LAKE COUNTY, IL

2015 LAKE LOUISE SUMMARY REPORT

LAKE COUNTY HEALTH DEPARTMENT

POPULATION HEALTH –ECOLOGICAL SERVICES

Lake Louise, 2015

Lake Louise is a private lake in the Village of Barrington. It is part of the Flint Creek drainage of the Fox River watershed. Lake Louise encompasses approximately 39.2 acres and has a shoreline length of 2.24 miles. The main management entity of Lake Louise is the Fox Point Homeowners Association (FPHA) who also owns lake bottom. Residents use Lake Louise for fishing and non motorized boating.

In 2015, the Lake County Health Department– Ecological Services (LCHD-ES) monitored Lake Louise. Water samples were collected once a month from May through September at two locations. Sample locations were near the center of the lake near the Flint Creek inlet taken at a depth of 3 feet below the surface and at the outlet near the spillway taken at the surface (Appendix A). Since Lake Louise is a shallow lake that does not thermally stratify, samples were only taken at one depth in the lake. Samples were analyzed for nutrients, solid concentrations and other physical parameters. Additionally, an aquatic plant survey was conducted in July (2015) and a shoreline assessment surveyed in October (2015). This report summarizes the water quality sampling results, aquatic plant survey, and shoreline survey conducted on Lake Louise by the LCHD-ES.

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LAKE FACTS

MAJOR WATERSHED:
FOX RIVER

SUB-WATERSHED:
FLINT CREEK

SURFACE AREA:
39.2 ACRES

SHORELINE LENGTH:
2.24 MILES

MAXIMUM DEPTH:
9 FEET

AVERAGE DEPTH:
4.6 FEET

LAKE VOLUME:
157.2 ACRE-FEET

WATERSHED AREA:
446.0 ACRES

LAKE TYPE:
IMPOUNDMENT

CURRENT USES:
SWIMMING, FISHING, NON-MOTORIZED BOATING

ACCESS:
NO PUBLIC ACCESS

LAKE LOUISE SUMMARY

Following are highlights of the water quality sampling, shoreline survey and aquatic macrophyte surveys from the 2015 monitoring season. Historically, Lake Louise has had a variety of lake quality issues dating back to the late 1950s. These problems include or have included excessive aquatic plants, unhealthy fishery, abundance of carp and geese, severe algal blooms and nutrient enrichment. Many water quality parameters remain above the Lake County median. The complete data sets for water quality, aquatic plant sampling, and shoreline surveys conducted on Lake Louise can be found in Appendix A and B of this report, and discussed in further detail in the following sections.

- Average water clarity was 1.04 ft., which is a 38% decrease since 2008, and 65% below the Lake County median Secchi depth of 2.96 ft.
- Water clarity is influenced by amount of particles in the water column; this is measured by total suspended solids. The average TSS concentrations on Lake Louise was 36.9 mg/L in 2015, which is significantly greater than the Lake County median of 8.2 mg/L. TSS concentrations increased by 58% since 2008.
- Nutrient availability indicated that the average TN:TP ratio was 14:1 meaning that Lake Louise had adequate amounts of both nitrogen and phosphorus to support algal blooms. Most of the lakes in Lake County tend to be phosphorus limited, meaning addition of phosphorus to the lake ecosystem can affect change in the lake, such as increased algal populations.
- The 2015 average total phosphorus concentration was 0.181 mg/L, which exceeds the Illinois Environmental Protection Agency (IEPA) water quality standard of 0.050 mg/L. Lake Louise is impaired for phosphorus
- In addition to having a phosphorus impairment, there was an increase by 16% in total phosphorus levels since the 2008 sampling.
- Trophic State index (TSIp) for Lake Louise was 79; meaning Lake Louise is considered hypereutrophic.
- Dissolved oxygen (DO) concentrations remained above 5 mg/L in the water column from surface to lake bottom, except in July when it dropped below 5 mg/L at depths greater than 6ft. When dissolved oxygen drops below 5 mg/L, aquatic life can become stressed.
- Dissolved oxygen concentrations never reached anoxic conditions (<1 mg/L) in the lake.
- The aquatic macrophyte survey showed that only 6.5% of all sampling sites had plant coverage.
- A total of 2 plant species were present which were: Giant Duckweed and Sago Pondweed.
- Lake Louise had 14% of its shoreline eroding with 12% classified as slight erosion and 2% as moderate erosion.
- Although minimal shoreline erosion was occurring, 76% of Lake Louise's lakeshore buffer condition was classified as poor based on the 2015 shoreline condition survey.

Lake Louise is in the Flint Creek watershed, which is part of the Fox River Watershed.

LAKES SAMPLED IN 2015

Echo Lake
Lake Zurich
Lake Barrington
Honey Lake
Lake Antioch
Little Silver Lake
Lake Tranquility
Cross Lake
Lake Minear
Lake Louise
St. Mary's Lake
Loch Lomond Lake
Butler Lake

WATERSHED & LANDUSE

A watershed is an area of land where all surface water from rain, melting snow and ice, converge at a lower elevation, usually a lake, river, or other body of water. The source of a lake's water supply is very important in determining its water quality and choosing management practices to protect the lake. Lake Louise is in the Flint Creek watershed and it's lakeshed is 446 acres (Figure 1). The size of the watershed feeding the lake relative to the size of the lake is also an important factor in determining the amount of pollutants in the lake. The watershed to lake surface area ratio is 11:1 and has a calculated retention time of 111 days. Retention time is the amount of time it takes for water entering the lake to flow out of it. The relatively small watershed for Lake Louise may make it easier to pinpoint where improvements need to be made in the watershed, but the longer retention means it takes longer to flush out the water.

Land use plays a significant role on water quality of a lake. Based on the 2010 land use data the current external sources affecting Lake Louise were from the following land uses: single family residential (67.5%), transportation (14%) and water (12%) (Figure 2, page 4). As areas become more developed, that typically means an increase in impervious cover; reducing the amount of open space for infiltrating and storing precipitation. Based on the amount of impervious surfaces each land use contributes varied amounts of runoff. Impervious surfaces (parking lots, roads, buildings, compacted soil) impact water quality in lakes by increasing pollutant loads and water temperature. During storm events, pollutants such as excess nutrients (nitrogen and phosphorus), metals, oil and grease, and bacteria are easily transferred from impervious surfaces to rivers, wetlands, and lakes. Impervious surfaces can also increase stormwater runoff temperature—and many aquatic fauna are sensitive to water temperature fluctuations.

Figure 1: Lake Louise Watershed Delineation

Everyone lives in a watershed! A watershed is an area of land where surface water from rain and melting snow meet at a point, such as a lake or stream.

As a watershed is developed, the amount of impervious surface increases resulting in a greater influx of runoff entering our waters due to reduced infiltration of rainwater into the ground.

WATERSHED & LANDUSE (CONT.)

Lake Louise receives the majority of it's water from singe family residential areas with approximately 57% of runoff attributed to "single family" landuse (Table 1). Lakes that receive a significant amount of stormwater runoff can have variable water quality that is heavily influenced by human activity.

Figure 2: Lake Louise Landuse

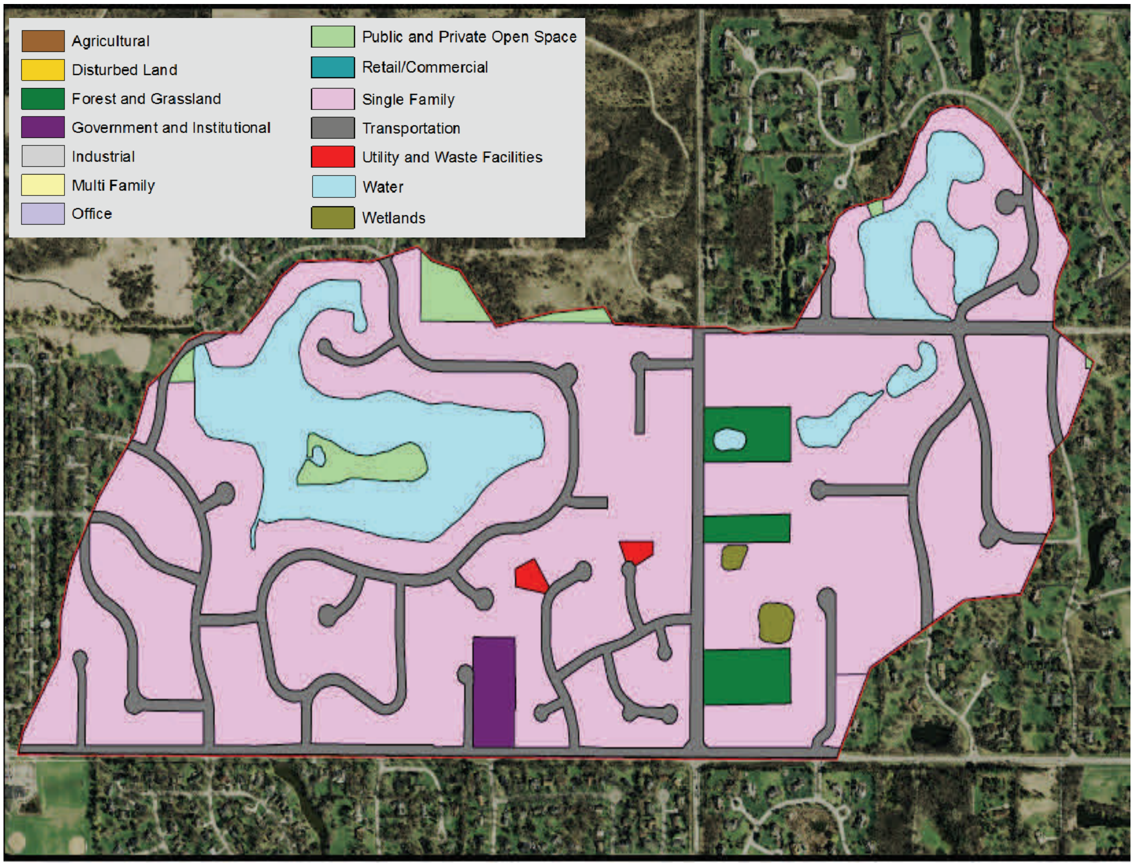


Table 1: Runoff Percentages by Landuse in the Lake Louise Watershed

Land Use	Acreage	% of Total	% Total of Estimated Runoff
Forest and Grassland	2.53	0.6%	0.1%
Government and Institutional	4.68	1.0%	7.5%
Public and Private Open Space	17.54	3.9%	1.7%
Single Family	301.20	67.5%	57.2%
Transportation	62.39	14.0%	33.6%
Water	56.36	12.6%	0.0%
Wetlands	1.27	0.3%	0.0%
Total Acres	**445.98**	**100.0%**	100.0%

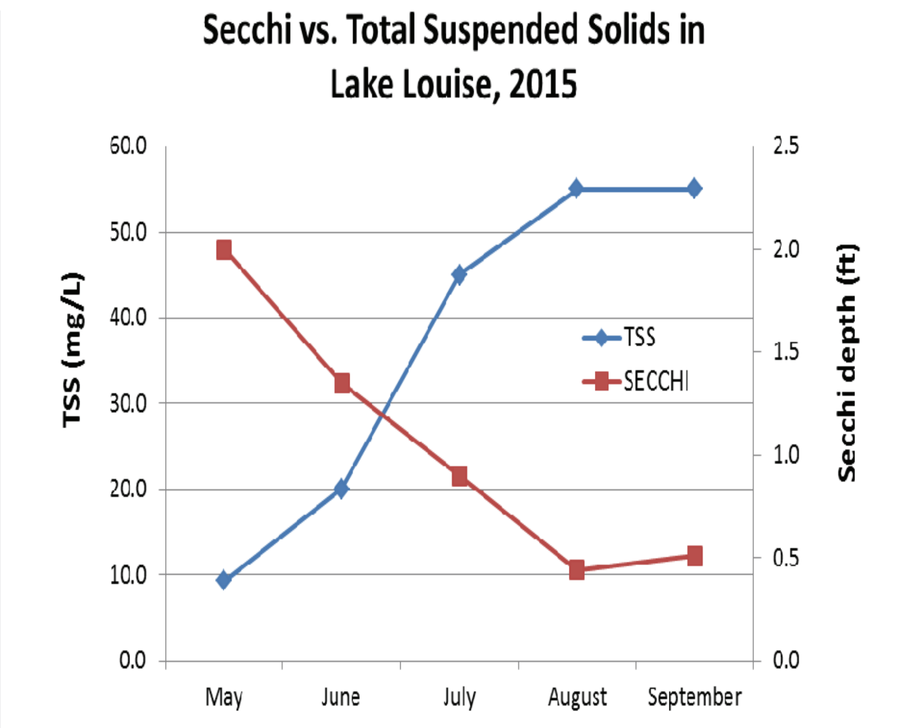
WATER CLARITY

Water clarity, or water transparency, is an indicator of water quality related to chemical and physical properties. Water clarity is typically measured with a Secchi disk and indicates the amount of light penetration into a body of water. It can also provide an indirect measurement of the amount of suspended material in water. A number of factors can interfere with light penetration and reduce water transparency. This includes: algae, water color, re-suspended bottom sediments, eroded soil and invasive species. Boat propellers can also impact water clarity by redistributing loose bottom sediment and creating more turbid waters.

Secchi disk depth is primarily used as an indicator of algal abundance and general lake productivity. Although it is only an indicator, Secchi disk depth is the simplest and one of the most effective tools for estimating a lake's productivity.

The 2015 average water clarity in Lake Louise was 1.04 ft., a 38% decrease in water clarity from 2008 sampling where the Secchi depth was only 1.68 ft. Compared to other lakes in Lake County, Lake Louise remains below the median Lake County Secchi depth of 2.96 ft. The overall decrease in water clarity since 2008 correlates with a decrease in water quality. Secchi depth and total suspended solids are inversely related. As total suspended solids increase, there is a decrease in Secchi depth, and vice versa. Figure 3 depicts this inverse relationship between TSS and Secchi in Lake Louise during the 2015 monitoring season. Carp most likely play a big role in decreasing water clarity in Lake Louise, and they can resuspend bottom sediments, reducing clarity. Also, algae blooms which were apparent on Lake Louise in 2015 also reduce water clarity.

Figure 3: Secchi and Total Suspended Solids Data for Lake Louise



LAKE LOUISE AVERAGE DEPTH WAS 1.68 FT.; WHICH IS BELOW THE LAKE COUNTY MEDIAN.

WHAT YOU CAN DO TO IMPROVE WATER QUALITY ON LAKE LOUISE

- Do not throw leaves, grass clippings, pet waste, and other organic debris into the street or driveway. Runoff carries these through storm sewers, directly into Lake Louise.
- Build a rain garden to filter run-off from roofs, driveways, and streets. This allows the phosphorus to be bound to the soil so it does not reach surface waters.
- Plant a buffer around your lake shoreline to reduce runoff and filter nutrients from entering your lake.
- Sweep up fertilizer that is spilled or inadvertently applied to hard surface areas, do not hose it away.

VOLUNTEER LAKE MONITORING PROGRAM (VLMP)

The VLMP was established in 1981 by the Illinois Environmental Protection Agency (IEPA) to be able to collect information on Illinois inland lakes, and to provide an educational program for citizens. The volunteers are primarily lakeshore residents, lake owners/managers, members of environmental groups, and citizens with interest in a particular lake.

The VLMP relies on volunteers to gather information on their chosen lake. The primary measurement by volunteers is Secchi depth (water clarity). Water clarity can provide an indication of the general water quality of the lake. Other observations such as water color, suspended algae and sediment, aquatic plants and odor are also recorded. The sampling season is May through October with measurements taken twice a month.

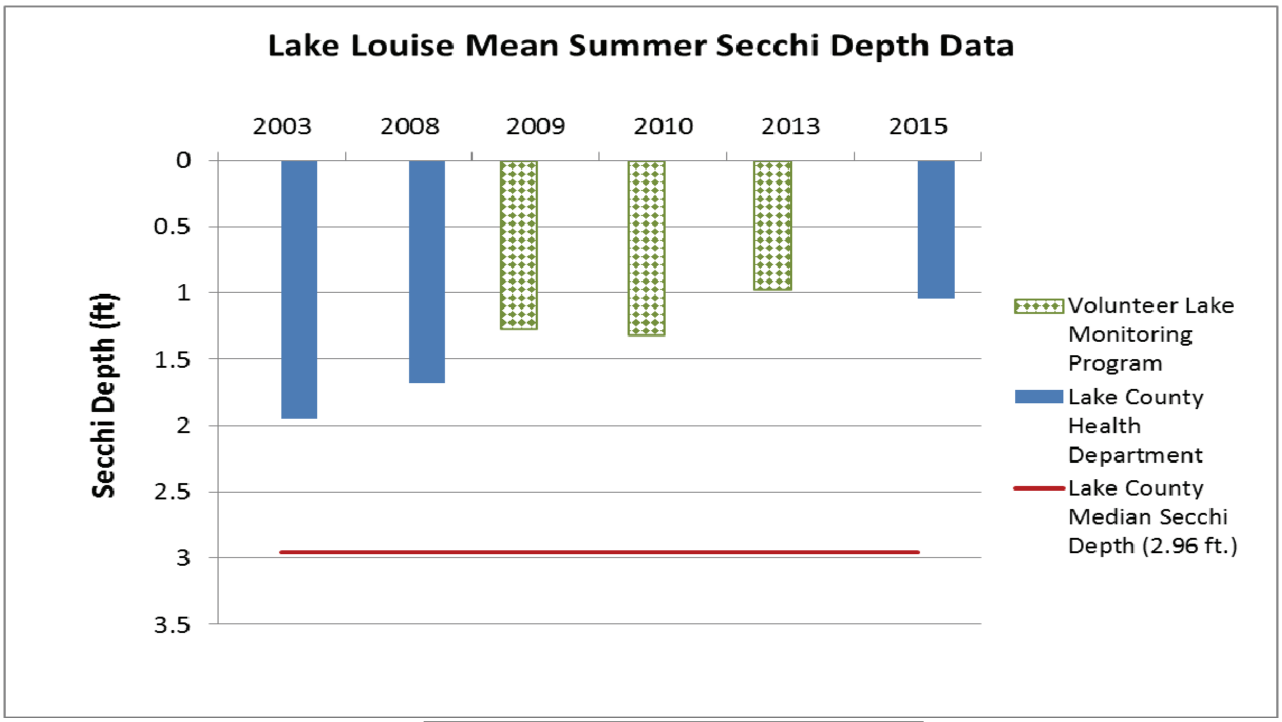
Lake Louise has participated as a VLMP in 2009, 2010, 2013, and 2015. Participating provides annual data that helps document water quality impacts and support lake management decisions. Lake Barrington is fortunate to have a long VLMP record and it is recommend to continue participating in this program for this valuable data (Figure 4).

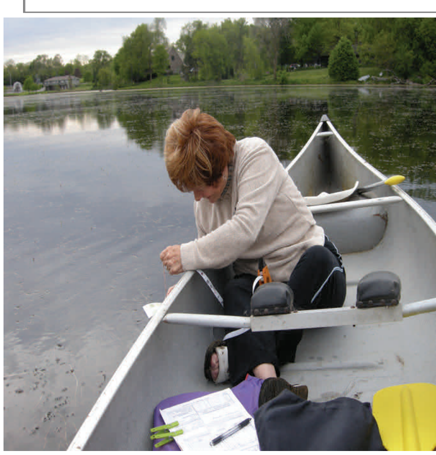
LAKE MONITORING VOLUNTEER PROGRAM ILLINOIS

For more information visit:

www.epa.state.il.us/water/vlmp/index.html

Figure 4: Volunteer Lake Monitoring Program Data





FOR MORE INFORMATION ON THE VLMP PROGRAM.

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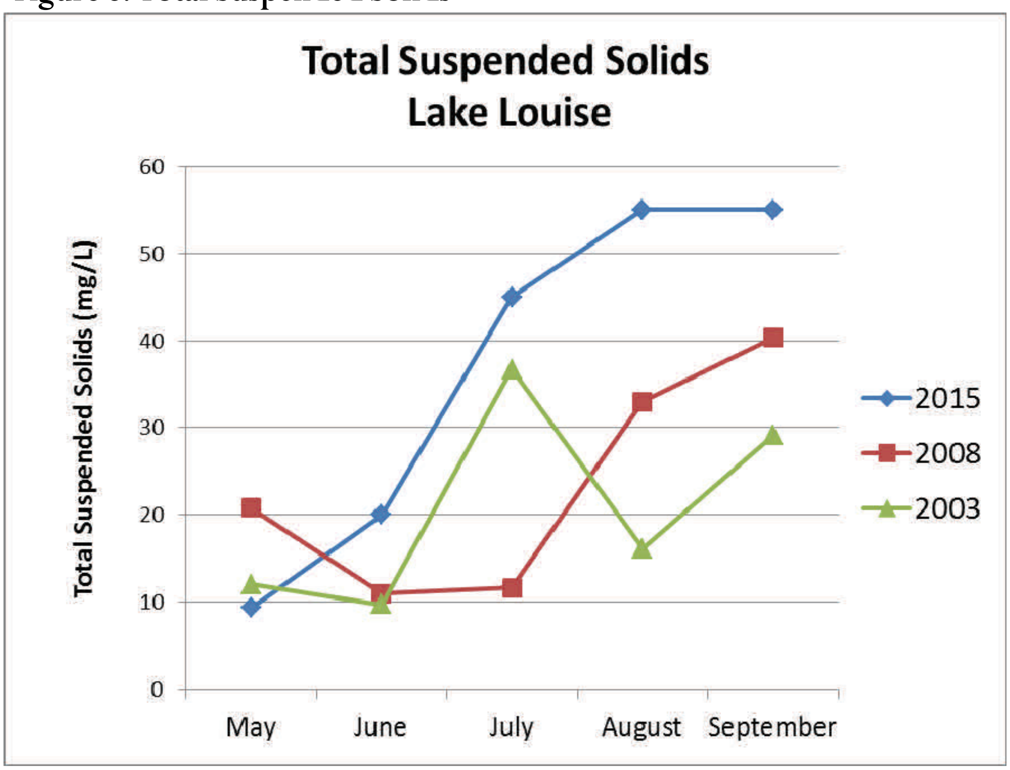
TOTAL SUSPENDED SOLIDS

Another measure of water clarity is turbidity and total suspended solids. Suspended particles dissipate light, which affects the depth at which plants can grow. The total suspended solid (TSS) parameter represents the concentration of all organic and inorganic materials suspended in the lake's water column. Typical inorganic components of TSS are referred to as non-volatile suspended solids (NVSS). NVSS originate from weathering and erosion of rocks and soils in the lake's watershed and re-suspension of lake sediments. The organic portion of TSS are called volatile suspended solids (TVS). TVS is mostly composed of algae and other organic matter such as decaying plant and animal matter.

2015 TSS concentrations in Lake Louise averaged 36.9 mg/L. 2015 concentrations were an increase of 58% in TSS since the 2008 sampling (23.3 mg/L). The 2015 TSS also remains significantly above the Lake County median TSS concentration of 8.2 mg/L. TSS ranged from 9.3 mg/L (May) to 55 mg/L (August, September) as seen in Figure 5. High TSS values are typically correlated with poor water clarity (Secchi disk depth) and can be detrimental to many aspects of lake ecosystem including the plant and fish communities. The carp population in Lake Louise contributes to high total suspended solid concentrations, as they resuspend bottom sediments. There was approximately 0.34 inches of rain within the previous 48 hours of the August sampling which may have played a role in the high August TSS. Algae blooms noted in September can also contribute to these higher concentrations.

A lake can have a TSS impairment which is based on if the median surface NVSS is greater or equal to 12 mg/L for the monitoring season. Based on the 2015 sampling data, Lake Louise is impaired for TSS with a median surface NVSS of 27 mg/L.

Figure 5: Total Suspended Solids



TSS

Total Suspended Solids

TSS are particles of algae or sediment suspended in the water column.

TVS

Total Volatile Solids

TVS represents the fraction of total solids that are organic in nature, such as algae cells.

NVSS

Non-Volatile Suspended Solids

NVSS represents the non-organic clay and sediments that are suspended in the water column.

TDS

Total Dissolved Solids

TDS are the amount of dissolved substance such as salts or minerals in the water after evaporation.

TOTAL SUSPENDED SOLIDS (CONTINUED)

The percentage of TSS that are non-volatile suspended solids gives insight into the source of the suspended solids. Lakes that have a higher percentage of NVSS to TSS represent more allochthonous (originating outside of the lake) input or re-suspended sediment (Jones and Knowlton, 2005). Another way to describe it is lakes with a higher ratio of NVSS to TSS indicate that the suspended solids represent more inorganic material whereas lakes with lower % NVSS may represent more algae and organic material. The calculated average nonvolatile suspended solids (NVSS) was 27.4 mg/L. Approximately 75 % of the total suspended solids concentration in in 2015 can be attributed to organic clay and sediments suspended in the water column. The increase in turbidity could have been caused by heavy rainfall events washing in sediments that became suspended in the water column. Lake Louise is a shallow lake and carp, wave, and wind action also resuspended the bottom sediments.

The algae and organic matter in the water column was higher in August. The average TVS for the monitoring season was 131.2 mg/L which is slightly above the county median of 121.0 mg/L. Algae blooms were noted in August and September.

There was a decrease in TSS in Lake Louise from 2008 to 2015. This correlated with an increase in water clarity and decrease in phosphorus concentrations from 2008 to 2015.

Table 2. 2015 Solid concentrations in Lake Louise 2015

Month	TSS (mg/L)	TS (mg/L)	TVS (mg/L)
May	9.3	610	99
June	20	559	136
July	45	557	135
August	55	543	139
September	55	559	147
Average	*36.9*	*566*	*131*

NUTRIENTS: PHOSPHORUS

Organisms take nutrients in from their environment. In a lake, the primary nutrients needed for aquatic plant and algal growth are phosphorus (P) and nitrogen (N). Phosphorus is a vital nutrient for converting sunlight into usable energy and essential for cellular growth and reproduction. Phosphorus occurs in dissolved organic and inorganic forms or attached to sediment particles. Phosphates, the inorganic form, are preferred for plant growth but other forms can be used. Phosphorus builds up in the bottom sediments of a lake.

The source of phosphorus to a lake can be external, internal, or both. Phosphorus originates from a variety of external sources, many of which are related to human activities including: human and animal waste, soil erosion, detergents, sewage treatment plants, septic systems, and runoff from lawn. Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. When it remains in the sediments it is generally not available for use by algae, however, various chemical and biological processes can allow phosphorus to be released from the sediment and be available in the water column. Carp spawning and feeding activity can release phosphorus by stirring up the bottom sediment and can add phosphorus through their fecal matter. This likely plays a significant role on Lake Louise due to the high carp population. Sediment resuspension and subsequent phosphorus release can occur through wind/wave action or heavy boat traffic. Lakes that experience anoxic conditions also contribute to the release of P from the bottom sediments.

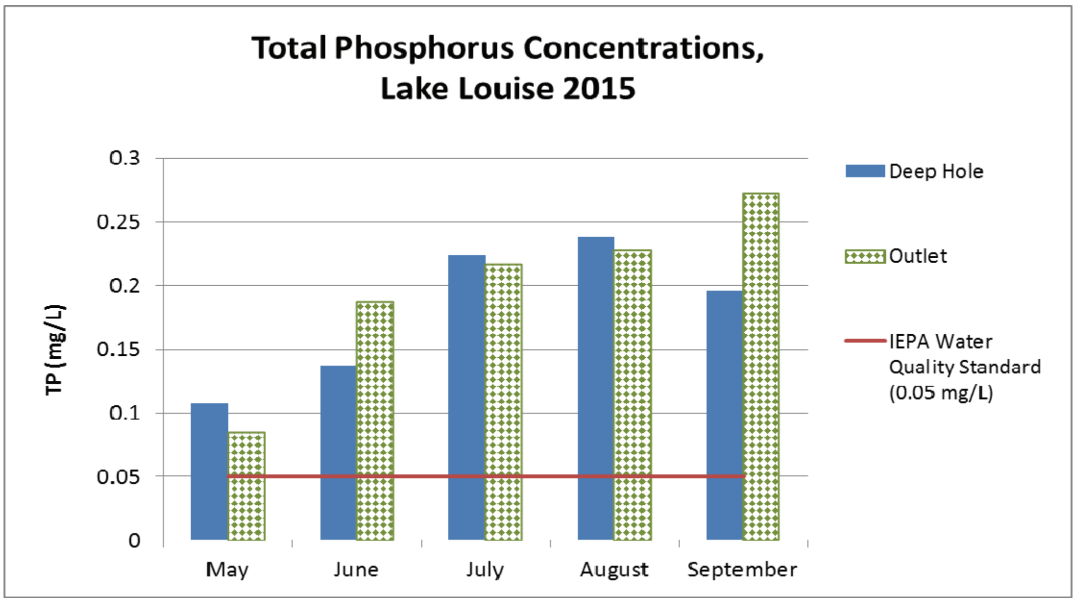
2015 total phosphorus concentrations in Lake Louise averaged 0.181 mg/L. Average TP values are above the Lake County median (0.068 mg/L) and there was an increase in P concentrations since 2008 — from 0.156 mg/L (2008) to 0.181 mg/L in 2015 (Figure 4). Phosphorus attaches to sediment as it moves across the landscape and water, and the high TSS values seen in Lake Louise are likely correlated with the high TP concentrations.

NUTRIENTS: PHOSPHORUS (CONT.)

Surface total phosphorus exceeded 0.05 mg/L on Lake Louise, which is the IEPA water quality standard. Lake Louise exceeded the 0.05 mg/L value May—September. Lakes with concentrations exceeding 0.050 mg/L may support high densities of algae and aquatic plants, which can reduce water clarity and dissolved oxygen and are considered impaired for phosphorus and are considered impaired.

Algal blooms were prevalent on Lake Louise in 2015 and were noted in August and September. Carp may play a role in increased phosphorus concentrations as they stir up bottom sediment, releasing phosphorus into the water column. In addition, Lake Louise is shallow in nature so it is more susceptible to wind and wave action (Figure 7). Soluble Reactive Phosphorus (SRP) was detected each month and that is related to the algae blooms observed on Lake Louise.

Figure 6: Total Phosphorus Concentrations at Two Sampling Sites in Lake Louise



WHAT HAS BEEN DONE TO REDUCE PHOSPHORUS LEVELS IN ILLINOIS?

2009- The Village of Barrington passed a resolution supporting the use of phosphorus-free fertilizers and detergents in the village of Barrington.

July 2010—The state of Illinois passed a law to reduce the amount of phosphorus content in dishwashing and laundry detergent

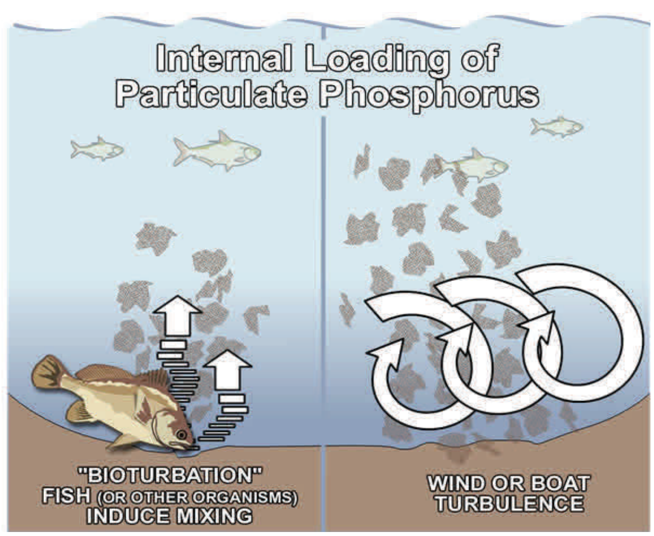
July 2010: The state of Illinois passed another law restricting the use of lawn fertilizers containing phosphorus by commercial applicators.

Table 3: TP Concentrations in Lake Louise, 2015

Month	Epiliminion TP (mg/L)	Epiliminion SRP (mg/L)
May	0.108	0.029
June	0.137	0.041
July	0.224	0.045
August	0.238	0.043
September	0.196	<0.005
Average	0.181	.03k

K= value is less than reported due to concentrations below the detection limit

Figure 7: Internal TP Loading Graphic

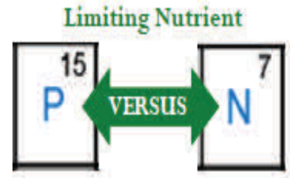


NUTRIENTS: NITROGEN

Nitrogen, in the forms of nitrate (NO_3^-), nitrite (NO_2^-), or ammonium (NH_4^+) is a nutrient needed for plant and algal growth. Nitrogen enters the ecosystem in a several chemical forms and a lake's nitrogen source can vary widely. Sources of nitrogen include septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, and sanitary landfills, and atmospheric deposition. All inorganic forms of nitrogen (NO3-, NO2-, and NH4+) can be used by aquatic plants and algae. If these inorganic forms exceed 0.3 mg/L, there is sufficient nitrogen to support summer algae blooms. If the surface median total nitrogen as N (TKN + NO2/NO3-N) exceeds 3.6 mg/L for the monitoring season, there is a nitrogen impairment for the water body.

Nitrogen concentrations (NO3-N and NH3-N) were below detectable concentrations for most months during the study except for May, where nitrate was 0.332 mg/L and ammonia was 0.38 mg/L. There were no nitrogen impairments for Lake Louise. Total Kjeldahl nitrogen (TKN), an organically (algae) associated form of nitrogen, in Lake Louise averaged 2.50 mg/L, which was greater than the Lake County median of 1.170 mg/L. Total Kjeldahl nitrogen is a measure of organic nitrogen, and is typically bound up in algal and plant cells.

The TN:TP ratio looks at TKN + NO3 to total phosphorus. This ratio can indicate whether plant and algae growth in a lake is limited by nitrogen of phosphorus. Typically ratios of less than 10:1 suggest the lake is limited by nitrogen, while ratios greater than 20:1 are limited by phosphorus. Lake Louise has a TN:TP ratio of 14:1, meaning the lake is impacted by both nutrients. There is adequate concentrations of both nutrients to support algal blooms in Lake Louise.



TN:TP Ratio

<10:1 = nitrogen limited

>20:1= phosphorus limited

TN:TP Ratio on Lake Louise:

14:1

Lake Louise is both phosphorus and nitrogen limited

WAYS TO REDUCE NUTRIENTS IN YOUR LAKE

Phosphorus and nitrogen originate from a variety of sources, many of which are related to human activities. Some sources include: human and animal waste, soil erosion, detergents, septic systems, common carp, and runoff from lawns and fields, fertilizers, manure and atmospheric deposition. Installing best management practices, such as buffer strips, planting more native plants, rain gardens, and using minimal amount of fertilizer are ways to help reduce nutrient runoff from your own property. Below are some suggestions to reduce nutrients to your lake:

Waterfowl management (ducks and geese)

- Do not feed or encourage others to feed waterfowl.
- Use good landscaping practices to discourage waterfowl. Landscapes with taller plants and shrubbery can discourage geese.

Fertilizer use:

- If you apply fertilizers to lawns and gardens, have your soil tested to determine how much fertilizer to apply.
- Check the weather before applying fertilizer—avoid applying before heavy rainfalls.
- Sweep up any fertilizer which is spilled on impervious surfaces such as walks and driveways.
- Do not spread fertilizer within 75 feet of surface waters or wetlands

Pet Waste Disposal

- Regularly scoop up and dispose of pest waste.

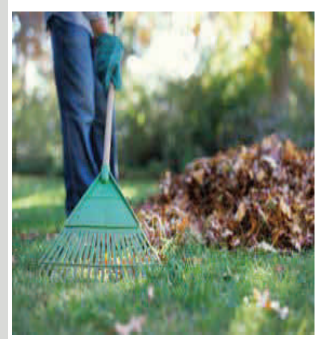
Landscaping Practices

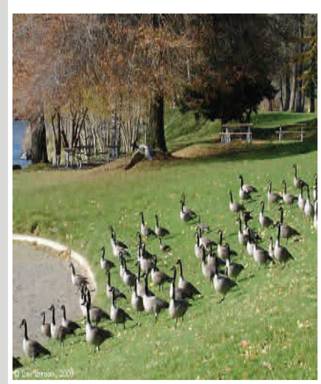
- Consider native vegetation as a quality alternative to lawns. Native vegetation provides a more diverse plant community, and can filter out nutrients and also provides habitat for important pollinators.
- Plant a buffer strip of native plants (at least 20 feet) between the lake's edge and your property.

Keep fall leaves out of the storm drains

- Never rake leaves into or near storm drains, ditches, creeks, or on lakeshore.

Regularly inspect septic systems





TROPHIC STATE INDEX

Trophic state describes the overall productivity of a lake, which has implications for the biological, chemical and physical conditions of the lake. The Trophic State Index (TSI) value is based on phosphorus (TSIp) and Secchi (TSIsd) and are calculated from the monitoring data. Lakes are classified into four main categories of trophic states that reflect nutrient levels and productivity. The four categories are: oligotrophic, mesotrophic, eutrophic, and hypereutrophic. These range from nutrient poor and least productive (oligotrophic) to most nutrient rich and most productive (eutrophic).

A lake's response to additional phosphorus is an accelerated rate of eutrophication. Eutrophication is a natural process where lakes become increasingly enriched with nutrients. Lakes start out with clear water and few aquatic plants and over time become more enriched with nutrients and vegetation until the lake becomes a wetland. This process takes thousands of years. However, human activities that supply lakes with additional phosphorus and nitrogen (such as fertilizer, household products, waste by-products, etc.) are accelerating the eutrophication process.

In 2015, Lake Louise was considered eutrophic with a TSIp value of 79 and on the verge of hyper-eutrophic. Based on the TSIp, Lake Louise ranked 145 out of 173 lakes studied by the LCHD-ES from 2000 –2015.

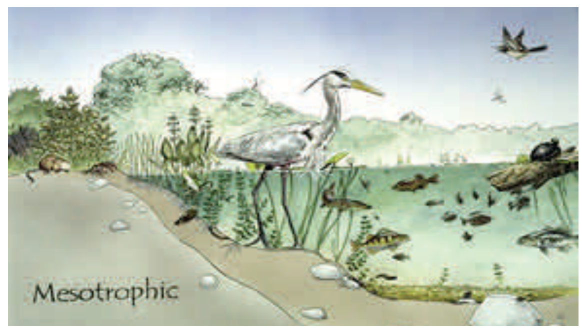
LAKE COUNTY AVERAGE TSIP = 67.3

LAKE LOUISE TSIP = 79.0

TROPHIC STATE: EUTROPHIC

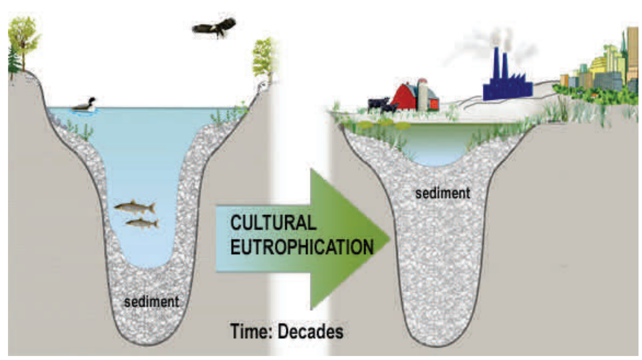
RANK = 145/173

OLIGOTROPHIC
Lakes have low nutrients and are generally deep and free of weeds or large algae blooms. They do not support large fish populations.



MESOTROPHIC
Lakes have medium nutrients and intermediate level of productivity. Mesotrophic lakes typically have clear water with beds of submerged aquatic plants. Mesotrophic lakes can have a diverse fish population.

EUTROPHIC
Lakes are high in nutrients, and are usually weedy or subject to frequent algae blooms. Eutrophic lakes often support large fish populations but are also susceptible to oxygen depletion. Increased sedimentation also is typical of eutrophic lakes



CULTURAL EUTROPHICATION
An enrichment and accumulation of a lake with nutrients, sediments, and organic matter from the surrounding watershed. It can be a natural process in lakes, occurring as they age through geologic time. Human activity that occurs in the watershed can accelerate eutrophication, known as cultural eutrophication and can lead to increased algal growth, increased rooted plant growth, and lower dissolved oxygen concentrations.

STRATIFICATION

A lake's water quality and ability to support fish are affected by the extent to which the water mixes. The depth, size, and shape of a lake are the most important factors influencing mixing, but climate, lakeshore topography, inflow from streams and vegetation also play a role. Variations in density caused by different temperatures can prevent warm and cold water from mixing, called stratification.

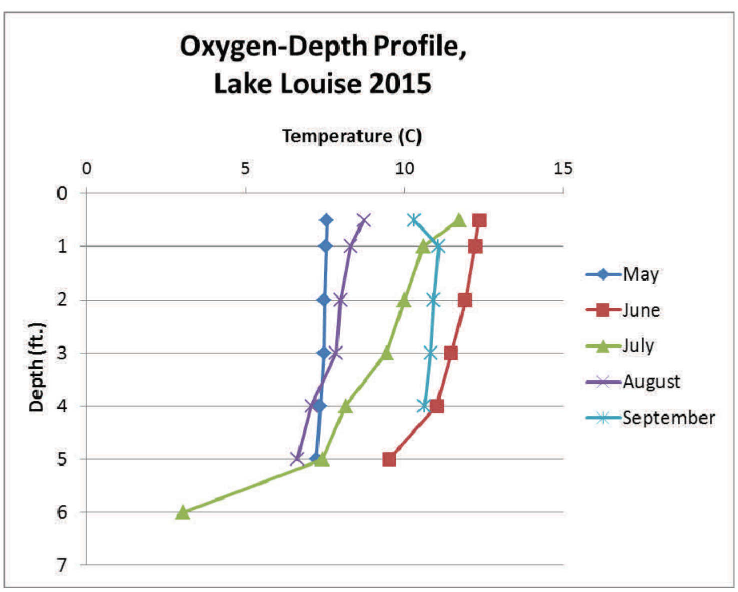
For example: when lake ice melts in early spring, the temperature and density of lake water will be similar from top to bottom. Since it is uniform throughout the water column, the lake can mix completely recharging the bottom water with oxygen and bringing nutrients up to the surface. Some lakes in summer experience stratification where the lake is dividing into three zones: epilimnion (warm surface layer), thermocline (transition zone between warm and cold water) and hypoliminion (cold bottom water). Stratification traps nutrients released from bottom sediments in the hypoliminion and prevents mixing (Figure 8).

Monthly depth profiles were measured on Lake Louise by measuring water temperature, dissolved oxygen, conductivity, and pH every foot from the lake surface to the lake bottom. The relative thermal resistance to mixing (RTRM) value can be calculated from this data which can tell us if the lake stratifies, how great the stratification is, and what depth it occurs. Lake Louise is a shallow lake that does not thermally stratify.

DISSOLVED OXYGEN

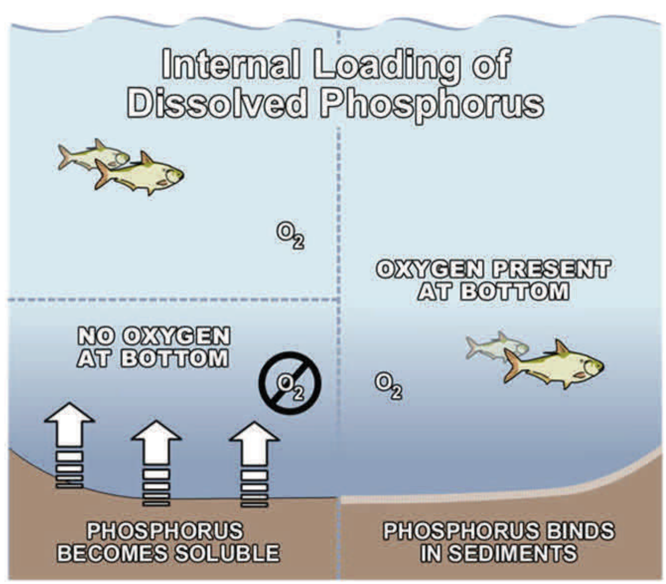
Dissolved oxygen (DO) concentrations in Lake Louise were adequate (>5.0 mg/L) throughout the monitoring season and only dropped below 5 mg/L in July at depths greater than 6 ft. Average DO concentrations ranged from 7.47 mg/L (May) to 11.47 mg/L (June). High dissolved oxygen concentrations also correlate with algae blooms, where there is increased amounts of photosynthesis occurring. Hypoxic conditions (DO<1.0 mg/L) never occurred. When DO concentration drop below 1.0 mg/L, biological and chemical processes release nutrients into the water, which are sequestered in the hypolimnion due to stratification and can be released into the surface waters. However, stratification and anoxic conditions did not occur on Lake Louise in 2015 (Figure 9).

Figure 9: Dissolved Oxygen Profile



The oxygen-depth profile on Lake Louise shows that DO concentrations remain above >5 mg/L except in July at depths greater than 6 ft. High DO concentrations are correlated with algae blooms.

Figure 8: Internal Loading Schematic of Phospho-



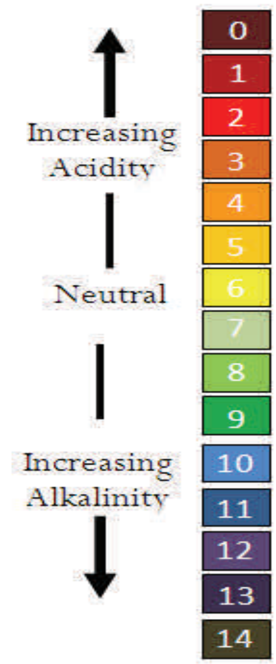
ALKALINITY AND PH

Alkalinity is the buffering capacity of a water body. It measures the ability of water bodies to neutralize acids and bases to maintain a stable pH. In a lake, alkalinity acts to buffer lakes from the effects of acid rain. Alkalinity comes from rocks, soils, salts, and certain plant activities. If a lakes watershed contains large quantities of calcium carbonate (CaCO3, limestone), the surface waters tend to be more alkaline.; while granite bedrock does not have high amounts of CaCO3 and therefore lacks alkaline materials to buffer acidic inputs.

pH is a measure of the hydrogen ion concentration of water. As the hydrogen ions are removed, pH goes up or halts its decline. A well buffered lake also means that daily fluctuations of CO2 concentrations result in only minor changes in pH throughout the day. Aquatic organisms benefit from stable pH. Each organism has an ideal pH threshold, but most aquatic organisms prefer pH of 6.5—8.0. pH values <6.5 or >9.0 cause a water quality impairment.

In 2015, the average alkalinity (CaCO3) concentration in Lake Louise was 163mg/L which is slightly above the Lake County median of 161 mg/L. The USEPA considers lakes with CaCO3 concentrations greater than 20 mg/L to not be sensitive to acidification.

Lake Louise's average pH in 2015 was 8.64 which is slightly above the Lake County median of 8.33 but remains within an adequate pH value for most aquatic organisms.

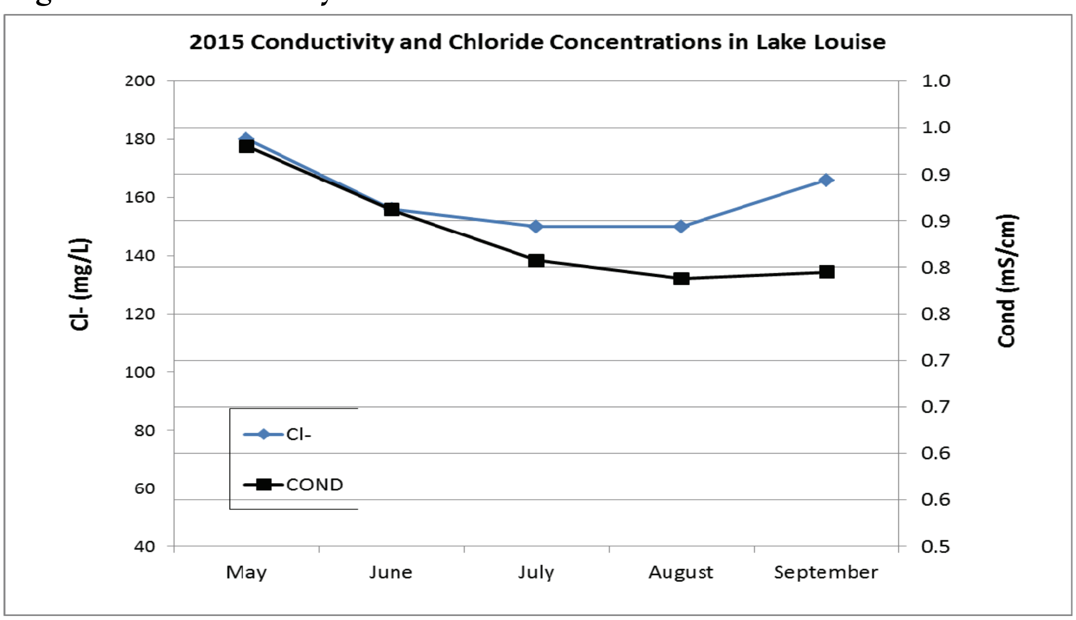


The pH scale ranges from 0 to 14. A pH of 7 is considered neutral. Substances with a pH of less than 7 are acidic, and greater than 7 are basic.

CONDUCTIVITY

Another parameter measured during the 2015 monitoring season that is important in comparing data from year to year is conductivity. Conductivity is the measure of different chemical ions in solution. As the concentration of these ions increases, conductivity increases. The conductivity of a lake is dependent on the lake and watershed geology, size of the watershed flowing into the lake, the land use, evaporation, and bacterial activity. Conductivity in urban areas has been shown to be highly correlated with chloride ions found in road salt mixes (Figure 10). In 2015, Lake Louise's average conductivity reading was 0.8365 mS/cm. This value is a 13% decrease since 2008 (0.9660 mS/cm) but remains above the county median of 0.7900 mS/cm.

Figure 10: Conductivity and Chloride Data



CHLORIDES

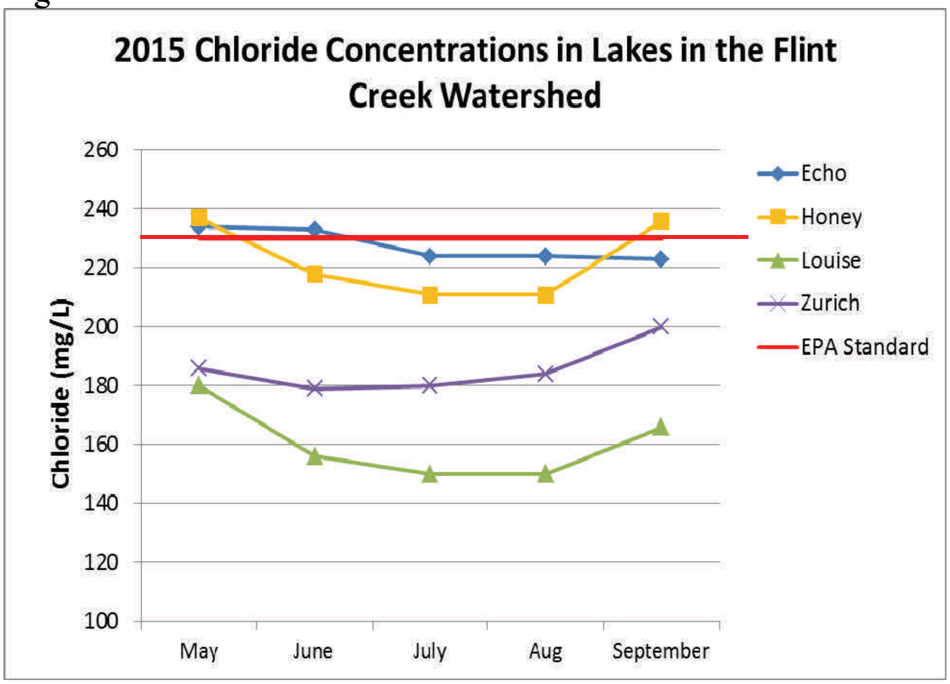
One of the most common dissolved solids is road salt used in winter road deicing. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocynaide salts. Lake Louise's average chloride concentration was 160 mg/L which is above the Lake County median of 139 mg/L. The United States Environmental Protection agency has determined that chloride concentrations higher than 230 mg/L can disrupt aquatic systems. Chloride ions do not break down and accumulate within a watershed. High chloride concentrations may make it difficult for many of our native plant species to survive while many of our invasive species such as Eurasian Watermilfoil, Cattail, and Common Reed are tolerant to high chloride levels. As salts dissolve and move through the watershed with snowmelt and stormwater runoff they tend to remain in the water cycle by settling.

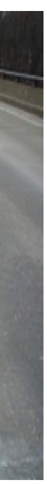
The Flint Creek Watershed had a range of chloride values in the 2015 sampling season from the lowest concentration in Lake Louise (160.4 mg/L) and the highest at Echo Lake (228 mg/L) (Figure 9). Lake Louise had the lowest chloride concentrations out of the lakes monitored in 2015 in the Flint Creek Waterhsed. It appears that road salt is compounding in many lakes in the county with conductivity and chloride readings increasing. Alternatives to road salt and proper road salt management can reduce chlorides in the environment.

THE CRITICAL VALUE FOR CHLORIDES IN AQUATIC SYSTEMS IS 230 MG/L.

230 mg/L = 1 teaspoon of salt added to 5 gallons of water.

Figure 11: Chloride within the Flint Creek Watershed





ICE FACTS

- De-icers melt snow and ice. They provide no traction on top of snow and ice.
- Anti-icing prevents the bond from forming between pavement and ice.
- De-icing works best if you plow/shovel before applying material.
- Pick the right material for the pavement temperatures.
- Sand only works on top of snow as traction. It provides no melting.
- Anti-icing chemicals must be applied prior to snow fall.
- NaCl (Road Salt) does not work on cold days, less than 15° F.

Pavement Temp (F)	One Pound of Salt (NaCl) melts	Melt times
30	46.3 lbs. of ice	5 min.
25	14.4 lbs. of ice	10 min.
20	8.6 lbs. of ice	20 min.
15	6.3 lbs. of ice	1 hour
10	4.9 lbs. of ice	Dry salt is ineffective and will blow away before it melts anything

HARMFUL ALGAL BLOOMS

Lake Louise experienced harmful algal blooms during the 2015 monitoring season. Blooms were noticed in July, August, and September by the LCHD. Samples were collected during bloom events and a qualitative test was preformed at LCHD to determine presence of microcystin toxins. The samples that were positive with microcystin toxins greater than 10 ug/L were then sent to the IEPA for quantitative testing (Table 3). The Fox Point Homeowners Association was notified during these occurrences.

Algae can grow quickly in water and is often associated with increased concentrations of nutrients such as nitrogen and phosphorus. Blue-green algae, or "cyanobacteria" are a type of algae that can bloom and produce toxins, which are similar to bacteria in structure but utilize photosynthesis to grow. Certain species of blue-green algae can produce toxins that could pose a health risk to people and animals when they are exposed to them in large enough quantities, and are identified as harmful algal blooms.

Blooms can last for an extended period of time and can deplete the oxygen and block sunlight in the water that other organisms needs to live. The water can appear blue-green, bright green, brown, or red and may look like paint floating on the water. Not all blue-green algae produce harmful toxins. The three types of cyanobacteria that are often associated with a harmful algal bloom (HAB) are Anabaena, Aphanizomenon, and Microcystis. The presence of these cyanobacteria does not always mean there are toxins are present in the water. The presence of toxins can only be verified through a sample analyzed in the lab.

Poisoning from harmful toxins in blue-green algae have caused the death of cows, dogs, and other animals. Most human cases occurred when people swim or ski in affected recreational water bodies during a bloom. If you suspect that you are experiencing symptoms related to exposure to blue-green algae such as stomach cramps, diarrhea, vomiting, headache, fever, muscle weakness, or difficulty breathing contact your doctor or the poison control center.

Table 3: Samples collected from Lake Louise and tested for Microcystin –LR

Date	Microcystin (ug/L)
7/1/2015	153
7/6/2015	23
8/12/2015	63.3
9/17/2015	2180

World Health Organization recreational guidelines for Microcystin

Relative Probability of Acute Health	Microcystin-LR (ug/L)
Low	<10
Moderate	10 –20
High	20 - 2,000
Very High	>2,000

For more information or to report a blue-green algae bloom, contact the Lake County Health Department Environmental Services (847) 377-8030.

FOR MORE INFORMATION ON BLUE-GREEN ALGAE:
www.epa.state.il.us/water/surface-water/blue-green-algae.html

TO REPORT BLUE-GREEN ALGAE BLOOM:
Lake County Health Department
847-377-8030

Anabaena Sp.

Microcystis Sp.

Aphanizomenon Sp.

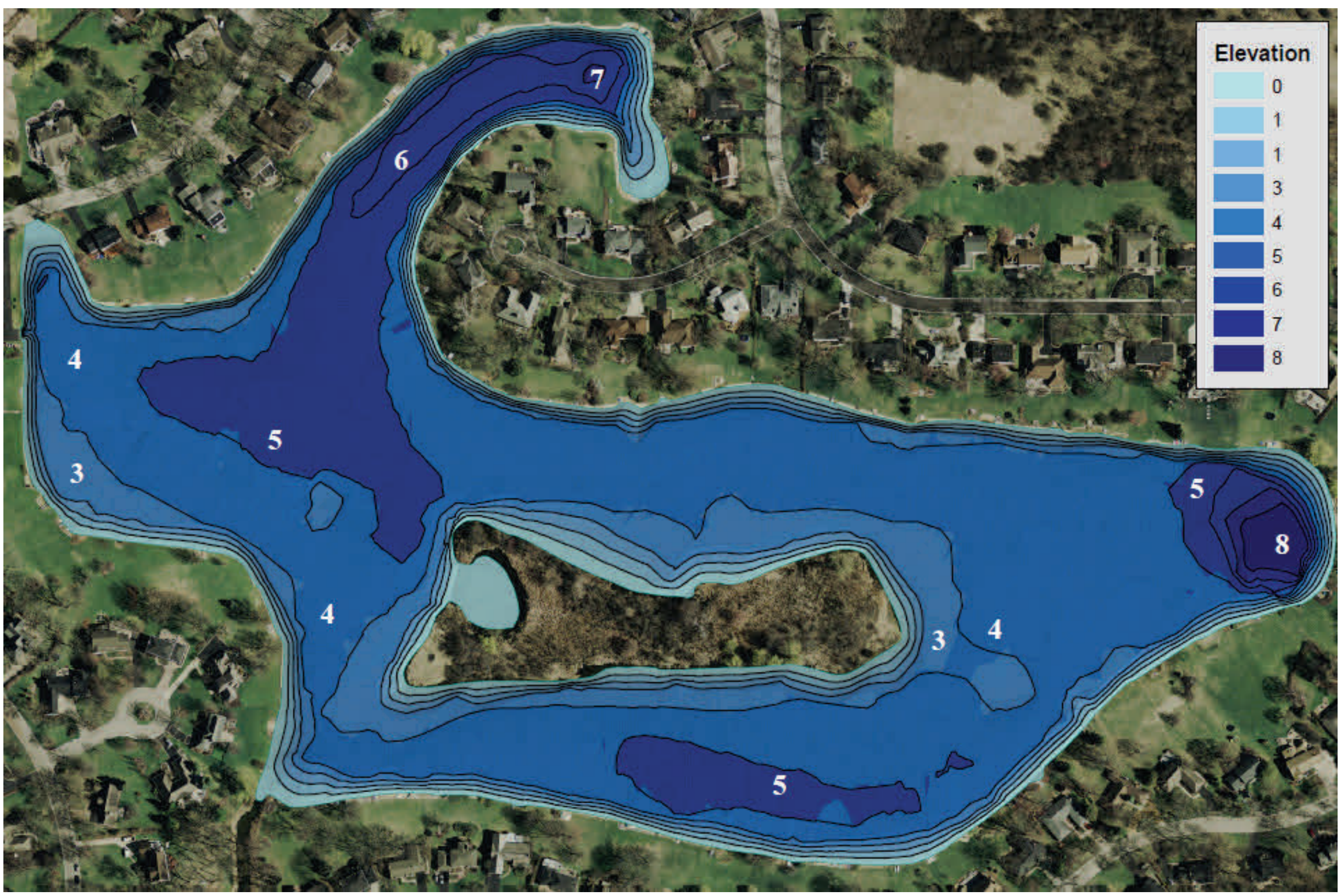
Bathymetric maps provide lake managers with an accurate lake volume that can be used for herbicide application and help anglers find potential fishing spots.

Bathymetric maps

Bathymetric maps are also known as depth contour maps and display the shape and depth of a lake. They are valuable tools for lake managers because they provide information about the surface area and volume of the lake at certain depths. This information can then be used to determine the volume of lake that goes anoxic, how much of the lake bottom can be inhabited by plants, and is essential in the application of whole-lake herbicide treatments, harvesting activities and alum treatments of your lake. Other common uses for the map include sedimentation control, fish stocking, and habitat management.

The Fox Point Homeowner Association contracted with Ganett Flemming in 2007 to do a sediment and bathymetric survey. In July 2015, field data was collected by LCHD-ES using a Lowrance HDS-% Gen2; Lowrance cites accuracy measures of approximately 5m however actual accuracy is typically better than this conservative estimate and has been discovered to be sub-meter (CIBiobase,2013) . Once collected, the data was analyzed and imported into ArcGiS 10.2 for further analysis. In ArcGIS 10.2, the contours and volumes were generated from the triangular irregular network (TIN) (Figure 12).

Figure 12: Bathymetric Map Lake Louise, 2015



SHORELINE EROSION

Erosion is a natural process primarily caused by water resulting in the loss of material from the shoreline. Disturbed shorelines caused by human activity such as clearing of vegetation and beach rocks, and increasing runoff will accelerate erosion. Eroded materials cause turbidity, sedimentation, nutrients, and pollutants to enter a lake. Excess nutrients are the primary cause of algal blooms and increased aquatic plant growth. Once in the lake, sediments, nutrients and pollutants are harder and more expensive to remove.

A shoreline erosion study was assessed for Lake Louise in 2015. Lake Louise was divided into reaches, and the shoreline evaluated for none, slight, moderate and severe erosion based on exposed soil and tree/plant roots, failing infrastructure, undercut banks, and other signs of erosion. Based on the 2015 data, 14% of Lake Louise's shoreline has erosion, with 12% considered slight erosion and 2 % moderate erosion (Table 5). For a complete list of shoreline erosion condition by reach, refer to Appendix B. It is recommended to fix shorelines with "slight" erosion as it is most cost efficient. As erosion becomes more severe, it becomes more costly to fix.

Figure 13: Shoreline Erosion Condition in Lake Louise in 2015

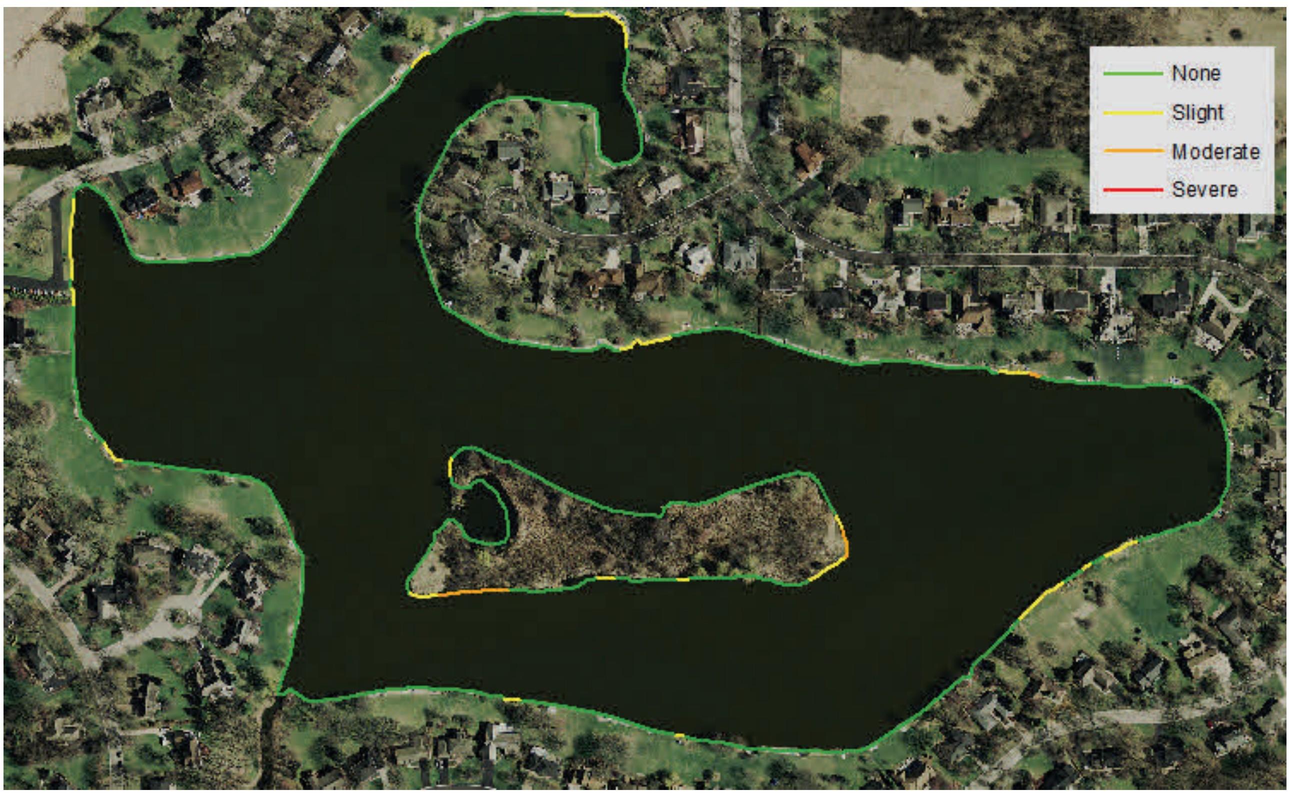


Table 5. Shoreline Erosion Condition in Lake Louise, 2015

None		Slight		Moderate		Severe	
Linear ft.	% Shoreline	Linear ft.	% Shoreline	Linear ft.	% Shoreline	Linear ft.	% Shoreline
9565	86%	1304	12%	252	2%	0	0%

SHORELAND BUFFERS

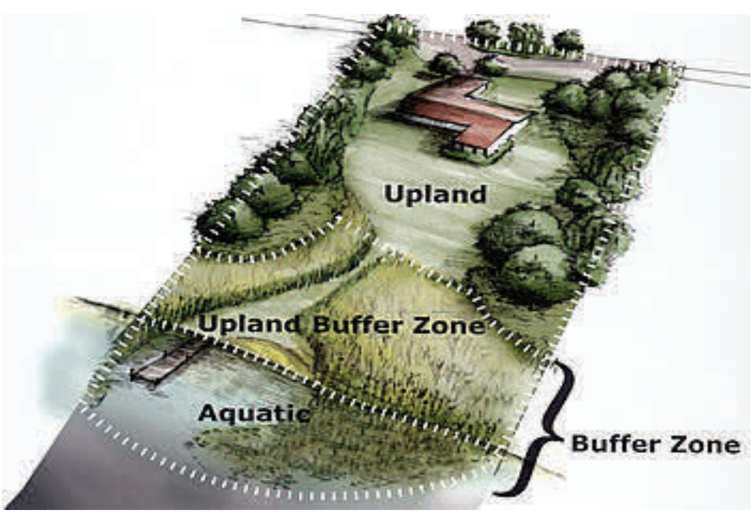
Many properties along the lake have manicured lawn and turf up to the lakes edge. Replacing lawn and turf grass at the shoreline with a buffer strip containing native deep-rooted plants will help with erosion and add wildlife habitat. A shoreland buffer helps stabilize the sediment near the lakes edge which prevents soil erosion. The buffer will also filter out pollutants and unwanted nutrients from entering the lake.

Buffer strips should be at least 25 feet wide and can include native wildflowers, native grasses, and native wetland plants. Wider buffers may be needed for areas with a greater slope or additional runoff issues. Areas that are already severely or moderately eroding, a buffer strip of native plants may need to be bolstered for additional stability. A concern with shoreland buffers is often that it may limit access to the lakefront. A smaller mowed path to the shoreline can still allow access to the lake while not interrupting the integrity of the buffer strip. The mowed path for lake access should be kept at least 6 inches tall and not more than 6 feet wide. Buffers do not have to block the view of the lake as there are many colorful, low-growing plants that can be incorporated in the buffer strip and will provide all the benefits of improved water quality.

A shoreland buffer condition of Lake Louise was assessed by looking at the land within 25 feet of the lake's edge on aerial images in ArcGIS. Shoreland buffer's were classified into three categories; poor, fair or good based on the amount of unmowed grasses, forbs, tree trunks and shrubs, and impervious surfaces within that 25 foot range. In 2015, Lake Louise had 76% of the shoreline with poor buffer, 0% with fair, and 24% with good. It is recommended that Lake Louise encourage homeowners to plant shoreland buffers along their lakeshore property. For a complete list of shoreland buffer condition by reach, refer to Appendix B.

Table 6. Shoreland Buffer Condition on Lake Louise, 2015

Poor		Fair		Good	
Linear ft.	% Shoreline	Linear ft.	% Shoreline	Linear ft.	% Shoreline
8478	76%	0	0%	2643	24%



Vertical seawalls can reflect wave energy

Rip rap with a native plant buffer

Buffer strip between upland area and lake edge

"VEGETATIVE BUFFER ZONES CAN PLAY A KEY ROLE IN LIMITING NEGATIVE WATER QUALITY IMPACTS FROM DEVELOPED SHORELAND PROPERTY"

AQUATIC PLANTS

Plants growing in our lakes, ponds, and streams are called macrophytes. These aquatic plants appear in many shapes and sizes. Some have leaves that float on the water surface, while others grow completely underwater. In moderation, aquatic plants are aesthetically pleasing and desirable environmentally. **Their presence is natural and normal in lakes.** Aquatic plant sampling was conducted on Lake Louise in July 2015. There were 46 points generated based on a computer grid system with points 60 meters apart that were sampled. Aquatic plants were scarce in Lake Louise and only occurred at 3 of the sites (6.5% total lake coverage). There were a total of 2 aquatic plant species found; giant duckweed and sago pondweed (Table 7).

In 1998, a fluridone treatment was conducted on Lake Louise to reduce the aquatic plant population that was viewed as being at nuisance levels. The treatment was conducted at a target concentration of 15 parts per billion. The treatment resulted in a change in the lake from a plant-dominated lake to an algae dominated one. Since this fluridone treatment, the lake has had few submersed plants and is annually treated for algae. In lakes in which this switch has occurred, it is difficult to change the lake back to one dominated by plants, since algae and sediment reduce the light penetration needed for plant growth. The poor water clarity and high total suspended solids in Lake Louise prevent a significant plant population to be able to grow. Unless water clarity is improved, it is unlikely that aquatic plants can become established in the lake. However, it is recommend that aquatic plants are allowed to grow and expand where possible. Establishing aquatic plant populations in the lake will help improve water quality by utilizing available nutrients, thus, competing with algae, stabilizing the bottom sediment, and providing habitat for fish and wildlife. Aquatic plants could be planted in certain areas to encourage growth. For instance, around the island would be a good location since the residents around the lake do not heavily use this area or in front of homeowner shorelines.

Littoral Zone– the area that aquatic plants grow in a lake.

Algae– have no true roots, stems, or leaves and range in size from tiny, one-celled organisms to large, multicelled plant-like organisms.

Submerged Plants– have stems and leaves that grow entirely underwater, although some may also have floating leaves.

Floating-leaf Plants– are often rooted in the lake bottom, but their leaves and flowers lay flat on the water surface.

Emergent Plants– are rooted in the lake bottom, but their leaves and stems extend out of the water.

Table 7 . Plant Rake Density in Lake Louise, 2015

Rake Density (coverage)	# Points	% of Points
No Plants	4	15%
>0-10%	10	37%
10-40%	3	11%
40-60%	4	15%
60-90%	2	7%
>90%	4	15%
Total Sites with Plants	23	85%
Total # of	27	100%

GIANT DUCKWEED

AQUATIC PLANTS

The diversity and extent of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of surface light level, plants can no longer grow. 1% surface light level is roughly at 2 times the average Secchi depth or can be measured with a photosynthetically active radiation (PAR) sensor. For Lake Louise, the 1% light level based on the average Secchi value was 2 feet. The low light level, impacted by suspended sediment and algae impact the ability for plants to grow. Table 7 displays the two aquatic plants observed in Lake Louise.

PLANTS FOUND IN LAKE LOUISE, JULY 2015

COMMON DUCKWEED

Lemna spp.

Common duckweed is a native plant, found throughout much of the temperate and subtropical regions of the world. It is food for fish and waterfowl and habitat for invertebrates. It has also been used to remove nutrients from sewage effluent. There are no true leaves. Their leaf-like body is nearly circular to oval, 2-5mm in diameter and float on the surface of the water. A single duckweed plant can reproduce about every 3 days under ideal conditions in nutrient-rich waters. Duckweed was present at two locations during the plant survey but can easily move around the water by wind and waves.

SAGO PONDWEED

Potamogeton pectinatus

Sago Pondweed is a native plant. It provides food and cover for many aquatic animals and is especially important waterfowl food. The leafs are alternate along the stem, and thin. They tend to be 2—15 cm long, to 1 mm wide leves and have pointed tips. Sago was only found at one location during the aquatic plant survey on the north side of the island.

Table 7 . Occurrence of specific plant species found in Lake Louise, 2015

Plant Density	Giant Duckweed	Sago Pondweed
Absent	41	42
Present	2	1
Common	0	0
Abundant	0	0
Dominant	0	0
% Plant Occurrence	4.3	2.2

Aquatic plants and fish

Fish depend on aquatic plants to provide habitat and forage for food and most freshwater fish rely on aquatic plants at some point during their life stage. The plant composition and density can play an important role in the nesting, growth, and foraging success of these fish. While many fish require some aquatic vegetation for growth, excessive amounts of aquatic vegetation can negatively impact growth by reducing foraging success. The parameters of an ideal fish habitat change base on the size and species of fish, the type of lake, structures present in the lake and man other factors.

How do plants impact fish?

- *Plants provide critical structure to aquatic habitats.*
- *Plants influence growth of fish by enhancing fish diversity, feeding, growth, and reproduction.*
- *Plants influence spawning. The structure provided by plant beds is important to fish reproduction.*
- *Plants influence the physical environment. Aquatic plants can change water temperatures and available oxygen in habitats.*

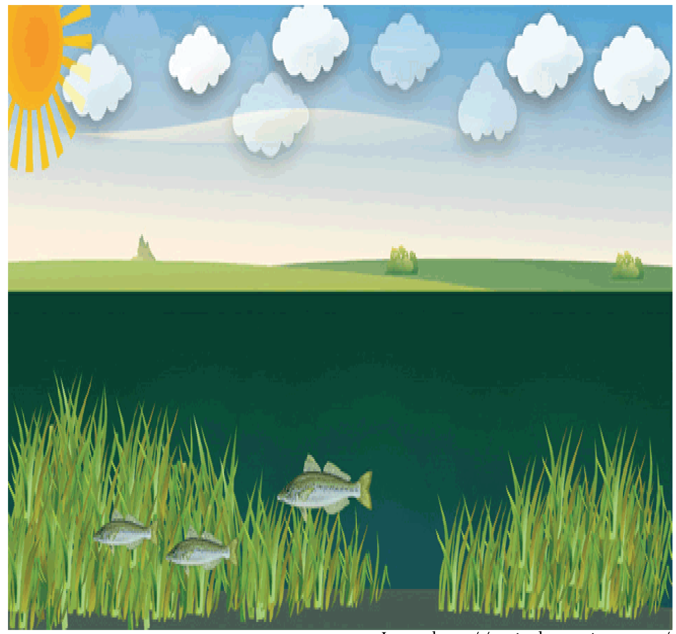


Image http://agriculture.vic.gov.au/

Table 1. Common fish and their plant affinity during various life stages and their relationship with plants

		Life Stage				Relationship	
Fish	**Plant Affinity**	**Larvae**	**Juvenile**	**Adult**	**Spawn**	**Forage**	**Predator avoidance**
Bluegill sunfish	High	X	X	X	X	X	X
Common carp	High	X	X	X	X	X	X
Largemouth bass	High	X	X	X	X	X	X
Musky	High	X	X	X	X	X	X
Northern Pike	High	X	X	X	X	X	X
Black crappie	Moderate		X	X	X	X	X
Smallmouth bass	Moderate		X	X		X	X
Yellow perch	Moderate	X	X			X	X
White crappie	Low		X			X	
Salmon, trout	Low		X				X
Shad	Low	X					
Walleye	Low			X		X	

Table adapted from Gettys, Lynn, William T. Haller and Marc Bellaud. "Biology and Control of Aquatic Plants: A Best Management Practices Handbook". 2009

FISH

A fish survey was conducted in 2013 by the Illinois Department of Natural Resources (IDNR). The survey consisted of 30 minutes of daytime electrofishing. The fishery in Lake Louise lacked diversity. A total of 5 species of fish were collected and 3 additional species observed while collecting carp for the extra 30 minutes (Table 8). A variety of habitats were sampled, including near the island. Fairly monotypic fisheries are common in small ponds but older, larger lakes usually contain 12 to 17 species of fish. Shoreline vegetation, and allowing plants to try and grow in the littoral zone would help reduce sediment re-suspension and increase water clarity. Aquatic vegetation management can be tricky in shallow lakes but it is possible.

The 2013 survey was initiated to assess the fishery in general and to address an abundant common carp population. Previous discussions about the origins of carp in Lake Louise have taken place for quite some time. According to IDNR fisheries biologist, the presence of gizzard shad observed in the 2013 highlights supports the point that fish are moving over the spillway from Flint Creek into the lake. Gizzard shad were not present in the Algonquin pool of the Fox River until around 2007. Prior to 2007 the furthest north gizzard shad were commonly documented was near Elgin. Without some sort of barrier modification to the spillway, carp will continue to invade Lake Louise each high water event. Carp found in Lake Louise were large (average size = 24" and 6.4 lbs.) and abundant in certain locations. Turbidity in Lake Louise may be partially caused by sediment re-suspension from carp rooting around in the soft sediments but not all of it: Wind driven re-suspension is probably another factor as shallow lakes can get "stirred up" by the wind. Carp probably enter the system by coming over the spillway during high water events and attempting to reduce their in-lake abundance would be difficult until they've been isolated from their source - Flint Creek.

Recommendations from IDNR:

1. Develop a plan to manage aquatic vegetation so plants are allowed to grow in areas of low use and are managed in high use areas. You may have to allow some E. milfoil to grow so other plants can become established.

2. Stocking (at least) 25 non-vulnerable (8"-10") or 15 adult channel catfish per acre biennially would diversify the predator base and increase options for fishermen. Channel catfish are good predators of panfish.

3. Establish a 14 inch minimum length limit and 1 fish per day catch limit on largemouth bass to maintain a good supply of breeding size fish.

Table 8: Catch Summary for Lake Louise, 6/4/2013

Species	Number	Min. Length (in.)	Avg. Length (in.)	Max. Length (in.)
Largemouth bass	41	9.6	14	16.3
Bluegill	39	3.3	6	8.2
Yellow bullhead	4	8.1	11	12.8
Black crappie	3	8.6	8.7	8.8
Common carp	111	23	24.8	27.4
Gizzard shad	Observed			
Goldfish	Observed			
Channel catfish	Observed			

Carp spawning and feeding can both cause increase in turbidity, especially in shallow waters where they uproot plants, and resuspend bottom sediments.

FLORISTIC QUALITY INDEX

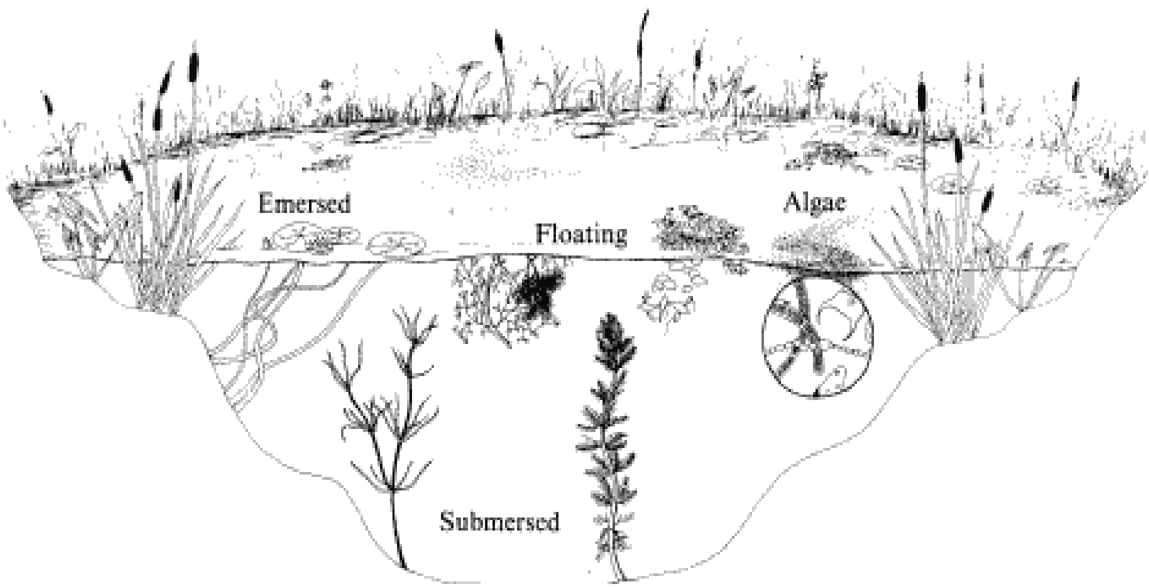
Floristic quality index (FQI) is an assessment tool designed to evaluate how close the flora of an area is compared to one of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site 3) monitor long-term floristic trends and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submerged plant species found in the lake. The FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that a large number of sensitive, high quality plant species are present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The median FQI for Lake County lakes from 2000-2015 was 13.4. Lake Louise had an FQI value of 8.3 ranking it 137 out of 170 lakes in Lake County (Appendix B) and 2 plant species were observe. This is a decrease since the 2008 sampling when Lake Louise had an FQI of 9.0. Development of an Aquatic Plant Management Plan (APMP) should focus on trying to re-establish plants in Lake Louise and improving water clarity.

LAKE COUNTY AVERAGE FQI = 13.4

LAKE LOUISE FQI = 8.3

RANK = 137/170

AQUATIC PLANTS SPECIES OBSERVED = 2



IN MANY LAKES MACROPHYTES CONTRIBUTE TO THE AESTHETICALLY PLEASING APPEARANCE OF THE SETTING AND ARE ENJOYABLE IN THEIR OWN RIGHT. BUT EVEN MORE IMPORTANT, THEY ARE AN ESSENTIAL ELEMENT IN THE LIFE SYSTEMS OF MOST LAKES.

- Macrophyte leaves and stems provide a habitat or home for small attached plants and animals. Some are microscopic in size and some are larger. These attached organisms are valuable as food for animals higher in the food chain, such as fish and birds.
- Many types of small organisms live in the sediment. There are insects that spend the immature stages of life in the sediments, leaving when they become adults. Decomposing plant life provides part of the food supply for these sediment-dwelling organisms and the emerging insects, in turn, are food for fish.
- The submerged portions of macrophytes provide shelter and cover for small or young fish from larger fish that would feed on them.
- Types of plants that extend above the water can provide cover for waterfowl and their young, and many plants can serve directly as food for certain types of waterfowl.
- Aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available nutrients.

AQUATIC HERBICIDES - COPPER SULFATE

Copper salts are one of the earliest know herbicides for terrestrial and aquatic weed control. Copper sulfate which is used strictly for algae control was first used in 1904. The use of copper sulfate is appealing because it generally has minimal effect on flowering plants at normal use rates and there are no restriction on the use of water following a treatment. McCloud Aquatics applied copper sulfate on 10 occasions during the season. The efficiency of copper sulfate is greatly affected by the carbonate alkalinity ($CaCO_3$) concentrations in the water. The copper will combine with the carbonates and precipitate out of the water preventing the copper from entering the algal cells. Lake's average alkalinity concentration in 2015 was 174 mg/L. Alkalinity concentrations 50 to 250 mg/L provide effective treatment and protect fish from lethal doses of copper. Copper sulfate is a contact herbicide. Therefore, direct exposure of the algae to the compound is required. Copper sulfate has a fairly short active period, and is quickly absorbed into the sediment. Over time a build up of copper can occur in the sediment. Copper is toxic to invertebrates, which are aquatic bugs that live in the sediment. This can cause a disruption in the food chain from the bottom up resulting in a reduction in growth rates in the fish community. Herbicide treatments is one the many tools available to lake managers when used alone they provide a quick fix, that does not address the source of the problem, high nutrient levels.

Chemical applications for algae is a temporary solution that often requires multiple applications As the treated algae sink to the bottom to decompose (use oxygen) they release nutrients that the surviving algae uses to rebound.

Copper Sulfate Application

REQUEST FOR SERVICE (RFP)

A key to a healthy lake is a well-balanced aquatic plant population. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake.

Putting together a good aquatic plant management plan should include a Request for Proposal (RFP). The RPF for aquatic plants ensures lake managers are able simultaneously distribute bids to qualified vendors with type of services, the frequency of needs, budget allocation and the length of the contract terms to get competitive prices.

In order to establish a plant management goal, a pre-treatment survey is necessary to identify the location, density and diversity of the aquatic plants in your lake. Set your goals within your budget and targeting areas that meets recommendations for maintaining the viability of the lake.

A pretreatment survey of your lakes aquatic plants is necessary prior to sending out a bid for your lakes survey prior to any vegetation order to assess the success of controls and locate potential treatment areas

Aquatic herbicides

New Permit Requirements for Applying Pesticides in Waters

A National Pesticide Elimination System (NPDES) permit is required when pesticides are applied to, over or near the waters of the State. This permit applies to all public waters that have an outflow to the State waters. If an individual is applying the herbicide, they must fill it out. If you contract with an applicator, they can apply for NPDES coverage. A Notice of Intent (NOI) must be filled and submitted electronically to the Illinois Environmental Protection Agency (IEPA) at least 14 days prior to any application of pesticides. You can find the application at the website listed on the right.

You are allowed to apply only a pesticide that is labeled for aquatic use. The General NPDES permit only applies to pesticide applications that will be made directly to or over waters of the State or at water's edge. Pesticide applications to dry ditches which discharge into waters of the State may also require General NPDES permit coverage.

You must file an updated NOI to modify your NPDES permit coverage to add additional use patterns or treatment areas at least 14 days prior to beginning the pesticide applications. The General NPDES permit coverage is good for 5 years from the issuance date on the permit.

Is anything else needed besides the permit?

An **Adverse Incident Report** is needed if there are any adverse impacts related to the application such as spills or accidental overdosing. The incident must be reported to the Illinois Emergency Management Agency immediately and the report must follow within 15 days.

A **Pesticide Discharge Management Plan (PDMP)** is required if the annual threshold of 80 acres is past and if you do not meet any of the additional exemptions within the permit. The threshold is determined not only by the size of the pond or lake but by the number of treatments. For example, if a 10 acre pond is treated 9 times with different herbicides within a one-year period, it would be counted as 90 treatment acres and the 80 acre threshold limit would have been passed. This would trigger the need for a PDMP. If treated with the same herbicide 9 times, the additional treatments would not count toward the threshold.

For full details of the rule see:

http://www.epa.illinois.gov/topics/forms/water-permits/pesticide/index

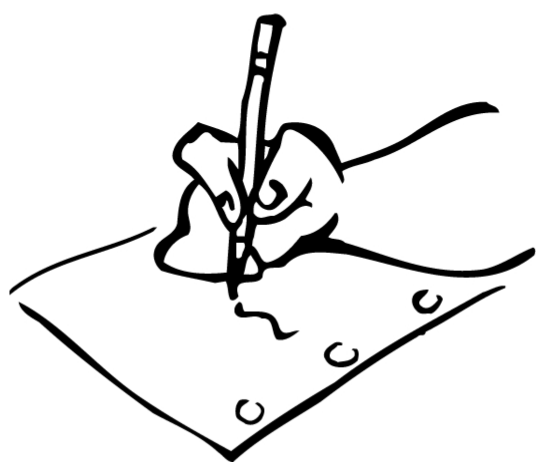
Lake management plans

It is recommended that a long term Lake Management Plans be developed to effectively manage lake issues. All stakeholders should participate in the development of the plan and include homeowners, recreational users, lake management associations, park districts, townships or any other entity involved in managing Lake Barrington. Lake Management plans should educate the public about specific lake issues, provide a concise assessment of the problem, outline methods and techniques that will be employed to control the problems and clearly define the goals of the program. Mechanisms for monitoring and evaluation should be developed as well and information gathered during these efforts should be used to implement management efforts (Biology and Control of Aquatic Plants, Gettys et al., 2009)

What are the steps in creating a Lake Management Plan?

1. **Getting Started**: Identify lake stakeholders and communication pathways
2. **Setting Goals:** Getting the effort organized, identifying problems to be addressed, and agreeing on the goals
3. **Problem Assessment & Analysis**: collecting baseline information to define the past and existing conditions. Synthesize the information, quantifying and comparing the current conditions to desired conditions, researching opportunities and constraints and setting direction to achieve goals.
4. **Alternatives:** List all possible management alternatives and evaluate their strengths, weakness, and general feasibility.
5. **Recommendations:** Prioritize management options, setting objectives and drafting the plan
6. **Project Management:** Management of assets, detailed records of expenses and time
7. **Implementation:** adopting the plan, lining up funding, and scheduling activities for taking action to achieve goals.
8. **Monitor & Modify:** Develop a mechanism for tracking activities and adjusting the plan as it evolves.

Follow these steps when getting started with writing Lake Management Plans. While each step is necessary, the level of effort and detail for each step will vary depending on the project's goals, size of the lake, and number of stakeholders.



AQUATIC INVASIVE SPECIES

Aquatic invasive species (AIS) are species that are typically not native to Illinois and cause economic or environmental harm, or harm to human health. Illinois has a number of invasive species with the most common including: common carp, grass carp, and zebra mussels. The most common aquatic invasive plants include Curlyleaf Pondweed and Eurasian Watermilfoil. Water recreation is a main transport of AIS, as these species can get transported from boats or trailers and then introduced into the water. Exotic species usually outcompete habitat of native species and are more tolerant to variations in water quality. While Lake Louise does not currently have populations of these, it has had Curlyleaf Pondweed in the past, including the 2008 survey. It's important to keep an eye on if these invasive species enter the lake; especially since they are observed in nearby lakes.

Zebra mussels are small, fingernail-sized mollusks originally native to eastern Europe and western Asia. Zebra mussels were most likely introduced to North America in 1985 or 1986 by ballast water of ships that traveled across the Atlantic and emptied their ballast in the Great Lakes ports. Zebra mussels spread by attaching to boats, nets, docks, swim platforms, boat lifts, and can be moved on any of these objects. They also can attach to aquatic plants which are often transported accidently when they become entangled on the boat parts. Microscopic larvae (called veligers) can also be carried in water contained in bait buckets, bilges, or any other water removed from an infested lake. Zebra mussels have damaged natural ecosystems, industrial infrastructure and recreational equipment including boats and motors.

Curlyleaf pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidently introduced to the United States water in the mid-1880's by hobbyists who use it as an aquarium plant. Unlike our native pondweeds, Curlyleaf Pondweed begins growing in the early spring. The vegetative part of the plant dies back completely in early summer and only seeds and turions remain over summer. The turions (which are the main source of reproduction in CLP) sprout in fall, and are rapidly able to elongate in spring after ice melts as temperatures reach 5°C. CLP becomes invasive in some areas because of its adaptations for low light tolerance and low water temperatures which allow the plant to get a head start and outcompete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen.

Large populations of CLP also can cause changes in nutrient availability. In mid-summer, CLP plants usually die back which is typically followed by an increase in phosphorus availability that may fuel nuisance algal blooms.

Eurasian Watermilfoil (EWM) is an invasive, submersed aquatic plant accidently introduced in the 1940s to North America from Europe from the aquarium trade. Eurasian watermilfoil can reproduce through stem fragmentation and runners meaning a single segment of stem and leaves can take root and form an entire new colony. Removing native vegetation allows for EWM to overtake a lake. EWM can have a difficult time becoming established in lakes with well established populations of native plants. EWM can be controlled using aquatically approved herbicides, mechanical (i.e. harvester or cutter) methods, or biological controls (i.e. weevil). In the Fox Chain O'Lakes, a Letter Of Permission (LOP) from the IDNR is required for any aquatic plant management (see Pesticides section). Aquatic management methods for EWM that cause as little damage to native aquatic plants as possible are encouraged and early season treatments will have the least impact on native populations.

LAKE RECOMMENDATIONS

Lake Louise has poor water quality and is impaired for phosphorus and total suspended solids. The poor water quality has led to a number of issues including, increased algae blooms, lack of aquatic plants, and high suspended solid concentrations. Parameters have decreased since the 2008 sampling many other water quality parameters remain above the Lake County median.

To improve the overall quality of Lake Louise; the ES (Ecological Services) has the following recommendations:

- Continue to participate in the Volunteer Lake Monitoring Program to give yearly data on water clarity for Lake Louise and observe changes in the lakes water clarity. Contact the LCHD-ES at 847-377-8009 to get involved in the VLMP program.
- Consider installing Best Management Practices (BMPs) to minimize phosphorus and sediment runoff into Lake Louise. This can include: rain gardens, native buffers between shoreline and homeowner property, and increasing native plantings around the lake. Currently, Lake Louise has 75% poor buffer around the shoreline and would benefit from homeowners installing native buffers.
- Practice best management practices for salt and de-icing of roads, sidewalks, and driveways in the Lake Louise Watershed. Consider the benefit of attending one of Lake County Health Departments De-Icing workshops held annually in October to learn about these best management practices.
- Follow IDNR recommendations for fisheries. Carp are major impact on water quality in Lake Louise; decreasing water clarity, increasing total phosphorus concentrations and making it difficult to plants to grow.
- Consider trying to promote aquatic plant growth in Lake Louise. The littoral area around the island would be a good place to try and get aquatic plant growth. Carp impact aquatic plant growth since they can make water too turbid for a healthy plant community.
- Install a sign to educate on ways to reduce the spread of Aquatic Invasive Species.
- Become familiar with the appearance of harmful algal blooms and report any blooms to the LCHD-ES to be tested for microcystin, a toxin found in HABs.
- Develop an action plan to respond to Harmful Algal Blooms.

Example of shoreland buffer (www.mn.dnr.gov)

LakeCounty
Health Department and Community Health Center

ECOLOGICAL SERVICES

Senior Biologist: Mike Adam

madam@lakecountyil.gov

Population Health Services
500 W. Winchester Road
Libertyville, Illinois 60048-1331

Phone: 847-377-8030
Fax: 847-984-5622

For more information visit us at:

http://www.lakecountyil.gov/Health/want/BeachLakeInfo.htm

Protecting the quality of our lakes is an increasing concern of Lake County residents. Each lake is a valuable resource that must be properly managed if it is to be enjoyed by future generations. To assist with this endeavor, Population Health Environmental Services provides technical expertise essential to the management and protection of Lake County surface waters.

Environmental Service's goal is to monitor the quality of the county's surface water in order to:

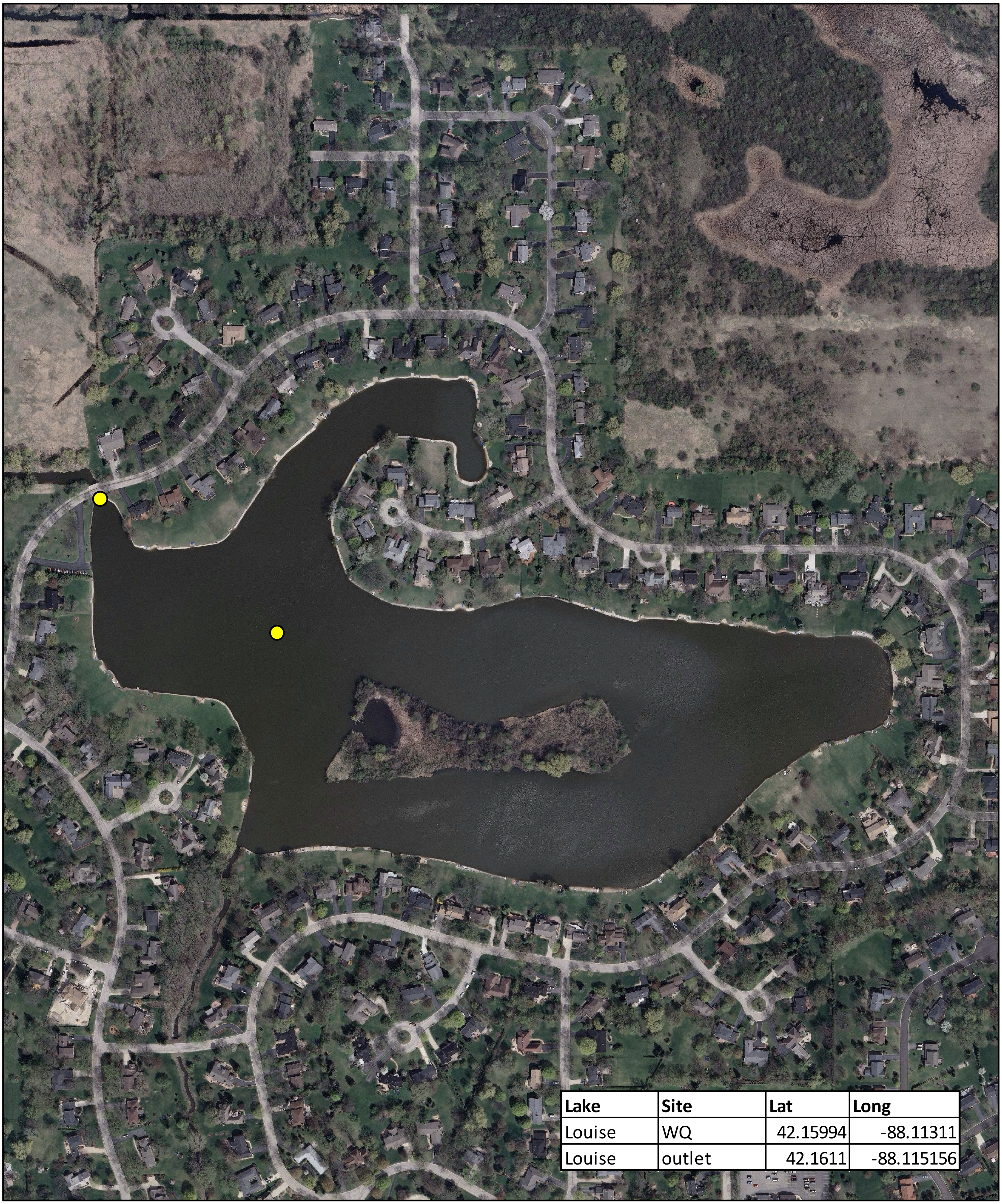
- Maintain or improve water quality and alleviate nuisance conditions
- Promote healthy and safe lake conditions
- Protect and improve ecological diversity

Services provided are either of a technical or educational nature and are provided by a professional staff of scientists to government agencies (county, township and municipal), lake property owners' associations and private individuals on all bodies of water within Lake County.

Figure 1: Sampling locations on Lake Louise, 2015

Appendix A:
Figures

Lake Louise Sampling Location



Lake	Site	Lat	Long
Louise	WQ	42.15994	-88.11311
Louise	outlet	42.1611	-88.115156

LakeCounty
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N
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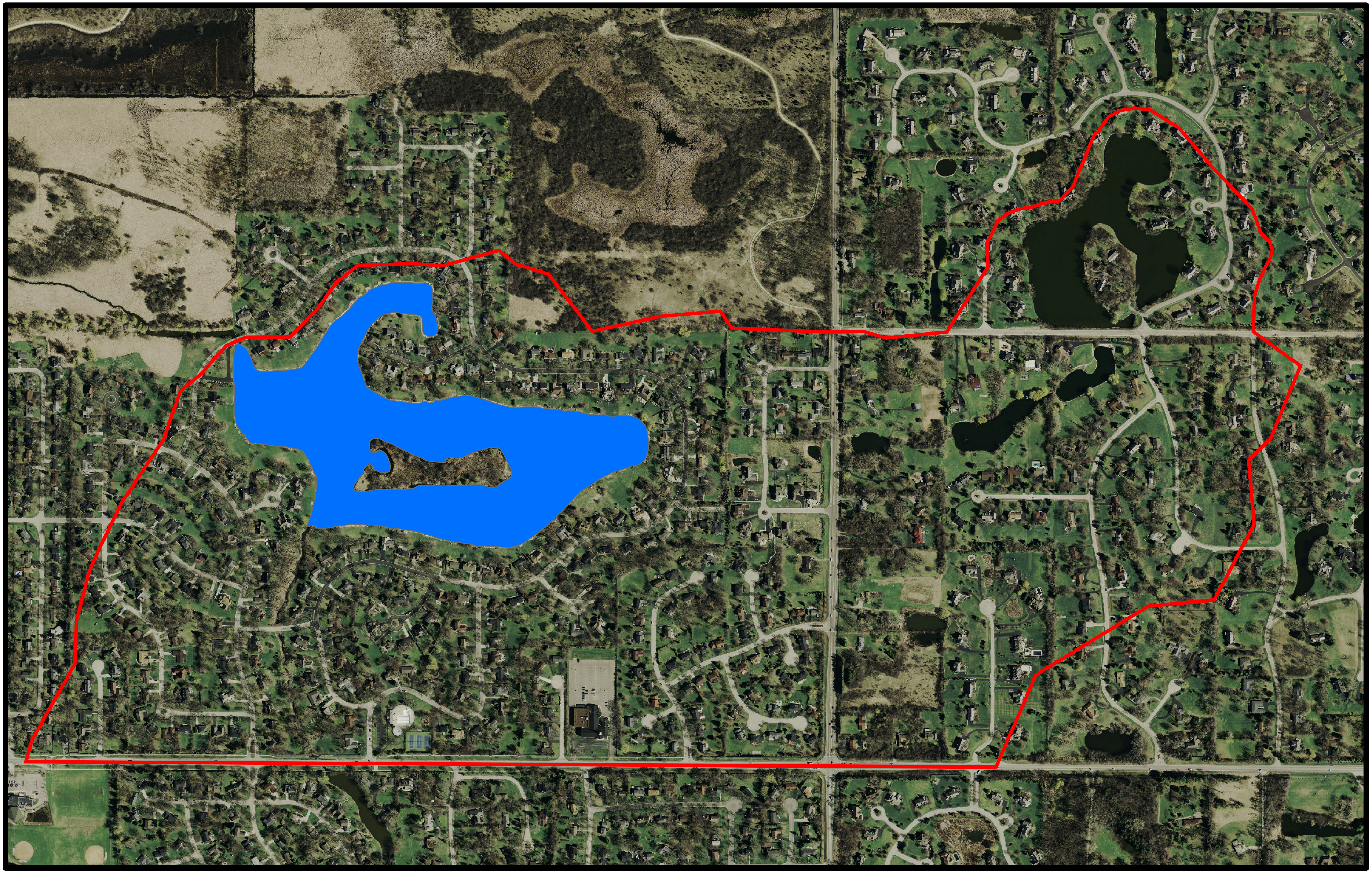
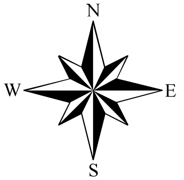
Feet

Environmental Services Unit
Product Number 2015
Revised 05/2015

Lake Louise Watershed





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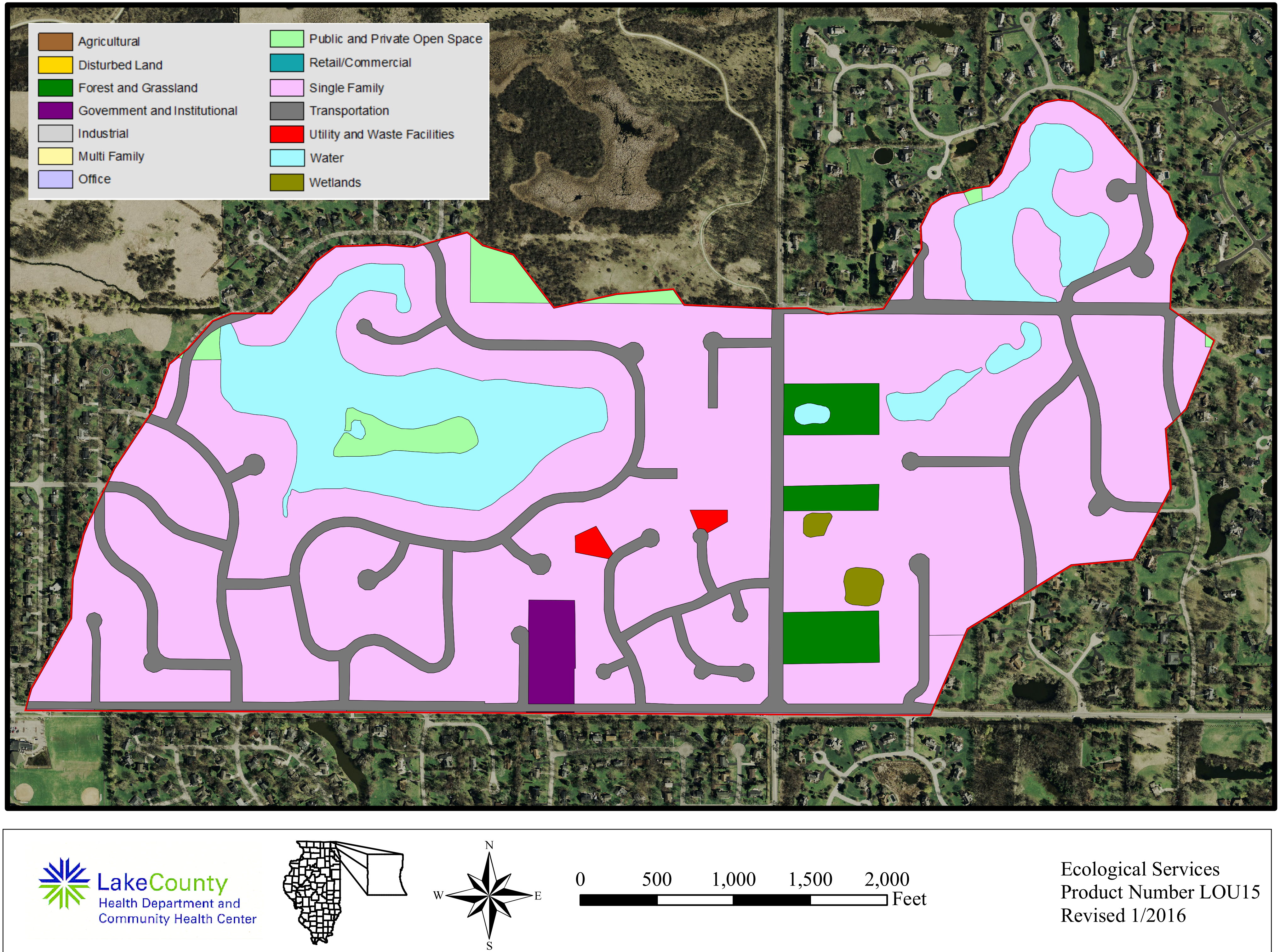
Lake Louise Lakeshed and Landuse



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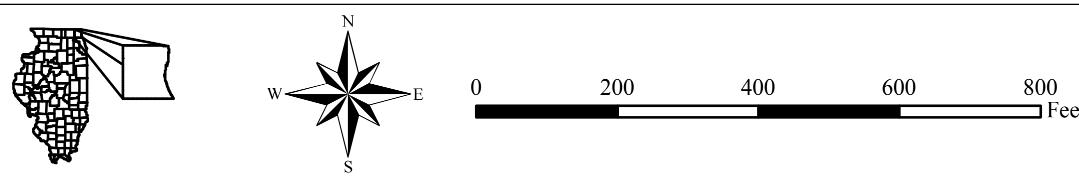
Ecological Services
Product Number LOU15
Revised 1/2016

Lake Louise Shoreline Reaches 2015



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LOU15
Revised 10/2015

Lake Louise Shoreline Erosion Condition, 2015

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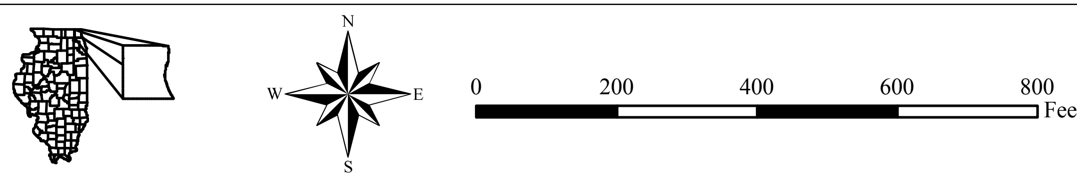
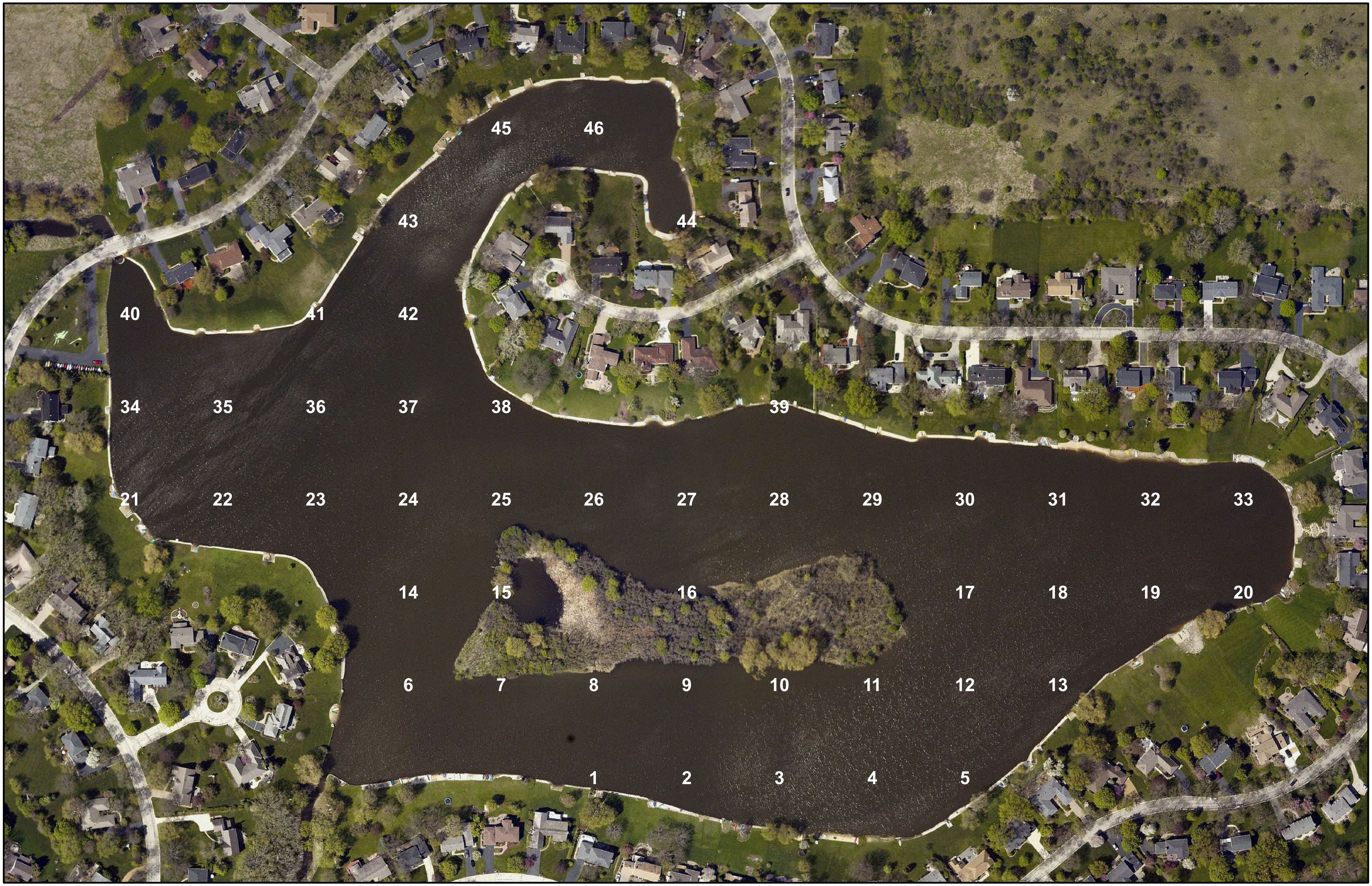
Lake Louise Shoreline Buffer Condition, 2015



Ecological Services
Product 10/2015
Revised 1/2016

Lake Louise Plant Grid 2015



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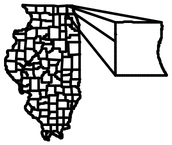

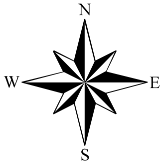

0 200 400 600 800 Feet

Ecological Services
Product Number LOU15
Revised 4/2015

Lake Louise Plant Rake Density, July 2015

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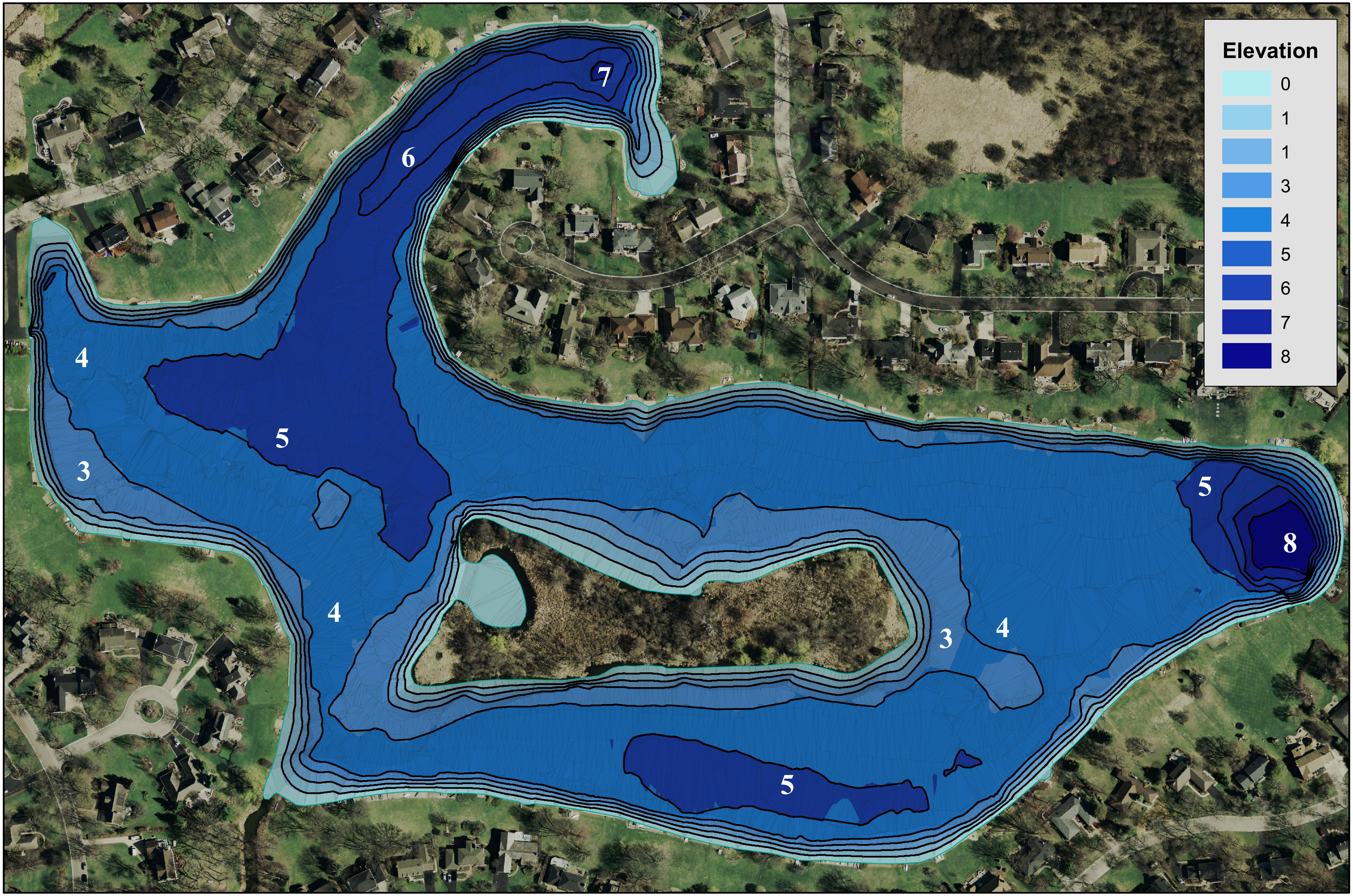
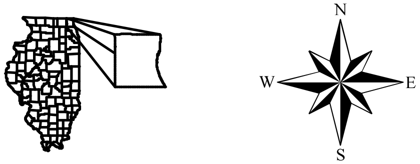
Ecological Services
Product Number LOU715
Revised 2/2016





0 150 300 450 600 Feet

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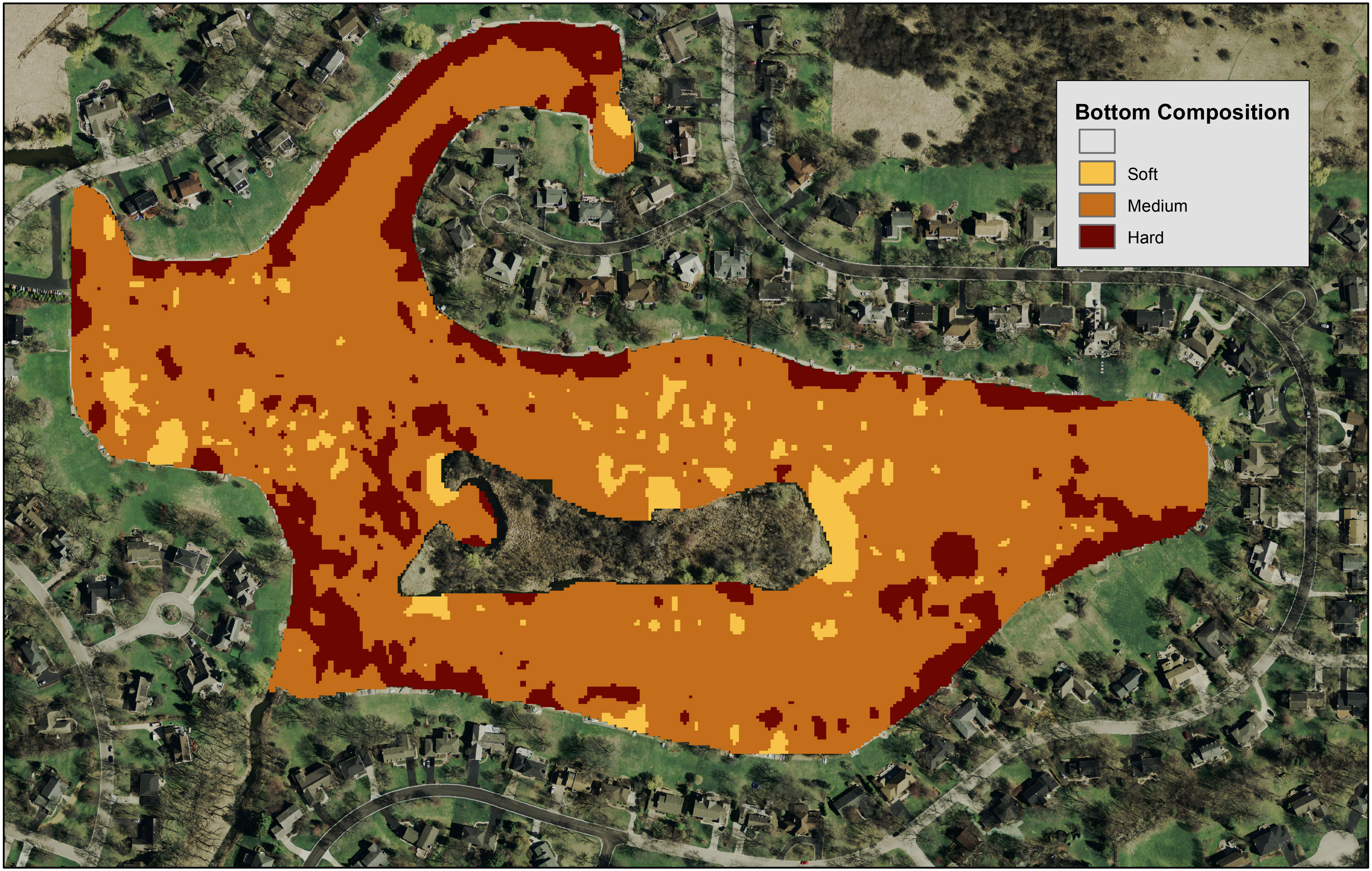
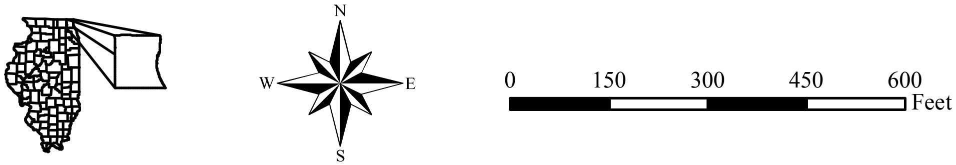
Ecological Services
Product Number 07.15
Revised 3/2016

Lake Louise Bottom Composition, 2015





LakeCounty Health Department and Community Health Center

Ecological Services
Product Number 07.2015
Revised 1/2016

Appendix B:
Tables

Lake Louise Water Quality Summary
(2015, 2008, 2003)

2015

DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	CL-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
5/13/2015	3	194	1.66	0.38	0.332	0.108	0.029	180	515	9.3	610	99	2	0.9298	8.01	7.47
6/17/2015	3	178	1.93	<0.1	<0.05	0.137	0.041	156	481	20	559	136	1.35	0.8621	8.7	11.47
7/15/2015	3	167	2.81	<0.1	<0.05	0.224	0.045	150	453	45	557	135	0.9	0.8074	8.86	9.44
8/12/2015	3	140	3.11	<0.1	<0.05	0.238	0.043	150	478[a]	55	543	139	0.44	0.788	8.74	7.85
9/17/2015	3	137	2.97	<0.1	<0.05	0.196	<0.005	166	447	55	559	147	0.51	0.795	8.91	10.83
	Average	163	2.50	0.16[k]	0.11[k]	0.181	.03[k]	160.4	475	36.9	566	131	1.04	0.8365	8.64	9.41

2008

DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	3	204	1.37	0.351	0.224	0.092	0.011	215	NA	20.8	666	98	1.81	1.1730	7.97	9.45
18-Jun	3	200	1.34	<0.1	<0.05	0.080	<0.005	192	NA	11.0	643	136	2.69	1.0620	8.65	12.23
16-Jul	3	180	1.75	0.439	0.091	0.268	0.140	172	NA	11.6	570	116	1.71	0.9570	8.29	6.38
20-Aug	3	188	1.75	0.260	<0.05	0.175	0.044	174	NA	33.0	585	107	1.51	0.9700	8.02	6.23
17-Sep	3	142	1.62	0.269	0.369	0.164	0.034	100	NA	40.3	433	90	0.69	0.6680	7.51	6.75
	Average	183	1.57	0.330[k]	0.228[k]	0.156	0.057[k]	171	NA	23.3	579	109	1.68	0.9660	8.09	8.21

2003

DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	3	173	1.59	0.298	0.699	0.081	0.013	NA	508	12	549	114	1.80	0.9290	7.90	7.44
18-Jun	3	204	1.66	<0.1	<0.05	0.071	<0.005	NA	564	9.7	604	145	2.92	0.9290	7.90	9.57
23-Jul	3	169	1.99	<0.1	<0.05	0.217	0.02	NA	550	36.7	588	137	1.05	0.942	8.54	9.42
20-Aug	3	182	1.89	<0.1	<0.05	0.280	0.12	NA	516	16.1	563	139	2.03	0.954	8.42	6.49
25-Sep	3	175	2.23	<0.1	<0.05	0.320	0.078	NA	501	29.1	576	129	1.51	0.9229	8.88	5.81
	Average	181	1.87	0.298[k]	0.699[k]	0.194	0.058[k]	NA	528	20.7	576	133	1.86	0.9354	8.33	7.75

ALK = Alkalinity, mg/L $CaCO_3$	TDS = Total dissolved solids, mg/L
TKN = Total Kjeldahl nitrogen, mg/L	TSS = Total suspended solids, mg/L
NH3 = Ammonia nitrogen, mg/L	TS = Total solids, mg/L
NO3 = Nitrate nitrogen, mg/L	TVS = Total volatile solids, mg/L
TP = Total phosphorus, mg/L	SECCHI = Secchi Disk Depth, Ft.
SRP = Soluble reactive phosphorus, mg/L	COND = Conductivity, milliSiemens/cm

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed
a= TDS calculated with LCHD lab, otherwise, TDS is a calculated value

Lake Louise Water Quality Summary
(2015, 2008, 2003)

2015	OUTLET															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N	TP	SRP	Cl-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
5/13/2015	0	193	1.6	0.324	0.332	0.085	0.025	180	514	6.9	593	100	NA	0.9285	8.19	9.44
6/17/2015	0	178	2.56	<0.1	<0.05	0.187	0.038	155	479	30	565	148	NA	0.8573	8.84	11.87
7/15/2015	0	165	2.74	<0.1	<0.05	0.217	0.041	151	452	32	550	128	NA	0.8044	8.82	11.96
8/12/2015	0	138	3.08	<0.1	<0.05	0.228	0.035	148	472[a]	48	531	123	NA	0.7844	8.97	11.5
9/17/2015	0	136	3.67	<0.1	<0.05	0.273	<0.005	167	447	63	571	166	NA	0.794	9.06	12.3
	Average	162	2.73	0.145[k]	0.106[k]	0.198	0.029[k]	160	473	36.0	562	133	NA	0.8337	NA	11.41

2008	Outlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
21-May	0	202	1.32	0.355	0.219	0.036	0.013	212	NA	17.0	661	100	NA	1.1660	8.03	9.20
18-Jun	0	199	1.39	0.000	<0.05	0.077	0.005	191	NA	11.0	631	120	NA	1.0520	8.68	14.51
16-Jul	0	180	1.62	0.332	0.09	0.242	0.121	172	NA	14.4	558	98	NA	0.9620	8.46	8.94
20-Aug	0	181	4.55	<0.1	<0.05	0.399	0.008	174	NA	62.8	621	149	NA	0.9460	8.03	12.43
17-Sep	0	142	1.69	0.3	0.371	0.171	0.034	92	NA	44.6	427	88	NA	0.6560	7.95	7.65
	Average	181	2.11	0.247[k]	0.227[k]	0.185	0.036	168	NA	30.0	580	111	NA	0.9564	8.23	10.55

2003	Outlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N[*]	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	0	173	1.64	0.331	0.651	0.081	0.018	NA	518	15.0	546	111	NA	NA	NA	NA
18-Jun	0	205	1.66	<0.1	<0.05	0.070	<0.005	NA	580	8.8	582	122	NA	NA	NA	NA
23-Jul	0	169	2.13	<0.1	<0.05	0.229	0.017	NA	510	49.1	600	149	NA	NA	NA	NA
20-Aug	0	179	1.85	<0.1	0.057	0.280	0.116	NA	528	22.0	592	172	NA	NA	NA	NA
25-Sep	0	171	2.06	<0.1	<0.05	0.301	0.080	NA	518	27.2	566	128	NA	NA	NA	NA
	Average	179	1.87	0.331[k]	0.354[k]	0.192	0.058[k]	NA	531	24.4	577	136	NA	NA	NA	NA

ALK = Alkalinity, mg/L $CaCO_3$	TDS = Total dissolved solids, mg/L
TKN = Total Kjeldahl nitrogen, mg/L	TSS = Total suspended solids, mg/L
NH3 = Ammonia nitrogen, mg/L	TS = Total solids, mg/L
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TP = Total phosphorus, mg/L	SECCHI = Secchi Disk Depth, Ft.
SRP = Soluble reactive phosphorus, mg/L	COND = Conductivity, milliSiemens/cm

k = Denotes that the actual value is known to be less than the value presented.

NA= Not applicable

* = Prior to 2006 only Nitrate - nitrogen was analyzed

a= TDS calculated with LCHD lab, otherwise, TDS is a calculated value

Lake Louise Multiparameter Data 2015

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	**0.82**
5/13/2015	0.5	0.68	15.68	7.56	76.8	0.9335	8.06	3979	Surface		
5/13/2015	1	1.03	15.65	7.54	76.6	0.9338	8.07	4251	Surface	100%	
5/13/2015	2	2.06	15.58	7.48	75.8	0.9331	8.03	1800	0.39	42%	2.20350663
5/13/2015	3	3.08	15.27	7.47	75.2	0.9298	8.01	889	1.41	21%	0.5003154
5/13/2015	4	4.08	15.12	7.35	73.8	0.9305	7.95	142	2.41	3%	0.76110796
5/13/2015	5	5.07	14.95	7.24	72.4	0.9318	7.94	271	3.4	6%	-0.1900858

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	**2.12**
6/17/2015	0.5	0.59	23.8	12.36	149.5	0.8583	8.78	2012	Surface		
6/17/2015	1	1.11	23.77	12.23	147.9	0.8593	8.77	2011	Surface	100%	
6/17/2015	2	2.2	23.68	11.92	143.9	0.8606	8.74	179	0.33	9%	7.33030783
6/17/2015	3	3.22	23.61	11.47	138.2	0.8621	8.7	121	1.33	6%	0.29443253
6/17/2015	4	4.05	23.53	11.01	132.5	0.8635	8.69	32	2.33	2%	0.5708389
6/17/2015	5	5.05	23.08	9.52	113.6	0.8781	8.46	13	3.33	1%	0.27050647

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	**1.40**
7/15/2015	0.5	0.68	25.48	11.72	146.8	0.8069	8.99	3948	Surface		
7/15/2015	1	1.31	25.04	10.6	131.6	0.8083	8.91	3665	Surface	100%	
7/15/2015	2	2.34	24.75	10	123.6	0.8076	8.89	70	0.67	2%	5.90759459
7/15/2015	3	3.25	24.6	9.44	116.3	0.8074	8.86	114	1.58	3%	-0.3086729
7/15/2015	4	4.11	24.34	8.15	99.9	0.8112	8.77	34	2.44	1%	0.49583521
7/15/2015	5	5.33	24.25	7.42	90.8	0.8144	8.69	6	3.66	0%	0.47393471
7/15/2015	6	5.62	24.17	3.04	37.1	0.816	8.28	1	3.95	0%	0.45360999

Lake Louise Multiparameter Data 2015

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	**0.69**
8/12/2015	0.5	0.45	25.52	8.73	108.6	0.787	8.82	4038	Surface		
8/12/2015	1	1.61	25.32	8.31	103.1	0.7876	8.76	52	Surface	100%	
8/12/2015	2	2.31	25.28	7.99	99	0.7876	8.73	25	0.64	48%	1.14432483
8/12/2015	3	3.41	25.13	7.85	97.1	0.788	8.74	3	1.74	6%	1.21854226
8/12/2015	4	4.46	25.02	7.08	87.3	0.7898	8.63	1	2.79	2%	0.39376785
8/12/2015	5	5.09	24.98	6.63	81.7	0.79	8.56	1	3.42	2%	0

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	**0.08**
9/17/2015	0.5	0.183	20.36	10.31	114.4	0.792	8.91	50417	Surface		
9/17/2015	1	1.063	20.3	11.08	122.8	0.795	8.93	72031	Surface	100%	
9/17/2015	2	2.115	20.22	10.93	121	0.795	8.91	67845	0.445	94%	0.13454133
9/17/2015	3	3.043	20.19	10.83	119.8	0.795	8.91	59085	1.373	82%	0.1006909
9/17/2015	4	4.043	20.15	10.64	117.6	0.795	8.89	58391	2.373	81%	0.00497906

Lake Louise Landuse and Runoff

Land Use	Acreage	% of Total
Agricultural	0.00	0.0%
Disturbed Land	0.00	0.0%
Forest and Grassland	2.53	0.6%
Government and Institutional	4.68	1.0%
Multi Family	0.00	0.0%
Office	0.00	0.0%
Public and Private Open Space	17.54	3.9%
Retail/Commercial	0.00	0.0%
Single Family	301.20	67.5%
Transportation	62.39	14.0%
Utility and Waste Facilities	0.00	0.0%
Water	56.36	12.6%
Wetlands	1.27	0.3%
Total Acres	**445.98**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	0.00	0.05	0.0	0.0%
Disturbed Land	0.00	0.05	0.0	0.0%
Forest and Grassland	2.53	0.05	0.3	0.1%
Government and Institutional	4.68	2.53	32.6	7.5%
Multi Family	0.00	0.50	0.0	0.0%
Office	0.00	0.85	0.0	0.0%
Public and Private Open Space	17.54	0.15	7.2	1.7%
Retail/Commercial	0.00	0.85	0.0	0.0%
Single Family	301.20	0.30	248.5	57.2%
Transportation	62.39	0.85	145.8	33.6%
Utility and Waste Facilities	0.00	0.30	0.0	0.0%
Water	56.36	0.00	0.0	0.0%
Wetlands	1.27	0.05	0.2	0.0%
TOTAL	**445.98**		**434.7**	100.0%

Lake volume	**132.19**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.30**	**years**
	111.01	**days**

Shoreline Condition Assessment Table

Lake Louise, 2015

Lake Louise Shoreline Erosion Condition, 2015

Reach	None		Slight		Moderate		Severe		Total
	Linear ft.	% of Reach	Linear Ft.	% of Reach	Linear Ft.	% of Reach	Linear Ft.	% of Reach	
LOU01	1337	96	56	4	0	0	0	0	1393
LOU02	266	60	181	40	0	0	0	0	447
LOU04	802	100	0	0	0	0	0	0	802
LOU05	1125	82	240	18	0	0	0	0	1365
LOU06	1475	92	125	8	0	0	0	0	1600
LOU07	1266	80	299	19	27	2	0	0	1592
LOU08	820	89	104	11	0	0	0	0	924
LOU09	1752	77	299	13	225	10	0	0	2276
LOU10	367	100	0	0	0	0	0	0	367
LOU11	355	100	0	0	0	0	0	0	355
Total	9565	86	1304	12	252	2	0	0	11121

Lake Louise Shoreline Buffer Condition, 2015.

Reach	Poor		Fair		Good		Shoreline Assessed
	Linear ft.	% of Reach	Linear Ft.	% of Reach	Linear Ft.	% of Reach	Linear ft.
LOU01	1393	100	0	0	0	0	1393
LOU02	447	100	0	0	0	0	447
LOU04	802	100	0	0	0	0	802
LOU05	1365	100	0	0	0	0	1365
LOU06	1600	100	0	0	0	0	1600
LOU07	1592	100	0	0	0	0	1592
LOU08	924	100	0	0	0	0	924
LOU09	0	0	0	0	2276	100	2276
LOU10	0	0	0	0	367	100	367
LOU11	355	100	0	0	0	0	355
Total	8478	76	0	0	2643	24	11121

Lake Louise Aquatic Plant Summary Table, 2015

Aquatic Plants found at 3 sampling sites on Lake Louise in July 2015.
The maximum depth that plants were found was 1.5 feet.

Plant Density	Giant Duckweed	Sago Pondweed
Absent	41	42
Present	2	1
Common	0	0
Abundant	0	0
Dominant	0	0
% Plant Occurance	4.3	2.2

Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	43	93.5
>0-10%	3	6.5
10-40%	0	0.0
40-60%	0	0.0
60-90%	0	0.0
>90%	0	0.0
Total Sites with Plants	3	6.5
Total # of Sites	46	100.0

Morphometric Features of Lake Louise
Data collected 7/01/2015

Contour (Feet)	Area Enclosed (Acres)	Percent of total acres	Volume (Acre-feet)	Depth Zone (Feet)	Area (Acres)	Percent (Depth zone to total acres)	Percent (Acre-feet to Total Volume)
0	39.19	100.0%	37.97	0 - 1	2.42	6.2%	24.2%
1	36.77	93.8%	35.56	1 - 2	2.41	6.1%	22.6%
2	34.36	87.7%	33.12	2 - 3	2.46	6.3%	21.1%
3	31.90	81.4%	28.89	3 - 4	5.93	15.1%	18.4%
4	25.98	66.3%	15.89	4 - 5	18.35	46.8%	10.1%
5	7.63	19.5%	4.26	5 - 6	6.00	15.3%	2.7%
6	1.63	4.1%	1.02	6 - 7	1.10	2.8%	0.7%
7	0.52	1.3%	0.40	7 - 8	0.23	0.6%	0.3%
8	0.29	0.7%	0.10	8 - 9	0.29	0.7%	0.1%
			157.22		39.19	100%	100%

Maximum Depth of Lake: 8.8 Feet
Average Depth of Lake: 4.6 Feet
Volume of Lake: 157.22 Acre-Feet

Area of Lake: 39.19 Acres
Shoreline Length: 2.26 Miles
Water elevation at 813.5 feet above mean sea level

LakeCounty Health Department and Community Health Center

Lake County average Floristic Quality Index (FQI) ranking 2000-2015.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	37.4	38.9
2	East Loon Lake	34.7	36.1
3	Cranberry Lake	29.7	29.7
4	Deep Lake	29.7	31.2
5	Round Lake Marsh North	29.1	29.9
6	West Loon Lake	27.1	29.5
7	Sullivan Lake	26.9	28.5
8	Bangs Lake	26.2	27.8
9	Little Silver Lake	25.2	26.7
10	Third Lake	25.1	22.5
11	Fourth Lake	24.7	27.1
12	Indpendence Grove	24.6	27.5
13	Sterling Lake	24.5	26.9
14	Sun Lake	24.3	26.1
15	Redwing Slough	24.0	25.8
16	Schreiber Lake	23.9	24.8
17	Lakewood Marsh	23.8	24.7
18	Deer Lake	23.5	24.4
19	Round Lake	23.5	25.9
20	Pistakee Lake	23.5	25.2
21	Lake Marie	23.5	25.2
22	Lake of the Hollow	23.0	24.8
23	Nippersink Lake (Fox Chain)	22.4	23.2
24	Countryside Glen Lake	21.9	22.8
25	Grass Lake	21.5	22.2
26	Davis Lake	21.4	21.4
27	Duck Lake	21.1	22.9
28	Timber Lake (North)	20.9	23.4
29	Lake Catherine	20.8	21.8
30	Cross Lake	20.7	18.7
31	ADID 203	20.5	20.5
32	Broberg Marsh	20.5	21.4
33	McGreal Lake	20.2	22.1
34	Fox Lake	20.2	21.2
35	Honey Lake	20.0	20.0
36	Lake Barrington	19.9	21.8
37	Lake Kathryn	19.6	20.7
38	Fish Lake	19.3	21.2
39	Druce Lake	19.1	21.8
40	Turner Lake	18.6	21.2
41	Wooster Lake	18.5	20.2
42	Salem Lake	18.5	20.2
43	Lake Helen	18.0	18.0
44	Old Oak Lake	18.0	19.1
45	Lake Minear	18.0	20.1
46	Potomac Lake	17.8	17.8
47	Lake Zurich	17.7	18.9
48	Redhead Lake	17.7	18.7
49	Long Lake	17.7	15.8
50	Hendrick Lake	17.7	17.7
51	Rollins Savannah 2	17.7	17.7
52	Grandwood Park Lake	17.2	19.0
53	Seven Acre Lake	17.0	15.5
54	Lake Miltmore	16.8	18.7
55	Petite Lake	16.8	18.7
56	Channel Lake	16.8	18.7
57	McDonald Lake 1	16.7	17.7
58	Highland Lake	16.7	18.9

Lake County average Floristic Quality Index (FQI) ranking 2000-2015.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
59	Bresen Lake	16.6	17.8
60	Almond Marsh	16.3	17.3
61	Owens Lake	16.3	17.3
62	Windward Lake	16.3	17.6
63	Butler Lake	16.1	18.1
64	Grays Lake	16.1	16.1
65	White Lake	16.0	17.0
66	Dunns Lake	15.9	17.0
67	Dog Bone Lake	15.7	15.7
68	Osprey Lake	15.5	17.3
69	Heron Pond	15.1	15.1
70	North Churchill Lake	15.0	15.0
71	Hastings Lake	15.0	17.0
72	Forest Lake	14.8	15.9
73	Dog Training Pond	14.7	15.9
74	Grand Ave Marsh	14.3	16.3
75	Nippersink Lake	14.3	16.3
76	Taylor Lake	14.3	16.3
77	Manning's Slough	14.1	16.3
78	Tower Lake	14.0	14.0
79	Dugdale Lake	14.0	15.1
80	Eagle Lake (S1)	14.0	15.1
81	Crooked Lake	14.0	16.0
82	Spring Lake	14.0	15.2
83	Lake Matthews	13.9	15.5
84	Longview Meadow Lake	13.9	13.9
85	Bishop Lake	13.4	15.0
86	Ames Pit	13.4	15.5
87	Mary Lee Lake	13.1	15.1
88	Old School Lake	13.1	15.1
89	Summerhill Estates Lake	12.7	13.9
90	Lake Tranquility (S1)	12.6	12.6
91	Buffalo Creek Reservoir 1	12.5	11.4
92	Buffalo Creek Reservoir 2	12.5	11.4
93	McDonald Lake 2	12.5	12.5
94	Rollins Savannah 1	12.5	12.5
95	Stone Quarry Lake	12.5	12.5
96	Kemper Lake 1	12.2	13.4
97	Pond-A-Rudy	12.1	12.1
98	Stockholm Lake	12.1	13.5
99	Lake Carina	12.1	14.3
100	Lake Leo	12.1	14.3
101	Lambs Farm Lake	12.1	14.3
102	Grassy Lake	12.0	12.0
103	Flint Lake Oulet	11.8	13.0
104	Albert Lake	11.5	10.3
105	Rivershire Pond 2	11.5	13.3
106	Hook Lake	11.3	13.4
107	Briarcrest Pond	11.2	12.5
108	Lake Naomi	11.2	12.5
109	Pulaski Pond	11.2	12.5
110	Lake Napa Suwe	11.0	11.0
111	Redwing Marsh	11.0	11.0
112	West Meadow Lake	11.0	11.0
113	Nielsen Pond	10.7	12.0
114	Lake Holloway	10.6	10.6
115	Sylvan Lake	10.6	10.6
116	Echo Lake	10.4	10.4

Lake County average Floristic Quality Index (FQI) ranking 2000-2015.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
117	Gages Lake	10.2	12.5
118	College Trail Lake	10.0	10.0
119	Valley Lake	9.9	9.9
120	Werhane Lake	9.8	12.0
121	Columbus Park Lake	9.2	9.2
122	Lake Lakeland Estates	9.2	9.2
123	Waterford Lake	9.2	9.2
124	Bluff Lake	9.1	11.0
125	Lake Fairfield	9.0	10.4
126	Fischer Lake	9.0	11.0
127	Antioch Lake	8.5	8.5
128	Loch Lomond	8.5	8.5
129	Lake Fairview	8.5	6.9
130	Timber Lake (South)	8.5	6.9
131	East Meadow Lake	8.5	8.5
132	South Churchill Lake	8.5	8.5
133	Kemper Lake 2	8.5	9.8
134	Lake Christa	8.5	9.8
135	Lake Farmington	8.5	9.8
136	Lucy Lake	8.5	9.8
137	Lake Louise	8.4	8.4
138	Bittersweet Golf Course #13	8.1	8.1
139	Lake Linden	8.0	8.0
140	Sand Lake	8.0	10.4
141	Countryside Lake	7.7	11.5
142	Fairfield Marsh	7.5	8.7
143	Lake Eleanor	7.5	8.7
144	Banana Pond	7.5	9.2
145	Slocum Lake	7.1	5.8
146	Lucky Lake	7.0	7.0
147	North Tower Lake	7.0	7.0
148	Lake Forest Pond	6.9	8.5
149	Ozaukee Lake	6.7	8.7
150	Leisure Lake	6.4	9.0
151	Peterson Pond	6.0	8.5
152	Little Bear Lake	5.8	7.5
153	Deer Lake Meadow Lake	5.2	6.4
154	ADID 127	5.0	5.0
155	Island Lake	5.0	5.0
156	Liberty Lake	5.0	5.0
157	Oak Hills Lake	5.0	5.0
158	Slough Lake	5.0	5.0
159	International Mining and Chemical Lake	5.0	7.1
160	Diamond Lake	3.7	5.5
161	Lake Charles	3.7	5.5
162	Big Bear Lake	3.5	5.0
163	Sand Pond (IDNR)	3.5	5.0
164	Harvey Lake	3.3	5.0
165	Half Day Pit	2.9	5.0
166	Lochanora Lake	2.5	5.0
167	Hidden Lake	0.0	0.0
168	St. Mary's Lake	0.0	0.0
169	Willow Lake	0.0	0.0
170	Woodland Lake	0.0	0.0
	Mean	**14.0**	**15.0**
	Median	**13.4**	**15.0**

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Cedar Lake	0.0130	41.14
4	Indpendence Grove	0.0130	41.14
5	Druce Lake	0.0140	42.00
6	Windward Lake	0.0160	44.13
7	Lake Minear	0.0164	44.44
8	Sand Pond (IDNR)	0.0165	44.57
9	West Loon	0.0170	45.00
10	Pulaski Pond	0.0180	45.83
11	Cross Lake	0.0216	46.80
12	Banana Pond	0.0200	47.35
13	Gages Lake	0.0200	47.35
14	Lake Kathryn	0.0200	47.35
15	Highland Lake	0.0202	47.49
16	Lake Miltmore	0.0210	48.00
17	Timber Lake (North)	0.0210	48.05
18	Lake Zurich	0.0210	48.19
19	Dog Training Pond	0.0220	48.72
20	Sun Lake	0.0220	48.72
21	Deep Lake	0.0230	49.36
22	Lake of the Hollow	0.0230	49.36
23	Round Lake	0.0230	49.36
24	Stone Quarry Lake	0.0230	49.36
25	Lake Barrington	0.0270	50.60
26	Bangs Lake	0.0260	51.13
27	Lake Leo	0.0260	51.13
28	Cranberry Lake	0.0270	51.68
29	Dugdale Lake	0.0270	51.68
30	Peterson Pond	0.0270	51.68
31	Little Silver Lake	0.0280	52.22
32	Fourth Lake	0.0360	53.00
33	Lambs Farm Lake	0.0310	53.67
34	Old School Lake	0.0310	53.67
35	Grays Lake	0.0310	54.00
36	Butler Lake	0.0324	54.33
37	Harvey Lake	0.0320	54.50
38	Hendrick Lake	0.0340	55.00
39	Sand Lake	0.0380	56.00
40	Third Lake	0.0384	56.00
41	Sullivan Lake	0.0370	56.22
42	Ames Pit	0.0390	56.98
43	Diamond Lake	0.0390	56.98
44	East Loon	0.0400	57.34
45	Schreiber Lake	0.0400	57.34
46	Waterford Lake	0.0400	57.34
47	Lake Tranquility (S1)	0.0412	57.38
48	Hook Lake	0.0410	57.70
49	Nielsen Pond	0.0450	59.04
50	Seven Acre Lake	0.0460	59.36
51	Turner Lake	0.0460	59.36

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
52	Willow Lake	0.0460	59.36
53	Honey Lake	0.0590	59.69
54	East Meadow Lake	0.0480	59.97
55	Lucky Lake	0.0480	59.97
56	Old Oak Lake	0.0490	60.27
57	College Trail Lake	0.0500	60.56
58	Hastings Lake	0.0520	61.13
59	West Meadow Lake	0.0530	61.40
60	Wooster Lake	0.0530	61.40
61	Lucy Lake	0.0550	61.94
62	Lake Linden	0.0570	62.45
63	Lake Christa	0.0580	62.70
64	Owens Lake	0.0580	62.70
65	Briarcrest Pond	0.0580	63.00
66	Redhead Lake	0.0608	63.20
67	St. Mary's Lake	0.0608	63.41
68	Lake Lakeland Estates	0.0620	63.66
69	Lake Naomi	0.0620	63.66
70	Lake Catherine	0.0620	63.76
71	Liberty Lake	0.0630	63.89
72	North Tower Lake	0.0630	63.89
73	Werhane Lake	0.0630	63.89
74	Countryside Glen Lake	0.0640	64.12
75	Davis Lake	0.0650	64.34
76	Leisure Lake	0.0650	64.34
77	Channel Lake	0.0680	64.91
78	Buffalo Creek Reservoir 1	0.0680	65.00
79	Mary Lee Lake	0.0680	65.00
80	Little Bear Lake	0.0680	65.00
81	Timber Lake (South)	0.0720	65.82
82	Lake Helen	0.0720	65.82
83	Grandwood Park Lake	0.0720	65.82
84	Crooked Lake	0.0710	66.00
85	ADID 203	0.0730	66.02
86	Broberg Marsh	0.0780	66.97
87	Echo Lake	0.0790	67.20
88	Redwing Slough	0.0822	67.73
89	Tower Lake	0.0830	67.87
90	Countryside Lake	0.0800	68.00
91	Lake Nippersink	0.0800	68.00
92	Woodland Lake	0.0800	68.00
93	Lake Fairview	0.0890	68.00
94	Antioch Lake	0.0850	68.18
95	Potomac Lake	0.0850	68.21
96	White Lake	0.0862	68.42
97	Grand Ave Marsh	0.0870	68.55
98	North Churchill Lake	0.0870	68.55
99	McDonald Lake 1	0.0880	68.71
100	Pistakee Lake	0.0880	68.71
101	Rivershire Pond 2	0.0900	69.04
102	South Churchill Lake	0.0900	69.04

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
103	McGreal Lake	0.0910	69.20
104	Lake Charles	0.0930	69.40
105	Deer Lake	0.0940	69.66
106	Eagle Lake (S1)	0.0950	69.82
107	International Mine and Chemical Lake	0.0950	69.82
108	Valley Lake	0.0950	69.82
109	Buffalo Creek Reservoir 2	0.0960	69.97
110	Fish Lake	0.0960	69.97
111	Lochanora Lake	0.0960	69.97
112	Big Bear Lake	0.0960	69.97
113	Fox Lake	0.1000	70.52
114	Nippersink Lake - LCFP	0.1000	70.56
115	Sylvan Lake	0.1000	70.56
116	Petite Lake	0.1020	70.84
117	Longview Meadow Lake	0.1020	70.84
118	Lake Marie	0.1030	70.93
119	Dunn's Lake	0.1070	71.53
120	Lake Forest Pond	0.1070	71.53
121	Long Lake	0.1070	71.53
122	Grass Lake	0.1090	71.77
123	Spring Lake	0.1100	71.93
124	Kemper 2	0.1100	71.93
125	Bittersweet Golf Course #13	0.1100	71.93
126	Bluff Lake	0.1120	72.00
127	Middlefork Savannah Outlet 1	0.1120	72.00
128	Osprey Lake	0.1110	72.06
129	Bresen Lake	0.1130	72.32
130	Round Lake Marsh North	0.1130	72.32
131	Deer Lake Meadow Lake	0.1160	72.70
132	Lake Matthews	0.1180	72.94
133	Taylor Lake	0.1180	72.94
134	Island Lake	0.1210	73.00
135	Columbus Park Lake	0.1230	73.54
136	Lake Holloway	0.1320	74.56
137	Lakewood Marsh	0.1510	76.50
138	Pond-A-Rudy	0.1510	76.50
139	Forest Lake	0.1540	76.78
140	Slocum Lake	0.1500	77.00
141	Middlefork Savannah Outlet 2	0.1590	77.00
142	Grassy Lake	0.1610	77.42
143	Salem Lake	0.1650	77.78
144	Half Day Pit	0.1690	78.12
145	Lake Louise	0.1810	79.08
146	Lake Eleanor	0.1810	79.11
147	Lake Farmington	0.1850	79.43
148	ADID 127	0.1890	79.74
149	Lake Napa Suwe	0.1940	80.00
150	Loch Lomond	0.1960	80.23
151	Patski Pond	0.1970	80.33
152	Dog Bone Lake	0.1990	80.48

Lake County average TSI phosphorus (TSIp) ranking 2000-2015.

RANK	LAKE NAME	TP AVE	TSIp
153	Summerhill Estates Lake	0.1990	80.48
154	Redwing Marsh	0.2070	81.05
155	Stockholm Lake	0.2082	81.13
156	Bishop Lake	0.2160	81.66
157	Ozaukee Lake	0.2200	81.93
158	Kemper 1	0.2220	82.08
159	Hidden Lake	0.2240	82.19
160	McDonald Lake 2	0.2250	82.28
161	Fischer Lake	0.2280	82.44
162	Oak Hills Lake	0.2790	85.35
163	Heron Pond	0.2990	86.35
164	Rollins Savannah 1	0.3070	87.00
165	Fairfield Marsh	0.3260	87.60
166	ADID 182	0.3280	87.69
167	Slough Lake	0.3860	90.03
168	Manning's Slough	0.3820	90.22
169	Rasmussen Lake	0.4860	93.36
170	Albert Lake, Site II, outflow	0.4950	93.67
171	Flint Lake Outlet	0.5000	93.76
172	Rollins Savannah 2	0.5870	96.00
173	Almond Marsh	1.9510	113.00
	Average	***0.1130***	***66.0***

Appendix C:
Methods for Field Data Collection and Laboratory Analyses

Water Sampling and Laboratory Analyses

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

Plant Sampling

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

Plankton Sampling

Plankton were sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a or YSI 6600 Sonde® 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 63μm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton were 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 were 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. Prior to sub-sample being removed for enumeration, the 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 in 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 1 mm deep. The slide was then placed under the microscope and counted at a 20X magnification (phytoplankton) or 10X magnification (zooplankton). For phytoplankton, twenty fields of view were randomly counted with all species within each field counted. Due to their larger size, zooplankton were counted throughout the entire slide. Through calculations, it was determined how many of each species were in 1 mL of lake water.

Phytoplankton (algae) are free-floating and microscopic and are distinguished from plants because they lack roots, stems and leaves. There are four distinct groups of phytoplankton found in Lake County lakes: blue-greens, greens, diatoms, and dinoflagellates/chrysophytes. Blue-greens are also known as cyanobacteria because they are the only group of bacteria that obtain their energy from photosynthesis like plants. Some of these species can be toxic. Green algae are the closest ancestors of land plants and are the most common group. Diatoms are unique because they are encased in a cell wall made of silica that can be very ornate. Dinoflagellates and chrysophytes are almost always flagellated (able to move by flagella, a whip-like tail) and some can both photosynthesize and consume bacteria for food.

Zooplankton are made up of rotifers and two crustacean groups; the cladocerans and the copepods (broken down further into calanoids and cyclopoids). Rotifers are smaller and most have a crown of cilia (hair-like structure) used for movement and drawing in suspended particles to eat. Crustaceans have jointed appendages and are enclosed in an exoskeleton. Cladocerans, such as the “water flea” Daphnia species, are filter-feeding like rotifers, while the copepod group contains both filter-feeders (calanoids and cyclopoids) and raptorial species (cyclopoids).

Shoreline Assessment

Shoreline Assessment Protocol

Each lake was divided into reaches in ArcGIS based on nearshore landuse. For each reach, a shoreline assessment worksheet was filled out in the field focusing on shoreline conditions (land use, slope, erosion, buffer, etc) that describe the overall reach segment of the lake.

A GPS Trimble unit was used to collect the degree of shoreline erosion along the entire length of the lake. The degree of shoreline erosion was categorically defined as none, slight, moderate, or severe. Below are brief descriptions of each category.

Table 1: Degree of Shoreline Erosion

Category	Description
None	Includes man-made erosion control such as 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”. Beaches have been included as “slight” erosion.
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.

Lateral recession rates were calculated on a per reach basis based on the IL EPA stream methodology, defining lateral recession into four main categories (slight, moderate, severe, and very severe). Descriptions of each category are defined in the Table 2.

Table 2: Lateral Recession Rate Categories

Lateral Recession Rate	Description	Description
0.01 – 0.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetation overhanging. No exposed tree roots.
0.06 – 0.2	Moderate	Bank mostly bare with some rills and vegetation overhanging.
0.3 – 0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U-shaped and streamcourse or gully may be meandering.

Shoreline Buffer Condition

Lakeshore buffer condition was assessed using a qualitative methodology that considered an area up to 25 feet inland from the shoreline for each reach. The assessment was done by viewing high resolution 2014 aerial images in ArcGIS. A 25 foot buffer was chosen based on research that indicates a 25-foot vegetated buffer is the minimum effective width for in-lake habitat maintenance (a 15 foot buffer is the minimum effective width for bank stability). Criteria used for category assignment are shown in table below.

Table 3: Shoreline Buffer Condition Categories

Category	Criteria	Percentage
Good	Unmowed grasses & forbs + tree trunks + shrubs *and* impervious surfaces	≥70% ≤5%
Fair	Unmowed grasses & forbs + tree trunks + shrubs *and* Impervious surface	≥50% and <70% ≤10%
Poor	Unmowed grasses & forbs +tree trunks + shrubs *and* Impervious surface	<50% ≥50%

Wildlife Assessment

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

Table A1. Analytical methods used for water quality parameters.

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

Appendix D:
Wisconsin Department of Natural Resources
Chemical Fact Sheets

Wisconsin Department of Natural Resources

January 2012

Diquat Chemical Fact Sheet

Formulations

Diquat, or diquat dibromide, is the common name of the chemical 6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium dibromide. Originally registered by the EPA in 1986, diquat was reregistered in 1995 and is currently being reviewed again. It is sold for agricultural and household uses as well as for use on certain floating-leaf and submersed aquatic plants and some algae. The aquatic formulations are liquids: two of the more commonly used in Wisconsin are Reward™ and Weedtrine-D™ (product names are provided solely for your reference and should not be considered endorsements).

Aquatic Use and Considerations

Diquat is a fast-acting herbicide that works by disrupting cell membranes and interfering with photosynthesis. It is a non-selective herbicide and will kill a wide variety of plants on contact. It does not move throughout the plants, so will only kill parts of the plants that it contacts. Following treatment, plants will die within a week.

Diquat will not be effective in lakes or ponds with muddy water or where plants are covered with silt because it is strongly attracted to silt and clay particles in the water. Therefore, bottom sediments must not be disturbed during treatment, such as may occur with an outboard motor. Only partial treatments of ponds or bays should be conducted (1/2 to 1/3 of the water body). If the entire pond were to be treated, the decomposing vegetation may result in very low oxygen levels in the water. This can be lethal to fish and other aquatic organisms. Untreated areas can be treated 10-14 days after the first treatment.

Diquat is used to treat duckweed (*Lemna* spp.), which are tiny native plants. They are a food source for waterfowl but can grow thickly and become a nuisance. Navigation lanes through cattails (*Typha* spp.) are also maintained with diquat. Diquat is labeled for use on the invasive Eurasian watermilfoil (*Myriophyllum spicatum*) but in practice is not frequently used to control it because other herbicide options are more selective.

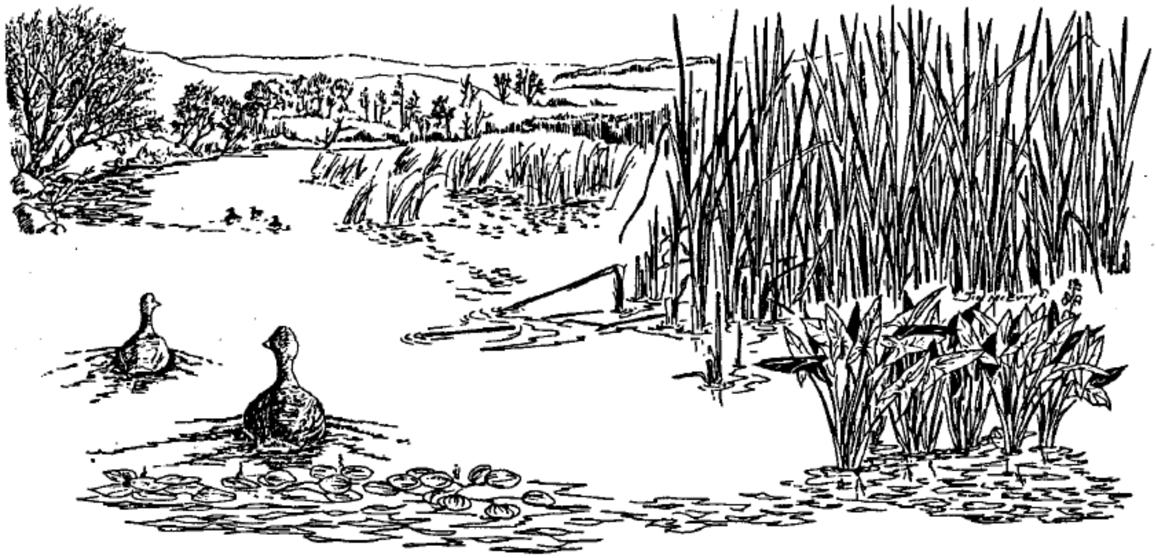
Post-Treatment Water Use Restrictions

There are no restrictions on swimming or eating fish from water bodies treated with diquat. Treated water should not be used for drinking water for one to three days, depending on the concentration used in the treatment. Do not use treated water for pet or livestock drinking water for one day following treatment. The irrigation restriction for food crops is five days, and for ornamental plants or lawn/turf, it varies from one to three days depending on the concentration used.

Herbicide Degradation, Persistence and Trace Contaminants

Diquat is not degraded by microbes. When applied to a waterbody, diquat binds with the organic matter in the sediment indefinitely. It does not degrade and will accumulate in the sediments. Diquat is usually detectable in the water column for less than a day to ~35 days after treatment. Diquat will remain in the water column longer when treating a waterbody with sandy soils due to the low organic matter and clay content. Because of its persistence and very high affinity for the soil, diquat does not leach into groundwater.

Ethylene dibromide (EDB) is a trace contaminant in diquat products. It originates from the manufacturing process. EDB is a carcinogen, and the EPA has evaluated the health risk of its presence in formulated diquat products. The maximum level of EDB in diquat dibromide is 10 ppb (parts per billion), it degrades over time, and it does not persist as an impurity.



Impacts on Fish and Other Aquatic Organisms

At application rates, diquat does not have any apparent short-term effects on most of the aquatic organisms that have been tested. However, certain species of important aquatic food chain organisms such as amphipods and Daphnia (water fleas) can be adversely affected at label application rates. Direct toxicity and loss of habitat are believed to be the causes. Tests on snails have shown that reproductive success may be affected, as well. These organisms only recolonize the treated area as vegetation becomes re-established.

Laboratory tests indicate walleye are the fish most sensitive to diquat, displaying toxic symptoms when confined in water treated with diquat at label application rates. Other game and panfish (e.g. northern pike, bass, and bluegills) are apparently not affected at these application rates. Limited field studies to date have not identified significant short or long-term impacts on fish and other aquatic organisms in lakes or ponds treated with diquat.

The bioconcentration factors measured for diquat in fish tissues is low. Therefore, bioconcentration is not expected to be a concern with diquat.

Human Health

The risk of acute exposure to diquat would be primarily to chemical applicators. Diquat causes severe skin and eye irritation and is toxic or fatal if absorbed through the skin, inhaled or swallowed. Wearing skin and eye protection (e.g. rubber gloves, apron, and goggles) to minimize eye and skin irritation is required when applying diquat.

The risk to water users of serious health impacts (e.g. birth defects and cancer) is not believed to be significant according to the EPA. Some risk of allergic reactions or skin irritation is present for sensitive individuals.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

2,4-D Chemical Fact Sheet

Formulations

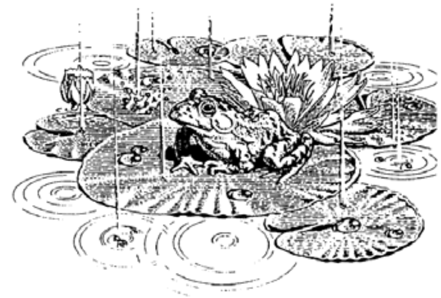
2,4-D is an herbicide that is widely used as a household weed-killer, agricultural herbicide, and aquatic herbicide. It has been in use since 1946, and was registered with the EPA in 1986 and re-reviewed in 2005. The active ingredient is 2,4-dichloro-phenoxyacetic acid. There are two types of 2,4-D used as aquatic herbicides: dimethyl amine salt and butoxyethyl ester. Both liquid and slow-release granular formulations are available. 2,4-D is sold under the trade names Aqua-Kleen, Weedar 64 and Navigate (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves. Plants begin to die in a few days to a week following treatment, but can take several weeks to decompose. Treatments should be made when plants are growing.

For many years, 2,4-D has been used primarily in small-scale spot treatments. Recently, some studies have found that 2,4-D moves quickly through the water and mixes throughout the waterbody, regardless of where it is applied. Accordingly, 2,4-D has been used in Wisconsin experimentally for whole-lake treatments.

2,4-D is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Desirable native species that may be affected include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.



Post-Treatment Water Use Restrictions

There are no restrictions on eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Following the last registration review in 2005, the ester products require a 24-hour waiting period for swimming. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of 2,4-D (the time it takes for half of the active ingredient to degrade) ranges from 12.9 to 40 days depending on water conditions. In anaerobic lab conditions, the half-life has been measured up to 333 days. After treatment, the 2,4-D concentration in the water is reduced primarily through microbial activity, off-site movement by water, or adsorption to small particles in silty water. It is slower to degrade in cold or acidic water, and appears to be slower to degrade in lakes that have not been treated with 2,4-D previously.

There are several degradation products from 2,4-D: 1,2,4-benzenetriol, 2,4-dichlorophenol, 2,4-dichloroanisole, chlorohydroquinone (CHQ), 4-chlorophenol and volatile organics.

Impacts on Fish and Other Aquatic Organisms

Toxicity of aquatic 2,4-D products vary depending on whether the formulation is an amine or an ester 2,4-D. The ester formulations are toxic to fish and some important invertebrates such as water fleas (*Daphnia*) and midges at application rates; the amine formulations are not toxic to fish or invertebrates at application rates. Loss of habitat following treatment may cause reductions in populations of invertebrates with either formulation, as with any herbicide treatment. These organisms only recolonize the treated areas as vegetation becomes re-established.

Available data indicate 2,4-D does not accumulate at significant levels in the bodies of fish that have been tested. Although fish that are exposed to 2,4-D will take up some of the chemical, the small amounts that accumulate are eliminated after exposure to 2,4-D ceases.

On an acute basis, 2,4-D is considered moderately to practically nontoxic to birds. 2,4-D is not toxic to amphibians at application rates; effects on reptiles are unknown. Studies have shown some endocrine disruption in amphibians at rates used in lake applications, and DNR is currently funding a study to investigate endocrine disruption in fish at application rates.

As with all chemical herbicide applications it is very important to read and follow all label instructions to prevent adverse environmental impacts.

Human Health

Adverse health effects can be produced by acute and chronic exposure to 2,4-D. Those who mix or apply 2,4-D need to protect their skin and eyes from contact with 2,4-D products to minimize irritation, and avoid inhaling the spray. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with 2,4-D.

Concerns have been raised about exposure to 2,4-D and elevated cancer risk. Some (but not all) epidemiological studies have found 2,4-D associated with a slight increase in risk of non-Hodgkin's lymphoma in high exposure populations (farmers and herbicide applicators). The studies show only a possible association that may be caused by other factors, and do not show that 2,4-D causes cancer. The EPA determined in 2005 that there is not sufficient evidence to classify 2,4-D as a human carcinogen.

The other chronic health concern with 2,4-D is the potential for endocrine disruption. There is some evidence that 2,4-D may have estrogenic activities, and that two of the break-down products of 2,4-D (4-chlorophenol and 2,4-dichloroanisole) may affect male reproductive development. The extent and implications of this are not clear and it is an area of ongoing research.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

DNR PUB-WT-964 2012

Wisconsin Department of Natural Resources

January 2012

Endothall Chemical Fact Sheet

Formulations

Endothall is the common name of the active ingredient endothal acid (7-oxabicyclo[2,2,1] heptane-2,3-dicarboxylic acid). Endothall products are used to control a wide range of terrestrial and aquatic plants. Both granular and liquid formulations of endothall are available for aquatic use in Wisconsin. Two types of endothall are available: dipotassium salt (such as Aquathol®) and monoamine salts (such as Hydrothol 191). Trade names are provided for your reference only and are neither exhaustive nor endorsements of one product over another.

Aquatic Use and Considerations

Endothall is a contact herbicide that prevents certain plants from making the proteins they need. Factors such as density and size of the plants present, water movement, and water temperature determine how quickly endothall works. Under favorable conditions, plants begin to weaken and die within a few days after application.

Endothall products vary somewhat in the target species they control, so it is important to always check the product label for the list of species that may be affected. Endothall products are effective on Eurasian watermilfoil (*Myriophyllum spicatum*) and also kill desirable native species such as pondweeds (*Potamogeton* spp.) and coontail (*Ceratophyllum* spp.). In addition, Hydrothol 191 formulations can also kill wild celery (*Vallisneria americana*) and some species of algae (*Chara, Cladophora, Spirogyra, and Pithophora*).

Endothall will kill several high value species of aquatic plants (especially *Potamogeton* spp.) in addition to nuisance species. The plants that offer important values to aquatic ecosystems often resemble, and may be growing with those plants targeted for treatment. Careful identification of plants and application of endothall products is necessary to avoid unintended harm to valuable native species.

For effective control, endothall should be applied when plants are actively growing. Most submersed weeds are susceptible to Aquathol formulations. The choice of liquid or granular formulations depends on the size of the area requiring treatment. Granular is more suited to small areas or spot treatments, while liquid is more suitable for large areas.

If endothall is applied to a pond or enclosed bay with abundant vegetation, no more than 1/3 to ½ of the surface should be treated at one time because excessive decaying vegetation may deplete the oxygen content of the water and kill fish. Untreated areas should not be treated until the vegetation exposed to the initial application decomposes.

Post-Treatment Water Use Restrictions

Due to the many formulations of this chemical the post-treatment water use restrictions vary. Each product label must be followed. For all products there is a drinking water standard of 0.1 ppm and can not be applied within 600 feet of a potable water intake. Use restrictions for Hyrdtohol products have irrigation and animal water restrictions.

Herbicide Degradation, Persistence and Trace Contaminants

Endothall disperses with water movement and is broken down by microorganisms into carbon, hydrogen, and oxygen. Field studies show that low concentrations of endothall persist in water for several days to several weeks depending on environmental conditions. The half-life (the time it takes for half of the active ingredient to degrade) averages five to ten days. Complete degradation by microbial action is 30-60 days. The initial breakdown product of endothall is an amino acid, glutamic acid, which is rapidly consumed by bacteria.

Impacts on Fish and Other Aquatic Organisms

At recommended rates, the dipotassium salts (Aquathol and Aquathol K) do not have any apparent short-term effects on the fish species that have been tested. In addition, numerous studies have shown the dipotassium salts induce no significant adverse effects in aquatic invertebrates (such as snails, aquatic insects, and crayfish) when used at label application rates. However, as with other herbicide use, some plant-dwelling populations of aquatic organisms may be adversely affected by application of endothall formulations due to habitat loss.

In contrast to the low toxicity of the dipotassium salt formulations, laboratory studies have shown the monoamine salts (Hydrothol 191 formulations) are toxic to fish at dosages above 0.3 parts per million (ppm). In particular, the liquid formulation will readily kill fish present in a treatment site. By comparison, EPA approved label rates for plant control range from 0.05 to 2.5 ppm. In recognition of the extreme toxicity of the monoamine salt, product labels recommend no treatment with Hydrothol 191 where fish are an important resource.

Other aquatic organisms can also be adversely affected by Hydrothol 191 formulations depending upon the concentration used and duration of exposure. Tadpoles and freshwater scuds have demonstrated sensitivity to Hydrothol 191 at levels ranging from 0.5 to 1.8 ppm.

Findings from field and laboratory studies with bluegills suggest that bioaccumulation of dipotassium salt formulations by fish from water treated with the herbicide is unlikely. Tissue sampling has shown residue levels become undetectable a few days after treatment.

Human Health

Most concerns about adverse health effects revolve around applicator exposure. Liquid endothall formulations in concentrated form are highly toxic. Because endothall can cause eye damage and skin irritation, users should minimize exposure by wearing suitable eye and skin protection.

At this time, the EPA believes endothall poses no unacceptable risks to water users if water use restrictions are followed. EPA has determined that endothall is not a neurotoxicant or mutagen, nor is it likely to be a human carcinogen.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources

January 2012

Fluridone Chemical Fact Sheet

Formulations

Fluridone is an aquatic herbicide that was initially registered with the EPA in 1986. The active ingredient is 1-methyl-3-phenyl-5-3-(trifluoromethyl)phenyl|-41H|-pyridinone. Both liquid and slow-release granular formulations are available. Fluridone is sold under the brand names Avast!, Sonar, and Whitecap (product names are provided solely for your reference and should not be considered endorsements).

Aquatic Use and Considerations

Fluridone is an herbicide that stops the plant from making a protective pigment that keeps chlorophyll from breaking down in the sun. Treated plants will turn white or pink at the growing tips after a week and will die in one to two months after treatment as it is unable to make food for itself. It is only effective if plants are growing at the time of treatment.

Fluridone is used at very low concentrations, but a very long contact time is required (45-90 days). If the fluridone is removed before the plants die, they will once again be able to produce chlorophyll and grow.

Fluridone moves rapidly through water, so it is usually applied as a whole-lake treatment to an entire waterbody or basin. There are pellet slow-release formulations that may be used as spot treatments, but the efficacy of this is undetermined. Fluridone has been applied to rivers through a drip system to maintain the concentration for the required contact time.

Plants vary in their susceptibility to fluridone, so typically some species will not be affected even though the entire waterbody is treated.

Plants have been shown to develop resistance to repeated fluridone use, so it is recommended to rotate herbicides with different modes of action when using fluridone as a control.

Fluridone is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). It also is commonly used for control of invasive hydrilla (*Hydrilla verticillata*) and water hyacinth (*Eichhornia crassipes*), neither of which are present in Wisconsin yet. Desirable native species that are usually affected at concentrations used to treat the invasives include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of fluridone (the time it takes for half of the active ingredient to degrade) ranges from 4 to 97 days depending on water conditions. After treatment, the fluridone concentration in the water is reduced through dilution due to water movement, uptake by plants, adsorption to the sediments, and break down from light and microbial action.

There are two major degradation products from fluridone: n-methyl formamide (NMF) and 3-trifluoromethyl benzoic acid. NMF has not been detected in studies of field conditions, including those at the maximum label rate.

Fluridone residues in sediments reach a maximum in one to four weeks after treatment and decline in four months to a year depending on environmental conditions. Fluridone adsorbs to clay and soils with high organic matter, especially in pellet form, and can reduce the concentration of fluridone in the water. Adsorption to the sediments is reversible; fluridone gradually dissipates back into the water where it is subject to chemical breakdown.

Impacts on Fish and Other Aquatic Organisms

Fluridone does not appear to have any apparent short-term or long-term effects on fish at application rates.

Fish exposed to water treated with fluridone absorb fluridone into their tissues. Residues of fluridone in fish decrease as the herbicide disappears from the water. The EPA has established a tolerance for fluridone residues in fish of 0.5 parts per million (ppm).

Studies on Fluridone's effects on aquatic invertebrates (i.e. midge and water flea) have shown increased mortality at label application rates.

Studies on birds indicate that fluridone would not pose an acute or chronic risk to birds. No studies have been conducted on amphibians or reptiles.

Human Health

The risk of acute exposure to fluridone would be primarily to chemical applicators. The acute toxicity risk from oral and inhalation routes is minimal. Concentrated fluridone may cause some eye or skin irritation. No personal protective equipment is required on the label to mix or apply fluridone.

Fluridone does not show evidence of causing birth defects, reproductive toxicity, or genetic mutations in mammals tested. It is not considered to be carcinogenic nor does it impair immune or endocrine function.

There is some evidence that the degradation product NMF causes birth defects. However, since NMF has only been detected in the lab and not following actual fluridone treatments, the manufacturer and EPA have indicated that fluridone use should not result in NMF concentrations that would adversely affect the health of water users. In the re-registration assessment that is currently underway for fluridone, the EPA has requested additional studies on both NMF and 3-trifluoromethyl benzoic acid.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Hamelink, J.L., D.R. Buckler, F.L. Mayer, D.U. Palawski, and H.O. Sanders. 1986. Toxicity of Fluridone to Aquatic Invertebrates and Fish. Environmental Toxicology and Chemistry 5:87-94.

Fluridone ecological risk assessment by the Bureau of Land Management, Reno Nevada:
http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/veis.Par.91082.File.tmp/Fluridone%20Ecological%20Risk%20Assessment.pdf

Wisconsin Department of Natural Resources

January 2012

Triclopyr Chemical Fact Sheet

Formulations

Triclopyr was initially registered with the EPA in 1979 and was reregistered in 1997. Triclopyr acid has different formulations for aquatic and terrestrial use. The active ingredient triethylamine salt (3,5,6-trichloro-2-pyridinyloxyacetic acid), commonly called triclopyr, is the formulation registered for use in aquatic systems. It is sold both as a liquid (Renovate 3™) as well as a granular form (Renovate OTF™) for control of submerged, emergent and floating-leaf vegetation. There is also a liquid premixed formulation (Renovate Max G™) that contains triclopyr plus 2,4-D, another aquatic herbicide.

Aquatic Use and Considerations

Triclopyr is used to treat the invasive Eurasian watermilfoil (Myriophyllum spicatum). Desirable native species that may also be affected include native milfoils, water shield (*Brasenia schreberi*), pickerelweed (*Pontederia cordata*), and lilies (*Nymphaea* spp. and *Nuphar* spp.).

Triclopyr is a systemic herbicide that moves throughout the plant tissue and works by interfering with cell growth and division. Following treatment, plant growth will be abnormal and twisted, and then plants will die within two to three weeks after application. Plants will decompose over several weeks.

Triclopyr needs to be applied to plants that are actively growing. A water body should not be treated with triclopyr if there is an outlet, or in moving waters such as rivers or streams. If there is water movement at a treated site, higher concentrations or a repeated application may be required.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated water bodies, or pet/livestock drinking water use. Before treated water can be used for irrigation, the concentration must be below one part per billion (ppb), or at least 120 days must pass. Treated water should not be used for drinking water until concentrations of triclopyr are less than 400 ppb.

Herbicide Degradation, Persistence and Trace Contaminants

Triclopyr is broken down rapidly by light and microbes and has a half-life (the time it takes for half of the active ingredient to degrade) of about a day. Dissipation studies in lakes indicate that the half-life in natural systems ranges from 0.5 to 7.5 days. Lakes with more organic matter in the soil will have more rapid degradation.

The initial breakdown products of triclopyr are TCP (3,5,6-trichloro-2-pyridinol) and TMP (3,5,6-trichloro-2-methoxypridine). TCP and TMP appear to be slightly more toxic to aquatic organisms than triclopyr; however the peak concentration of these degradates is very low following treatment, so that they do not pose a concern to aquatic organisms. The half-lives for TCP and TMP are similar to those of triclopyr.

Triclopyr doesn't bind to soil, and limited leaching of triclopyr and its degradation products may occur. It likely is not mobile enough to contaminate groundwater, and EPA has determined that the evidence of possible leaching is not sufficient to require further study.

Impacts on Fish and Other Aquatic Organisms

Testing indicates that the aquatic formulation of triclopyr is practically non-toxic to fish and invertebrates. Species tested included catfish, trout, bluegill, minnows, crayfish and water fleas (*Daphnia* sp.). Triclopyr is slightly toxic to mallards, but at concentrations well above (400x) the highest allowed application rate. Water pH will affect toxicity because greater exposure to triclopyr will occur in low pH water. Tests have not been conducted in low pH water except for salmon species. However, the margin of safety in the toxicity tests that were conducted suggest that even in low pH water there would not be toxic effects on fish.

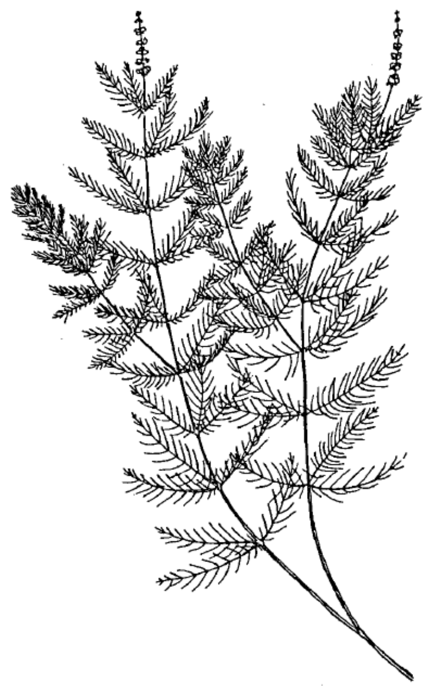
Tests on the degradation product TCP indicate that acute effects to bluegill and rainbow trout would not occur at label usage rates, although it is slightly more toxic than triclopyr. The degradation product TMP is moderately toxic to fish, but after treatment is found only in low proportions if it is detected at all. The EPA has requested additional data to evaluate the fate of the degradation product TCP in aquatic systems as well as its chronic toxicity to fish.

Triclopyr and TCP do not bioaccumulate and clear from fish and crayfish tissues at rates similar to that which occurs in the water. TMP does appear to bioaccumulate in fatty fish tissues, such as inedible and visceral tissues, but does not persist in fish following TMP disappearance from the water.

Human Health

The risk of acute exposure to triclopyr would be primarily to chemical applicators. Concentrated triclopyr does not pose an inhalation risk, but can cause skin irritation and eye corrosion. Persons who mix or apply triclopyr need to protect their skin and eyes from contact. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with triclopyr.

Triclopyr does not show evidence of birth defects, reproductive toxicity or genetic mutations in mammals tested. Triclopyr is not metabolized by humans and the majority is excreted intact. Some tumors of breast tissue occurred in tests on rodents; however there was no consistent pattern and insufficient evidence to list triclopyr as a carcinogen. Based on its low acute toxicity to mammals, and its rapid disappearance from the water column due to light and microbial degradation, triclopyr is not considered to pose a risk to water users.



For Additional Information

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Wisconsin Department of Natural Resources

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Copper Compounds Chemical Fact Sheet

Formulations

Copper has been used as an aquatic herbicide and algaecide since 1950. Copper compounds for aquatic use are manufactured either as copper sulfate, or as a copper chelate. Both forms contain metallic copper as the active ingredient, but in the chelate forms the copper is combined with other compounds to keep the copper in solution and active in the water longer. Chelated copper is also less toxic to non-target organisms.

There are copper sulfate products available as fungicides and other terrestrial uses, which are not allowed for use in water. Aquatic copper products are sold under a variety of brand names, including Nautique™, Komeen®, Captain™, K-Tea™, Earthec®, Cutrine®-Plus, Clearigate® and SeClear (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

Copper products are primarily used to treat algae but certain formulations will affect some plants, as well. The target species vary by product, so it is important to confirm that the intended target is listed on the label of the product being used.

Copper works by interfering with enzyme production. Results from treatments for algae occur within hours, while the effects of treatment on plants will be evident in about a week. Large-scale algae die-off can deplete oxygen levels in the water quickly, which can be lethal to fish and other aquatic life. If more than a 1/3 of the total water area is covered in algae, treatments should be done in sections, and applied in a pattern that allows fish an escape route to untreated water. Ten to fourteen days are needed between treatments to protect fish and aquatic life.

Copper products will treat blue-green (free-floating) algae and filamentous (mat-forming) algae as well as larger algae species that look like plants, such as *Chara* spp. and *Nitella* spp.. In Wisconsin, copper is not typically used to treat aquatic plants, but some are labeled to treat the invasives Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), as well as the native species coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*), sago pondweed (*Stuckenia pectinata*) and water celery (*Vallisneria americana*).

Determining the correct copper formulation and calculating the proper dosage are key factors in determining how well copper will control undesirable algae. Applicators need to consider target species, water hardness, water temperature, amount of algae present, as well as water clarity and flow.

In hard or alkaline waters, copper sulfate tends to settle to the bottom within 24 hours after application. Chelated copper remains in solution longer, allowing for a longer contact time with the algae.

All copper formulations can be toxic to some species of fish at recommended application rates, especially if the water has less than 50 ppm (parts per million) of carbonate hardness (soft water). However, toxicity generally decreases as water hardness increases.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated water bodies, human drinking water, pet/livestock drinking water, or irrigation.

Herbicide Degradation, Persistence and Trace Contaminants

Copper is an element, and so is not broken down like other herbicides. Copper precipitates out of the water over a few days and settles into the sediments, where it persists indefinitely and accumulates over time. The buildup of copper in lake sediments is a serious concern, because high concentrations of copper in the sediment are toxic to both plant and animal life.

Impacts on Fish and Other Aquatic Organisms

Copper sulfate is rarely used in Wisconsin, in part due to its high toxicity to invertebrates (water fleas, crustaceans, mollusks, mayflies, snails, and crayfish) and multiple species of fish (trout, bluegill and minnow) at typical application concentrations. The chelated forms of copper have different toxicology profiles from each other and from copper sulfate.

The chelated copper products can also be toxic to fish at application rates, particularly to trout and bluegill in soft water ($CaCO_3$ <50ppm). Applications to harder water provide a greater margin of safety to fish.

Many of the chelated copper products are also toxic to invertebrates at application rates. High concentrations of copper in lake sediment can be toxic to invertebrates that live on the lake bottom, as well. These invertebrates are an important source of fish food.

Copper does temporarily accumulate in fish, but more in the gills and the liver than in muscle tissue. The copper in fish tissues are reduced once the copper level in the water is reduced.

The EPA risk assessment for birds and small mammals (based on dietary consumption) indicates that some risk may be present to birds or mammals at the worst-case scenario. However, this maximum dietary exposure scenario is likely much higher than the exposure level that might occur to birds when copper is released into the environment as an algaecide. Birds, like humans, can physiologically acclimate to higher concentrations of copper in order to slow its uptake. Studies of copper's effects on birds have shown to be toxic at high levels; however, effects at standard treatment levels have not been shown to be harmful. Studies have shown that even at low levels (.07ppm) copper sulfate can have detrimental effects on amphibians, including slowed growth rates, decreased mobility and death. Effects on reptiles have not been documented.

Human Health

The risk of acute exposure to copper is primarily to chemical applicators. The acute toxicity risk from oral and inhalation routes is minimal; however concentrated copper products can be corrosive to the eyes and cause irreversible damage. Prolonged or frequent skin contact can cause allergic reactions in some people. Goggles, protective clothing, and rubber gloves are required when handling.

Even with regular use for many years, very few chronic health concerns have been documented. In one study agricultural applicators of copper were found to have some signs of liver damage, and there is some evidence that high copper may impair immune function. Copper is not carcinogenic.

For Additional Information

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