# 2005 SUMMARY REPORT
# of
# Long Lake

## Lake County, Illinois

*Prepared by the*

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# EXECUTIVE SUMMARY

Long Lake is a 393-acre glacial lake located in unincorporated Lake County within both Grant and Avon Townships. Long Lake has a maximum depth of approximately 30 feet and a shoreline length of approximately 7.73 miles. The Long Lake watershed encompasses approximately 25,441 acres. Eagle Creek, Squaw Creek, and Round Lake Drain empty into Long Lake. Squaw Creek is the sole outlet and exits on the northwest side continuing to Fox Lake.

Water clarity averaged 4.18 feet during 2005, which was an increase from previous sampling when the average Secchi depths were 4.05 feet, 4.11 feet, 2.44 feet, and 2.81 feet in 2002, 2001, 1996, and 1991 respectively. As the Secchi depth has been increasing over the years, the average total suspended solids (TSS) concentration has decreased from 23.6 mg/L in 1991 to the 2005 average of 10.9 mg/L. Total phosphorous (TP) concentrations in Long Lake have remained relatively consistent in both the epilimnion and hypolimnion since 1991. During 2005, the average epilimnetic conductivity reading for Long Lake was 1.0821 mS/cm. This was up 15% from the 2001 average of 0.9430 mS/cm and more than twice the 1996 average of 0.5222 mS/cm. Dissolved oxygen (DO) concentrations in the epilimnion did not indicate any significant problems. Anoxic conditions (where DO concentrations drop below 1 mg/L) existed from June through September in the hypolimnion. The anoxic boundary was at its shallowest in August at approximately 8 feet and deepest in September, during turnover, at approximately 16 feet.

An aquatic plant survey was conducted during the end of June into the first part of July and then again in August of 2005. There were nine aquatic plant species found during both sampling events. Eurasian Watermilfoil, an exotic, was the most dominant species found at 59% and 63% of the sampling sites, respectively. Coontail was the second most common species found at 25% and 34% of the sampling sites, respectively. Maximum seasonal bottom aquatic plant coverage was calculated to be approximately 29%.

The shoreline was also reassessed in 2005 to document any changes in erosion since 2001. The LMU found some areas of severe erosion had been repaired and some areas that had been moderate were reclassified as slight. However, others areas were reclassified from slight to moderate and some from moderate to severe. An area of severe erosion in 2001 consisted of land owned by the Lake County Forest Preserve District (LCFPD). In 2005, the LCFPD conducted a rehabilitation project and that area was reclassified as having no erosion. However, in 2005 an area on the southeastern part of the lake was reclassified from slight erosion to moderate and severe erosion. There were invasive shoreline plant species that should be controlled/eliminated: Purple Loosestrife, Reed Canary Grass, and Buckthorn. These species have been noted in several areas around the lake. These plants should be eliminated before they spread and displace other native, more desirable plant species.

# LAKE FACTS

| | |
|---|---|
| **Lake Name:** | Long Lake |
| **Historical Name:** | None |
| **Nearest Municipality:** | Round Lake Beach |
| **Location:** | T44N, R10E, Sections 26,27,34,35 |
| **Elevation:** | 738.0 feet |
| **Major Tributaries:** | Eagle Creek, Round Lake Drain, Squaw Creek |
| **Watershed:** | Fox River |
| **Sub-watershed:** | Squaw Creek |
| **Receiving Waterbody:** | Fox Lake |
| **Surface Area:** | 392.57 acres |
| **Shoreline Length:** | 7.73 miles |
| **Maximum Depth:** | 30.0 feet |
| **Average Depth:** | 13.1 feet |
| **Lake Volume:** | 4400.00 acre-feet |
| **Lake Type:** | Glacial |
| **Watershed Area:** | 25440.95 acres |
| **Major Watershed Land Uses:** | Agriculture, Single Family, and Public and Private Open Space |
| **Bottom Ownership:** | Village of Round Lake Beach, Forest Preserve, State, and Private |
| **Management Entities:** | Long Lake Improvement and Sanitation Association |
| **Current and Historical Uses:** | Fishing, boating, swimming |
| **Description of Access:** | Private (public may launch with fee) |

# SUMMARY OF WATER QUALITY

Water samples were collected monthly from April through October at the deepest point in the lake (Figure 1; See Appendix A for water sampling methods). Long Lake was sampled at depths of three feet and 23 to 26 feet depending on water level (Table 1). Long Lake was also sampled in 1991, 1996, and 2001 by the Lake County Health Department – Lakes Management Unit (LMU) and participated in the Ambient Lake Monitoring Program (ALMP) in 2002 (Table 2). The results from previous monitoring will be compared to the 2005 data. Appendix C explains the various water quality parameters measured, how these parameters relate to each other, and why the measurement of each parameter is important.

Secchi disk depth (water clarity) averaged 4.18 feet during 2005, which was above the Lake County median of 3.17 feet (Appendix E). This was an increase from previous sampling when the average Secchi depth was 4.05 feet, 4.11 feet, 2.44 feet, and 2.81 feet in 2002, 2001, 1996, and 1991, respectively. Water clarity is related to the amount of total suspended solids (TSS) concentration in the water column, which is composed of nonvolatile suspended solids, non-organic clay or sediment materials, and volatile suspended solids, algae and other organic matter. As the Secchi depth has been increasing over the years, the average TSS has decreased (Figure 2). The 2005 average epilimnetic TSS of 10.9 mg/L is slightly lower than the 2002 ALMP average (12.3 m/L) and slightly higher than the 2001 average (9.7 mg/L). The 2005 average epilimnetic TSS was slightly higher than the Lake County median of 7.9 mg/L. Overall, the average epilimnetic TSS has declined since 1991 (23.6 mg/L).

Another aspect of water quality is the nutrients within a water column, especially nitrogen (N) and phosphorus (P). These are the two nutrients limiting plant and algal growth. Carbon and light are the other factors that control plant and algae growth, but these are not normally limiting. To compare the availability of N and P, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate that phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate that there are enough of both nutrients to facilitate excess algae or plant growth. Long Lake had a TN:TP ratio of 20:1 in 2005 and 15:1 in 2001. In both years this indicates that the lake was phosphorus limited, which means that any addition of phosphorus could result in increases in plant and algae biomass. Most lakes in Lake County are phosphorus limited.

A 2005 seasonal average epilimnetic total phosphorus (TP) concentration of 0.076 mg/L was above the county median of 0.063 mg/L. TP concentrations in Long Lake have remained relatively stable since 1991. The 2001 epilimnion TP average was 0.092 mg/L, up slightly from the 1996 average of 0.086 mg/L and the 1991 average of 0.063 mg/L. The 2005 seasonal hypolimnetic average of 0.827 mg/L was well above the county median of 0.174 mg/l. The hypolimnetic TP concentrations have also remained relatively stable over the past years with averages of 0.799 mg/L and 0.661 mg/L in 1996 and 2001, respectively. Much of this fluctuation may have been due to environmental affects, such as rain events or water temperature, which influence the thermal stratification and turnover of the lake , and therefore varies between years. Phosphorus can be released from sediment through biological or mechanical processes, or from plant or algae as they die. This explains why the TP concentrations were higher in the hypolimnion. Long Lake also has external sources such as

**Figure 1. Water quality sampling site on Long Lake, 2005.**

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

| 2005 | Epilimnion | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | DEPTH | ALK | TKN | $NH_3$-N | $NO_3$-N | TP | SRP | $Cl^-$ | TDS | TSS | TS | TVS | SECCHI | COND | pH | DO |
| 11-Apr | 3 | 190 | 1.05 | <0.1 | 0.552 | 0.051 | <0.005 | 181 | NA | 12.0 | 682 | 147 | 6.14 | 1.0680 | 8.17 | 12.12 |
| 11-May | 3 | 196 | 1.10 | <0.1 | 0.088 | 0.051 | <0.005 | 191 | NA | 8.1 | 682 | 126 | 6.10 | 1.1000 | 7.91 | 8.78 |
| 15-Jun | 3 | 185 | 1.32 | <0.1 | <0.05 | 0.052 | <0.005 | 189 | NA | 6.8 | 671 | 127 | 4.04 | 1.0980 | 7.89 | 6.68 |
| 13-Jul | 3 | 172 | 1.21 | <0.1 | <0.05 | 0.051 | <0.005 | 198 | NA | 7.8 | 700 | 170 | 3.94 | 1.1180 | 7.99 | 7.27 |
| 10-Aug | 3 | 154 | 1.38 | <0.1 | <0.05 | 0.071 | <0.005 | 205 | NA | 8.2 | 721 | 204 | 4.43 | 1.0720 | 9.11 | 9.04 |
| 14-Sep | 3 | 143 | 2.08 | <0.1 | <0.05 | 0.148 | 0.008 | 207 | NA | 16.8 | 680 | 170 | 2.30 | 1.0530 | 8.66 | 3.78 |
| 18-Oct | 3 | 152 | 1.87 | <0.1 | <0.05 | 0.109 | 0.012 | 208 | NA | 16.7 | 647 | 140 | 2.29 | 1.0660 | 8.22 | 6.81 |
| | **Average** | 170 | 1.43 | <0.1 | 0.320 | 0.076 | 0.010 | 197 | NA | 10.9 | 683 | 155 | 4.18 | 1.0821 | 8.28 | 7.78 |

| 23-Jun | Epilimnion | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | DEPTH | ALK | TKN | $NH_3$-N | $NO_3$-N | TP | SRP | $Cl^-$ | TDS | TSS | TS | TVS | SECCHI | COND | pH | DO |
| 21-May | 3 | 214 | 0.78 | <0.1 | 0.345 | 0.059 | <0.005 | NA | 619 | 8.8 | 670 | 193 | 3.61 | 0.9992 | 8.03 | 7.72 |
| 19-Jun | 3 | 210 | 1.13 | <0.1 | 0.380 | 0.049 | <0.005 | NA | 608 | 6.3 | 677 | 205 | 5.61 | 0.9464 | 8.11 | 7.24 |
| 24-Jul | 3 | 194 | 1.66 | <0.1 | <0.05 | 0.093 | 0.007 | NA | 577 | 10.5 | 631 | 188 | 3.64 | 0.9432 | 8.19 | 5.64 |
| 21-Aug | 3 | 181 | 1.63 | <0.1 | <0.05 | 0.112 | 0.008 | NA | 578 | 11.9 | 627 | 188 | 3.61 | 0.9083 | 8.19 | 8.93 |
| 18-Sep | 3 | 182 | 1.72 | <0.1 | <0.05 | 0.146 | 0.022 | NA | 550 | 11.0 | 573 | 153 | 4.10 | 0.9181 | 8.02 | 6.55 |
| | **Average** | 196 | 1.38 | <0.1 | 0.363[k] | 0.092 | 0.012[k] | NA | 586 | 9.7 | 636 | 185 | 4.11 | 0.9430 | 8.11 | 7.22 |

**Glossary**

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

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable

# Table 1.  Continued.

| **2005** | **Hypolimnion** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | DEPTH | ALK | TKN | $NH_3$-N | $NO_3$-N | TP | SRP | $Cl^-$ | TDS | TSS | TS | TVS | SECCHI | COND | pH | DO |
| 11-Apr | 26 | 198 | 1.59 | 0.531 | 0.481 | 0.062 | <0.005 | 189 | NA | 6.4 | 687 | 147 | NA | 1.1000 | 7.47 | 4.06 |
| 11-May | 24 | 200 | 1.33 | 0.258 | 0.077 | 0.071 | <0.005 | 191 | NA | 8.6 | 676 | 122 | NA | 1.1020 | 7.45 | 3.73 |
| 15-Jun | 26 | 232 | 3.64 | 2.250 | <0.05 | 1.050 | 0.793 | 185 | NA | 11.0 | 685 | 123 | NA | 1.1310 | 6.92 | 0.08 |
| 13-Jul | 26 | 271 | 5.10 | 4.110 | <0.05 | 1.150 | 1.080 | 186 | NA | 8.4 | 730 | 187 | NA | 1.1790 | 6.63 | 0.09 |
| 10-Aug | 24 | 292 | 6.69 | 4.850 | <0.05 | 1.340 | 1.240 | 191 | NA | 4.4 | 725 | 175 | NA | 1.1780 | 6.82 | 0.11 |
| 14-Sep | 24 | 310 | 10.90 | 8.680 | <0.05 | 2.010 | 1.920 | 194 | NA | 7.2 | 706 | 145 | NA | 1.2230 | 6.86 | 0.25 |
| 18-Oct | 23 | 151 | 2.06 | <0.1 | <0.05 | 0.104 | 0.012 | 205 | NA | 16.0 | 641 | 135 | NA | 1.0660 | 8.40 | 6.84 |
| | **Average** | 236 | 4.47 | 3.447 | 0.279 | 0.827 | 1.009 | 192 | NA | 8.9 | 693 | 148 | NA | 1.1399 | 7.22 | 2.17 |

| **23-Jun** | **Hypolimnion** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | DEPTH | ALK | TKN | $NH_3$-N | $NO_3$-N | TP | SRP | $Cl^-$ | TDS | TSS | TS | TVS | SECCHI | COND | pH | DO |
| 21-May | 26 | 227 | 2.25 | 1.120 | 0.113 | 0.309 | 0.163 | NA | 630 | 35.0 | 668 | 170 | NA | 1.0160 | 7.28 | 0.02 |
| 19-Jun | 26 | 225 | 1.85 | 0.725 | 0.121 | 0.209 | 0.152 | NA | 640 | 4.7 | 643 | 168 | NA | 0.9914 | 7.26 | 0.05 |
| 24-Jul | 25 | 270 | 3.52 | 2.590 | <0.05 | 0.815 | 0.744 | NA | 584 | 6.8 | 681 | 183 | NA | 1.0235 | 6.77 | 0.01 |
| 21-Aug | 26 | 316 | 7.10 | 6.000 | <0.05 | 1.230 | 1.230 | NA | 636 | 9.6 | 654 | 219 | NA | 1.0510 | 6.55 | 0.01 |
| 18-Sep | 26 | 233 | 4.45 | 3.180 | <0.05 | 0.743 | 0.671 | NA | 570 | 10.0 | 576 | 167 | NA | 1.0920 | 6.35 | 0.15 |
| | **Average** | 254 | 3.83 | 2.723 | 0.117[k] | 0.661 | 0.592 | NA | 612 | 13.2 | 644 | 181 | NA | 1.0348 | 6.84 | 0.05 |

**Glossary**

ALK = Alkalinity, mg/L $CaCO_3$
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$NH_3$-N = Ammonia nitrogen, mg/L
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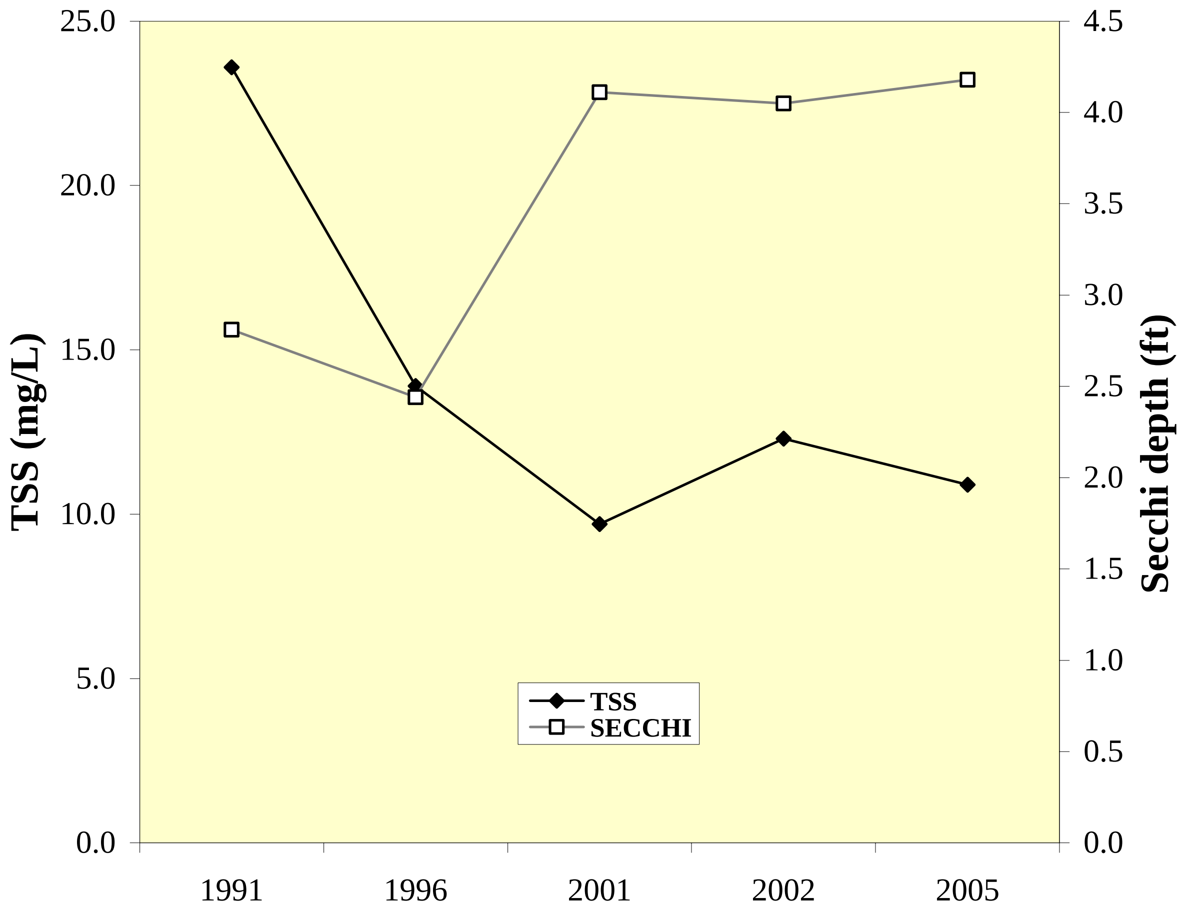
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable

**Table 2. Ambient Lake Monitoring Program water quality data for Long Lake, 2002.**

| 2002 | Epilimnion | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | DEPTH | ALK | TKN | NH3-N | NO3-N | TP | SRP | TSS | SECCHI | COND | pH | DO |
| 13-May | 1 | 235 | 0.91 | 0.110 | 0.350 | 0.030 | 0.014 | 10.0 | 4.58 | 0.9230 | 8.10 | 8.20 |
| 17-Jun | 1 | 235 | 2.07 | <0.01 | 0.880 | 0.050 | 0.013 | 13.0 | 3.83 | 0.8000 | 8.60 | 11.00 |
| 22-Jul | 1 | 230 | NA | <0.01 | <0.01 | 0.041 | 0.008 | 4.0 | 4.00 | 0.8030 | 8.60 | 7.90 |
| 26-Aug | 1 | 255 | NA | 0.050 | <0.01 | 0.011 | 0.010 | NA | 5.17 | 0.7900 | 9.00 | 13.00 |
| 14-Oct | 1 | 190 | NA | 0.010 | <0.01 | 0.095 | 0.018 | 22.0 | 2.67 | 0.7760 | 8.60 | 8.90 |
| | **Average** | 229 | 1.49 | 0.057[k] | 0.615[k] | 0.045 | 0.013 | 12.3 | 4.05 | 0.8184 | 8.58 | 9.80 |

**Figure 2. Total suspended solid (TSS) concentrations vs. Secchi depth for Long Lake, 1991-2005.**



stormwater from approximately 25,441 acres within its watershed (Figure 3), which includes Round Lake, Highland Lake, and numerous smaller lakes and ponds. The four largest land uses within the watershed are agricultural (26%), single family (19%), public and private open space (16%), and forest and grassland (8%)(Figure 4). The land uses within the watershed can contribute to external phosphorus loading (Table 3). For Long Lake, the land uses contributing the highest percentages of estimated runoff were transportation (i.e., road) and single family, which are 32% and 27%, respectively. Since single family contributes a significant portion of runoff, the promotion of phosphorous free fertilizer use on residential lawns is strongly encouraged. Other lake associations in Lake County have passed no phosphorous fertilizer rules. The Lake County Stormwater Management Commission (SMC) developed the Squaw Creek Watershed Management Plan in May 2004. This will help monitor and reduce external inputs from the watershed to Long Lake.

The sewage treatment plants at Fremont School District 79 and Camp Hickory along with the effluent from Baxter Corporation, likely contribute minimal amounts of nutrient loads into Long Lake, particularly when considering the size of the lake's watershed. However, historic sewage effluent from the Round Lake Sewage Treatment Plant (RLSTP and the Lake Villa Sewage Treatment Plant (LVSTP) accelerated eutrophication of the lake. In the early 1980s, the RLSTP diverted its effluent away from Long Lake. During the same time period, sanitary sewers were installed around the lake, replacing septic systems. The LVSTP stopped discharging effluent into Eagle Creek in 1991. The retention time for water entering the lake was calculated to be approximately 108 days. Baxter Corporation conducted an analysis of nutrient contributions to the watershed in 2003.

TP can be used for the trophic state index (TSIp), which classifies lakes according to the overall level of nutrient enrichment. The TSIp score falls within one of four categories: hypereutrophic, eutrophic, mesotrophic, or oligotrophic. Hypereutrophic lakes are those that have excessive nutrients, with nuisance algae growth reminiscent of "pea soup" and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae. Mesotrophic and oligotrophic lakes are those with lower nutrient levels. These are very clear lakes, with little algae growth. Most lakes in Lake County are eutrophic. The trophic state of Long Lake based on phosphorus concentration during 2001 was eutrophic, with a TSIp score of 69.4. In 2005 it was still eutrophic with a lower TSIp score of 66.6. Long Lake ranked 87$^{th}$ out of 162 lakes in Lake County based on average TP concentrations (Table 4). Other lakes in the watershed include Round Lake which ranked 23$^{rd}$ and Highland Lake which ranked 34$^{th}$.

The IEPA has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, and recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations (for the trophic state index), and aquatic plant coverage. According to this index, Long Lake provides *Full* support of aquatic life and *Partial* support of swimming and recreational activities as a result of moderate TP concentrations. The lake provides *Partial* overall use.

**Figure 3. Approximate watershed delineation for Long Lake, 2005.**

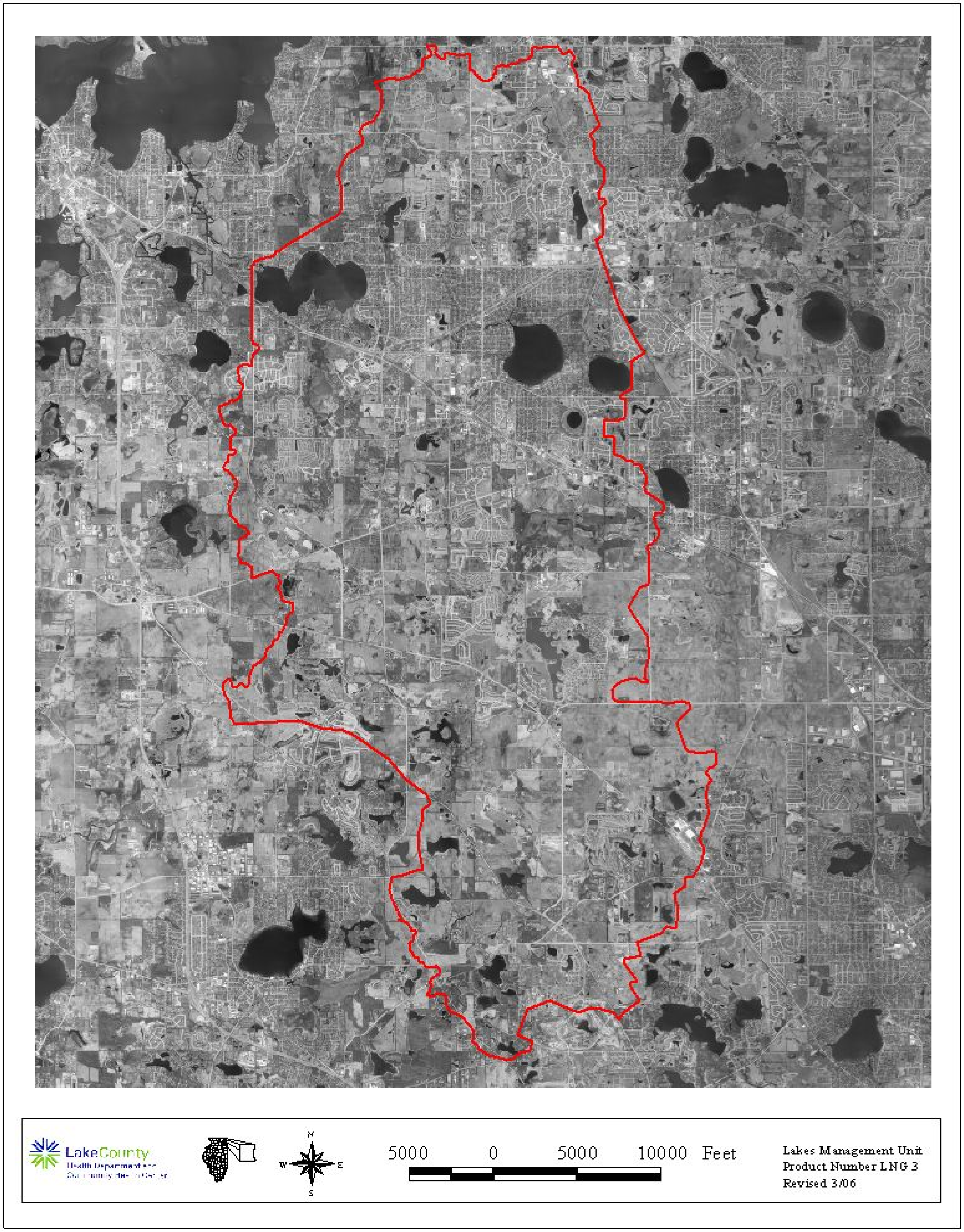
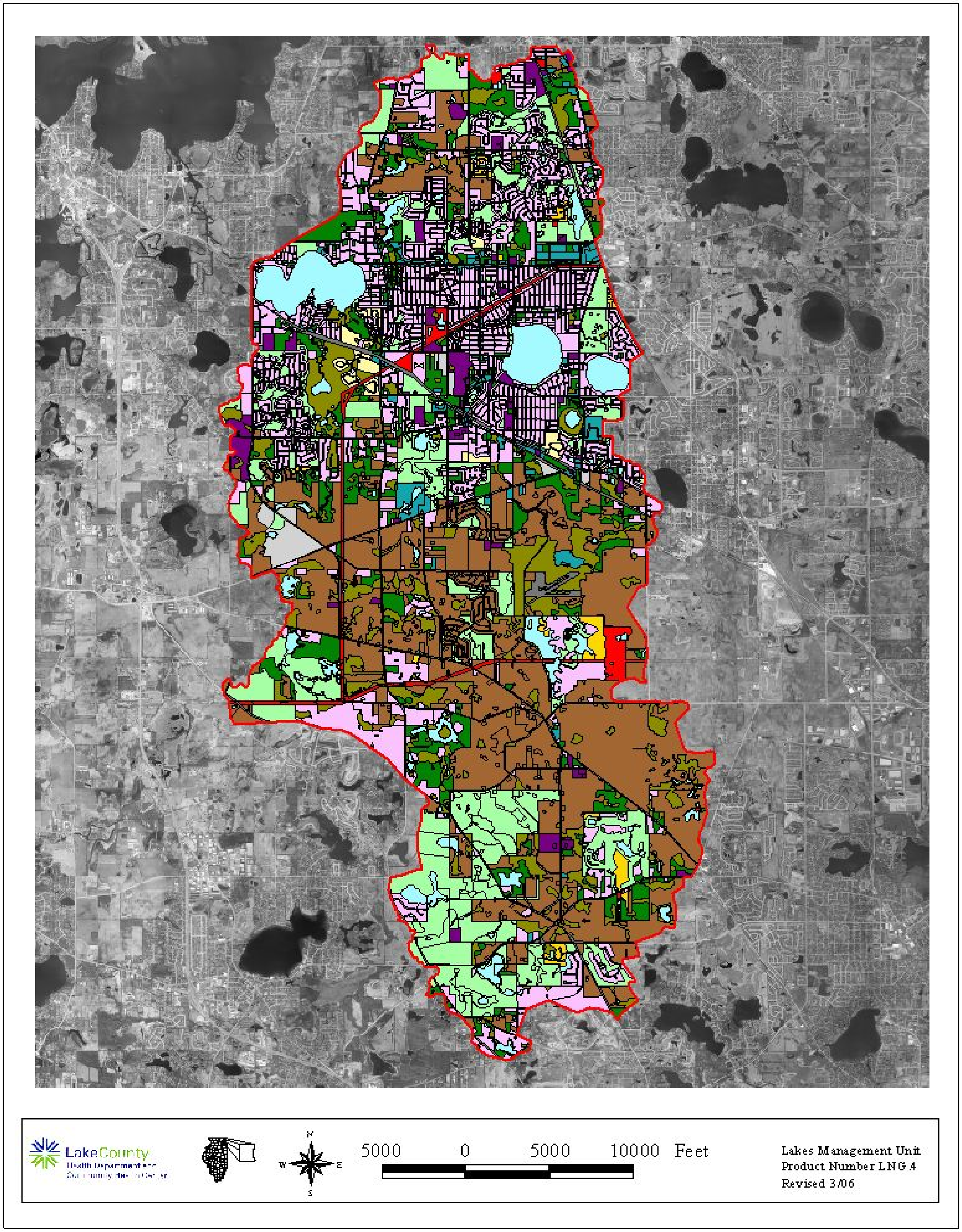


**Figure 4. Approximate land uses within the Long Lake watershed, 2005.**



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

| Land Use | Acreage | % of Total |
|---|---|---|
| Agricultural | 6640.54 | 26.10% |
| Disturbed Land | 200.33 | 0.79% |
| Forest and Grassland | 2067.63 | 8.13% |
| Government and Institutional | 509.87 | 2.00% |
| Industrial | 249.92 | 0.98% |
| Multi Family | 177.79 | 0.70% |
| Office | 3.45 | 0.01% |
| Public and Private Open Space | 3981.99 | 15.65% |
| Retail/Commercial | 471.40 | 1.85% |
| Single Family | 4806.33 | 18.89% |
| Transportation | 2045.30 | 8.04% |
| Utility and Waste Facilities | 392.04 | 1.54% |
| Water | 1571.95 | 6.18% |
| Wetlands | 2323.44 | 9.13% |
| **TOTAL** | **25442.00** | 100.00% |

| Land Use | Acreage | Runoff Coeff. | Estimated Runoff, acft. | % total of Estimated Runoff |
|---|---|---|---|---|
| Agriculture | 6640.54 | 0.05 | 913.07 | 6.13% |
| Disturbed Land | 200.33 | 0.05 | 27.55 | 0.18% |
| Commercial | 471.40 | 0.85 | 1101.91 | 7.40% |
| Forest and Grassland | 2067.63 | 0.05 | 284.30 | 1.91% |
| Govt. & Institution | 509.87 | 0.50 | 701.07 | 4.71% |
| Industrial | 249.92 | 0.85 | 584.19 | 3.92% |
| Multi Family | 177.79 | 0.50 | 244.47 | 1.64% |
| Public & Private Open Space | 3981.99 | 0.15 | 1642.57 | 11.03% |
| Office | 3.45 | 0.85 | 8.07 | 0.05% |
| Open water | 1571.95 | 0.00 | 0.00 | 0.00% |
| Single Family | 4806.33 | 0.30 | 3965.22 | 26.62% |
| Transportation | 2045.30 | 0.85 | 4780.89 | 32.09% |
| Utility & Waste | 392.04 | 0.30 | 323.43 | 2.17% |
| Wetlands | 2323.44 | 0.05 | 319.47 | 2.14% |
| **TOTAL** | **25442.00** | | **14896.22** | **100.00%** |

| | | |
|---|---|---|
| **Lake volume** | **4400** | **acre-feet** |
| **Retention Time (years)= lake volume/runoff** | **0.30** | **years** |
| | **107.81** | **days** |

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

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

## Table 4. Continued.

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

## Table 4. Continued.

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

## Table 4. Continued.

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

Long Lake was thermally stratified from May through September. Thermal stratification occurs when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically experiences anoxic conditions (where DO concentrations drop below 1 mg/L) by mid-summer. In 2005, the lake was weakly stratified by May and strongly stratified by June (at approximately the 12-14 foot depth). The thermocline (the transition region between the epilimnion and the hypolimnion) remained strong until September, when water temperatures throughout the water column grew closer. Turnover was beginning during the September sampling, although the thermocline was still present at approximately 24 feet, which was the depth at which the water sample was collected that month. The start of turnover explains why some of the values in the hypolimnion were less than August values.

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support a sunfish/bass fishery, since these fish can suffer oxygen stress below this amount. DO concentrations in the epilimnion did not indicate any significant problems (Appendix B). Anoxic conditions existed from June through September in the hypolimnion. This is a normal phenomenon in large, deep lakes that stratify. The anoxic boundary was at its shallowest in August at approximately 8 feet and deepest in September, during turnover, at approximately 16 feet. Since an accurate bathymetric map with volumetric calculations does not exist for Long Lake it was impossible to determine the volume of the lake that was anoxic during 2005.

Conductivity is a measurement of water's ability to conduct electricity and is positively correlated with chloride ($Cl^-$) concentration. Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watersheds often have higher conductivity readings and higher $Cl^-$ concentrations because of the use of road salts. The median conductivity reading for near surface samples is 0.7748 milliSiemens/cm (mS/cm) for Lake County lakes. During 2005, the average epilimnetic conductivity reading for Long Lake was higher than the county median at 1.0821 mS/cm. This was up 15% from the 2001 average of 0.9430 mS/cm and more than twice the 1996 average of 0.5222 mS/cm. The hypolimnetic conductivity reading showed a similar pattern to the epilimnetic conductivity readings. The 2005 readings remained relatively consistent throughout the season. Typically lakes that receive road salts have higher readings early in the year as spring rains flush salts from the watershed with readings dropping off as the summer goes on. The readings most likely didn't drop off due to the lack of precipitation during the summer not replenishing the lake volume and concentrating the $Cl^-$ and other ions. Water levels on Long Lake dropped more than 7 inches from April to July. After July the seawall used to measure lake level was out of the water so an accurate measurement of the total water level decrease wasn't possible. $Cl^-$ concentrations in Long Lake were higher in 2005 than the Lake County epilimnetic median of 183 mg/L and hypolimnetic median of 102 mg/L, with a seasonal epilimnetic average of 197 mg/L and hypolimnetic average of 192 mg/L. Stormwater runoff from impervious surfaces such as roads and parking lots can deliver high concentrations of this $Cl^-$ to nearby lakes and ponds. Road salt was probably the reason for the high readings because $Cl^-$ concentrations detect sodium chloride, calcium chloride, potassium chloride, or magnesium chloride, which make up most road salt. The Illinois Environmental Protection Agency (IEPA) standard for chloride is 500 mg/L. Once values exceed this standard, the waterbody is deemed to be impaired, thus impacting aquatic life. A study done in Canada reported 10% of aquatic species are harmed by prolonged exposure to $Cl^-$ concentrations greater than 220 mg/L.

Additionally, shifts in algal populations in lakes were associated with $Cl^-$ concentrations as low as 12 mg/l. Therefore, it was likely that Long Lake was being negatively impacted by the high $Cl^-$ concentrations.

## SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted during the end of June into the first part of July and then again in August of 2005. Sampling sites were based on a grid system created by mapping software (ArcGIS), with each site located 60 meters apart with Long Lake having 442 sites. On Long Lake, there were 207 sites sampled in June/July (Figure 5) and 206 sites sampled in August (Figure 6). Once plants were not found at a site, any sites deeper were not sampled. There were nine aquatic plant species found during both sampling events (Table 5). Eurasian Watermilfoil (EWM) was the most dominant species found at 59% and 63% of the sampling sites. Coontail was the second most common species found at 25% and 34% of the sampling sites (Table 6a,b). Aquatic plant composition was similar in 2001 with EWM being the most abundant species. Two exotic aquatic plants, EWM and Curlyleaf Pondweed, were found in Long Lake. Both of these exotics compete with native plants, eventually crowding them out and providing little or poor natural diversity in addition to limiting uses by wildlife.

**Table 5. Aquatic plant species found in Long Lake in 2005.**

| | |
|---|---|
| Coontail | *Ceratophyllum demersum* |
| American Elodea | *Elodea canadensis* |
| Water Stargrass | *Heteranthera dubia* |
| Small Duckweed | *Lemna minor* |
| Eurasian Water Milfoil^ | *Myriophyllum spicatum* |
| White Water Lily | *Nymphaea tuberosa* |
| Curlyleaf Pondweed^ | *Potamogeton crispus* |
| Sago Pondweed | *Potamogeton pectinatus* |
| Giant Duckweed | *Spirodella polyrhiza* |
| Watermeal | *Wolffia columbiana* |

**^ Exotic plant**

To maintain a healthy sunfish/bass fishery, the Illinois Department of Natural Resources (IDNR) recommends plant coverage be 30% to 40% across the lake bottom. These surveys found approximately 66% and approximately 69% of the sites sampled had aquatic plants, respectively (Table 6c). It was calculated that approximately 29% of the lake bottom was covered by plants. Thus, intensive aquatic management is not recommended at this time, however, limited controls should be considered in areas impeding reasonable recreational use.

Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. During 2005, the depth of the 1% light level ranged from 6 feet (September and October) to 12 feet (May). This corresponded to the maximum depth aquatic plants were found. Maximum depth at which

**Figure 5. Aquatic plant sampling grid that illustrates plant density on Long Lake, June/July 2005.**

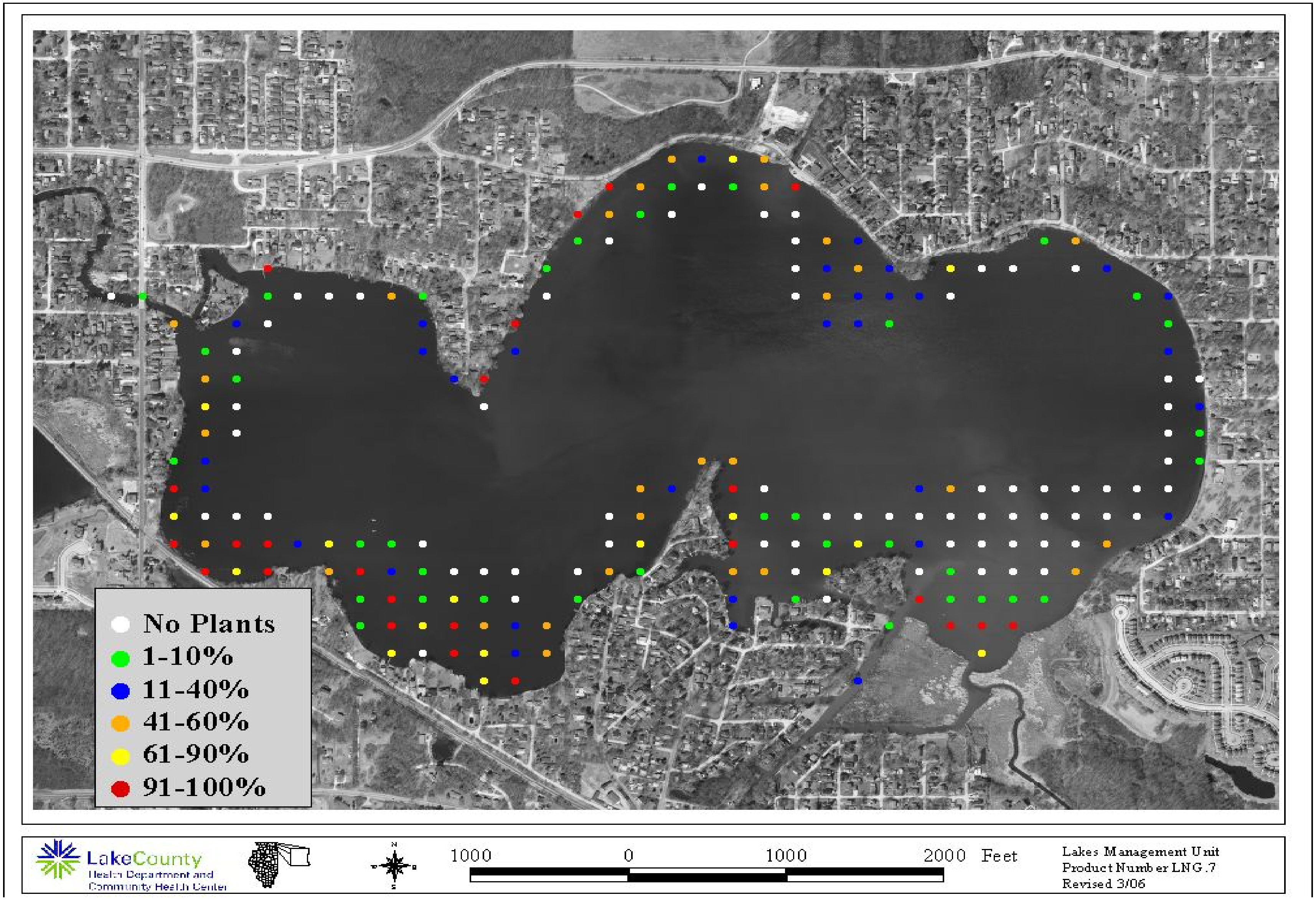


**Figure 6. Aquatic plant sampling grid that illustrates plant density on Long Lake, August 2005.**

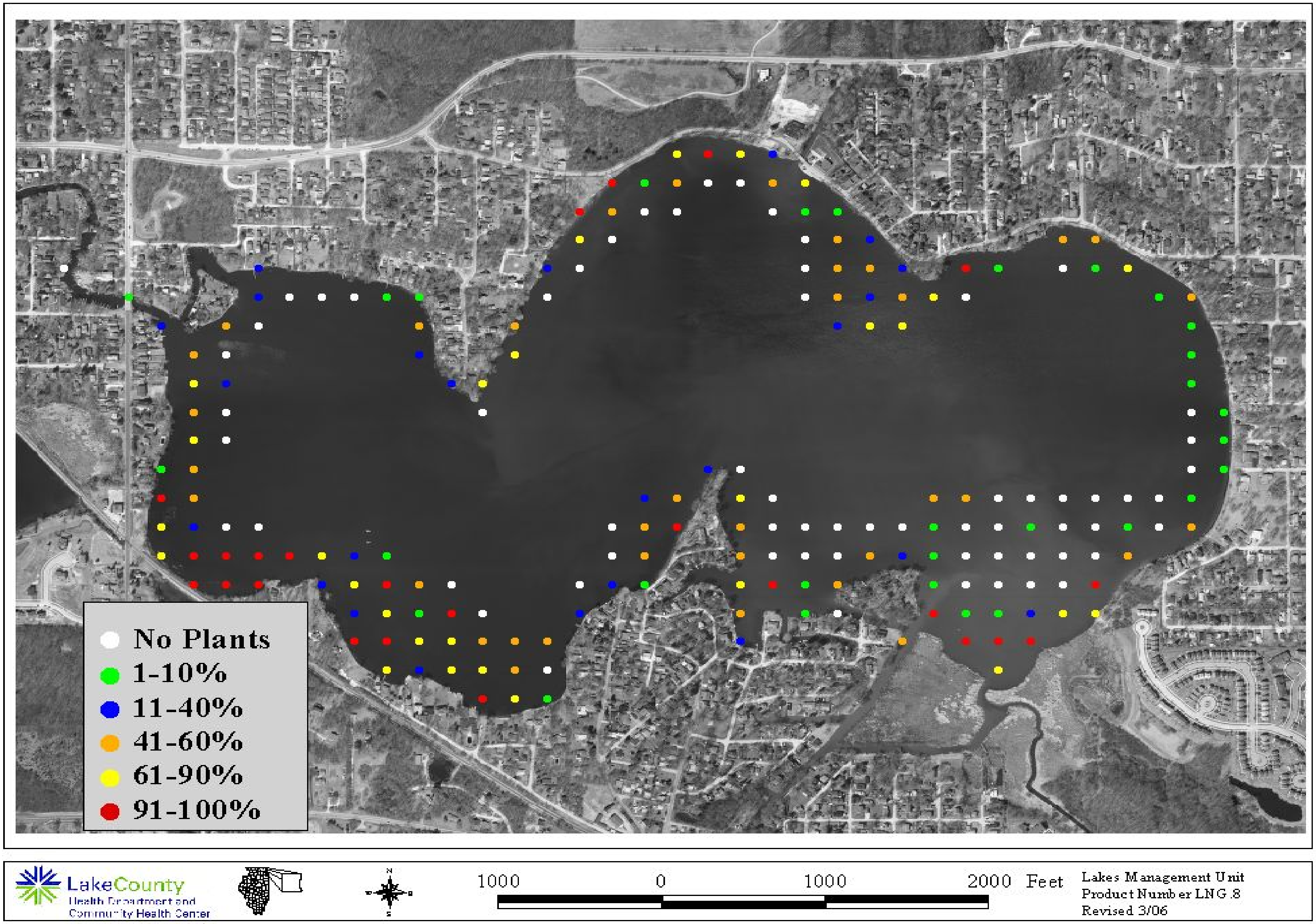


**Table 6a. Aquatic plant species found at the 207 sampling sites on Long Lake in June/July, 2005. The maximum depth that plants were found was 6.4 feet.**

| June/July | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Plant Density | Coontail | Curlyleaf Pondweed | Duckweed | Elodea | Eurasian Watermilfoil | Giant Duckweed | Sago Pondweed | Water Stargrass | White Water Lily |
| Present | 19 | 19 | 7 | 3 | 39 | 6 | 5 | 1 | 9 |
| Common | 11 | 0 | 2 | 1 | 45 | 0 | 2 | 0 | 1 |
| Abundant | 12 | 0 | 0 | 0 | 31 | 0 | 1 | 1 | 1 |
| Dominant | 10 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 |
| % Plant Occurrence | 25.1 | 9.2 | 4.3 | 1.9 | 59.4 | 2.9 | 3.9 | 1.0 | 5.3 |

**Table 6b. Aquatic plant species found at the 206 sampling sites on Long Lake in August 2005. The maximum depth that plants were found was 7.3 feet.**

| August | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Plant Density | Coontail | Curlyleaf Pondweed | Duckweed | Elodea | Eurasian Watermilfoil | Sago Pondweed | Watermeal | Water Stargrass | White Water Lily |
| Present | 25 | 2 | 1 | 2 | 43 | 8 | 0 | 1 | 5 |
| Common | 12 | 0 | 2 | 1 | 39 | 1 | 0 | 0 | 4 |
| Abundant | 25 | 0 | 2 | 0 | 34 | 2 | 1 | 1 | 0 |
| Dominant | 7 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 |
| % Plant Occurrence | 33.5 | 1.0 | 2.4 | 1.5 | 62.6 | 5.3 | 0.5 | 1.0 | 4.4 |

**Table 6c. Distribution of rake density across all sampled sites.**

| June/July | | |
|---|---|---|
| Rake Density (Coverage) | # of Sites | % |
| No plants | 71 | 34.3% |
| >0 to 10% | 37 | 17.9% |
| >10 to 40% | 31 | 15.0% |
| >40 to 60% | 28 | 13.5% |
| >60 to 90% | 16 | 7.7% |
| >90% | 24 | 11.6% |
| Total Sites with Plants | 136 | 65.7% |
| Total # of Sites | 207 | 100.0% |

| August | | |
|---|---|---|
| Rake Density (Coverage) | # of Sites | % |
| No plants | 64 | 31.1% |
| >0 to 10% | 30 | 14.6% |
| >10 to 40% | 24 | 11.7% |
| >40 to 60% | 36 | 17.5% |
| >60 to 90% | 28 | 13.6% |
| >90% | 24 | 11.7% |
| Total Sites with Plants | 142 | 68.9% |
| Total # of Sites | 206 | 100.0% |

aquatic plants were found was 6.4 feet in June/July and 7.3 feet in August and the 1% light level during these months was 8 feet.

Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts (Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates there are a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2005 Lake County lakes was 14.0 (Table 7). Long Lake had a FQI of 15.5 in 2005. This is an increase since the 2001 survey was conducted, when the FQI was 13.6. However, the change in the aquatic plant sampling procedure could be a potential reason for this increase. Also, plant community composition may vary from year to year.

Plankton are microscopic plants and animals that are free-floating within the water column. Samples were collected during water quality testing and analyzed for species content (See Appendix A for methods). Diatoms (*Asterionella*) were the dominant plankton in April while flagellates dominated the remainder of the season (Figure 7). A blue-green algal boom occurred in July and was dominated by *Aphanizomenon*.

## SUMMARY OF SHORELINE CONDITION

In 2001 an assessment was conducted to determine the condition of the shoreline at the water/land interface. Approximately 80% of Long Lake's shoreline was developed and the majority of the developed shoreline was comprised of seawall (36%) and riprap (25%). The remainder of the developed shoreline consisted of shrub (13%), wetland (8%), beach (6%), lawn (6%), woodland (3%), and buffer (3%). The shoreline was also assessed for the degree of erosion. Seventy-four percent of the shoreline had no erosion, 20% had slight erosion, 5% had moderate erosion, and only 1% had severe erosion.

The shoreline was reassessed on August 30, 2005 for significant changes since 2001, however the assessment was not as extensive. Based on the 2005 assessment, areas classified as severe erosion in 2001 had been repaired and some areas that had been moderate were reclassified as slight. However, others areas were reclassified from slight to moderate or from moderate to severe (Figure 8). Overall, approximately 70% of the shoreline had no erosion, 19% had slight erosion, 8% had moderate erosion, and 2% had severe erosion. The area of severe erosion in 2001 consisted mainly of land owned by the Lake County Forest Preserve District (LCFPD). In 2005, the LCFPD conducted a rehabilitation project to stop the erosion. However, in 2005 an area on the southeastern part of the lake was reclassified from slight erosion to moderate and severe erosion.

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

| Rank | Lake Name | FQI (w/A) | FQI (native) |
|---|---|---|---|
| 1 | Cedar Lake | 35.6 | 37.8 |
| 2 | Deep Lake | 33.9 | 35.4 |
| 3 | Round Lake Marsh North | 29.1 | 29.9 |
| 4 | East Loon Lake | 28.4 | 29.9 |
| 5 | Cranberry Lake | 28.3 | 28.3 |
| 6 | Sullivan Lake | 28.2 | 29.7 |
| 7 | Deer Lake | 27.9 | 30.2 |
| 8 | Little Silver Lake | 27.9 | 30.0 |
| 9 | Schreiber Lake | 26.8 | 27.6 |
| 10 | Redwing Slough | 26.0 | 26.9 |
| 11 | West Loon Lake | 26.0 | 27.6 |
| 12 | Timber Lake (North) | 25.5 | 27.1 |
| 13 | Cross Lake | 25.2 | 27.8 |
| 14 | Wooster Lake | 25.2 | 26.9 |
| 15 | Lake Zurich | 24.0 | 26.0 |
| 16 | Lake of the Hollow | 23.8 | 26.2 |
| 17 | Lakewood Marsh | 23.8 | 24.7 |
| 18 | Round Lake | 23.5 | 25.9 |
| 19 | Fourth Lake | 23.0 | 24.8 |
| 20 | Druce Lake | 22.8 | 25.2 |
| 21 | Sun Lake | 22.7 | 24.5 |
| 22 | Countryside Glen Lake | 21.9 | 22.8 |
| 23 | Sterling Lake | 21.8 | 24.1 |
| 24 | Butler Lake | 21.4 | 23.1 |
| 25 | Bangs Lake | 21.2 | 23.7 |
| 26 | ADID 203 | 20.5 | 20.5 |
| 27 | Broberg Marsh | 20.5 | 21.4 |
| 28 | Davis Lake | 20.5 | 21.4 |
| 29 | McGreal Lake | 20.2 | 22.1 |
| 30 | Lake Kathryn | 19.6 | 20.7 |
| 31 | Third Lake | 19.6 | 21.7 |
| 32 | Owens Lake | 19.3 | 20.2 |
| 33 | Redhead Lake | 19.3 | 21.2 |
| 34 | Lake Minear | 18.8 | 20.6 |
| 35 | Turner Lake | 18.6 | 21.2 |
| 36 | Salem Lake | 18.5 | 20.2 |
| 37 | Lake Miltmore | 18.4 | 20.3 |
| 38 | Fish Lake | 18.1 | 20.0 |
| 39 | McDonald Lake 1 | 17.7 | 18.7 |
| 40 | Potomac Lake | 17.3 | 18.5 |
| 41 | Hendrick Lake | 17.2 | 19.0 |
| 42 | Duck Lake | 17.1 | 19.1 |
| 43 | Summerhill Estates Lake | 17.1 | 18.0 |

## Table 7. Continued.

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

## Table 7. Continued.

| Rank | Lake Name | FQI (w/A) | FQI (native) |
|---|---|---|---|
| 87 | Stockholm Lake | 12.1 | 13.5 |
| 88 | Lake Matthews | 12.0 | 12.0 |
| 89 | McDonald Lake 2 | 12.0 | 12.0 |
| 90 | Flint Lake | 11.8 | 13.0 |
| 91 | Harvey Lake | 11.8 | 13.0 |
| 92 | Rivershire Pond 2 | 11.5 | 13.3 |
| 93 | Antioch Lake | 11.3 | 13.4 |
| 94 | Lake Charles | 11.3 | 13.4 |
| 95 | Lake Naomi | 11.2 | 12.5 |
| 96 | Pulaski Pond | 11.2 | 12.5 |
| 97 | Lake Christa | 11.0 | 12.7 |
| 98 | Redwing Marsh | 11.0 | 11.0 |
| 99 | West Meadow Lake | 11.0 | 11.0 |
| 100 | Nielsen Pond | 10.7 | 12.0 |
| 101 | Lake Holloway | 10.6 | 10.6 |
| 102 | Lake Carina | 10.2 | 12.5 |
| 103 | College Trail Lake | 10.0 | 10.0 |
| 104 | Lake Lakeland Estates | 10.0 | 11.5 |
| 105 | Crooked Lake | 9.8 | 12.0 |
| 106 | Hastings Lake | 9.8 | 12.0 |
| 107 | Werhane Lake | 9.8 | 12.0 |
| 108 | Big Bear Lake | 9.5 | 11.0 |
| 109 | Little Bear Lake | 9.5 | 11.0 |
| 110 | Loch Lomond | 9.4 | 12.1 |
| 111 | Sand Pond (IDNR) | 9.4 | 12.1 |
| 112 | Columbus Park Lake | 9.2 | 9.2 |
| 113 | Sylvan Lake | 9.2 | 9.2 |
| 114 | Grandwood Park Lake | 9.0 | 11.0 |
| 115 | Lake Fairfield | 9.0 | 10.4 |
| 116 | East Meadow Lake | 8.5 | 8.5 |
| 117 | Lake Farmington | 8.5 | 9.8 |
| 118 | Lucy Lake | 8.5 | 9.8 |
| 119 | South Churchill Lake | 8.5 | 8.5 |
| 120 | Bittersweet Golf Course #13 | 8.1 | 8.1 |
| 121 | Woodland Lake | 8.1 | 9.9 |
| 122 | Albert Lake | 7.5 | 8.7 |
| 123 | Banana Pond | 7.5 | 9.2 |
| 124 | Fairfield Marsh | 7.5 | 8.7 |
| 125 | Lake Eleanor | 7.5 | 8.7 |
| 126 | Lake Louise | 7.5 | 8.7 |
| 127 | Patski Pond | 7.1 | 7.1 |
| 128 | Rasmussen Lake | 7.1 | 7.1 |
| 129 | Lucky Lake | 7.0 | 7.0 |

## Table 7. Continued.

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

**Figure 7. Plankton counts for Long Lake, 2005.**

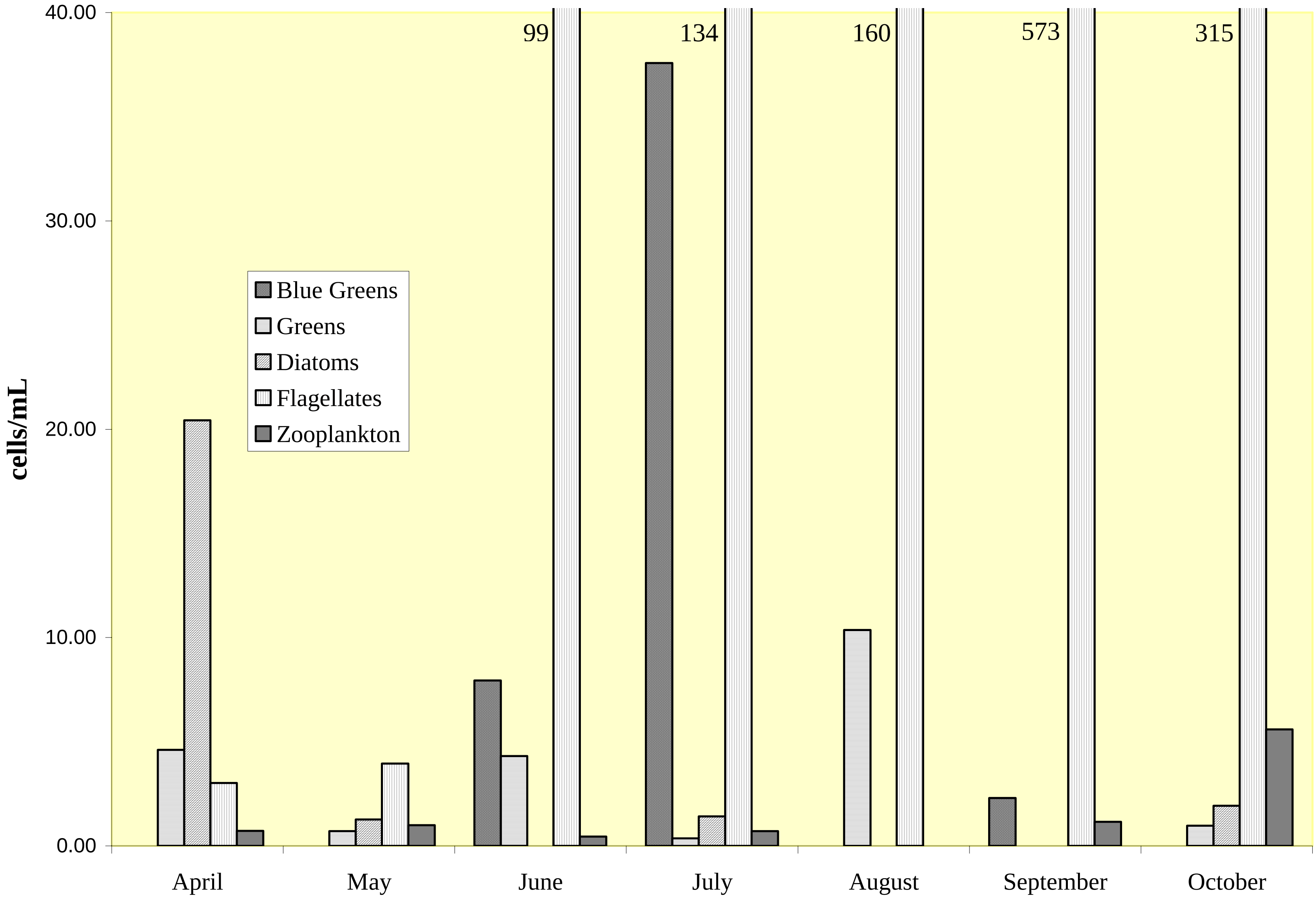


**Figure 8. Shoreline erosion on Long Lake, 2005.**

It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits can be three-fold. First, the erosion is repaired and new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds habitat for wildlife to a shoreline that is otherwise limited in habitat. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and keep geese and gulls from congregating, as it is not desirable habitat for them.

There were invasive shoreline plant species that should be controlled/eliminated: Purple Loosestrife, Reed Canary Grass, and Buckthorn. These species have been noted in several areas around the lake. They should be eliminated before they spread and displace other native and more desirable plant species.

## SUMMARY OF WILDLIFE AND HABITAT

Visual wildlife observations were made during all sampling activities. Because the lake is in the middle of a residential setting with the majority of the shoreline seawall or riprap, habitat for wildlife was limited. Most of the birds observed were those common in residential settings (Table 8). The size of Long Lake makes it a potential stopover or staging area for migrating birds, particularly waterfowl. However, the lack of desirable aquatic plants and the low water clarity reduce the potential uses of the lake for these birds and other wildlife. There was a healthy population of mature trees providing good habitat for a variety of wildlife species, and a few large dead trees providing excellent habitat for Double Crested Cormorants. Additionally, there were several shrub areas that provided habitat for smaller bird and mammal species. Several areas around the lake were undeveloped and had a good mix of mature trees and under story vegetation. Unfortunately, much of the under story in these areas consists of exotic plants such as Buckthorn, Purple Loosestrife, or Reed Canary Grass. Several areas are in need of habitat improvement on Long Lake, however. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians.

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

| | |
|---|---|
| <u>*Birds*</u> | |
| Double-crested Cormorant | *Phalacrocorax auritus* |
| Mute Swans | *Cygnus olor* |
| Canada Goose | *Branta canadensis* |
| Mallard | *Anas platyrhnchos* |
| Ring-billed Gull | *Larus delawarensis* |
| Common Tern* | *Sterna hirundo* |
| Great Blue Heron | *Ardea herodias* |
| Barn Swallow | *Hirundo rustica* |
| Tree Swallow | *Iridoprocne bicolor* |

**Table 8. Continued**

| | |
|---|---|
| Rough-wing Swallow | *Stelgidopteryx ruficollis* |
| Chimney Swift | *Chaetura pelagica* |
| Warbling Vireo | *Vireo gilvus* |
| Yellow Warbler | *Dendroica petechia* |
| Red-winged Blackbird | *Agelaius phoeniceus* |
| Northern Oriole | *Icterus galbula* |
| Northern Cardinal | *Cardinalis cardinalis* |
| Chipping Sparrow | *Spizella passerina* |
| *Mammals* | |
| Gray Squirrel | *Sciurus carolinensis* |

*** Endangered in Illinois**

The Illinois Department of Natural Resources (IDNR) conducted a fish population survey in 2001. A total of 200 fish were collected representing 15 species. Bluegill was the most abundant species followed by Yellow Perch, Channel Catfish, and Yellow Bass. The IDNR concluded the fishery was composed of a variety of large predatory fish. They suggest the presence of these fish in quality sizes would help to control Yellow Bass, crappie, and carp populations. The IDNR recommendations include establishing a 15-inch minimum length limit and 1 per day bag limit on Largemouth Bass, a 16-inch minimum length limit and 3 per day bag limit on Walleye, initiating a supplemental stocking program for Largemouth Bass and Walleye, and promoting the harvest of Yellow Bass and Common Carp.

# LAKE MANAGEMENT RECOMMENDATIONS

Long Lake has both positive and negative aspects. Some of the positives include participation in the VLMP and ALMP, the presence of the Long Lake Improvement and Sanitation Association (LLISA), a decrease in suspended solids and an increase in water clarity, having a watershed management plan developed, as well as being classified as a sentinel lake by the Lakes Management Unit (LMU). By being classified as a sentinel lake, the LMU will be sampling the lake yearly through 2009. Long Lake participated in the ALMP in 2002 providing valuable data from a year the LMU did not sample the lake. In addition to continuing to collect the VLMP and ALMP data, the LMU recommends installing another staff gauge on the main part of the lake to monitor the lake water level. LLISA is active in the management activities of the lake and an active association helps with communication among those concerned about the lake. Over the past 4 years, TSS has shown a decrease while Secchi transparency has increased. This is encouraging, and hopefully will persist in the future. Having a watershed management plan will help with future management throughout the watershed and possibly improve the water quality of Long Lake. To improve the quality of Long Lake, the LMU has the following recommendations:

- **Creating a bathymetric map**

  Creating an updated bathymetric map can help with improvements to Long Lake. The LMU recommends a bathymetric map for lakes to help with management strategies. Long Lake has a map that was created in 1969; however, there are no volumetric calculations so it is impossible to determine accurately how much of the lake goes anoxic or a volume for pesticide applications, etc. In addition, LMU suggests any maps older than 10 years be updated (Appendix D1).

- **Lakes with shoreline erosion**

  There have been areas of the lake rehabilitated to control erosion. However, in 2005 an area on the southeastern part of the lake has degraded to moderate and severe erosion. These eroded areas should be repaired to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls (Appendix D2).

- **Watershed nutrient reduction**

  Long Lake's phosphorous has remained relatively stable since the 1990's. Internal loading will likely continue for years to come. Some recommendations to reduce any further phosphorous input include the use of phosphorous free lawn fertilizers along with watershed management practices (Appendix D3; D4).

**Aquatic plant management**

Approximately 29% of Long Lake's bottom had aquatic plant coverage with Eurasian Watermilfoil (EWM) dominating the plant community. An increase of plant diversity in the lake is recommended, with control of EWM being a high priority. At this time, it is not a problem but has the potential to become one. Since Long Lake has several boat launches, signage is recommended each launch notifying users of the presence of exotic species in the lake, so it does not spread to other lakes that do not already have it. The Exotic Species Advisory signs are available to homeowner associations from the Illinois-Indiana Sea Grant Program by calling 217-333-0240 (Appendix D5). Native plants will help improve the water quality of the lake and utilize the abundant nutrients, as well as increased habitat for fish and wildlife. Emergent plants (like arrowheads and bulrushes) will also help buffer wave action that cause erosion.

**Eliminate or control exotic species**

Numerous shoreline exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. The outcome is a loss of plant and animal diversity. Plants such as Purple Loosestrife (*Lithium salicaria*), Buckthorn (*Rhamnus cathartica*), and Reed Canary Grass (*Phalaris arundinacea*) are three examples. During 2001 these exotic species were found along the shoreline and should be eliminated (Appendix D6).

**Enhance wildlife habitat conditions on a lake**

Although the lake is in a residential setting, there is a good mix of wildlife habitat. A variety of wildlife, primarily birds, existed around the lake. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones and are recommended as one aspect of shoreline protection. Erecting birdhouses and allowing brush or trees that have fallen into the water to remain creates additional habitat for birds, fish, reptiles, and amphibians (Appendix D7).

**Lakes with high Canada Geese populations**

Long Lake has a resident goose population. The presence of geese can contribute to the nutrients in the lake (especially TP). Methods should be taken to control and discourage the geese congregating around the lake. A possible reason for the geese residing could be people feeding them. It is recommended signs stating "No Feeding Waterfowl" be installed (Appendix D8).

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

## Plankton Sampling

Plankton was sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a, 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 80μm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton was collected within a small cup on the bottom of the tow. The collected sample was then emptied into a pre-labeled brown plastic bottle. The net was rinsed with deionized water into the bottle in order to ensure all the plankton was collected. The sample was then transferred to a graduated cylinder to measure the amount of milliliters (mL) that the sample was. The sample was then returned to the bottle and preserved with Lugol's iodine solution (5 drops/mL). The sample bottle was then closed and stored in a cooler until returning to the lab, where it was transferred to the refrigerator until enumeration. Enumeration was performed within three months, but ideally within one month, under a microscope. Sample bottle was inverted several times to ensure proper homogenization. An automated pipette was used to retrieve 1 mL of sample, which was then placed on a Sedgewick Rafter slide. This is a microscope slide on which a rectangular chamber has been constructed, measuring 50 mm x 20 mm in area and with a depth of 1 mm. The slide was then placed under the microscope and counted at a 20X magnification. Twenty fields of view were randomly counted with all species within each field counted. Through calculations, it was determined how many of each species were in 1 mL of lake water.

## 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<br>YSI 6600 Sonde® |
| Dissolved oxygen | Hydrolab DataSonde ®4a or<br>YSI 6600 Sonde® |
| Nitrate nitrogen | Brucine method<br>Standard Methods (SM) 14$^{th}$ ed 419D<br>Detection Limit = 0.05 mg/L |
| Ammonia nitrogen | SM 18$^{th}$ ed. Electrode method,<br>#4500 $NH_3$-F<br>Detection Limit = 0.1 mg/L |
| Total Kjeldahl nitrogen | SM 18$^{th}$ ed, 4500-$N_{org}$ C<br>Semi-Micro Kjeldahl, plus 4500 $NH_3$-F<br>Detection Limit = 0.5 mg/L |
| pH | Hydrolab DataSonde® 4a, or<br>YSI 6600 Sonde®<br>Electrometric method |
| Total solids | SM 18$^{th}$ ed, Method #2540B |
| Total suspended solids | SM 18$^{th}$ ed, Method #2540D<br>Detection Limit = 0.5 mg/L |
| Total dissolved solids | SM 18$^{th}$ ed, Method #2540C |
| Total volatile solids | SM 18$^{th}$ ed, Method #2540E, from total solids |
| Alkalinity | SM 18$^{th}$ ed, Method #2320B,<br>patentiometric titration curve method |
| Conductivity | Hydrolab DataSonde® 4a or<br>YSI 6600 Sonde® |
| Total phosphorus | SM 18$^{th}$ ed, Methods #4500-P B 5 and #4500-P E<br>Detection Limit = 0.01 mg/L |
| Soluble reactive phosphorus | SM 18$^{th}$ ed, Methods #4500-P B 1 and #4500-P E<br>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 LONG LAKE IN 2005.

Long Lake 2005 Multiparameter data

| Date MMDDYY | Time HHMMSS | Text Depth feet | Dep25 feet | Temp øC | DO mg/l | DO% Sat | SpCond mS/cm | pH Units | PAR æE/s/mý | Depth of Light Meter feet | % Light Transmission | Extinction Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Average | 2.19 |
| 4/11/2005 | 8:29:40 | 0.25 | 0.37 | 12.97 | 12.32 | 119.90 | 1.068 | 8.15 | 2447 | Surface | | |
| 4/11/2005 | 8:30:55 | 1 | 0.88 | 12.97 | 12.25 | 119.20 | 1.068 | 8.16 | 1692 | Surface | 100% | |
| 4/11/2005 | 8:31:49 | 2 | 1.85 | 12.97 | 12.17 | 118.50 | 1.068 | 8.16 | 528 | 0.10 | 31% | 11.65 |
| 4/11/2005 | 8:32:37 | 3 | 2.85 | 12.78 | 12.12 | 118.00 | 1.068 | 8.17 | 287 | 1.10 | 17% | 0.61 |
| 4/11/2005 | 8:33:49 | 4 | 3.81 | 12.78 | 12.05 | 117.20 | 1.067 | 8.17 | 159 | 2.06 | 9% | 0.62 |
| 4/11/2005 | 8:34:38 | 6 | 6.00 | 12.75 | 11.93 | 116.00 | 1.067 | 8.16 | 39 | 4.25 | 2% | 0.64 |
| 4/11/2005 | 8:35:41 | 8 | 7.94 | 12.75 | 11.95 | 116.20 | 1.067 | 8.16 | 15 | 6.19 | 0.9% | 0.49 |
| 4/11/2005 | 8:36:46 | 10 | 9.96 | 12.65 | 11.80 | 114.50 | 1.068 | 8.15 | 3 | 8.21 | 0% | 0.80 |
| 4/11/2005 | 8:38:23 | 12 | 12.00 | 11.93 | 10.87 | 103.70 | 1.072 | 8.05 | 1 | 10.25 | 0% | 0.54 |
| 4/11/2005 | 8:39:27 | 14 | 13.99 | 11.24 | 0.08 | 94.70 | 1.074 | 7.96 | 0 | 12.24 | 0% | 0.00 |
| 4/11/2005 | 8:40:33 | 16 | 15.93 | 10.68 | 9.14 | 84.80 | 1.078 | 7.85 | 0 | 14.18 | 0% | 0.00 |
| 4/11/2005 | 8:41:50 | 18 | 17.90 | 10.11 | 8.44 | 77.30 | 1.080 | 7.77 | 0 | 16.15 | 0% | 0.00 |
| 4/11/2005 | 8:42:52 | 20 | 19.81 | 9.61 | 7.83 | 71.00 | 1.085 | 7.70 | 0 | 18.06 | 0% | 0.00 |
| 4/11/2005 | 8:44:33 | 22 | 22.08 | 9.27 | 7.03 | 63.10 | 1.087 | 7.62 | 0 | 20.33 | 0% | 0.00 |
| 4/11/2005 | 8:45:54 | 24 | 23.96 | 8.67 | 5.74 | 50.80 | 1.093 | 7.54 | 0 | 22.21 | 0% | 0.00 |
| 4/11/2005 | 8:46:58 | 26 | 26.07 | 8.20 | 4.06 | 35.50 | 1.100 | 7.47 | 0 | 24.32 | 0% | 0.00 |
| 4/11/2005 | 8:48:14 | 28 | 28.00 | 8.02 | 3.32 | 28.90 | 1.105 | 7.41 | 0 | 26.25 | 0% | 0.00 |

Long Lake 2005 Multiparameter data

| Date MMDDYY | Time HHMMSS | Text Depth feet | Dep25 feet | Temp øC | DO mg/l | DO% Sat | SpCond mS/cm | pH Units | PAR æE/s/mý | Depth of Light Meter feet | % Light Transmission | Extinction Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Average | 0.91 |
| 5/11/2005 | 93227 | 0.25 | 0.26 | 16.83 | 8.88 | 94.3 | 1.102 | 7.81 | 535 | Surface | | |
| 5/11/2005 | 93304 | 1 | 1.04 | 16.82 | 8.82 | 93.5 | 1.102 | 7.84 | 454 | Surface | 100% | |
| 5/11/2005 | 93424 | 2 | 2.01 | 16.82 | 8.73 | 92.6 | 1.102 | 7.88 | 168 | 0.26 | 37% | 3.82 |
| 5/11/2005 | 93530 | 3 | 2.99 | 16.66 | 8.78 | 92.9 | 1.100 | 7.91 | 106 | 1.24 | 23% | 0.47 |
| 5/11/2005 | 93648 | 4 | 3.98 | 16.68 | 8.81 | 93.2 | 1.100 | 7.92 | 63 | 2.23 | 14% | 0.53 |
| 5/11/2005 | 93824 | 6 | 5.96 | 16.40 | 8.89 | 93.5 | 1.097 | 7.95 | 29 | 4.21 | 6% | 0.39 |
| 5/11/2005 | 93939 | 8 | 8.02 | 16.33 | 8.98 | 94.3 | 1.097 | 7.95 | 17 | 6.27 | 4% | 0.26 |
| 5/11/2005 | 94045 | 10 | 9.96 | 16.30 | 9.04 | 94.9 | 1.098 | 7.97 | 8 | 8.21 | 2% | 0.39 |
| 5/11/2005 | 94157 | 12 | 11.94 | 15.19 | 8.98 | 92.0 | 1.097 | 7.95 | 3 | 10.19 | 0.7% | 0.50 |
| 5/11/2005 | 94252 | 14 | 13.94 | 13.54 | 7.99 | 79.0 | 1.100 | 7.86 | 1 | 12.19 | 0% | 0.55 |
| 5/11/2005 | 94343 | 16 | 16.00 | 11.55 | 6.91 | 65.4 | 1.097 | 7.76 | 1 | 14.25 | 0% | 0.00 |
| 5/11/2005 | 94512 | 18 | 18.00 | 10.72 | 5.11 | 47.4 | 1.099 | 7.60 | 4 | 16.25 | 0% | 0.00 |
| 5/11/2005 | 94608 | 20 | 19.97 | 10.61 | 4.49 | 41.5 | 1.100 | 7.53 | 4 | 18.22 | 0% | 0.00 |
| 5/11/2005 | 94648 | 22 | 21.97 | 10.49 | 4.04 | 37.2 | 1.101 | 7.49 | 4 | 20.22 | 0% | 0.00 |
| 5/11/2005 | 94733 | 24 | 23.98 | 10.41 | 3.73 | 34.3 | 1.102 | 7.45 | 5 | 22.23 | 0% | 0.00 |
| 5/11/2005 | 94830 | 26 | 25.98 | 10.24 | 2.72 | 25.0 | 1.103 | 7.38 | 4 | 24.23 | 0% | 0.00 |

Long Lake 2005 Multiparameter data

| Date MMDDYY | Time HHMMSS | Text Depth feet | Dep25 feet | Temp øC | DO mg/l | DO% Sat | SpCond mS/cm | pH Units | PAR æE/s/mý | Depth of Light Meter feet | % Light Transmission | Extinction Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Average | 1.01 |
| 6/15/2005 | 82733 | 0.25 | 0.43 | 24.20 | 6.97 | 86.7 | 1.097 | 7.69 | 623 | Surface | | |
| 6/15/2005 | 82832 | 1 | 0.87 | 24.22 | 6.79 | 84.6 | 1.097 | 7.81 | 553 | Surface | 100% | |
| 6/15/2005 | 82933 | 2 | 2.04 | 24.25 | 6.67 | 83.1 | 1.097 | 7.86 | 172 | 0.29 | 31% | 4.03 |
| 6/15/2005 | 83027 | 3 | 3.07 | 24.24 | 6.68 | 83.2 | 1.097 | 7.89 | 88 | 1.32 | 16% | 0.65 |
| 6/15/2005 | 83131 | 4 | 4.06 | 24.24 | 6.65 | 82.8 | 1.097 | 7.91 | 65 | 2.31 | 12% | 0.31 |
| 6/15/2005 | 83304 | 6 | 5.98 | 24.23 | 6.54 | 81.5 | 1.097 | 7.93 | 20 | 4.23 | 4% | 0.61 |
| 6/15/2005 | 83350 | 8 | 7.95 | 24.24 | 6.56 | 81.7 | 1.097 | 7.93 | 7 | 6.20 | 1.3% | 0.53 |
| 6/15/2005 | 83455 | 10 | 10.06 | 24.19 | 6.39 | 79.5 | 1.097 | 7.93 | 2 | 8.31 | 0% | 0.59 |
| 6/15/2005 | 83557 | 12 | 12.03 | 23.91 | 5.73 | 71.0 | 1.098 | 7.88 | 1 | 10.28 | 0% | 0.35 |
| 6/15/2005 | 83728 | 14 | 14.04 | 19.26 | 0.20 | 2.3 | 1.114 | 7.45 | 0 | 12.29 | 0% | 0.00 |
| 6/15/2005 | 83915 | 16 | 15.99 | 17.49 | 0.11 | 1.3 | 1.118 | 7.27 | 0 | 14.24 | 0% | 0.00 |
| 6/15/2005 | 84018 | 18 | 18.01 | 16.40 | 0.10 | 1.1 | 1.121 | 7.20 | 0 | 16.26 | 0% | 0.00 |
| 6/15/2005 | 84114 | 20 | 20.01 | 15.56 | 0.10 | 1.0 | 1.118 | 7.14 | 0 | 18.26 | 0% | 0.00 |
| 6/15/2005 | 84248 | 22 | 22.09 | 15.13 | 0.10 | 1.0 | 1.122 | 7.05 | 0 | 20.34 | 0% | 0.00 |
| 6/15/2005 | 84344 | 24 | 23.96 | 14.69 | 0.09 | 1.0 | 1.127 | 6.99 | 0 | 22.21 | 0% | 0.00 |
| 6/15/2005 | 84441 | 26 | 25.98 | 14.05 | 0.08 | 0.8 | 1.131 | 6.93 | 0 | 24.23 | 0% | 0.00 |
| 6/15/2005 | 84547 | 28 | 27.95 | 13.67 | 0.08 | 0.8 | 1.138 | 6.86 | 0 | 26.20 | 0% | 0.00 |

Long Lake 2005 Multiparameter data

| Date MMDDYY | Time HHMMSS | Text Depth feet | Dep25 feet | Temp øC | DO mg/l | DO% Sat | SpCond mS/cm | pH Units | PAR æE/s/mý | Depth of Light Meter feet | % Light Transmission | Extinction Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Average | 1.20 |
| 7/13/2005 | 85221 | 0.25 | 0.54 | 25.24 | 7.27 | 91.2 | 1.119 | 7.84 | 613 | Surface | | |
| 7/13/2005 | 85402 | 1 | 1.04 | 25.25 | 7.32 | 91.9 | 1.119 | 7.95 | 572 | Surface | 100% | |
| 7/13/2005 | 85517 | 2 | 2.03 | 25.26 | 7.22 | 90.6 | 1.119 | 7.97 | 130 | 0.28 | 23% | 5.29 |
| 7/13/2005 | 85603 | 3 | 2.95 | 25.25 | 7.27 | 91.3 | 1.118 | 7.99 | 64 | 1.20 | 11% | 0.77 |
| 7/13/2005 | 85727 | 4 | 4.00 | 25.24 | 7.32 | 91.9 | 1.119 | 8.01 | 36 | 2.25 | 6% | 0.55 |
| 7/13/2005 | 85841 | 6 | 6.00 | 25.25 | 7.32 | 91.9 | 1.118 | 8.01 | 14 | 4.25 | 2% | 0.47 |
| 7/13/2005 | 85959 | 8 | 8.12 | 25.23 | 7.40 | 92.9 | 1.119 | 8.02 | 6 | 6.37 | 1.0% | 0.40 |
| 7/13/2005 | 90053 | 10 | 9.86 | 25.21 | 7.04 | 88.4 | 1.119 | 8.01 | 2 | 8.11 | 0% | 0.63 |
| 7/13/2005 | 90226 | 12 | 12.04 | 25.11 | 5.88 | 73.6 | 1.122 | 7.95 | 1 | 10.29 | 0% | 0.32 |
| 7/13/2005 | 90404 | 14 | 14.04 | 23.45 | 0.17 | 2.1 | 1.142 | 7.47 | 3 | 12.29 | 0% | -0.55 |
| 7/13/2005 | 90624 | 16 | 16.04 | 21.79 | 0.11 | 1.4 | 1.146 | 7.19 | 4 | 14.29 | 0% | -0.14 |
| 7/13/2005 | 90744 | 18 | 18.05 | 19.64 | 0.10 | 1.1 | 1.149 | 7.05 | 4 | 16.30 | 0% | 0.00 |
| 7/13/2005 | 90930 | 20 | 19.99 | 17.54 | 0.09 | 1.0 | 1.159 | 6.92 | 4 | 18.24 | 0% | 0.00 |
| 7/13/2005 | 91022 | 22 | 21.94 | 15.40 | 0.09 | 1.0 | 1.168 | 6.79 | 4 | 20.19 | 0% | 0.00 |
| 7/13/2005 | 91111 | 24 | 23.69 | 14.96 | 0.09 | 0.9 | 1.176 | 6.71 | 4 | 21.94 | 0% | 0.00 |
| 7/13/2005 | 91151 | 26 | 26.03 | 14.46 | 0.09 | 0.9 | 1.180 | 6.65 | 4 | 24.28 | 0% | 0.00 |
| 7/13/2005 | 91253 | 28 | 28.04 | 14.11 | 0.08 | 0.8 | 1.190 | 6.53 | 4 | 26.29 | 0% | 0.00 |

Long Lake 2005 Multiparameter data

| Date MMDDYY | Time HHMMSS | Text Depth feet | Dep25 feet | Temp øC | DO mg/l | DO% Sat | SpCond mS/cm | pH Units | PAR æE/s/mý | Depth of Light Meter feet | % Light Transmission | Extinction Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Average | 0.90 |
| 8/10/2005 | 81958 | 0.25 | 0.51 | 28.01 | 9.38 | 123.8 | 1.074 | 9.03 | 3265 | Surface | | |
| 8/10/2005 | 82054 | 1 | 0.94 | 28.01 | 9.34 | 123.2 | 1.073 | 9.04 | 3291 | Surface | 100% | |
| 8/10/2005 | 82147 | 2 | 2.06 | 28.01 | 9.17 | 121.0 | 1.072 | 9.10 | 1101 | 0.31 | 33% | 3.53 |
| 8/10/2005 | 82248 | 3 | 3.01 | 28.01 | 9.04 | 119.2 | 1.072 | 9.16 | 664 | 1.26 | 20% | 0.53 |
| 8/10/2005 | 82354 | 4 | 4.02 | 28.01 | 9.14 | 120.7 | 1.071 | 9.20 | 380 | 2.27 | 12% | 0.55 |
| 8/10/2005 | 82458 | 6 | 6.03 | 28.01 | 9.07 | 119.7 | 1.071 | 9.24 | 149 | 4.28 | 5% | 0.47 |
| 8/10/2005 | 82741 | 8 | 8.02 | 27.05 | 0.98 | 12.7 | 1.087 | 8.40 | 65 | 6.27 | 2% | 0.42 |
| 8/10/2005 | 82907 | 10 | 10.03 | 26.52 | 0.44 | 5.6 | 1.086 | 8.32 | 23 | 8.28 | 0.7% | 0.52 |
| 8/10/2005 | 83006 | 12 | 12.03 | 25.55 | 0.33 | 4.2 | 1.092 | 8.10 | 13 | 10.28 | 0% | 0.29 |
| 8/10/2005 | 83114 | 14 | 13.99 | 25.13 | 0.23 | 2.9 | 1.097 | 7.96 | 8 | 12.24 | 0% | 0.25 |
| 8/10/2005 | 83214 | 16 | 16.01 | 23.61 | 0.18 | 2.2 | 1.108 | 7.70 | 4 | 14.26 | 0% | 0.34 |
| 8/10/2005 | 83329 | 18 | 18.03 | 21.43 | 0.15 | 1.7 | 1.125 | 7.40 | 1 | 16.28 | 0% | 0.69 |
| 8/10/2005 | 83436 | 20 | 20.04 | 18.51 | 0.12 | 1.3 | 1.149 | 7.11 | 0 | 18.29 | 0% | 0.00 |
| 8/10/2005 | 83542 | 22 | 22.04 | 16.83 | 0.11 | 1.2 | 1.169 | 6.91 | 0 | 20.29 | 0% | 0.00 |
| 8/10/2005 | 83653 | 24 | 23.99 | 16.08 | 0.11 | 1.1 | 1.176 | 6.84 | 0 | 22.24 | 0% | 0.00 |
| 8/10/2005 | 83748 | 26 | 26.03 | 15.25 | 0.10 | 1.0 | 1.193 | 6.73 | 0 | 24.28 | 0% | 0.00 |

Long Lake 2005 Multiparameter data

| Date MMDDYY | Time HHMMSS | Text Depth feet | Dep25 feet | Temp øC | DO mg/l | DO% Sat | SpCond mS/cm | pH Units | PAR æE/s/mý | Depth of Light Meter feet | % Light Transmission | Extinction Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Average | 1.16 |
| 9/14/2005 | 83132 | 0.25 | 0.40 | 24.36 | 4.14 | 51.2 | 1.055 | 8.63 | 910 | Surface | | |
| 9/14/2005 | 83251 | 1 | 1.00 | 24.37 | 3.90 | 48.3 | 1.053 | 8.64 | 773 | Surface | 100% | |
| 9/14/2005 | 83346 | 2 | 2.05 | 24.37 | 3.79 | 46.9 | 1.052 | 8.65 | 314 | 0.30 | 41% | 3.00 |
| 9/14/2005 | 83431 | 3 | 2.99 | 24.38 | 3.78 | 46.8 | 1.053 | 8.66 | 111 | 1.24 | 14% | 1.11 |
| 9/14/2005 | 83530 | 4 | 4.00 | 24.37 | 3.70 | 45.8 | 1.053 | 8.68 | 41 | 2.25 | 5% | 0.99 |
| 9/14/2005 | 83644 | 6 | 6.02 | 24.37 | 3.69 | 45.7 | 1.053 | 8.72 | 8 | 4.27 | 1.0% | 0.81 |
| 9/14/2005 | 83758 | 8 | 7.96 | 24.36 | 3.74 | 46.3 | 1.053 | 8.76 | 1 | 6.21 | 0% | 1.07 |
| 9/14/2005 | 84043 | 10 | 9.99 | 24.34 | 4.21 | 52.1 | 1.053 | 8.77 | 1 | 8.24 | 0% | 0.00 |
| 9/14/2005 | 84158 | 12 | 11.98 | 24.27 | 4.29 | 53.0 | 1.053 | 8.78 | 0 | 10.23 | 0% | 0.00 |
| 9/14/2005 | 84318 | 14 | 14.07 | 24.20 | 3.68 | 45.4 | 1.055 | 8.70 | 0 | 12.32 | 0% | 0.00 |
| 9/14/2005 | 84421 | 16 | 15.97 | 23.73 | 0.62 | 7.6 | 1.070 | 7.97 | 1 | 14.22 | 0% | 0.00 |
| 9/14/2005 | 84527 | 18 | 18.04 | 22.75 | 0.45 | 5.4 | 1.087 | 7.62 | 0 | 16.29 | 0% | 0.00 |
| 9/14/2005 | 84622 | 20 | 20.05 | 21.59 | 0.36 | 4.2 | 1.109 | 7.36 | 1 | 18.30 | 0% | 0.00 |
| 9/14/2005 | 84715 | 22 | 22.01 | 20.30 | 0.27 | 3.1 | 1.148 | 7.14 | 0 | 20.26 | 0% | 0.00 |
| 9/14/2005 | 84814 | 24 | 24.05 | 18.04 | 0.25 | 2.7 | 1.223 | 6.86 | 0 | 22.30 | 0% | 0.00 |
| 9/14/2005 | 84922 | 26 | 26.03 | 16.71 | 0.20 | 2.1 | 1.263 | 6.73 | 1 | 24.28 | 0% | 0.00 |

Long Lake 2005 Multiparameter data

| Date MMDDYY | Time HHMMSS | Text Depth feet | Dep25 feet | Temp øC | DO mg/l | DO% Sat | SpCond mS/cm | pH Units | PAR æE/s/mý | Depth of Light Meter feet | % Light Transmission | Extinction Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Average | 2.87 |
| 10/18/2005 | 84242 | 0.25 | 0.28 | 15.16 | 6.98 | 71.9 | 1.065 | 7.97 | 3506 | Surface | | |
| 10/18/2005 | 84404 | 1 | 1.00 | 15.16 | 6.94 | 71.5 | 1.065 | 8.13 | 3646 | Surface | 100% | |
| 10/18/2005 | 84508 | 2 | 1.98 | 15.16 | 6.85 | 70.6 | 1.065 | 8.18 | 123 | 0.23 | 3% | 14.74 |
| 10/18/2005 | 84610 | 3 | 3.01 | 15.16 | 6.81 | 70.2 | 1.066 | 8.22 | 280 | 1.26 | 8% | -0.80 |
| 10/18/2005 | 84716 | 4 | 3.99 | 15.15 | 6.77 | 69.7 | 1.066 | 8.24 | 109 | 2.24 | 3% | 0.96 |
| 10/18/2005 | 84816 | 6 | 6.03 | 15.15 | 6.89 | 71.0 | 1.066 | 8.27 | 24 | 4.28 | 0.7% | 0.74 |
| 10/18/2005 | 84932 | 8 | 8.02 | 15.15 | 6.87 | 70.7 | 1.066 | 8.29 | 4 | 6.27 | 0% | 0.90 |
| 10/18/2005 | 85040 | 10 | 10.06 | 15.14 | 6.81 | 70.1 | 1.066 | 8.31 | 1 | 8.31 | 0% | 0.68 |
| 10/18/2005 | 85136 | 12 | 12.01 | 15.15 | 6.82 | 70.3 | 1.066 | 8.33 | 0 | 10.26 | 0% | 0.00 |
| 10/18/2005 | 85319 | 14 | 14.02 | 15.14 | 6.82 | 70.2 | 1.067 | 8.34 | 0 | 12.27 | 0% | 0.00 |
| 10/18/2005 | 85456 | 16 | 16.00 | 15.13 | 6.92 | 71.2 | 1.066 | 8.35 | 1 | 14.25 | 0% | 0.00 |
| 10/18/2005 | 85602 | 18 | 18.03 | 15.12 | 6.90 | 71.0 | 1.066 | 8.36 | 0 | 16.28 | 0% | 0.00 |
| 10/18/2005 | 85720 | 20 | 20.04 | 15.11 | 6.74 | 69.3 | 1.066 | 8.37 | 1 | 18.29 | 0% | 0.00 |
| 10/18/2005 | 85826 | 22 | 22.02 | 15.08 | 6.85 | 70.4 | 1.066 | 8.39 | 1 | 20.27 | 0% | 0.00 |
| 10/18/2005 | 85932 | 24 | 24.04 | 15.06 | 6.82 | 70.1 | 1.066 | 8.41 | 0 | 22.29 | 0% | 0.00 |
| 10/18/2005 | 90031 | 26 | 25.99 | 15.01 | 6.52 | 67.0 | 1.067 | 8.37 | 0 | 24.24 | 0% | 0.00 |

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

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

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

**Temperature and Dissolved Oxygen:**

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

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

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

**Nutrients:**

*Phosphorus:*

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

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

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

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

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

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

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

**Solids:**

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

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

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

**Water Clarity:**

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

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

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

**Alkalinity, Conductivity, Chloride, pH:**

*Alkalinity:*

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

*Conductivity and Chloride:*

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

*pH:*

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

**Eutrophication and Trophic State Index:**

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

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

**Table 1. Trophic State Index (TSI).**

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

# APPENDIX D.  LAKE MANAGEMENT OPTIONS.

## *D1. Option for Creating a Bathymetric Map*

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Maps can be created by the Lake County Health Department - Lakes Management Unit (LMU). LMU recently purchased a BioSonics DT-X™ Echosounder. With this equipment the creation of an accurate bathymetric map of almost any size lake in the county is possible. Costs vary, but can range from $2,000-5,000 depending on lake size.

## *D2. Options for 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.

## *D3. Options for Watershed Nutrient Reduction*

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

**Option 1. Buffer Strips**

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

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

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

**b**. Avoid dumping yard waste along or into a ditch, pond, lake, or stream. As yard waste decomposes, the nutrients are released directly into the water, or flushed to the lake via the ditch.
**c**. Avoid applying fertilizer up to the water's edge. Leave a buffer strip of at least 25 feet of unfertilized yard before the shoreline.
**d**. Avoid applying fertilizers when heavy rains are expected, or over-watering the ground after applying fertilizer.
**e**. When landscaping, keep site disturbance to a minimum, especially the removal of vegetation and exposure of bare soil. Exposed soil can easily erode.
**f**. When landscaping, seed or plant exposed soil and cover it with mulch as soon as possible to minimize erosion and runoff.
**g**. Use lawn and garden chemicals sparingly, or do not use them at all.

**Option 3. Street Sweeping**

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

**Option 4: Reduce Stormwater Volume from Impervious Surfaces**

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

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

**Option 5: Required Practices for Construction**

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

**Option 6.  Organize a Local Watershed Organization**

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

**Option 7.  Discourage Waterfowl from Congregating**

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

## *D4.  Options for Large Scale Sediment and Nutrient Controls*

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

**Option 1.  Detention Basins**

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

**Option 2.  Catch Basins**

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

**Option 3.  Constructed Wetlands**

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

**Option 4.  Vegetated Swales**

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

**Option 5.  Infiltration Devices**

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

**Option 6.  Settling Basins**

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

## *D5. Options for Aquatic Plant Management*

**Option 1: Aquatic Herbicides**

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

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

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

**Option 2: Mechanical Harvesting**

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

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

**Option 3: Hand Removal**

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

**Option 4: Water Milfoil Weevil**

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

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

**Option 5: Reestablishing Native Aquatic Vegetation**

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

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

## *D6. Options to Eliminate or Control Exotic Species*

**Option 1: Biological Control**

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

**Option 2: Control by Hand**

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

**Option 3: Herbicide Treatment**

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

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

## *D7. Options to Enhance Wildlife Habitat Conditions on a Lake*

**Option 1: Increase Habitat Cover**

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

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

**Option 2: Increase Natural Food Supply**

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

**Option 3: Limit Disturbance**

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

## *D8. Options for Lakes with High Canada Geese Populations*

**Option 1: Removal**

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

**Option 2: Dispersal/Repellent Techniques**

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

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

**Option 3: Exclusion**

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

**Option 4: Habitat Alteration**

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

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

**Option 5: Do Not Feed Waterfowl!**

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

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

# 2000 - 2005 Water Quality Parameters, Statistics Summary

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

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

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

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

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

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

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

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

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

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

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

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

LCHD Lakes Management Unit ~ 12/8/2005

# 2000 - 2005 Water Quality Parameters, Statistics Summary continued

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

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

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

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

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

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

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

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

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

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

No 2002 IEPA Chain Lakes

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

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

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

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

LakeCounty
Health Department and
Community Health Center

# APPENDIX F.  GRANT PROGRAM OPPORTUNITES.

## Table F1. A list of potential grant opportunities

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

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

## Table F2. Grant Contacts

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**Other Related Contacts**

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

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

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

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

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