2009 SUMMARY REPORT
of
Davis Lake

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Davis Lake is a 36 acre impoundment located in southwestern Lake County and it is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency. Davis Lake receives water from both Owens and Schreiber lakes and empties into Tamarack Lake via the Davis Lake Drain. The lake is part of a Lake County Forest Preserve District property with one private bottom owner living along side it. The lake is used for aesthetics.

The water quality of Davis Lake was average. The Lake County median Secchi disk transparency (water clarity) for the period 2000-2009 was 3.15 feet. Davis Lake averaged 9.65 feet during 2009, which was well above the Lake County median. Water clarity is influenced by the amount of total suspended solids (TSS) in the water column. In 2009 the average TSS was 2.6 mg/L. The amount of TSS measured has increased slightly since 2000 when the TSS average was 2.1 mg/L. However, both values were well below the current county median of 7.9 mg/L. The slight increase that occurred in the concentrations between 2000 and 2009 were likely due to weather conditions and massive algal blooms that occurred during the 2009 monitoring season.

The average total phosphorus (TP) concentration of 0.065 mg/L was above the county median of 0.063 mg/L. This concentration was also 26% greater than the average TP concentration of 0.048 mg/L recorded in 2000. The average N:P ratio was 14.88 indicating that there was sufficient amounts of both nutrients to facilitate plant and algae growth, however, phosphorus was the limiting nutrient during the period between June though August. This means that any additional phosphorus into the system could increase the amount of alga present into the lake.

The median conductivity reading for lakes sampled in the county was 0.7910 milliSiemens/cm, (mS/cm). The average conductivity reading in 2009 was below this at 0.6306 mS/cm, however, the conductivity did increase by 25% from 2000 (0.5143 mS/cm). Conductivity is positively correlated with chloride (Cl^-). Road salt has been found to be a major source of chloride found in waters. The average Cl^- concentration in Davis Lake was measured at 89 mg/L, which is lower than the Lake County median of 145 mg/L. In 2000 it is estimated that the chloride level in Davis Lake was 36 mg/L.

Davis Lake's aquatic plant community was diverse, a total of twelve plant species and one macro algae were detected during meander and quantitative surveys that took place in 2009. There were four species dominating the lake; they were Coontail, Star Duckweed, Watermeal and White Water Lily. The number of plant species detected increased by one species in 2009, Giant Duckweed was not detected in 2000. The shoreline was assessed in 2009 for significant changes in erosion since 2000. Based on the 2009 assessment 27% of the shoreline was experiencing some level of erosion. Seventeen percent was experiencing moderate to severe erosion, much of which was taking place in the inlet channel. The remaining 73% of the shoreline showed no signs of erosion.

Davis Lake is located in a forest preserve and its shoreline is mainly undeveloped. This provides excellent habitat for a variety of birds, mammals, and other wildlife. Habitat around Davis Lake was good. The undeveloped areas were comprised of cattail fringe and islands, wetlands and wooded corridors.

LAKE FACTS

Lake Name:	Davis Lake ~ ADID 125
Historical Name:	None
Nearest Municipality:	Wauconda
Location:	T44N, R10E, Section 29, SE 1/4
Elevation:	810.0 feet mean sea level
Major Tributaries:	Owens Lake and Schreiber Lake
Watershed:	Fox River
Sub-watershed:	Squaw Creek
Receiving Waterbody:	Tamarack Lake
Surface Area:	35.9 acres
Shoreline Length:	1.5 miles
Maximum Depth:	18.0 feet (estimated)
Average Depth:	9.0 feet (estimated)
Lake Volume:	323.4 acre-feet (estimated)
Lake Type:	Flooded wetland (1940)
Watershed Area:	636.8 acres
Major Watershed Land Uses:	Public and Private Open Space and Single Family
Bottom Ownership:	Public and Private
Management Entities:	Lake County Forest Preserve District
Current and Historical Uses:	Aesthetics
Description of Access:	Public and Private

SUMMARY OF WATER QUALITY

Water samples were collected monthly from May through September at the deepest point in the lake (Figure 1, Appendix A). Davis Lake was sampled at a depth of three feet and between 11 and 14 feet or 3 feet from the lake bottom. The samples were analyzed for various water quality parameters (Appendix B). Lake County Health Department-Environmental Services (LCHD-ES) recommend that Davis Lake participate in the State of Illinois' Volunteer Lake Monitoring Program. This would assist in providing data during the periods when LCHD–ES is not monitoring the lake.

Since 2000, the dissolved oxygen (DO) concentrations have improved in Davis Lake and were adequate to support a sunfish/bass fishery (at or above 5.0 mg/L), below this concentration, fish can suffer oxygen stress which can result in fish kills. The lake was thermally stratified during the entire monitoring season, May through September. However, DO concentrations fluctuated throughout the season and algal blooms appear to have contributed. For instance, in June, the anoxic boundary was estimated to be at 9.55 feet. At 10 feet the DO concentration was measured to be 0.67 mg/L. The DO then increased to 6.39 mg/L at 14 feet, before then once again becoming anoxic towards the lake bottom. In July the lake was anoxic by 8 feet with DO concentrations increasing towards the bottom after decreasing within the water column. In August, DO concentrations were adequate to support aquatic organisms throughout the entire profile, however the same pattern repeated itself. No algal blooms were observed during the visit but the pattern is likely due to algae suspended near the lake bottom. An accurate bathymetric map should be completed to allow an assessment to be made as to whether or not Davis Lake has DO problems, as the lake was considered anoxic between depths of 7.5 and 13.9 feet and has historically been subject to fish kills. DO concentrations fluctuating in and out of anoxic conditions can impact both hypolimnetic and benthic organisms having an impact on the entire lake ecology. Further, depending on the LCFPD goals for Davis Lake, an accurate map will assist in making better management decisions for the lake. Based on these conditions, caution is recommended if a fishery is primary management goal for this lake.

Secchi disk transparency depth (water clarity) averaged 9.65 feet during 2009 which was improved from 8.14 feet in 2000 (Table 1). Both of these readings were well above the Lake County median of 3.15 feet (Appendix E). The abundance of plants found likely contributed to the good water clarity in Davis Lake.

Total suspended solids (TSS) in the water column are inversely correlated to decreasing water clarity (Figure 2). TSS is composed of nonvolatile suspended solids, non-organic clay or sediment materials, and volatile suspended solids (TVS), algae and other organic matter. In 2009, the average TSS was 2.6 mg/L. This remained relatively unchanged from the average concentration in 2000 (2.1 mg/L). Both values were much less than the 2009 county median of 7.9 mg/L. The average TVS concentration of 104 mg/L was near the county median of 125.5 mg/L and decreased slightly from the 2000 concentration of 110 mg/L. Non volatile solids also decreased in within lake from 2000 from 1.48 mg/L to 0.44 mg/L in 2009. The abundance of plants likely trapped much of the sediment, plus much of the construction in the watershed has diminished.

Figure 1. Water quality sampling site on Davis Lake, 2009.

Table 1. Water quality data for Davis Lake, 2000 and 2009.

2009	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	170	0.85	<0.1	<0.05	0.071	0.019	90	374	1.8	388	98	13.62	0.6500	9.09	10.32
17-Jun	3	143	0.83	<0.1	<0.05	0.048	0.009	88	355	1.3	373	108	10.50	0.6120	8.67	8.00
22-Jul	3	165	1.06	<0.1	<0.05	0.067	0.01	89	370	5.5	401	116	5.80	0.6410	8.03	6.07
19-Aug	3	164	1.00	<0.1	<0.05	0.061	0.014	89	366	2.3	390	113	8.20	0.6330	8.06	8.64
23-Sep	3	159	1.08	<0.1	<0.05	0.077	0.015	88	358	2.1	358	83	10.11	0.6170	8.37	5.64
	Average	160	0.96	<0.1	<0.05	0.065	0.013	89	365	2.6	382	104	9.65	0.6306	8.44	7.73

2000	Epilimnion															
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	Cl-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
15-May	3	175	1.17	<0.1	0.039	0.041	0.011	NA	376	1.0	382	142	12.37	0.6367	7.91	6.42
19-Jun	3	151	0.92	<0.1	0.053	0.030	<0.005	NA	362	1.7	387	135	8.76	0.5573	8.36	8.45
17-Jul	3	131	1.08	<0.1	0.057	0.066	0.011	NA	268	2.2	265	100	4.76	0.4150	7.60	3.05
21-Aug	3	148	0.96	<0.1	0.055	0.056	<0.005	NA	264	3.2	295	79	5.97	0.4643	7.56	1.44
18-Sep	3	162	1.26	<0.1	<0.05	0.045	<0.005	NA	296	2.3	307	93	8.83	0.4983	7.58	5.10
	Average	153	1.08	<0.1	0.051[k]	0.048	0.011	NA	313	2.1	327	110	8.14	0.5143	7.80	4.89

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 + Nitrite 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
** = Parameters estimated from conductivity reading.

Table 1. Continued.

2009	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	12	176	0.88	<0.1	<0.05	0.122	0.062	92	402	2.2	402	103	NA	0.7050	8.44	4.14
17-Jun	14	188	1.95	<0.1	<0.05	0.406	0.064	99	421	16.0	457	131	NA	0.7420	7.77	6.39
22-Jul	13	218	3.10	2.130	<0.05	0.795	0.495	99	437	6.8	451	115	NA	0.7750	6.85	0.83
19-Aug	11	228	4.39	2.750	<0.05	0.918	0.758	96	433	11.0	461	127	NA	0.7670	6.78	11.79
23-Sep	12	159	1.06	<0.1	<0.05	0.064	0.015	88	439	1.6	360	87	NA	0.7780	7.35	0.56
	Average	194	2.28	2.440[k]	<0.05	0.461	0.279	95	426	7.5	426	113	NA	0.7534	7.44	4.74

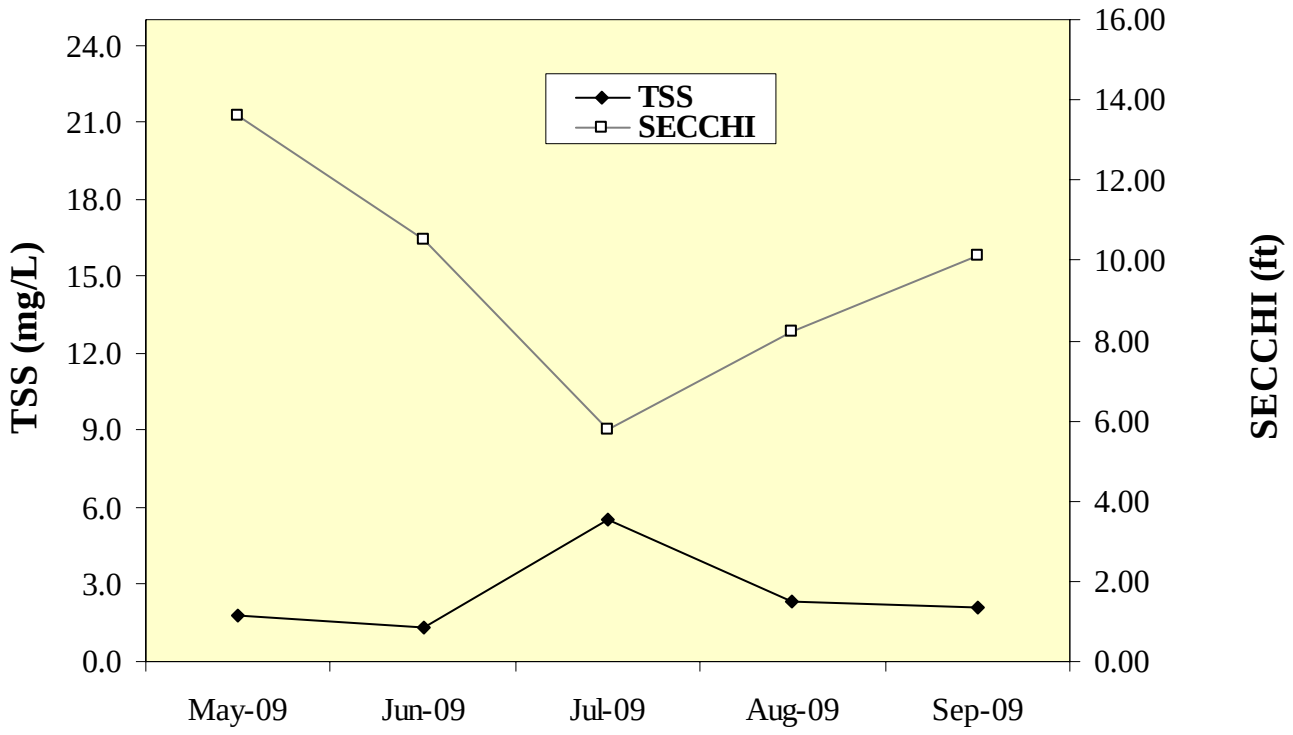
2003	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	Cl-**	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
15-May	16	209	2.22	1.040	0.054	0.303	0.222	85	384	7.1	412	146	NA	0.6701	7.21	0.00
19-Jun	16	212	3.44	1.830	0.095	0.479	0.407	85	405	7.0	447	148	NA	0.6703	6.85	0.04
17-Jul	16	225	4.35	3.040	0.094	0.571	0.455	95	380	13.0	424	136	NA	0.7005	6.50	0.00
21-Aug	14	254	5.90	5.450	<0.05	0.837	0.756	96	393	5.6	430	143	NA	0.7029	6.77	0.09
18-Sep	15	250	5.85	4.570	<0.05	0.662	0.596	105	390	6.0	403	115	NA	0.7329	6.65	0.10
	Average	230	4.35	3.186	0.081[k]	0.570	0.4872	93	390	7.7	423	138	NA	0.6953	6.80	0.046

Glossary

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

Figure 2. Total suspended solid (TSS) concentrations vs. Secchi depth for Davis Lake, 2009.



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) was 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. Davis Lake had a TN:TP ratio of 14.9 indicating there was enough of both nutrients to facilitate plant and algae growth. This was observed during 2009. Davis Lake is almost completely under ownership by the Lake County Forest Preserve District. The other owner is a horse farm. Davis Lake receives waters from two drainages, one from Schreiber Lake and the other from Owens Lake. Schreiber Lake has not had much change occur in it's watershed since 2000, however, the drainage from Owens Lake has had rather significant changes with construction of a golf course and part of it's residential community feeding into it (Figure 3 and Table2). Nitrogen naturally occurs in high concentrations and comes from a variety of sources (soil, air, etc.), which are more difficult to control than sources of phosphorus. Phosphorus is usually easier to manage and more feasible to control than nitrogen. It is recommended that homeowners and businesses within the watershed use phosphorus-free fertilizers.

The amount of phosphorus present in the lake was more than sufficient during the entire growing season to support algae blooms and excessive plant growth. Epilimnetic average TP concentrations increased from 2000 (0.048 mg/L) to 0.065 mg/L in 2009. The external sources of TP affecting Davis Lake come from stormwater runoff from the 636.8 acres within its watershed (Figure 4). Management practices within the watershed can directly affect the lake. Internal sources from natural processes in occurring in the hypolimnion may have also affected the epilimnetic concentrations. Davis Lake is a relatively shallow possibly polymixtic lake, which means that the lake could have mixed and re-stratified between monthly sampling visits. In 2009, lakes within the Squaw Creek watershed were monitored (Figure 4). Davis Lake is near the top of this watershed being fed by Owens Lake located to its south and has better than average water quality compared to the other lakes monitored within the Squaw Creek watershed (Table 3). Owens Lake had a significant drop in the amount of average TP present in its waters although it still has sufficient phosphorus available to be a source of excessive plant growth and algal blooms. Davis Lake which is recipient of these waters has a much longer retention time (approx. 3 months) before exiting the lake on its way to Squaw Creek via the Davis Lake Drain. In Illinois, 2009 was the fourth wettest on record with 50.27 inches of precipitation falling. This followed the second wettest year of 2008 in which 50.46 inches fell. In theory our area potentially had up to 100.73 inches of precipitation, which amounts to a surplus 22.4 inches of precipitation in that two year period (http://www.isws.illinois.edu/atmos/statecli/).

Rain events can contribute additional sediment or nutrients (like phosphorus) to a lake, which may influence water sample results. Rain events occurred within 48 hours prior to sampling in June (0.56 inches) and July (0.06 inches) as recorded at the Lake County Stormwater Management Commission (LCSMC) rain gage in Wauconda. In Based on this gage there was 23.06 inches of rain that fell in the area from April 1 – September 30. Monthly precipitation as measured at LCSMC Wauconda station yielded 5.35, 4.12, 3.32, 5.00 and 3.23 inches of rain, for

Figure 3. Approximate land use within the Davis Lake watershed, 2009 (Based upon 2008 digital imagery).

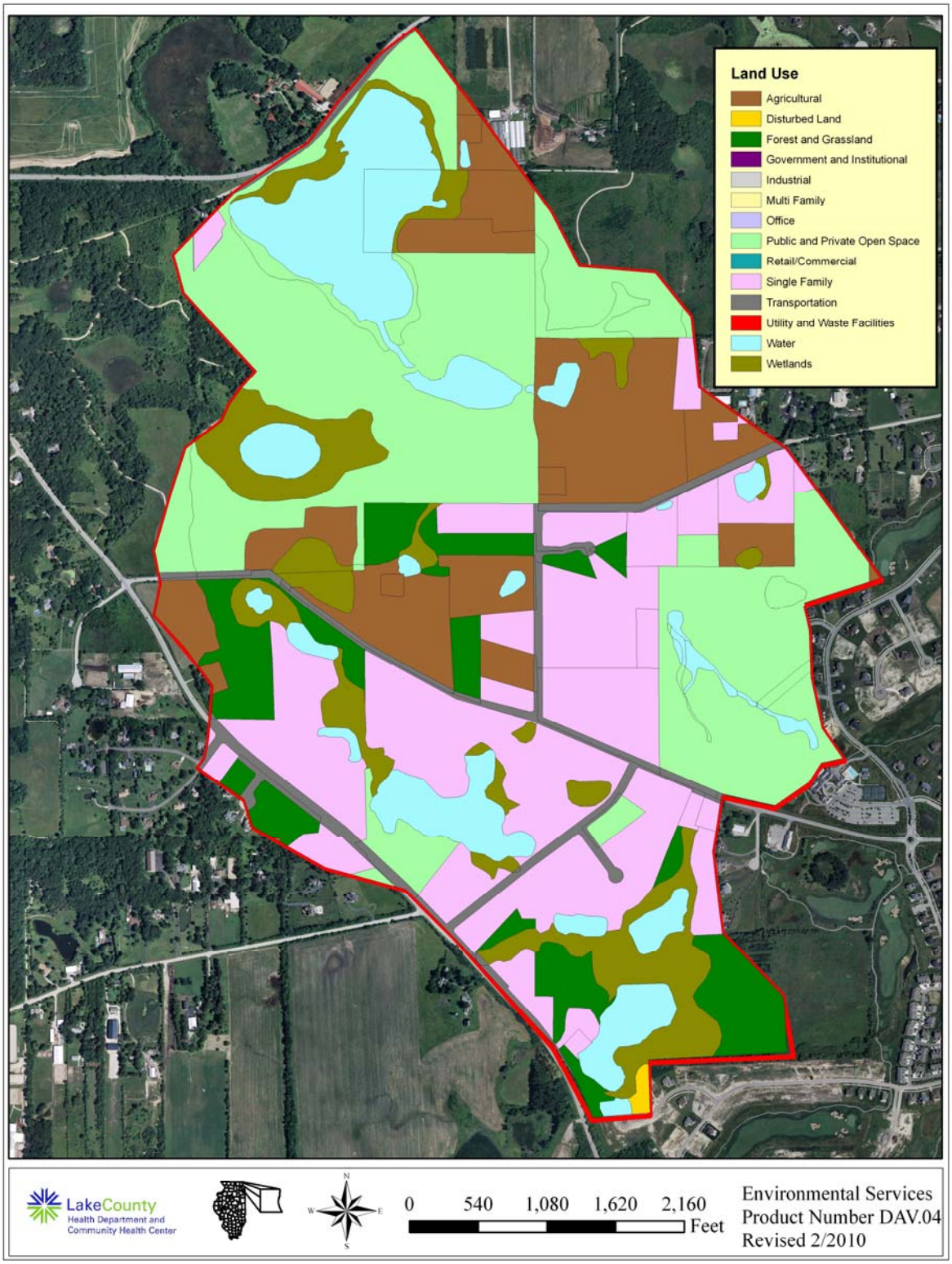


Table 2. Approximate land uses and retention time for Davis Lake, 2009. (Based upon 2008 digital imagery.)

Land Use	Acreage	% of Total
Agricultural	88.45	13.9%
Disturbed Land	1.03	0.2%
Forest and Grassland	50.64	8.0%
Government and Institutional	0.00	0.0%
Industrial	0.00	0.0%
Multi Family	0.00	0.0%
Office	0.00	0.0%
Public and Private Open Space	185.42	29.1%
Retail/Commercial	0.00	0.0%
Single Family	144.72	22.7%
Transportation	24.67	3.9%
Utility and Waste Facilities	0.00	0.0%
Water	80.06	12.6%
Wetlands	61.79	9.7%
Total Acres	**636.78**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acre ft.	% Total of Estimated Runoff
Agricultural	88.45	0.05	12.2	4.7%
Disturbed Land	1.03	0.05	0.1	0.1%
Forest and Grassland	50.64	0.05	7.0	2.7%
Government and Institutional	0.00	0.50	0.0	0.0%
Industrial	0.00	0.50	0.0	0.0%
Multi Family	0.00	0.50	0.0	0.0%
Office	0.00	0.85	0.0	0.0%
Public and Private Open Space	185.42	0.15	76.5	29.7%
Retail/Commercial	0.00	0.85	0.0	0.0%
Single Family	144.72	0.30	119.4	46.4%
Transportation	24.67	0.50	33.9	13.2%
Utility and Waste Facilities	0.00	0.30	0.0	0.0%
Water	80.06	0.00	0.0	0.0%
Wetlands	61.79	0.05	8.5	3.3%
TOTAL	**636.78**		**257.6**	100.0%

Lake volume	**63.92**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.25**	**years**
	90.58	**days**

Figure 4. Approximate watershed delineation for Davis Lake, 2009 (Digital Image from 2008).

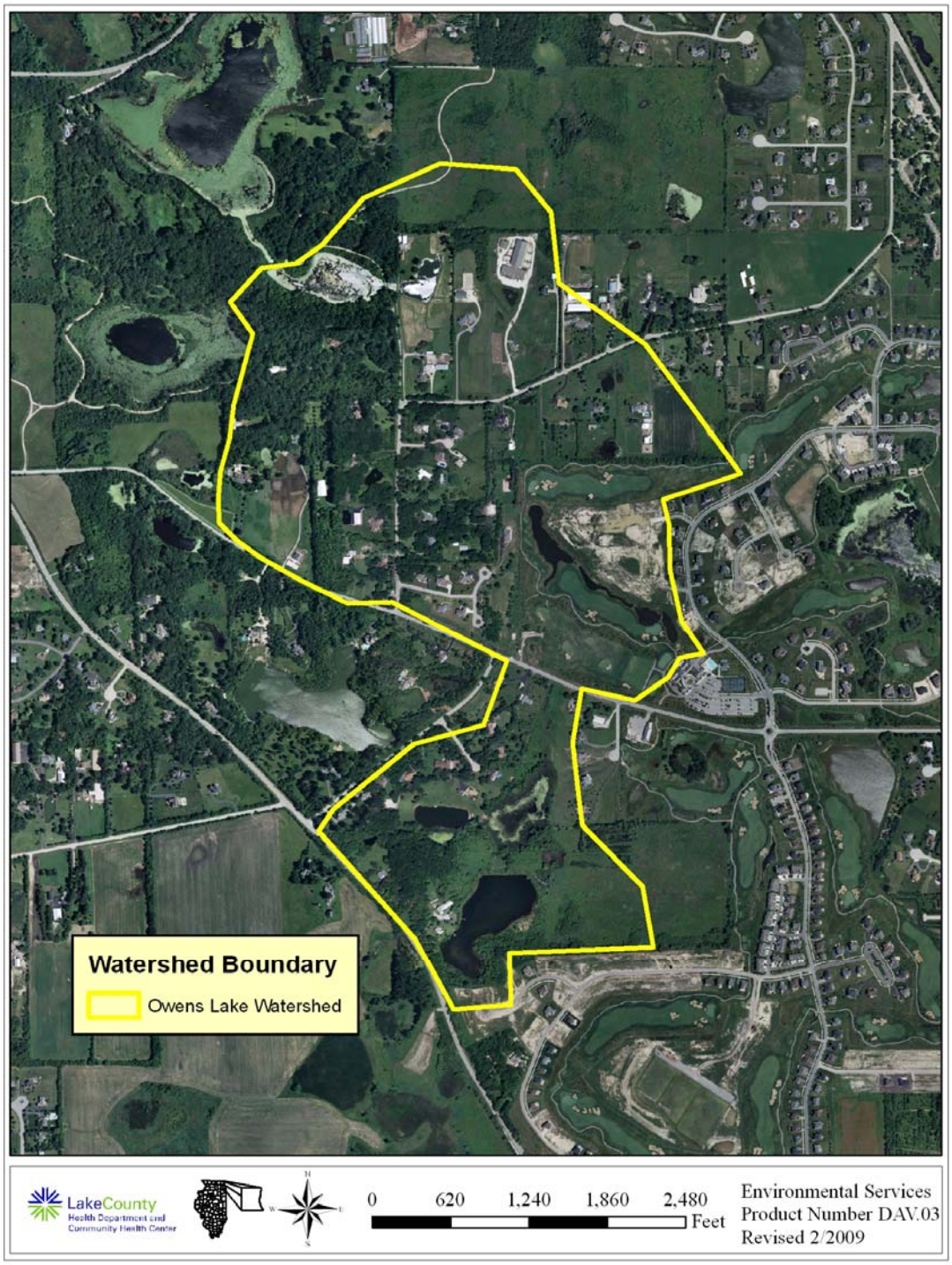


Table 3. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity within the Squaw Creek watershed.

Lake Name	Year	Secchi (feet)	TSS (mg/L)	TP (mg/L)	Conductivity (milliSiemens/cm)
Cranberry Lake	2000	10.96	1.2	0.024	0.3809
Cranberry Lake	2005	10.52	1.5	0.024	0.5625
Cranberry Lake	2006	9.33	1.6	0.024	0.6019
Cranberry Lake	2007	9.06	1.8	0.023	0.5138
Cranberry Lake	2008	9.63	2.2	0.027	0.5070
Cranberry Lake	2009	8.56	3.7	0.036	0.4262
Highland Lake	1991	7.08	3.4	0.039	NA
Highland Lake	1996	7.98	2.4	0.023	0.4076
Highland Lake	2001	6.58	3.3	0.030	0.5560
Highland Lake	2009	6.97	4.8	0.020	0.5834
Round Lake	1989	7.07	4.4	0.100	NA
Round Lake	1991	5.20	5.4	0.031	NA
Round Lake	1995	7.44	3.4	0.024	0.6290
Round Lake	1999	10.32	2.7	0.015	0.8364
Round Lake	2003	6.25	3.5	0.025	1.0730
Round Lake	2009	7.01	3.0	0.023	1.2292
Long Lake	1996	2.44	13.9	0.086	0.5222
Long Lake	2001	4.11	9.7	0.092	0.9430
Long Lake	2005	4.18	10.9	0.076	1.0821
Long Lake	2006	4.52	7.2	0.068	1.1120
Long Lake	2007	3.24	11.1	0.103	0.9066
Long Lake	2008	2.69	11.6	0.117	0.8722
Long Lake	2009	4.16	10.2	0.092	0.7587
Old Oak Lake	2003	5.08	3.6	0.043	0.7240
Old Oak Lake	2009	4.85	4.9	0.049	0.7700
Schreiber Lake	1999	9.70	3.4	0.035	0.2750
Schreiber Lake	2003	9.59	3.1	0.043	0.2882
Schreiber Lake	2009	7.25	2.8	0.040	0.2582
Owens Lake	2000	4.38	11.0	0.124	0.5395
Owens Lake	2009	5.30	3.5	0.058	0.5274
Davis Lake	2000	8.14	2.1	0.048	0.5143
Davis Lake	2009	9.65	2.6	0.065	0.6306
Summmerhill Estates Lake	2004	3.65	6.1	0.138	0.5858
Summmerhill Estates Lake	2009	3.27	9.4	0.199	0.5552
Lake Helen	2009	6.43	4.1	0.072	0.4742
Lake Nippersink (LCFPD)	2009	1.73	18.9	0.100	0.4588
Patski Pond	2004	NA	52.7	0.251	0.8194
Patski Pond	2009	NA	33.7	0.197	0.8994
Hook Lake	2004	5.03	5.1	0.030	1.1067
Hook Lake	2009	3.95	6.5	0.041	1.4690

May, June, July, August and September, respectively. The July rain event was exhibited in some water quality parameters in Davis Lake. TSS increased, subsequently water clarity was the lowest it was all season and TP and SRP increased as well.

Public and private open space (29%) and single family (23%) were the major land uses within the Davis Lake watershed (Figure 3). Table 2 shows that the land use single family contributed the highest percentage of estimated runoff (46.4%) followed by public and private open space (29.7%). It is important to keep in mind that although the amount of estimated runoff from certain land uses may be low, those areas can still deliver high concentrations of pollutants. The retention time (the amount of time it takes for water entering a lake to flow out again) for Davis Lake was estimated to be approximately 91 days.

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 Davis Lake in terms of its phosphorus concentration during 2009 was eutrophic, with a TSIp score of 64.3 which ranked it 82 out of 165 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 and recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations (TSIp), and aquatic plant coverage. According to this index, Davis Lake provides *Full* support of aquatic life and *Partial* support of recreational activities. The lake provides P*artial* overall use.

There was a significant increase in pH from 2000 to 2009 from 7.8 to 8.4 respectively (Table 1). This is likely due to photosynthesizing plants and phytoplankton present in the lake. There have been instances, where pH has exceeded 10 in the late afternoon especially in lakes where phytoplankton are photosynthesizing.

Conductivity is a measurement of water's ability to conduct electricity and is correlated with chloride (Cl^-) concentrations (Figure 5). 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 0.7910 milliSiemens/cm (mS/cm). During 2009, the Davis Lake average conductivity reading was lower, at 0.6306 mS/cm. However, this was an approximate 23% increase from the 2000 average of 0.5143 mS/cm. Average chloride concentration in Davis Lake in 2009 was 89 mg/L. A study done in Canada reported 10% of aquatic species are harmed by prolonged exposure to Cl^- concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were

Table 4. Lake County average TSI phosphorous (TSIp) ranking 2000-2009.

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	Cedar 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	Highland Lake	0.0200	47.35
14	Banana Pond	0.0202	47.49
15	Lake Minear	0.0204	47.63
16	Cross Lake	0.0220	48.72
17	Sun Lake	0.0220	48.72
18	Dog Pond	0.0222	48.85
19	Lake of the Hollow	0.0230	49.36
20	Stone Quarry Lake	0.0230	49.36
21	Round Lake	0.0230	49.36
22	Deep Lake	0.0234	49.61
23	Bangs Lake	0.0240	49.98
24	Druce Lake	0.0244	50.22
25	Little Silver	0.0250	50.57
26	Lake Leo	0.0256	50.91
27	Dugdale Lake	0.0274	51.89
28	Peterson Pond	0.0274	51.89
29	Lake Miltmore	0.0276	51.99
30	Lake Fairfield	0.0296	53.00
31	Third Lake	0.0300	53.20
32	Gray's Lake	0.0302	53.29
33	Lake Catherine (Site 1)	0.0308	53.57
34	Lambs Farm Lake	0.0312	53.76
35	Old School Lake	0.0312	53.76
36	Sand Lake	0.0316	53.94
37	Lake Linden	0.0326	54.39
38	Gages Lake	0.0338	54.92
39	Honey Lake	0.0340	55.00
40	Hendrick Lake	0.0344	55.17
41	Cranberry Lake	0.0360	55.82
42	Sullivan Lake	0.0370	56.22
43	Diamond Lake	0.0372	56.30
44	Channel Lake (Site 1)	0.0380	56.60
45	Ames Pit	0.0390	56.98
46	Schreiber Lake	0.0400	57.34

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Hook Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Deer Lake	0.0434	58.52
52	Nielsen Pond	0.0448	58.98
53	Turner Lake	0.0458	59.30
54	Seven Acre Lake	0.0460	59.36
55	Willow Lake	0.0464	59.48
56	Lucky Lake	0.0476	59.85
57	East Meadow Lake	0.0478	59.91
58	Old Oak Lake	0.0490	60.27
59	East Loon Lake	0.0490	60.27
60	Countryside 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 Napa Suwe (Outlet)	0.0570	62.45
69	Lake Christa	0.0576	62.60
70	Lake Charles	0.0580	62.70
71	Owens Lake	0.0580	62.70
72	Crooked Lake	0.0608	63.38
73	Waterford Lake	0.0610	63.43
74	Wooster Lake	0.0610	63.43
75	Lake Naomi	0.0616	63.57
76	Lake Tranquility S1	0.0618	63.62
77	Werhane Lake	0.0630	63.89
78	Liberty Lake	0.0632	63.94
79	Countryside Glen Lake	0.0642	64.17
80	Lake Fairview	0.0648	64.30
81	Leisure Lake	0.0648	64.30
82	Davis Lake	0.0650	64.34
83	Tower Lake	0.0662	64.61
84	St. Mary's Lake	0.0666	64.70
85	Mary Lee Lake	0.0682	65.04
86	Hastings Lake	0.0684	65.08
87	Lake Helen	0.0720	65.82
88	Spring Lake	0.0726	65.94
89	ADID 203	0.0730	66.02
90	Bluff Lake	0.0734	66.10
91	Harvey Lake	0.0766	66.71
92	Broberg Marsh	0.0782	67.01

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Sylvan Lake	0.0794	67.23
94	Big Bear Lake	0.0806	67.45
95	Petite Lake	0.0834	67.94
96	Timber Lake (South)	0.0848	68.18
97	Lake Marie (Site 1)	0.0850	68.21
98	North Churchill Lake	0.0872	68.58
99	Grand Avenue Marsh	0.0874	68.61
100	Grandwood Park, Site II, Outflow	0.0876	68.65
101	North Tower Lake	0.0878	68.68
102	South Churchill Lake	0.0896	68.97
103	Rivershire Pond 2	0.0900	69.04
104	McGreal Lake	0.0914	69.26
105	Long Lake	0.0920	69.35
106	International Mine and Chemical Lake	0.0948	69.79
107	Eagle Lake (Site I)	0.0950	69.82
108	Valley Lake	0.0950	69.82
109	Dunns Lake	0.0952	69.85
110	Fish Lake	0.0956	69.91
111	Lochanora Lake	0.0960	69.97
112	Woodland Lake	0.0986	70.35
113	Island Lake	0.0990	70.41
114	McDonald Lake 1	0.0996	70.50
115	Nippersink Lake	0.1000	70.56
116	Longview Meadow Lake	0.1024	70.90
117	Lake Barrington	0.1053	71.30
118	Redwing Slough, Site II, Outflow	0.1072	71.56
119	Lake Forest Pond	0.1074	71.59
120	Bittersweet Golf Course #13	0.1096	71.88
121	Fox Lake (Site 1)	0.1098	71.90
122	Osprey Lake	0.1108	72.04
123	Bresen Lake	0.1126	72.27
124	Round Lake Marsh North	0.1126	72.27
125	Deer Lake Meadow Lake	0.1158	72.67
126	Taylor Lake	0.1184	72.99
127	Columbus Park Lake	0.1226	73.49
128	Nippersink Lake (Site 1)	0.1240	73.66
129	Echo Lake	0.1250	73.77
130	Grass Lake (Site 1)	0.1288	74.21
131	Lake Holloway	0.1322	74.58
132	Lakewood Marsh	0.1330	74.67
133	Redhead Lake	0.1412	75.53
134	Forest Lake	0.1422	75.63
135	Antioch Lake	0.1448	75.89
136	Slocum Lake	0.1496	76.36
137	Pond-a-Rudy	0.1514	76.54
138	Lake Matthews	0.1516	76.56

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Buffalo Creek Reservoir	0.1550	76.88
140	Pistakee Lake (Site 1)	0.1592	77.26
141	Grassy Lake	0.1610	77.42
142	Salem Lake	0.1650	77.78
143	Half Day Pit	0.1690	78.12
144	Lake Eleanor Site II, Outflow	0.1812	79.13
145	Lake Farmington	0.1848	79.41
146	Lake Louise	0.1850	79.43
147	ADID 127	0.1886	79.71
148	Patski Pond (outlet)	0.1970	80.33
149	Summerhill Estates Lake	0.1990	80.48
150	Dog Bone Lake	0.1990	80.48
151	Redwing Marsh	0.2072	81.06
152	Stockholm Lake	0.2082	81.13
153	Bishop Lake	0.2156	81.63
154	Ozaukee Lake	0.2200	81.93
155	Hidden Lake	0.2236	82.16
156	Fischer Lake	0.2278	82.43
157	Oak Hills Lake	0.2792	85.36
158	Loch Lomond	0.2954	86.18
159	McDonald Lake 2	0.3254	87.57
160	Fairfield Marsh	0.3264	87.61
161	ADID 182	0.3280	87.69
162	Slough Lake	0.4134	91.02
163	Flint Lake Outlet	0.4996	93.75
164	Rasmussen Lake	0.5025	93.84
165	Albert Lake, Site II, outflow	1.1894	106.26

Figure 5. Lakes sampled in the Squaw Creek Watershed, 2009.

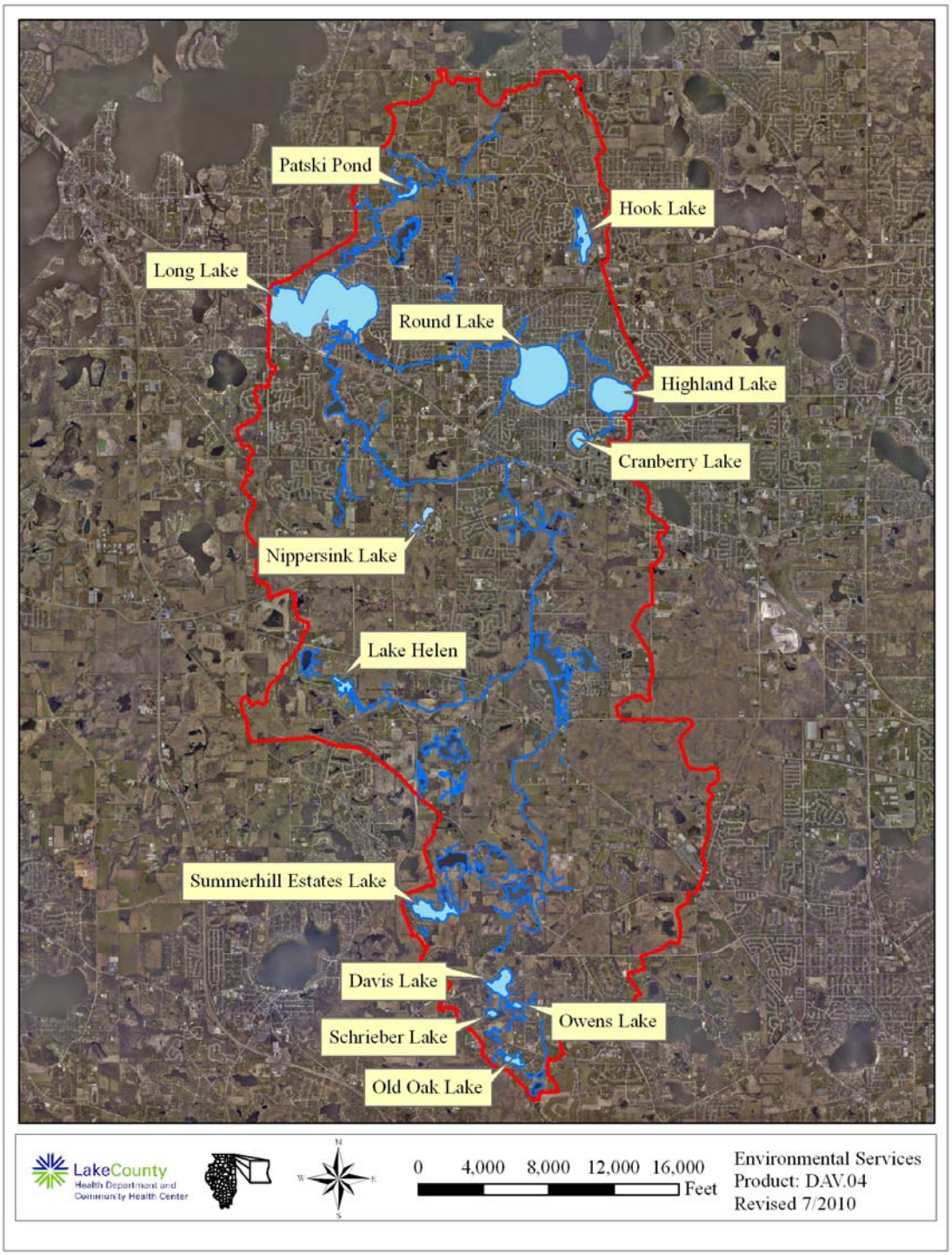
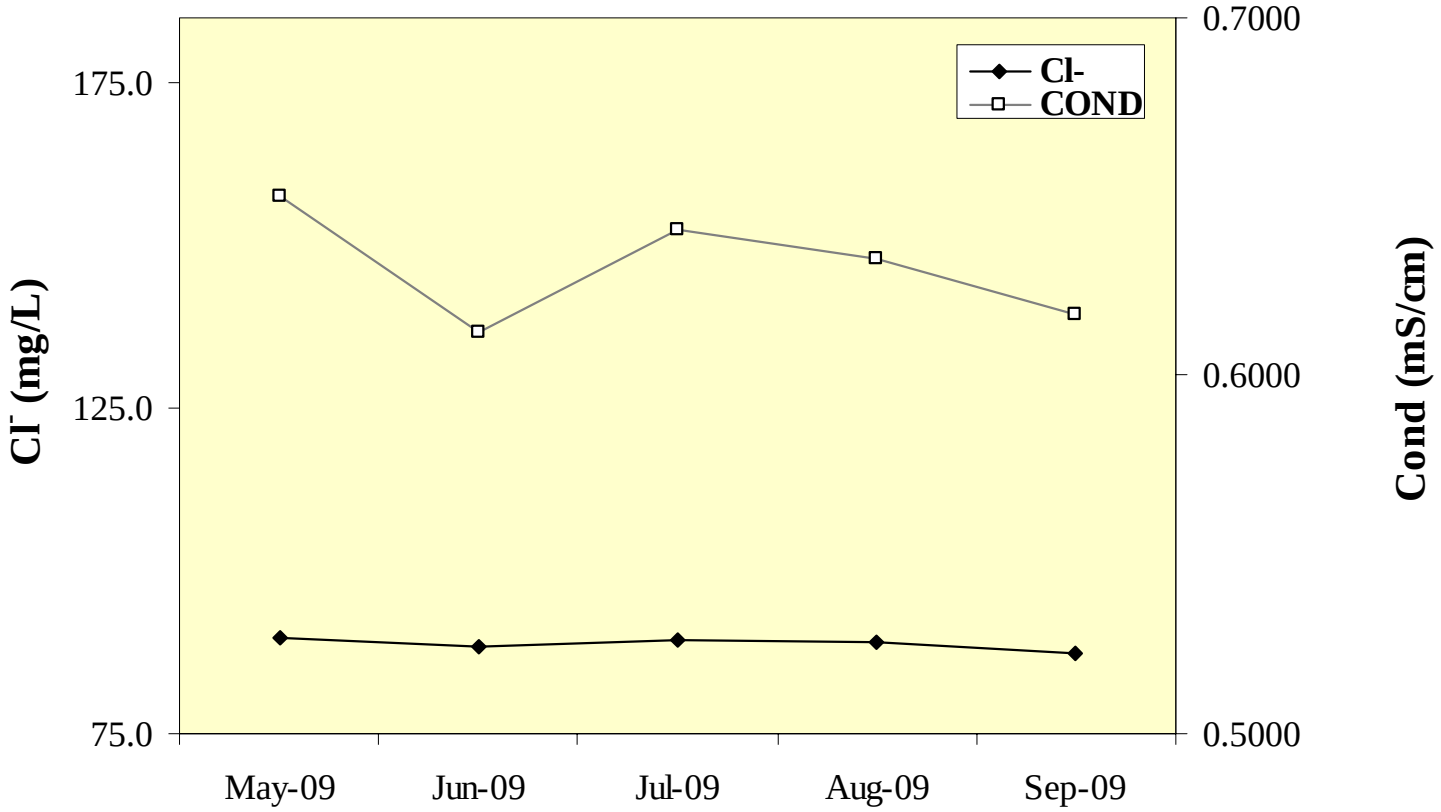


Figure 6. Chloride (Cl^-) concentration vs. conductivity for Davis Lake, 2009.



associated with Cl^- concentrations as low as 12 mg/l. Therefore, lakes can be negatively impacted by the high Cl^- concentrations. Chloride concentrations, correlate well with conductivity readings. Both measures have experienced increases between 2000 and 2009. Increases in chloride levels have been linked to the use of road salt and other de-icing alternatives. The concern of increases in chloride levels in lakes is in loss of species, especially plankton and benthic communities as well as interruption of mixing of lakes due to the dense "salt water" remaining at the bottom of the lake, which would impact on an entire lake ecosystem.

Practices that can be adopted within the watershed to alleviate some of the impacts by pollutants such as phosphorus are to phosphorus free fertilizer to their lawns, have their septic tanks pumped and serviced regularly, and use alternative material to road salt 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 surface or stormwater runoff contains more nutrients and pollutants and can also lead to flooding.

SUMMARY OF AQUATIC MACROPHYTES

Davis Lake was surveyed for aquatic plants (macrophytes) in August of 2009. Overall, a total of 10 plant species and one macro algae Chara (also known as muskgrass) were detected in the lake during the quantitative survey (Table 5a). White Crowfoot and Curlyleaf Pondweed were detected earlier in the season during a meander search along the shorelines and wetlands, they were not detected during the quantitative survey. Coontail, Star Duckweed and Watermeal were the dominant plants found in August. Curlyleaf Pondweed is an invasive exotic species as are Cattail, Purple Loosestrife, Common Reed, and Reed Canary Grass, all are capable of outcompeting native plants while providing little or poor natural diversity in addition to limited uses by wildlife. However at this time, Curlyleaf Pondweed was limited to the channel on the south end of the lake. Its population seems to be controlled by the abundance of native vegetation within the lake and it was not detected during our quantitative survey. To give an idea of how much algae was present in the lake in 2009, Star Duckweed, a dominant, was incorporated into the algae that formed massive blooms throughout the water column.

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 May through July, 2009, the 1% light level ranged from the lake bottom to a depth recorded in July of between 6 and 7 feet.

To maintain a healthy sunfish/bass fishery, the optimal plant coverage is 30% to 40% across the lake bottom. Plants were present at 94.9 percent of the sites sampled within Davis Lake (Table 5b). Thirty-four of the sites (87.2%) had greater than 50% of vegetative cover. If an aquatic plan is not in place for Davis Lake one should be developed, identifying management goals, usage issues, habitat maintenance and/or restoration, and limitations of the lake. Because if the goal of the lake is aesthetics, then the abundance of plants is beneficial to the lake as they are improving the water quality of the lake and competing with algal populations for nutrients. However, if the goal of the LCFPD is to have the lake be a fishery, first, it would be recommended that a bathymetric map be made for the lake so that it can be assessed to check for DO problems and

Table 5a. Aquatic vegetation species found at the 39 sampling sites on Davis Lake, August 2009. Maximum depth that plants were found was 14.5 feet.

August											
Plant Density	Chara	Coontail	Duckweed	Elodea	Flatstem Pondweed	Giant Duckweed	Leafy Pondweed	Sago Pondweed	Star Duckweed	Watermeal	White Water Lily
Absent	36	4	12	37	32	18	38	34	5	8	15
Present	0	2	19	1	2	11	1	2	9	17	9
Common	1	4	5	1	4	8	0	2	11	4	8
Abundant	0	3	3	0	0	2	0	0	12	7	1
Dominant	2	26	0	0	1	0	0	1	2	3	6
% Plant Occurrence	7.7	89.7	69.2	5.1	17.9	53.8	2.6	12.8	87.2	79.5	61.5

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

August		
Rake Density (Coverage)	# of Sites	%
No plants	2	5.1%
>0 to 10%	1	2.6%
>10 to 40%	2	5.1%
>40 to 60%	0	0.0%
>60 to 90%	4	10.3%
>90%	30	76.9%
Total Sites with Plants	37	94.9%
Total # of Sites	39	100.0%

Secondly, a good aquatic plant management plan should be initiated to strategically reduce the plant community. A good aquatic plant management plan considers both the short and long-term needs of the lake. As with any plan, follow up is critical for an aquatic plant management plan to achieve long-term success.

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 plant species found in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The median FQI for the 154 Lake County lakes assessed 2000-2009 was 12.5 (Table 6). Davis Lake had a FQI of 21.4 in 2009, and was ranked 26th of 154 lake county lakes assessed.

SUMARY OF SHORELINE CONDITION

In 2009 the shoreline was assessed for the degree of erosion. Overall, 73% of the shoreline had no erosion, 10% was assessed as having slight erosion, and an additional 17% was assessed as having moderate to severe shoreline erosion (Figure 6). Areas of moderate to severe erosion occurred in mainly on dense wooded shorelines in the channel on the southwest side of the lake or in areas infested by reed canary grass (*Phalaris arundinacea*). These shorelines lack the deep root system provided by native shoreline herbaceous vegetation. Clearing of invasive species such as buckthorn (*Rhamnus cathartica*) and honeysuckle (*Lonicera spp.*) are recommended in this area. The wooded shoreline opens up to Reed Canary Grass on both sides of the channel. Reed canary grass' fibrous root system is easily undercut by hydraulic forces of water (wave or flow). Control of reed canary grass and replacement by native plant species would do a better job of anchoring shorelines. Areas experiencing slight as one area

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 native buffer strip, the benefits can be three-fold. First, the deep root systems found in our 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.

A meander search for vegetative species occurring along shorelines was conducted in June, 2009. The islands and cattail fringe offered little diversity and were dominated by cattail. Two wetland areas had some diversity, one was on the north end of the lake, and the other extended from where the inlet channel opened on the west side of the lake towards the landowner's property to the north. The wetland area on the east side of the inlet channel where it opened to the lake was dominated by reed canary grass to the point of monotypic stand. A complete listing of all species found during 2009 listed in Table 7.

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

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.2	40.2
2	Cranberry Lake	32.5	33.3
3	East Loon Lake	30.6	32.7
4	Deep Lake	29.7	31.2
5	Little Silver	29.6	31.6
6	Bangs Lake	29.5	31.0
7	Round Lake Marsh North	29.1	29.9
8	Deer Lake	28.2	29.7
9	Sullivan Lake	26.9	28.5
10	West Loon Lake	25.7	27.3
11	Cross Lake	25.2	27.8
12	Wooster Lake	25.0	26.6
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	Lakewood Marsh	23.8	24.7
18	Round Lake	23.5	25.9
19	Schreiber Lake	23.4	24.4
20	Honey Lake	23.3	25.1
21	Fourth Lake	23.0	24.8
22	Lake of the Hollow	23.0	24.8
23	Druce Lake	22.8	25.2
24	Countryside Glen Lake	21.9	22.8
25	Butler Lake	21.4	23.1
26	Davis Lake	21.4	21.4
27	Duck Lake	21.1	22.9
28	Timber Lake (North)	20.8	22.8
29	ADID 203	20.5	20.5
30	Broberg Marsh	20.5	21.4
31	McGreal Lake	20.2	22.1
32	Lake Kathryn	19.6	20.7
33	Fish Lake	19.3	21.2
34	Redhead Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Lake Helen	18.0	18.0
39	Old Oak Lake	18.0	19.1
40	Hendrick Lake	17.7	17.7
41	Long Lake	17.2	19.0
42	Seven Acre Lake	17.0	15.5
43	Gray's Lake	16.9	19.8
44	Owens Lake	16.3	17.3

Table 6. Continued.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
45	Countryside Lake	16.7	17.7
46	Highland Lake	16.7	18.9
47	Lake Barrington	16.7	17.7
48	Bresen Lake	16.6	17.8
49	Diamond Lake	16.3	17.4
50	Windward Lake	16.3	17.6
51	Dog Bone Lake	15.7	15.7
52	Redwing Slough	15.6	16.6
53	Osprey Lake	15.5	17.3
54	Lake Fairview	15.2	16.3
55	Heron Pond	15.1	15.1
56	Lake Tranquility (S1)	15.0	17.0
57	North Churchill Lake	15.0	15.0
58	Dog Training Pond	14.7	15.9
59	Island Lake	14.7	16.6
60	Grand Avenue Marsh	14.3	16.3
61	Lake Nippersink	14.3	16.3
62	Taylor Lake	14.3	16.3
63	Dugdale Lake	14.0	15.1
64	Eagle Lake (S1)	14.0	15.1
65	Longview Meadow Lake	13.9	13.9
66	Third Lake	13.9	16.6
67	Ames Pit	13.4	15.5
68	Bishop Lake	13.4	15.0
69	Buffalo Creek Reservoir	13.1	14.3
70	Mary Lee Lake	13.1	15.1
71	McDonald Lake 2	13.1	14.3
72	Old School Lake	13.1	15.1
73	Dunn's Lake	12.7	13.9
74	Summerhill Estates Lake	12.7	13.9
75	Timber Lake (South)	12.7	14.7
76	White Lake	12.7	14.7
77	Hastings Lake	12.5	14.8
78	Sand Lake	12.5	14.8
79	Stone Quarry Lake	12.5	12.5
80	Lake Carina	12.1	14.3
81	Lake Leo	12.1	14.3
82	Lambs Farm Lake	12.1	14.3
83	Pond-A-Rudy	12.1	12.1
84	Stockholm Lake	12.1	13.5
85	Grassy Lake	12.0	12.0
86	Lake Matthews	12.0	12.0
87	Flint Lake	11.8	13.0
88	Harvey Lake	11.8	13.0
89	Lake Napa Suwe	11.7	13.9
90	Rivershire Pond 2	11.5	13.3

Table 6. Continued.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
91	Antioch Lake	11.3	13.4
92	Hook Lake	11.3	13.4
93	Lake Charles	11.3	13.4
94	Lake Linden	11.3	11.3
95	Lake Naomi	11.2	12.5
96	Pulaski Pond	11.2	12.5
97	Lake Minear	11.0	13.9
98	Redwing Marsh	11.0	11.0
99	Tower Lake	11.0	11.0
100	West Meadow Lake	11.0	11.0
101	Nielsen Pond	10.7	12.0
102	Lake Holloway	10.6	10.6
103	Crooked Lake	10.2	12.5
104	College Trail Lake	10.0	10.0
105	Lake Lakeland Estates	10.0	11.5
106	Valley Lake	9.9	9.9
107	Werhane Lake	9.8	12.0
108	Big Bear Lake	9.5	11.0
109	Little Bear Lake	9.5	11.0
110	Loch Lomond	9.4	12.1
111	Columbus Park Lake	9.2	9.2
112	Sylvan Lake	9.2	9.2
113	Fischer Lake	9.0	11.0
114	Grandwood Park Lake	9.0	11.0
115	Lake Fairfield	9.0	10.4
116	Lake Louise	9	10.4
117	McDonald Lake 1	8.9	10.0
118	East Meadow Lake	8.5	8.5
119	Lake Christa	8.5	9.8
120	Lake Farmington	8.5	9.8
121	Lucy Lake	8.5	9.8
122	South Churchill Lake	8.5	8.5
123	Bittersweet Golf Course #13	8.1	8.1
124	Woodland Lake	8.1	9.9
125	Albert Lake	7.5	8.7
126	Banana Pond	7.5	9.2
127	Fairfield Marsh	7.5	8.7
128	Lake Eleanor	7.5	8.7
129	Patski Pond	7.1	7.1
130	Rasmussen Lake	7.1	7.1
131	Slough Lake	7.1	7.1
132	Lucky Lake	7.0	7.0
133	Lake Forest Pond	6.9	8.5
134	Ozaukee Lake	6.7	8.7
135	Leisure Lake	6.4	9.0
136	Peterson Pond	6.0	8.5

Table 6. Continued.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
137	Gages Lake	5.8	10.0
138	Slocum Lake	5.8	7.1
139	Deer Lake Meadow Lake	5.2	6.4
140	ADID 127	5.0	5.0
141	IMC Lake	5.0	7.1
142	Liberty Lake	5.0	5.0
143	Oak Hills Lake	5.0	5.0
144	Forest Lake	3.5	5.0
145	Sand Pond (IDNR)	3.5	5.0
146	Half Day Pit	2.9	5.0
147	Lochanora Lake	2.5	5.0
148	Echo Lake	0.0	0.0
149	Hidden Lake	0.0	0.0
150	North Tower Lake	0.0	0.0
151	Potomac Lake	0.0	0.0
152	St. Mary's Lake	0.0	0.0
153	Waterford Lake	0.0	0.0
154	Willow Lake	0.0	0.0
	Mean	**13.7**	**15.0**
	Median	**12.5**	**14.3**

Figure 7. Shoreline erosion on Davis Lake, 2009.

Table 7. Plant List with Submerged and Shoreline Species, Davis Lake, 2009.

SCIENTIFIC NAME	COMMON NAME
Arisaema triphyllum	Jack in the Pulpit
Asclepias incarnata	Swamp Milkweed
Asclepias syriaca	Common Milkweed
Boehmeria cylindrica	False Nettle
Carex lacustris	Common Lake Sedge
Carex pellita	Broad-Leaved Wooly Sedge
Carex stricta	Common Tussock Sedge
Ceratophyllum demersum	Coontail
Cicuta maculate	Water Hemlock
Convolvulus sepium	Hedge Bindweed
Cornus racemosa	Gray Dogwood
Eleocharis acicularis	Needle Spike Rush
Eleocharis erythropoda	Red-rooted Spike Rush
Elodea canadensis	Common Waterweed
Equisetum arvense	Horsetail
Erigeron annuus	Annual Fleabane
Geum laciniatum	Northern Rough Avens
Impatiens capensis	Orange Jewelweed
Iris virginica shrevei	Blueflag
Juncus torreyi	Torrey's Rush
Leersia oryzoides	Rice Cut Grass
Lemna minor	Small Duckweed
Lemna trisulca	Forked Duckweed
Lonicera tatarica	Tartarian Honeysuckle
Lythrum salicaria	Purple loosestrife
Nymphaea tuberosa	White Water Lily
Penthorum sedoides	Ditch Stone Crop
Phalaris arundinacea	Reed Canary Grass
Poa compressa	Canada Blue Grass
Potamogeton crispus	Curly leaf Pondweed
Potamogeton pectinatus	Sago Pondweed
Potamogeton pusillus	Small Pondweed
Potamogeton zosteriformis	Flat-Stemmed Pondweed
Ranunculus longirostris	White Water Crowfoot
Rhamnus cathartica	Common Buckthorn
Rorripa sylvestris	Creeping Yellow Cress
Rosa multiflora	Multiflora Rose
Rumex crispus	Curly Dock
Sagittaria latifolia	Common Arrowhead
Scirpus atrovirens	Dark Green Rush
Scutellaria lateriflora	Mad-Dog Skullcap
Solidago gigantea	Late Goldenrod
Spirodela polyrhiza	Great Duckweed
Typha angustifolia	Narrow-leaved Cattail
Typha X glauca	Hybrid Cattail
Vitis riparia	Riverbank Grape
Wolffia columbiana	American Water Meal

SUMMARY OF WILDLIFE AND HABITAT

Davis Lake is located in a rural setting with the north side of the lake bordered by Illinois Route 176 and there is one horse farm that shares the lake bottom with the forest preserve. To the east of the lake is a nursery and to the west was another homestead. The remainder of shoreline was either cattail fringe, seep wetland areas or wooded. There were two adult mute swans nesting on a cattail island early in the season. They produced three cygnets and were seen throughout the remainder of the monitoring season on the lake. Sunfish and beaver were also noted during the season. It is recommended that a fish survey be conducted on the lake to assess the fish population as there is not one on record. It should be noted that Davis Lake has historically experienced fish kills. This has been on-going since 1958. Verbal communication with a resident on Davis Lake confirms these kills are still present. It is likely that sport fish populations are no longer existent in Davis Lake. In order to potentially manage the lake for fish, installation of aerators may be necessary. However, due to the density of algae observed both in 2000 and again in 2009, and the availability of phosphorus in both the epilimnion and hypolimnion, there is concern that the now plant dominated lake would become an algal dominated lake, both of which become problematic in terms of DO.

LAKE MANAGEMENT RECOMMENDATIONS

Davis Lake has both positive and negative aspects. Some of the positives include that is relatively undeveloped and therefore provides habitat and although its plant community is unbalanced, it does house a diverse aquatic plant population. Phosphorous levels were high in our study. There was more than adequate phosphorus to support abundant plant and algal growth. The lake historically and recently has experienced fish kills. To improve the quality of Davis Lake, the LMU has the following recommendations:

- **Create a Bathymetric Map**

  It is recommended that a bathymetric map be created for Davis 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 plan (Appendix D1).

- **Participate in VLMP**

  LCHD-ES recommends that the LCFPD or one of the adjacent property owners participate in the Volunteer Lake Monitoring Program. We also recommend the installation and monitoring of a staff gauge in the lake to monitor the lake level. The data collected through the VLMP and staff gauge, provides some additional data for years when the LCHD-ES is not actively monitoring the lake and can assist the forest preserve district in resource management decisions for Davis Lake (Appendix D2).

- **Aquatic Plant Management**

  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. Although there is an abundant yet somewhat diverse plant community existing on Davis

Lake, care should be taken when implementing an aquatic plant management plan because of the abundant algal blooms encountered over the monitoring season. Curlyleaf pondweed, although a non-native invasive species, seems restricted to the south channel although it was quite abundant in this area in the spring. Its population should be monitored.

When managing the plants in the lake, careful consideration and follow up monitoring needs to take place. There is a significant algae problem in the lake, and plants do compete for nutrients with algae. Not carefully implementing a plan with proper follow up could result in a lake that is abundant in plants and algae to a lake that is dominated by algae. An overall aquatic management plan should be developed and based upon the goals of the lake, 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 D3).

Reduce Conductivity and Chloride Concentrations

The average conductivity in Davis Lake was up 25% from the 2000 monitoring year. In addition, the chloride concentration was greater than the county median and 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 10% of the landuse within the watershed, they contribute 30% of the estimated runoff. Proper application procedures by road crews and alternative methods can help to keep these concentrations minimized (Appendix D4).

Lakes with Shoreline Erosion

The shoreline of Davis Lake had 10% classified as slightly eroded. Seventeen percent of the lake was assessed as having moderate to severe erosion problems. The areas of moderate to severe erosion should be remediated as soon as possible to prevent loss of shoreline and continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired/restored using natural vegetation. (Appendix D5).

Watershed Nutrient Reduction and Watershed Sediment Reduction

Davis Lake has seen a 26% increase in total suspended solids (TSS) concentration since 2000. Excess sediment in the water reduces water clarity and can affect the overall water quality. Management within the watershed can help reduce nutrients and sediment entering the lake (Appendix D6). Other contributors to TSS are carp and algae. The Nitrogen levels have increased in Davis, and the current TN: TP ratio makes the lake susceptible to algal blooms, as was observed during 2009. Steps should be taken throughout the watershed to help maintain these levels to prevent problematic algae blooms (Appendix D7). Davis Lake has TP concentration above the county median in 2008.

Most established lawns do not require additional phosphorous fertilizer so any applied generally runs off into the lake. Some local communities within Lake County have adopted an ordinance banning the use of phosphorous fertilizer. Since 46% of the total runoff is estimated to be contributed from single family land use, the LMU encourages that residents adjacent to the lake use phosphorus-free fertilizers, and that the communities within the watershed adopt a phosphorous fertilizer ban.

Grant Program Opportunities

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.

Shoreline Assessment

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

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

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

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

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

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

APPENDIX B. MULTI-PARAMETER DATA FOR *DAVIS LAKE* IN *2009*

Davis Lake 2009 Multiparameter data

Date MMDDYY	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 Average	Extinction Coefficient 0.55
05/20/2009	0	0.43	18.08	11.16	118.3	0.6500	9.09	3396	Surface		
05/20/2009	1	1.00	18.07	10.32	109.4	0.6500	9.09	3289	Surface	100%	
05/20/2009	2	2.03	18.04	10.32	109.3	0.6500	9.09	1148	0.278	34%	3.787
05/20/2009	3	3.00	18.01	10.32	109.2	0.6500	9.09	885	1.246	26%	0.208
05/20/2009	4	4.01	17.99	10.38	109.8	0.6500	9.08	650	2.263	19%	0.136
05/20/2009	6	6.00	17.92	10.56	111.6	0.6490	9.07	562	4.254	17%	0.034
05/20/2009	8	8.00	17.85	10.69	112.8	0.6490	9.08	347	6.25	10%	0.077
05/20/2009	10	9.99	16.21	10.78	109.9	0.6620	8.96	254	8.243	7%	0.038
05/20/2009	12	11.98	13.81	4.14	40.1	0.7050	8.44	178	10.232	5%	0.035
05/20/2009	14	13.99	10.76	0.89	8.1	0.7360	8.08	91	12.244	3%	0.055

Date MMDDYY	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 Average	Extinction Coefficient 0.60
06/17/2009	0	0.30	19.71	9.01	98.6	0.6110	8.68	925	Surface		
06/17/2009	1	1.00	19.72	8.16	89.4	0.6120	8.69	806	Surface	100%	
06/17/2009	2	2.00	19.71	8.04	88.0	0.6110	8.69	293	0.251	36%	4.034
06/17/2009	3	3.00	19.69	8.00	87.6	0.6120	8.67	142	1.253	18%	0.579
06/17/2009	4	4.01	19.68	7.85	86.0	0.6110	8.66	183	2.262	23%	-0.112
06/17/2009	6	6.00	19.63	7.43	81.2	0.6110	8.64	150	4.248	19%	0.047
06/17/2009	8	8.00	18.82	2.15	23.2	0.6450	7.75	76	6.254	9%	0.108
06/17/2009	10	10.00	18.20	0.67	7.1	0.6660	7.61	49	8.25	6.1%	0.054
06/17/2009	12	12.02	16.54	1.47	15.1	0.6910	7.73	31	10.27	3.9%	0.043
06/17/2009	14	14.01	12.96	6.39	60.7	0.7420	7.77	14	12.256	1.8%	0.065
06/17/2009	16	16.02	10.59	0.68	6.2	0.7840	6.94	0	14.272		
06/17/2009	18	17.77	9.43	-0.01	-0.1	0.9060	6.75	0	16.022		

Date MMDDYY	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 Average	Extinction Coefficient 1.13
07/22/2009	0	0.50	22.27	7.38	84.9	0.6430	8.05	3286	Surface		
07/22/2009	1	1.01	22.21	5.70	65.6	0.6410	7.97	3388	Surface	100%	
07/22/2009	2	2.00	21.89	5.85	66.8	0.6420	7.99	583	0.246	17%	7.152
07/22/2009	3	3.00	21.71	6.07	69.1	0.6410	8.03	916	1.248	27%	-0.362
07/22/2009	4	4.00	21.60	3.53	40.1	0.6420	7.82	633	2.25	19%	0.164
07/22/2009	6	6.00	21.12	1.42	16.0	0.6480	7.64	307	4.248	9%	0.171
07/22/2009	8	8.00	20.44	0.88	9.7	0.6630	7.36	29	6.252	0.9%	0.376
07/22/2009	10	9.99	18.08	0.80	8.5	0.7210	7.02	7	8.239	0.2%	0.170
07/22/2009	12	12.01	15.47	0.82	8.3	0.7460	6.93	1	10.257	0.01%	0.260
07/22/2009	14	14.01	13.34	0.84	8.1	0.8040	6.77	0	12.257		
07/22/2009	16	15.66	12.45	2.06	19.3	0.9400	6.62	0	13.906		

Davis Lake 2009 Multiparameter data

Date MMDDYY	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 Average	Extinction Coefficient NA
08/19/2009	0	0.30	24.61	10.26	123.5	0.6350	8.17	NA	Surface		
08/19/2009	1	1.01	24.66	8.73	105.2	0.6340	8.05	NA	Surface	NA	
08/19/2009	2	2.01	24.64	8.80	106.0	0.6330	8.05	NA	0.255	NA	NA
08/19/2009	3	3.00	24.60	8.64	103.9	0.6330	8.06	NA	1.246	NA	NA
08/19/2009	4	4.01	24.55	9.51	114.3	0.6330	8.07	NA	2.257	NA	NA
08/19/2009	6	6.00	24.36	6.84	82.0	0.6390	7.86	NA	4.251	NA	NA
08/19/2009	8	8.00	22.36	6.89	79.5	0.6780	7.51	NA	6.251	NA	NA
08/19/2009	10	10.00	18.69	9.84	105.6	0.7450	6.90	NA	8.246	NA	NA
08/19/2009	12	12.01	15.97	13.74	139.4	0.7880	6.65	NA	10.255	NA	NA
08/19/2009	14	14.00	14.95	12.54	124.6	0.8240	6.58	NA	12.254	NA	NA

Date MMDDYY	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 Average	Extinction Coefficient NA
09/23/2009	0	0.32	20.02	6.31	69.5	0.6170	8.77	NA	Surface		
09/23/2009	1	1.00	20.03	5.75	63.4	0.6170	8.55	NA	Surface	NA	
09/23/2009	2	2.00	20.02	5.65	62.3	0.6170	8.45	NA	0.251	NA	NA
09/23/2009	3	3.02	20.01	5.64	62.1	0.6170	8.37	NA	1.269	NA	NA
09/23/2009	4	4.02	20.00	5.68	62.5	0.6170	8.35	NA	2.272	NA	NA
09/23/2009	6	6.00	19.89	5.05	55.5	0.6180	8.28	NA	4.254	NA	NA
09/23/2009	8	8.01	19.70	1.96	21.5	0.6230	8.12	NA	6.26	NA	NA
09/23/2009	10	10.00	19.42	0.87	9.5	0.6390	7.96	NA	8.252	NA	NA
09/23/2009	12	12.00	17.00	0.56	5.8	0.7780	7.35	NA	10.251	NA	NA
09/23/2009	14	13.99	15.38	0.37	3.8	0.8440	6.99	NA	12.236	NA	NA

APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY DATA

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

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2009 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 2000-2009 was 0.063 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2009 was 0.167 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 was 7.9 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 2000-2009, Ozaukee Lake had the lowest Secchi depths (0.25 feet) and West Loon Lake had the highest (24.77 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 was 8.34, with a minimum of 7.07 in Bittersweet #13 Lake and a maximum of 10.40 in Summerhill Estates Lake.

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 – Environmental Services (ES). ES 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. Participate in the Volunteer Lake Monitoring Program

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

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

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

For information, please contact:

VLMP Regional Coordinator: Mike Adam
Lake County Health Department – Environmental Services
500 W. Winchester Unit 102
Libertyville, IL 60048
(847) 377-8030

D3. Options for Aquatic Plant Management

Option 1: Aquatic Herbicides

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

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

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

Option 2: Mechanical Harvesting

Mechanical harvesting involves the cutting and removal of nuisance aquatic vegetation by large specialized boats with underwater cutting bars. The total removal or over

removal (neither of which should never be the plan of any management entity) of plants by mechanical harvesting should never be attempted. To avoid complete or over removal, the management entity should have a harvesting plan that determines where and how much vegetation is to be removed.

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

Option 3: Hand Removal

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

Option 4: Water Milfoil Weevil

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

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

Option 5: Reestablishing Native Aquatic Vegetation

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

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

D4. Options to Reduce Conductivity and Chloride Concentrations

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

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

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

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

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

Option 1. Proper Use on Your Property

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

Option 2. Examples of Alternatives

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

Calcium, Magnesium or Potassium Chloride

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

Calcium Magnesium Acetate (CMA)

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

Agricultural Byproducts

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

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

Option 3. Talk to Your Municipality About Using an Alternative

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

D5. Options to Assess Your Lake's Fishery

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

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

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

The Illinois Department of Natural Resources (IDNR) will perform a fish survey at no charge on most public and some private water bodies. In order to determine if your lake is eligible for a survey by the IDNR, contact Frank Jakubecik, Fisheries Biologist, at

(815) 675-2319. If a lake is not eligible for an IDNR fish survey or if a more comprehensive survey is desired, contact the Environmental Services for a list of consultants.

D6. Options for Lakes with Shoreline Erosion

Option 1: Install a Seawall

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

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

Option 2: Install Rock Rip-Rap or Gabions

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

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

and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning.

Option 3: Create a Buffer Strip

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

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

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

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

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from

watershed sources. They are most effective in areas where plantings alone are not effective due to existing erosion.

Option 5: Install A-Jacks®

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

Option 6: Establish a "No Wake" Zone or No Motor Area

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

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

D7. 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.
e. Most lawns in Lake County do not need additional phosphorus for sufficient plant growth. Consider using a phosphorus-free fertilizer.

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. Motor Boat Restrictions for Shallow Lakes

To reduce resuspension of phosphorus from the sediment, communities that have a shallow lake or large shallow areas in their lake may want to restrict motorized boating. The action of a spinning prop in shallow areas can disturb the sediment. Flocculent sediment particles can release loosely attached phosphorus into the water. Restrictions could include a ban of motorized traffic in certain areas or ban the use of motors entirely, however this could be hard to enforce without hiring law enforcement personnel. This would work best for lakes with shallow areas that have a large phosphorus source in the sediment.

Option 8. 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 Environmental Services.

D8. Options for Watershed Sediment Reduction

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

Option 1. Municipal Street Sweeping

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

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

Please refer to the Watershed Development Ordinance for requirements.

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

This will allow water to infiltrate into the ground rather than flow across impervious surfaces.

Option 3. Agricultural Practices

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

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

2000 - 2009 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2009	
Average	**166**	
Median	**161**	
Minimum	**65**	**IMC**
Maximum	**330**	**Flint Lake**
STD	**42**	
n =	**819**	

	ALKanoxic 2000-2009	
Average	**198**	
Median	**189**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**49**	
n =	**251**	

	Condoxic <=3ft00-2009	
Average	**0.8846**	
Median	**0.7910**	
Minimum	**0.2260**	**Schreiber Lake**
Maximum	**6.8920**	**IMC**
STD	**0.5217**	
n =	**823**	

	Condanoxic 2000-2009	
Average	**1.0121**	
Median	**0.8431**	
Minimum	**0.3210**	**Lake Kathyrn, Schreiber Lake**
Maximum	**7.4080**	**IMC**
STD	**0.7784**	
n =	**251**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2009	
Average	**0.514**	
Median	**0.160**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.087**	
n =	**824**	

*ND = Many lakes had non-detects (76.5%)
Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2009	
Average	**2.134**	
Median	**1.430**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.325**	
n =	**251**	

*ND = 20.3% Non-detects from 32 different lakes

	pHoxic <=3ft00-2009	
Average	**8.35**	
Median	**8.34**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.40**	**Summerhill Estates**
STD	**0.46**	
n =	**818**	

	pHanoxic 2000-2009	
Average	**7.31**	
Median	**7.33**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.41**	
n =	**251**	

	All Secchi 2000-2009	
Average	**4.56**	
Median	**3.15**	
Minimum	**0.25**	**Ozaukee Lake**
Maximum	**24.77**	**West Loon Lake**
STD	**3.80**	
n =	**763**	

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2000 - 2009 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2009	
Average	**1.418**	
Median	**1.180**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.826**	
n =	**824**	

*ND = 3.8% Non-detects from 15 different lakes

	TKNanoxic 2000-2009	
Average	**2.883**	
Median	**2.235**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.300**	
n =	**251**	

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

	TPoxic <=3ft00-2009	
Average	**0.099**	
Median	**0.063**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**824**	

*ND = 2.4% Non-detects from 8 different lakes

	TPanoxic 2000-2009	
Average	**0.311**	
Median	**0.167**	
Minimum	**0.012**	**Independ. Grove**
Maximum	**3.800**	**Taylor Lake**
STD	**0.417**	
n =	**251**	

	TSSall <=3ft00-2009	
Average	**15.3**	
Median	**7.9**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**830**	

*ND = 1.3% Non-detects from 8 different lakes

	TVSoxic <=3ft00-2009	
Average	**129.7**	
Median	**125.5**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.8**	
n =	**774**	

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 <=3ft00-2009	
Average	**198**	
Median	**117**	
Minimum	**3.5**	**Schreiber Lake**
Maximum	**2390**	**IMC**
STD	**327**	
n =	**159**	

	CLoxic <=3ft00-2009	
Average	**191**	
Median	**145**	
Minimum	**2.7**	**Schreiber Lake**
Maximum	**2760**	**IMC**
STD	**220**	
n =	**561**	

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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 2000-2009 (n=1378).

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

LCHD Lakes Management Unit ~ 12/9/2009

APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

Grant Program Name	Funding Source	Contact Information	Funding Focus				Cost Share
			Water Quality/ Wetland	Habitat	Erosion	Flooding	
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
IEPA = Illinois Environmental Protection Agency
IDNR = Illinois Department of Natural Resources
IDOA = Illinois Department of Agriculture
LCSMC = Lake County Stormwater Management Commission
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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