2005 SUMMARY REPORT
of
Loch Lomond Lake

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Loch Lomond is a privately owned, 75-acre impoundment located in central Lake County, within the Village of Mundelein. The lake was created in 1955 by damming Bull Creek, which enters the lake adjacent to the Loch Lomond Property Owner's Association (LLPOA) North Beach. This is a "flow through" system, with the water entering the lake from Bull Creek and then exiting on the east side over a spillway that flows to St. Mary's Lake and Butler Lake eventually reaching the Des Plaines River. Residents use Loch Lomond Lake for swimming, fishing, non-motorized boating, and aesthetics.

The water quality in Loch Lomond is poor with low water clarity, high total suspended solids (TSS) concentration and total phosphorous (TP) concentrations, and few aquatic plants. The Lake is classified as hypereutrophic, and ranked 157th out of 162 lakes in Lake County based on average TP. These high concentrations have been causing nuisance algal blooms for many years. The LLPOA has algaecides applied annually to help control the algae. In August 2005 there was an algal bloom that may have contributed to the lake becoming hypoxic (dissolved oxygen < 1.0 mg/L) below 4 feet. The heavy algal growth didn't allow light to penetrate below 3 feet, thus not allowing any photosynthetic activity, which releases oxygen. In addition, algae release oxygen during the day, but consume oxygen at night.

Loch Lomond's aquatic plants consisted of scattered beds along the near-shore areas. Poor water clarity prohibited plant growth deeper than 2 – 3 feet. Of the aquatic plants that were found, Curlyleaf Pondweed, an exotic, was the most common. Other aquatic plants noted include Small Pondweed, Floatingleaf Pondweed, White Water Lily, and Eurasian Watermilfoil, another exotic.

There were only a few areas of erosion noted around the lake. One hundred percent of the shoreline was developed with the major shoreline types being riprap, seawall, and lawn. A highly developed shoreline doesn't usually offer quality wildlife habitat. However, some of the lots around the lake have created buffer strips offering good habitat for birds and small mammals. Most of the birds seen during the sampling season were those common to residential settings.

The Illinois Department of Natural Resources (IDNR) completed fisheries surveys on Loch Lomond in 1994 and 2002. The IDNR states the fishery is in relatively good condition in the 1994 report. The 2002 report states that Loch Lomond has a well-balanced sunfish/bass fishery, although there was some concern about the low amount of aquatic vegetation. The limited access to the lake and the low harvest pressure on the lake has helped the fishery develop to its present state.

The Lake County Health Department (LCHD) also tests the two beaches on the lake for bacteria twice a month from early May until Labor Day. In 2005 there were no LCHD recommended beach closings on Loch Lomond Lake.

LAKE FACTS

Lake Name:	Loch Lomond Lake
Historical Name:	None
Nearest Municipality:	Mundelein
Location:	T44N, R10E, Section 24
Elevation:	737.97 feet
Major Tributaries:	Bull Creek
Watershed:	Des Plaines River
Sub-watershed:	Bull Creek
Receiving Waterbody:	St. Mary's Lake
Surface Area:	74.85 acres
Shoreline Length:	2.18 miles
Maximum Depth:	8.0 feet
Average Depth:	5.04 feet
Lake Volume:	376.08 acre-feet
Lake Type:	Impoundment
Watershed Area:	1439.10 acres
Major Watershed Land Uses:	Single Family and Agricultural
Bottom Ownership:	Private
Management Entities:	Loch Lomond Property Owners Association
Current and Historical Uses:	Swimming, fishing, non-motorized boating
Description of Access:	All access locations are private

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). Loch Lomond was sampled at a depth of three feet. Loch Lomond was also sampled in 1999 and 2004 and the results will be compared to the 2005 data (see Table 1 for 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. In addition, The Lake County Health Department's beach sampling program has included both Loch Lomond Property Association (LLPOA) beaches since 1988.

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support a sunfish/bass fishery, since these fish can suffer oxygen stress below this amount. Concentrations of at least 5.0 mg/L were recorded in Loch Lomond from the water's surface down to the lake bottom for May through July during 2005 (Appendix B). In August the lake experienced hypoxia (<1.0 mg/L) below 4 feet. This was likely due to an extensive algal bloom that was noted that month. The heavy algal growth didn't allow light to penetrate below 3 feet, thus not allowing any photosynthetic activity, which releases oxygen. In September DO concentrations were low (<5.0 mg/L but >3.0mg/L) throughout the water column, likely caused by decaying algae using up the available oxygen.

Loch Lomond Lake has a history of experiencing severe algal blooms. The LLPOA had the lake treated with Cutrine Plus® to help control these algal blooms. Exact dates and amounts applied are not available. Sediment resuspended by carp and wind and wave action, along with the algal blooms, created poor water clarity. Secchi disk depth averaged 2.17 feet during 2005, which is below the Lake County median of 3.17 feet (Appendix E). This is a decrease from the 2004 sampling when the average Secchi depth was 3.27 feet. Water clarity is related to the amount of TSS concentration in the water column, which is composed of nonvolatile suspended solids (NVSS), non-organic clay or sediment materials, and volatile suspended solids (VSS), algae and other organic matter. As the TSS increased over the summer, the water clarity decreased (Figure 2). The 2005 average TSS of 13.1 mg/L was 66% greater then the Lake County median of 7.9 mg/L. The lakes in the Bull Creek watershed were all sampled during 2005 and include Loch Lomond Lake, St. Mary's Lake, and Butler Lake. Loch Lomond Lake had the lowest average Secchi depth and highest TSS, while Butler Lake had the highest average Secchi depth and lowest TSS (Table 2). This is unusual since lakes on the top of a watershed generally have better water quality, but may be explained by the lack of aquatic plants and extensive algal growth in Loch Lomond Lake. In May and June the water clarity was better than the remainder of the summer, which is common in many lakes. Although some algae were present during these months, algal blooms that occurred in July and August had greater affects on the water clarity. Another factor affecting water clarity is the amount of nutrients in the water. Algae require nutrients such as nitrogen and phosphorus, which are two key ingredients for growth, and can regulate populations. Typically, lakes are either phosphorus or nitrogen limited. This means that one of the nutrients is in short supply and any addition of that nutrient to the lake will result in an increase of plant or algal growth. Most lakes in Lake County are phosphorus limited. 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

Figure 1. Water quality sampling site (blue) and beaches (green) on Loch Lomond Lake, 2005.

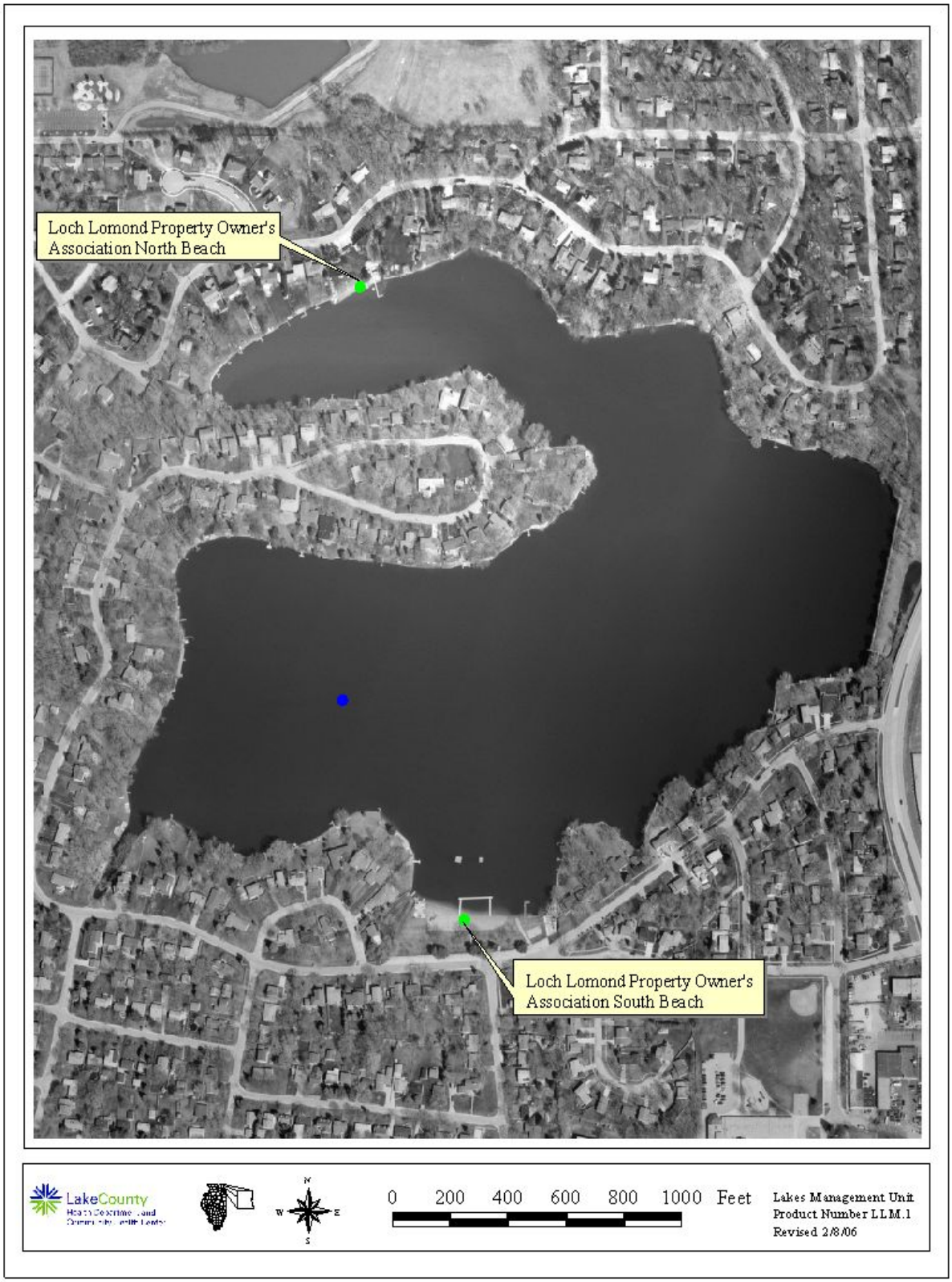


Table 1. Water quality data for Loch Lomond Lake, 2004 and 2005.

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	180	0.80	<0.1	<0.05	0.035	<0.005	270	NA	3.1	728	100	>6.99[a]	1.3100	7.76	8.57
14-Jun	3	192	1.04	<0.1	0.057	0.050	<0.005	277	NA	6.4	802	153	3.67	1.3540	7.88	7.15
12-Jul	3	195	1.58	<0.1	<0.05	0.131	0.027	288	NA	11.0	826	159	2.72	1.3610	8.47	8.05
9-Aug	3	154	2.90	<0.1	<0.05	0.642	0.160	296	NA	24.9	818	201	1.10	1.2770	9.10	10.27
13-Sep	3	171	2.48	<0.1	<0.05	0.619	0.377	305	NA	20.0	788	147	1.18	1.3470	8.62	4.17
	Average	178	1.76	<0.1	0.057[k]	0.295	0.188[k]	287	NA	13.1	792	152	2.17[b]	1.3298	8.37	7.64

2004	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
5-May	3	165	1.02	<0.1	<0.05	0.041	<0.005	NA	600	4.8	667	127	5.41	1.1030	8.02	9.61
2-Jun	3	155	0.96	<0.1	0.304	0.037	<0.005	NA	428	4.3	468	99	5.61	0.7850	7.98	9.23
7-Jul	3	155	1.47	<0.1	<0.05	0.160	0.028	NA	408	17.0	446	89	2.20	0.7430	8.21	6.59
4-Aug	3	161	2.26	<0.1	<0.05	0.418	0.218	NA	412	21.8	449	104	1.44	0.7270	9.12	8.03
8-Sep	3	169	2.82	<0.1	<0.05	0.570	0.332	NA	438	18.1	475	106	1.71	0.7580	8.58	5.19
	Average	161	1.71	<0.1	0.304[k]	0.245	0.193[k]	NA	457	13.2	501	105	3.27	0.8232	8.38	7.73

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

Figure 2. Total suspended solid (TSS) concentrations vs. Secchi depth for Loch Lomond Lake, 2005.

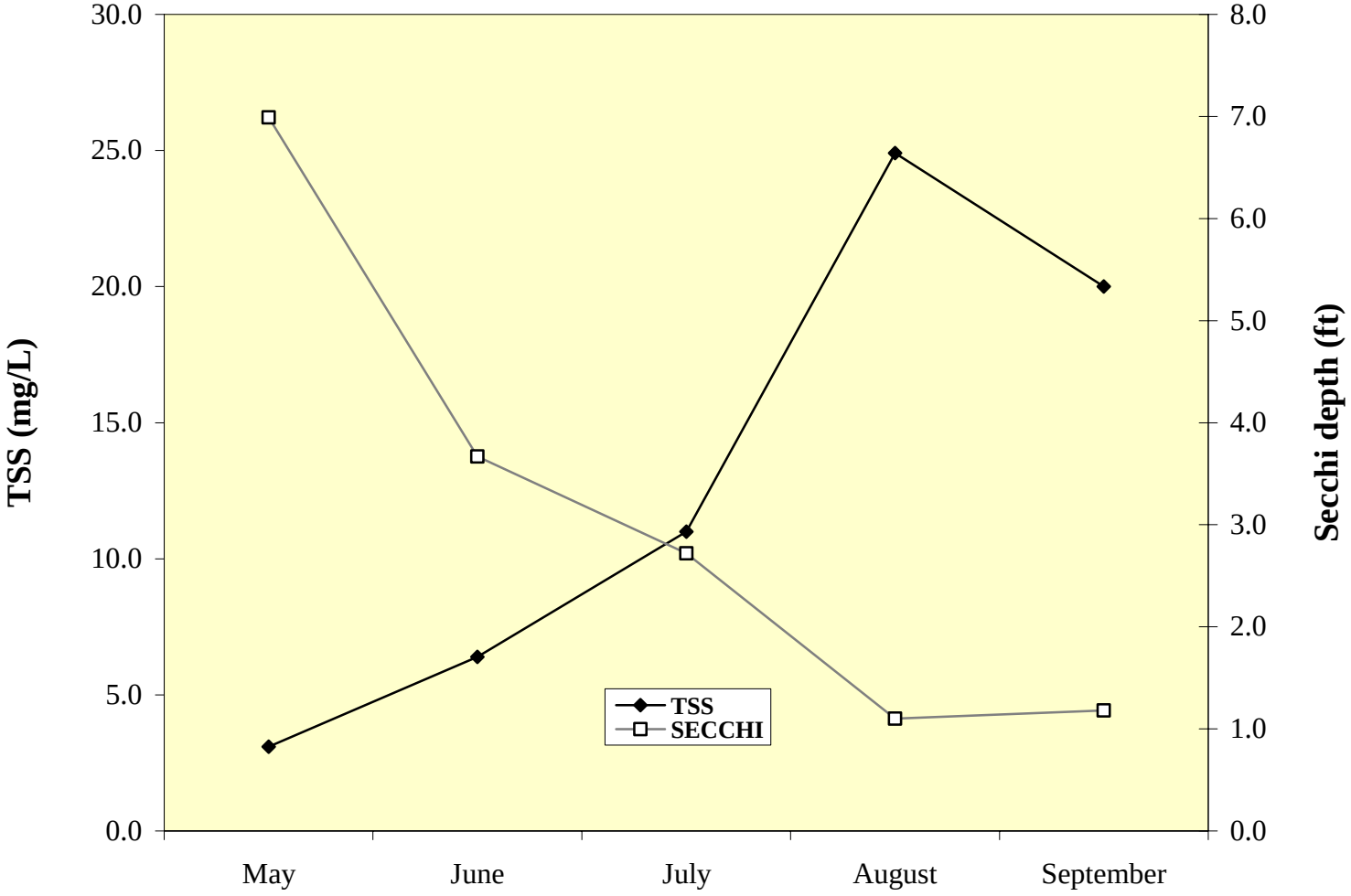


Table 2. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity readings in the Bull Creek watershed (Loch Lomond Lake, St. Mary's Lake, and Butler Lake).

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

Direction of Watershed Flow

than or equal to 15:1 indicate phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate there are enough of both nutrients to facilitate excess algae or plant growth. Loch Lomond had an average TN:TP ratio of 6:1 in 2005 and 8:1 in 2004. This indicates the lake was nitrogen limited. The concentration of total Kjeldahl nitrogen (TKN) increased during the season, averaging 1.76 mg/L, which is 44% higher than the Lake County median of 1.220 mg/L. Nitrogen is difficult to control because it can come from a variety of external sources including being transformed by blue-green algae from an atmospheric form to an organic form. Similar to1999 and 2004, when the TN:TP ratios are calculated monthly it shows some months were phosphorous limited and other months were nitrogen limited. In May and June of 2005, the lake was limited by phosphorus with TN:TP ratios of 23:1 and 22:1, respectively. TP concentrations were low at this time, 0.035 mg/L and 0.050 mg/L, respectively. During the month of July the TN:TP ratio was 12:1 indicating neither nutrient was limiting. In the months afterward the lake was limited by nitrogen with ratios of 5:1 in August and 4:1 in September. From July through September, concentrations of TP increased tremendously, corresponding with algal blooms, the increase in TSS (Figure 3), and the subsequent decrease in water clarity. This nitrogen limitation may have caused the TP concentrations to increase from 0.035 mg/L in May to 0.131 mg/L in July and then increased again to 0.642 mg/L in August. When nitrogen is limited, aquatic organisms are unable to utilize the available phosphorus and the concentrations increase. Overall, TP increased more than 18 times between the May and August sampling dates. Phosphorus can also be released from sediment through biological or mechanical processes, or from plant or algae cells as they die. This typically occurs in lakes like Loch Lomond Lake that do not stratify, therefore phosphorus attached to bottom sediment or released from dying algae/plant cells can be easily distributed throughout the water column. Limited rainfall during the summer of 2005 caused drought like conditions by September. Evaporation had taken place during this time dropping the lake's water elevation 5.9 inches between the May and September sampling dates and concentrating the TP into a smaller lake volume. This loss, coupled with internal loading from sediment resuspension, and nitrogen limitation are the probable factors that triggered the large TP increase. Loch Lomond Lake TP concentrations had a seasonal average of 0.295 mg/L, which is more than four times higher than the Lake County median of 0.063 mg/L. This is also an increase from 1999 when the average TP was 0.235 mg/L and 2004 when the average TP was 0.245 mg/L (Table 2).

Usually, soluble reactive phosphorus (SRP) is undetected in the near surface water since algae uses it almost as quickly as it becomes available. This form of phosphorus is most readily available for algal growth, and was detected in most of Loch Lomond's samples in 1999, 2004 and 2005, with seasonal averages of 0.140 mg/L, 0.193 mg/L, and 0.188 mg/L, respectively. The SRP concentrations during 2004 and 2005 displayed a pattern similar to that of the TP concentrations, which was low early in the season, then increasing in the later months (Figure 4). As stated previously, when nitrogen is limited, aquatic organisms are unable to utilize the available phosphorus and the concentrations increase. Loch Lomond has an excessive amount of TP and SRP. With this much TP and SRP, Loch Lomond will likely continue to be affected by nuisance algae. Once TP reaches a lake, it can be recycled through the processes of internal loading described previously. There were also external sources of TP affecting Loch Lomond Lake such as stormwater from the 1,439 acres within its watershed (Figure 5). Figure 6 shows the land uses within the watershed, with the four largest being single family (37%), agricultural (19%),

Figure 3. Total suspended solid (TSS) concentrations vs. total phosphorous (TP) concentrations for Loch Lomond Lake, 2005.

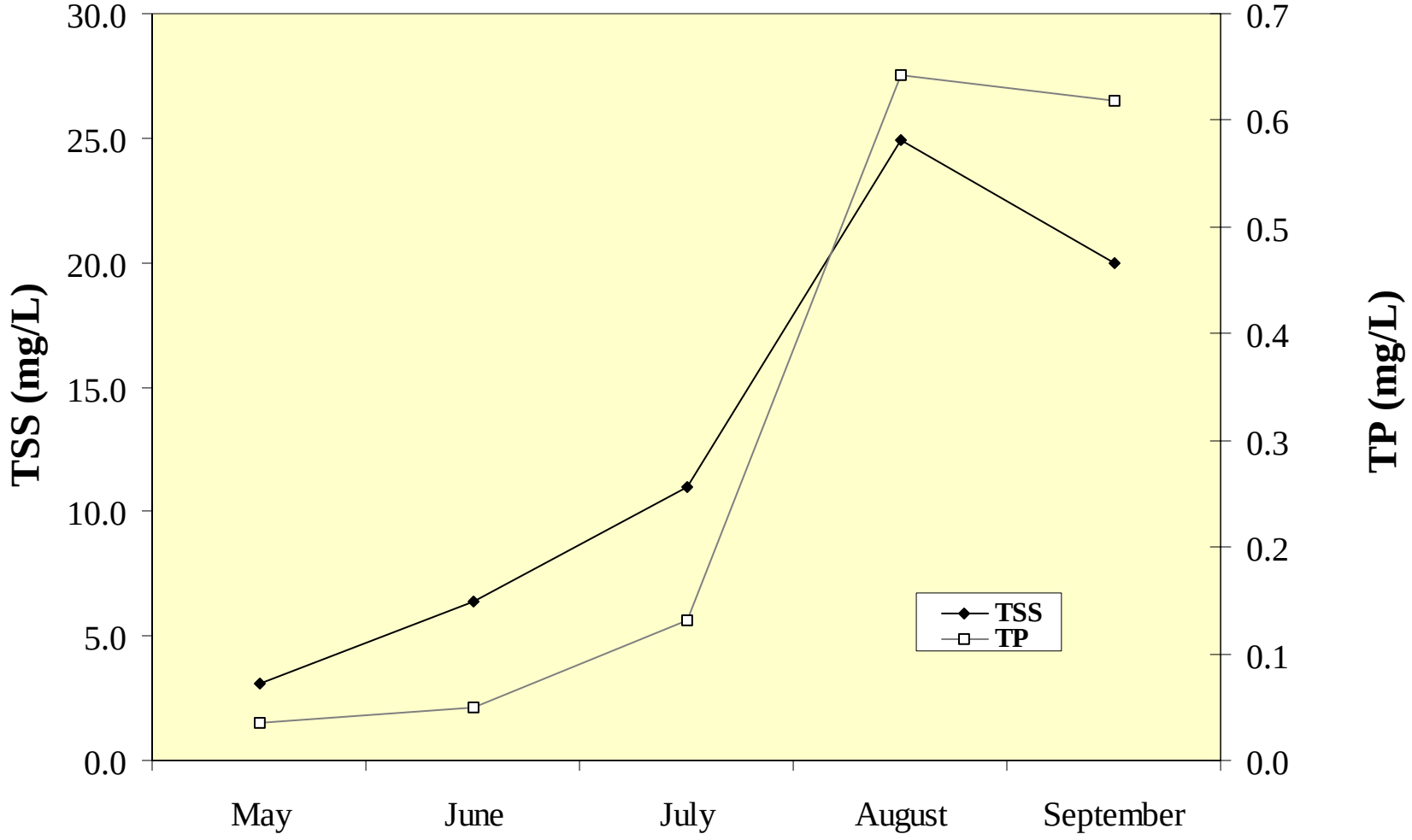


Figure 4. Total phosphorous (TP) concentrations vs. soluble reactive phosphorus (SRP) concentrations for Loch Lomond Lake, 2005.

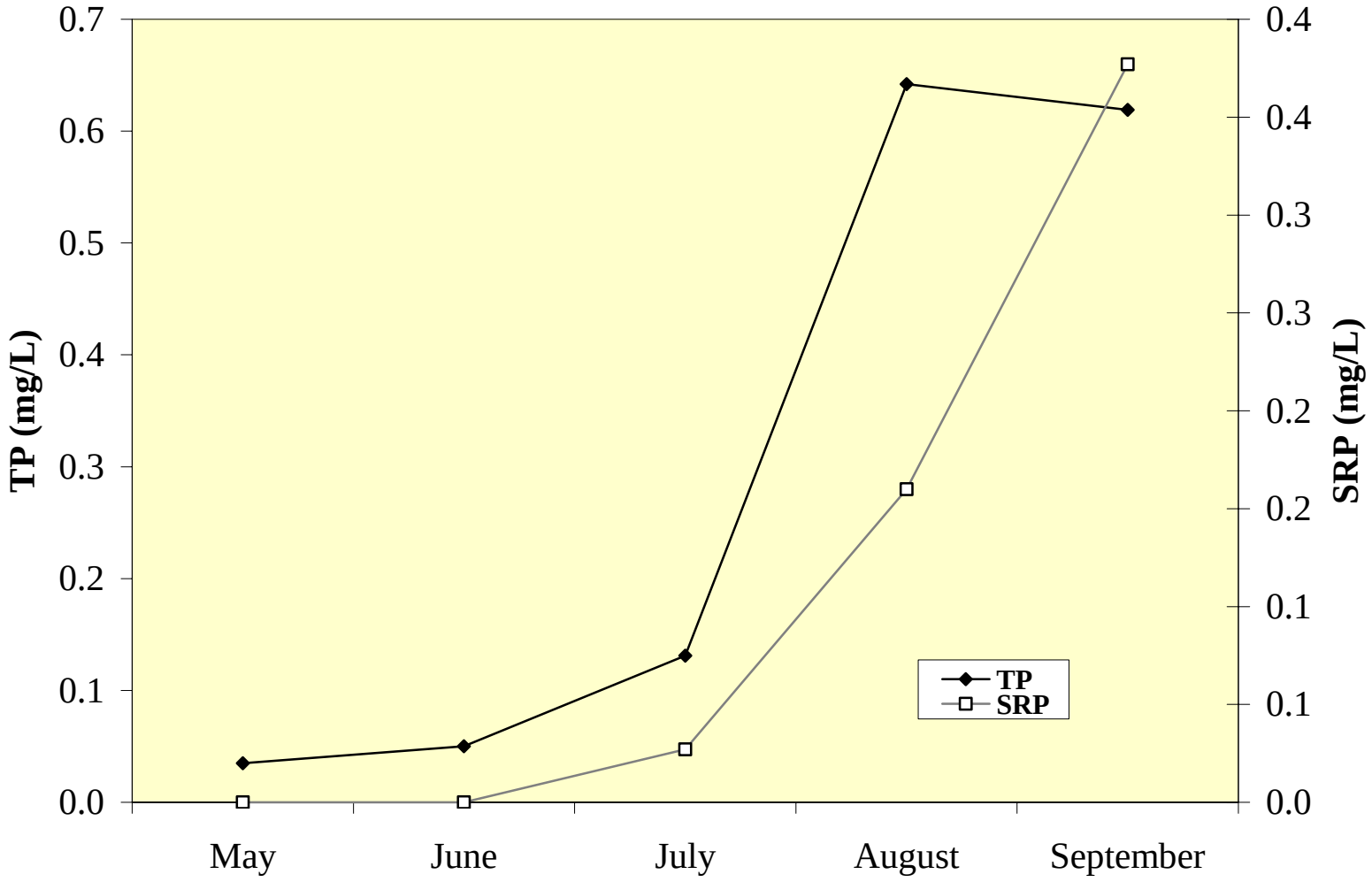


Figure 5. Approximate watershed delineation for Loch Lomond Lake, 2005.

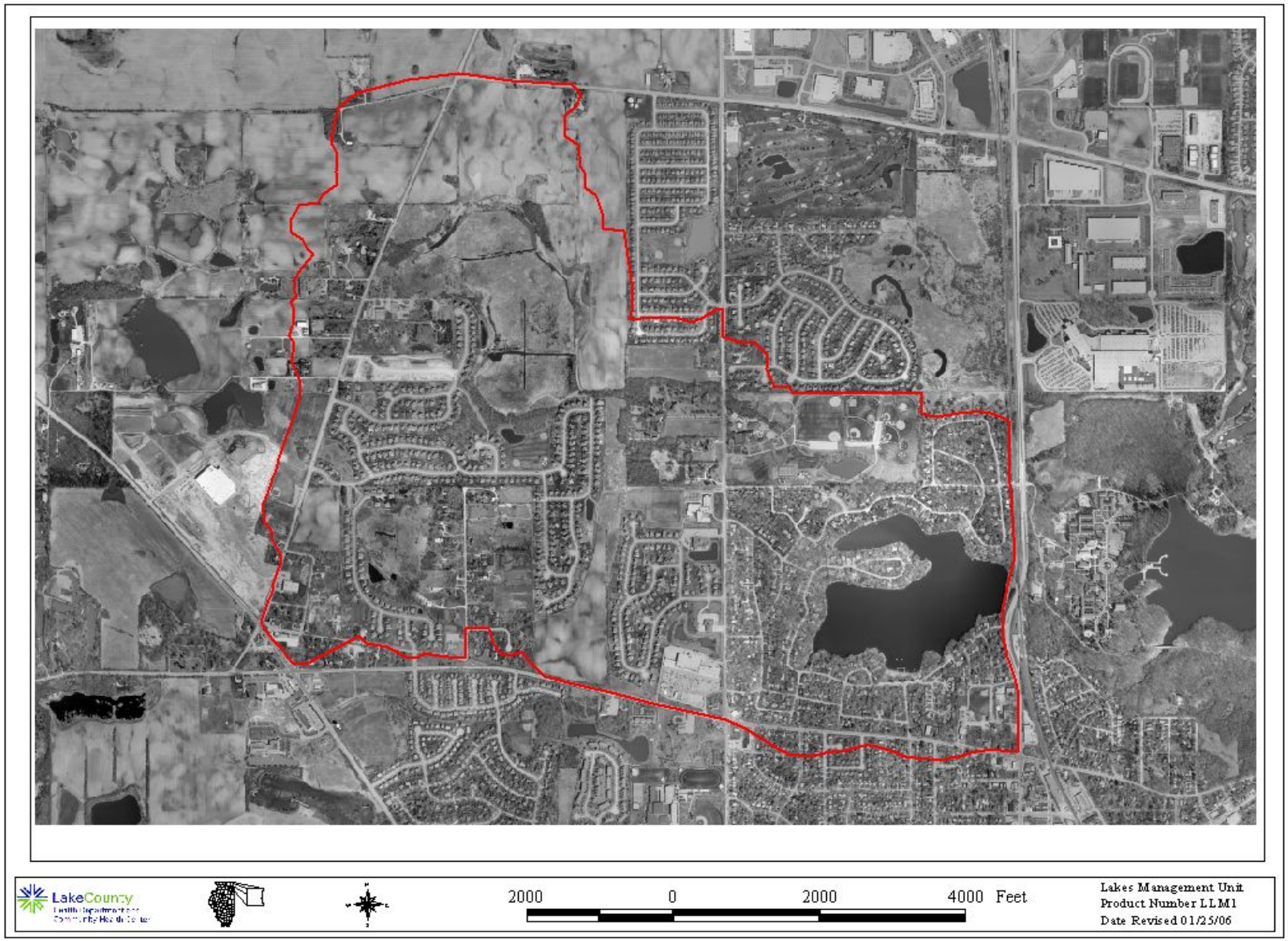
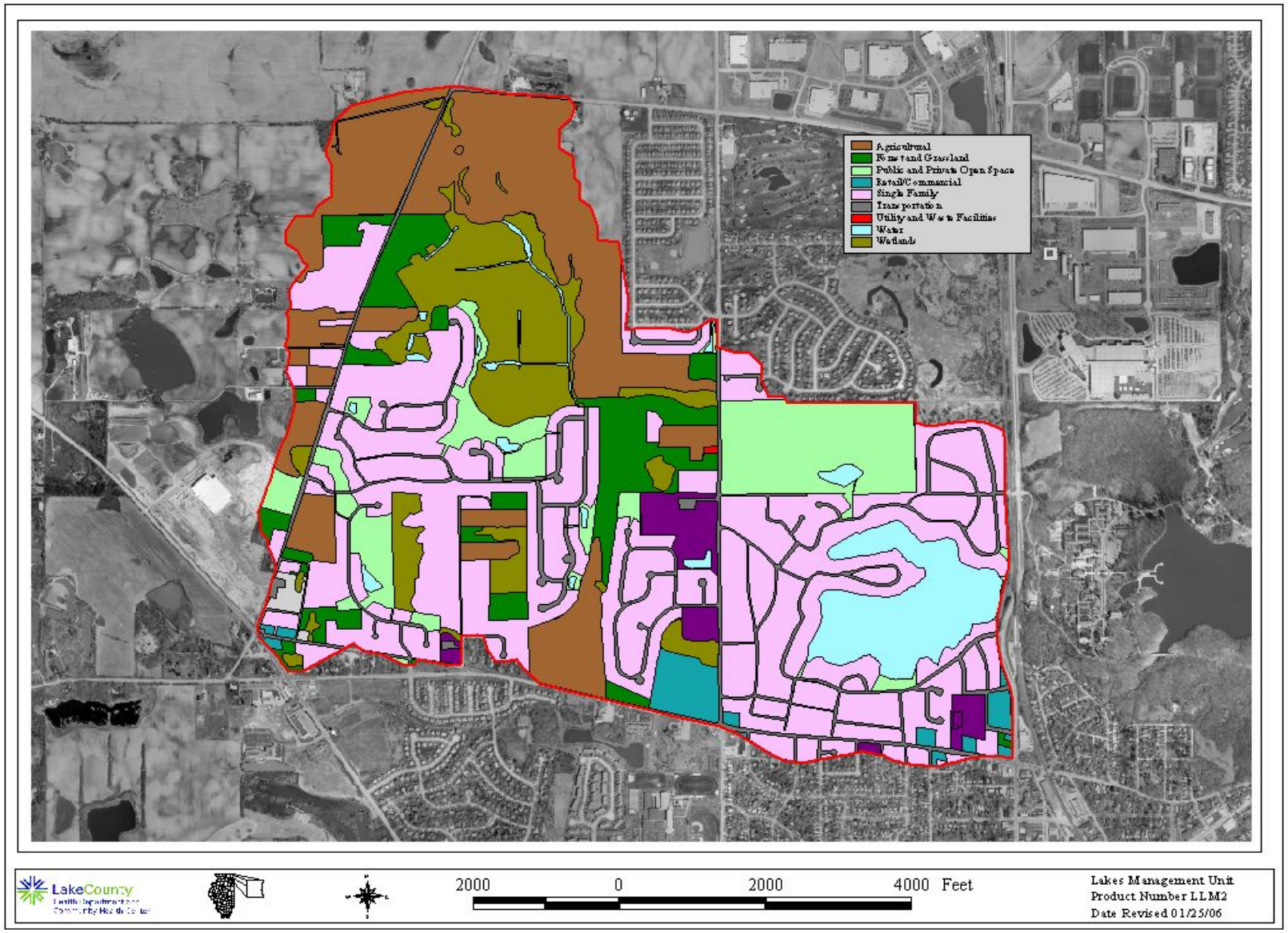


Figure 6. Approximate land use within the Loch Lomond Lake watershed, 2005.



wetland (10%) and public and private open space (10%). Table 2 lists the land uses and percentages within the watershed, all of which can contribute to external phosphorus loading. For Loch Lomond Lake, the land uses contributing the highest percentages of estimated runoff are single family and transportation (i.e., road) areas, which are 48% and 24%, respectively. Even though it is the second largest land use, the agricultural areas within the watershed contribute approximately 4% of the estimated runoff (Table 3). It is important to keep in mind, however, that although the amount of estimated runoff from certain areas may be low, it can deliver high concentrations of TSS and TP. The retention time for water entering the lake was calculated to be approximately 150 days. It is likely that Loch Lomond Lake is a source of TP and TSS to St. Mary's Lake because it is within the St. Mary's Lake watershed. St. Mary's Lake also has high TP, TSS, and low water clarity.

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 the range of one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Hypereutrophic lakes are those with 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 and fish. Mesotrophic and oligotrophic lakes have lower nutrient levels. These are very clear lakes, with little algal growth. Most lakes in Lake County are eutrophic. The trophic state of Loch Lomond Lake in terms of its phosphorus concentration during 2004 was hypereutrophic, with a TSIp score of 83.5. In 2005 the TSIp score was a little higher at 86.2, still hypereutrophic and ranked Loch Lomond 157th out of 162 lakes in Lake County based on average TP concentrations (Table 4). St. Mary's Lake ranked 78th while Butler Lake ranked 62nd.

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, phosphorus concentrations (for the trophic state index) and aquatic plant coverage. Loch Lomond partially supports aquatic life uses according to these guidelines. However, the lake is impaired for recreational and swimming uses because of the high TP concentrations, suspended sediment that affected the water clarity, and lack of aquatic plant coverage.

Conductivity is a measurement of water's ability to conduct electricity and is correlated with chloride (Cl^-) concentrations. Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watershed often have higher conductivity readings and higher 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. The median conductivity reading for near surface samples was 0.7748 milliSiemens/cm (mS/cm) for Lake County lakes. During 2005, the average conductivity reading in Loch Lomond was higher, at 1.3298 mS/cm. This was up 62% from the 2004 average of 0.8232 mS/cm and 88% higher than the 1999 average of 0.7076 mS/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 with readings dropping off as the summer goes on. The readings most likely didn't drop off due to the lack of precipitation during the summer not replenishing the lake volume and concentrating the Cl^-. Chloride concentration in Loch Lomond Lake was higher than the Lake County median of 183 mg/L during 2005, with a

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

Land Use	Acreage	% of Total
Agricultural	268.8	18.7
Forest and Grassland	98.7	6.9
Government and Institutional	34.2	2.4
Industrial	4.6	0.3
Public and Private Open Space	139.5	9.7
Retail/Commercial	28.6	2.0
Single Family	533.5	37.1
Transportation	93.8	6.5
Utility and Waste Facilities	0.4	0.0
Water	89.3	6.2
Wetlands	148.0	10.3
Total Acres	**1439.4**	**100.0**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agriculture	268.8	0.05	37.0	4.0%
Commercial	28.6	0.85	66.9	7.3%
Forest & Grassland	98.7	0.05	13.6	1.5%
Govt. & Institution	34.2	0.50	47.0	5.2%
Industrial	4.6	0.85	10.8	1.2%
Public and Private Open Space	139.5	0.15	57.5	6.3%
Open water	89.3	0.00	0.0	0.0%
Single-Family	533.5	0.30	440.1	48.2%
Transportation	93.8	0.85	219.3	24.0%
Utility & Waste	0.4	0.30	0.3	0.04%
Wetlands	148.0	0.05	20.4	2.2%
TOTAL	**1439.4**		**912.8**	**100.0%**

Lake volume **376.08 acre-feet**

Retention Time (years)= lake volume/runoff **0.41 years**

150.39 days

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

seasonal average of 287 mg/L. Both St. Mary's Lake and Butler Lake had a Cl^- concentration of 244 mg/L. A study done in Canada reported 10% of aquatic species are harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. Therefore, these lakes are being negatively impacted by the high Cl^- concentrations.

The LCHD has been testing the two beaches on Loch Lomond Lake (LLPOA North Beach and LLPOA South Beach) bimonthly for bacteria from early May to Labor Day annually since 1988. Prior to 2002, the beaches were tested for fecal coliform bacteria. Beginning in 2002, the testing protocol was changed to monitor *E. coli* bacteria, which is one species in the coliform group. The Illinois Department of Public Health standard for the bacteria is 235-cfu/100 mL. Beach closure is recommended when samples exceed this standard. From Memorial Day through Labor Day when the beaches were open low levels of bacteria (range 0-112 cfu/100 mL) were detected, thus neither was recommended for closure during the summer of 2005. Both beaches have stormwater inlets near the swimming areas, which can add bacteria to the water after rain events. In addition, Canada Geese and gulls are common at these beaches and can contribute nutrients and *E. coli* to the beaches and water.

SUMMARY OF AQUATIC MACROPHYTES

To maintain a healthy sunfish/bass fishery, the optimal plant (macrophyte) coverage is 30% to 40% across the lake bottom. Loch Lomond had approximately 5% aquatic plant coverage, and consisted of scattered beds along the near-shore areas. Of the aquatic plants that were found, Curlyleaf Pondweed, an exotic, was the most common. Table 5 lists the other aquatic plants found in Loch Lomond Lake during 2005.

Table 5. Aquatic plant species found in Loch Lomond Lake in 2005.

Curlyleaf Pondweed^	*Potamogeton crispus*
Floatingleaf Pondweed	*Potamogeton natans*
Small Pondweed	*Potamogeton pusillus*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
White Water Lily	*Nymphaea tuberosa*

^ Exotic plant

The 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 is 14.0 (Table 6). Loch

Lomond had a FQI of 9.4 in 2005. This is a decrease since the 2000 survey was conducted, when the FQI was 16.7. However, the change in the aquatic plant sampling procedure could be a potential reason for this decrease. Also, plant community composition may vary from year to year.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. During 2005, the depth of the 1% light level was at the bottom in May, June, and July. In August and September, the depth of the 1% light level was 3 feet deep. The increasing algae growth extinguished some of the available light. This is one reason aquatic plant growth may be hindered in Loch Lomond. Another possibility is the presence of Grass Carp. If there are any still alive from the 1990 stocking, they could be restricting any aquatic plant growth as they forage on aquatic plants. Common Carp are also present and, along with wind and wave action, may contribute to the poor water clarity.

SUMMARY OF SHORELINE CONDITION

In 2004 an assessment was conducted to determine the condition of the shoreline at the water/land interface. The entire shoreline was developed, with 42.3% typified as riprap. The two other major shoreline types were seawall (26.9%) and lawn (15.8%). Beach and buffer strips each made up less than 8% of the total shoreline. One positive aspect of the shoreline was only about 14% was eroding. Approximately 11% of the eroding shoreline was classified as slightly eroding, with the remainder classified as moderately eroding (2.5%) and severely eroding (1%). Even though only a small percentage was eroding, continued neglect of these shorelines could lead to further erosion, resulting not only in a loss of property, but additional soil inputs into the water that negatively affect water clarity.

The shoreline was reassessed on July 27, 2005 for significant changes in erosion since the previous survey in 2004. This survey, however, was not as extensive as in 2004. Based on this assessment, some of the eroded areas have been fixed with riprap while other areas still remain eroded. No new erosion appeared and the remaining shore was similar to the 2004 assessment.

It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits can be three-fold. First, the erosion is repaired and the new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds habitat for wildlife to a shoreline that is otherwise limited in habitat. Although some people are hesitant about installing buffer strips along their shoreline, buffer strips can be attractive and still allow lake access by adding a mowed path to the water. Some homeowners on Loch Lomond have installed buffer strips that include native plants, behind existing seawall or riprap. A few areas around Loch Lomond had some exotic shoreline plants such as Reed Canary Grass, Honeysuckle, and Purple Loosestrife. These plants are noted to be aggressively invasive and can crowd out beneficial native species. They do not offer ideal wildlife habitat and should be removed. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and keep geese and gulls from congregating, as it is not desirable habitat for them.

Table 6. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/A) 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 6. 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 6. 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 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
130	Lake Forest Pond	6.9	8.5
131	Leisure Lake	6.4	9.0
132	Peterson Pond	6.0	8.5
133	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**

SUMMARY OF WILDLIFE AND HABITAT

Due to the lake being in the middle of a residential setting with the majority of the shoreline riprap, seawall, or lawn, habitat for wildlife is limited. Most of the birds observed were those common in residential settings (Table 7). 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.

Table 7. Wildlife species observed on Loch Lomond, May – September 2005.

Birds	
Double-crested Cormorant	*Phalacrocorax auritus*
Mallard	*Anas platyrhnchos*
Canada Goose	*Branta canadensis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Barn Swallow	*Hirundo rustica*
Blue Jay	*Cyanocitta cristata*
House Wren	*Troglodytes aedon*
American Robin	*Turdus migratorius*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
Chipping Sparrow	*Spizella passerina*
Red-winged Blackbird	*Agelaius phoeniceus*
Mourning Dove	*Zenaida macroura*
American Goldfinch	*Carduelis tristis*
Ring-billed Gull	*Larus delawarensis*
Mammals	
Eastern Chipmunk	*Tamias striatus*
Muskrat	*Ondatra zibethica*
Fish	
Black Crappie	*Pomoxis nigromaculatus*

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.

Muskrats were seen during the sampling season and their damage is a concern of the lake management entity. These rodents can cause problems with shoreline stabilization by digging holes in the shoreline bank and potentially clogging drainpipes with debris generated while foraging and building homes. Management of muskrats requires an ongoing monitoring plan that includes removal of the animals and repairing the damaged shoreline bank.

Loch Lomond has been stocked with Grass Carp, Northern Pike, Largemouth Bass and Channel Catfish in the past. About 600 Grass Carp were stocked in 1990 at the recommendation of a consultant. The Illinois Department of Natural Resources (IDNR) completed fisheries surveys on Loch Lomond in 1994 and in 2002. The IDNR reported in 1994 that the fishery was in relatively good condition. It was noted that there were few Largemouth Bass collected that were larger than 14", which means the population of breeding bass was limited. The 1994 report does not mention Common Carp as a problem. Of the 252 fish collected during the survey, only one carp was captured. One recommendation was that the LLPOA post creel and length limits to boost the rather small overall size of the Largemouth Bass population. Creel and length limits have been posted listing three Largemouth Bass per day with a 15" minimum length, and one Northern Pike per day with a 30" minimum length. The stocking recommendation in the 1994 report was to biennially add 222 8-12" Northern Pike. According to LLPOA information, this has not been followed. In 1995, the LLPOA stocked 2,000 6-10" bass, 2,701-3lb bass and 25 Channel Catfish of an unknown size.

In the 2002 fisheries survey, an improvement was noted for the bass. The comments from the 2002 report state that Loch Lomond has a well-balanced sunfish/bass fishery. However, concerns were noted about the low amount of aquatic plant coverage. The limited access to this lake and the low harvest pressure at this time has allowed the fishery to develop to its present state. The 2002 report does not mention Common Carp as a problem. Of the 320 fish collected in 2002, 15 were carp. Their populations could be larger given the fishery assessment methods (electrofishing) is not conducive to accurately assessing populations of this rough fish. Bottom dwelling fish, like carp, are less susceptible to the electricity due to it not reaching the bottom of the lake. Also, the lack of aquatic vegetation hurts electrofishing efficiency because fish don't have a refuge to escape to as they feel the electric current from the sampling boat. The fish will seek refuge in the aquatic plants, making them easier to find and capture. The last stocking took place in the spring of 2003, when about 180 12-18" Northern Pike were put into the lake.

LAKE MANAGEMENT RECOMMENDATIONS

Loch Lomond Lake has both positive and negative aspects. Some of the positives include the presence of buffer strips, a good Largemouth Bass population, and the presence of an active lake association (LLPOA). Buffer strips help to protect the shoreline from erosion, provide habitat for wildlife, and help to filter water entering the lake. A good Largemouth Bass fishery provides people and visitors of the lake with good opportunities to fish. LLPOA is active in the management activities of the lake. They have the lake treated yearly for algae and currently have a staff gauge installed at the spillway to monitor the water level. To improve the quality of Loch Lomond Lake, the Lake County Health Department – Lakes Management Unit (LCHD-LMU) has the following recommendations.

- **Creating a bathymetric map**

  Creating an updated bathymetric map can help with improvements to Loch Lomond Lake. We recommend a bathymetric map for lakes to help with management strategies. Loch Lomond has a map that was created in 1988; however, we suggest any maps older than 15 years old be updated (Appendix D1).

- **Nuisance algae management, reducing bacteria inputs into a lake, watershed nutrient reduction, and watershed sediment reduction**

  Loch Lomond Lake has poor water clarity, high phosphorus concentrations, and seasonal algal blooms, which can be related. High phosphorus triggers algal blooms and as a result water clarity goes down (Appendix D2). Algal blooms may be kept under control by reducing nutrients and sediment entering the lake from the watershed (Appendix D3-5).

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

  To track future water quality trends, it is recommended that the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the Secchi disk readings on a bimonthly basis from April to October (Appendix D6).

- **Lakes with shoreline erosion**

  There are some areas around the lake with erosion. These eroded areas should be remediated 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 D7).

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

  With the lake being in a residential setting with the majority of the shoreline as riprap, seawall, or lawn, wildlife habitat is limited. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones, which were noted on some lots, and are recommended as one aspect of shoreline

protection (Appendix D8). Most of the birds observed were those common to residential settings.

- **Lakes with high Canada Geese populations**

Loch Lomond 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 D9).

- **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

The plant survey consisted of canoeing around the lake and noting areas with plants and the plants were identified. The areas were recorded on an aerial photo of the lake. The survey was all visual.

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

APPENDIX B. MULTI-PARAMETER DATA FOR LOCH LOMOND IN 2005.

Loch Lomond 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	0.41
5/10/2005	8:47:50	0.25	0.469	17.24	8.63	90.1	1.31	7.75	2763.2	Surface		
5/10/2005	8:49:58	1	1.281	17.26	8.57	89.5	1.31	7.74	1026.7	Surface	100%	
5/10/2005	8:51:06	2	2.248	17.22	8.57	89.4	1.31	7.75	608.5	0.498	59%	1.05
5/10/2005	8:52:20	3	3.262	17.23	8.57	89.4	1.31	7.76	520.5	1.512	51%	0.15
5/10/2005	8:53:26	4	4.243	17.17	8.50	88.6	1.31	7.76	369.3	2.493	36%	0.35
5/10/2005	8:54:21	5	5.238	17.14	8.49	88.4	1.31	7.77	291.9	3.488	28%	0.24
5/10/2005	8:55:43	6	6.249	17.10	8.23	85.7	1.31	7.75	224.9	4.499	22%	0.26

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	0.94
6/14/2005		0.25	0.498	26.77	6.98	87.6	1.353	7.75	2880.7	Surface		
6/14/2005		1	0.961	26.76	7.16	89.7	1.353	7.84	1371.1	Surface	100%	
6/14/2005		2	1.999	26.79	7.16	89.8	1.354	7.86	652.5	0.249	48%	2.98
6/14/2005		3	2.981	26.79	7.15	89.8	1.354	7.87	423.5	1.231	31%	0.44
6/14/2005		4	4.002	26.79	7.17	90.0	1.354	7.88	197.7	2.252	14%	0.75
6/14/2005		5	4.996	26.78	7.12	89.3	1.355	7.88	123.5	3.246	9%	0.47
6/14/2005		6	6.043	26.75	6.96	87.3	1.355	7.86	113.6	4.293	8%	0.08

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	2.09
7/12/2005		0.25	0.515	27.01	8.08	101.8	1.359	8.40	230.0	Surface		
7/12/2005		1	1.013	27.04	8.15	102.7	1.360	8.46	86.7	Surface	100%	
7/12/2005		2	1.994	27.04	8.13	102.5	1.361	8.47	10.9	0.244	13%	8.50
7/12/2005		3	3.011	27.04	8.05	101.4	1.361	8.47	8.7	1.261	10%	0.22
7/12/2005		4	3.981	27.03	7.96	100.3	1.361	8.46	5.5	2.231	6%	0.47
7/12/2005		5	4.997	27.03	7.92	99.8	1.361	8.46	3.7	3.247	4%	0.39
7/12/2005		6	5.961	27.00	7.59	95.6	1.362	8.44	1.6	4.211	2%	0.87

Loch Lomond 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	2.96
8/9/2005		0.25	0.493	27.55	12.00	152.7	1.275	9.06	3132.0	Surface		
8/9/2005		1	0.998	27.54	12.05	153.2	1.275	9.12	1298.9	Surface	100%	
8/9/2005		2	1.988	27.46	11.66	148.0	1.276	9.14	105.2	0.238	8%	10.56
8/9/2005		3	3.002	27.30	10.27	130.0	1.277	9.10	18.5	1.252	1.4%	1.71
8/9/2005		4	4.007	27.09	6.63	83.6	1.280	8.96	5.7	2.257	0.4%	1.17
8/9/2005		5	4.983	26.65	0.25	3.1	1.286	8.52	2.3	3.233	0.2%	0.93
8/9/2005		6	6.028	26.44	0.07	0.9	1.289	8.41	1.5	4.278	0.1%	0.41

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	2.91
9/13/2005		0.25	0.503	25.02	4.35	52.9	1.347	8.48	1075.6	Surface		
9/13/2005		1	1.027	25.02	4.33	52.6	1.346	8.57	823.3	Surface	100%	
9/13/2005		2	2.004	25.02	4.24	51.5	1.347	8.60	57.3	0.254	7%	10.49
9/13/2005		3	2.993	25.01	4.17	50.6	1.347	8.62	7.7	1.243	0.9%	2.03
9/13/2005		4	4.003	25.02	4.04	49.1	1.347	8.62	3.1	2.253	0.4%	0.90
9/13/2005		5	4.998	25.01	3.98	48.4	1.348	8.62	1.9	3.248	0.2%	0.49
9/13/2005		6	5.987	24.99	3.84	46.6	1.348	8.62	1.0	4.237	0.1%	0.65

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™ 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 Nuisance Algae Management

Option 1: Algaecides

Algaecides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algaecides in use. There is also a non-copper based algaecide on the market called GreenClean™ from BIOsafe Systems, which contains the active ingredient sodium carbonate peroxyhydrate. Regardless of active ingredient, all forms act as contact killers. This means that the product has to come into contact with the algae to be effective. Algaecides come in two forms: granular and liquid. Granular algaecides are mainly used on filamentous algae where they are spread over their mats. Liquid algaecides are mixed with a known amount of water to achieve a known concentration and sprayed onto/into the water. Liquid forms are used on both filamentous and planktonic algae. When applying an algaecide it is important that the label is completely read and followed. If too much of the lake is treated, an oxygen crash caused by the decomposition of treated algae may cause fish kills. Additionally, treatments should never be applied when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections depending on the size of the lake, (larger lakes will need to be divided into more sections), and then treat the lake one section at a time allowing at least two weeks between treatments. Furthermore, application of algaecides should never be done in extremely hot weather (>90°F) or when dissolved oxygen concentrations are low. It is best to treat in spring or when the blooms/mats start to appear.

A properly implemented plan can often provide season long control with minimal applications. The fishery and waterfowl populations of the lake would also benefit due to a decrease in nuisance algal blooms, which would increase water clarity. This in turn would allow the native aquatic plants to return to the lake. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would also benefit from increases in quality food sources. By implementing a good management plan, usage opportunities for the lake would increase. Activities such as boating and swimming would improve due to the removal of thick blooms and/or mats of algae.

The most obvious drawback of using algaecides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error and overuse can make them unsafe and bring about undesired outcomes. As the algae are continuously exposed to copper, some species are becoming more and more tolerant. This results in the use of higher concentrations in order to achieve adequate control, which can be unhealthy for the lake. In other instances, by eliminating one type of algae, lake managers are finding that other species that are even more problematic are showing up. These species can often be more difficult to control due to an inherent resistance to copper products. Additionally, excessive use of copper products can lead to a build up of copper in lake sediment. This can cause problems for activities such as dredging. Due to a large amount of copper in the sediment, special permits and disposal methods would have to be utilized.

Option 2: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom making it unavailable, thus reducing algal growth. This flocculent layer can then prevent sediment bound phosphorus from entering the water column. Alum treatments typically last 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio benefit more quickly from alum applications, while lakes with high mean depth to surface area ratio (thermally stratified lakes) will see more longevity from an alum application due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited.

Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. This makes alum more cost effective in the long-term compared to continual treatment with algaecides. Effects of alum treatments can be seen in as little as a few days. The increase in clarity can have many positive effects on the lakes ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food/habitat sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations.

There are also several drawbacks to alum. In order for alum to provide long-term effectiveness, external nutrient inputs must also be reduced or eliminated. With larger watersheds this could prove to be physically and financially difficult. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long term control due to disruption of the flocculent layer. If alum is not properly applied, toxicity problems may occur. Due to these concerns, it is recommended that a lake management professional plans and administers the alum treatment.

Option 3: Revegetation With Native Aquatic Plants

A healthy native plant population can reduce algal growth. Many lakes with long-standing algal problems have a sparse to non-existent plant population. This is due to reduction in light penetration by excessive algal blooms and/or mats. Revegetation should only be done when existing nuisance algal blooms 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. Planting depth light levels must be greater than 1-5% of the surface light levels for plant growth. If aquatic herbicides are being used to control existing vegetation, their use should be scaled back or abandoned all together. This will allow the vegetation to grow back, which will help in controlling the algae in addition to other positive impacts associated with a healthy plant population.

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. Plants from one part of the lake should be allowed to naturally expand into adjacent areas filling the niche left by the nuisance algae. 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. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with each other to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire should be erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. A list can be obtained from the Lake Management Unit that lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc).

By revegetating opened areas, the lake will benefit in several ways. Once established, native plant populations will help to control growth of nuisance algae by shading and competition for resources. This provides a more natural approach as compared to other management options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also improve due to the improvement in water quality and the suppression of weedy species.

One drawback is the possibility of new vegetation expanding to nuisance levels and needing control. Another drawback could be high costs if extensive revegetation is needed using imported plants. If a consultant were used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

D3. 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.

D4. 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.

D5. 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.

D6. 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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D7. Options for Lakes with Shoreline Erosion

Option 1: Install a Seawall

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

If installed properly and in the appropriate areas (i.e., shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last many years and have relatively low maintenance. However, seawalls are disadvantageous for several reasons. One of the main

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

Option 2: Install Rock Rip-Rap or Gabions

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

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

Option 3: Create a Buffer Strip

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

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have

to be continuously mowed, watered, or fertilized. Buffer strips may slow the velocity of floodwaters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. In addition, many wildlife species prefer the native shoreline vegetation habitat and various species are even dependent on native shoreline vegetation for their existence. In addition to the benefits of increased wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

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

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

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

Option 5: Install A-Jacks®

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone.
The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® cannot be seen. A disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site.

D8. 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.

D9. 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/