	80.4
147	Dog Bone Lake	0.1990	80.5
148	Redwing Marsh	0.2072	81.1
149	Stockholm Lake	0.2082	81.1
150	Bishop Lake	0.2156	81.6
151	Hidden Lake	0.2236	82.2
152	Lake Napa Suwe (Outlet)	0.2304	82.6
153	Patski Pond (Outlet)	0.2512	83.8
154	Slough Lake	0.2634	84.5
155	McDonald Lake 2	0.2706	84.9
156	Oak Hills Lake	0.2792	85.4
157	Loch Lomond	0.2954	86.2
158	Fairfield Marsh	0.3264	87.6
159	ADID 182	0.3280	87.7
160	Flint Lake Outlet	0.4996	93.8
161	Rasmussen Lake	0.5025	93.8
162	Albert Lake, Site II, outflow	1.1894	106.3

phosphorus concentrations (for the trophic state index) and aquatic plant coverage. According to this index, Butler Lake provides *Full* support of aquatic life and *Partial* support of swimming and recreational activities (such as boating) as a result of moderate TP and aquatic macrophytes. The lake provides *Partial* overall use.

Conductivity is a measurement of water's ability to conduct electricity and is correlated with chloride (Cl^-) concentrations (Figure 4). Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watersheds often have higher conductivity readings and Cl^- concentrations because of the use of road salts. Stormwater runoff from impervious surfaces such as roads and parking lots can deliver high concentrations of this Cl^- to nearby lakes and ponds. Road salt was probably the reason for such high readings because chloride concentrations detect sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts, which make up most road salt. The median conductivity reading for near surface samples is 0.7748 milliSiemens/cm (mS/cm) for Lake County lakes. During 2005, the average conductivity reading for Butler Lake was 1.1602 mS/cm. This was up 7% from the 2001 average of 1.0893 mS/cm and was nearly twice the average conductivity reading from 1995 (0.5852 milliSiemens/cm). The 2005 readings remained relatively consistent throughout the season. Typically lakes that receive road salts have higher readings early in the year as spring rains flush salts from the watershed and then the readings tend to drop off as the summer goes on. The readings most likely did not drop off due to the lack of precipitation during the summer causing a lower lake volume and concentrating the Cl^-. The Cl^- concentration in Butler Lake was higher than the Lake County median of 183 mg/L during 2005, with a seasonal average of 244 mg/L. Loch Lomond Lake, IMC Lake, and St. Mary's Lake also had high Cl^- concentrations of 287 mg/L, 1852 mg/L, and 244 mg/L, respectfully. The Illinois Environmental Protection Agency (IEPA) standard for chloride is 500 mg/L. Once values exceed this standard, the waterbody is deemed to be impaired, thus impacting aquatic life. Approximately 71% of IMC Lake's watershed consists of impervious surfaces that can contribute road salt. A study done in Canada reported 10% of aquatic species are harmed by prolonged exposure to Cl^- concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with Cl^- concentrations as low as 12 mg/l. Therefore, it is likely these lakes are being negatively impacted by the high Cl^- concentrations.

SUMMARY OF AQUATIC MACROPHYTES

To maintain a healthy sunfish/bass fishery, the optimal plant coverage is 30% to 40% across the lake bottom. An aquatic plant (macrophyte) survey was conducted in July of 2005 and found approximately 95% of the lake bottom had aquatic plant coverage. Sampling sites were based on a grid system created by mapping software (ArcGIS), with each site located 60 meters apart. On Butler Lake, there were 54 sites sampled (Figure 5). Plants were found at 51 of the 54 sites sampled and at a maximum depth of 6.5 feet (Table 5a,b). Overall, there was a total of 14 plant species and one macro-algae found (Table 6), with the most common species being Coontail at 74 % of the sampling sites (Table 5a). White Water Lily was the second most common species at 52 % of the sampling sites. Similarly, Coontail and White Water Lily were the two most abundant aquatic plants found in 2001. Diversity was slightly higher in 2001 with Slender Naiad

Figure 4. Chloride (Cl^-) concentration vs. conductivity for Butler Lake, 2005.

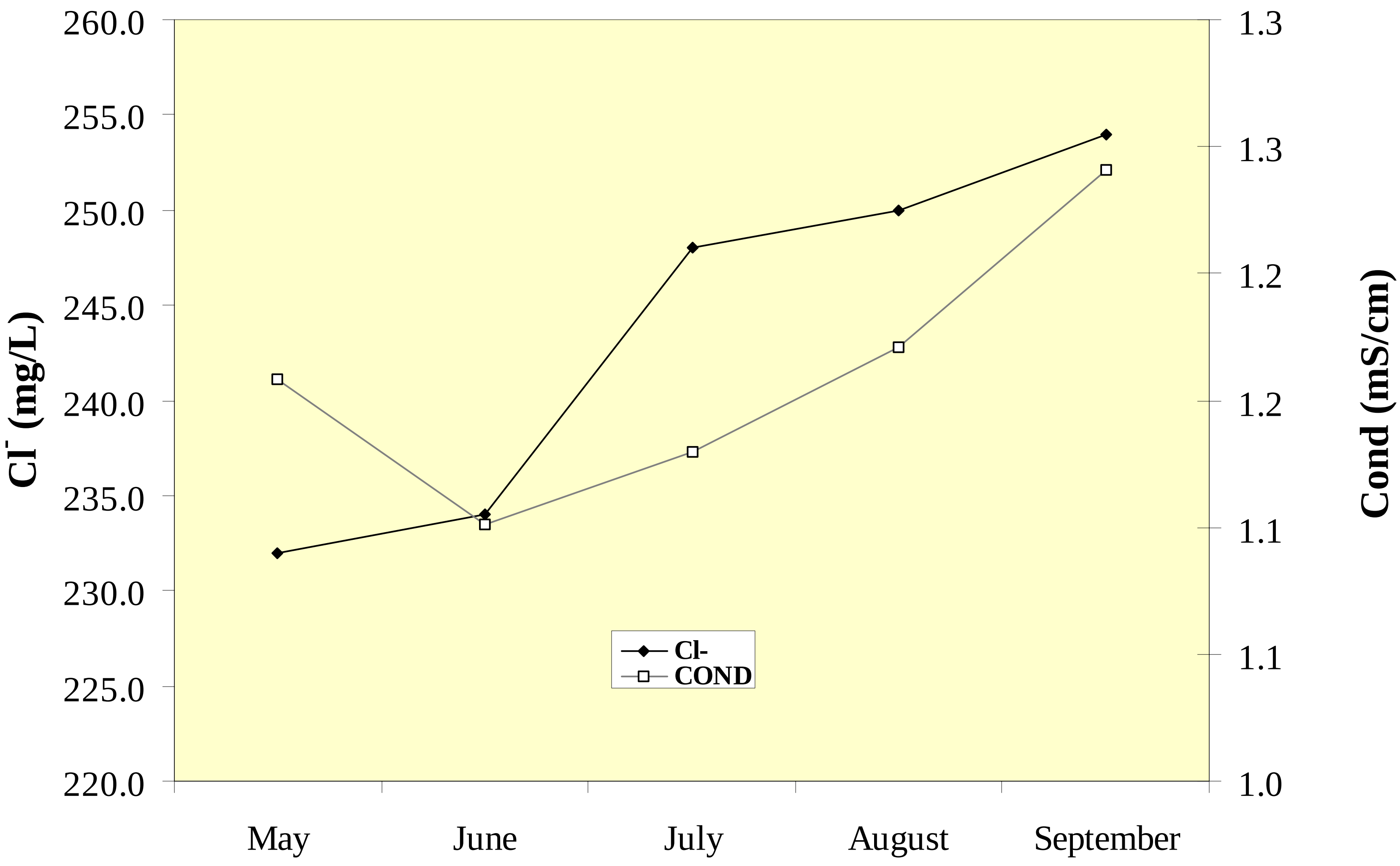

Figure 5. Aquatic plant sampling grid that illustrates plant density on Butler Lake, July 2005.

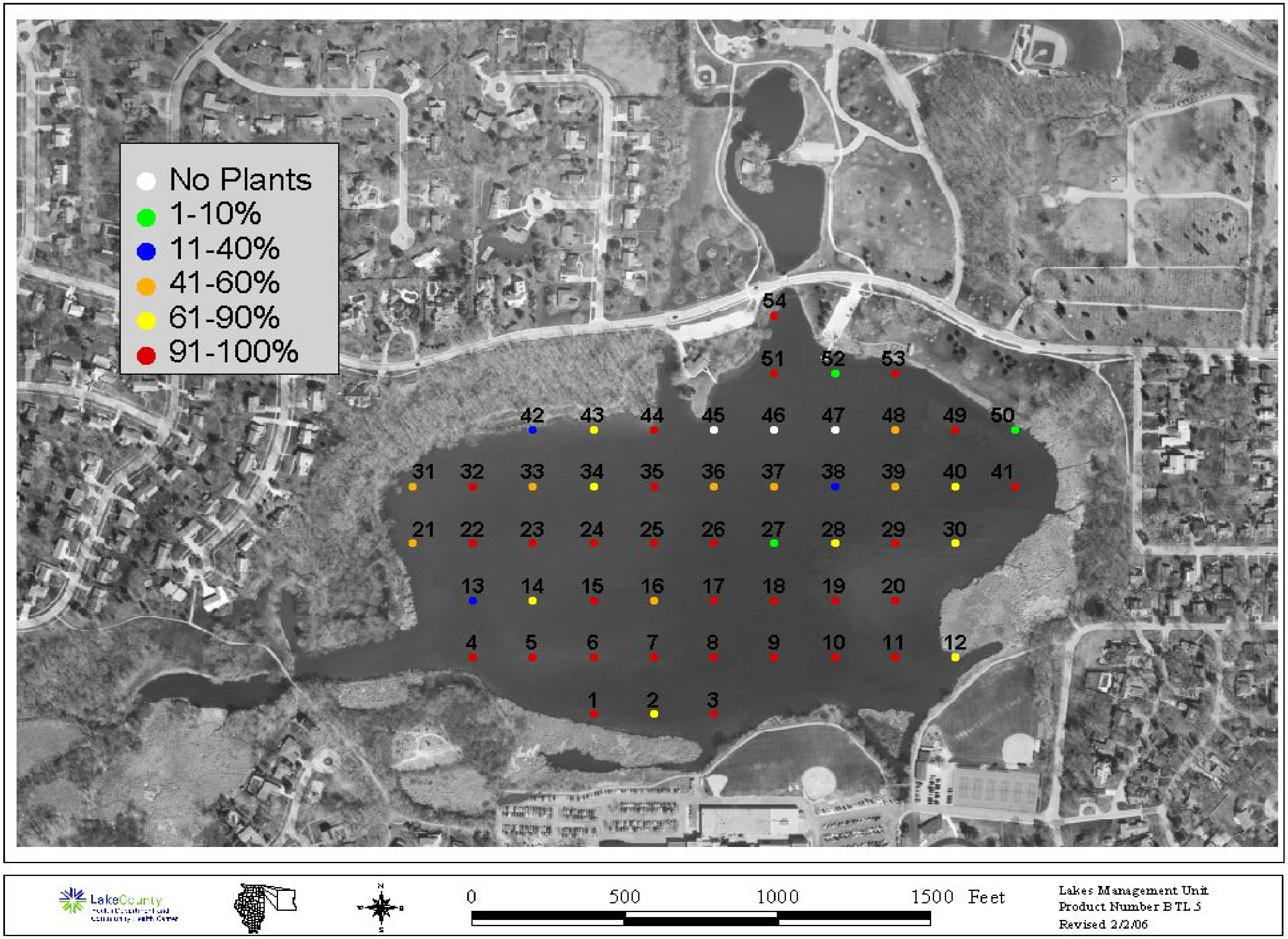

Table 5a. Aquatic plant species found at the 54 sampling sites on Butler Lake, July 2005. Maximum depth that plants were found was 6.5 feet.

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Giant Duckweed	Leafy Pondweed	Sago Pondweed	Small Pondweed	Star Duckweed	Watermeal	Water Stargrass	White Water Lily
Present	2	7	7	16	12	7	1	2	0	0	5	3	9	6	7
Common	1	8	0	1	2	1	0	0	1	2	1	0	0	1	6
Abundant	5	13	0	0	5	0	0	0	0	1	1	0	0	0	12
Dominant	2	12	0	0	2	0	0	0	0	0	0	0	0	1	3
% Plant Occurrence	18.5	74.1	13.0	31.5	38.9	14.8	1.9	3.7	1.9	5.6	13.0	5.6	16.7	14.8	51.9

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

Rake Density (Coverage)	# of Sites	%
No plants	3	5.6
>0 to 10%	3	5.6
>10 to 40%	3	5.6
>40 to 60%	8	14.8
>60 to 90%	8	14.8
>90%	29	53.7
Total Sites with Plants	51	94.4
Total # of Sites	54	100.0

Table 6. Aquatic plant species found in Butler Lake in 2005.

Chara (Macro algae)	*Chara* spp.
Coontail	*Ceratophyllum demersum*
American Elodea	*Elodea canadensis*
Water Stargrass	*Heteranthera dubia*
Small Duckweed	*Lemna minor*
Star Duckweed	*Lemna trisulca*
Eurasian Water Milfoil^	*Myriophyllum spicatum*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed^	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
Sago Pondweed	*Potamogeton pectinatus*
Small Pondweed	*Potamogeton pusillus*
Flatstem Pondweed	*Potamogeton zosteriformis*
Giant Duckweed	*Spirodella polyrhiza*
Bladderwort	*Utricularia vulgaris*
Watermeal	*Wolffia columbiana*

^ Exotic plant

(*Najas flexilis*), Vallisneria (*Vallisneria Americana*), and Horned Pondweed (*Zannichellia palustris*) also found.

Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. During 2005, the depth of the 1% light level was at the bottom for the entire season. Based on this data, vegetative coverage of the lake bottom could theoretically be 100% during the entire season. Thus, an active aquatic plant management plan may be needed on Butler Lake.

Two exotic aquatic plants, Eurasian Water Milfoil (EWM) and Curlyleaf Pondweed, were found in Butler Lake. Neither was present in significant numbers (15% and 13% of the sites sampled, respectively). Both of these exotics compete with native plants, eventually crowding them out, providing little or poor natural diversity in addition to limited uses by wildlife. Removal or control of exotic species is recommended.

Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. 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 (Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes.

The average FQI for 2000-2005 Lake County lakes was 14.0 (Table 7). Butler Lake had a FQI of 21.4 in 2005. This is a decrease since the 2001 survey was conducted, when the FQI was 25.0. However, the change in the aquatic plant sampling procedure from 2001 to 2005 could be a potential reason for this decrease. Also, plant community composition may experience natural variation from year to year.

SUMMARY OF SHORELINE CONDITION

In 2001 an assessment was conducted to determine the condition of the shoreline at the water/land interface. Approximately 65% of the shoreline was classified as undeveloped, although human impacts have disturbed much of the entire lake shoreline. The developed areas were mostly the park grounds along the northern and northeastern shorelines. Wetland habitat comprised approximately 39% of the shoreline, followed by buffer (22%) and woodland (20%). The remaining habitats included seawall (8%), rip-rap (6%), shrub (3%), and lawn (2%).

Several areas around Butler Lake were classified as moderately or severely eroded. The moderately eroded areas (approximately 5% of the shoreline) included a section located along the southwestern shoreline and an area along the northeastern shoreline where the park is located. The shoreline along the northeastern section consisted of either rip-rap or buffer. The rip-rap was broken concrete chunks that are ineffective at absorbing wave energy, due in part to the flat surfaces of the concrete. The buffer located in this area was poorly maintained and consisted of unmowed turfgrass, which is a poor shoreline stabilizer due to a shallow root system. Only one section was classified as severely eroded. This section was located along the western side of the small bay near the warming house on the northern shoreline. Two sections of the shoreline have been rehabilitated with bioengineering techniques (biologs). Both sections appeared to be doing well.

The shoreline was not reassessed in 2005 due to the proposed rehabilitation project. The first phase of the project includes the previously described dredging. The second phase (depending of funding availability) will consist of restoration of habitat that includes a native prairie, buffer zones, riffle creation, and bank stabilization.

SUMMARY OF WILDLIFE AND HABITAT

Although the lake is in a residential setting, there was diverse wildlife habitat. A good mix of wildlife, primarily birds, existed around the lake (Table 8). Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians.

During the winter of 2000-2001, Butler Lake experienced a fish kill. The USACOE conducted a near shore fish survey in August of 2001 and found mainly tolerant species including Common Carp. On May 29, 2003 the Illinois Department of Natural Resources (IDNR) conducted a fish population survey. The survey consisted of electrofishing, trapnetting, and gillnetting, yielding

Table 7. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	35.6	37.8
2	Deep Lake	33.9	35.4
3	Round Lake Marsh North	29.1	29.9
4	East Loon Lake	28.4	29.9
5	Cranberry Lake	28.3	28.3
6	Sullivan Lake	28.2	29.7
7	Deer Lake	27.9	30.2
8	Little Silver Lake	27.9	30.0
9	Schreiber Lake	26.8	27.6
10	Redwing Slough	26.0	26.9
11	West Loon Lake	26.0	27.6
12	Timber Lake (North)	25.5	27.1
13	Cross Lake	25.2	27.8
14	Wooster Lake	25.2	26.9
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	Sterling Lake	21.8	24.1
24	**Butler Lake**	**21.4**	**23.1**
25	Bangs Lake	21.2	23.7
26	ADID 203	20.5	20.5
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	McGreal Lake	20.2	22.1
30	Lake Kathryn	19.6	20.7
31	Third Lake	19.6	21.7
32	Owens Lake	19.3	20.2
33	Redhead Lake	19.3	21.2
34	Lake Minear	18.8	20.6
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Fish Lake	18.1	20.0
39	McDonald Lake 1	17.7	18.7
40	Potomac Lake	17.3	18.5
41	Hendrick Lake	17.2	19.0
42	Duck Lake	17.1	19.1
43	Summerhill Estates Lake	17.1	18.0

Table 7. Continued.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
44	Ames Pit	17.0	18.0
45	Seven Acre Lake	17.0	15.5
46	Grand Avenue Marsh	16.9	18.7
47	Gray's Lake	16.9	19.8
48	White Lake	16.9	18.7
49	Bresen Lake	16.6	17.8
50	Waterford Lake	16.6	17.8
51	Diamond Lake	16.3	17.4
52	Lake Barrington	16.3	17.4
53	Lake Napa Suwe	16.3	17.4
54	Windward Lake	16.3	17.6
55	Fischer Lake	16.0	18.1
56	Dog Bone Lake	15.7	15.7
57	Independence Grove	15.5	16.7
58	Long Lake	15.5	17.3
59	Tower Lake	15.2	17.6
60	Heron Pond	15.1	15.1
61	Lake Linden	15.1	16.5
62	Lake Tranquility (S1)	15.0	17.0
63	North Churchill Lake	15.0	15.0
64	Dog Training Pond	14.7	15.9
65	Island Lake	14.7	16.6
66	Highland Lake	14.5	16.7
67	Lake Fairview	14.3	16.3
68	Taylor Lake	14.3	16.3
69	Dugdale Lake	14.0	15.1
70	Eagle Lake (S1)	14.0	15.1
71	Longview Meadow Lake	13.9	13.9
72	Bishop Lake	13.4	15.0
73	Hook Lake	13.4	15.5
74	Timber Lake (South)	13.4	15.5
75	Buffalo Creek Reservoir	13.1	14.3
76	Mary Lee Lake	13.1	15.1
77	Old School Lake	13.1	15.1
78	Dunn's Lake	12.7	13.9
79	Old Oak Lake	12.7	14.7
80	Echo Lake	12.5	14.8
81	Sand Lake	12.5	14.8
82	Stone Quarry Lake	12.5	12.5
83	Honey Lake	12.1	14.3
84	Lake Leo	12.1	14.3
85	Lambs Farm Lake	12.1	14.3
86	Pond-A-Rudy	12.1	12.1

Table 7. Continued.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
87	Stockholm Lake	12.1	13.5
88	Lake Matthews	12.0	12.0
89	McDonald Lake 2	12.0	12.0
90	Flint Lake	11.8	13.0
91	Harvey Lake	11.8	13.0
92	Rivershire Pond 2	11.5	13.3
93	Antioch Lake	11.3	13.4
94	Lake Charles	11.3	13.4
95	Lake Naomi	11.2	12.5
96	Pulaski Pond	11.2	12.5
97	Lake Christa	11.0	12.7
98	Redwing Marsh	11.0	11.0
99	West Meadow Lake	11.0	11.0
100	Nielsen Pond	10.7	12.0
101	Lake Holloway	10.6	10.6
102	Lake Carina	10.2	12.5
103	College Trail Lake	10.0	10.0
104	Lake Lakeland Estates	10.0	11.5
105	Crooked Lake	9.8	12.0
106	Hastings Lake	9.8	12.0
107	Werhane Lake	9.8	12.0
108	Big Bear Lake	9.5	11.0
109	Little Bear Lake	9.5	11.0
110	Loch Lomond	9.4	12.1
111	Sand Pond (IDNR)	9.4	12.1
112	Columbus Park Lake	9.2	9.2
113	Sylvan Lake	9.2	9.2
114	Grandwood Park Lake	9.0	11.0
115	Lake Fairfield	9.0	10.4
116	East Meadow Lake	8.5	8.5
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	Lucky Lake	7.0	7.0

Table 7. Continued.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
130	Lake Forest Pond	6.9	8.5
131	Leisure Lake	6.4	9.0
132	Peterson Pond	6.0	8.5
133	Countryside Lake	5.8	7.1
134	Gages Lake	5.8	10.0
135	Grassy Lake	5.8	7.1
136	Slocum Lake	5.8	7.1
137	Deer Lake Meadow Lake	5.2	6.4
138	ADID 127	5.0	5.0
139	Drummond Lake	5.0	7.1
140	IMC	5.0	7.1
141	Liberty Lake	5.0	5.0
142	Oak Hills Lake	5.0	5.0
143	Slough Lake	5.0	5.0
144	North Tower Lake	4.9	7.0
145	Forest Lake	3.5	5.0
146	Half Day Pit	2.9	5.0
147	Lochanora Lake	2.5	5.0
148	Hidden Lake	0.0	0.0
149	St. Mary's Lake	0.0	0.0
150	Valley Lake	0.0	0.0
151	Willow Lake	0.0	0.0
	Mean	**14.0**	**15.4**
	Median	**13.1**	**14.8**

Table 8. Wildlife species observed on Butler Lake, May – September 2005.

Birds	
Mallard	*Anas platyrhnchos*
Canada Goose	*Branta canadensis*
Ring-billed Gull	*Larus delawarensis*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Spotted Sandpiper	*Actitis macularia*
Purple Martin	*Progne subis*
Barn Swallow	*Hirundo rustica*
Chimney Swift	*Chaetura pelagica*
American Crow	*Corvus brachyrhynchos*
Cedar Waxwing	*Bombycilla cedrorum*
Yellow Warbler	*Dendroica petechia*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
House Sparrow	*Passer domesticus*
Amphibians	
American Toad	*Bufo americanus*
Fish	
Bullhead	*Ameiurus sp.*
Northern Pike	*Esox lucius*
Mussels	
Giant Floater	*Pyganodon grandis*

195 fish consisting of 16 species. Black Bullhead dominated the catch and Common Carp made up approximately 7% of the catch. According to the IDNR, it appears the Park District had stocked fish after the fish kill since three age classes of Largemouth Bass and two age classes of Northern Pike were collected. The IDNR recommends protecting the predatory fish through size and bag limits, which would allow the fish to grow to a reproductive size before harvest. For Largemouth Bass, a local ordinance establishing a 14 inch minimum size and a daily bag limit of 3 should be established. Northern Pike currently have a statewide regulation of 24 inch minimum size and daily bag limit of 3. Posting signs at the access points can bring awareness to these regulations. The IDNR was also worried about Bluegills becoming stunted and suggest harvesting fish in the 5 to 7 inch range and allowing the larger ones to remain to prevent this from occurring. A follow up fish population survey is planned for 2008.

One wildlife problem that was identified was the large numbers of resident Canada geese that were seen throughout the season. Resident geese contribute large amounts of feces to the surrounding landscape that eventually washes into the lake, which can exacerbate the nutrient problems in the lake, leading to excessive algae blooms. Controlling resident geese can be difficult and in some cases permits are required by the Illinois Department of Natural Resources. Maintaining the buffer strips around the lake and replacing some of the turfgrass in the watershed will help discourage geese from using these areas. In addition, allowing the lake to completely freeze in the winter will encourage geese to move away from the lake. Posting signage around the lake tell people not to feed the waterfowl will also discourage the geese from congregating.

LAKE MANAGEMENT RECOMMENDATIONS

Butler Lake has both positive and negative aspects. Some of the positives include the presence of buffer strips, an active management by the Libertyville Park and Recreation Department (LPRD), a current bathymetric map, a healthy aquatic plant community, and the aerator to help during periods of low DO. Buffer strips help to protect the shoreline from erosion, provide habitat for wildlife, and help to filter water entering the lake. LPRD is currently working with the USACOE on a rehabilitation project that consists of restoration of a native prairie, buffer zones, riffle creation, bank stabilization, and dredging of the lake. To improve the quality of Butler Lake, the LCHD-LMU has the following recommendations.

Creating a bathymetric map

As part of the rehabilitation project, a bathymetric map was created before the project and a new one will be created once the dredging is complete. Bathymetric maps help with management decisions (Appendix D1).

Aquatic plant management

Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake (Appendix D2). Eurasian Watermilfoil and Curlyleaf Pondweed, two exotic aquatic plant species, were found in Butler Lake during the 2005 sampling season. The aquatic plant management plan should include controls to limit their expansion. Currently there is no aquatic plant management plan and this should be reassessed after the dredging project.

Use of the aeration system

Butler Lake had good DO concentrations during the summer, however the winter concentration is unknown. The aerators may only be required during the winter, but should be turned on one month after the lake freezes over. The aerators can be turned on earlier than one month after ice over if there is heavy snow coverage. Allowing the lake to freeze over will force the geese to move off the lake.

Eliminate or control exotic species

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. The outcome is a loss of plant and animal diversity. Plants such as Purple Loosestrife (*Lythrum salicaria*), Buckthorn (*Rhamnus cathartica*), and Reed Canary Grass (*Phalaris arundinacea*) are three examples. During

2001 these exotic species were found along the shoreline and should be eliminated (Appendix D3).

- **Large scale sediment and nutrient controls, reducing bacteria inputs to a lake, watershed nutrients reduction, and watershed sediment reduction**

Nutrient and solid concentrations in Butler Lake have increased since the 2001 survey. Lakes naturally become nutrient enriched and shallow over long periods of time. Without human interference, this process can take hundreds, even thousands of years. However, this process may take only decades if people are negatively impacting a lake's watershed. A watershed is the surrounding land that directs runoff to a lake. Most nutrient and sediment management options focus on the watershed (Appendix D4-7).

- **Participate in the Volunteer Lake Monitoring Program (VLMP)**

To track future water quality trends, it is recommended the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure Secchi disk readings on a bimonthly basis from April to October (Appendix D8). In addition to the VMLP, a staff gauge should be installed to monitor the lake level each month.

- **Lakes with shoreline erosion**

There are some areas around the lake that have erosion. These eroded areas should be repaired to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls (Appendix D9).

- **Enhance wildlife habitat conditions on a lake**

Although the lake is in a residential setting, there is a good mix of wildlife habitat. A good mix of wildlife, primarily birds, existed around the lake. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians (Appendix D10).

- **Lakes with high Canada Geese populations**

Butler Lake has a resident goose population. The presence of geese can contribute to the nutrients in the lake. Methods should be taken to control and discourage the geese congregating around the lake. A possible reason for the geese residing could be people feeding them. It is recommended that signs "No Feeding Waterfowl" be installed (Appendix D11).

- **Grant program opportunities**
  There are opportunities to receive grants to help accomplish some of the management recommendations listed above. Appendix F is a list of grant program opportunities.

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 (ArcGIS 3.2) overlaid a grid pattern onto a 2004 aerial photo of Lake County and placed points 60 meters apart. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation.

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

Parameter	***Method***
Temperature	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Dissolved oxygen	Hydrolab DataSonde ®4a or YSI 6600 Sonde®
Nitrate nitrogen	Brucine method Standard Methods (SM) 14^{th} ed 419D Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18^{th} ed. Electrode method, #4500 NH_3-F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18^{th} ed, 4500-N_{org} C Semi-Micro Kjeldahl, plus 4500 NH_3-F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18^{th} ed, Method #2540B
Total suspended solids	SM 18^{th} ed, Method #2540D Detection Limit = 0.5 mg/L
Total dissolved solids	SM 18^{th} ed, Method #2540C
Total volatile solids	SM 18^{th} ed, Method #2540E, from total solids
Alkalinity	SM 18^{th} ed, Method #2320B, patentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18^{th} ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18^{th} ed, Methods #4500-P B 1 and #4500-P E Detection Limit = 0.005 mg/L
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a or YSI 6600 Sonde®, LI-COR® 192 Spherical Sensor

APPENDIX B. MULTI-PARAMETER DATA FOR BUTLER LAKE IN 2005.

Butler Lake 2005 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	0.58
5/10/2005	11:33:57	0.25	0.495	18.78	9.65	103.9	1.1580	8.12	3305.8	Surface		
5/10/2005	11:35:20	1	1.005	18.83	9.64	103.9	1.1570	8.08	1851.7	Surface	100%	
5/10/2005	11:36:22	2	2.012	18.85	9.64	103.9	1.1580	8.08	1056.8	0.262	57%	2.14
5/10/2005	11:37:51	3	3.030	18.82	9.61	103.6	1.1580	8.08	916.4	1.280	49%	0.14
5/10/2005	11:38:39	4	4.003	18.77	9.59	103.3	1.1580	8.08	600.3	2.253	32%	0.43
5/10/2005	11:39:53	5	4.963	18.77	9.57	103.1	1.1580	8.09	372.1	3.213	20%	0.50
5/10/2005	11:40:34	6	5.998	18.74	9.58	103.1	1.1590	8.10	284.9	4.248	15%	0.26
5/10/2005	11:41:29	7	6.964	18.80	9.55	102.9	1.1580	8.10	225.5	5.214	12%	0.24
5/10/2005	11:42:14	8	8.009	18.65	9.58	102.9	1.1590	8.10	160.4	6.259	9%	0.33

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	1.51
6/14/2005		0.25	0.532	26.55	6.67	83.3	1.1010	8.16	4155.3	Surface		
6/14/2005		1	0.910	26.57	6.74	84.1	1.1010	8.23	2208.2	Surface	100%	
6/14/2005		2	2.001	26.56	6.73	84.1	1.1010	8.27	218.1	0.251	10%	9.22
6/14/2005		3	2.961	26.55	6.74	84.2	1.1010	8.28	87.9	1.211	4%	0.95
6/14/2005		4	4.022	26.56	6.75	84.3	1.1010	8.29	58.4	2.272	3%	0.39
6/14/2005		5	5.031	26.55	6.70	83.6	1.1010	8.29	36.3	3.281	2%	0.47
6/14/2005		6	5.959	26.53	6.68	83.4	1.1010	8.28	35.2	4.209	2%	0.03
6/14/2005		7	6.941	26.54	6.70	83.7	1.1010	8.28	96.6	5.191	4%	-1.03
6/14/2005		8	8.070	26.52	6.66	83.1	1.1010	8.28	54.2	6.320	2%	0.51

Butler Lake 2005 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	1.24
7/12/2005		0.25	0.504	26.33	6.18	76.8	1.1280	8.27	2375.7	Surface		
7/12/2005		1	0.995	26.33	6.12	76.1	1.1290	8.30	1399.3	Surface	100%	
7/12/2005		2	2.034	26.34	6.11	76.0	1.1300	8.30	292.4	0.284	21%	5.51

7/12/2005		3	2.991	26.31	6.10	75.8	1.1290	8.30	143.3	1.241	10%	0.75
7/12/2005		4	3.993	26.30	6.09	75.7	1.1300	8.30	104.3	2.243	7%	0.32
7/12/2005		5	5.008	26.29	6.05	75.2	1.1300	8.29	71.9	3.258	5%	0.37
7/12/2005		6	5.996	26.24	5.78	71.8	1.1300	8.26	45.6	4.246	3%	0.46
7/12/2005		7	6.996	25.75	1.85	22.8	1.1360	7.74	29.8	5.246	2%	0.43
7/12/2005		8	8.017	25.16	0.47	5.7	1.1360	7.49	12.2	6.267	0.9%	0.87

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	1.69
8/9/2005		0.25	0.486	27.40	7.44	94.3	1.1710	7.89	2363.6	Surface		
8/9/2005		1	1.010	27.41	7.40	93.9	1.1710	7.83	2824.4	Surface	100%	
8/9/2005		2	1.999	27.36	7.38	93.5	1.1710	7.90	289.8	0.249	10%	9.14
8/9/2005		3	2.591	27.36	7.40	93.7	1.1710	7.89	388.1	0.841	14%	-0.49
8/9/2005		4	3.996	27.01	6.70	84.3	1.1690	7.84	251.1	2.246	9%	0.31
8/9/2005		5	4.997	26.89	6.65	83.6	1.1700	7.81	179.4	3.247	6%	0.34
8/9/2005		6	5.989	26.70	5.72	71.6	1.1720	7.74	125.3	4.239	4%	0.36
8/9/2005		7	7.009	26.52	4.22	52.6	1.1720	7.64	27.5	5.259	1.0%	1.49
8/9/2005		8	7.930	26.39	2.00	24.9	1.1720	7.47	15.0	6.18	0.5%	0.66

Butler Lake 2005 Multiparameter data

Date MMDDYY	Time HHMMSS	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.76
9/13/2005		0.25	0.497	24.74	5.90	71.3	1.2410	7.82	4167.1	Surface		
9/13/2005		1	1.001	24.74	5.82	70.3	1.2410	7.80	1246.3	Surface	100%	
9/13/2005		2	2.027	24.74	5.79	70.0	1.2410	7.78	472.8	0.277	38%	3.50
9/13/2005		3	3.009	24.72	5.78	69.8	1.2410	7.78	182.8	1.259	15%	0.97
9/13/2005		4	3.992	24.71	5.77	69.7	1.2410	7.77	165.9	2.242	13%	0.10
9/13/2005		5	4.972	24.69	5.76	69.5	1.2410	7.77	88.8	3.222	7%	0.64
9/13/2005		6	5.970	24.62	5.58	67.3	1.2410	7.76	80.8	4.220	6%	0.09
9/13/2005		7	6.965	24.51	5.55	66.8	1.2410	7.75	99.7	5.215	8%	-0.21
9/13/2005		8	7.962	24.46	5.51	66.2	1.2400	7.74	79.8	6.212	6%	0.22

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

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

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2005 will be used in the following discussion.

Temperature and Dissolved Oxygen:

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

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

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

Nutrients:

Phosphorus:

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

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

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

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

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

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

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

Solids:

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

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

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

Water Clarity:

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

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

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

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:

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

Conductivity and Chloride:

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

pH:

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

Eutrophication and Trophic State Index:

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

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

Table 1. Trophic State Index (TSI).

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

APPENDIX D. 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 Aquatic Plant Management

<u>Option 1: Aquatic Herbicides</u>

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.

D3. Options to Eliminate or Control Exotic Species

Option 1: Biological Control

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase. Control of exotics by a natural mechanism is preferable to chemical treatments, however there are few exotics that can be controlled by biological means. Insects, being part of the same ecological system as the exotic plant (i.e., the beetles and weevils with Purple Loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. Bio-control can also be expensive and labor intensive.

Option 2: Control by Hand

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

Option 3: Herbicide Treatment

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

Herbicides are commonly used to control nuisance shoreline vegetation by applying it to green foliage or cut stems. They provide a fast and effective way to control or eliminate nuisance vegetation by killing the root of the plant, preventing regrowth. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

D4. Options for Large Scale Sediment and Nutrient Controls

Below are controls that are helpful in sediment and/or nutrient controls within a watershed. These are expensive, and are usually municipal projects or those set in place by developers as part of their projects.

Option 1. Detention Basins

Detention basins are man made bodies of water with restricted discharge outlets that allow gradual release of stormwater runoff to a downstream drainage system. The primary method of runoff pollutant (sediment, nutrients) removal is settling. Detention basins have a removal efficiency of at least 60% for sediment, between 20% - 80% for total phosphorus, and between 20% - 60% for total nitrogen. When designed properly and maintained, these basins can enhance wildlife habitat and add to the aesthetics of the neighborhood, however water is often turbid and nutrient enriched.

Option 2. Catch Basins

Stormwater that flows down streets with curbs and gutters empty into stormwater drains. During construction, these drains are fitted with a catch basin to collect coarse sediment. Some existing stormwater drains can be retrofitted with catch basins. These catch basins have a short holding time, and need to be regularly cleaned out in order for them to function properly.

Option 3. Constructed Wetlands

Wetlands can act as traps for nutrients and sediment as stormwater flows toward a lake or pond. The removal efficiency of constructed wetlands depends on the design and is site specific. A naturally established wetland is easier to use for this purpose than constructing a new one, but a natural wetland cannot properly perform these functions under high flows or repeatedly for years. Construction of a wetland can be difficult and expensive and may take a few years for plants to establish, however once established it most likely will provide good wildlife habitat.

Option 4. Vegetated Swales

Vegetated swales are open, vegetated ditches that are frequently used as an alternative to curb and gutter, and are well suited for road drainage. The plants within the swales can slow the runoff flow, and allows runoff to infiltrate into the soil. The runoff flow velocity usually decreases in swales with flatter side slopes and wider bottom widths. Standing water may be an issue because it encourages the breeding of mosquitoes; some maintenance may be needed.

Option 5. Infiltration Devices

Infiltration devices such as basins, trenches and dry wells temporarily store runoff and then release the water over time into the surrounding soil. Infiltration basins are similar to detention basins except they have only an overflow outlet. They don't have an outlet that allows low, or continual flow. Runoff eventually drains through the bottom and sides of the basin filled with stones. Infiltration basins are suitable as an alternative or supplement to detention basins for larger lot residential developments or campus developments. They have high failure rate if the runoff carries high concentrations of sediment, which clogs the basin or trench and does not allow drainage.

Option 6. Settling Basins

Settling basins are devices that are primarily used for reducing sediment runoff velocity. This allows protection of downstream stormwater facilities and natural areas from sedimentation, debris clogging and scouring. They do not significantly control runoff velocity from large flood events, however. They are designed in a manner that provides an access for sediment removal and initial costs are expensive. Settling basins are rarely used alone; they are intended for use as part of an overall system that uses one or more different methods of runoff management. For example, a settling basin is frequently placed upstream for a detention basin or infiltration device. The settling basin can extend the life of a detention basin or infiltration device by trapping some sediment before the runoff reaches its destination. This can reduce the cost of future sediment removal or repairs to a clogged infiltration device. They should always be used as pretreatment for infiltration basins or trenches and for existing wetlands that will be receiving stormwater runoff from a development, especially if no other means to manage runoff will be used. These devices should be considered at the inlets to most detention basins. Settling basins can be appropriate where full-scale detention basins are impractical due to the small size of the site. This is because of the difficulty in designing reliable outlet structures for small release rates.

D5. Options for Reducing Bacteria Inputs to a Lake

Option 1. Septic Care and Maintenance

A lack of septic tank maintenance can result in septic failure. A failing septic system can deliver a high number of bacteria or other pathogens to a lake. In addition, nutrients are added to the water, which increases the risk of a nuisance algal bloom.

a. The tank should be inspected yearly to check the level of solids, especially if the homeowner is unfamiliar with the age of the septic system or its size. Depending on usage, one septic tank can fill with solids faster than another. If a homeowner is not sure how quickly solids will fill their septic tank, checking the level yearly can give the homeowner a better idea when their tank needs pumping. For the average use of a

1,200 – 1,500 gallon septic tank, the Health Department recommends pumping the tank every three to five years.

b. Avoid washing several loads of laundry in one day, and only wash with full loads. Similarly, only run a dishwasher when full. If heavy rains have caused the ground to become over-saturated, avoid using these appliances. Take the laundry to a laundromat and/or wash dishes by hand. When washing dishes by either method, scrape as much leftover food off as possible to lessen the amount of food particles that reach the septic tank.

c. Conserve water by installing flow saving devices in sinks, toilets and washing machines.

d. Avoid installing or using a garbage disposal. If one is used, pump your septic tank annually. In this case, the tank should be 1.5 times larger than normal, and have two compartments.

Option 2: Pet Waste

Pick up pet waste and dispose of it properly to help prevent bacteria and nutrients from entering the lake via runoff. To encourage people to pick up pet waste in public areas, the managing entity could provide waste disposal bags (such as "Mutt Mitts") onsite, and post signs about cleaning up after pets.

Option 3. Discourage Waterfowl from Congregating

Waterfowl droppings (feces) can be a source of bacteria (and phosphorus) to the water, especially if they are congregating in large numbers along beaches and/or other nearshore areas. These birds prefer habitat with short plants or no plants, such as lawns mowed to the water's edge and beaches. Waterfowl avoid areas with tall, dense vegetation through which they are unable to see predators. Tactics to discourage waterfowl from congregating in large groups include scare devices, a buffer strip of tall plants along the shoreline, and discouraging people from feeding geese and ducks. Signage could be erected discouraging people from feeding waterfowl. A template is available from Lakes Management Unit.

D6. Options for Watershed Nutrient Reduction

The two key nutrients for plant and algae growth are nitrogen and phosphorus. Fertilizers used for lawn and garden care have significant amounts of both. The three numbers on the fertilizer bag identify the percent of nitrogen, phosphorus and potash in the fertilizer mixture. For example, a fertilizer with the numbers 5-10-5 has 5% nitrogen, 10% phosphorus and 5% potash. Fertilizers considered low in phosphorus (the second number) have a number of 5 or lower. A lower concentration of phosphorus applied to a lawn will result in a smaller concentration of phosphorus in stormwater runoff. An established lawn will not be negatively affected by a lower phosphorus rate. However, for areas with new seeding or new sod, the homeowner would still want to use a fertilizer formulated for encouraging growth until the lawn is established. A simple soil test can determine the correct type and amount of fertilizer needed for the soil. Knowing this, homeowners can avoid applying the wrong type or amount of fertilizer.

Option 1. Buffer Strips

Buffer strips of unmowed native vegetation at least 25 feet wide along the shoreline can slow nutrient laden runoff from entering a lake. It can help prevent shoreline erosion and provide habitat beneficial for wildlife. Different plant mixes can be chosen to allow for more aesthetically pleasing buffer strips and tall species can be used to deter waterfowl from congregating along the shore. Initially the cost of plants can be expensive, however, over time less maintenance is required for the upkeep of a buffer strip.

Option 2. Lake Friendly Lawn and Garden Care Practices – Phosphorus Reduction

a. Compost yard waste instead of burning. Ashes from yard waste contain nutrients and are easily washed into a lake.

b. Avoid dumping yard waste along or into a ditch, pond, lake, or stream. As yard waste decomposes, the nutrients are released directly into the water, or flushed to the lake via the ditch.

c. Avoid applying fertilizer up to the water's edge. Leave a buffer strip of at least 25 feet of unfertilized yard before the shoreline.

d. Avoid applying fertilizers when heavy rains are expected, or over-watering the ground after applying fertilizer.

e. When landscaping, keep site disturbance to a minimum, especially the removal of vegetation and exposure of bare soil. Exposed soil can easily erode.

f. When landscaping, seed or plant exposed soil and cover it with mulch as soon as possible to minimize erosion and runoff.

g. Use lawn and garden chemicals sparingly, or do not use them at all.

Option 3. Street Sweeping

Street sweeping has been used in communities to help prevent debris from clogging stormsewer drains, but it also benefits lakes by removing excess phosphorus, sand, silt and other pollutants. Leftover sand and salt applied to streets has been found to contain higher concentrations of silt, phosphorus and trace metals than new sand and salt mixes. If a municipality does not manage the lake, the lake management entity may be able to offer the village or city extra payment for sweeping streets closest to the lake.

Option 4: Reduce Stormwater Volume from Impervious Surfaces

The quality and quantity of runoff directly affects the lake's water quality. With continued growth and development in Lake County, more impervious surfaces such as parking lots and buildings contribute to the volume of stormwater runoff. Runoff picks up pollutants such as nutrients and sediment as it moves over land or down gutters. A faster flow rate and higher volume can result in erosion and scouring, adding sediment and nutrients to the runoff.

Roof downspouts should be pointed away from driveways and foundations and toward lawns or planting beds where water can soak into the soil. A splash block directly below downspouts helps prevent soil erosion. If erosion still occurs, a flexible perforated plastic tubing attached to the downspout can dissipate the water flow.

Option 5: Required Practices for Construction

Follow the requirements in the Watershed Development Ordinance (WDO) concerning buffer strips. Buffer strips can slow the velocity of runoff and trap sediment and attached nutrients. Setbacks, buffer strips and erosion control features, when done properly, will help protect the lake from excessive runoff and associated pollutants. Information about the contents of the ordinance can be obtained through Lake County Planning and Development, (847) 360-6330.

Option 6. Organize a Local Watershed Organization

A watershed organization can be instrumental in circulating educational information about watersheds and how to care for them. Often a galvanized organization can be a stronger working unit and a stronger voice than a few individuals. Watershed residents are the first to notice problems in the area, such as a lack of erosion control at construction sites. This organization would be an advocate for the watershed, and members could voice their concerns about future development impacts to local officials. This organization could educate the community about how phosphorus (and other pollutants) affect lakes and can help people implement watershed controls. Several types of educational outreaches can be used together for best results. These include: community newsletters, newspaper articles, local cable and radio station announcements. In some cases fundraising may be utilized to secure more funding for a project.

Option 7. Discourage Waterfowl from Congregating

Waterfowl droppings (feces) can be a source of phosphorus (and bacteria) to the water, especially if they are congregating in large numbers along beaches and/or other nearshore areas. The annual nutrient load from two Canada Geese can be greater than the annual nutrient load from residential areas (Gremlin and Malone, 1986). These birds prefer habitat with short plants or no plants, such as lawns mowed to the water's edge and beaches. Waterfowl avoid areas with tall, dense vegetation through which they are unable to see predators. Tactics to discourage waterfowl from congregating in large groups include scare devices, a buffer strip of tall plants along the shoreline, and discouraging people from feeding geese and ducks. Signage could be erected at public parks/beaches discouraging people from feeding waterfowl. A template is available from Lakes Management Unit.

D7. Options for Watershed Sediment Reduction

Continued sediment inflow can fill areas of the lake and cause the water to become turbid. Incoming sediment can smother fish eggs or cover young aquatic plants. Increased turbidity reduces sunlight penetration limiting aquatic plant growth. Damage to native aquatic plants from multiple sediment inputs can lead to the loss of these plant species and the animals that depend on them. Sight-feeding fish have a difficult time finding food in turbid water. Often nutrients, such as phosphorus, are attached to sediment particles that reach the lake through stormwater runoff, which can contribute to plant and algae growth.

Option 1. Municipal Street Sweeping

Street sweeping has been used by communities to help prevent debris from clogging stormsewer drains, but it also benefits a lake by removing excess sand, silt, phosphorus, and other pollutants. Leftover sand and salt applied to streets has been found to contain higher concentrations of silt, phosphorus and trace metals than new sand and salt mixes.

Option 2. Lake Friendly Lawn, Garden and Home Building Practices – Sediment

Please refer to the Watershed Development Ordinance for requirements.

a. Seed and mulch bare soil as soon as possible to minimize erosion and runoff.
b. During home building projects, disturb as little vegetation as possible to minimize erosion and runoff.
c. Incorporate a buffer strip of native vegetation next to the shoreline to improve the area for wildlife, enhance the aesthetics, and possibly increase the property value.
d. Minimize impervious surfaces when considering installing pathways or even driveways. Gravel can be a suitable and less expensive option than asphalt or concrete. This will allow water to infiltrate into the ground rather than flow across impervious surfaces.

Option 3. Agricultural Practices

Soil conservation practices such as leaving crop residue on agricultural fields helps protect the soil from erosion and potential delivery to lakes and streams by runoff. The soils and their nutrients stay where the crops can use them. In turn, less money is spent on fertilizers. Crop rotation can help rejuvenate soil that has been stripped of nutrients due to years of one crop being grown. Soil conservation practices can help protect soil from eroding and aid in maintaining the integrity of the soil.

D8. Participate in the Volunteer Lake Monitoring Program

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

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

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

For information, please contact:

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D9. Options for Lakes with Shoreline Erosion

<u>Option 1: Install a Seawall</u>

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.

D10. Options to Enhance Wildlife Habitat Conditions on a Lake

Option 1: Increase Habitat Cover

One of the best ways to increase habitat cover is to leave a minimum 25-foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes. This will provide cover from predators and provide nesting structure for many wildlife species and their prey.

Brush piles also make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake. Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets. Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife. Finally, by increasing habitat, wildlife is attracted to and uses the area as a place to raise their young. However, if vegetation is allowed to grow, lake access and visibility may be limited. If this occurs, a small path can be made to the shoreline.

Option 2: Increase Natural Food Supply

This can be accomplished in conjunction with Option 1. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Beneficial aquatic plants are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration. Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, “people food” such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks. Providing food for wildlife will increase the likelihood they will use the area. Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish.

Option 3: Limit Disturbance

Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances is beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl). Limiting disturbance will increase the chance that wildlife will use the lake, particularly for raising their young. Many wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance.

D11. Options for Lakes with High Canada Geese Populations

Option 1: Removal

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg destruction becomes an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700). Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. However, if the habitat conditions still exist, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

Option 2: Dispersal/Repellent Techniques

Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellant techniques may be less effective and geese more difficult to coerce into leaving. Harassment techniques include scaring off geese with noisemakers, or chasing them off using dogs or swans. Chemical repellents may also be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese.

With persistence, harassment and/or use of repellants can result reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. However, the effectiveness of harassment techniques is reduced over time since geese will adapt to the devices.

Option 3: Exclusion

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline. This technique will not be effective if the geese are using a large area. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owner's problem, it creates one for another.

Option 4: Habitat Alteration

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn by planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally. Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife. A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. The more area that has natural vegetation, the less turfgrass needs to be constantly manicured and maintained.

Option 5: Do Not Feed Waterfowl!

There are few “good things”, if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the “foods” (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustomed to hand feeding may become aggressive toward other geese or even the people feeding the geese.

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

2000 - 2005 Water Quality Parameters, Statistics Summary

	ALK (oxic) <=3ft 2000-2005	
Average	**167.0**	
Median	**162.0**	
Minimum	**64.9**	**IMC**
Maximum	**330.0**	**Flint Lake**
STD	**42.2**	
n =	**803**	

	ALK (anoxic) 2000-2005	
Average	**205**	
Median	**194**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**53**	
n =	**265**	

	Cond (oxic) <=3ft 2000-2005	
Average	**0.8536**	
Median	**0.7748**	
Minimum	**0.2305**	**White Lake**
Maximum	**6.8920**	**IMC**
STD	**0.5203**	
n =	**808**	

	Cond (anoxic) 2000-2005	
Average	**0.9606**	
Median	**0.8210**	
Minimum	**0.3031**	**White Lake**
Maximum	**7.4080**	**IMC**
STD	**0.7611**	
n =	**265**	

	NO3-N (oxic) <=3ft 2000-2005	
Average	**0.480**	
Median	**0.116**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.019**	
n =	**808**	

*ND = Many lakes had non-detects (69%)
Only compare lakes with detectable
concentrations to the statistics above

	NH3-N (anoxic) 2000-2005	
Average	**2.296**	
Median	**1.560**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.483**	
n =	**265**	

*ND = 21% Non-detects from 32 different lakes

	pH (oxic) <=3ft 2000-2005	
Average	**8.31**	
Median	**8.30**	
Minimum	**7.06**	**Deer Lake**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.46**	
n =	**807**	

	pH (anoxic) 2000-2005	
Average	**7.11**	
Median	**7.13**	
Minimum	**5.80**	**Third Lake**
Maximum	**8.48**	**Heron Pond**
STD	**0.41**	
n =	**265**	

	All Secchi 2000-2005	
Average	**4.39**	
Median	**3.17**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pond**
Maximum	**29.23**	**Bangs Lake**
STD	**3.65**	
n =	**740**	

81 of 161 lakes had anoxic conditions
Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

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2000 - 2005 Water Quality Parameters, Statistics Summary continued

	TKN (oxic) <=3ft 2000-2005	
Average	**1.457**	
Median	**1.220**	
Minimum	**<0.5**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.831**	
n =	**808**	

*ND = 5% Non-detects from 19 different lakes

	TKN (anoxic) 2000-2005	
Average	**3.067**	
Median	**2.270**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.467**	
n =	**265**	

*ND = 5% Non-detects from 7 different lakes

	TP (oxic) <=3ft 2000-2005	
Average	**0.098**	
Median	**0.063**	
Minimum	**<0.01**	**From 5 Lakes**
Maximum	**3.880**	**Albert Lake**
STD	**0.168**	
n =	**795**	

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

	TP (anoxic) 2000-2005	
Average	**0.320**	
Median	**0.174**	
Minimum	**0.012**	**West Loon Lake**
Maximum	**3.800**	**Taylor Lake**
STD	**0.412**	
n =	**265**	

	TSS (all) <=3ft 2000-2005	
Average	**15.3**	
Median	**7.9**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**815**	

*ND = 2% Non-detects from 10 different lakes

	TVS (oxic) <=3ft 2000-2005	
Average	**136.0**	
Median	**132.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**40.4**	
n =	**758**	

No 2002 IEPA Chain Lakes

	TDS (oxic) <=3ft 2000-2004	
Average	**470**	
Median	**454**	
Minimum	**150**	**Lake Kathryn, White**
Maximum	**1340**	**IMC**
STD	**169**	
n =	**745**	

No 2002 IEPA Chain Lakes, Data from 00-04.

	CL (anoxic) 2004-2005	
Average	**277**	
Median	**102**	
Minimum	**53**	**Banana Pond**
Maximum	**2390**	**IMC**
STD	**489**	
n =	**66**	

	CL (oxic) <=3ft 2004-2005	
Average	**243.8**	
Median	**183.0**	
Minimum	**51.7**	**Heron Pond**
Maximum	**2760.0**	**IMC**
STD	**339.4**	
n =	**197**	

LakeCounty
Health Department and
Community Health Center

APPENDIX F. GRANT PROGRAM OPPORTUNITES.

Table F1. A list of potential grant opportunities

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

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

Table F2. Grant Contacts

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Other Related Contacts

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

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

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

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

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