LAKE COUNTY, ILLINOIS

2010 LAKE LINDEN LAKE SUMMARY REPORT

PREPARED BY THE

LAKE COUNTY HEALTH DEPARTMENT

Population Health Environmental Services

Lake Linden

Picture provided by: Lake Lindenhurst Lake Commission

Lake Linden was created in the early 1960's by developer, Mort Eagle, and construction of homes began immediately after the lake was created. The lake has a surface area of 31 acres and a mean depth of 4.8 feet. It is located entirely within the village limits of Lindenhurst and is managed by the Lindenhurst Lakes Commission. Lindenhurst village residents use the lake for swimming, boating and fishing. There are two state licensed beaches, three parks and a boat launch on the lake. Lake Linden has also been a participant in the Illinois Environmental Protection Agency's (IEPA) Volunteer Lake Monitoring Program since 1994.

Lake Linden receives water from its approximate 354 acre watershed and drains into Hastings Lake which enters North Mill Creek. The land use within the Lake Linden watershed is nearly completely composed of single family homes.

Overall water quality in Lake Linden has not improved since the 2006 lake study. Total phosphorus concentrations in Lake Linden averaged 0.057 mg/L which is 42% increase from the 2006 concentration of 0.033 mg/L and is above the IEPA's impairment rate of 0.050 mg/L. Nitrogen is the other nutrient critical for

ENVIRONMENTAL SERVICES WATER QUALITY SPECIALISTS

Kelly Deem kdeem@lakecountyil.gov

Leonard Dane ldane@lakecountyil.gov

Kathy Paap kpaap@lakecountyil.gov

SPECIAL POINTS OF INTEREST:

- *Decreased Water Quality*
- *No Exotic Plants*
- *Participation in the Volunteer Lakes Monitoring Program*

INSIDE THIS ISSUE:

LAKE LINDEN SUMMARY (CONTINUED FROM PAGE 1)

Lake Facts:

Major Watershed: Des Plaines

Sub-Watershed: North Mill Creek

Location: T46N, R21E, Section 35

Surface Area: 30.5 acres

Shoreline Length: 1.4 miles

Maximum Depth: 10.1 feet

Average Depth: 3.1 feet

Lake Volume: 94.8 acre-feet

Watershed Area: 283.4 acres

Lake Type: Human-made

Management Entity: Lindenhurst Lakes Commission

Current Uses: swimming, fishing, and non-gas powered boating

Access: Lindenhurst residents

algal growth. The Total Kjeldahl nitrogen concentration for Lake Linden was 1.02 mg/L which was below the 2009 county median of 1.18 mg/L and slightly lower than the 2006 concentration (1.13 mg/L). A total nitrogen to total phosphorus (TN:TP) ratio of 18:1 indicates that phosphorus is limiting. Also using phosphorus as an indicator, the trophic state index (TSPp) classified Lake Linden as eutrophic with a TSIp value of 62.4.

The 2010 average total suspended solids (TSS) concentration for Lake Linden was 4.2 mg/L, which was less than the county median but a 31% increase from the 2006 average of 2.9 mg/L. Water clarity was measured by Secchi depth, with the lowest reading in August (2.15 feet) corresponding to the high TSS concentration (8.8 mg/L). The average Secchi depth for the season was 4.60 feet, which is higher than the county median of 3.15 feet.

Conductivity concentrations are correlated with chloride concentrations, the average conductivity reading for Lake Linden was in 2010 was 0.7294 mS/cm, which was slightly below the county median (0.7910 mS/cm). This was a 65% decrease from the 2006 average (1.2028 mS/cm). The chloride concentration in Lake Linden in 2010 was 134 mg/L which is also below the county median of 145 mg/L.

Aquatic plant sampling was conducted on Lake Linden in July. The aquatic plant community consisted of two species and plants were found at 97% of the sites sampled. *Chara* spp. was the dominant species at 77% of the sites sampled and Water Stargrass at 53% of sites sampled. The species diversity has decreased since 2006.

Based on the 2010 shoreline erosion assessment, 84% of Lake Linden shoreline had no erosion. The other 16 % exhibited signs of slight erosion. Fluctuation in lake level can increase erosion, fluctuation in lake levels was observed during the sampling season. Data from the Stormwater Management Commission's Lindenhurst rain gauge was correlated to rain events and increased lake levels in Lake Linden. The most notable event in 2010 was 7.34 inches of rain fall between the July and August sampling events that resulted in the season's highest lake level in August.

LAKE LINDEN WATERSHED

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.

Which watershed do you live in?

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 Linden is in the North Mill Creek watershed and receives water from its small watershed and drains into Hastings Lake from the south inlet. The 283 acre watershed carries storm water and pollutants into Lake Linden. The external sources affecting Lake Linden were from the following land uses: single family homes (65%) and transportation (15%). Based on the amount of impervious surfaces each land use contributes varied amounts of runoff. Because impervious surfaces (parking lots, roads, buildings, compacted soil) do not allow rain to infiltrate into the ground, more runoff is generated than in the undeveloped condition. The two major sources of runoff for Lake Linden were single family homes (53%) and transportation (34%). The lake is surrounded by developed land which provides the lake with little protection from runoff and nutrients before it enters the lake.

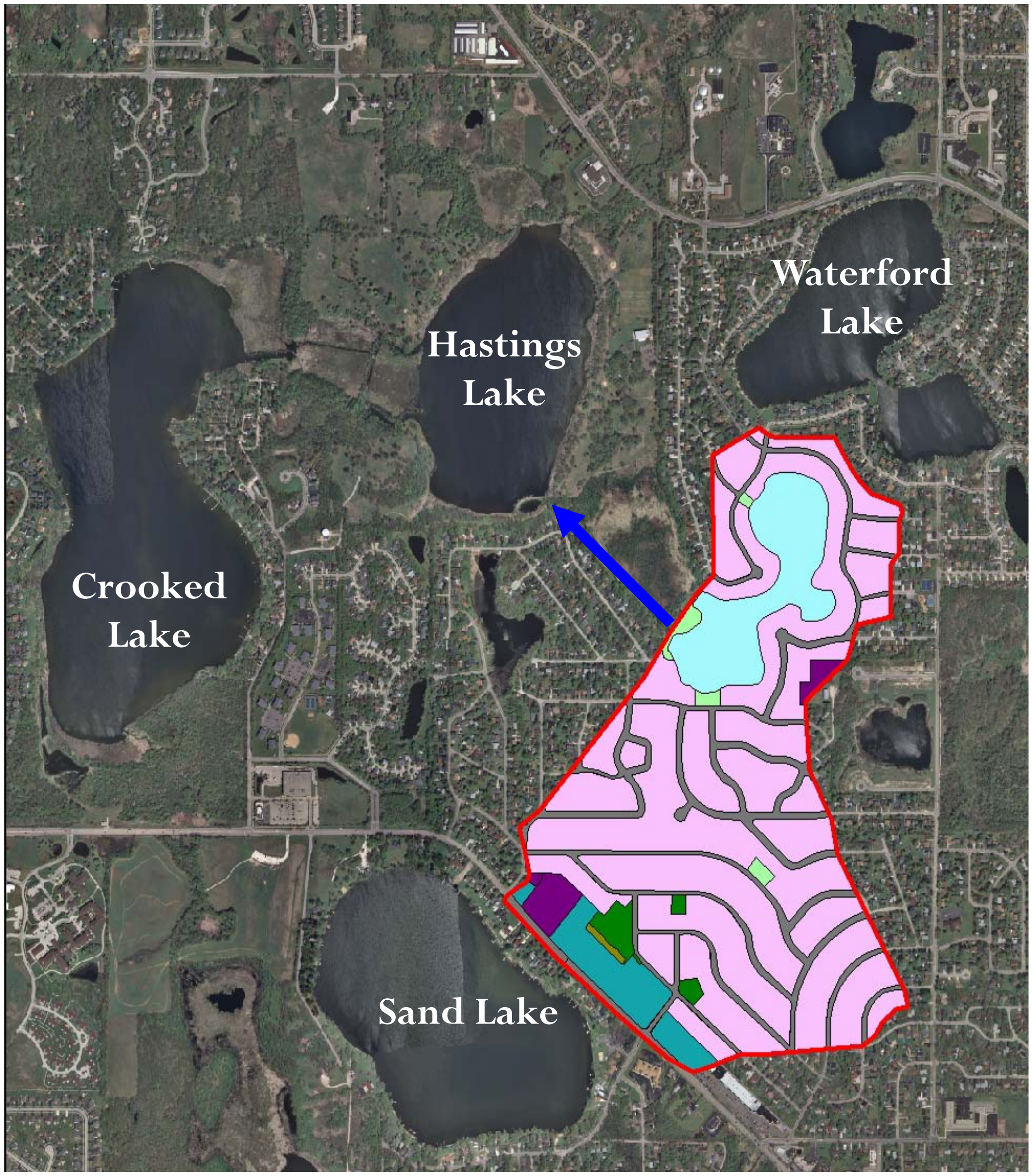
The size of the watershed feeding the lake relative to the lakes size is also an important factor in determining the amount of pollutants in the lake. The retention time, the amount of time it takes for water entering a lake to flow out of it again, was calculated to be approximately 118 days.

Typically water quality declines as pollutants accumulate from the top to the bottom of the watershed. However the water quality actually improves as it travels downstream to Hastings Lake. The water moves from the outlet through a wetland area that helps to buffer against upstream impacts.

LAKE LINDEN WATERSHED

2010 Land use in the Lake Linden watershed

Lake Linden Outlet



Direction of watershed:
Lake Linden drains into Hastings Lake from the south west outlet. Hastings Lake drains north into North Mill Creek and eventually enters Rasmussen Lake.

Lake	Lake Linden	Lake Linden	Lake Linden	Hastings Lake	Hastings Lake	Hastings Lake
Year	2002	2006	2010	2001	2006	2010
Secchi (feet)	5.87	6.54	4.6	3.29	4.85	3.52
TSS (mg/L)	2.3	2.9	4.2	7.6	6.2	5.2
TP (mg/L)	0.042	0.033	0.057	0.066	0.068	0.052
Conductivity (milliSiemens/cm)	0.9772	1.2028	0.7294	0.7863	1.0886	0.8491

2001 to 2010 Comparisons for epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity readings for Lake Linden and Hastings Lake.

VOLUNTEER LAKE MONITORING PROGRAM

The VLMP was established in 1981 to gather information on Illinois inland lakes, and to provide an educational program for citizens. The primary measurement by volunteers is the secchi depth (water clarity). 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. . In 2010 there were **43 lakes** participating in Lake County.

For more information visit: www.epa.state.il.us/water/vlmp/index.html

WATER CLARITY

Water clarity is an indicator of water quality related to chemical and physical properties.

Measurements taken with a Secchi disc indicate the light penetration into a body of water.

Algae, microscopic animals, water color, eroded soil, and resuspended bottom sediment are factors that interfere with light penetration and reduce water transparency.

The 2010 average water clarity in Lake Linden was 4.60 feet; this was a 30% reduction in the lake's transparency since 2006 (6.54 feet) however the water clarity was above the county median of 2.95.

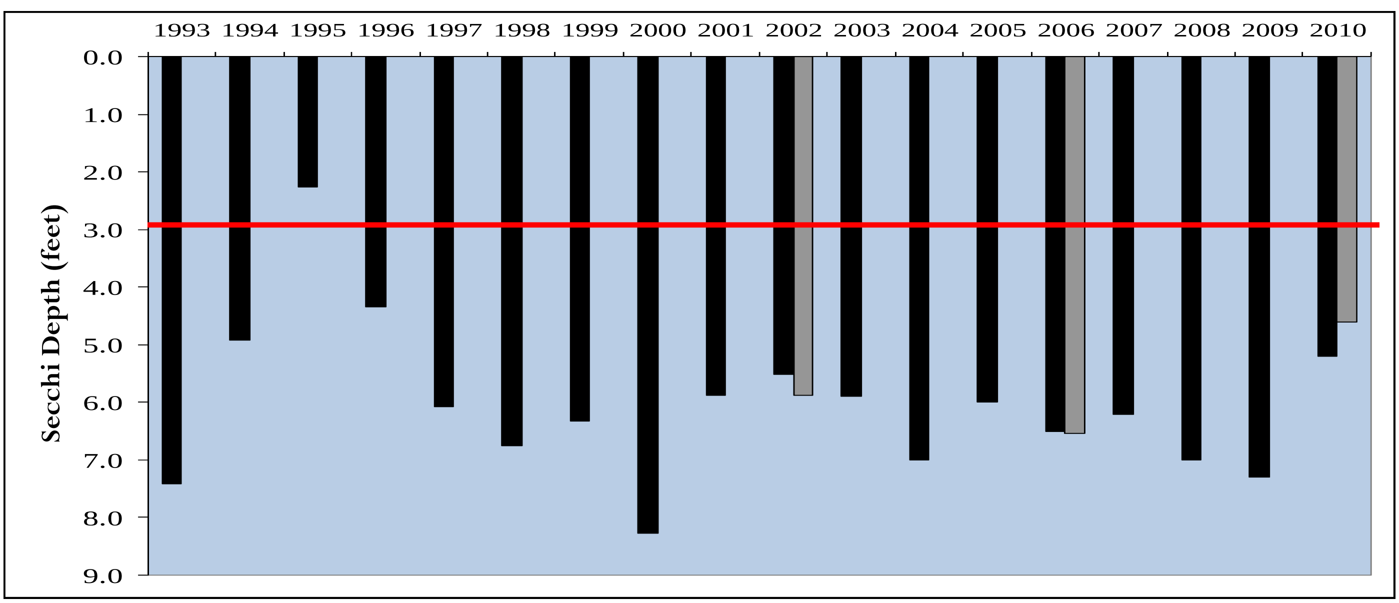
A Secchi disk is an eight-inch diameter weighted metal plate painted black and white in alternating quadrants. A calibrated rope is used to lower the disc into the water and measure the depth to which it is visible.

WATER CLARITY-VOLUNTEER LAKE MONITOR PROGRAM

Additional water clarity measurements were taken in Lake Linden through participation in the Illinois Environmental Protection Agency's (IEPA) Volunteer Lake Monitoring Program (VLMP). Lake Linden has participated in the program since 1993. Lake Linden has been monitored by Lyle Erickson with McCloud Aquatic Services since 1996; in addition to Secchi depth measurements Mr. Erickson also records dissolved oxygen concentrations. Participation in the VLMP program has provided Lake Linden with baseline data that can be used to determine long-term water quality trends and support current lake management decision making. The average VLMP Secchi disk depth from 1993 through 2010 was 6.05 feet. Yearly readings have varied from 2.25 feet in 1995 to 8.2 feet in 2000. Water clarity has remained above the 2010 county median since 1993 the only exception being 1995. Lake Linden has provided data that is vital for the continued monitoring and management of this lake. The LCHD-ES would like to thank them for their efforts and recommend continued involvement in the future.

SECCHI DISK AVERAGES FROM VLMP AND LCHD RECORDS FOR LAKE LINDEN 1993-2010.

- VLMP
- LCHD
- LAKE COUNTY 2010 MEDIAN 2.95 FEET



TOTAL SUSPENDED SOLIDS

Another measure of water clarity is turbidity, which is caused by particles of matter rather than dissolved organic compounds. Suspended particles dissipate light, which affects the depth at which plants can grow. The total suspended solid (TSS) parameter (turbidity) is composed of nonvolatile suspended solids (NVSS), non-organic clay or sediment materials, and volatile suspended solids (TVS) (algae and other organic matter).

2010 TSS concentrations averaged 4.2 mg/L which was below the county median of 8.1 mg/L. This is a 31% increase since 2006 (2.9 mg/L). High TSS values are typically correlated with poor water clarity (Secchi disk depth) and can be detrimental to many aspects of the lake ecosystem including the plant and fish communities. Calculated nonvolatile suspended solids (NVSS) was <1 mg/L. This means that the majority of the TSS concentration can be attributed to organic particles, such as algae. Turbidity caused by algae is the most common reason for low Secchi disc readings in Lake Linden. Algae blooms were documented throughout the sampling season.

There were two main types of algae documented during the 2010 sampling season. Early in the summer filamentous algae mats could be found along the shorelines, primarily consisting of *Mougeotia* sp. a non branching filamentous green algae. As summer progressed planktonic algae blooms occurred. In August a blue-green algae bloom consisting primarily of *Anabaena* sp. occurred. August had the highest TSS concentration and the lowest Secchi depth. measurement since 1995.

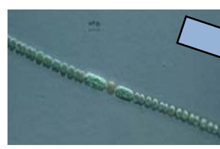
Year	TSS
2010	4.2
2006	2.9
2002	2.3
1996	2.9

Total Suspended Solids concentration (mg/L) in Lake Linden from 1996-2010.

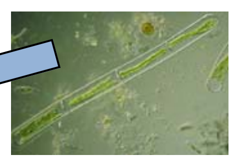
***2010 Lake County median TSS = 8.1 mg/L**

Green Filamentous Algae Bloom

Picture provided by: Lindenhurst Lakes Commission



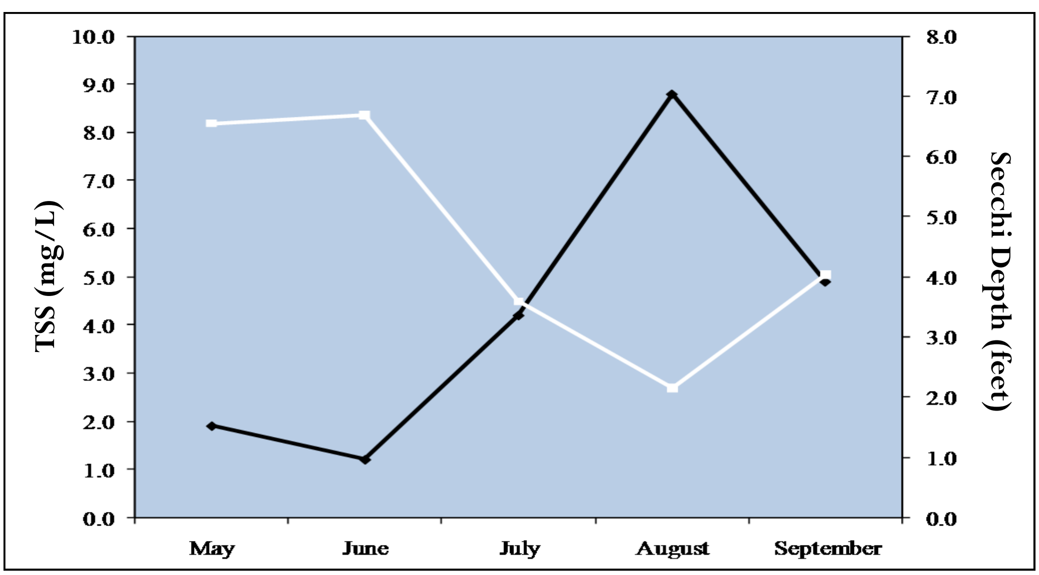
Anabaena *Sp.*



Mougeotia *Sp.*

Blue-green Planktonic Algae Bloom

Picture provided by: Lindenhurst Lakes Commission



Monthly Total Suspended Solid Concentrations and Secchi Depth in Lake Linden, 2010.

TSS (mg/L)

Secchi Depth (feet)

Blue-green algae-the facts

Homeowners can help reduce nutrient concentrations by promoting the following land management practices:

- Use phosphorus free fertilizers and only where truly needed
- Plant and maintain native plant buffer strips along shorelines of lakes, ponds, and streams
- Prevent yard debris from leaving property (ie leaves, grass clippings, etc.)
- Clean up after pets
- Don't dump anything in the storm drain

For more information on Blue-green algae.

http://dnr.wi.gov/lakes/bluegreenalgae/

http://www.health.state.ny.us/environmental/water/drinking/bluegreenalgae.pdf

To report a blue-green algae bloom:

Lake County Health Department
Environmental Services
(8470 377-8030

Bacteria Blue-green algae, also known as cyanobacteria, are not a true algae but are in fact closely related to bacteria. Similar to bacteria in structure, these simple organisms are credited for first using chlorophyll to make food from sunlight and for boosting oxygen in the Earth's early atmosphere. Today this organism forms an important role at the base of the food chain in our lakes; however they also pose a potential harmful health effect as they reach nuisance and noxious populations due to the high nutrient loads in our lakes.

Blue-green algae are naturally present in lakes and streams in low numbers. Blue-green algae can become abundant in warm, shallow, undisturbed surface water that receives a lot of sunlight. Under some conditions the algae becomes so abundant that they can form floating rafts or scums on the surface of the water. Both true algae and blue-green have similar growth requirements including sunlight, warmth, and nutrients (phosphorus and nitrogen). However an oversupply of nutrients, especially phosphorus, will often result in excessive growth of blue-green algae because they possess certain **Adaptations** adaptations that enable them to out compete true algae. One of these adaptations is positive buoyancy; blue-greens contain gas vesicles that allow them to rise to the lake surface during calm conditions to take advantage of sunlight. The second adaptation of some blue-green algae is the ability to fix nitrogen from the atmosphere when nitrogen supplies are low. This is especially useful in Lake County where 62% of the lakes have high levels of phosphorus. This means that in lakes with high phosphorus there is not enough nitrogen, thus the need for this adaptation.

In addition to having unique adaptations, some blue-green **Toxins** algae can also produce toxins, these are known collectively as cyanotoxins. Not all blue-green algae produce harmful conditions. The three primary genera in our area that are responsible are *Anabaena, Aphanizomenon, and Microcystis*.

Algal toxins could pose a health risk to people and animals when they are exposed to the toxins in large quantities. Health effects could occur when surface scums or water containing high levels of blue-green algal toxins are swallowed, come in contact with the skin or when airborne droplets containing toxins are inhaled while swimming, bathing, or showering. Lake County residents get their drinking water from Lake Michigan and ground water; both of which have minimal levels of nutrients and algae cells unlike our inland lakes. Direct contact or breathing airborne droplets containing high levels of blue-green algal toxins during swimming or showering can cause irritation of the skin, eyes, nose and throat and inflammation in the respiratory tract. To protect yourself against exposure do not swim, boat, etc in water that looks like "pea soup," green or blue paint, or that has a scum layer or puffy blobs floating on the surface.

Treatments There is no quick or easy way to control blue-green algae. Chemical treatments can control blue-green algae temporarily, but repeated applications are often necessary. It is best to treat blue-green algae when populations are low. Treating large populations can cause large amounts of toxins to be released at once. Reducing the amount of nutrients in the lake or pond will eventually reduce the frequency and intensity of the blooms. It is not understood when or why blue-green algae release toxins, if you **Symptoms** 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. For more information or to report a blue-green algae bloom contact the Lake County Health Department.

During a blue green algae bloom the lake can develop a paint-like appaearance

Slocum Lake

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 Aquatic Services treated Lake Linden for algae every two weeks from April through August with copper sulfate. The largest application occurred on Lake Linden April 13, 2010 to treat a heavy filamentous algae bloom and moderate Chara sp. growth. 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 Linden average alkalinity concentration in 2010 was 149 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.

Copper Sulfate Application

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.**

Aquatic Herbicides-Floridone (Sonar)

Sonar™ is a broad spectrum herbicide used to reduce the populations of a variety of submerged, emergent, and floating plants, and shoreline plants. Sonar is absorbed through the leaves and shoots and from the soil through the roots. Sonar is a photosynthetic inhibitor, the application blocks the light reactions of photosynthesis where plants convert the energy from sunlight into food. Depending on conditions symptoms of the treatment can be observed 7-10 days after treatment. Leaves will appear pale green, yellow, or yellow-white in color. McCloud Aquatic Services applied Sonar in Lake Linden on April 13, and May 05, 2010 to reduce Curlyleaf Pondweed (exotic and invasive) and Waterstargrass.

New Permit Requirements for Applying Pesticides in Waters

Starting this October, new regulations go into effect that will significantly affect how pesticides are used in Illinois waters. A National Pollutant Discharge Elimination System (NPDES) permit will now be required to apply any type of pesticides over or into waters of the State. In Illinois, the permitting process will be administrated through the Illinois Environmental Protection Agency (IEPA).

Who has to get a permit? According to the language in the permit, anyone who qualifies as an "operator", which is defined as: "any person, persons, group, or entity in control over the financing for, or over the decision to perform pest control activities, or applying pesticides that will result in a discharge to waters of the State". Homeowner associations or even individuals may need to get a permit. However, it is believed that it will be primarily aimed at commercial applicators. Regardless of the size of treatment, a permit will be needed. If the treatment area or total annual area exceeds certain thresholds then additional requirements will be required such as a Pesticide Discharge Management Plan and an annual report. The thresholds vary depending on type of treatment. For weed and algae control, the threshold is 20 acres of treatment or 20 linear miles along the water's edge. The threshold is an annual total, so for example, algaecides applied to five acres four times during the year, would meet this 20 acre threshold requirement.

Anyone or any group planning to treat their pond or lake with pesticide this year should take into account these new requirements.

FOR FULL DETAILS OF THE RULE SEE:

HTTP://WWW.EPA.STATE.IL.US/WATER/PERMITS/PESTICIDE/INDEX.HTML

Excerpt from Winter 2011 Cattail Chronicles.

YEAR	TP
1996	0.034
2002	0.042
2006	0.033
2010	0.057

PHOSPHORUS CONCENTRATIONS FOR LAKE LINDEN 1996-2010

2010 Lake County median TP = 0.065 mg/L

WHAT HAS BEEN DONE TO REDUCE PHOSPHORUS LEVELS IN LAKE LINDEN

January 2009- Lindenhurst passed an ordinance prohibiting the use of lawn fertilizers containing phosphorus

July 2010- The state of Illinois passed a law to reduced the amount of phosphorus content in dishwashing and laundry detergents

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

WHAT YOU CAN DO TO HELP LOWER PHOSPHORUS LEVELS IN LAKE LINDEN

*Do not throw leaves, grass clippings, pet waste, other organic debris into the street or driveway. Runoff carries these through storm sewers, directly to Lake Linden

*Build a rain garden to filter run-off from roofs, driveways, streets. This allows the phosphorus to be bound to the soil so it does not reach surface waters.

*Sweep up fertilizer that is spilled or inadvertently applied to hard surface areas, do not hose it away.

NUTRIENTS-PHOSPHORUS/NITROGEN

Organisms need nutrients to live or grow and are typically taken in from its environment. In a lake the primary nutrients needed for aquatic plant and algal growth are phosphorus and nitrogen. In most lakes, including Lake Linden phosphorus is the limiting nutrient, which means everything that plants and algae need to grow is available in excess: sunlight, warmth, and nitrogen. Phosphorus has a direct effect on the amount of plant and algal growth in lakes.

The 2010 average total phosphorus concentration in Lake Linden was 0.057 mg/L this was a 42% reduction from the 2006 concentration (0.033 mg/L). The Illinois Environmental Protection Agency (IEPA) will list Lake Linden as being impaired for total phosphorus as the 2010 phosphorus concentration exceeds the impairment level of 0.050 mg/L. Concentrations above the impairment level can support high densities of algae and aquatic plants which can reduce water clarity and dissolved oxygen levels.

Phosphorus originates from a variety of sources, many of which are related to human activities which include: human and animal waste, soil erosion, detergents, septic systems, common carp, and runoff from farmland and lawns.

Nitrogen is the other nutrient critical for algal growth. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average 2010 TKN for Lake Linden was 1.49 mg/L, which was higher than the county median of 1.18 mg/L.

TROPHIC STATE INDEX

Another way to look at phosphorus levels and how they affect lake productivity is to use a Trophic State Index (TSI) based on phosphorus (TSIp). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). A lakes 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 that drives eutrophication is speeding up this process significantly. The TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich, productive). In 2010, Lake Linden was eutrophic with a TSIp value of 62.4. Based on the TSIp, Lake Linden ranked 64th out of 162 lakes studied by the ES from 2000-2010. The 2010 value has dropped 23 spots from the 2006 TSIp value of 54.4.

OLIGOTROPHIC:

Lakes are generally clear, deep and free of weeds or large algae blooms. Though beautiful, they are low in nutrients and do not support large fish populations.

MESOTROPHIC:

Lakes lie between the oligotrophic and eutrophic stages. Devoid of oxygen in late summer, their hypolimnions limit cold water fish and cause phosphorus cycling from sediments.

EUTROPHIC:

Lakes are high in nutrients, they are usually either weedy or subject to frequent algae blooms, or both. Eutrophic lakes often support large fish populations, but are also susceptible to oxygen depletion.

Conductivity and Chloride

Conductivity is a measure of a water's ability to conduct electricity , which is a measure of the water's ionic activity and content. The higher the concentration of (dissolved) ions the higher the conductivity. Conductivity readings, which are influenced by chloride concentrations, have been increasing throughout the past decade in Lake County. Road salts used in winter road maintenance consist of the following ions sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanides which are detected when chlorides are analyzed. The 2010 average conductivity reading for Lake Linden was 0.7294 mS/cm. This parameter was below the county median of 0.7800 mS/cm and a 41% decrease from 2006 (1.203 mS/cm). This reduction was influenced by the weather. In 2010 there was significantly more rain events than 2006 causing some of the Cl- ions to be diluted or flushed out of the lake. Concentrations averaged 134 mg/L for the season and were below the county median of 142 mg/L. The United States Environmental Protection Agency has determined that chloride concentrations higher than 230 mg/L can disrupt aquatic systems and prolonged exposure can harm 10% of aquatic species. Additionally, shifts in algal populations were associated with chloride concentrations as low as 12 mg/L. To illustrate the critical value concentration 1 teaspoon of table salt added to 5 gallons of water is equivalent to 230 mg/L.

It appears that road salt is compounding in many lakes in the county. Some lakes in the county have seen a doubling of conductivity readings in the past 10-15 years particularly lakes within watersheds that have transportation as a primary land use. Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watershed often have higher conductivity readings and higher Cl^- concentrations because of the use of road salts. Lake Linden had lower conductivity readings than Hastings Lake. Chlorides tend to accumulate within a watershed as these ions do not break down and are not utilized by plants or animals. High chloride concentrations may make it difficult for many of our native species to survive. However, many of our invasive species, such as Eurasian Watermilfoil, Cattail and Common Reed, are tolerant to high chloride concentrations.

YEAR	COND	Cl^-
1996	0.8360	NA
2002	0.9772	NA
2006	1.203	209
2010	0.7294	134

Chloride Concentrations (CL-) and Conductiviy for Lake Linden 1996-2010

***2010 Lake County medians**

Conductivity = 0.7800 mS/cm

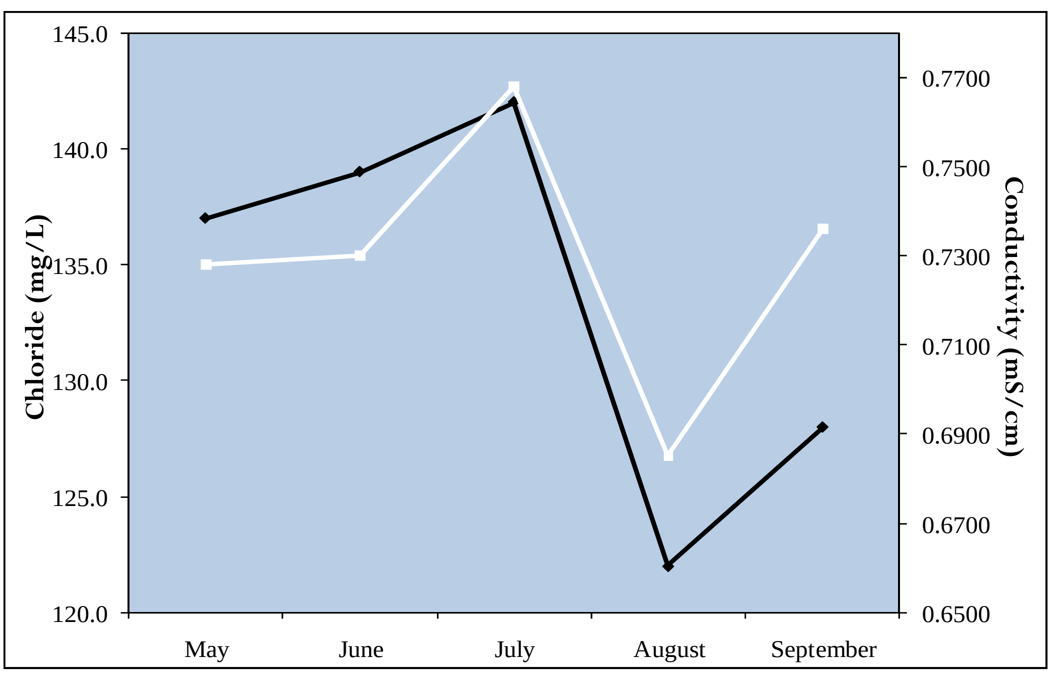
Chloride= 142mg/L

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.



Monthly Chloride Concentrations (CL) Vs. Conductivity in Lake Linden, 2010.

Conductivity

Chlorides

DATE	COND	Cl^-
May	0.728	137
June	0.730	139
July	0.768	142
August	0.685	122
September	0.736	128

Monthly Chloride Concentrations (CL-) and Conductiviy for Lake Linden, 2010.

TIPS

- 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.

CHLORIDES: WHAT HAS BEEN DONE TO REDUCE CHLORIDE LEVELS IN LAKE LINDEN

Village of Lindenhurst Public Works:

Uses an environmentally friendly alternative to salt a liquid by-product consisting of salt brine mix (70%), beet juice (20%) (beet by-product) and calcium chloride (10%). This product will be mixed with the salt on the trucks to create an oatmeal like substance, and then applied to the streets.

This liquid has several advantages.

1. Beet juice adds moisture to help salt work better.
2. Lowers the working temperature of salt to around 20 degrees (below zero).
3. Creates a composition that sticks to the pavement versus dry salt that can bounce off of the pavement.
4. Reduces salt use by 20%.
5. Environmentally friendly product.

Lake County Division of Transportation:

Is enhancing efficiency of snow removal, and going green through innovation and technology. Global positioning systems (GPS) on snow plows are providing real-time tracking of these vehicles, as well as the application of salt and de-ice materials. The data is then used to better coordinate and target services, saving on salt and gas.

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

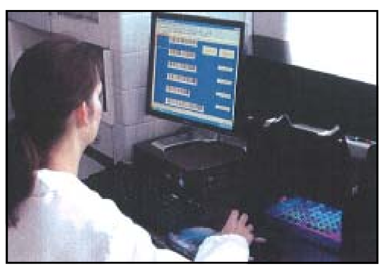
TIPS

Practicing common sense and good hygiene will go a long way in preventing illness from swimming beaches.

- If you are sick, do NOT swim.
- Do NOT drink the water while swimming.
- Avoid swimming during heavy algae blooms.
- Keep geese off the beach.
- Children who are not toilet trained should wear tight-fitting rubber or plastic pants.
- Take a shower before entering the water, and have kids take frequent bathroom breaks.
- Wash your hands after exiting the lake.

SWIMMING BEACH MONITORING

There are two state licensed swimming beaches on Lake Linden: Linden's Landing and Meyer's Beach. They were sampled for the bacteria *Eschericia coli* (*E. coli*) levels every two weeks, from mid May to the end of August, by the LCHD-ES in 2010. The water samples are tested for *E. coli* bacteria, which are found in the intestines of warm-blooded animals. While not all strains of *E. coli* are the same, certain strains can make humans sick if ingested in high enough concentrations. If water samples come back high for E. coli (>235 E. coli/100 ml), the management body for the bathing beach is notified and a sign is posted indicating the swim ban. *E. coli* is used as an indicator organism, meaning that high concentrations of E. coli might suggest the presence of harmful pathogens such as, *Salemnella*, *Giardia*, etc.



Kerry McCaughey LCHD Lab staff uses black light technology to report E. coli beach data.

Year	Linden's Landing	Meyers Beach
2010	1	0
2009	0	0
2008	0	0
2007	1	1

Swim Bans on Lake Linden from 2007 - 2010.

There are many ways E.coli can end up in a swimming beach. Heavy rainfall and strong wind associated with storms can cause the water to become cloudy with sediment from the lake bottom. Stormwater from rain can also wash in other particles from lawns, streets, and buildings. This sediment and stormwater may contain high concentrations of *E. coli*. Another source of *E. coli* contamination is the feces of gulls, geese, and other wildlife.

No bacteria related swim bans were reported at Meyer's Beach in 2010, and only one closing was reported from 2007 – 2010. Linden's Landing had one closure in 2010 and 2007.

BATHYMETRIC MAP

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake such as depth, surface area, and volume. This information is particularly important when intensive management techniques such as chemical treatments for plant or algae control, dredging, fish stocking or habitat enhancement are part of the lake's overall management plan.

In October 2010 the LCHD-ES collected the field data to replace the bathymetric map created by the LCHD-ES in 1998. Field data was collected using Biosonics equipment along with a Trimble GPS unit with sub-foot accuracy. Once collected, the data was analyzed and imported into ArcGis for further analysis. In ArcGis, the contours were drawn and the volume was calculated.

Morphometric Data

Surface Area: 30.45 acres

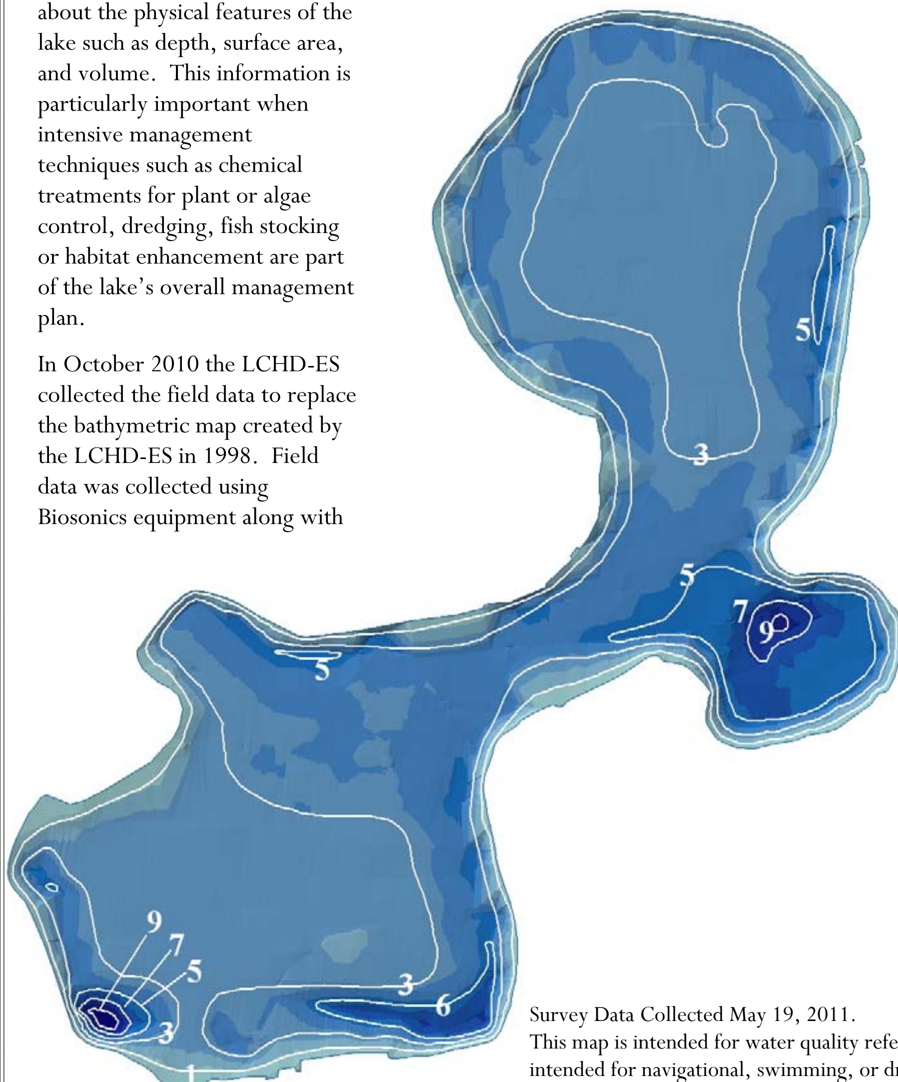
Maximum Depth: 10.14 feet

Average Depth: 3.11 feet

Lake Volume: 94.74 acre-feet

Shoreline Length: 1.36 miles

Lake Elevation: 767.25 feet,



Survey Data Collected May 19, 2011.
This map is intended for water quality reference only, not intended for navigational, swimming, or driving purposes.

COLOR RAMP ILLUSTRATING ELEVATION OF LAKE LINDEN

Elevation

- -1.126 - 0
- -2.253 - -1.126
- -3.379 - -2.253
- -4.506 - -3.379
- -5.632 - -4.506
- -6.759 - -5.632
- -7.885 - -6.759
- -9.011 - -7.885
- -10.138 - -9.011

At the time of data collection Lake Linden had an elevation of 772.32 feet above mean sea

Contour (feet)	Area enclosed (acres)	Percent of total acres	Volume (acre-feet)	Depth zone (feet)	Area (acres)	Depth Zone to Total Acres (percent)	Acre-Feet to Total Volume (percent)
0	30.45	100%	29.59	0 - 1	1.71	5.6%	31.2%
1	28.73	94%	27.86	1 - 2	1.74	5.7%	29.4%
2	26.99	89%	21.43	2 - 3	10.67	35.1%	22.6%
3	16.32	54%	10.37	3 - 4	10.91	35.8%	10.9%
4	5.41	18%	3.56	4 - 5	3.42	11.2%	3.8%
5	1.98	7%	1.28	5 - 6	1.29	4.2%	1.4%
6	0.69	2%	0.47	6 - 7	0.42	1.4%	0.5%
7	0.27	1%	0.16	7 - 8	0.20	0.7%	0.2%
8	0.07	0.2%	0.05	8 - 9	0.05	0.2%	0.05%
9	0.03	0.1%	0.01	9 - 10	0.02	0.1%	0.01%
10	0.001	0.003%	0.01	10 - 11	0.001	0.003%	0.01%
			94.79		30.45	100%	100%

1 CARP FOUND!

Common Carp spawn in late May or early June, this is the best time to document their presence in a lake as they splash around in the shallows.

> "SMALL BLUEGILL FLARED EACH TIME WE DROVE OVER VEGETATION"
>
> -Frank Jakubicek
> IDNR

Fishing Logs

You can track/ detect changes in the fishery by recording catches and observations in fishing logs!

2007 FISH SURVEY: ILLINOIS DIVISION OF NATURAL RESOURCES

In September of 2007 the Illinois Department of Natural Resources (IDNR) conducted a 45 minute daytime electrofishing survey of Lake Linden. The survey was undertaken to assess the abundance and diversity of fish following rehabilitation on 1991. The IDNR collected 236 fish representing five fish species: Largemouth Bass, Bluegill, Catfish, Black Crappie and Common Carp.

Largemouth Bass was the most abundant fish species collected at 79% of the catch (187 individuals) ranging in length from 3.3 to 19.3 inches. The catch per unit effort of 4.1 was well above the Management Objective of 1.0 fish per minute. A high proportion of the catch (76%) was composed of individuals between 6 and 11 inches long. The IDNR used an index called the Proportional Stock Density (PSD) to evaluate adult abundance of Largemouth Bass in the sample. The index compares the number of fish longer than 12" (Quality size) to the number of bass longer than 8" (Stock size) and produces a value that can be used to compare samples from different years or different lakes. The PSD value basically produces a number that represents the percent of sexually mature fish in the sample to fish that survived their first winter (roughly 8" long) and are likely to survive to maturity. A balanced population has a PSD value between 40% and 60%. The Lake Linden sample had a PSD of 23%, below management goals. The PSD illustrates the sample contained a large proportion of immature to mature fish. Suggesting that the large year class will grow into maturity (12" long) in the next couple of years and increase the potential for natural reproduction. Alternatively, the large year class (between 6" and 11") could be stockpiling and maybe stunting (showing slowing growth rates) from increased competition for food. If the population was stunted, condition factors as described with Relative Weights (Wr) would be low for certain size groups and fish would appear "thin" for their size. The Relative Weight (Wr's) for the 6-11 inch size class was 92 and for Largemouth Bass over 12 inches was 89. Lakes in our area usually have bass Wr's between 90 and 95 so the population appears to be in the normal range. Stunting does not appear to be occurring; the issue appears to be abundance.

Bluegill made up 19% of the sample even though they were only collected for a portion of the sample. Due to the large quantities of Bluegill, IDNR focuses their collection on size groups and sunfish diversity to save space and reduce stress during the survey in the holding tank. Overall in 2007 the population had strong reproduction, ranging in size from young of the year <10. to 8.5 inches and averaged 4.8 inches. Huge numbers of young of the year were observed and noted on our data sheet as TNTC (Too Numerous To Count). Small bluegill flared each time we drove over vegetation. These small bluegill are the forage that drive Lake Linden's food web and are a major component of most lakes in Illinois.

Tiger Muskellunge were not collected during the sampling event but have been consistently stocked into Lake Linden. This is a good species to stock to diversify the predator base and provide additional sport fishing opportunities. They work well in smaller lakes and are good predators in open water and away from vegetation that is too thick. Channel catfish are another way of diversifying the predator base in different parts of the lake, and like tiger muskie do not reproduce in small lakes so they are a controllable species.

Following the 2007 IDNR fish survey fisheries biologist, Frank Jakubicek, concluded that besides the original species stocked after the 1991 rehabilitation two black crappie and one carp were collected. The abundant Largemouth Bass population should keep the fishery balanced and it would take a detectable die-off of Largemouth Bass to "allow" Bluegill, Crappie or Common Carp populations to explode unchecked. This is where diversity in the predator base helps equal out changes that naturally occur time to time.

ILLINOIS DIVISION OF NATURAL RESOURCES 2007 CATCH SUMMARY FOR LAKE LINDEN

SPECIES	NUMBER	PERCENT	LENGTH (In) MINIMUM	AVERAGE	MAXIMUM
LARGEMOUTH BASS	187	79.2	3.3	9.8	19.3
BLUEGILL	45	19.1	0.8	4.8	8.5
BLACK CRAPPIE	2	0.8	9.7	10.9	12
CHANNEL CATFISH	1	0.4	27.5	27.5	27.5
CARP	1	0.4	21.3	21.3	21.3
TOTAL=	**236**	**100.0**			

FISHING

Lake Linden is located entirely within the village limits of Lindenhurst. Residents can access the lake from two beaches, three parks and a boat launch on the lake. The lake is used for non-gas motor boating and fishing and managed by the Lindenhurst Lakes Commission (LLC). The village of Lindenhurst has passed several ordinances (95.58 Fishing) to protect the Lake Linden's fishery. The two ordinances that further restrict Illinois anglers are the use of live bait fish and the catch and release of game fish species. The village also urges anglers to use barbless hooks. The village reduced the state unlimited daily bag limit on Bluegill to 25 and specifically stated that all Largemouth Bass, Muskellunge species, and Channel Catfish must be released.

The village of Lindenhurst supplements the fish populations in Lake Linden based on IDNR and LLC recommendations to maintain a balanced fish community.

Lindenhurst Lakes Commission Fish Stocking History

Year	Species	Quantity	Size	Rate	Strain
1999	Bluegill	1400	1"		
1999	Fathead Minnow	1400	2-3"	3lbs/acre	
2000	Channel Catfish	52	15"		
2001	Muskellunge	32	18-22"		Leech Lake
2002	Muskellunge	40	18-22"		Tiger
2003	Muskellunge	70	12-16"		Tiger
2004	Muskellunge	30	18-22"		Tiger
2005	No Stocking				
2006	No Stocking				
2007	Muskellunge	66	18-22"	2/acre	Tiger
2008	Channel Catfish	425	8-11"	15/acre	
2010	Muskellunge	25			Natural

2010 STOCKING IN LAKE LINDEN
Picture provided by: Lake Lindenhurst Lake Commission

IDNR 2007 RECOMMENDATIONS

1. Stock (at least) 25 non-vulnerable channel catfish per acre, every two or three years.
2. It's tough to do but harvesting 200 to 300 largemouth bass less than 12" would free up some space in that size group and help prevent problems (disease, stunting, etc,) in those age groups. We usually like to set a high length limit to shift a population with poor reproduction toward more reproduction but your lake has an issue with too many 6" to 11" fish.
3. Remove carp if caught.
4. To prevent Muskellunge from moving down stream, a spillway barrier could be constructed of horizontal rebar spaced 2.5" apart so water and most debris can flow through the bars but fish can't.

2007 ELECTROFISHING SURVEY LAKE LINDEN
Pictures provided by: Lake Lindenhurst Lake Commission

COLLECTION

DATA

THE CARP!

Aquatic Plant Sampling

Distribution of rake density across all sites sampled

Rake Density	# of Sites	%
No plants	1	2.9
>0 to 10%	2	5.9
>10 to 40%	8	23.5
>40 to 60%	14	41.2
>60 to 90%	7	20.6
>90%	2	5.9
Total Sites with Plants	33	97.1
Total # of Sites	34	100.0

Abundance of aquatic plant species found in Lake Linden, July 2010

Plant Density	Chara	Water Stargrass
Absent	17	25
Present	5	3
Common	7	5
Abundant	13	2
Dominant	1	8
% Plant Occurrence	76.5%	52.9%

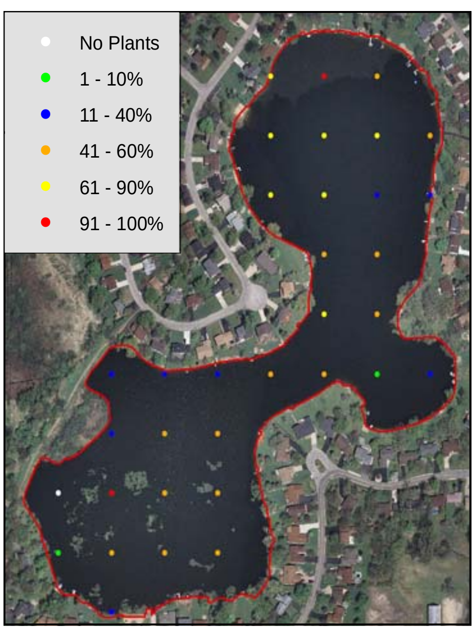
Plants growing in our lakes, ponds, and streams are called macrophytes. These aquatic plants appear in many shapes and sizes. Some have leaves that float on the water surface, while others grow completely underwater. In moderation, aquatic plants are aesthetically pleasing and desirable environmentally. Their presence is natural and normal in lakes.

Aquatic plant sampling was conducted on Lake Linden in July 2010. There were 34 points generated based on a computer grid system with points 60 meters apart. Aquatic plants existed at 33 of the sites that included 1 native aquatic plant species and one macro-algae (Chara sp.). No exotics species were present.

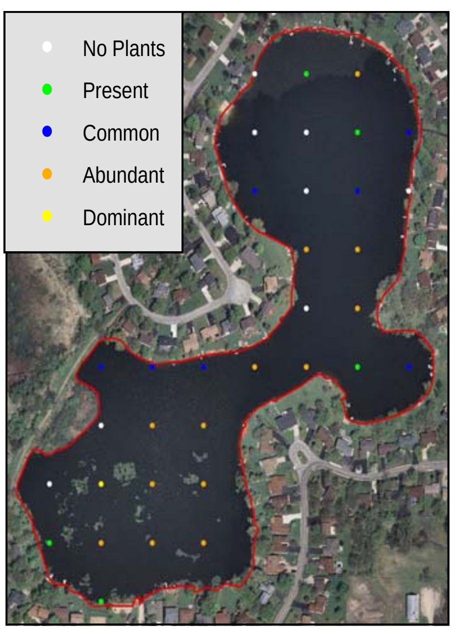
Species diversity has continued to decline since the 2000 and 2006 surveys. In 2010 the most common species was Chara at 77% of the sites sampled and Water Stargrass was present 53%. This is a significant increase in Water Stargrass abundance from 2006 (3%) and a slight reduction in Chara (85%). Chara does not provide good habitat for fish, however the macro algae does compete with microscopic algae that can cloud the water. A truly healthy aquatic plant community contains a large number of plant species that provide different types of habitat and structure to the lake that covers 30-40% of the lake. In 2010 Lake Linden aquatic plants covered 97% of the lake bottom. 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 the surface light level, plants can no longer grow. The 1% light level in Lake Linden could reach the bottom of the lake May through August (parameter was not analyzed in September due to equipment failure). Plants were found down to a depth of 9.5 feet, which relates to the 1% light level depth.

Lake Linden's water clarity and relatively shallow morphology are key components in establishing an effective aquatic plant management plant. The 2010 aquatic plant community contained no exotic species and the addition of Water Stargrass, compared to 2006. The future aquatic plant management plan should focus on increasing the diversity of aquatic plant species, to provide a variety of habitats. Aquatic plants provide sediment stabilization and competition for algae for resources. The water quality benefits of an improved aquatic plant community in Lake Linden would help increase the water clarity and decrease total phosphorus and suspended solids.

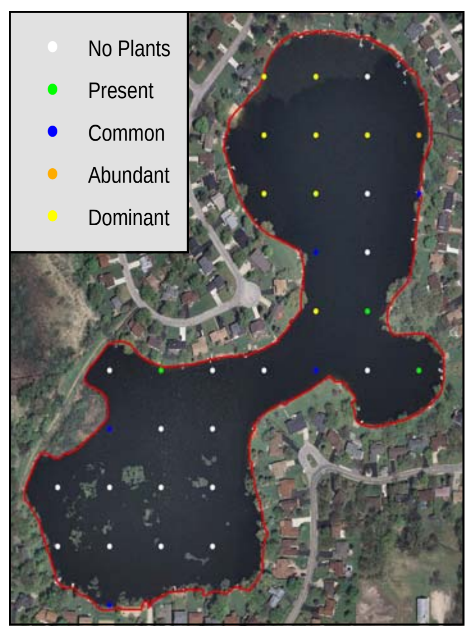
Although these common lake inhabitants look similar to many underwater plants, there are actually ALGAE!



Aquatic Plant Density at 34 sites on Lake Linden in July 2010



Density of Chara at 34 sites on Lake Linden in July 2010

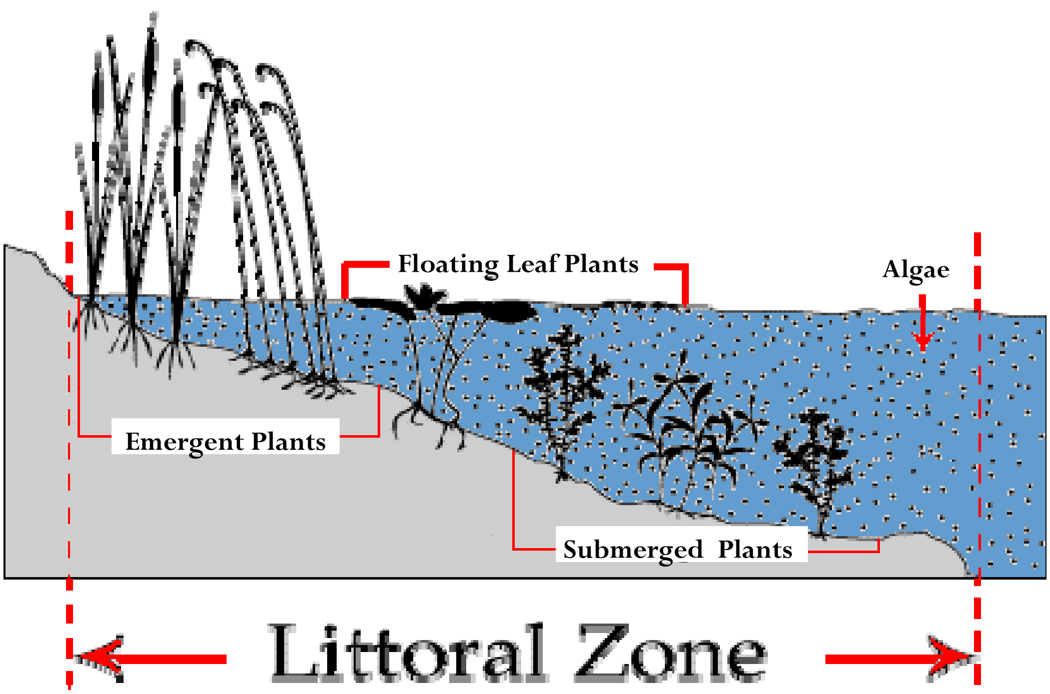


Density of Water Stargrass at 34 sites on Lake Linden in July 2010

FLORISTIC QUALITY INDEX

Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each 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 submersed plant species found in the lake. An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for Lake County lakes from 2000-2010 was 14.4. Lake Linden had an FQI of 8.0 ranking 136th out of 154.

The Average FQI for Lake County Lakes = 14.4



Source: Minnesota Department of Natural Resources

AQUATIC PLANTS: WHERE DO THEY GROW?

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 flat on the water surface.

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

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.

Excerpt: Department of Ecology, Washington state

Lake County Health Department and Community Health Center

ENVIRONMENTAL 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.

Lake Recomedations

Lake Linden provides a good place for recreational opportunities to its residents. Overall water quality decreased since 2006 however many water quality parameters remained above the county medians. The aquatic plant density has significantly expanded but diversity remains low.

Lake Linden, lake's management is administered by Lindenhurst Lakes Commission. To improve the overall quality of Lake Linden, the ES (Environmental Services) has the following recommendations:

- **Increase aquatic plant diversity**
- **Participate in the winter Volunteer Lake Monitoring Program administered by the LCHD-ES**
- **Mitigate shoreline exhibiting erosion**
- **Encourage homeowners to incorporate native plants in their landscaping through rain gardens or shoreline filter strips**
- **Install a staff gauge to monitor lake level fluctuations**

SHORELINE RESTORATION ON LAKE LINDEN

A BATHYMETRIC MAP WAS CREATED FOR LAKE LINDEN IN 2011, FOR A COPY VISIT:

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

Water quality data for Lake Linden 2006 and 2010.

2010	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO3*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	3	145	0.63	<0.1	<0.05	0.024	<0.005	NA	137	1.9	406	64	6.55	0.7280	8.65	12.79
15-Jun	3	139	0.74	<0.1	<0.05	0.041	<0.005	NA	139	1.2	403	75	6.69	0.7300	7.75	6.01
20-Jul	3	148	1.04	<0.1	0.051	0.076	<0.005	NA	142	4.2	428	81	3.59	0.7680	8.26	4.60
17-Aug	3	148	1.39	<0.1	<0.05	0.077	<0.005	NA	122	8.8	401	81	2.15	0.6850	8.38	6.57
20-Sep	3	166	1.32	0.254	<0.05	0.066	<0.005	NA	128	4.9	428	85	4.04	0.7360	7.7	5.66
	Average	149	1.02	<0.1	0.050^k	0.057	<0.005	NA	134	4.2	413	77	4.60	0.7294	8.15	7.13

2006	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO3*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
17-May	3	177	0.96	<0.1	0.084	0.029	<0.005	NA	260	1.7	664	99	0*	1.2090	8.08	10.70
21-Jun	3	156	1.00	<0.1	<0.05	0.034	<0.005	NA	258	2.9	669	127	7.46	1.1910	8.25	8.74
19-Jul	3	135	1.10	<0.1	<0.05	0.034	<0.005	NA	264	3.1	647	104	6.88	1.1940	8.42	7.28
16-Aug	3	136	1.31	<0.1	<0.05	0.037	<0.005	NA	292	3.5	674	113	5.57	1.2200	9.22	8.53
20-Sep	3	156	1.30	<0.1	<0.05	0.029	<0.005	NA	277	3.5	649	103	6.23	1.2000	8.43	8.89
	Average	152	1.13	<0.1	0.084^k	0.033	<0.005	NA	270	2.9	661	109	6.54^k	1.2028	8.48	8.83

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate + Nitrite nitrogen, mg/L
NO2+NO3 = Nitrite and Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chlorides, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

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

2010	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO3*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	8	143	0.64	<0.1	<0.05	0.029	<0.005	NA	139	2.4	413	70	NA	0.7290	8.66	12.45
15-Jun	7	139	0.60	<0.1	<0.05	0.041	<0.005	NA	137	1.4	401	68	NA	0.7310	7.89	5.72
20-Jul	6	147	0.99	<0.1	0.099	0.075	<0.005	NA	140	4.2	424	77	NA	0.7680	8.26	4.60
17-Aug	6	149	1.41	<0.1	<0.05	0.078	<0.005	NA	123	8.4	401	79	NA	0.6850	8.51	6.40
9\20	8	167	1.42	0.267	0	0.074	0	418	128	5.6	424	81	NA	0.7370	7.72	5.20
	Average	149	1.01	<0.1	0.062[k]	0.059	<0.005	NA	133	4.4	413	75	NA	0.7300	8.21	6.87

2006	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO3*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
17-May	6	178	0.96	<0.1	0.074	0.023	<0.005	NA	260	1.1	656	89	NA	1.2110	8.04	10.62
21-Jun	6	155	0.94	<0.1	<0.05	0.027	<0.005	NA	257	2.0	668	129	NA	1.1910	8.30	8.47
	Average	167	0.95	<0.1	0.074[k]	0.025	<0.005	NA	259	1.6	662	109	NA	1.2010	8.17	9.55

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate + Nitrite nitrogen, mg/L
NO2+NO3 = Nitrite and Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chlorides, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

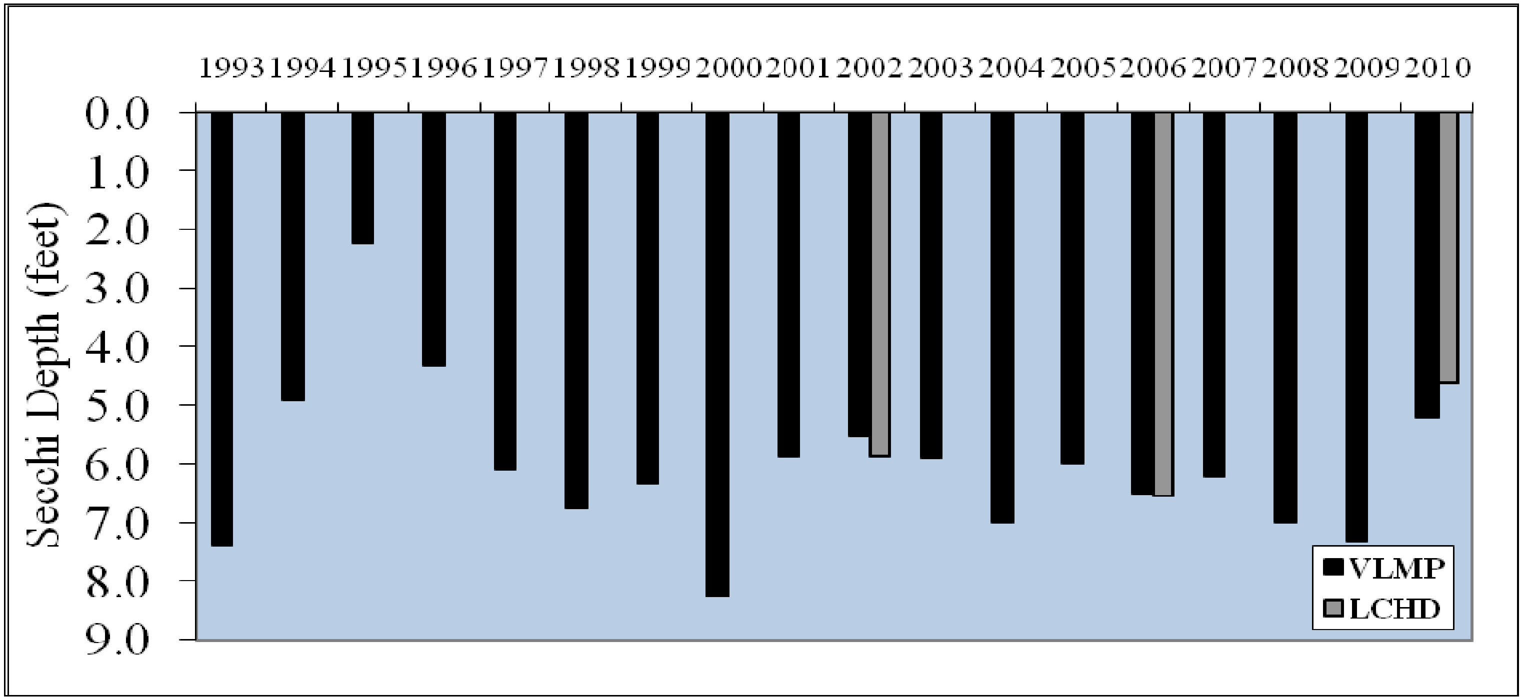
k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate was analyzed

Linden Lake 2010 IEPA Ranking

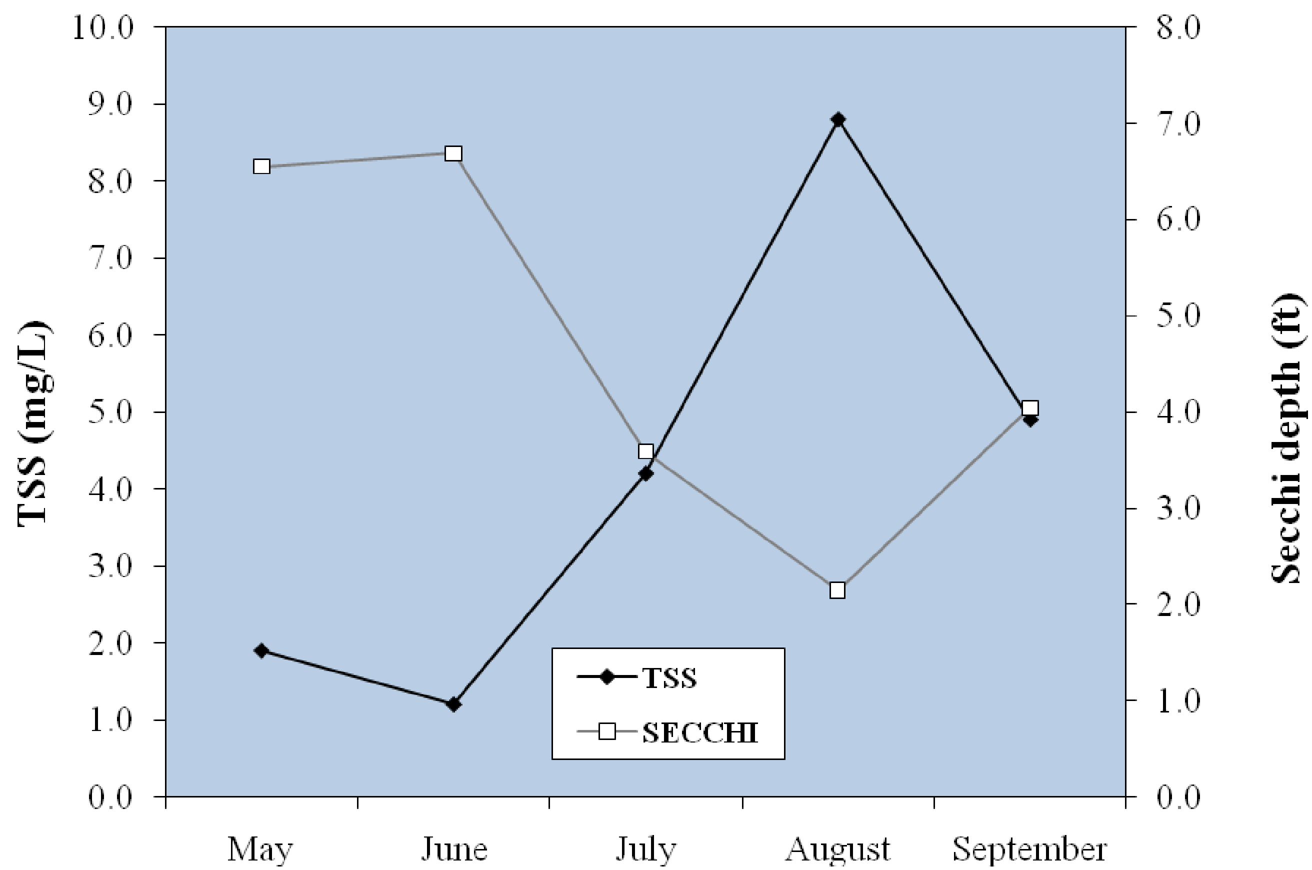
TROPHIC STATUS		
Carlson's TSIp	62.4	Eutrophic
IMPAIRMENT ASSESSMENTS		
Total Phosphorus	Yes	
Total Nitrogen	None	
pH	None	
Low DO	None	
Total Dissolved Solids	None	
Total Supended Solids	None	
Aquatic Plants-Native	Yes	
Non-Native Aquatic Plants	None	
Non-Native Animals	None	

	Weighting Criteria	Points	Overall Use Support Points	Degree of Support
AQUATIC LIFE USE IMPAIRMENT INDEX				
Mean Trophic State	62.4	50		
Macrophyte Impairment	Substantial	15		
Sediment Impairment (NVSS)	Minimal	0		
Degree of Use Support		**65**	0	**Full**
RECREATION USE IMPAIRMENT INDEX				
Mean Trophic State Index	62.4	62.4		
Macrophyte Impairment	Substantial	15		
Sediment Impairment (NVSS)	Minimal	0		
Degree of Use Support		**77.4**	1	**Partial**
Overall Use Index			**0.50**	**Partial**

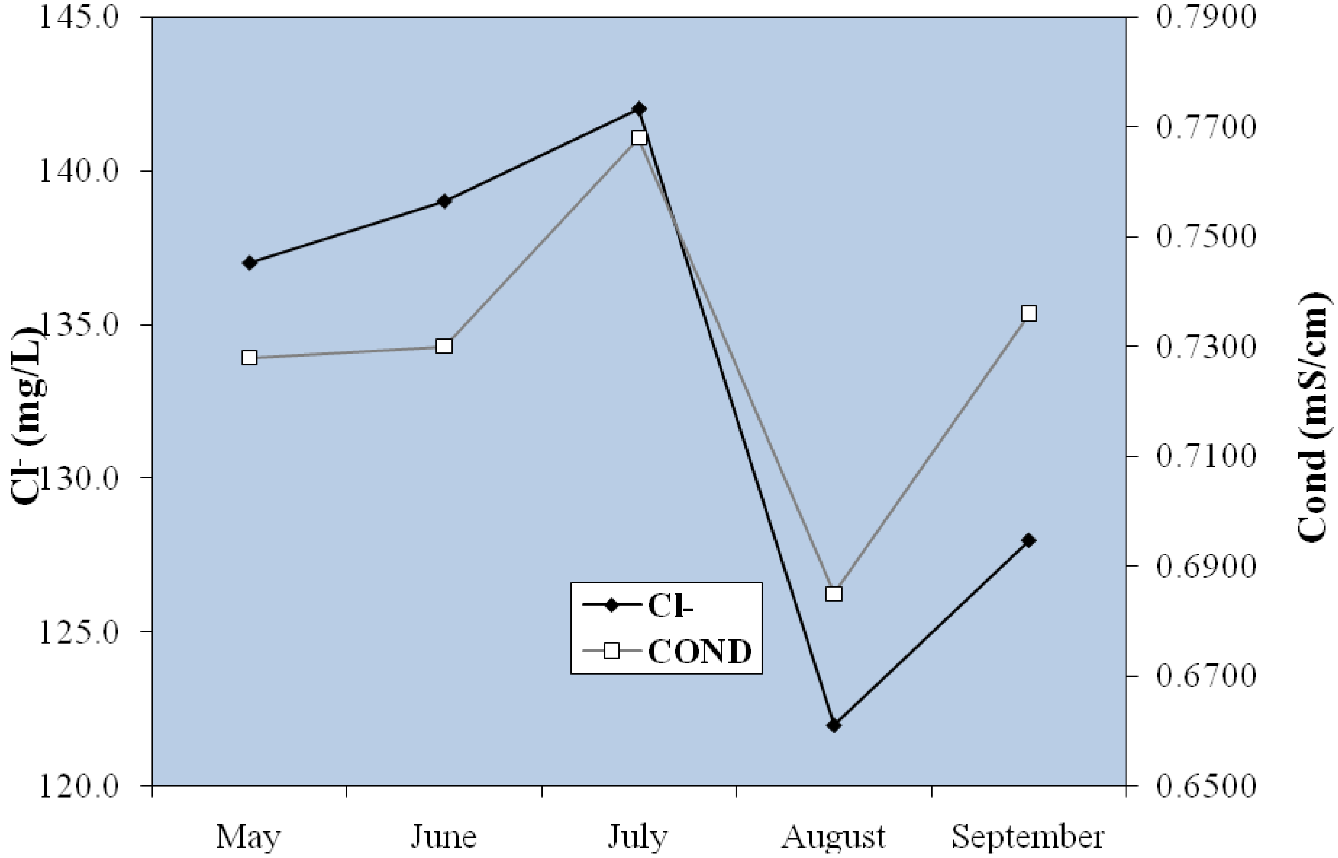
Secchi disk averages from VLMP and LCHD records for Lake Linden.



Total suspended solid (TSS) concentrations vs. Secchi depth for Lake Linden, 2010.



Chloride (Cl^-) concentration vs. conductivity for Lake Linden, 2010.



Aquatic vegetation species found at the 34 sampling sites on Lake Linden, July 2010. Maximum depth that plants were found was 9.5 feet. **Maximum depth that plants were found was 9.5 feet.**

Plant Density	Chara	Water Stargrass
Absent	17	25
Present	5	3
Common	7	5
Abundant	13	2
Dominant	1	8
% Plant Occurrence	76.5%	52.9%

Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	1	2.9
>0 to 10%	2	5.9
>10 to 40%	8	23.5
>40 to 60%	14	41.2
>60 to 90%	7	20.6
>90%	2	5.9
Total Sites with Plants	33.00	97.1
Total # of Sites	34	100.0

Lake County average Floristic Quality Index (FQI) ranking 2000-2010.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.0	40.0
2	Cranberry Lake	34.4	34.4
3	West Loon Lake	34.3	35.7
4	East Loon Lake	33.6	35.0
5	Little Silver	31.6	29.6
6	Deep Lake	31.2	29.7
7	Round Lake Marsh North	29.9	29.1
8	Bangs Lake	29.8	32.0
9	Sullivan Lake	28.5	26.9
10	Independence Grove	27.5	24.6
11	Lake Zurich	27.1	24.3
12	Sterling Lake	26.9	24.5
13	Sun Lake	26.1	24.3
14	Round Lake	25.9	23.5
15	Druce Lake	25.2	22.8
16	Honey Lake	25.1	23.3
17	Schreiber Lake	24.8	23.9
18	Fourth Lake	24.8	23.0
19	Lake of the Hollow	24.8	23.0
20	Lakewood Marsh	24.7	23.8
21	Redwing Slough	24.0	25.8
22	Deer Lake	23.5	24.4
23	Butler Lake	23.1	21.4
24	Third Lake	23	24.7
25	Duck Lake	22.9	21.1
26	Countryside Glen Lake	22.8	21.9
27	Cross Lake	22.4	24.2
28	McGreal Lake	22.1	20.2
29	Wooster Lake	21.9	23.6
30	Davis Lake	21.4	21.4
31	Broberg Marsh	21.4	20.5
32	Fish Lake	21.2	19.3
33	Redhead Lake	21.2	19.3
34	Turner Lake	21.2	18.6
35	Timber Lake (North)	20.9	23.4
36	Lake Kathryn	20.7	19.6
37	ADID 203	20.5	20.5
38	Lake Miltmore	20.3	18.4
39	Salem Lake	20.2	18.5
40	Gray's Lake	19.8	16.9
41	Old Oak Lake	19.1	18.0
42	Highland Lake	18.9	16.7
43	Forest Lake	18.0	19.0
44	Lake Helen	18.0	18.0
45	Potomac Lake	17.8	17.8
46	Bresen Lake	17.8	16.6
47	Hendrick Lake	17.7	17.7
48	Lake Barrington	17.7	16.7
49	Windward Lake	17.6	16.3
50	Diamond Lake	17.4	16.3
51	Owens Lake	17.3	16.3
52	Osprey Lake	17.3	15.5
53	Long Lake	17.2	19.0
54	Lake Tranquility (S1)	17.0	15.0

Lake County average Floristic Quality Index (FQI) ranking 2000-2010.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
55	McDonald Lake 1	16.7	17.7
56	Island Lake	16.6	14.7
57	Lake Fairview	16.3	15.2
58	Grand Avenue Marsh	16.3	14.3
59	Lake Nippersink	16.3	14.3
60	Taylor Lake	16.3	14.3
61	White Lake	16.0	17.0
62	Dog Training Pond	15.9	14.7
63	Dog Bone Lake	15.7	15.7
64	Seven Acre Lake	15.5	17.0
65	Ames Pit	15.5	13.4
66	Heron Pond	15.1	15.1
67	Dugdale Lake	15.1	14.0
68	Eagle Lake (S1)	15.1	14.0
69	Mary Lee Lake	15.1	13.1
70	Old School Lake	15.1	13.1
71	Hastings Lake	15.0	17.0
72	North Churchill Lake	15.0	15.0
73	Bishop Lake	15.0	13.4
74	Sand Lake	14.8	12.5
75	Countryside Lake	14.7	14.7
76	Timber Lake (South)	14.7	12.7
77	Buffalo Creek Reservoir	14.3	13.1
78	Lake Carina	14.3	12.1
79	Lake Leo	14.3	12.1
80	Lambs Farm Lake	14.3	12.1
81	Crooked Lake	14.0	16.0
82	Longview Meadow Lake	13.9	13.9
83	Dunn's Lake	13.9	12.7
84	Summerhill Estates Lake	13.9	12.7
85	Lake Napa Suwe	13.9	11.7
86	Lake Minear	13.9	11.0
87	Stockholm Lake	13.5	12.1
88	Antioch Lake	13.4	11.3
89	Hook Lake	13.4	11.3
90	Lake Charles	13.4	11.3
91	Rivershire Pond 2	13.3	11.5
92	Flint Lake	13.0	11.8
93	Harvey Lake	13.0	11.8
94	McDonald Lake 2	12.5	12.5
95	Stone Quarry Lake	12.5	12.5
96	Lake Naomi	12.5	11.2
97	Pulaski Pond	12.5	11.2
98	Pond-A-Rudy	12.1	12.1
99	Loch Lomond	12.1	9.4
100	Grassy Lake	12.0	12.0
101	Lake Matthews	12.0	12.0
102	Nielsen Pond	12.0	10.7
103	Werhane Lake	12.0	9.8
104	Lake Lakeland Estates	11.5	10.0
105	Redwing Marsh	11.0	11.0
106	Tower Lake	11.0	11.0
107	West Meadow Lake	11.0	11.0
108	Big Bear Lake	11.0	9.5
109	Little Bear Lake	11.0	9.5
110	Fischer Lake	11.0	9.0
111	Grandwood Park Lake	11.0	9.0

Lake County average Floristic Quality Index (FQI) ranking 2000-2010.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
112	Lake Holloway	10.6	10.6
113	Lake Fairfield	10.4	9.0
114	Lake Louise	10.4	9.0
115	College Trail Lake	10.0	10.0
116	Gages Lake	10.0	5.8
117	Valley Lake	9.9	9.9
118	Woodland Lake	9.9	8.1
119	Lake Christa	9.8	8.5
120	Lake Farmington	9.8	8.5
121	Lucy Lake	9.8	8.5
122	Columbus Park Lake	9.2	9.2
123	Sylvan Lake	9.2	9.2
124	Waterford Lake	9.2	9.2
125	Banana Pond	9.2	7.5
126	Leisure Lake	9.0	6.4
127	Albert Lake	8.7	7.5
128	Fairfield Marsh	8.7	7.5
129	Lake Eleanor	8.7	7.5
130	Ozaukee Lake	8.7	6.7
131	East Meadow Lake	8.5	8.5
132	South Churchill Lake	8.5	8.5
133	Lake Forest Pond	8.5	6.9
134	Peterson Pond	8.5	6.0
135	Bittersweet Golf Course #13	8.1	8.1
136	Lake Linden	8.0	8.0
137	Patski Pond	7.1	7.1
138	Rasmussen Lake	7.1	7.1
139	Slocum Lake	7.1	5.8
140	IMC Lake	7.1	5.0
141	Lucky Lake	7.0	7.0
142	Deer Lake Meadow Lake	6.4	5.2
143	ADID 127	5.0	5.0
144	Liberty Lake	5.0	5.0
145	Oak Hills Lake	5.0	5.0
146	Slough Lake	5.0	5.0
147	Sand Pond (IDNR)	5.0	3.5
148	Half Day Pit	5.0	2.9
149	Lochanora Lake	5.0	2.5
150	Echo Lake	0.0	0.0
151	Hidden Lake	0.0	0.0
152	North Tower Lake	0.0	0.0
153	St. Mary's Lake	0.0	0.0
154	Willow Lake	0.0	0.0
	Mean	**15.3**	**14.4**
	Median	**14.3**	**12.9**

Morphometric Features of Lake Linden ~
Data From the May 19, 2011 Bathymetric Survey, LCHD Environmental Services

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	30.45	100%	29.59	0 - 1	1.71	5.6%	31.2%
1	28.73	94%	27.86	1 - 2	1.74	5.7%	29.4%
2	26.99	89%	21.43	2 - 3	10.67	35.1%	22.6%
3	16.32	54%	10.37	3 - 4	10.91	35.8%	10.9%
4	5.41	18%	3.56	4 - 5	3.42	11.2%	3.8%
5	1.98	7%	1.28	5 - 6	1.29	4.2%	1.4%
6	0.69	2%	0.47	6 - 7	0.42	1.4%	0.5%
7	0.27	1%	0.16	7 - 8	0.20	0.7%	0.2%
8	0.07	0.2%	0.05	8 - 9	0.05	0.2%	0.05%
9	0.03	0.1%	0.01	9 - 10	0.02	0.1%	0.01%
10	0.001	0.003%	0.01	10 - 11	0.001	0.003%	0.01%
			94.79		30.45	100%	100%

Maximum Depth of Lake: 10.14 feet
Average Depth of Lake: 3.11 feet
Volume of Lake: 94.79 acre-feet

Area of Lake: 30.45 acres
Shoreline Length: 1.36 miles
Water Elevation at 772.32 feet above mean sea level

LakeCounty
Health Department and
Community Health Center

Linden Lake 2010 Multiparameter data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient
											0.297
51810	0.25	0.505	15.24	12.85	128.4	0.728	8.39	1234	Surface		
51810	1	1.019	15.27	12.84	128.4	0.728	8.55	1162	Surface	100%	
51810	2	1.908	15.28	12.79	127.9	0.728	8.65	626	0.24	54%	2.60
51810	3	2.187	15.28	12.79	127.9	0.728	8.65	639	0.52	55%	-0.04
51810	4	3.529	15.24	12.77	127.6	0.728	8.69	503	1.86	43%	0.13
51810	5	3.894	15.23	12.76	127.4	0.727	8.69	471	2.22	41%	0.03
51810	6	4.587	15.20	12.75	127.3	0.713	8.69	378	2.92	32%	0.08
51810	7	5.997	15.11	12.59	125.4	0.727	8.68	243	4.33	21%	0.10
51810	8	6.689	15.02	12.45	123.8	0.729	8.66	256	5.02	22%	-0.01
51810	9	7.796	14.78	11.02	108.9	0.732	8.56	193	6.13	17%	0.05
51810	10	8.298	14.65	9.82	96.8	0.719	8.49	185	6.63	16%	0.01
51810	11	9.036	14.53	3.90	38.4	0.738	8.36	142	7.37	12%	0.04

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient
											0.161
61510	0.25	0.25	21.72	6.45	73.5	0.751	7.89	977.0	Surface		
61510	1	1	22.03	6.24	71.5	0.735	7.73	945.7	Surface	100%	
61510	2	2	22.13	6.11	70.2	0.732	7.72	802.1	0.33	85%	0.50
61510	3	3	22.13	6.01	69.0	0.730	7.75	503.1	1.33	53%	0.35
61510	4	4	22.07	5.91	67.8	0.731	7.80	294.4	2.33	31%	0.23
61510	5	5	22.03	5.85	67.0	0.731	7.83	195.9	3.33	21%	0.12
61510	6	6	22.01	5.76	66.0	0.731	7.86	129.0	4.33	14%	0.10
61510	7	7	21.98	5.72	65.5	0.731	7.89	119.5	5.33	13%	0.01
61510	8	8	21.95	5.68	65.1	0.731	7.90	102.6	6.33	11%	0.02
61510	9	9	21.92	5.59	64.0	0.731	7.92	66.8	7.33	7%	0.06
61510	10	10	21.91	2.88	33.0	0.735	7.91	43.0	8.33	5%	0.05

Date	Text Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light Meter	% Light Transmission	Extinction

MMDDYY	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	Coefficient
											0.181
72010	0.25	0.25	28.02	4.55	58.2	0.772	8.25	780.6	Surface		
72010	1	1	28.18	4.58	58.9	0.770	8.23	771.4	Surface	100%	
72010	2	2	28.27	4.59	59.0	0.769	8.23	657.4	0.33	85%	0.48
72010	3	3	28.31	4.48	57.7	0.768	8.23	467.5	1.33	61%	0.26
72010	4	4	28.34	3.96	50.9	0.768	8.24	274.6	2.33	36%	0.23
72010	5	5	28.35	4.22	54.3	0.768	8.25	151.6	3.33	20%	0.18
72010	6	6	28.36	4.60	59.2	0.768	8.26	103.6	4.33	13%	0.09
72010	7	7	28.33	4.09	52.6	0.768	8.27	68.2	5.33	9%	0.08
72010	8	8	28.27	4.17	53.6	0.768	8.27	43.4	6.33	6%	0.07
72010	9	9	28.24	3.69	47.4	0.769	8.26	28.2	7.33	4%	0.06

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient
											0.216
81710	0.25	0.25	26.39	6.93	86.1	0.684	8.56	699.8	Surface		
81710	1	1	26.40	6.72	83.6	0.685	8.37	721.0	Surface	100%	
81710	2	2	26.42	6.65	82.7	0.685	8.35	614.4	0.33	85%	0.48
81710	3	3	26.43	6.57	81.8	0.685	8.38	351.1	1.33	49%	0.42
81710	4	4	26.44	6.51	81.1	0.685	8.43	205.7	2.33	29%	0.23
81710	5	5	26.44	6.45	80.2	0.685	8.48	112.7	3.33	16%	0.18
81710	6	6	26.44	6.40	79.6	0.685	8.51	67.2	4.33	9%	0.12
81710	7	7	26.44	6.35	79.0	0.685	8.54	38.0	5.33	5%	0.11
81710	8	8	26.38	4.98	61.9	0.691	8.51	17.6	6.33	2%	0.12
81710	9	9	26.30	4.40	54.7	0.698	8.46	11.1	7.33	2%	0.06

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient
											NA
92010	0.25	0.25	18.75	5.92	63.6	0.736	7.78	NA	NA	NA	NA
92010	1	1	18.75	5.82	62.6	0.736	7.73	NA	NA	NA	NA
92010	2	2	18.75	5.74	61.7	0.736	7.71	NA	NA	NA	NA
92010	3	3	18.74	5.66	60.9	0.736	7.70	NA	NA	NA	NA
92010	4	4	18.73	5.59	60.1	0.736	7.70	NA	NA	NA	NA

92010	5	5	18.70	5.51	59.2	0.737	7.70	NA	NA	NA	NA
92010	6	6	18.66	5.28	56.7	0.737	7.71	NA	NA	NA	NA
92010	7	7	18.64	5.23	56.1	0.737	7.72	NA	NA	NA	NA
92010	8	8	18.62	5.20	55.7	0.737	7.72	NA	NA	NA	NA
92010	9	9	18.61	5.14	55.1	0.737	7.72	NA	NA	NA	NA
92010	10	10	18.60	5.08	54.4	0.7370	7.72	NA	NA	NA	NA
92010	11	11	18.60	1.22	13.1	0.7360	7.73	NA	NA	NA	NA