2008 SUMMARY REPORT
of
West Loon Lake

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

West Loon Lake is a 166-acre glacial lake south of the Village of Antioch in northern Lake County. West Loon Lake receives water from approximately 1136 acres within its watershed and drains to East Loon Lake. The lake is a recreational lake used primarily for fishing, boating, and swimming.

West Loon Lake is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency and an Illinois Natural Areas Inventory (INAI) by the state of Illinois. This indicates that the lake and surrounding natural environments have potential to have high quality aquatic resources based on water quality and hydrology values.

Dissolved oxygen concentrations in the epilimnion did not indicate any significant problems during 2008. Anoxic conditions existed from June through September in the hypolimnion. The anoxic boundary ranged from 28 feet (June) to 20 feet (July and August). This represents 6.9% to 23.2%, respectively, of the lake volume based on the bathymetric map created by the Lakes Management Unit (LMU) in 1991.

Water clarity averaged 16.64 feet during 2008 which was a 39% increase from 2003. The May 2008 reading was 24.77 feet and was the 2^{nd} highest single reading of all Lake County lakes. This increase in water clarity was correlated with a decrease in total suspended solids from 1.8 mg/L in 2003 to <1.6 mg/L in 2008. The increased clarity is presumed to be due to the population of zebra mussels which have been present in the lake since 2001.

The Lake County epilimnetic median conductivity reading was 0.8195 milliSiemens per centimeter (mS/cm). During 2008, the West Loon Lake average epilimnetic conductivity reading was lower, at 0.6907 mS/cm. However, this was a 6.5% increase from the 2003 average of 0.6483 mS/cm. Total phosphorus concentrations in 2008 had decreased in the epilimnion (0.014 mg/L) from 2003 (0.018 mg/L) and increased in the hypolimnion (0.205 mg/L) from 2003 (0.131 mg/L). Total Kjeldahl nitrogen concentration had decreased in the epilimnion from a 2003 average of 0.79 mg/L to a 2008 average of 0.72 mg/L, while the hypolimnetic average decreased from 1.80 mg/L in 2003 to 1.49 mg/L in 2008.

West Loon Lake had a diverse aquatic plant community with a total of 18 plant species and one macro-algae found. The most common species found were Flatstem Pondweed at 24% (June) and Water Stargrass at 51% (August) of the sampled sites, while Vallisneria was the second most abundant species in June at 23% of the sampled sites and Sago Pondweed was the second most abundant species on August at 43% of the sampled sites. In 2003 Sago Pondweed was the most common aquatic plant found at 44% of the sampled sites.

The shoreline was reassessed in 2008 for significant changes in erosion since 2003. Based on the 2008 assessment, there was an increase in shoreline erosion with approximately 19% of the shoreline having some degree of erosion. Overall, 81% of the shoreline had no erosion, 13% had slight erosion, and 6% had moderate erosion. There was no severe erosion found in 2008.

LAKE FACTS

Lake Name:	West Loon Lake
Historical Name:	Loon Lake
Nearest Municipality:	Antioch
Location:	T46N, R10E, Section 20 and 21
Elevation:	772.7 feet mean sea level
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Sequoit Creek
Receiving Waterbody:	East Loon Lake
Surface Area:	166.2 acres
Shoreline Length:	2.1 miles
Maximum Depth:	38.0 feet
Average Depth:	14.8 feet
Lake Volume:	2466.7 acre-feet
Lake Type:	Glacial
Watershed Area:	1135.8 acres
Major Watershed Land Uses:	Single family, forest and grassland, and agriculture
Bottom Ownership:	LCFPD, private
Management Entities:	Loon Lakes Management Association
Current and Historical Uses:	Fishing, hunting, swimming, and boating
Description of Access:	Private (public may access for a fee)

SUMMARY OF WATER QUALITY

Water samples were collected monthly from May through September at the deepest point in the lake (Figure 1, Appendix A). West Loon Lake was sampled at depths of three feet and 35 to 37 feet depending on water level and the samples were analyzed for various water quality parameters (Appendix C). In addition, West Loon Lake participated in the Volunteer Lake Monitoring Program (VLMP) from 1988 to 2007. It is strongly recommended that West Loon Lake become a member of the VLMP program again. West Loon Lake is within the Sequiot Creek watershed which the Lakes Management Unit (LMU) sampled in its entirety in 2008. This watershed also includes Cedar Lake, Deep Lake, Sun Lake, East Loon Lake, and Little Silver Lake.

West Loon Lake was thermally stratified from May through September. Thermal stratification is when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold-water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically experiences anoxic conditions (where dissolved oxygen [DO] concentrations drop below 1 mg/L) by mid-summer. In 2008, West Loon Lake was weakly stratified in May and strongly stratified at approximately the 18 feet by June. The thermocline (the transitional region between the epilimnion and the hypolimnion) remained strong throughout the season. Turnover (mixing) was beginning during the September sampling, although the thermocline was still present at approximately 24 feet.

A DO concentration of 5.0 mg/L is considered adequate to support a sport fish fishery, since fish can suffer oxygen stress below this amount. DO concentrations in the epilimnion did not indicate any significant problems (Appendix B). Anoxic conditions existed from June through September in the hypolimnion. This is a normal phenomenon in large, deep lakes that stratify. The anoxic boundary ranged from 28 feet (June) to 20 feet (July and August). This represents 6.9% to 23.2%, respectively, of the lake volume based on the bathymetric map created by the LMU in 1991. It is recommended that any bathymetric map older than 15 years be updated.

The Zebra Mussel population, which has been present in the lake since 2001, appears to be affecting the water clarity and quality in West Loon Lake. Zebra Mussels filter out zooplankton and phytoplankton from the water column with increases water clarity and decreases total suspended solids (TSS). Secchi disk depth (water clarity) averaged 16.64 feet during 2008 which was a 39% increase from the 2003 average of 11.96 feet (Table 1). Both of these readings were above the Lake County median of 3.12 feet (Appendix E). In the monitoring before the discovery of Zebra Mussels the Secchi depth averaged 9.52 feet and since 2001 the average has increased 50% to 14.30 feet. From 1988 to 2007, West Loon Lake participated in the Volunteer Lake Monitoring Program (VLMP). This program provided beneficial information on the annual water clarity trends in the lake. However, the lake currently lacks a volunteer. It is strongly recommended that West Loon Lake become a member of the VLMP program again. The VLMP average Secchi depth averaged 11.16 feet from 1988 – 2007. This data also shows an increase in clarity since the discovery of Zebra Mussels. The average Secchi depth from 1988 – 2000 was 9.07 feet and from 2001 to 2007 the average Secchi depth increased 53% to 13.85 feet (Figure 2).

Figure 1. Water quality sampling site on West Loon Lake, 2008

Table 1. Water quality data for West Loon Lake, 2003 and 2008

2008	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	3	167	0.58	<0.1	<0.05	<0.01	<0.005	125	NA	<1.0	421	83	24.77	0.7588	8.43	9.52
17-Jun	3	163	1.12	0.424	0.080	<0.01	<0.005	116	NA	2.4	419	95	14.60	0.7262	8.47	8.49
15-Jul	3	151	0.69	<0.1	<0.05	0.015	<0.005	107	NA	1.5	407	100	14.63	0.6698	8.66	8.46
19-Aug	3	143	0.55	<0.1	<0.05	0.014	<0.005	109	NA	1.4	404	112	14.47	0.6500	8.71	8.54
16-Sep	3	137	0.65	<0.1	<0.05	0.012	<0.005	109	NA	1.1	394	111	14.73	0.6489	8.41	7.34
	Average	152	0.72	0.424^k	0.080^k	0.014^k	<0.005	113	NA	1.6^k	409	100	16.64	0.6907	8.54	8.47

2003	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
07-May	3	168	0.83	<0.1	<0.05	0.018	<0.005	NA	353	2.5	392	96	9.19	0.6602	8.44	9.47
04-Jun	3	170	0.90	<0.1	<0.05	0.020	<0.005	NA	373	2.2	399	107	11.98	0.6695	8.54	9.20
09-Jul	3	151	0.77	<0.1	<0.05	0.021	<0.005	NA	374	1.5	387	104	12.47	0.6324	8.46	7.03
06-Aug	3	150	0.73	<0.1	<0.05	0.020	<0.005	NA	342	1.5	385	104	12.27	0.6358	8.67	7.54
10-Sep	3	151	0.69	<0.1	<0.05	0.012	<0.005	NA	358	1.3	382	117	13.91	0.6435	8.59	8.62
	Average	158	0.79	<0.1	<0.05	0.018	<0.005	NA	360	1.8	389	106	11.96	0.6483	8.54	8.37

Glossary

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

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

Table 1. Continued

2008	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	35	174	0.857	0.349	0.059	0.013	<0.005	124	NA	<1	437	95	NA	0.7600	7.69	2.23
17-Jun	36	178	0.644	<0.1	<0.05	0.083	0.051	125	NA	3.6	462	108	NA	0.7721	7.45	0.22
15-Jul	37	186	1.36	0.633	<0.05	0.200	0.142	125	NA	3.9	488	128	NA	0.7759	7.38	0.19
19-Aug	35	200	1.83	1.090	<0.05	0.294	0.223	126	NA	3.3	481	123	NA	0.7753	7.18	0.19
16-Sep	36	211	2.78	2.060	<0.05	0.434	0.329	127	NA	4.9	475	109	NA	0.7995	7.09	0.20
	Average	190	1.49	1.033	0.059	0.205	0.186	125	NA	3.9[k]	469	113	NA	0.7766	7.36	0.61

2003	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
07-May	33	168	0.75	<0.1	<0.05	0.012	<0.005	NA	340	2.6	391	102	NA	0.6643	7.55	0.71
04-Jun	36	177	1.51	0.526	<0.05	0.09	0.043	NA	388	2.5	401	103	NA	0.6782	7.50	0.11
09-Jul	33	189	1.93	0.928	<0.05	0.143	0.097	NA	382	3.3	410	121	NA	0.6733	7.34	0.06
06-Aug	34	192	1.78	0.929	<0.05	0.149	0.078	NA	391	3.5	417	112	NA	0.6966	7.36	0.08
10-Sep	33	215	3.03	2.310	<0.05	0.259	0.236	NA	411	4.2	413	124	NA	0.7068	7.2	0.06
	Average	188	1.80	1.173[k]	<0.05	0.131	0.114[k]	NA	382	3.2	406	112	NA	0.6838	7.39	0.20

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L
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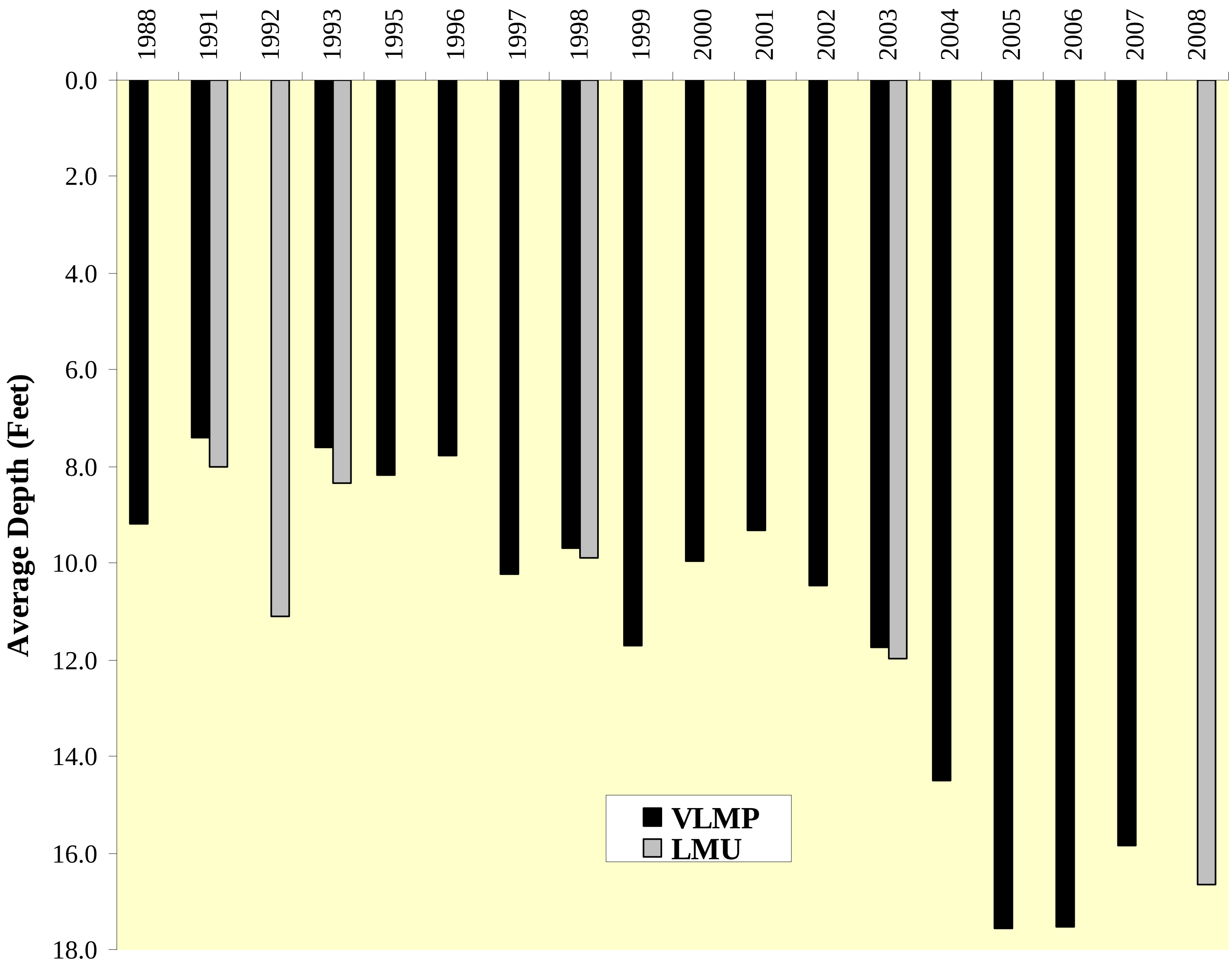
k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed

Figure 2. Secchi disk averages from VLMP and LCHD records for West Loon Lake.



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The LMU May reading of 24.77 feet was the 2nd highest single record in Lake County (Bangs Lake in May 2005 was 29.25 feet). The water clarity averaged just over 14.61 feet for the rest of the sampling season. The increase in water clarity was correlated with a decrease in TSS in the water column (Figure 3). TSS is composed of nonvolatile suspended solids, non-organic clay or sediment materials, and volatile suspended solids, algae and other organic matter. In 2008 the average TSS in the epilimnion was <1.6 mg/L while in 2003 it averaged 1.8 mg/L. Both values were below the county median of 8.2 mg/L. In May 2008, the TSS concentration below the detection limit of the lab so the actual value is less than 1.6 mg/L. While Zebra Mussels may be contributing to the increase in water clarity and decrease in TSS, the healthy aquatic plant populations in the lake also contributed. The plant populations appear to be well balanced, in contrast to the potential long-term negative impacts Zebra Mussels may have.

West Loon Lake had the deepest average Secchi depth and the lowest average TSS of all the lakes within the watershed (Table 2). This is likely due to West Loon Lake being near the top of the watershed. Sun Lake and East Loon Lake had the lowest average Secchi depth and highest average TSS of all the lakes within the watershed in 2008.

Another factor affecting water clarity was the amount of nutrients in the water. Typically, lakes are either phosphorus (P) or nitrogen (N) 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 and/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 than or equal to 15:1 indicate phosphorus is limiting, and ratios greater than 10:1, but less than 15:1 indicate there is enough of both nutrients to facilitate excess algae or plant growth. West Loon Lake had a TN:TP ratio of 44:1 in 2003 and 53:1 in 2008, indicating the lake was highly phosphorous limited. Nitrogen naturally occurs in high concentrations and come from a variety of sources (soil, air, etc.), which are more difficult to control than sources of phosphorus. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen.

Total Kjeldahl nitrogen (TKN) measures organic forms of nitrogen. TKN concentration averages for both the epilimnion and hypolimnion in 2008 decreased from 2003. The near surface samples in 2003 had a TKN average of 0.79 mg/L, which decreased slightly to 0.72 mg/L in 2008. The TKN averages in the hypolimnion decreased from 1.80 mg/L in 2003 to 1.49 mg/L in 2008.

Total phosphorus (TP) concentrations in 2008 in West Loon Lake averaged lower than the Lake County epilimnetic median of 0.065 mg/L and higher than the hypolimnetic median of 0.181 mg/L. The epilimnetic TP has decreased since 2003 when it averaged 0.018 mg/L and the hypolimnetic TP has increased from 2003 when it averaged 0.131 mg/L. The 2008 average TP concentration was 0.014 mg/L in the epilimnion and 0.205 mg/L in the hypolimnion. TP concentrations in the hypolimnion increased from May through September as the thermocline strengthened prohibiting the internally loaded TP in the hypolimnion to mix with the epilimnion.

Figure 3. Total suspended solid (TSS) concentrations vs. Secchi depth for West Loon Lake, 2008

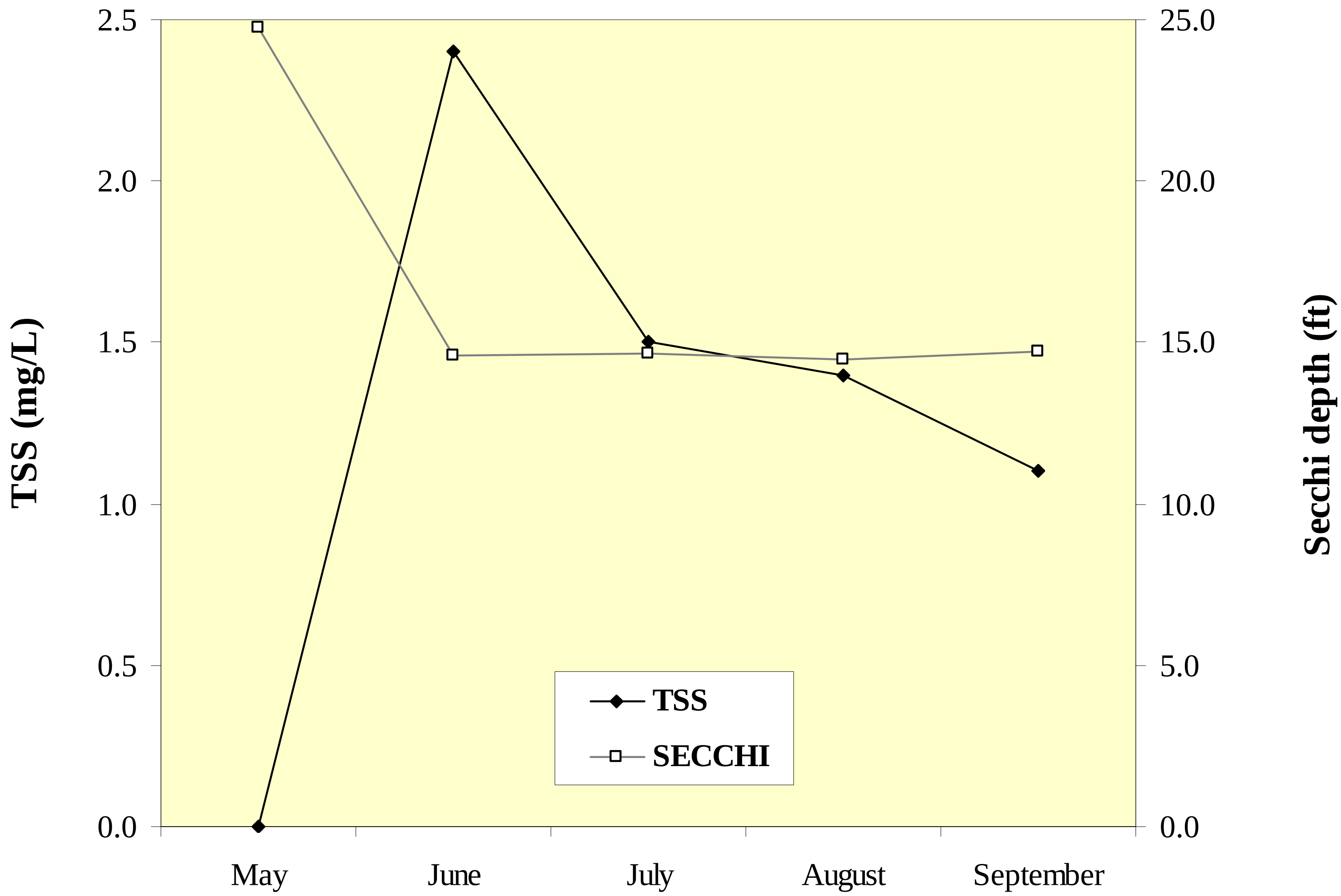


Table 2. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus and conductivity readings in the Sequiot Creek watershed (Cedar Lake, Deep Lake, Sun Lake, East Loon Lake, West Loon, and Little Silver Lake)

	Cedar Lake	Cedar Lake	Cedar Lake	Cedar Lake	Cedar Lake	Cedar Lake	Deep Lake	Deep Lake	Deep Lake	Deep Lake	Deep Lake	Deep Lake	Sun Lake	Sun Lake	Sun Lake
Year	**1998**	**2003**	**2005**	**2006**	**2007**	**2008**	**1989**	**1992**	**1993**	**1998**	**2003**	**2008**	**1993**	**2001**	**2008**
Secchi (feet)	8.5	12.16	8.58	13.07	11.35	7.04	11.55	10.34	9.65	9.76	12.48	8.14	8.46	8.22	6.33
TSS (mg/L)	3.1	2.2	2.4	1.9	2.1	2.6	6.3	1.7	2.0	2.6	2.4	3.0	0.5	2.4	2.2
TP (mg/L)	0.015	0.021	0.018	0.015	0.016	0.022	0.040	0.021	0.025	0.023	0.024	0.023	0.031	0.041	0.022
Conductivity (milliSiemens/cm)	0.5816	0.5932	0.6447	0.6745	0.6690	0.6723	NA	NA	NA	0.8112	0.9520	1.0726	NA	0.8068	1.0548

	West Loon Lake	West Loon Lake	West Loon Lake	West Loon Lake	West Loon Lake	West Loon Lake	East Loon Lake	East Loon Lake	East Loon Lake	East Loon Lake	East Loon Lake	East Loon Lake	Little Silver Lake	Little Silver Lake	Little Silver Lake
Year	**1991**	**1992**	**1993**	**1998**	**2003**	**2008**	**1991**	**1992**	**1993**	**1998**	**2003**	**2008**	**1999**	**2003**	**2008**
Secchi (feet)	8.00	11.13	9.08	9.88	11.96	16.64	4.30	6.26	4.01	5.94	5.32	6.39	10.72	10.12	9.42
TSS (mg/L)	10.7	2.7	5.8	2.2	1.8	1.6	5.3	3.4	3.1	4.0	4.1	4.6	1.5	1.8	1.8
TP (mg/L)	0.016	0.013	0.017	0.011	0.018	0.014	0.026	0.018	0.052	0.028	0.028	0.049	0.020	0.025	0.025
Conductivity (milliSiemens/cm)	NA	NA	NA	0.6476	0.6483	0.6907	NA	NA	NA	0.6710	0.8160	0.8148	0.6024	0.7619	0.7270

Direction of Watershed Flow

There were external sources of TP affecting West Loon Lake such as stormwater from the 1135.80 acres within its watershed (Figure 4). Single family (24%), forest and grassland (16%), and agriculture (15%) were the major land uses within the watershed (Figure 5). For West Loon Lake, single family (32%) and transportation (31%) were the land uses contributing the highest percentages of estimated runoff (Table 3). It is important to keep in mind that although the amount of estimated runoff from certain areas may be low, they can still deliver high concentrations of TSS and TP. The retention time (the amount of time it takes for water entering a lake to flow out of it again) was calculated to be approximately 3.53 years.

The watershed is the land and water around a lake that drains to that lake. This means that any management of the land within the watershed can directly affect the lake. To reduce impacts to the lake residents can apply phosphorous free fertilizer to their lawns, have their septic tanks pumped, serviced, and inspected regularly, and use alternative methods for winter de-icing of sidewalks and roads. Also, increased impervious surface creates increased run-off which can raise the lake level by not allowing as much water to infiltrate into the ground. Increased water in a lake creates a larger volume of water which can hold more nutrients and can also lead to flooding.

Total phosphorous can be used to calculate 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 that can support nuisance algae growth reminiscent of “pea soup” and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae. Mesotrophic and oligotrophic lakes have lower nutrient levels. These are very clear lakes, with little algal growth. Most lakes in Lake County are eutrophic. The trophic state of West Loon Lake in terms of its phosphorus concentration during 2003 was mesotrophic, with a TSIp score of 46.0. In 2008 the TSIp score was lower at 42.2, which still classified West Loon Lake as mesotrophic and ranked 6^{th} out of 163 lakes in Lake County based on average TP concentrations (Table 4).

The Illinois Environmental Protection Agency (IEPA) has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, and recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations (TSIp), and aquatic plant coverage. According to this index, West Loon Lake provides *Full* support of aquatic life and *Full* support of recreational activities. The lake provides *Full* overall use.

Conductivity is a measurement of water’s ability to conduct electricity and is correlated with chloride (Cl^-) concentrations (Figure 6). 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 Cl^- to nearby waterbodies. The Lake County epilimnetic median conductivity reading was 0.8195 milliSiemens per centimeter (mS/cm). During 2008, the West Loon Lake average epilimnetic conductivity reading was lower, at 0.6907 mS/cm. However, this was a 6.5% increase from the

Figure 4. Approximate watershed delineation for West Loon Lake, 2008

Figure 5. Approximate land use within the West Loon Lake watershed, 2008

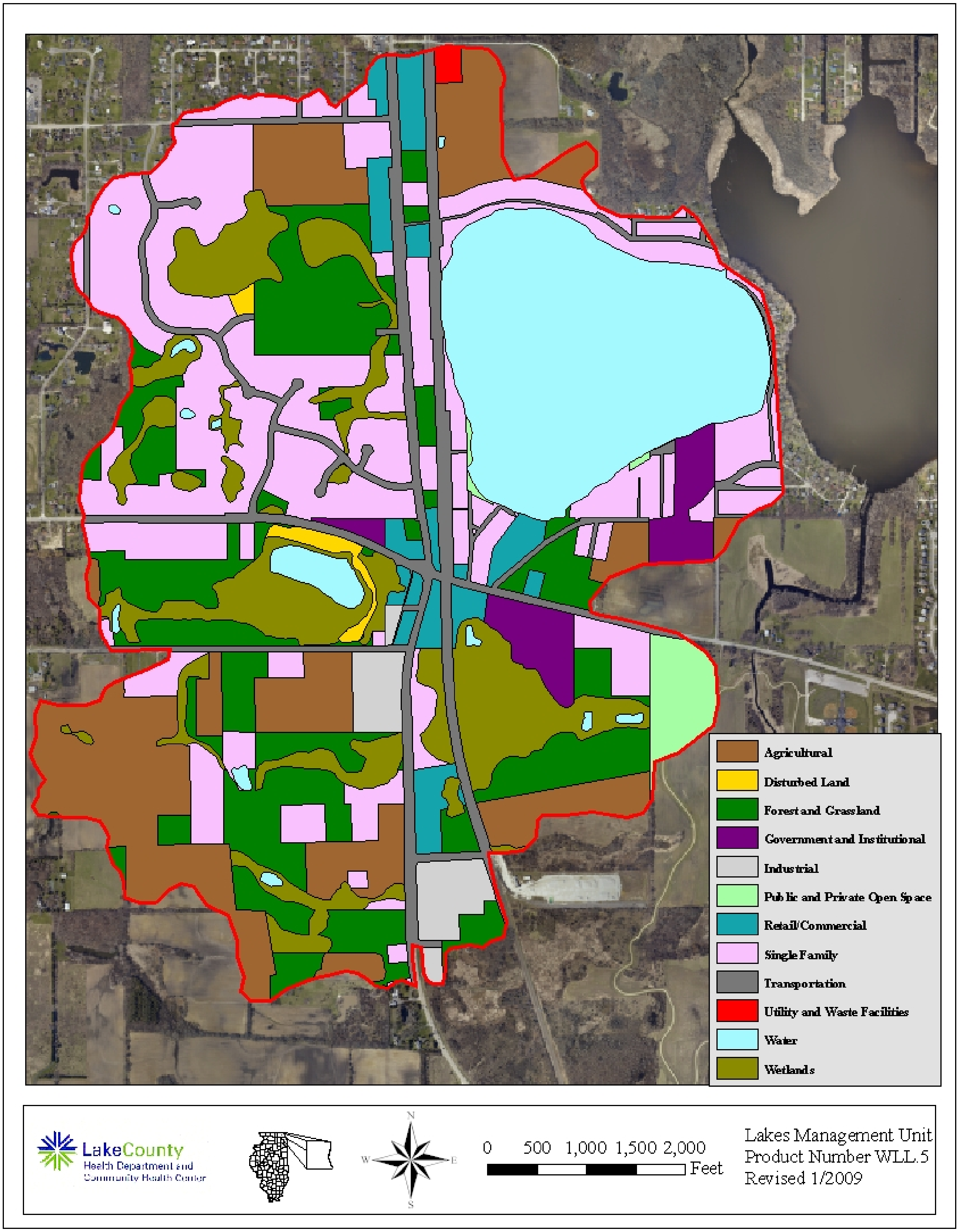


Table 3. Approximate land uses and retention time for West Loon Lake, 2008

Land Use	Acreage	% of Total
Agricultural	166.18	14.6%
Disturbed Land	6.42	0.6%
Forest and Grassland	177.36	15.6%
Government and Institutional	29.60	2.6%
Industrial	23.82	2.1%
Public and Private Open Space	18.07	1.6%
Retail/Commercial	40.30	3.5%
Single Family	267.88	23.6%
Transportation	91.55	8.1%
Utility and Waste Facilities	2.28	0.2%
Water	177.05	15.6%
Wetlands	135.26	11.9%
Total Acres	**1135.75**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	166.18	0.05	22.8	3.3%
Disturbed Land	6.42	0.05	0.9	0.1%
Forest and Grassland	177.36	0.05	24.4	3.5%
Government and Institutional	29.60	0.50	40.7	5.8%
Industrial	23.82	0.80	52.4	7.5%
Public and Private Open Space	18.07	0.15	7.5	1.1%
Retail/Commercial	40.30	0.85	94.2	13.5%
Single Family	267.88	0.30	221.0	31.6%
Transportation	91.55	0.85	214.0	30.6%
Utility and Waste Facilities	2.28	0.30	1.9	0.3%
Water	177.05	0.00	0.0	0.0%
Wetlands	135.26	0.05	18.6	2.7%
TOTAL	**1135.75**		**698.3**	100.0%

Lake volume	**2466.56**	**acre-feet**
Retention Time (years)= lake volume/runoff	**3.53**	**years**
	1289.21	**days**

Table 4. Lake County average TSI phosphorous (TSIp) ranking 2000-2008

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0135	39.24
4	Lake Zurich	0.0130	41.14
5	Sand Pond (IDNR)	0.0165	41.36
6	**West Loon Lake**	**0.0140**	**42.21**
7	Windward Lake	0.0158	43.95
8	Bangs Lake	0.0170	45.00
9	Pulaski Pond	0.0180	45.83
10	Timber Lake	0.0180	45.83
11	Fourth Lake	0.0182	45.99
12	Lake Kathryn	0.0200	47.35
13	Lake of the Hollow	0.0200	47.35
14	Banana Pond	0.0202	47.49
15	Lake Minear	0.0204	47.63
16	Cedar Lake	0.0220	48.72
17	Cross Lake	0.0220	48.72
18	Sun Lake	0.0220	48.72
19	Dog Pond	0.0222	48.85
20	Stone Quarry Lake	0.0230	49.36
21	Deep Lake	0.0234	49.61
22	Druce Lake	0.0244	50.22
23	Little Silver	0.0250	50.57
24	Round Lake	0.0254	50.80
25	Lake Leo	0.0256	50.91
26	Cranberry Lake	0.0270	51.68
27	Dugdale Lake	0.0274	51.89
28	Peterson Pond	0.0274	51.89
29	Lake Miltmore	0.0276	51.99
30	Third Lake	0.0280	52.20
31	Lake Fairfield	0.0296	53.00
32	Gray's Lake	0.0302	53.29
33	Highland Lake	0.0302	53.29
34	Hook Lake	0.0302	53.29
35	Lake Catherine (Site 1)	0.0308	53.57
36	Lambs Farm Lake	0.0312	53.76
37	Old School Lake	0.0312	53.76
38	Sand Lake	0.0316	53.94
39	Sullivan Lake	0.0320	54.13
40	Lake Linden	0.0326	54.39
41	Gages Lake	0.0338	54.92
42	Honey Lake	0.0340	55.00
43	Hendrick Lake	0.0344	55.17
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	Ames Pit	0.0390	56.98

Table 4. Continued

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Potomac Lake	0.0424	58.18
49	Duck Lake	0.0426	58.25
50	Old Oak Lake	0.0428	58.32
51	Deer Lake	0.0434	58.52
52	Schreiber Lake	0.0434	58.52
53	Nielsen Pond	0.0448	58.98
54	Turner Lake	0.0458	59.30
55	Seven Acre Lake	0.0460	59.36
56	Willow Lake	0.0464	59.48
57	Lucky Lake	0.0476	59.85
58	Davis Lake	0.0476	59.85
59	East Meadow Lake	0.0478	59.91
60	East Loon Lake	0.0490	60.27
61	College Trail Lake	0.0496	60.45
62	Lake Lakeland Estates	0.0524	61.24
63	Butler Lake	0.0528	61.35
64	West Meadow Lake	0.0530	61.40
65	Heron Pond	0.0545	61.80
66	Little Bear Lake	0.0550	61.94
67	Lucy Lake	0.0552	61.99
68	Lake Christa	0.0576	62.60
69	Lake Charles	0.0580	62.70
70	Crooked Lake	0.0608	63.38
71	Waterford Lake	0.0610	63.43
72	Lake Naomi	0.0616	63.57
73	Lake Tranquility S1	0.0618	63.62
74	Wooster Lake	0.0620	63.66
75	Countryside Lake	0.0620	63.66
76	Werhane Lake	0.0630	63.89
77	Liberty Lake	0.0632	63.94
78	Countryside Glen Lake	0.0642	64.17
79	Lake Fairview	0.0648	64.30
80	Leisure Lake	0.0648	64.30
81	Tower Lake	0.0662	64.61
82	St. Mary's Lake	0.0666	64.70
83	Mary Lee Lake	0.0682	65.04
84	Hastings Lake	0.0684	65.08
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Sylvan Lake	0.0794	67.23
91	Big Bear Lake	0.0806	67.45
92	Petite Lake	0.0834	67.94

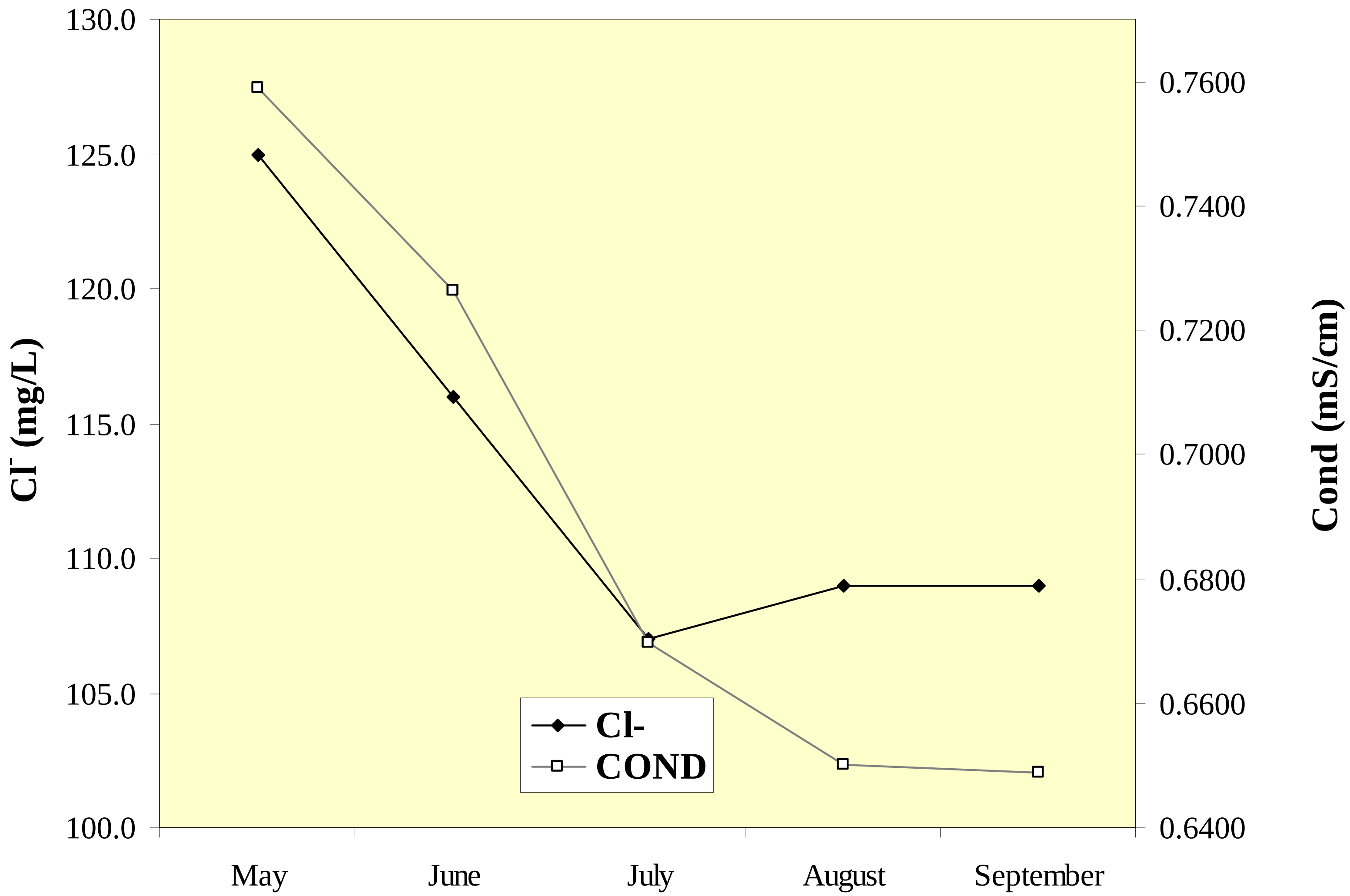
Table 4. Continued

RANK	LAKE NAME	TP AVE	TSIp
93	Timber Lake (South)	0.0848	68.18
94	Lake Marie (Site 1)	0.0850	68.21
95	North Churchill Lake	0.0872	68.58
96	Grand Avenue Marsh	0.0874	68.61
97	Grandwood Park, Site II, Outflow	0.0876	68.65
98	North Tower Lake	0.0878	68.68
99	South Churchill Lake	0.0896	68.97
100	Rivershire Pond 2	0.0900	69.04
101	McGreal Lake	0.0914	69.26
102	International Mine and Chemical Lake	0.0948	69.79
103	Eagle Lake (Site I)	0.0950	69.82
104	Valley Lake	0.0950	69.82
105	Dunns Lake	0.0952	69.85
106	Fish Lake	0.0956	69.91
107	Lochanora Lake	0.0960	69.97
108	Owens Lake	0.0978	70.23
109	Woodland Lake	0.0986	70.35
110	Island Lake	0.0990	70.41
111	McDonald Lake 1	0.0996	70.50
112	Longview Meadow Lake	0.1024	70.90
113	Lake Barrington	0.1053	71.31
114	Redwing Slough, Site II, Outflow	0.1072	71.56
115	Lake Forest Pond	0.1074	71.59
116	Bittersweet Golf Course #13	0.1096	71.88
117	Fox Lake (Site 1)	0.1098	71.90
118	Osprey Lake	0.1108	72.04
119	Bresen Lake	0.1126	72.27
120	Round Lake Marsh North	0.1126	72.27
121	Deer Lake Meadow Lake	0.1158	72.67
122	Long Lake	0.1170	72.82
123	Taylor Lake	0.1184	72.99
124	Columbus Park Lake	0.1226	73.49
125	Nippersink Lake (Site 1)	0.1240	73.66
126	Echo Lake	0.1250	73.77
127	Grass Lake (Site 1)	0.1288	74.21
128	Lake Holloway	0.1322	74.58
129	Lakewood Marsh	0.1330	74.67
130	Summerhill Estates Lake	0.1384	75.24
131	Redhead Lake	0.1412	75.53
132	Forest Lake	0.1422	75.63
133	Antioch Lake	0.1448	75.89
134	Slocum Lake	0.1496	76.36
135	Drummond Lake	0.1510	76.50
136	Pond-a-Rudy	0.1514	76.54
137	Lake Matthews	0.1516	76.56
138	Buffalo Creek Reservoir	0.1550	76.88

Table 4. Continued

RANK	LAKE NAME	TP AVE	TSIp
139	Pistakee Lake (Site 1)	0.1592	77.26
140	Grassy Lake	0.1610	77.42
141	Salem Lake	0.1650	77.78
142	Half Day Pit	0.1690	78.12
143	Lake Eleanor Site II, Outflow	0.1812	79.13
144	Lake Farmington	0.1848	79.41
145	Lake Louise	0.1850	79.43
146	ADID 127	0.1886	79.71
147	Dog Bone Lake	0.1990	80.48
148	Redwing Marsh	0.2072	81.06
149	Stockholm Lake	0.2082	81.13
150	Bishop Lake	0.2156	81.63
151	Hidden Lake	0.2236	82.16
152	Fischer Lake	0.2278	82.43
153	Lake Napa Suwe (Outlet)	0.2304	82.59
154	Patski Pond (outlet)	0.2512	83.84
155	Oak Hills Lake	0.2792	85.36
156	Loch Lomond	0.2954	86.18
157	McDonald Lake 2	0.3254	87.57
158	Fairfield Marsh	0.3264	87.61
159	ADID 182	0.3280	87.69
160	Slough Lake	0.4134	91.02
161	Flint Lake Outlet	0.4996	93.75
162	Rasmussen Lake	0.5025	93.84
163	Albert Lake, Site II, outflow	1.1894	106.26

Figure 6. Chloride (Cl^-) concentration vs. conductivity for West Loon Lake, 2008



2003 average of 0.6483 mS/cm. The hypolimnetic averages were also lower than the county median of 0.8695mS/cm both in 2003 (0.6838 mS/cm) and 2008 (0.7766 mS/cm). In addition, Cl^- concentration in West Loon Lake was lower than the Lake County epilimnetic median of 166 mg/L during 2008, with an epilimnetic average of 125 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, lakes can be negatively impacted by the high Cl^- concentrations.

Since the 2003 report, significant development has occurred in the lake's immediate watershed, which has caused legitimate concerns among residents and stakeholders. Specifically, a Wal-Mart store and various out lots have been constructed. Stormwater from this site is detained in a pond in the west end of the developed property, before being release through a pipe and draining to East Loon Lake. It is possible that stormwater from adjacent developments or private property in the watershed may be negatively impacting the lake or surrounding wetlands. As a result of the concern for the lake and surrounding wetlands in 2003, the Illinois Environmental Protection Agency (IEPA) required the contractor (Great Lakes Principals), as part of their certification under Section 401 of the Clean Water Act, to limit the annual application of chloride containing de-icing agents to 5,562 pounds per year on the approximately 67 acre development site. This includes the Menards and Wal-Mart complexes and associated out lot businesses. This reduction of potentially harmful chemicals is certainly a positive action that resulted from the construction problems that occurred on the site prior to 2003. Any future development within the watershed should follow this precedent.

SUMMARY OF AQUATIC MACROPHYTES

Aquatic plant (macrophyte) surveys were conducted in June and August of 2008. Sampling sites were based on a grid system created by mapping software (ArcMap), with each site located 60 meters apart for a total of 188 sites. There were 90 sites sampled in June (Figure 7) and 94 sites sampled in August (Figure 8). Plants were found at 64 sites in June and 83 sites in August, at maximum depths of 12.4 feet and 13.5 feet respectively (Table 5a, b). Overall, a total of 18 plant species and one macro-algae were found (Table 6). The most common species found were Flatstem Pondweed at 24% (June) and Water Stargrass at 51% (August) of the sampled sites, while Vallisneria was the second most abundant species in June at 23% of the sampled sites and Sago Pondweed was the second most abundant species on August at 43% of the sampled sites. In 2003 Sago Pondweed was the most common aquatic plant found at 44% of the sampled sites. Species composition remained the same as 2003 when 18 plant species and one macro-algae were found. However the species composition differed. There were four species (Northern Watermilfoil (1%), Threadleaf Pondweed (4%), Grass-leaved Pondweed (3%), and Small Pondweed (1%)) found in 2003 that were not found in 2008 and four species (Small Duckweed (2 – 3%), Elodea (5%), Star Duckweed (2%), and Watermeal (1%)) found in 2008 that were not found in 2003. The different sampling techniques between the two years could be why some species were not found. Two exotic aquatic plants, Eurasian Watermilfoil (EWM) and Curlyleaf Pondweed, were found in West Loon Lake in both years. EWM was found at 18% of the sampled sites in June and 33% of the sampled sites in August. Exotic species compete with

Figure 7. Aquatic plant sampling grid that illustrates plant density on West Loon Lake, June 2008

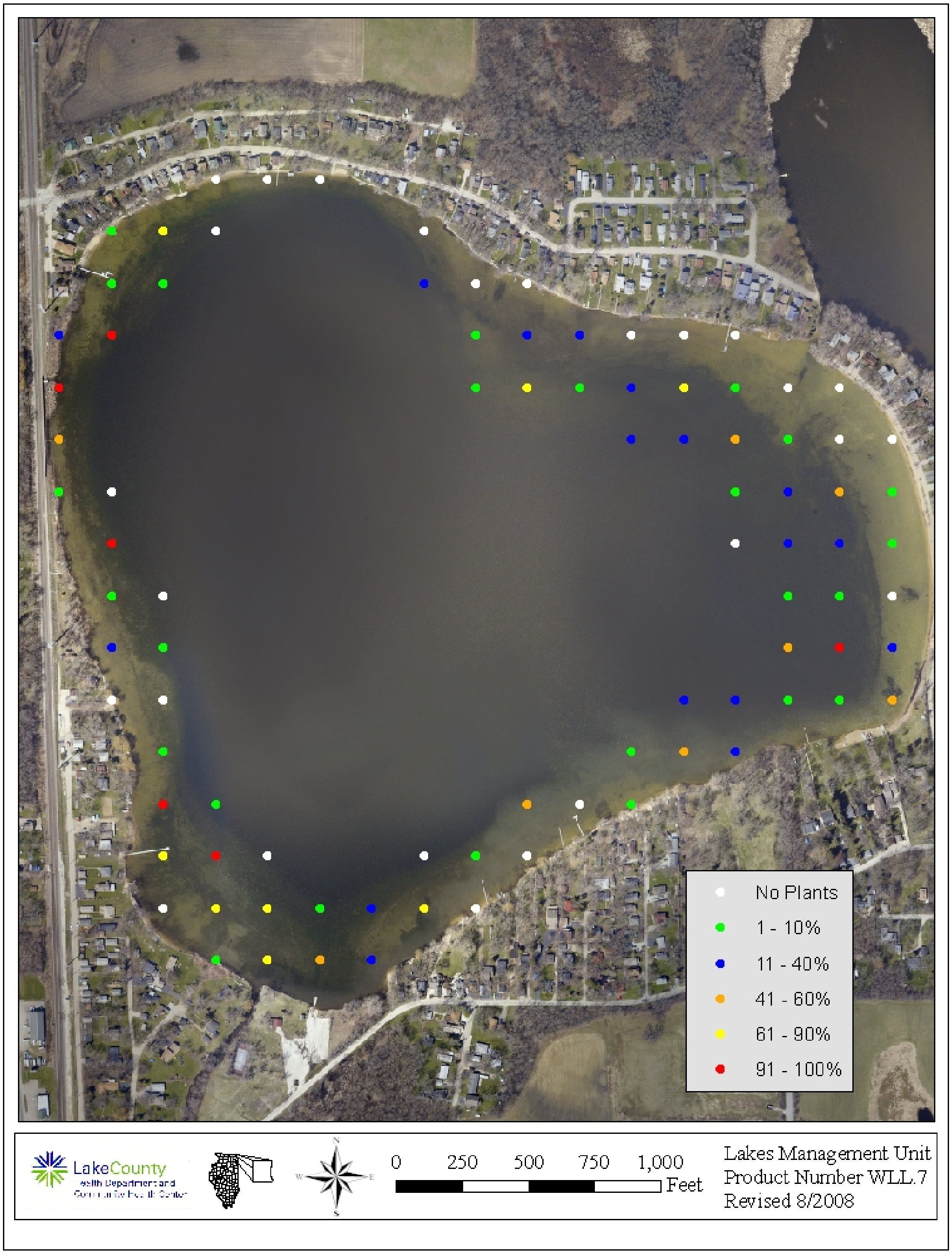


Figure 8. Aquatic plant sampling grid that illustrates plant density on West Loon Lake, August 2008

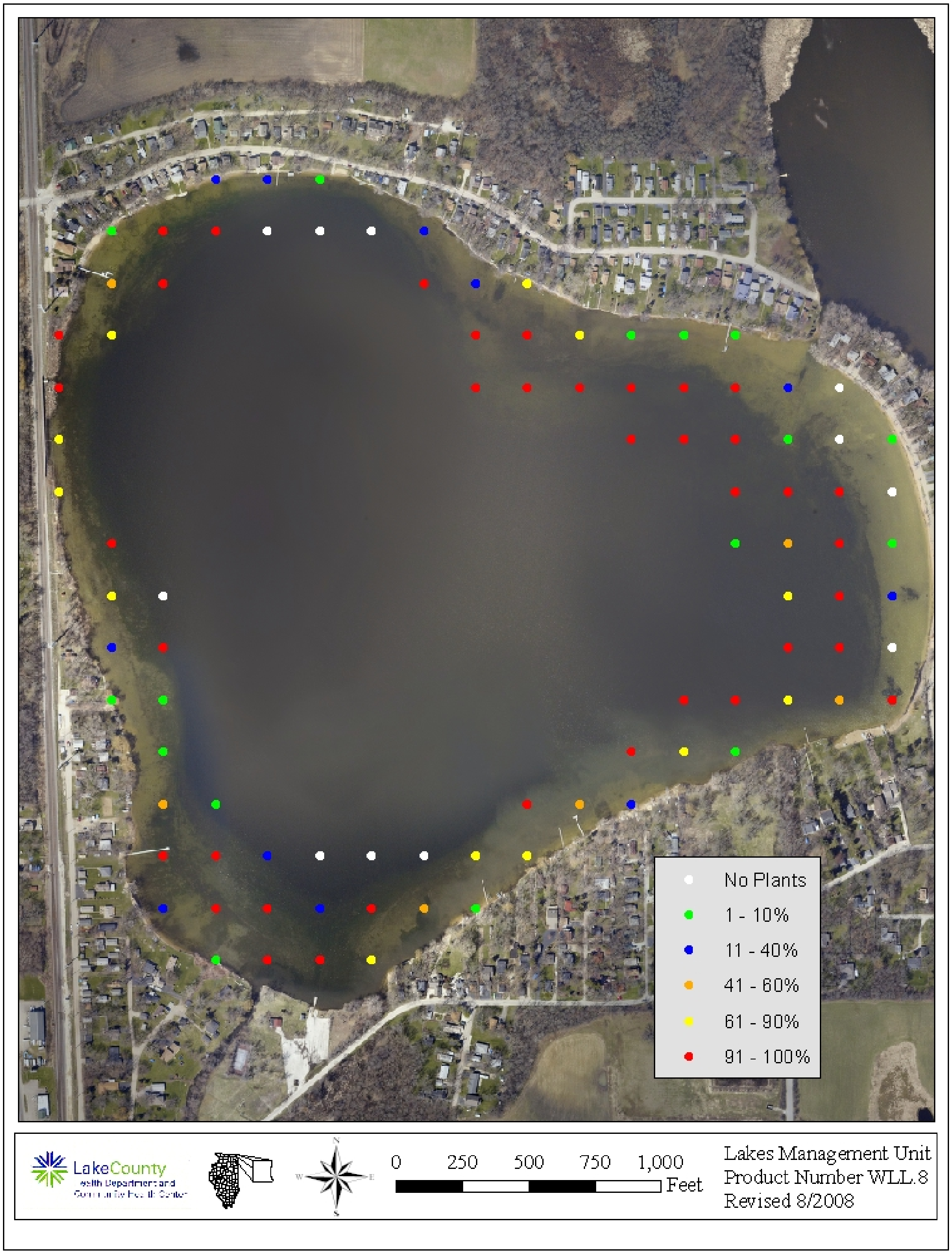


Table 5a. Aquatic plant species found at the 90 sampling sites on West Loon Lake, June 2008. Maximum depth that plants were found was 12.4 feet

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Floatingleaf Pondweed
Absent	76	86	80	88	87	74	68	89
Present	8	3	6	2	2	11	14	1
Common	3	0	1	0	1	4	4	0
Abundant	3	1	2	0	0	0	1	0
Dominant	0	0	1	0	0	1	3	0
% Plant Occurrence	15.6%	4.4%	11.1%	2.2%	3.3%	17.8%	24.4%	1.1%

Plant Density	Illinois Pondweed	Largeleaf Pondweed	Sago Pondweed	Star Duckweed	Vallisneria	White Water Crowfoot	Water Stargrass	White Water Lily
Absent	75	89	72	88	69	88	78	81
Present	15	0	9	2	20	0	4	8
Common	0	0	5	0	1	2	4	1
Abundant	0	1	3	0	0	0	2	0
Dominant	0	0	1	0	0	0	2	0
% Plant Occurrence	16.7%	1.1%	20.0%	2.2%	23.3%	2.2%	13.3%	10.0%

Table 5b. Aquatic plant species found at the 94 sampling sites on West Loon Lake, August 2008. Maximum depth that plants were found was 13.5 feet

Plant Density	American Pondweed	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Illinois Pondweed
Absent	84	73	85	92	91	89	63	75	63
Present	8	13	5	2	3	4	23	11	24
Common	2	2	2	0	0	0	6	8	6
Abundant	0	5	0	0	0	1	2	0	1
Dominant	0	1	2	0	0	0	0	0	0
% Plant Occurrence	10.6%	22.3%	9.6%	2.1%	3.2%	5.3%	33.0%	20.2%	33.0%

Plant Density	Largeleaf Pondweed	Sago Pondweed	Slender Naiad	Vallisneria	White Water Crowfoot	Watermeal	Water Stargrass	White Water Lily
Absent	90	54	72	58	90	93	46	85
Present	3	22	14	19	4	1	15	7
Common	1	12	7	7	0	0	4	1
Abundant	0	4	1	5	0	0	5	1
Dominant	0	2	0	5	0	0	24	0
% Plant Occurrence	4.3%	42.6%	23.4%	38.3%	4.3%	1.1%	51.1%	9.6%

Table 6. Aquatic plant species found in West Loon Lake in 2008.

Coontail	*Ceratophyllum demersum*
Chara (Macro algae)	*Chara* spp.
American Elodea	*Elodea canadensis*
Water Stargrass	*Heteranthera dubia*
Small Duckweed	*Lemna minor*
Star Duckweed	*Lemna trisulca*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
White Water Lily	*Nymphaea tuberosa*
Largeleaf Pondweed	*Potamogeton amplifolius*
Curlyleaf Pondweed^	*Potamogeton crispus*
Illinois Pondweed	*Potamogeton illinoensis*
Floatingleaf Pondweed	*Potamogeton natans*
American Pondweed	*Potamogeton nodosus*
Sago Pondweed	*Potamogeton pectinatus*
Flatstem Pondweed	*Potamogeton zosteriformis*
White Water Crowfoot	*Ranunculus longirostris*
Vallisneria	*Vallisneria americana*
Watermeal	*Wolffia columbiana*

^ Exotic plant

native plants, potentially crowding them out, providing little or poor natural diversity and limited uses by wildlife. Removal or control of exotic species is recommended. Loon Lakes Management Association (LLMA) is currently working on an aquatic plant management plan for both East and West Loon Lakes for 2009. The plan is being developed to concentrate on areas where EWM was most dense (Figure 9; Figure 10). The proposed plan includes herbicide treatment and mechanical harvesting of EWM in East Loon Lake and mechanical harvesting in West Loon Lake (Figure 11). To improve aquatic habitat and recreational quality, LLMA proposes to chemically treat approximately 19.3 acres on East Loon Lake in May. The area was selected based on LMU the aquatic plant survey in 2008 that found heavy EWM infestation in East Loon Lake. It is the opinion of LMU that EWM is extirpating native aquatic plants in many portions of the lake. The treatment area is to serve as a pilot project area with the goal of knocking back the EWM and allowing native species to repopulate the area. LMU staff will monitor the area in 2009 for changes in the aquatic plant distribution and density. LMU will assist LLMA in preparing a request for proposal (RFP) for this work. The successful contractor will work with LMU and LLMA to ensure proper application rates (including buoys marking limits of the treatment area), timing of application and any follow-up work necessary. It is anticipated that a 2,4-D product will be used. In addition, the use of bacterial pellets to reduce bottom sediment has been proposed (Figure 12). The areas selected for pellet distribution are generally swimming beaches and boat launches. The pellets will be applied according to manufacturers recommendations (twice per year), anticipated in June and again in August.

Figure 9. Aquatic plant sampling grid that illustrates Eurasian Watermilfoil density on West Loon Lake, June 2008

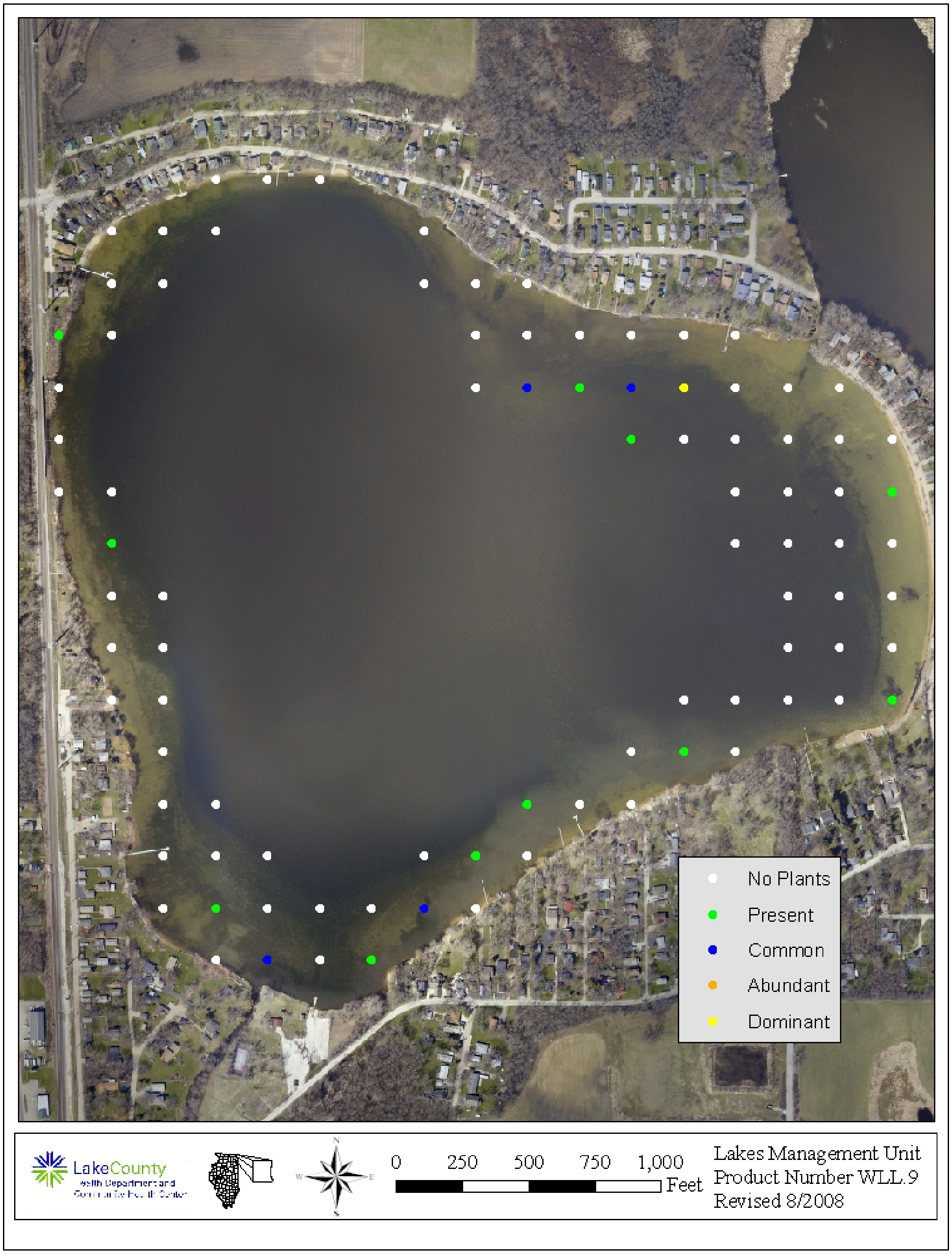


Figure 10. Aquatic plant sampling grid that illustrates Eurasian Watermilfoil density on West Loon Lake, August 2008

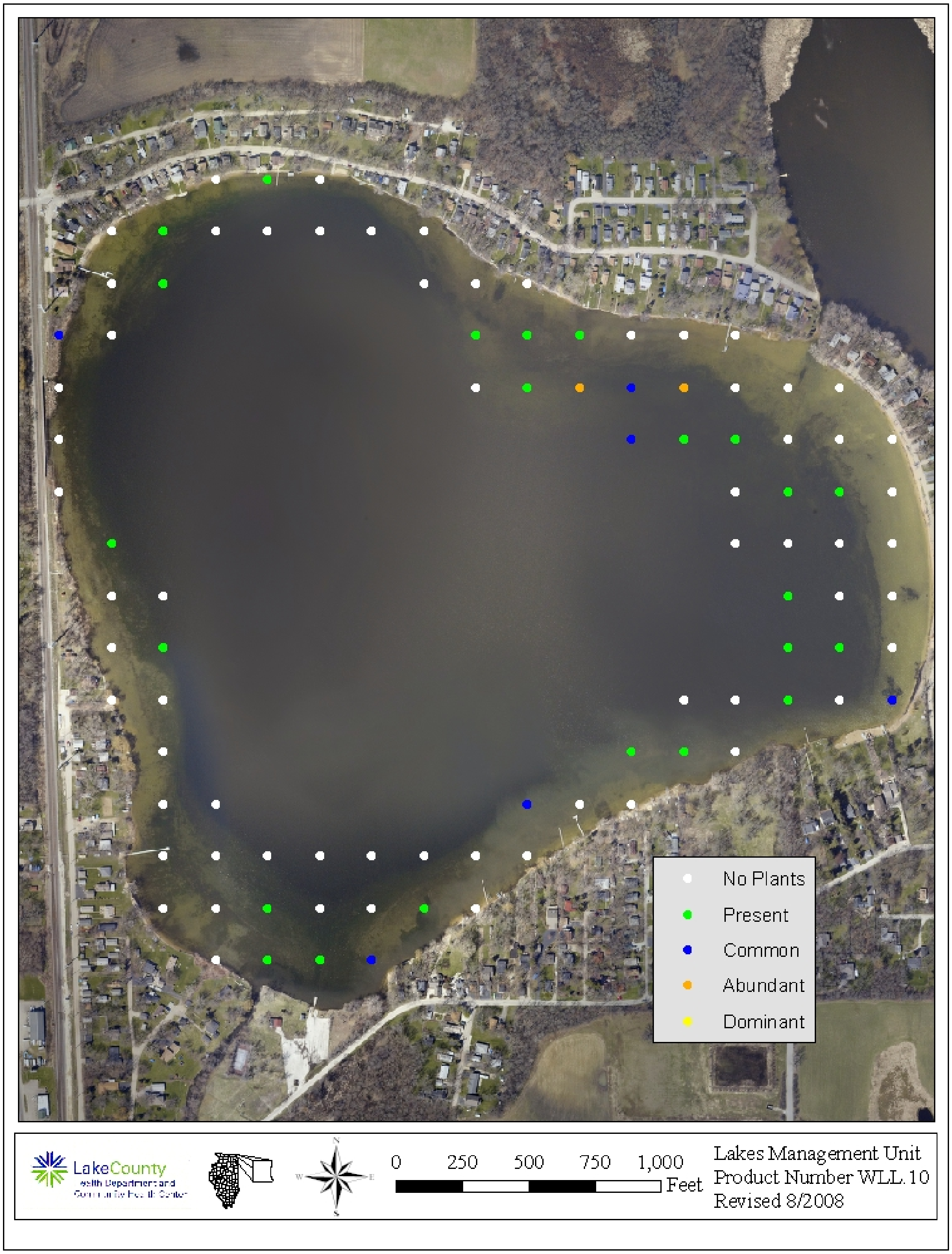


Figure 11. Proposed 2009 Herbicide Application and Mechanical Harvesting on East and West Loon Lake

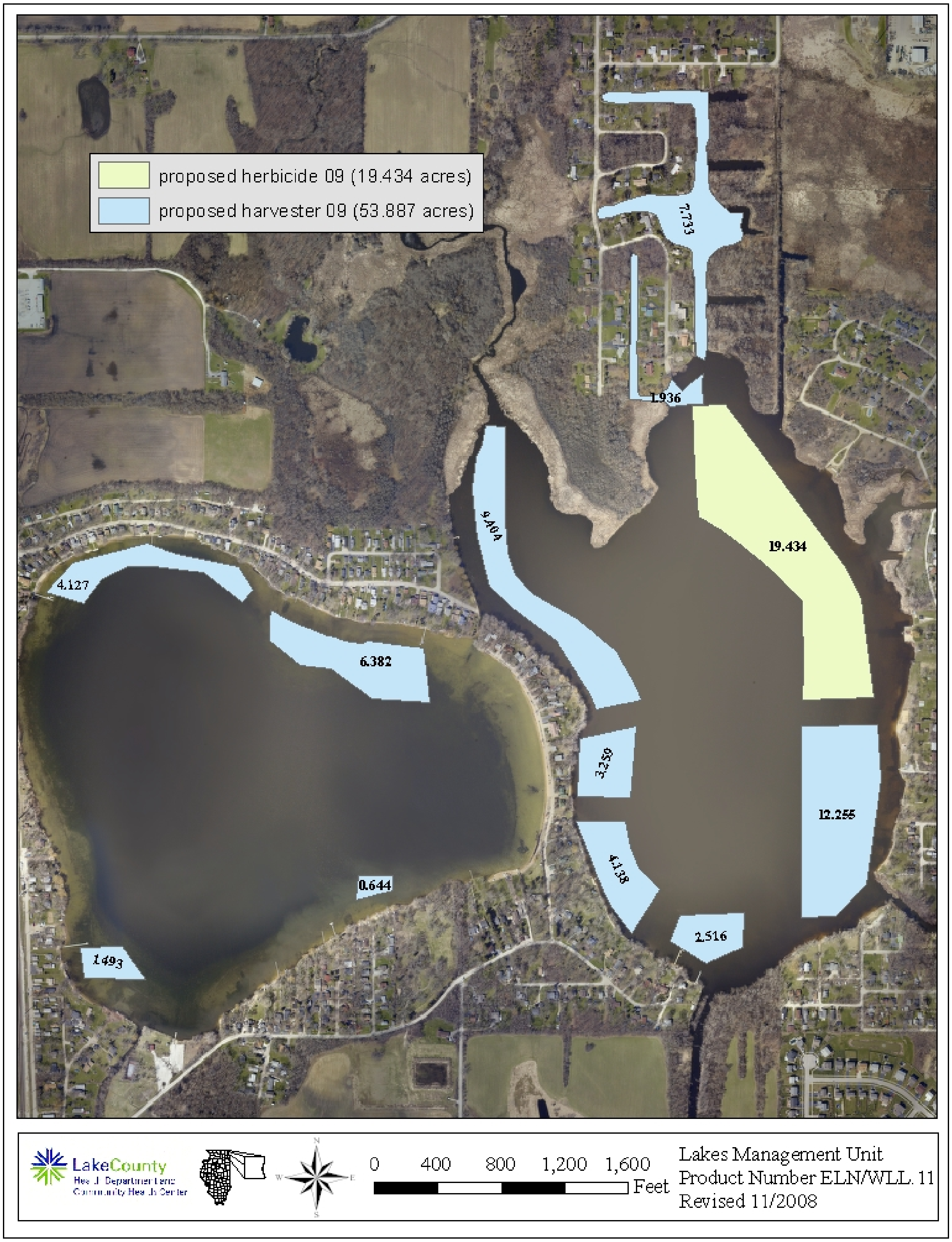


Figure 12. Proposed 2009 Bacterial Pellet Application on East and West Loon Lake

LLMA is requesting that Special Service Area 8 money be used for this management strategy; as such the proposal has to go through a consultation with the Illinois Department of Natural Resources (IDNR).

To maintain a healthy sunfish/bass fishery, the optimal plant coverage is 30% to 40% across the lake bottom. These surveys found approximately 71% (June) and approximately 88% (August) of the sites sampled had aquatic plants (Table 5c). It was calculated that approximately 34% - 44% of the lake bottom was covered by plants. Thus, the aquatic plant populations in West Loon Lake were in good condition and contribute to the overall high quality of the lake. Care should be taken maintain these populations and not to over manage them. The Illinois threatened Iowa Darter, Banded Killifish, Starhead Topminnow, Blackchin Shiner and Illinois endangered Pugnose Shiner and Blacknose Shiner have all been found in West Loon Lake. These species require abundant native vegetation so care should be taken when establishing a plant management plan.

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 in water depths with less than 1% of the available sunlight. During 2008, the 1% light level was available down to 28 - 30 feet in May and decreased to 18 – 22 feet for the remaining months. In June and August the 1% light level was 20 – 22 feet however, plants were only found down to 12.4 and 13.5 feet, respectively. Plants most likely were not found deeper due to the morphology of the lake as the depth drops off relatively quickly after 6 feet deep.

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. 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 indicate that there were large numbers 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 2000-2008 Lake County lakes was 13.6 (Table 7). West Loon Lake had a FQI of 25.7 in 2008 ranking 11th of 152 lakes in Lake County. This was a slight decrease from 2003 when the FQI was 26.0.

SUMARY OF SHORELINE CONDITION

Lakes with stable water levels potentially have less shoreline erosion problems. The water level fluctuated each month in West Loon Lake. From May to June the level increased 13 inches, as a result of heavy rains, and increased another 4.1 inches in July. There was a dramatic decrease from July to August of 16.38 inches, then increased 6.5 inches from August to September. There was a seasonal increase of 7.3 inches from May to September. These types of water level fluctuations can have a negative impact on shoreline erosion.

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

June		
Rake Density (Coverage)	# of Sites	%
No plants	26	28.9
>0 to 10%	25	27.8
>10 to 40%	17	18.9
>40 to 60%	8	8.9
>60 to 90%	8	8.9
>90%	6	6.7
Total Sites with Plants	64	71.1
Total # of Sites	90	100.0

August		
Rake Density (Coverage)	# of Sites	%
No plants	11	11.7
>0 to 10%	16	17.0
>10 to 40%	11	11.7
>40 to 60%	6	6.4
>60 to 90%	12	12.8
>90%	38	40.4
Total Sites with Plants	83	88.3
Total # of Sites	94	100.0

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

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	36.3	38.4
2	East Loon Lake	30.6	32.7
3	Cranberry Lake	30.1	31.6
4	Deep Lake	29.7	31.2
5	Little Silver	29.6	31.6
6	Round Lake Marsh North	29.1	29.9
7	Deer Lake	28.2	29.7
8	Sullivan Lake	28.2	29.7
9	Schreiber Lake	26.8	27.6
10	Bangs Lake	25.7	27.4
11	**West Loon Lake**	**25.7**	**27.3**
12	Cross Lake	25.2	27.8
13	Independence Grove	24.6	27.5
14	Sterling Lake	24.5	26.9
15	Lake Zurich	24.3	27.1
16	Sun Lake	24.3	26.1
17	Lake of the Hollow	23.8	26.2
18	Lakewood Marsh	23.8	24.7
19	Round Lake	23.5	25.9
20	Honey Lake	23.3	25.1
21	Fourth Lake	23.0	24.8
22	Druce Lake	22.8	25.2
23	Countryside Glen Lake	21.9	22.8
24	Butler Lake	21.4	23.1
25	Duck Lake	21.1	22.9
26	Timber Lake (North)	20.8	22.8
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	ADID 203	20.5	20.5
30	McGreal Lake	20.2	22.1
31	Lake Kathryn	19.6	20.7
32	Fish Lake	19.3	21.2
33	Owens Lake	19.3	20.2
34	Redhead Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	Wooster Lake	18.5	20.2
37	Salem Lake	18.5	20.2
38	Lake Miltmore	18.4	20.3
39	Hendrick Lake	17.7	17.7
40	Summerhill Estates Lake	17.1	18.0
41	Seven Acre Lake	17.0	15.5
42	Gray's Lake	16.9	19.8
43	Lake Barrington	16.7	17.7
44	Bresen Lake	16.6	17.8

Table 7. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
45	Diamond Lake	16.3	17.4
46	Lake Napa Suwe	16.3	17.4
47	Windward Lake	16.3	17.6
48	Dog Bone Lake	15.7	15.7
49	Redwing Slough	15.6	16.6
50	Osprey Lake	15.5	17.3
51	Lake Fairview	15.2	16.3
52	Heron Pond	15.1	15.1
53	Lake Tranquility (S1)	15.0	17.0
54	North Churchill Lake	15.0	15.0
55	Dog Training Pond	14.7	15.9
56	Island Lake	14.7	16.6
57	Highland Lake	14.5	16.7
58	Grand Avenue Marsh	14.3	16.3
59	Taylor Lake	14.3	16.3
60	Dugdale Lake	14.0	15.1
61	Eagle Lake (S1)	14.0	15.1
62	Longview Meadow Lake	13.9	13.9
63	Ames Pit	13.4	15.5
64	Bishop Lake	13.4	15.0
65	Hook Lake	13.4	15.5
66	Long Lake	13.1	15.1
67	Buffalo Creek Reservoir	13.1	14.3
68	Mary Lee Lake	13.1	15.1
69	McDonald Lake 2	13.1	14.3
70	Old School Lake	13.1	15.1
71	Dunn's Lake	12.7	13.9
72	Old Oak Lake	12.7	14.7
73	Timber Lake (South)	12.7	14.7
74	White Lake	12.7	14.7
75	Hastings Lake	12.5	14.8
76	Sand Lake	12.5	14.8
77	Stone Quarry Lake	12.5	12.5
78	Lake Carina	12.1	14.3
79	Lake Leo	12.1	14.3
80	Lambs Farm Lake	12.1	14.3
81	Pond-A-Rudy	12.1	12.1
82	Stockholm Lake	12.1	13.5
83	Grassy Lake	12	12
84	Lake Matthews	12.0	12.0
85	Flint Lake	11.8	13.0
86	Harvey Lake	11.8	13.0
87	Rivershire Pond 2	11.5	13.3
88	Antioch Lake	11.3	13.4
89	Lake Charles	11.3	13.4
90	Lake Linden	11.3	11.3

Table 7. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
91	Lake Naomi	11.2	12.5
92	Pulaski Pond	11.2	12.5
93	Lake Minear	11.0	13.9
94	Redwing Marsh	11.0	11.0
95	Tower Lake	11.0	11.0
96	West Meadow Lake	11.0	11.0
97	Nielsen Pond	10.7	12.0
98	Lake Holloway	10.6	10.6
99	Third Lake	10.2	12.5
100	Crooked Lake	10.2	12.5
101	College Trail Lake	10.0	10.0
102	Lake Lakeland Estates	10.0	11.5
103	Valley Lake	9.9	9.9
104	Werhane Lake	9.8	12.0
105	Big Bear Lake	9.5	11.0
106	Little Bear Lake	9.5	11.0
107	Loch Lomond	9.4	12.1
108	Columbus Park Lake	9.2	9.2
109	Sylvan Lake	9.2	9.2
110	Lake Louise	9	10.4
111	Fischer Lake	9.0	11.0
112	Grandwood Park Lake	9.0	11.0
113	Lake Fairfield	9.0	10.4
114	McDonald Lake 1	8.9	10.0
115	Countryside Lake	8.7	10.6
116	East Meadow Lake	8.5	8.5
117	Lake Christa	8.5	9.8
118	Lake Farmington	8.5	9.8
119	Lucy Lake	8.5	9.8
120	South Churchill Lake	8.5	8.5
121	Bittersweet Golf Course #13	8.1	8.1
122	Woodland Lake	8.1	9.9
123	Albert Lake	7.5	8.7
124	Banana Pond	7.5	9.2
125	Fairfield Marsh	7.5	8.7
126	Lake Eleanor	7.5	8.7
127	Patski Pond	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Slough Lake	7.1	7.1
130	Lucky Lake	7.0	7.0
131	Lake Forest Pond	6.9	8.5
132	Leisure Lake	6.4	9.0
133	Peterson Pond	6.0	8.5
134	Gages Lake	5.8	10.0
135	Slocum Lake	5.8	7.1
136	Deer Lake Meadow Lake	5.2	6.4

Table 7. Continued

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

In 2003 an assessment was conducted to determine the condition of the shoreline at the water/land interface. One-hundred percent of the shoreline was developed with the majority of shoreline consisting of beach (33%), buffer strip (29%), rip rap (18%), and seawall (15%). The shoreline was also assessed for the degree of erosion. Based on that assessment 97% of the shoreline had no erosion and 3% had slight erosion. There was no moderate or severe erosion. The shoreline was reassessed in 2008 for significant changes in erosion since 2003. Based on the 2008 assessment, there was an increase in shoreline erosion with approximately 19% of the shoreline having some degree of erosion (Figure 13). Overall, 81% of the shoreline had no erosion, 13% had slight erosion, and 6% had moderate erosion. There was no severe erosion found in 2008. The areas of moderate erosion should be addressed soon. 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. 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.

OBSERVATIONS OF WILDLIFE AND HABITAT

Visual wildlife observations were made on a monthly basis during water quality and plant sampling activities. West Loon Lake is located in a rural, residential setting with some buffered and natural shoreline. This provides habitat for a variety of birds, mammals, and other wildlife. Good numbers of birds were noted on and around West Loon Lake (Table 7).

Wildlife habitat on West Loon Lake was average for a residential lake. On many lots around the lake there are healthy populations of mature trees that provide good habitat for a variety of bird species. Additionally, there are several shrub and wetland areas that provide habitat for bird and mammal species

In May 2007 the IDNR conducted a 30 minute electrofishing survey and overnight sets of two trapnets on West Loon Lake. This survey found 228 fish representing 20 species. The state threatened Blackchin Shiner was one of the species collected. Bluegill and Largemouth Bass were the most abundant species collected. The Bluegills ranged is in size from 1.0 – 9.8 inches. Largemouth Bass ranged in size from 3.7 – 16.8 inches. Only 20% of the Largemouth Bass collected were larger than 12 inches. This falls below the IDNR management goal. There was a large portion of the population ready to mature and start spawning which should raise the objective. Other species collected included Lake Chubsucker, Redear Sunfish, Warmouth, Grass Pickerel, Yellow Perch, Northern Pike, Black Bullhead, Yellow Bullhead, Bowfin, Longnose Gar, Common Carp, Pumpkinseed, Black Crappie, Walleye, Bluntnose Minnow, White Sucker, and Golden Shiner.

The IDNR recommended stocking 15 – 25 non-vulnerable catfish per acre every third year, posting the Largemouth Bass and Walleye regulations at all access locations and in the newsletter, removing and disposing of any Common Carp or Yellow Bass caught by fishermen, and maintaining the harvesting of vegetation.

Figure 13. Shoreline erosion on West Loon Lake, 2008

Table 7. Wildlife species observed around West Loon Lake, May – September 2008.

Birds	
Mute Swan	*Cygnus olor*
Canada Goose	*Branta Canadensis*
Mallard	*Anas platyrhnchos*
Common Tern+	*Sterna hirundo*
Gull	*Larus* sp.
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
American Robin	*Turdus migratorius*
Red-winged Blackbird	*Agelaius phoeniceus*

+Endangered species in Illinois

LAKE MANAGEMENT RECOMMENDATIONS

West Loon Lake is a high quality aquatic resource. Both East and West Loon Lakes benefit from having a lake management association, funded by SSA8 tax money for lake management. There is a memorandum of agreement (MOA) between the LMU and LLMA that stipulates specific requirements of the association. West Loon Lake had low nutrient levels and the 2nd best water clarity ever recorded by the LMU in Lake County. To improve the quality of West Loon Lake, the LMU has the following recommendations:

- **Creating a Bathymetric Map**

  Creating an updated bathymetric map can help with improvements to West Loon Lake. A bathymetric 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 (Appendix D1). West Loon Lake has a bathymetric map created in 1991. It is recommended that any map older than 15 years be updated.

- **Aquatic Plant Management and Eliminate or Control Exotic Species**

  A key to a healthy lake is a well-balanced aquatic plant population. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake (Appendix D2-3). Currently, West Loon Lake has excellent aquatic plant diversity, however Eurasian Watermilfoil is present. LLMA is proposing a 2009 aquatic plant management plan which includes using mechanical harvesting to target Eurasian Watermilfoil.

- **Lakes with Shoreline Erosion**

  West Loon Lake has seen an increase in shoreline erosion since the 2003 study. Areas along the north and south shorelines have seen the greatest increase in erosion. The moderate erosion is concentrated around the boat launch on the southwest corner of the lake and should be addressed before it gets any worse. Actually, all of the 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 D4).

- **Reduce Conductivity and Chloride Concentrations**

  The average conductivity in West Loon Lake was up 7% in the epilimnion and 14% in the hypolimnion since 2003. Although the chloride concentration was below the county median, it was still high enough to potentially have impacts on aquatic life. The use of road salts for winter road management is a major contributor to chloride concentrations and conductivity. Although roads only make up 8% of the landuse within the watershed, they contribute 31% of the estimated runoff. Proper application procedures and alternative methods should be considered to keep these concentrations under control (Appendix D5). Individual homeowners should also look into the wise-use of deicing products around their homes.

- **Lakes with Zebra Mussels**

West Loon Lake has the confirmed presence of Zebra Mussels. Steps should be taken to keep them from spreading to other lakes (Appendix D6).

- **Reduce or Eliminate User Conflicts**

West Loon Lake is a popular recreational lake. Many people use the lake for various activities. Some of these activities overlap and conflicts occur. Although it may be tough to satisfy everyone's idea of the proper use of the lake, some steps can be taken to reduce conflicts (Appendix 7).

- **Participate in the Volunteer Lake Monitoring Program**

West Loon Lake had participated in the VLMP since 1988-2007 providing valuable data during the years the LMU did not sample the lake. No VLMP was in place in 2008. It is strongly recommended that the association find volunteers to staff these positions (Appendix D8). It is also recommended that a permanent staff gauge be installed to monitor the lake water level.

- **Watershed Nutrient Reduction**

Although West Loon Lake has not seen any nutrient increase, the approximately 1136 acre watershed can potentially lead to increases in the future. Single family contributes the greatest amount of estimated runoff. Most established lawns do not require additional phosphorous fertilizer so any applied runs off and into the lake. Some local communities around West Loon Lake have adopted an ordinance banning the use of phosphorous fertilizer. For this reason, the LMU encourages the LLMA to adopt a phosphorous fertilizer ban. Residents should also have their septic systems pumped and serviced regularly and inspected for any failures. Excess phosphorous in the water column allows for more aquatic plants and algae growth. Management within the watershed can help reduce nutrients entering the lake (Appendix D9).

- **Grant program opportunities**

In addition to the SSA8 monies, there are opportunities to receive grants to help accomplish some of the management recommendations listed above (Appendix F).

APPENDIX A. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were at the deepest point in the lake (see sample site map), three feet below the surface, and 3 feet above the bottom. Samples were collected with a horizontal Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. Analytical methods for the parameters are listed in Table A1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every two feet until reaching the bottom.

Plant Sampling

In order to randomly sample each lake, mapping software (ArcMap 9.3) overlaid a grid pattern onto an aerial photo of Lake County and placed points 60 or 30 meters apart, depending on lake size. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation.

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

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

APPENDIX B. MULTI-PARAMETER DATA FOR WEST LOON LAKE IN 2008.

West Loon Lake 2008 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	0.52
52008	91814	0	0.25	15.23	9.61	99.8	0.7616	8.39	4385	Surface	100%	
52008	91900	1	1.00	15.40	9.56	99.6	0.7595	8.39	4565.0	Surface	100%	
52008	92035	2	1.98	15.40	9.54	99.4	0.7588	8.41	364	0.230	8%	11.00
52008	92122	3	3.01	15.39	9.52	99.2	0.7588	8.43	1482	1.260	32%	-1.11
52008	92222	4	4.06	15.38	9.52	99.1	0.7588	8.46	1144	2.310	25%	0.11
52008	92313	6	5.97	15.37	9.50	99.0	0.7586	8.48	199	4.220	4%	0.41
52008	92340	8	8.00	15.36	9.49	98.8	0.7586	8.52	394	6.250	9%	-0.11
52008	92412	10	10.01	15.34	9.49	98.8	0.7590	8.54	282	8.260	6%	0.04
52008	92447	12	12.04	15.32	9.47	98.5	0.7588	8.56	147	10.290	3%	0.06
52008	92532	14	14.02	15.32	9.43	98.1	0.7588	8.57	212	12.270	5%	-0.03
52008	92605	16	16.05	15.30	9.41	97.9	0.7588	8.58	203	14.300	4%	0.00
52008	92707	18	18.00	15.29	9.36	97.4	0.7586	8.58	196	16.250	4%	0.00
52008	92752	20	20.02	14.25	8.54	86.8	0.7573	8.39	115	18.270	3%	0.03
52008	92913	22	21.99	13.23	7.71	76.7	0.7590	8.21	96	20.240	2%	0.01
52008	92959	24	24.05	10.45	5.70	53.2	0.7573	7.92	73	22.300	2%	0.01
52008	93137	26	26.03	9.41	4.32	39.3	0.7576	7.79	67	24.280	1.5%	0.00
52008	93249	28	28.02	9.12	3.76	34.0	0.7575	7.73	51	26.270	1.1%	0.01
52008	93332	30	30.02	8.83	3.36	30.2	0.7594	7.72	42	28.270	0.9%	0.01
52008	93358	32	32.07	8.68	3.34	29.9	0.7596	7.73	29	30.320	0.6%	0.01
52008	93505	34	33.96	8.56	2.37	21.1	0.7594	7.68	24	32.210	0.5%	0.01
52008	93551	36	36.00	8.44	2.18	19.3	0.7606	7.69	18	34.250	0.4%	0.01
52008	93646	38	37.57	8.33	1.98	17.6	0.7612	7.68	16	35.820	0.4%	0.003

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	0.05
61708	85741	0	0.45	22.52	8.50	101.1	0.7261	8.48	4202	7.6	100%	
61708	85841	1	1.16	22.53	8.51	101.2	0.7261	8.49	3899	7.6	100%	
61708	85938	2	2.00	22.52	8.50	101.1	0.7259	8.50	93	7.6	2%	0.49
61708	90102	3	3.10	22.53	8.49	101.0	0.7262	8.47	840	7.6	22%	-0.29
61708	90201	4	4.06	22.52	8.49	100.9	0.7261	8.49	1055	7.6	27%	-0.03
61708	90243	6	5.98	22.52	8.46	100.6	0.7261	8.54	721	7.6	18%	0.05
61708	90433	8	8.01	22.48	8.43	100.2	0.7261	8.53	576	7.6	15%	0.03
61708	90544	10	10.00	22.48	8.41	100.0	0.7261	8.54	172	7.6	4%	0.16
61708	90651	12	11.98	22.46	8.39	99.7	0.7257	8.54	177	7.6	5%	0.00
61708	90754	14	14.00	22.45	8.37	99.4	0.7258	8.56	111	7.6	3%	0.06
61708	90852	16	16.09	22.42	8.36	99.2	0.7257	8.57	89	7.6	2.3%	0.03
61708	90958	18	17.99	18.46	6.50	71.3	0.7651	8.22	66	7.6	1.7%	0.04
61708	91054	20	20.01	16.31	5.83	61.1	0.7686	8.11	43	7.6	1.1%	0.06
61708	91213	22	22.00	14.87	5.17	52.6	0.7705	8.00	32	7.5	0.82%	0.04
61708	91312	24	24.05	13.58	3.65	36.1	0.7691	7.81	26	7.6	0.67%	0.03
61708	91433	26	25.99	12.38	2.07	19.9	0.7719	7.67	22	7.5	0.56%	0.02
61708	91553	28	28.03	11.26	0.72	6.8	0.7732	7.54	17	7.5	0.44%	0.03
61708	91650	30	29.98	10.41	0.29	2.7	0.7711	7.50	14	7.5	0.36%	0.03
61708	91758	32	31.96	9.97	0.24	2.2	0.7713	7.45	11	7.5	0.28%	0.03
61708	91859	34	33.99	9.71	0.22	2.0	0.7716	7.46	8	7.5	0.21%	0.04
61708	91955	36	35.97	9.63	0.22	1.9	0.7721	7.45	6	7.5	0.15%	0.04

61708	92055	38	38.00	9.55	0.21	1.9	0.7726	7.44	4	7.5	0.10%	0.05

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.18
71508	91949	0	1.04	25.09	8.46	105.6	0.6692	8.62	3845	Surface	100%	
71508	92037	1	0.26	24.98	8.52	106.1	0.6708	8.62	3670	Surface	100%	
71508	92123	2	1.99	25.08	8.48	105.8	0.6692	8.64	2159	0.240	59%	2.21
71508	92218	3	3.01	25.07	8.46	105.6	0.6698	8.66	670	1.260	18%	0.93
71508	92321	4	3.99	24.93	8.49	105.7	0.6706	8.68	1301	2.240	35%	-0.30
71508	92455	6	6.02	24.73	8.51	105.5	0.6717	8.70	878	4.270	24%	0.09
71508	92652	8	8.06	24.42	8.32	102.6	0.6694	8.67	384	6.310	10%	0.13
71508	92742	10	9.96	24.3	8.07	99.3	0.6706	8.67	360	8.210	10%	0.01
71508	92900	12	12.00	24.14	7.56	92.7	0.6679	8.61	167	10.250	5%	0.07
71508	92958	14	14.00	23.88	6.75	82.4	0.6557	8.48	160	12.250	4%	0.00
71508	93056	16	16.03	23.38	5.76	69.6	0.6647	8.26	104	14.280	3%	0.03
71508	93209	18	18.03	22.13	1.38	16.3	0.7109	7.83	68	16.280	2%	0.03
71508	93320	20	19.98	19.70	0.42	4.7	0.7476	7.70	49	18.230	1.3%	0.02
71508	93437	22	21.99	17.47	0.30	3.2	0.7646	7.63	36	20.240	1.0%	0.02
71508	93556	24	23.95	16.09	0.35	3.6	0.7681	7.63	26	22.200	0.7%	0.01
71508	93803	26	26.07	13.13	0.26	2.5	0.7697	7.53	17	24.320	0.5%	0.02
71508	93907	28	28.05	11.82	0.20	1.9	0.7697	7.48	12	26.300	0.3%	0.01
71508	94000	30	30.04	11.25	0.19	1.8	0.7716	7.46	9	28.290	0.2%	0.01
71508	94054	32	32.01	10.79	0.19	1.7	0.7719	7.43	6	30.260	0.2%	0.01
71508	94145	34	34.04	10.36	0.19	1.7	0.7745	7.41	4	32.290	0.1%	0.01
71508	94244	36	35.87	10.25	0.19	1.7	0.7748	7.39	0	34.120		
71508	94402	38	38.06	10.07	0.18	1.7	0.7770	7.36	0	36.310		

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	0.35
81908	83806	0	0.29	24.88	8.52	106.4	0.6500	8.76	1888	Surface	100%	
81908	83852	1	1.11	24.91	8.54	106.6	0.6499	8.73	1821	Surface	100%	
81908	83943	2	2.09	24.93	8.53	106.6	0.6498	8.72	265	0.340	15%	5.67
81908	84021	3	3.06	24.92	8.54	106.7	0.6500	8.71	283	1.310	16%	-0.05
81908	84113	4	3.98	24.92	8.52	106.4	0.6498	8.68	257	2.230	14%	0.04
81908	84215	6	5.89	24.92	8.51	106.3	0.6500	8.70	167	4.140	9%	0.10
81908	84257	8	7.96	24.92	8.5	106.2	0.6498	8.70	159	6.210	9%	0.01
81908	84345	10	10.09	24.91	8.47	105.9	0.6498	8.69	121	8.340	7%	0.03
81908	84436	12	12.03	24.89	8.4	104.9	0.6501	8.68	90	10.280	5%	0.03
81908	84517	14	13.93	24.84	7.58	94.5	0.6510	8.60	70	12.180	4%	0.02
81908	84737	16	16.00	24.03	5.25	64.5	0.6599	8.34	58	14.250	3%	0.01
81908	85008	18	18.14	22.28	1.93	22.9	0.6964	7.89	31	16.390	2%	0.04
81908	85129	20	20.11	19.30	0.96	10.8	0.7388	7.70	22	18.360	1.2%	0.02
81908	85310	22	22.15	17.11	0.72	7.7	0.7537	7.58	16	20.400	0.9%	0.02
81908	85412	24	24.11	15.51	0.22	2.3	0.7592	7.50	11	22.360	0.6%	0.02
81908	85507	26	26.08	13.84	0.19	1.9	0.7621	7.46	7	24.330	0.4%	0.02
81908	85629	28	28.02	11.99	0.2	1.9	0.7653	7.38	4	26.270	0.2%	0.02
81908	85717	30	29.92	11.09	0.19	1.8	0.7702	7.31	4	28.170	0.2%	0.00
81908	85800	32	31.92	10.87	0.19	1.8	0.7720	7.26	3	30.170	0.2%	0.01
81908	85902	34	33.99	10.58	0.19	1.8	0.7742	7.20	0	32.240		
81908	85951	36	36.08	10.35	0.19	1.7	0.7763	7.16	0	34.330		

81908	90100	38	37.87	10.17	0.19	1.8	0.7809	7.10	0	36.120

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	0.77
91608	74901	0	0.69	20.07	7.37	83.4	0.6490	8.50	3667	Surface	100%	
91608	75000	1	1.02	20.08	7.35	83.2	0.6490	8.46	3982	Surface	100%	
91608	75057	2	1.94	20.07	7.34	83.1	0.6496	8.41	1082	0.190	27%	6.86
91608	75158	3	3.00	20.08	7.34	83.1	0.6489	8.41	571	1.250	14%	0.51
91608	75354	4	3.96	20.08	7.32	82.8	0.6491	8.38	485	2.210	12%	0.07
91608	75456	6	6.02	20.08	7.28	82.4	0.6493	8.37	262	4.270	7%	0.14
91608	75621	8	7.97	20.08	7.28	82.5	0.6492	8.35	228	6.220	6%	0.02
91608	75752	10	9.99	20.08	7.27	82.3	0.6490	8.34	178	8.240	4%	0.03
91608	75850	12	11.97	20.07	7.24	81.9	0.6492	8.33	129	10.220	3%	0.03
91608	80109	14	13.98	20.07	7.22	81.7	0.649	8.32	87	12.230	2%	0.03
91608	80327	16	16.05	19.98	6.94	78.4	0.6479	8.26	60	14.300	2%	0.03
91608	80452	18	18.09	19.84	7.12	80.2	0.6482	8.28	43	16.340	1.1%	0.02
91608	80605	20	20.00	19.76	5.89	66.3	0.6488	8.10	33	18.250	0.8%	0.01
91608	80732	22	22.05	19.48	3.62	40.4	0.6725	7.92	23	20.300	0.6%	0.02
91608	80901	24	23.96	17.24	0.73	7.8	0.7639	7.70	16	22.210	0.4%	0.02
91608	81018	26	25.93	15.10	0.28	2.9	0.7687	7.62	9	24.180	0.2%	0.02
91608	81112	28	28.06	13.04	0.22	2.2	0.7776	7.54	4	26.310	0.1%	0.03
91608	81258	30	29.98	12.20	0.20	1.9	0.7832	7.43	3	28.230	0.1%	0.01
91608	81408	32	31.99	11.56	0.20	1.9	0.7875	7.34	0	30.240		
91608	81601	34	34.03	10.66	0.20	1.8	0.7965	7.15	0	32.280		
91608	81729	36	35.97	10.40	0.20	1.8	0.7995	7.09	0	34.220		
91608	81809	38	38.02	10.35	0.19	1.8	0.8007	7.08	0	36.270		

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 2000-2008 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 2000-2008 is 0.065 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 2000-2008 was 0.181 mg/L and ranged from a minimum of 0.012 mg/L in Independence Grove 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 8.2 mg/L, ranging from below the 0.1 mg/L detection limit 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 132.8 mg/L, ranging from 34.0 mg/L in Pulaski Pond to 298.0 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 3.12 feet. From 2000-2008, 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 8.32, 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 Aquatic Plant Management

Option 1: Aquatic Herbicides

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

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

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

Option 2: Mechanical Harvesting

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

Mechanical harvesting can be a selective means to reduce stands of nuisance vegetation in a lake. Typically, plants cut low enough to restore recreational use and limit or prevent regrowth. This practice normally improves habitat for fish and other aquatic organisms.
High initial investment, extensive maintenance, and high operational costs have led to decreased use. Mechanical harvesters cannot be used in less than 2-4 feet of water (depending on draft of the harvester) and cannot maneuver well in tight places. The harvested plant material must be disposed of properly to a place that can accommodate large quantities of plants and prevent any from washing back into the lake. Fish, mussels, turtles and other aquatic organisms are commonly caught in the harvester and injured or even removed from the lake in the harvesting process. After the initial removal, there is a possibility for vegetation regrowth. If complete/over removal does occur several problems can result. One problem is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process.

Option 3: Hand Removal

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

Option 4: Water Milfoil Weevil

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

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

Option 5: Reestablishing Native Aquatic Vegetation

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

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

D3. Options to Eliminate or Control Exotic Species

Option 1. Biological Control

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

bio-control measures target specific plant species. Bio-control can also be expensive and labor intensive.

Option 2. Control by Hand

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

Option 3. Herbicide Treatment

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

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

D4. Options for 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.

D5. Options to Reduce Conductivity and Chloride Concentrations

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

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

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

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

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

Option 1. Proper Use on Your Property

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

Option 2. Examples of Alternatives

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

Calcium, Magnesium or Potassium Chloride

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

Calcium Magnesium Acetate (CMA)

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

Agricultural Byproducts

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

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

<u>Option 3. Talk to Your Municipality About Using an Alternative</u>

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

D6. Options for Lakes with Zebra Mussels

Zebra Mussels get their name from the alternating black and white stripped pattern on their shells. They have spread extensively in the Great Lakes region in the past decade. They attach themselves to any solid underwater object such as boat hulls, piers, intake pipes, plants, other bivalves (mussels), and even other Zebra Mussels. Zebra Mussels originated from Eastern Europe, specifically the Black and Caspian Seas. By the mid 18^{th} and 19^{th} centuries they had spread to most of Europe. The mussels were believed to have been spread to this country in the mid 1980s by cargo ships that discharged their ballast water into the Great Lakes. They were first discovered in Lake St. Clair (the body of water that connects lakes Erie and Huron) in June of 1988. The mussels then spread to the rest of the Great Lakes. The first sighting in Lake Michigan was in June 1989. By 1990, Zebra Mussels had been found in all of the Great Lakes. By 1991 they had made their way into the adjacent waters of the Great Lakes such as the Illinois River, which eventually led to their spread into the Mississippi River and all the way down to the Gulf of Mexico. Other states in the Midwest have also experienced Zebra Mussel infestations of their inland lakes. Southeastern Wisconsin has about a dozen lakes infested and Michigan has about 100 infested lakes. Even though they are a fresh water mussel they have also been found in brackish (slightly saline) water and they can even live out of the water for up to 10 days at high humidity and cool temperatures. At average summer temperatures, Zebra Mussels can survive out of water for an average of five days.

The Zebra Mussels reproductive cycle allows for rapid expansion of the population. A mature female can produce up to 40,000 eggs in a cycle and up to one million in a season. Eggs hatch within a few days and young larvae (called veligers) are free floating for up to 33 days, carried along on water currents. This allows for the distribution of larvae to uninfected areas, which accelerates their spread. The larvae attach themselves by a filamentous organ (called a byssus) near their foot. Once attached to a solid surface, larvae develop into a double shelled adult within three weeks and are capable of reproduction in a year. Zebra Mussels can live as long as five years and have an average life span of about 3.5 years. The adults are typically about the size of a thumb nail but can grow as large as 2 inches in diameter. Colonies can reach densities of 30,000 - 70,000 mussels per square meter.

Due to their quick life cycle and explosive growth rate, Zebra Mussels can quickly edge out native mussel species. Negative impacts on native bivalve populations include interference with feeding, habitat, growth, movement, and reproduction. Some native species of bivalves have been found with 10,000 Zebra Mussels attached to them. Many of these native, rare, threatened and endangered bivalve species may not be able to survive if Zebra Mussels populations continue to expand. The impact that the mussels have on fish populations is not fully understood. However, they feed on phytoplankton (algae), which is also a major food source for planktivorous fish, such as Bluegill. These fish, in turn, are a food source for piscivorus fish (fish eating fish), such as Largemouth Bass and Northern Pike. Concern has also arisen over the concentration of pollutants found in Zebra Mussels. Mussels are filter feeders, taking up water and sediment containing pollutants, which then builds to high concentrations in their tissue (bioaccumulation). Due to the large number of mussels that are consumed by fish, concentrations of pollutants are even higher in the fish (biomagnification), which are potentially consumed by humans.

In addition to the ecological impacts, there are also many economical concerns. Zebra Mussels have caused major problems for industrial complexes located on the Great Lakes and associated bodies of water. Mussels can clog water intakes of power plants, public water supplies, and other industrial facilities. This can reduce water flow (by as much as two-thirds) to heat exchangers, condensers, fire fighting equipment, and air conditioning systems. Zebra Mussels can infest inboard motor intakes and can actually grow inside the motor, causing considerable damage. Navigational buoys have sunk due to the weight of attached mussels. Corrosion of concrete and steel, which can lead to loss of structural integrity, can occur from long-term mussel attachment. A Michigan-based paper company recently reported that it had spent 1.4 million dollars in removing only 400 cubic yards of Zebra Mussels. It has been estimated that billions of dollars have been incurred in removal efforts and in damage to factories, water supply companies, power plants, ships, and the fishing industry. There are several methods of control, which include both removal and eradication. Many are site specific, so control methods are often dictated by the situation. These control methods include chemical molluscicides, manual removal, thermal irritation, acoustical vibration, toxic and non-toxic coatings, CO_2 injection, and ultraviolet light. Additionally, several biological controls are being investigated. However, there is currently no widespread/whole lake control practice that would be effective without harming other wildlife.

Surprisingly, some positive impacts have been observed from Zebra Mussel infestations. They are capable of filtering one liter of water per day. This water often contains sediment and phytoplankton, which contribute to turbidity. As a result, large infestations have brought about significant improvements in water clarity in some lakes. Due to severe mussel infestations, Lake Erie water clarity has increased four to six times what it was before Zebra Mussels invaded the lake (in addition to improvements as a result of pollution control measures). This has resulted in deeper penetration of light and an expansion of aquatic plant populations, something that has not been seen for decades. In turn, the increased plant growth is providing better fish habitat and better fishing. Unfortunately, the negative ecological and economical impacts associated with Zebra Mussels far outweigh any positive benefits.

Here are some tips from the Great Lakes Sea Grant Network that can help prevent the spread of Zebra Mussels:

- Flush clean water (tap) through the cooling system of your motor to rinse out any larvae.

- Drain all bilge water, live wells, bait buckets, and engine compartments. Make sure water is not trapped in your trailer.

- Always inspect your boat and boat trailer carefully before transporting.

- In their earlier stages, attached Zebra Mussels may not be easily seen. Pass your hand across the bottom of the boat - if it feels grainy, it is probably covered with mussels. Don't take a chance; clean them off by scraping or blasting.

- Full grown Zebra Mussels can be easily seen but cling stubbornly to surfaces. Carefully scrape the hull (or trailer), or use a high pressure spray (250 psi) to dislodge them. Or leave your boat out of the water for at least 10-14 days, preferably two weeks. The mussels will die and drop off.

- Dispose of the mussels in a trash barrel or other garbage container. Don't leave them on the shore where they could be swept back into the lake or foul the area.

- Before you leave the boat launch site, remove from the boat trailer any plant debris where tiny Zebra Mussels may be entangled.

- Always use extra caution when transporting bait fish from one lake to another. You could be carrying microscopic veligers. To be safe, do not take water from one lake to another.

Certain polymer waxes discourage Zebra Mussels from attaching. But check your hull periodically because the mussels cling to drain holes and speedometer brackets.

D7. Options to Reduce or Eliminate User Conflicts

One of the most challenging management issues on residential lakes involves their use by a variety of different interest groups (i.e., user conflicts). Problems occur when the lake is used at the same time for recreational activities that inherently conflict. Numerous potential conflicts can be cited. For example, fishermen may feel the quality of their fishing experience is greatly diminished when powerboats are using the lake. Often, the overriding priority when dealing with user conflicts is safety. Unfortunately, these conflicts are not limited to human-to-human conflicts. Fish and wildlife may also be adversely affected by human activities.

User conflicts can also have significant effects on how a lake is managed. For example, water skiers may feel that the aquatic plant population is impeding with their ability to safely use certain portions of the lake and want the plants removed or dramatically reduced. At the same time, the fishermen and wildlife enthusiasts do not want plant reductions because they believe the plants are enhancing the habitat in the lake.

Another important component to consider is the enforcement of any use conflict resolutions. As with any rule or regulation, it is only as good as the ability to enforce it. A significant factor is determining who has jurisdiction to enforce any regulations. Any law enforcement officer can enforce boating regulations or ordinances enacted by the State of Illinois or local government entities. Verbal or "gentlemen's" agreements that are more stringent than state laws are not legally binding. Similarly, a law enforcement officer may not enforce regulations adopted by a lake management association.

The following are several options that may help reduce some of the user conflicts that may be occurring on your lake.

Option 1: Time Zoning

As the name implies, time spacing requires that certain times of the day are allocated for various activities, while other activities are restricted or not permitted. For example, water skiing or jet skiing may only be permitted between certain periods of the day (i.e., 9AM to 6PM). This option may be combined with other options such as zone spacing or speed/power limits. Certain areas of the lake may be restricted only during parts of the day (i.e., early morning or evening) or users may be required to use "no-wake" speeds during these times. Time zoning allows various activities on the lake that may otherwise conflict. However, care should be taken in arrangement of times so all interest groups are considered.

Option 2: Space Zoning

Designating areas of the lake where uses are restricted or even not allowed is known as zone spacing. A "no-wake" zone is an example of using zone spacing to achieve a management goal. Zone spacing is generally used to isolate or consolidate certain lake activities for various reasons. Frequently, user safety is a priority and thus activities such as water skiing or jet skiing are limited to the deeper areas of the lake where they will not conflict with other lake users, such as swimmers.
Another reason zone spacing is implemented is for the prevention of shoreline erosion. Wave action generated by boat traffic can cause erosion, which can reduce property values and fish and wildlife habitat. In addition, the water quality of the lake may be degraded when wave activity suspends lake bottom nutrients and sediment. Shoreline erosion also adds nutrients and sediment to the lake, causing a decrease in water quality, which impacts all users of the lake. In some cases, certain areas of lakes may be zoned "no entry" or "restricted use only". This designation is usually to protect sensitive fish and wildlife habitat of threatened or endangered species. These areas may have this restriction only during times of the year that are the most critical for a particular species (i.e., nesting or spawning season), or the restrictions may be year-round.

A "no wake" zone is generally established in a defined area from the shoreline out to a certain point in a lake and is usually marked by buoys. This area should be wide enough to allow wave action from boats to dissipate before reaching the shoreline.

Option 3: Speed/Power Limits

Powerboat motor limits or no motor areas may be warranted on small shallow lakes or in areas of a lake that are particularly susceptible to erosion or otherwise need protection. As mentioned previously, boat traffic may produce wave action that may cause shoreline erosion or degrade fish and wildlife habitat. Limited boat traffic may lead to less wave action battering shorelines and causing erosion, thus reducing the suspension of nutrients and sediment in the water column. Less nutrients and sediment in the water column may improve water quality by increasing water clarity and limiting nutrient availability for excessive plant or algae growth. Motor limits can reduce boat speeds however, the type of boat may be more important that the motor size or speed limit. Recent studies have shown that a boat traveling at "near plane" speed actually displaces more water and potentially resuspend lake bottom sediment at a greater volume than boats traveling at either idle speeds or speeds high enough to allow the boat to plane on the water's surface. Enforcement would be the most difficult aspect of this option.

Another option is to limit the number of boats that use a lake at one time. This is generally most effective on private lakes where the number of boats can be more easily controlled. Large lakes with public access would have a difficult time enforcing regulations of this nature. To achieve this option, a lake management entity could issue a limited number of permits or require stickers for any boat using the lake.

D8. Participate in the Volunteer Lake Monitoring Program

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

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

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

For information, please contact:

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D9. Options for 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.

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

2000 - 2008 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2008	
Average	**167**	
Median	**162**	
Minimum	**65**	**IMC**
Maximum	**330**	**Flint Lake**
STD	**42**	
n =	**802**	

	ALKanoxic 2000-2008	
Average	**202**	
Median	**194**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**50**	
n =	**243**	

	Condoxic <=3ft00-2008	
Average	**0.8934**	
Median	**0.8195**	
Minimum	**0.2542**	**Broberg Marsh**
Maximum	**6.8920**	**IMC**
STD	**0.5250**	
n =	**806**	

	Condanoxic 2000-2008	
Average	**1.0312**	
Median	**0.8695**	
Minimum	**0.3210**	**Lake Kathyrn**
Maximum	**7.4080**	**IMC**
STD	**0.7985**	
n =	**243**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2008	
Average	**0.508**	
Median	**0.156**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.073**	
n =	**807**	

*ND = Many lakes had non-detects (74.1%)
Only compare lakes with detectable
concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3- Nanoxic 2000-2008	
Average	**2.192**	
Median	**1.630**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.343**	
n =	**243**	

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

	pHoxic <=3ft00-2008	
Average	**8.32**	
Median	**8.32**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.44**	
n =	**801**	

	pHanoxic 2000-2008	
Average	**7.28**	
Median	**7.28**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.42**	
n =	**243**	

	All Secchi 2000-2008	
Average	**4.51**	
Median	**3.12**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pon**
Maximum	**24.77**	**West Loon Lake**
STD	**3.78**	
n =	**749**	

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2000 - 2008 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2008	
Average	**1.450**	
Median	**1.200**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.845**	
n =	**802**	

*ND = 3.9% Non-detects from 15 different lakes

	TKNanoxic 2000-2008	
Average	**2.973**	
Median	**2.330**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.324**	
n =	**243**	

*ND = 2.9% Non-detects from 4 different lakes

	TPoxic <=3ft00-2008	
Average	**0.105**	
Median	**0.065**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.218**	
n =	**808**	

*ND = 2.6% Non-detects from 9 different lakes

	TPanoxic 2000-2008	
Average	**0.316**	
Median	**0.181**	
Minimum	**0.012**	**Independ. Grove**
Maximum	**3.800**	**Taylor Lake**
STD	**0.419**	
n =	**243**	

	TSSall <=3ft00-2008	
Average	**15.5**	
Median	**8.2**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**813**	

*ND = 1.5% Non-detects from 9 different lakes

	TVSoxic <=3ft00-2008	
Average	**132.8**	
Median	**129.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.8**	
n =	**757**	

No 2002 IEPA Chain Lakes

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

No 2002 IEPA Chain Lakes.

	CLanoxic <=3ft00-2008	
Average	**234**	
Median	**139**	
Minimum	**41**	**Timber Lake (N)**
Maximum	**2390**	**IMC**
STD	**364**	
n =	**125**	

	CLoxic <=3ft00-2008	
Average	**210**	
Median	**166**	
Minimum	**30**	**White Lake**
Maximum	**2760**	**IMC**
STD	**233**	
n =	**470**	

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

Minimums and maximums are based on data from all lakes from 2000-2008 (n=1351).

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

LCHD Lakes Management Unit ~ 12/1/2008

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APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

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

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

Table F1. Continued

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

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
IEMA = Illinois Emergency Management Agency
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IDNR = Illinois Department of Natural Resources
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LCSMC = Lake County Stormwater Management Commission
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