Long Trade Lake
Lake Management Plan, 2019-2024

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Round Trade Lake Improvement Association

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Purpose of the Study

In December 2015, the Polk County Land and Water Resources Department applied for a Wisconsin Department of Natural Resources Lake Planning Grant in partnership with the Round Trade Lake Improvement Association. The grant was awarded and data collection occurred in 2016, 2017, and 2018.

Methods and activities completed through this grant award include:

- ✓ Lake level and precipitation monitoring data
- ✓ In-lake physical and chemical data
- ✓ Phytoplankton
- ✓ Tributary physical and chemical data
- ✓ Water Action Volunteer monitoring
- ✓ Invertebrate workshop
- ✓ Shoreline inventory
- ✓ Watershed delineation and boundaries
- ✓ Watershed modeling
- ✓ No-till and cover crop inventory

The following report details the methods and activities completed through this grant award.

Background Information on Lakes, Studies, and Management Plans

Lakes are a product of the landscape they are situated in and of the actions that take place on the land which surrounds them. Factors such as lake size, lake depth, water sources, and geology all cause inherent differences in lake quality. As a result, lakes situated within feet of others can differ profoundly in the uses they support.

A landscape can be divided into watersheds and subwatersheds. These areas define the land that drains to a particular lake, flowage, stream, or river. Watersheds that preserve native vegetation and minimize impervious surfaces (cement, concrete, and other materials that water can't permeate) are less likely to cause negative impacts on lakes, rivers, and streams. This arises because rain and melting snow eventually end up in lakes and streams through surface runoff or groundwater infiltration. Rain and melting snow entering a waterbody are not inherently problematic. However, water has the ability to carry nutrients, bacteria, sediments, and chemicals into a waterbody. These inputs can impact aquatic organisms such as insects, fish, and wildlife and—especially in the case of the nutrient phosphorus—fuel problematic algae blooms.

Lake studies often examine the underlying factors that impact a lake's health, such as lake size, depth, water sources, and the land use in a lake's watershed. Many forms of data can be collected and analyzed to gauge a lake's health including: physical data (oxygen, temperature, etc.), chemical data (including nutrients such a phosphorus and nitrogen), biological data (algae, zooplankton, and aquatic plants), geological data (soils, glacial till, and sediment chemistry) and land use within a lake's watershed. Additionally, sediment cores can be used to determine how a lake has changed over the course of hundreds of years.

Lake studies identify challenges and threats to a lake's health along with opportunities for improvement. These studies identify practices already being implemented by watershed residents to improve water quality and areas providing benefits to a lake's ecosystem. Additionally, these studies quantify practices or areas on the landscape, or within the lake, which have the potential to negatively impact the health of a lake and identify best management practices for improvement.

The end product of a lake study is a **Lake Management Plan** which identifies goals, objectives, and action items to either maintain or improve the health of a lake. Goals should be realistic based on inherent lake and watershed characteristics (lake size, depth, land use etc.) and should align with the goals of watershed residents.

Lake management plans are designed to be working documents that are used to guide the actions which take place to manage a specific lake.

Introduction to Long Trade Lake

Long Trade Lake[1] is located in the Town of Laketown in Polk County Wisconsin, approximately 70 miles northeast of the Minneapolis/St. Paul MN metropolitan area. Laketown is 36 square miles in size and inhabited by less than 1,000 people. According to Natural Heritage Inventory data, Blanding's turtle (SC/P[2]) and brittle prickly pear (THR[3]) occur in Laketown.

Long Trade Lake is 150 acres in size with a maximum depth of 13 feet. The Trade River enters Long Trade Lake on the south end of the lake and exits on the north end.

The area of land that drains to a lake is called a watershed. Long Trade Lake is situated within the Trade River Watershed which is 195 square miles (124,800 acres) and includes Little Butternut Lake and Big Butternut Lake in Polk County, and Round Lake, Big Trade Lake, Little Trade Lake, Dueholm Flowage, Grettum Flowage, Daniels Flowage, and Fish Lake in Burnett County. Land use in the Trade River watershed is primarily forest (45%), agriculture (22%), and a mix of wetlands (15%), grassland (9%), suburban (5%), and other uses (4%).

On a smaller scale, the area of land that drains to an individual lake, or the Long Trade Lake watershed, is also defined. Long Trade Lake's watershed is 29,228 acres in size. The most common land use in the Long Trade Lake watershed is forest (44%), followed by grassland (24%), wetland (15%), agriculture (11%), developed (3%), and open water (3%).

Lakes are hydrologically classified according to their primary source of water and how that water enters and leaves the system. Long Trade Lake is classified as an impoundment, or flowage, which are formed when the flow of a stream or river is impeded. The restriction on the natural flow of water often results in the collection of soil and nutrients in impoundments. By definition all impoundments have outlet flows and are categorized as drainage lakes. Drainage lakes receive their water from streams, groundwater, precipitation, and runoff and are drained by a stream.

Polk County owns a very small parcel of land on the north end of the lake reaching the water's edge and a large parcel of land on the north east side of the lake which includes the Trade River as it exits the lake (including the dam). This large parcel is designated as the Atlas County Park and provides considerable public lands with accessible lake frontage, public access (including the boat landing), public fishing opportunities on Long Trade Lake and the Trade River, hiking and biking trails, a ballfield, and a playground.

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[1] Long Trade Lake water body identification code WBIC: 2640500
[2] SC/P = special concern protected wild animal
[3] THR = threatened

Two invasive species, curly-leaf pondweed and Eurasian water-milfoil, have been documented on Long Trade Lake.

The trophic state is a measure of a lakes health which relates to the amount of algae in the water. The average summer trophic state for the last five years indicated that Long Trade Lake was hypereutrophic (72) which is poor based on lake type[4].

Long Trade Lake has been monitored by volunteers since 1986.

[4] Accessed May 21, 2019

Lake Classification

Lake classification in Polk County is a relatively simple model that considers:

- ✓ Lake surface area
- ✓ Maximum depth
- ✓ Lake type
- ✓ Watershed area
- ✓ Shoreline irregularity
- ✓ Existing level of shoreline development

These parameters are used to classify lakes as class one, class two, or class three lakes. Long Trade Lake is classified as a class one lake with low vulnerability and moderate development.

Class one lakes are large and highly developed.
Class two lakes are less developed and more sensitive to development pressure.
Class three lakes are usually small, have little or no development, and are very sensitive to development pressure.

Long Trade Lake Characteristics[5]

Area: 150 Acres
Maximum depth: 13 feet
Mean depth: 8 feet
Bottom: 75% sand, 5% gravel, 0% rock, and 20% muck
Waterbody type: Flowage
Hydrologic lake type: Drainage
Invasive species: Curly-leaf pondweed and Eurasian water-milfoil
Fish: Panfish, largemouth bass, and northern pike
Trophic Status: Hypereutrophic

Oligotrophic lakes are generally clear, deep, and free of plants and large algae blooms.

Mesotrophic lakes lie between oligotrophic and eutrophic lakes. They usually have productive fisheries, healthy plant life, and occasional algae blooms.

Eutrophic lakes are generally high in nutrients and support a large number of plant and animal populations. They are usually very productive and subject to frequent algae blooms.

Hypereutrophic lakes are characterized by dense algae communities and can experience heavy blooms throughout the summer.

[5] http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2640500&page=facts

Impaired Waters

Wisconsin lakes, rivers, and streams are managed to determine if their conditions are meeting state and federal water quality standards. Water samples are collected through monitoring studies and results are compared to guidelines designed to evaluate conditions as compared to state standards. General assessments place waters in four different categories: poor, fair, good, and excellent. The results of assessments can be used to determine which actions will ensure that water quality standards are being met (anti-degradation, maintenance, or restoration).

If a waterbody does not meet water quality standards, it is placed on Wisconsin's Impaired Waters List under the Federal Clean Water Act, Section 303(d). Every two years the State of Wisconsin is required to submit list updates to the United States Environmental Protection Agency for approval.

Waterbodies can be listed as impaired based on pollutants such as total phosphorus, total suspended solids, and metals. Wisconsin waters are each assigned four uses (fish and aquatic life, recreation, public health and welfare, and wildlife) that carry with them a set of goals.

Impairment thresholds vary for each use and vary based on lake characteristics such as whether a waterbody is shallow or deep and whether a waterbody is a drainage or seepage lake. Long Trade Lake is classified as a shallow lowland drainage lake that mixes. [6]

- ✓ Natural community: Reservoir
- ✓ Stratification status: Mixed
- ✓ Hydrology: Lowland drainage

Long Trade Lake was assessed during the 2014 and 2016 listing cycle. In both years, total phosphorus data overwhelmingly exceeded the listing threshold for recreational use and chlorophyll data exceeded the listing thresholds for recreational use and fish and aquatic life use.

The lake was also assessed during the 2018 listing cycle at which time total phosphorus and chlorophyll data exceeded the thresholds for both recreational use and fish and aquatic life use.

The impairment threshold for total phosphorus is 40 µg/L for both recreational use and fish and aquatic life use. The impairment threshold for chlorophyll is met when greater than 30% of days in the sampling season have moderate algae levels (greater than 20 µg/L) for recreational use and 27 µg/L for aquatic life.

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[6] Listing thresholds can be found in Wisconsin 2020 Consolidated Assessment and Listing Methodology (WisCALM) Clean Water Act Section 303(d) and 305(b) Integrated Reporting, Wisconsin Department of Natural Resources, April 2019

Previous Lake Studies

Past studies and grant awards on Long Trade Lake include:

Long Trade Lake Eurasian Water-milfoil Weevil Study initiated in 1996

The purpose of this study was to collect data on the macrophyte community in Long Trade Lake and document the effects of the milfoil weevil on Eurasian water-milfoil in the lake. A final report is not available.

Round and Long Trade Lakes Water Quality, Vegetation Assessment, Tributary Assessment, and Watershed Assessment initiated in 2007

This two phase project included water quality monitoring (in-lake and tributary), lake level and precipitation monitoring, curly leaf pondweed monitoring, a shoreline and coarse woody habitat assessment, groundwater reconnaissance of drinking water wells, watershed delineation and modeling, and identification of critical sites within the watershed.

Data for total phosphorus, chlorophyll a, and secchi depth indicated a eutrophic to hyper-eutrophic state in Long Trade Lake. Tributary monitoring indicated that the average instantaneous load of total phosphorus per year was greater from the Trade River as compared with Butternut Creek. Groundwater phosphorus concentrations were comparatively high in the Long Trade Lake watershed. The study concluded that elevated levels were more likely due to geology rather than human impact. Modeling predicted that of the 12,403 pounds of phosphorus entering the lake per year, 37% originated from point sources (streams), 63% originated from non-point sources (watershed), and less than 1% originated from atmospheric loading (precipitation).

Trade Lakes Eurasian Water-milfoil Early Detection and Response Project initiated in 2009

This project was initiated to monitor and manage a pioneer population of Eurasian water-milfoil in Trade Lake and to develop a management plan for the lake. An aquatic plant survey completed as part of this grant documented diminished species richness, with filamentous algae and small duckweed being the most common aquatic plants found in the lake. In 2010, 25.33 acres of Eurasian water-milfoil were mapped in Long Trade Lake. The beds covered the majority of the littoral zone of the lake and many were canopied out. The overall goal of the lake management plan was to decrease the impact of Eurasian water-milfoil on the lake's ecosystem and to prevent its spread into Big Trade Lake and other surrounding waterbodies. The goals of the plan are to: prevent the spread of Eurasian water-milfoil; prevent the spread of curly-leaf pondweed; prevent the spread and introduction of other aquatic invasive species; preserve, protect, and enhance the lake's native plant communities; and to minimize the runoff of pollutants, nutrients, and sediment from the Trade Lake watershed.

Round Trade Lakes 3-Year Aquatic Invasive Species Control Project initiated in 2011

Activities funded with this project included: pre and post treatment aquatic plant survey and

bed mapping, purple loosestrife and Japanese knotweed monitoring and control, watercraft inspections, and AIS monitoring.

In 1995, the WDNR identified hybrid watermilfoil in Long Trade Lake. The Round-Trade Lake Improvement Association began actively managing curly-leaf pondweed and Eurasian water-milfoil with herbicides in 2013. At this time 16 areas totaling 9.31 acres were treated for curly-leaf pondweed and nine areas totaling 5.24 acres were treated for Eurasian watermilfoil. Following treatment, the Simpsons Diversity Index, the Floristic Quality Index, and species richness increased; whereas, the total rake fullness value decreased. Although a reduction in Eurasian water-milfoil did occur post-treatment, the difference was not significant. However, the reduction in curly-leaf pondweed following treatment was highly significant. Coontail, large duckweed, small duckweed, white water lily, and common watermeal exhibited highly significant increases following treatment.

In September, the littoral zone of the entire lake was monitored with only three rooted Eurasian water-milfoil plants being located. Likely the decline is in response to the herbicide treatment in addition to extremely poor water clarity.

2016-2017 Trade Lake System AIS Management Implementation initiated in 2016

This study included aquatic plant management and monitoring on Long Trade Lake, a dye study, a native plant reintroduction project, watercraft inspection, purple loosestrife monitoring and bio-control, and volunteer monitoring. An aquatic plant management plan will be completed at the conclusion of this study.

Summary of Past Point Intercept Surveys and Herbicide Treatment

Whole lake point intercept surveys were completed by Polk County in 2006 and by Endangered Resource Sciences in 2016. Additionally, a summer bed mapping survey was conducted by Polk County in 2006 and a fall bed mapping survey for Eurasian water-milfoil was conducted by Endangered Resource Sciences in 2013. Eurasian water-milfoil was not documented in 2006 but was documented at 25 acres in 2010. However, in the 2013 fall survey only three rooted Eurasian water-milfoil plants were located and in 2016 Eurasian water-milfoil was identified at only two points totaling less than 1 acre.

Herbicide has been used to treat curly leaf pondweed and Eurasian water-milfoil since 2013, with curly leaf pondweed being treated every year and Eurasian water-milfoil being treated in 2013, 2016, and 2017.

Fisheries[7]

The most recent fisheries survey conducted on Long Trade Lake was in 2008. The lake is next scheduled to be sampled in 2020. Late spring boom shocking in May was used to sample the fisheries population.

The following number of fish were caught per mile on Long Trade Lake: 26 black crappie, 334 bluegill, 40 largemouth bass, 18 pumpkinseed, and two yellow perch.

An abundant black crappie population ranging in size from 7-9 inches in length was found. Bluegill were considered abundant and while their size structure was lower, larger fish were present. Largemouth bass were moderately abundant with good size structure and quite a few fish over 15 inches. Pumpkinseed and yellow perch were captured in lower numbers.

[7] Information provided by Aaron Cole, Fisheries Biologist, Wisconsin DNR

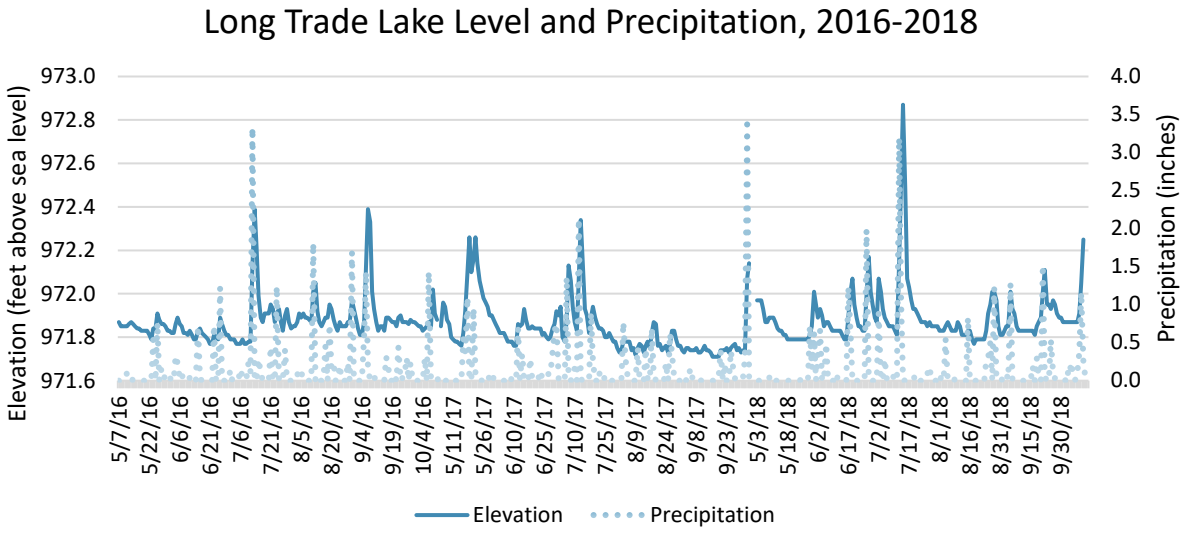
Lake Level and Precipitation Monitoring

Lake water-level fluctuations are important to lake managers, lakeshore property owners, developers, and recreational users because they can have significant impacts on lake water quality and usability. Although lake levels naturally change from year to year, extreme high or low levels can present problems such as restricted water access, flooding, shoreline and structure damage, and changes in near shore vegetation.

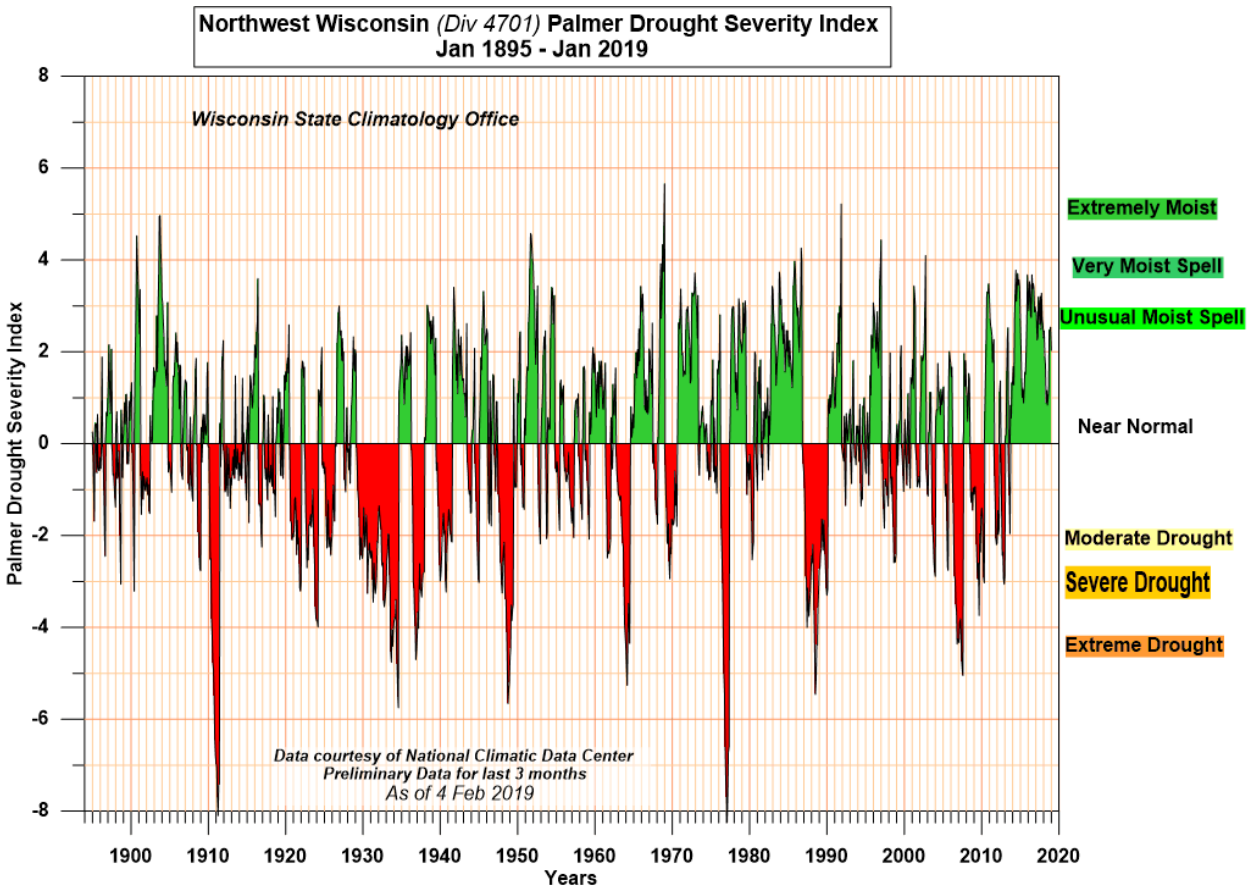
Records of lake water elevations can be very useful in understanding changes that may occur in lakes. While some lakes respond almost immediately to precipitation, other lakes do not reflect changes in precipitation until months later.

A volunteer monitored lake level and precipitation on Long Trade Lake in 2016, 2017, and 2018. Polk County Land and Water Resources Department provided training on data collection. The Polk County Land Information Department calibrated the staff gage by referencing the numbered height on the gage to the surveyed elevation of the water when the gage was installed in the spring and prior to removal in the fall. Monitoring began in the spring and continued through fall.

Seasonal precipitation on Long Trade Lake totaled 25.29 inches in 2016 (167 sampling days), 26.92 inches in 2017 (205 sampling days), and 23.54 inches in 2018 (167 sampling days). Lake level did respond to precipitation events, with levels increasing following rainfall events. Lake level remained fairly constant throughout the study, although it did increase following rainfall events.



Wisconsin State Climatology Office data indicate that 2016, 2017, and 2018 were years of unusual and very moist conditions.



Lake Mixing and Stratification: Background Information

Water quality is affected by the degree to which the water in a lake mixes. Within a lake, mixing is most directly impacted by the temperature-density relationship of water. When comparing why certain lakes mix differently than others, lake area, depth, shape, and position in the landscape become important factors to consider.

Water reaches its greatest density at 3.9^{o}C (39°F) and becomes less dense as temperatures increase and decrease. Compared to other liquids, the temperature-density relationship of water is unusual: liquid water is more dense than water in its solid form (ice). As a result, ice floats on liquid water.

When ice melts in the early spring, the temperature and density of the water will be constant from the top to the bottom of the lake. This uniformity in density allows a lake to completely mix. As a result, oxygen is brought to the bottom of a lake, and nutrients are re-suspended from the sediments. This event is termed **spring turnover**.

As the sun's rays warm the surface waters in the spring, the water becomes less dense and remains at the surface. Warmer water is mixed deeper into the water column through wind and wave action. However, these forces can only mix water to a depth of approximately twenty to thirty feet. Generally, in a shallow lake, the water may remain mixed all summer. However, a deeper lake usually experiences layering based on temperature differences, called **stratification**.

During the summer, lakes have the potential to divide into three distinct zones: the **epilimnion**, **thermocline** or **metalimnion**, and the **hypolimnion**. The epilimnion describes the warmer surface layer of a lake and the hypolimnion describes the cooler bottom area of a lake. The thermocline, or metalimnion, describes the transition area between the epilimnion and hypolimnion.

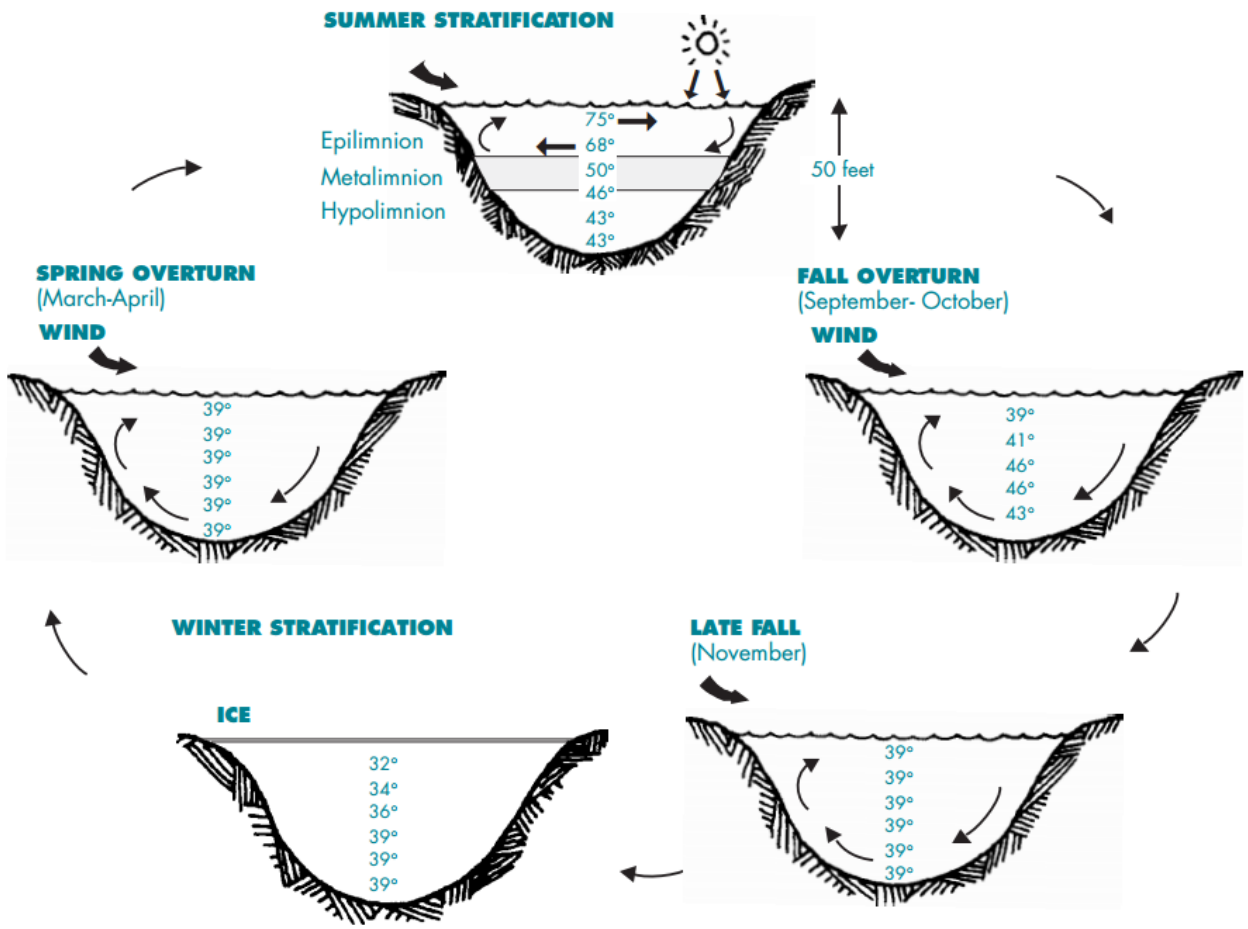
As surface waters cool in the fall, they become more dense and sink until the water temperature evens out from top to bottom. This process is called **fall turnover** and allows for a second mixing event to occur. Occasionally, algae blooms can occur at fall turnover when nutrients from the hypolimnion are made available throughout the water column.

Variations in density arising from differences in water temperatures can prevent warmer water from mixing with cooler water. As a result, nutrients released from the sediments can become trapped in the hypolimnion of a lake that stratifies. Additionally, since mixing is one of the main ways oxygen is distributed throughout a lake, lakes that don't mix have the potential to have very low levels of oxygen in the hypolimnion.

If oxygen is available in the hypolimnion, iron forms sediment particles that store phosphorus in the sediments. However, when lakes lose oxygen in the winter or when the hypolimnion becomes anoxic in the summer, these particles dissolve and phosphorus is redistributed throughout the water column with strong wind action or turnover events.

The absence of oxygen in the hypolimnion can have adverse effects on fisheries. Species of cold water fish require the cooler waters that result from stratification. Cold water holds more oxygen as compared to warm water. As a result, the cooler waters of the hypolimnion can provide a refuge for cold water fisheries in the summer as long as oxygen is present. Respiration by plants, animals, and especially bacteria is the primary way oxygen is removed from the hypolimnion. A large algae bloom can cause oxygen depletion in the hypolimnion as algae die, sink, and decay.

In the winter, stratification remains constant because ice cover prevents mixing by wind action.



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[8] Figure from Understanding Lake Data (G3582), UW-Extension, Byron Shaw, Christine Mechenich, and Lowell Klessig, 2004

Deep Hole Sampling Procedure

In-lake data were collected by the Polk County Land and Water Resources Department during the 2016, 2017, and 2018 growing season.

Lake profile monitoring

Dissolved oxygen, temperature, conductivity, specific conductance, and pH were recorded at meter increments with a Hanna Instruments 9828 multi-parameter probe biweekly.

Secchi depth

Secchi depth was recorded with an eight inch diameter round disk with alternating black and white quadrants called a secchi disk. To record secchi depth, the disk was lowered into the lake on the shady side of a boat until just before it disappeared from sight. This depth was measured in feet and recorded as the secchi depth. Data was collected biweekly to correspond with lake profile monitoring readings.

Chemistry and chlorophyll a

Top and bottom samples were collected once a month with a composite sampler and analyzed at the Water and Environmental Analysis Lab. Top samples were analyzed for total phosphorus, soluble reactive phosphorus, nitrate/nitrite, ammonium, total Kjeldahl nitrogen, total suspended solids, chloride, and chlorophyll a. Bottom samples were analyzed for total phosphorus and soluble reactive phosphorus.

Citizen Lake Monitoring Network

Volunteers collected secchi depth, phosphorus, and chlorophyll samples as part of the Citizen Lake Monitoring Network program.

Dissolved Oxygen

Oxygen is required by all aquatic organisms for survival. The amount of oxygen dissolved in water depends on temperature, the amount of wind mixing that brings water into contact with the atmosphere, the biological activity that consumes or produces oxygen within a lake, and the composition of groundwater and surface water entering a lake.

In a process called photosynthesis, plants use carbon, water, and the sun's energy to produce simple sugars and oxygen. Chlorophyll, the pigment in plants that captures the light energy necessary for photosynthesis, is the site where oxygen is produced. Since photosynthesis requires light, the oxygen producing process only occurs during the daylight hours and only at depths where sunlight can penetrate. Plants and animals also use oxygen in a process called respiration. During respiration, sugar and oxygen are used by plants and animals to produce carbon dioxide and water.

Cold water has a higher capacity for oxygen than warm water. Although temperatures are coolest in the deepest part of a lake, these waters often do not contain the most oxygen. This arises because in the deepest parts of lakes, oxygen producing photosynthesis is not occurring, mixing is unable to introduce oxygen, and the only reaction occurring is oxygen consuming respiration. Therefore, it is not uncommon for oxygen depletion to occur in the hypolimnion.

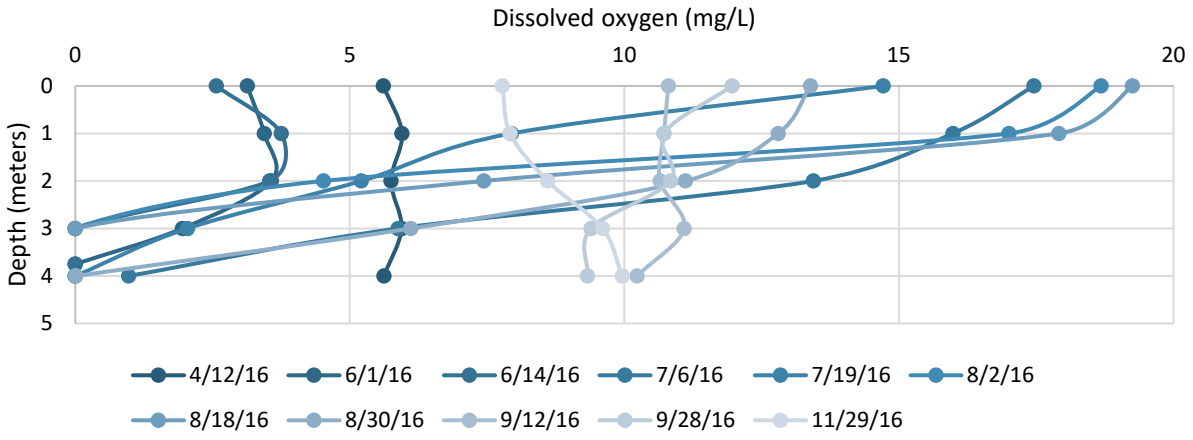
During the sunlight hours, when photosynthesis is occurring, dissolved oxygen levels at a lake's surface may be quite high. Conversely, at night or early in the morning (when photosynthesis is not occurring), the dissolved oxygen values can be expected to be lower.

A water quality standard for dissolved oxygen in warm water lakes and streams is set at 5 mg/L. This standard is based on the minimum amount of oxygen required by fish for survival and growth. For cold water lakes supporting trout, the standard is set even higher at 7 mg/L.

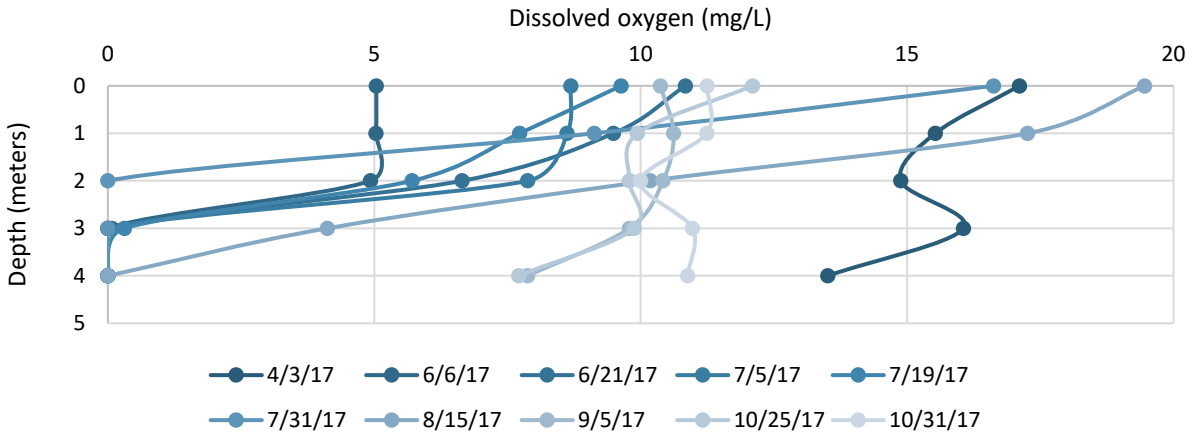
The Land and Water Resources Department probe used for this study was sent off for repairs due to a faulty dissolved oxygen sensor in July 2016 and July of 2018.

The water column was well oxygenated at both spring and fall turnover (April and October) and also throughout September. During the remainder of the growing season, oxygen dropped to zero at a depth of three or four meters. The surface waters of Long Trade Lake were well oxygenated during the entire sampling season with the exception of June in all three years.

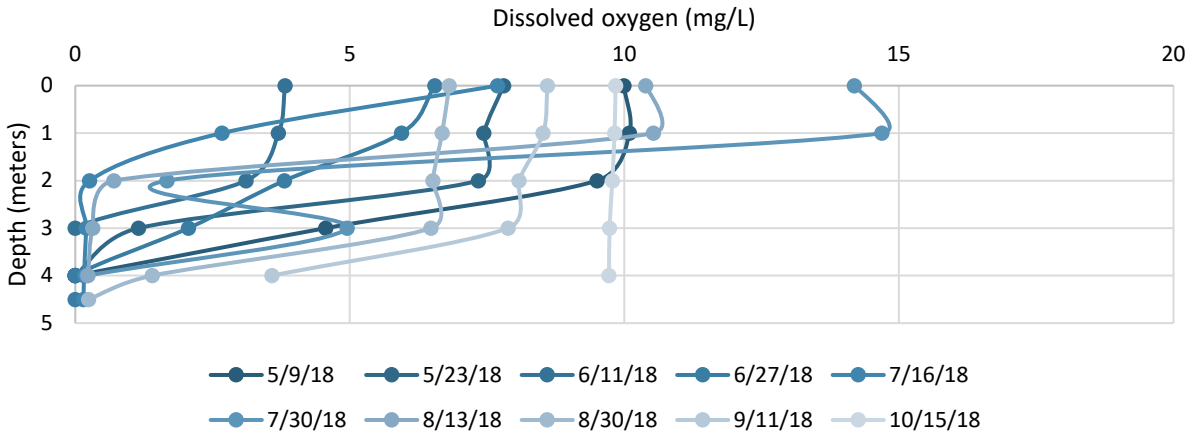
2016 Long Trade Lake Dissolved Oxygen



2017 Long Trade Lake Dissolved Oxygen



2018 Long Trade Lake Dissolved Oxygen

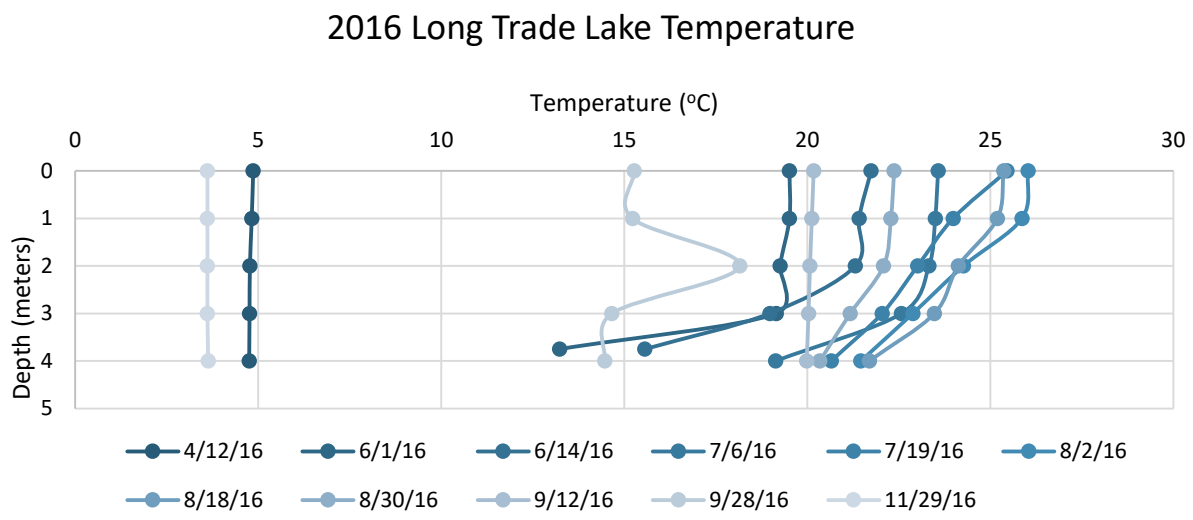


Temperature

Long Trade Lake stratified, or set up density dependent layers, during each year of the study. The upper level of the lake, or the epilimnion, reaches to a depth of two meters during the majority of the growing season. The water in this area of the lake is warmer and is well mixed by wind and wave action. The cooler bottom area of the lake, or the hypolimnion does not mix with the waters of the epilimnion.

The surface temperature was greatest in July and August across all three years of the study.

Surface Temperature on Long Trade Lake (°C)	
4/12/16	4.86
6/1/16	19.51
6/14/16	21.74
7/6/16	23.57
7/19/16	25.45
8/2/16	26.03
8/18/16	25.36
8/30/16	22.37
9/12/16	20.17
9/28/16	15.27
11/29/16	3.61
4/3/17	7.17
5/23/17	13.27
6/6/17	22.29
6/21/17	22.62
7/5/17	23.54
7/19/17	23.86
7/31/17	25.33
8/15/17	23.48
9/5/17	18.81
10/25/17	10.84
10/31/17	4.92
5/9/18	14.56
5/23/18	18.77
6/11/18	20.77
6/27/18	22.93
7/16/18	26.2
7/30/18	25.3
8/13/18	27.1
8/30/18	20.9
9/11/18	20.14
10/15/18	6.4


2016 Long Trade Lake Temperature
Temperature (ºC)
0
5
10
15
20
25
30
Depth (meters)
0
1
2
3
4
5
4/12/16
6/1/16
6/14/16
7/6/16
7/19/16
8/2/16
8/18/16
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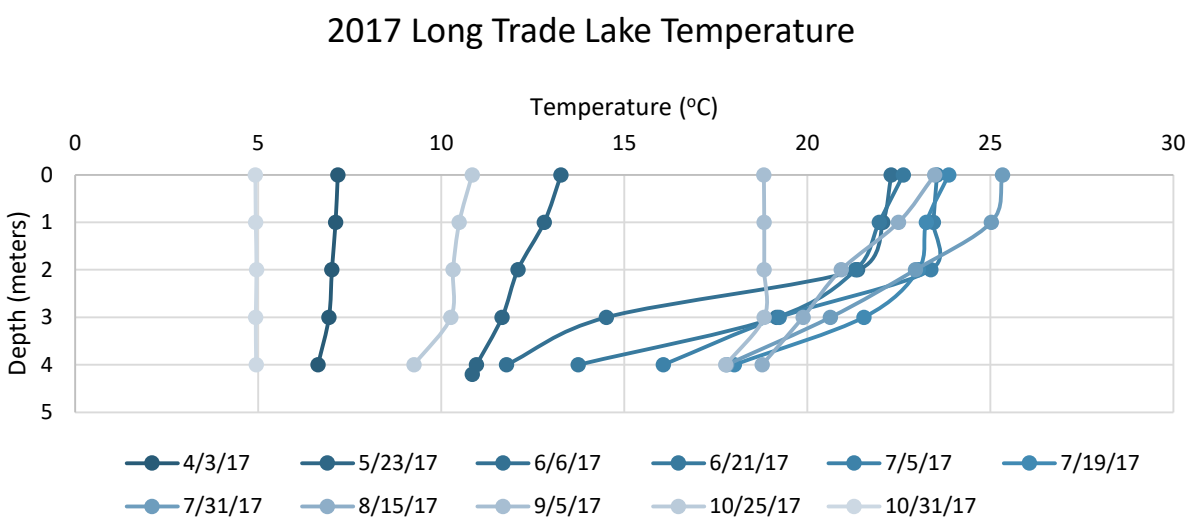
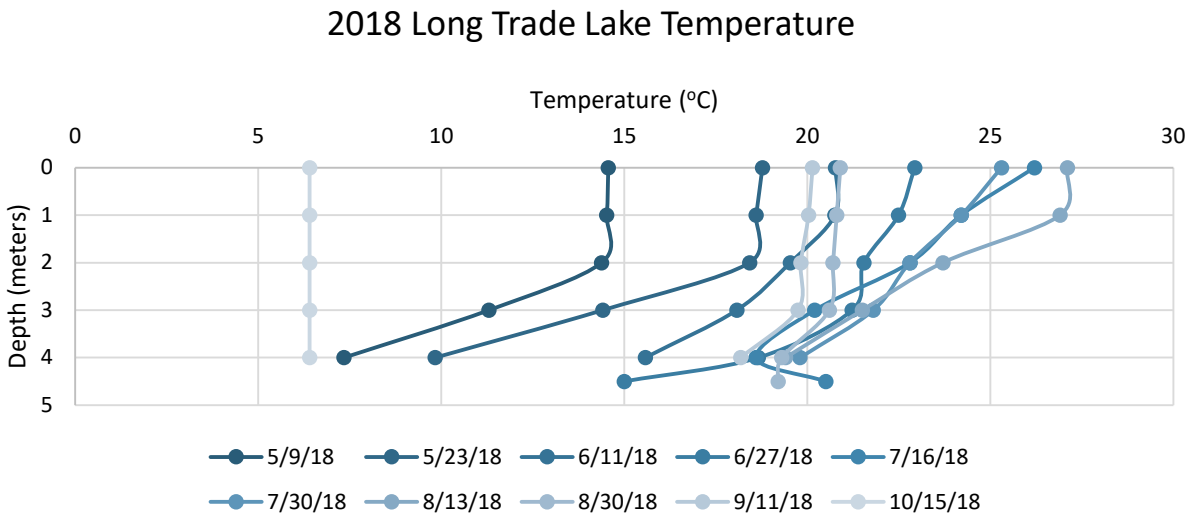
9/12/16
9/28/16
11/29/16


2017 Long Trade Lake Temperature
Temperature (ºC)
0
5
10
15
20
25
30
Depth (meters)
0
1
2
3
4
5
4/3/17
5/23/17
6/6/17
6/21/17
7/5/17
7/19/17
7/31/17
8/15/17
9/5/17
10/25/17
10/31/17

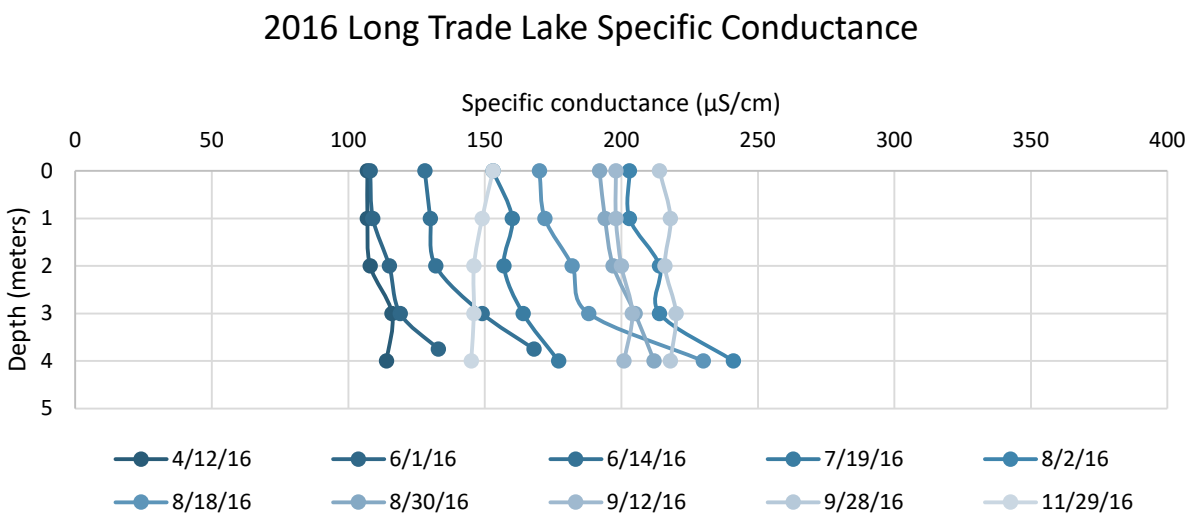

2018 Long Trade Lake Temperature
Temperature (ºC)
0
5
10
15
20
25
30
Depth (meters)
0
1
2
3
4
5
5/9/18
5/23/18
6/11/18
6/27/18
7/16/18
7/30/18
8/13/18
8/30/18
9/11/18
10/15/18

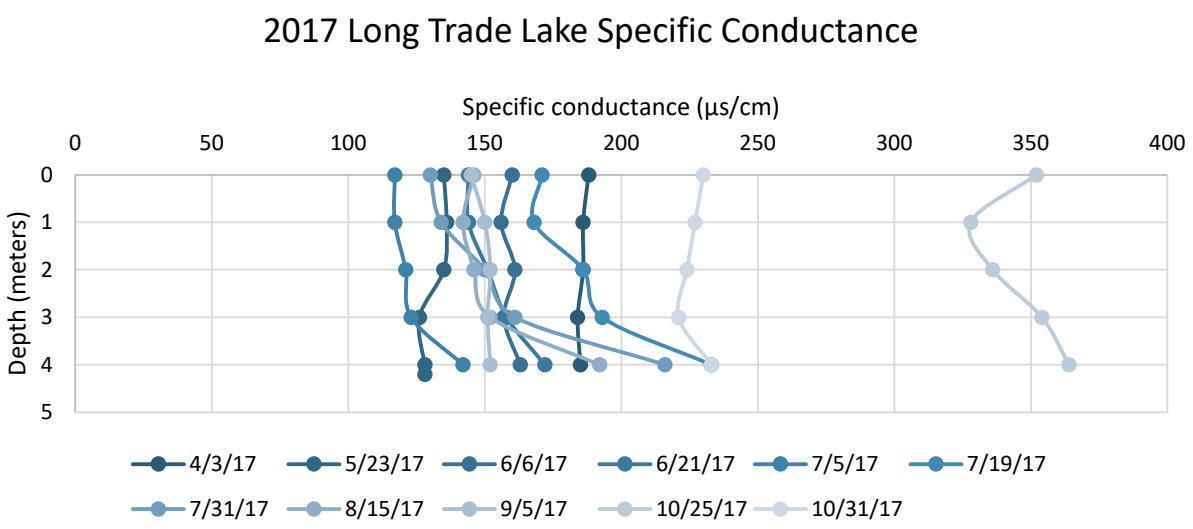
Specific Conductance (Conductivity)

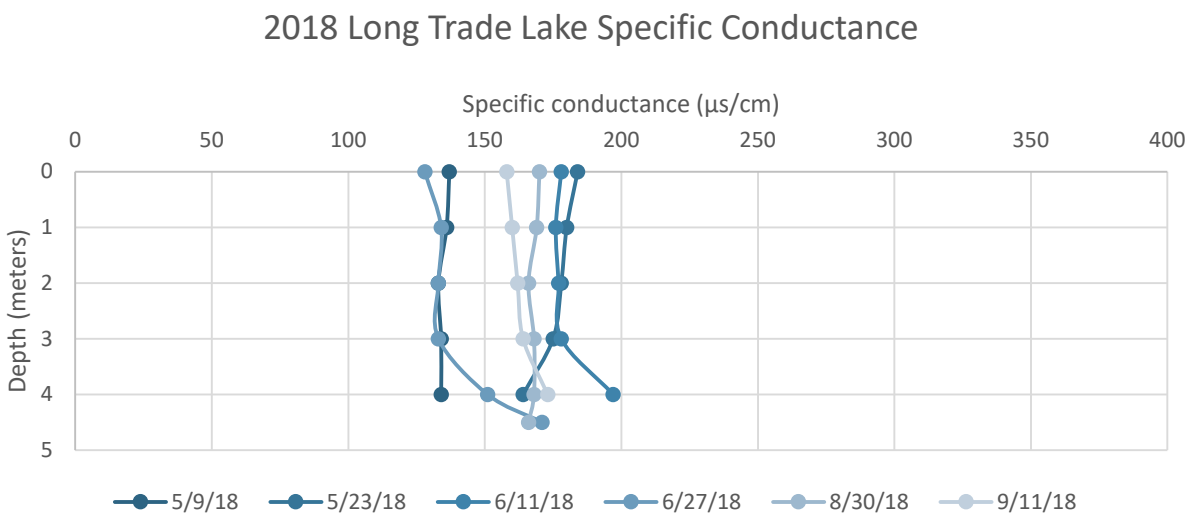
Conductivity is the measure of the ability of water to conduct an electrical current and serves as an indicator of the concentration of total dissolved inorganic chemicals in the water. Since conductivity is temperature related, reported values are normalized at 25°C and termed specific conductance. Specific conductance increases as the concentration of dissolved minerals in a lake increase.

In general, specific conductance values at the surface were between 100 and 200 µS/cm in Long Trade Lake. Specific conductance increased in the bottom meter of the lake during the growing season. In the absence of high concentrations of contaminants, conductivity values indicate that Long Trade Lake is a moderately hard water lake.

When watersheds contain easily dissolved carbonate rocks, lakes are more likely to have higher conductivity. In contrast, watersheds that contain slow-to-dissolve rocks, such as granite, are more likely to have lower conductivity. Lakes with especially low conductivity are also more likely to be precipitation dominated (rather than groundwater or runoff dominated), because precipitation contains very little dissolved minerals.


2016 Long Trade Lake Specific Conductance
Specific conductance (µS/cm)
0
50
100
150
200
250
300
350
400
Depth (meters)
0
1
2
3
4
5
4/12/16
6/1/16
6/14/16
7/19/16
8/2/16
8/18/16
8/30/16
9/12/16
9/28/16
11/29/16


2017 Long Trade Lake Specific Conductance
Specific conductance (µs/cm)
0
50
100
150
200
250
300
350
400
Depth (meters)
0
1
2
3
4
5
4/3/17
5/23/17
6/6/17
6/21/17
7/5/17
7/19/17
7/31/17
8/15/17
9/5/17
10/25/17
10/31/17


2018 Long Trade Lake Specific Conductance
Specific conductance (µs/cm)
0
50
100
150
200
250
300
350
400
Depth (meters)
0
1
2
3
4
5
5/9/18
5/23/18
6/11/18
6/27/18
8/30/18
9/11/18

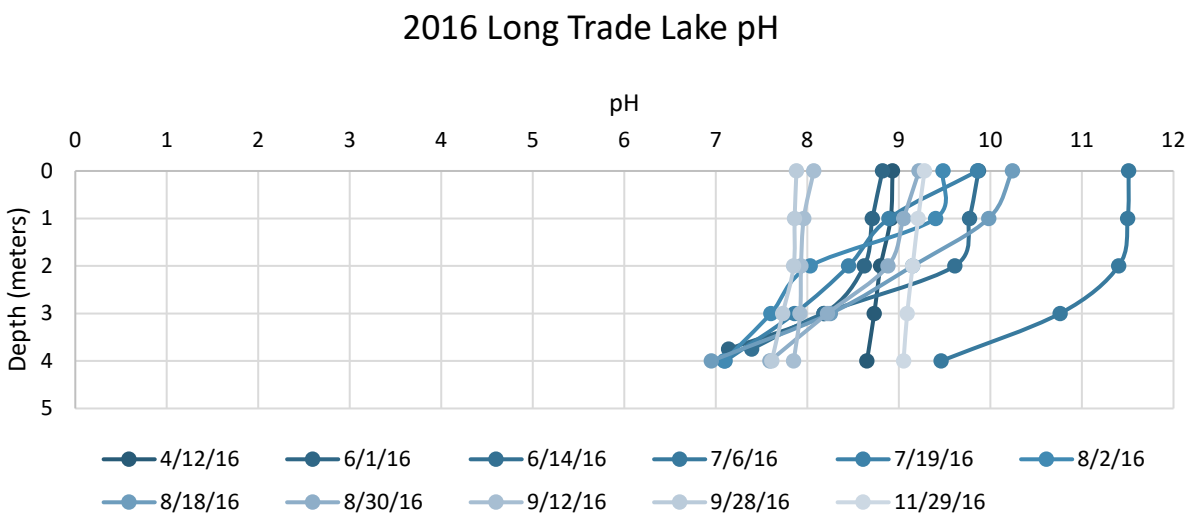
pH

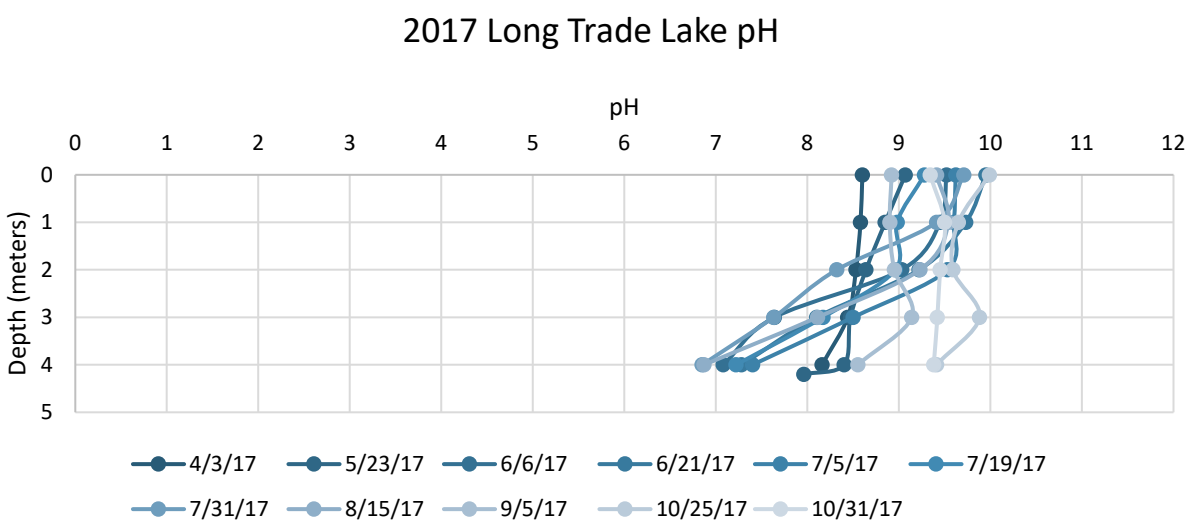
An indicator of acidity, pH is the negative logarithm of the hydrogen ion (H+) concentration. Lower pH waters have more hydrogen ions and are more acidic, and higher pH waters have less hydrogen ions and are less acidic.

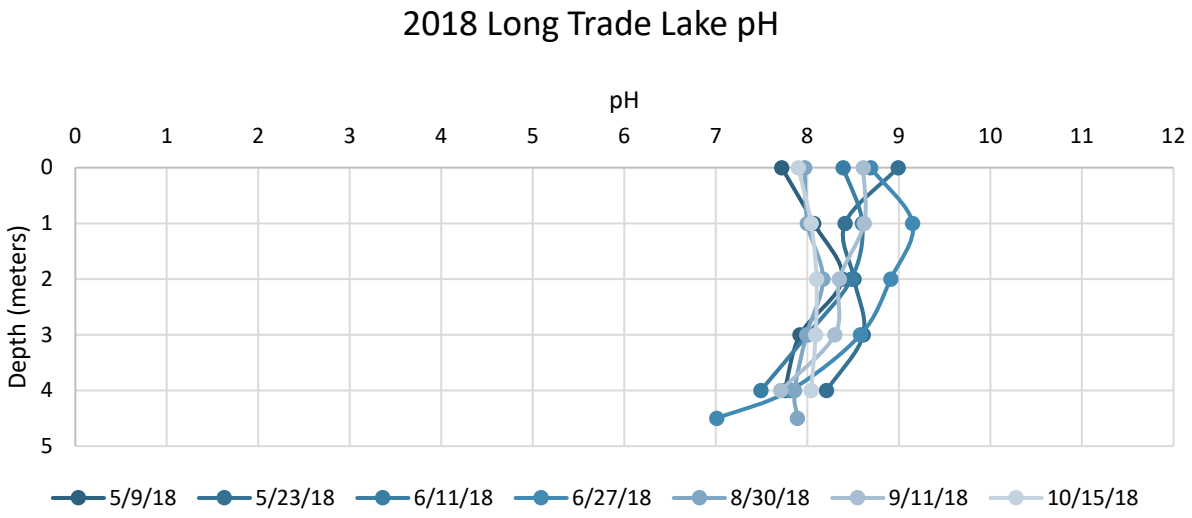
A pH value of seven is considered neutral. Values less than seven indicate acidic conditions; whereas, values greater than seven indicate alkaline conditions. A single pH unit change represents a tenfold change in the concentration of hydrogen ions. As a result, a lake with a pH value of eight is ten times less acidic than a lake with a pH value of seven. Across Wisconsin lakes, pH values can range from 4.5 (acid bog lakes) to 8.4 (hard water, marl lakes).

Through the removal of CO_2 from the water column, photosynthesis has the effect of increasing pH. As a result, pH generally increases during the day and decreases at night. Under conditions such as high temperature, high nutrients, and dense algae blooms, pH levels can increase.

Over the majority of the summer sampling dates, pH on Long Trade Lake was above 9 at the lake's surface and decreased towards the bottom waters. These values are relatively high for Polk County lakes.

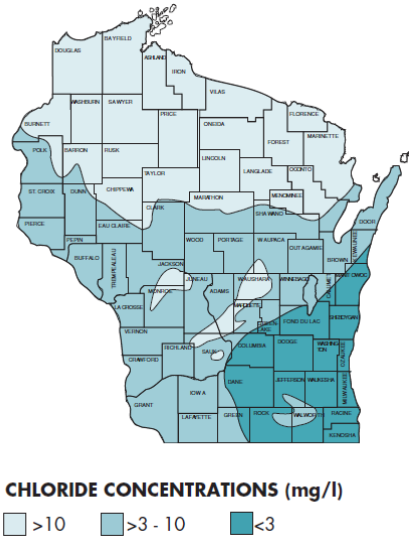

2016 Long Trade Lake pH
pH
0 1 2 3 4 5 6 7 8 9 10 11 12
Depth (meters)
0 1 2 3 4 5
4/12/16
6/1/16
6/14/16
7/6/16
7/19/16
8/2/16
8/18/16
8/30/16
9/12/16
9/28/16
11/29/16


2017 Long Trade Lake pH
pH
0 1 2 3 4 5 6 7 8 9 10 11 12
Depth (meters)
0 1 2 3 4 5
4/3/17
5/23/17
6/6/17
6/21/17
7/5/17
7/19/17
7/31/17
8/15/17
9/5/17
10/25/17
10/31/17


2018 Long Trade Lake pH
pH
0 1 2 3 4 5 6 7 8 9 10 11 12
Depth (meters)
0 1 2 3 4 5
5/9/18
5/23/18
6/11/18
6/27/18
8/30/18
9/11/18
10/15/18

Chloride [9]

Although chloride does not directly negatively impact plants, algae, or aquatic organisms, elevated levels of chloride in a lake can indicate possible water pollution.

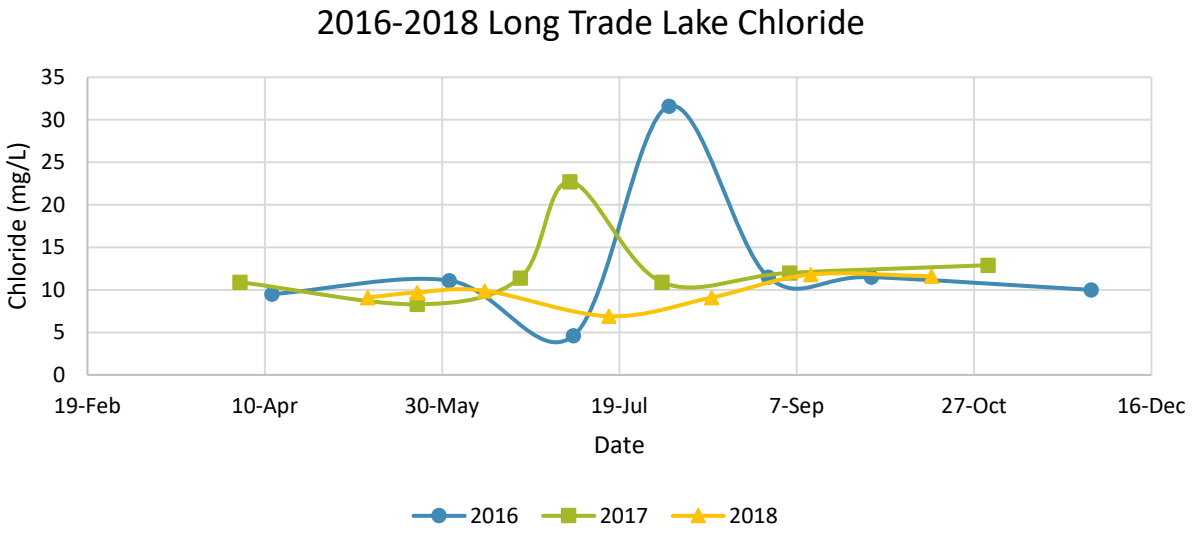


With the exception of limestone deposits, chloride is uncommon in Wisconsin soils, rocks, and minerals. Background levels of chloride are generally found in small quantities in nearly every Wisconsin lake and can be introduced to waterways through rainwater.

The watershed for Long Trade Lake is located in an area of Wisconsin where chloride concentrations can be expected to range from three to ten mg/L. In both 2016 and 2017 chloride concentrations were above 10 mg/L on all but three sampling dates. In 2018, chloride concentrations were below 10 mg/L until September. Chloride concentrations spiked on August 2nd in 2016 and on July 5th in 2017.

Growing season average chloride (May-September) was 14.1 mg/L in 2016, 13.1 mg/L in 2017, and 9.5 mg/L in 2018.

One possible explanation for the 2016 and 2017 summer spike in chloride could be the disposal of liquid cheese brine on land in the Long Trade Lake watershed.

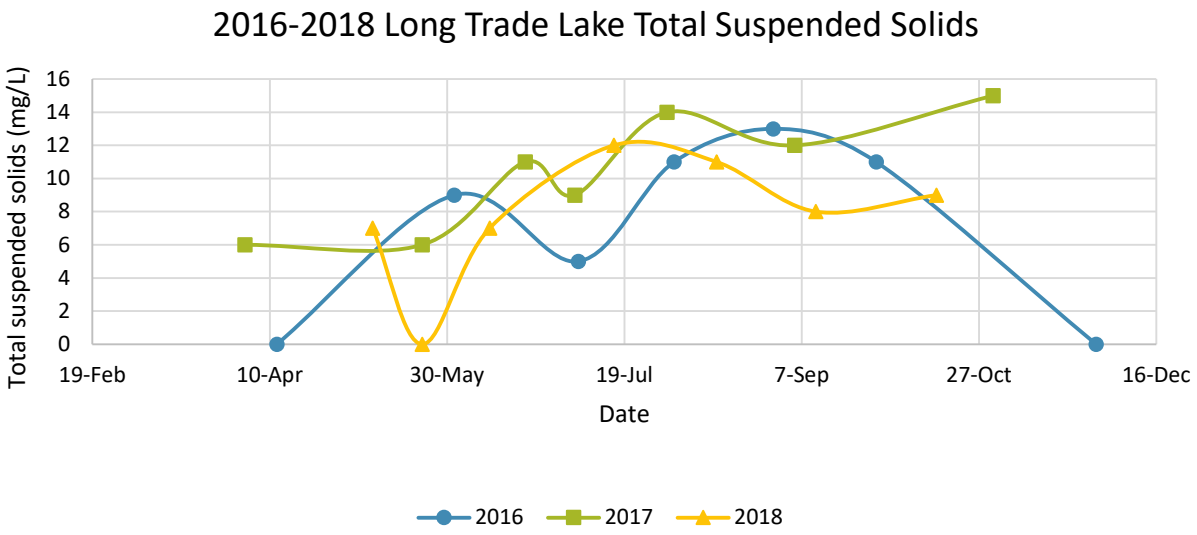


[9] Figure from Understanding Lake Data (G3582), UW-Extension, Byron Shaw, Christine Mechenich, and Lowell Klessig, 2004

Total Suspended Solids

Total suspended solids (TSS) quantify the amount of inorganic matter that is floating in the water column. Wind, waves, boats, and even some fish species can stir up sediments from the lake bottom re-suspending them in the water column. Fine sediments, especially clay, can remain suspended in the water column for weeks. These particles scatter light and decrease water transparency.

Growing season average total suspended solids (May-September) were 9.8 mg/L in 2016, 10.4 mg/L in 2017, and 7.6 mg/L in 2018.

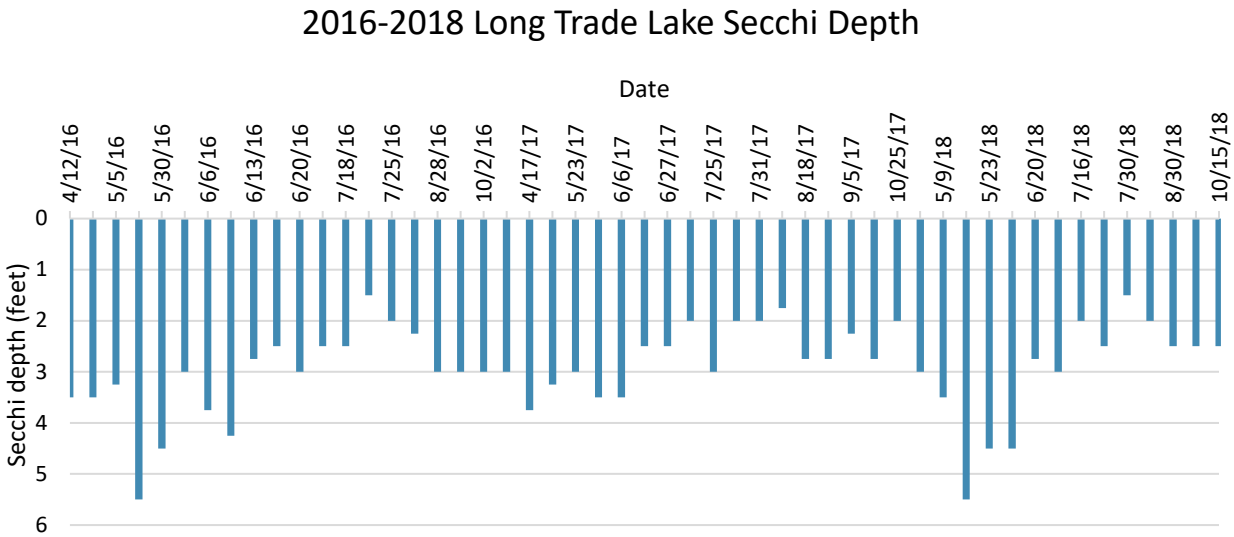


Secchi Depth

The depth which light can penetrate into lakes is affected by suspended particles, dissolved pigments, and absorbance by water. Often, the ability of light to penetrate the water column is determined by the abundance of algae or other photosynthetic organisms in a lake.

One method of measuring light penetration is with a secchi disk. A secchi disk is an eight inch diameter round disk with alternating black and white quadrants that is used to provide a rough estimate of water clarity. The depth at which the secchi disk is just visible is defined as the secchi depth. A greater secchi depth indicates greater water clarity.

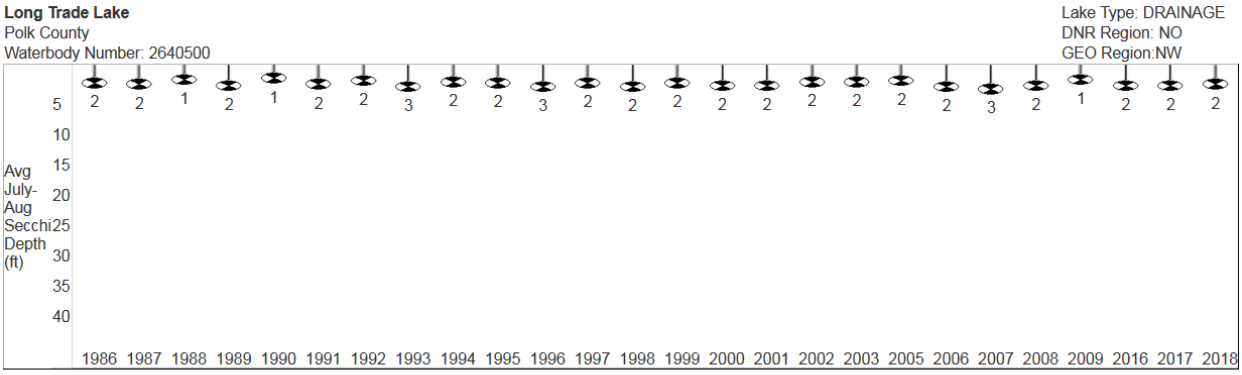
Secchi depth values on Long Trade Lake ranged from a low of 1.5 feet to a high of 5.5 feet over the course of this study.



Growing season average secchi depth (May-September) was 3.1 feet in 2016, 2.7 feet in 2017, and 3.0 feet in 2018. Summer index period average secchi depth (July 15-September 15) was 2.4 feet in 2016, 2.4 feet in 2017, and 2.2 feet in 2018.

The Wisconsin Department of Natural Resources website provides historic secchi depth averages for the months of July and August. This data exists for Long Trade Lake from 1986-2003, 2005-2009, and 2016-2018. Over this timeframe, average secchi depth has ranged from 1 to 3 feet. In 2016 and 2017 the average secchi depth for the months of July and August was 2.32 feet in 2016 and 2017 and 2.1 feet in 2018.

The average summer secchi depth (July and August) for the Northwest geo-region was 8.2 feet in 2016, 8.1 feet in 2017, and 8.7 feet in 2018. In each year of this study, secchi depth on Long Trade Lake was well below the geo-region average.



Past secchi averages in feet (July and August only).

Phosphorus

Phosphorus is an element present in lakes which is necessary for plant and algae growth. It occurs naturally in soil and rocks and in the atmosphere in the form of dust. Phosphorus can make its way into lakes through groundwater and human induced disturbances such as soil erosion. Additional sources of phosphorus inputs into a lake can include external sources such as fertilizer runoff from urban and agricultural settings and internal sources such as release from lake bottom sediments.

Phosphorus does not readily dissolve in water, instead it forms insoluble precipitates with calcium, iron, manganese, sulfur, and aluminum. If oxygen is available in the hypolimnion, iron forms sediment particles that store phosphorus in the sediments. However, when lakes lose oxygen in the winter or when the hypolimnion becomes anoxic in the summer, these particles dissolve and phosphorus is redistributed throughout the water column with strong wind action or turnover events.

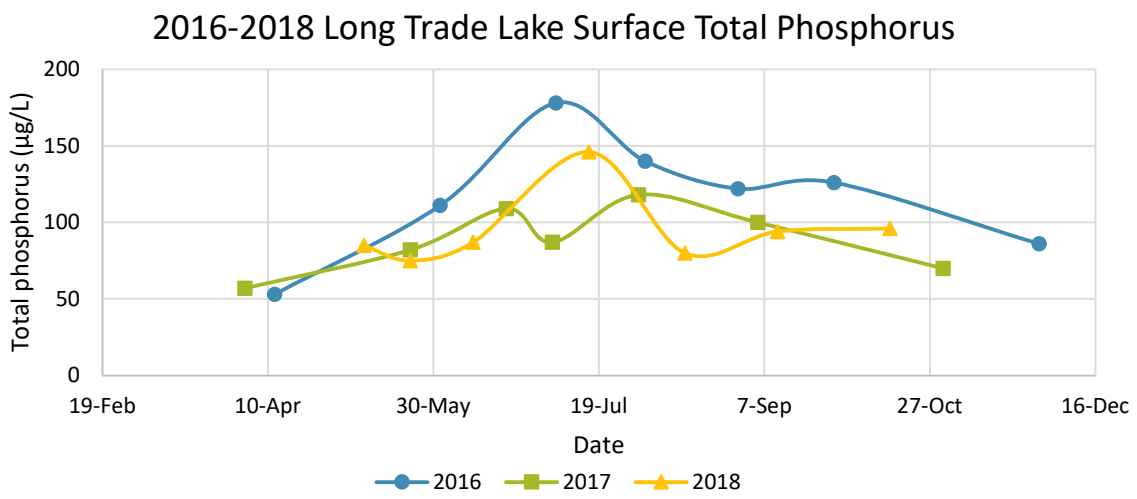
Phosphorus is necessary for plant and animal growth. Excessive amounts can lead to an overabundance of growth which can decrease water clarity and lead to nutrient pollution in lakes.

Total phosphorus is a measure of all the phosphorus in a sample of water. In many cases total phosphorus is the preferred indicator of a lake's nutrient status because it remains more stable than other forms over an annual cycle.

In lakes, a healthy limit of total phosphorus is set at 20 µg/L. If a value is above the healthy limit it is more likely that a lake could support nuisance algae blooms. On all sampling dates, surface phosphorus was above the healthy limit on Long Trade Lake.

Growing season average surface phosphorus (May-September) on Long Trade Lake was 131 µg/L in 2016, 108 µg/L in 2017, and 100 µg/L in 2018.

Summer index period (July 15-September 15) average surface phosphorus on Long Trade Lake was 145 µg/L in 2016, 122 µg/L in 2017, and 116 µg/L in 2018.

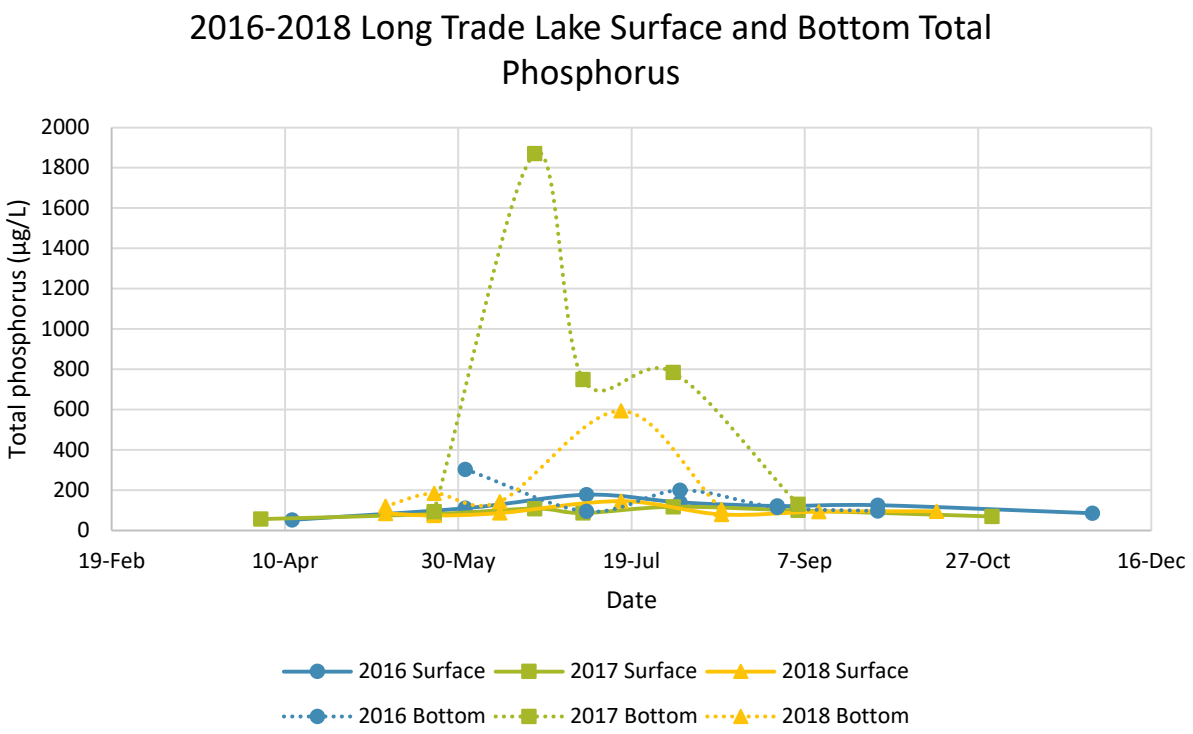


Growing season average bottom phosphorus on Long Trade Lake was 162 µg/L in 2016, 726 µg/L in 2017, and 326 µg/L in 2018.

Summer index period (July 15-September 15) average bottom phosphorus on Long Trade Lake was 158 µg/L in 2016, 458 µg/L in 2017, and 388 µg/L in 2018.

The relationship between top and bottom total phosphorus was variable across the years of the study. In 2016, bottom total phosphorus was actually lower than top total phosphorus on the majority of sampling dates. In contrast, in 2017 and 2018 bottom total phosphorus was much greater than top total phosphorus on all sampling dates, especially in June and July of 2017 and August of 2018.

Date	Surface Total Phosphorus (µg/L)	Bottom Total Phosphorus (µg/L)	Percent change
6/1/2016	111	304	174%
7/6/2016	178	95	-47%
8/2/2016	140	200	43%
8/30/2016	122	115	-6%
9/28/2016	126	97	-23%
5/23/2017	82	94	15%
6/21/2017	109	1870	1616%
7/5/2017	87	750	762%
7/31/2017	118	785	565%
9/5/2017	100	130	30%
5/23/18	75	196	161%
6/11/18	87	272	213%
7/16/18	146	290	99%
8/14/18	80	674	743%
9/11/18	94	199	112%

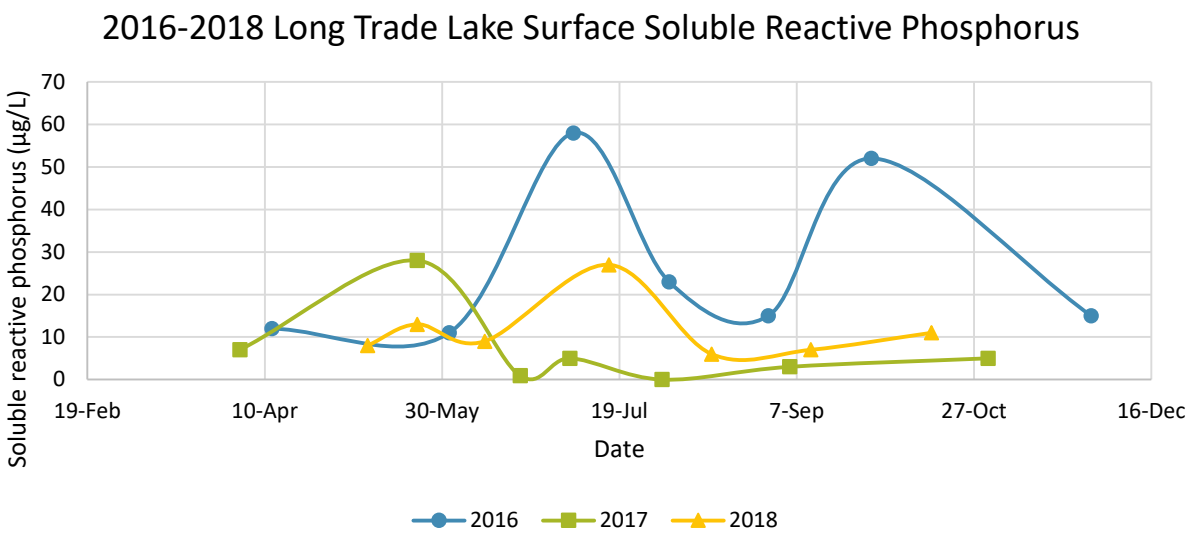


Soluble reactive phosphorus includes forms of phosphorus that are dissolved in the water and are readily available for uptake by algae and aquatic plants.

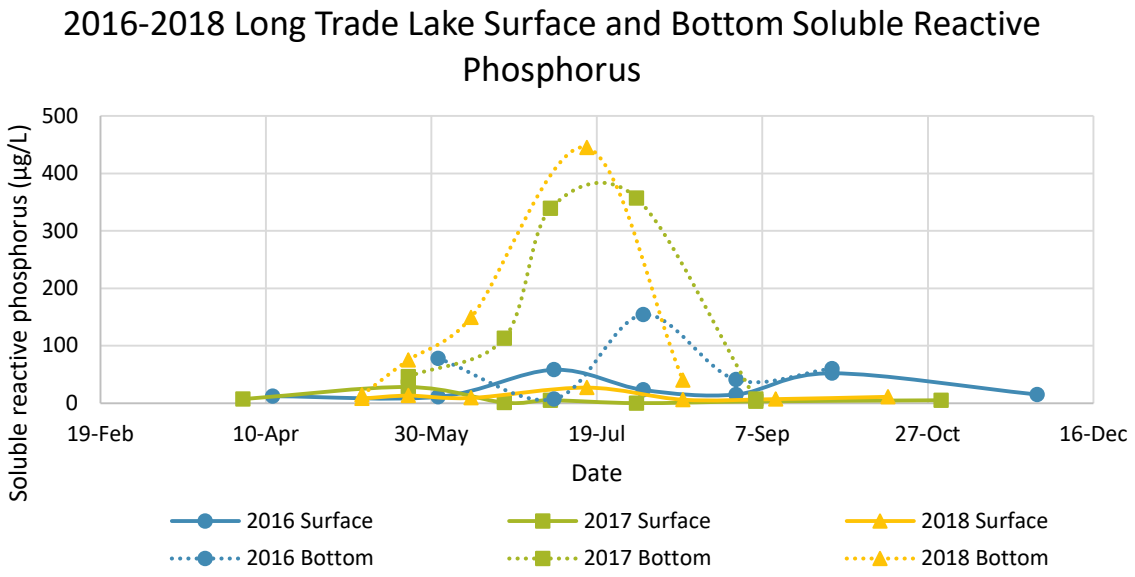
In lakes, a healthy limit of soluble reactive phosphorus is set at 10 µg/L. If a value is above the healthy limit it is more likely that a lake could support nuisance algae blooms. In 2016, surface soluble reactive phosphorus was above the healthy limit on Long Trade Lake on all sampling dates. In 2017, surface soluble reactive phosphorus was below the healthy limit on all sampling dates except May 23rd.

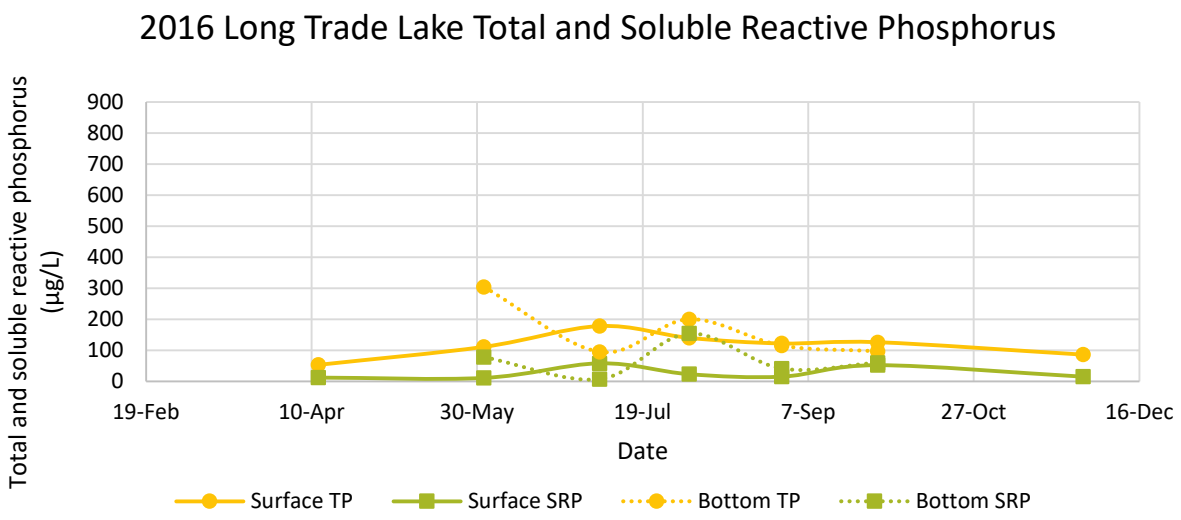
Growing season average surface phosphorus on Long Trade Lake was 32 µg/L in 2016, 7 µg/L in 2017, and 12 µg/L in 2018.

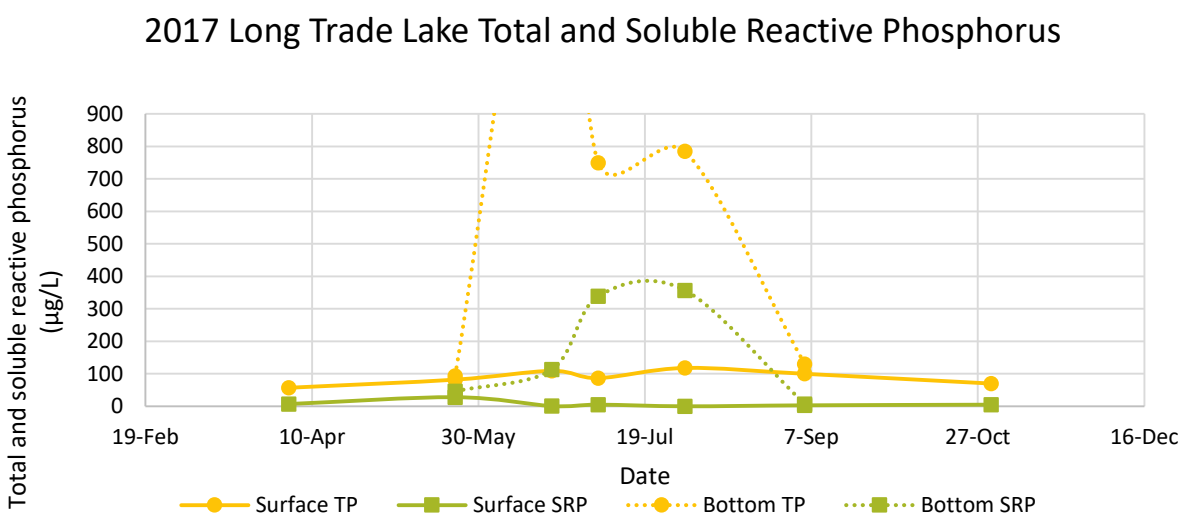
Summer index period (July 15-September 15) average surface phosphorus on Long Trade Lake was 19 µg/L in 2016, 3 µg/L in 2017, and 13 µg/L in 2018.

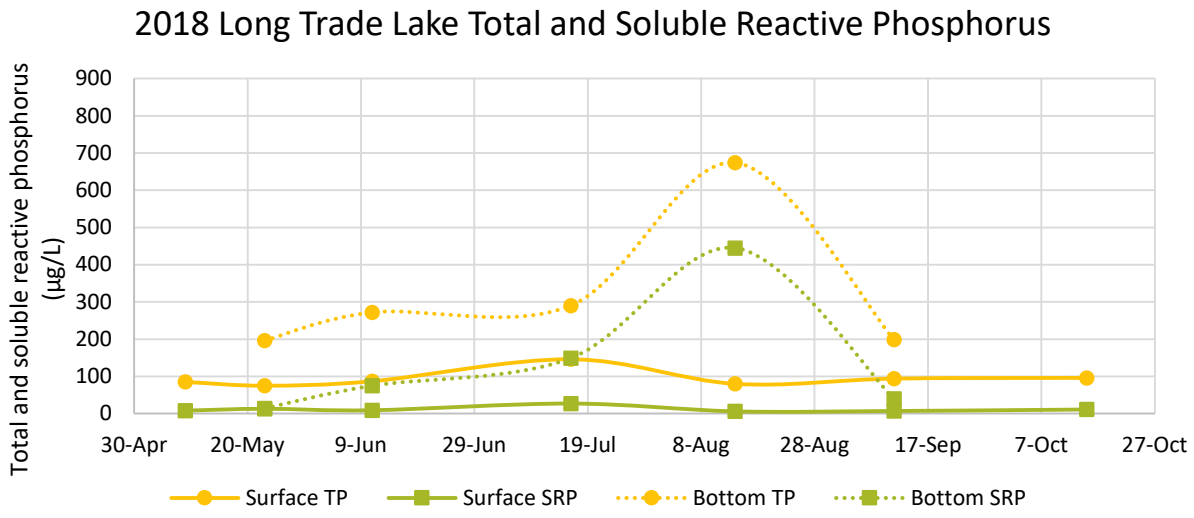


In 2016, soluble reactive phosphorus values were greater at the bottom of Long Trade Lake (with the exception of the July 6th sampling date). This trend was also evident in 2017 and 2018, although the difference between top and bottom samples was much more pronounced.




2016 Long Trade Lake Total and Soluble Reactive Phosphorus
Total and soluble reactive phosphorus (µg/L)
900
800
700
600
500
400
300
200
100
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
Date
Surface TP
Surface SRP
Bottom TP
Bottom SRP


2017 Long Trade Lake Total and Soluble Reactive Phosphorus
Total and soluble reactive phosphorus (µg/L)
900
800
700
600
500
400
300
200
100
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
Date
Surface TP
Surface SRP
Bottom TP
Bottom SRP


2018 Long Trade Lake Total and Soluble Reactive Phosphorus
Total and soluble reactive phosphorus (µg/L)
900
800
700
600
500
400
300
200
100
0
30-Apr
20-May
9-Jun
29-Jun
19-Jul
8-Aug
28-Aug
17-Sep
7-Oct
27-Oct
Surface TP
Surface SRP
Bottom TP
Bottom SRP

Nitrogen

Nitrogen, like phosphorus, is an element necessary for plant growth. Nitrogen sources in a lake can vary widely. Nitrogen does not occur naturally in soil minerals; however, it is a major component of all plant and animal matter. The decomposition of plant and animal matter releases ammonia, which is converted to nitrate in the presence of oxygen. This reaction accelerates when water temperatures increase. Nitrogen can also be introduced to a lake through rainfall, in the form of nitrate and ammonium, and through groundwater in the form of nitrate.

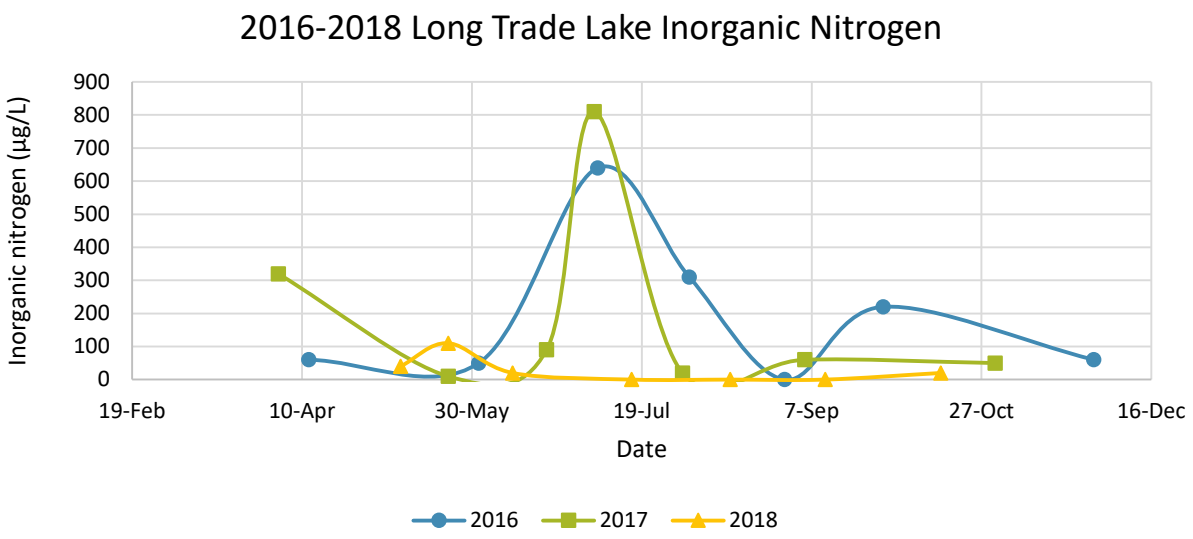
In most instances, the amount of nitrogen in a lake corresponds to land use. Nitrogen can enter a lake from surface runoff or groundwater sources as a result of fertilization of lawns and agricultural fields, animal waste, or human waste from septic systems or sewage treatment plants. During spring and fall turnover events, nitrogen is recycled back into the water column, which can cause spikes in ammonia levels. Under low oxygen circumstances, nitrogen can be lost from a lake system through a process called denitrification. Under these conditions, nitrate is converted to nitrogen gas. Additionally, nitrogen can be lost through permanent sedimentation.

Nitrogen comprises the majority (78%) of the gases in the Earth's atmosphere. As with other gases, nitrogen is more soluble in cooler water as compared to warmer water. Nitrogen gas is not readily available to most aquatic plants, with the exception of blue green algae.

Nitrogen is divided into many components. In this study nitrate/nitrite, ammonium, and total Kjeldahl nitrogen were analyzed.

Nitrate/nitrite and ammonium are inorganic forms of nitrogen which can be used by aquatic plants and algae. Inorganic nitrogen concentrations above 300 µg/L can support summer algae blooms.

Nitrate/nitrite was below the limit of detection or less than 100 µg/L on all sample dates with the exception of April 3rd and July 5th 2017. Inorganic nitrogen was well above 300 µg/L in July of 2016 and 2017.

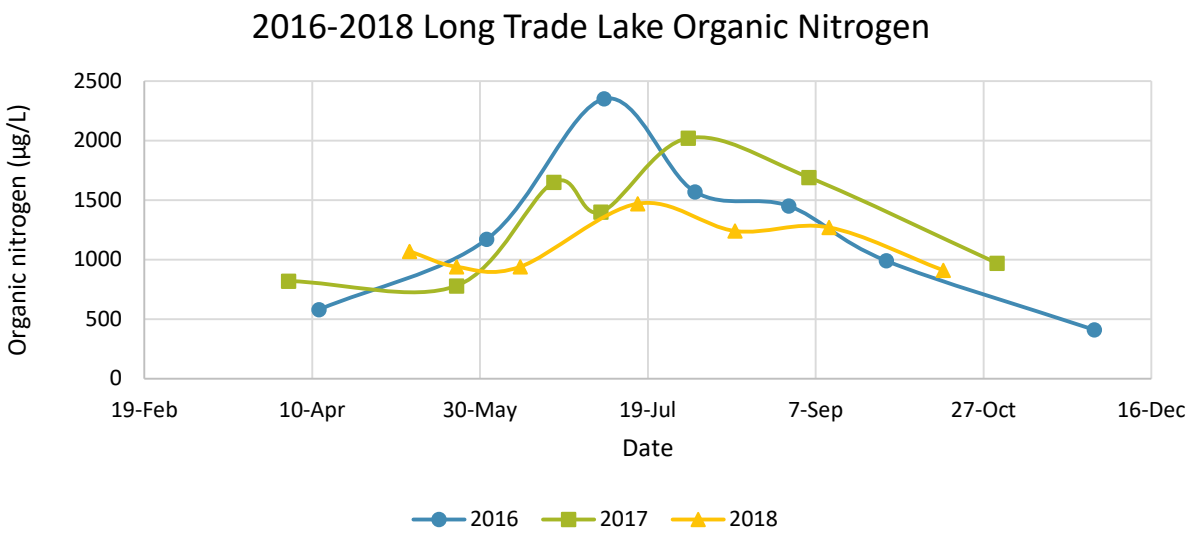


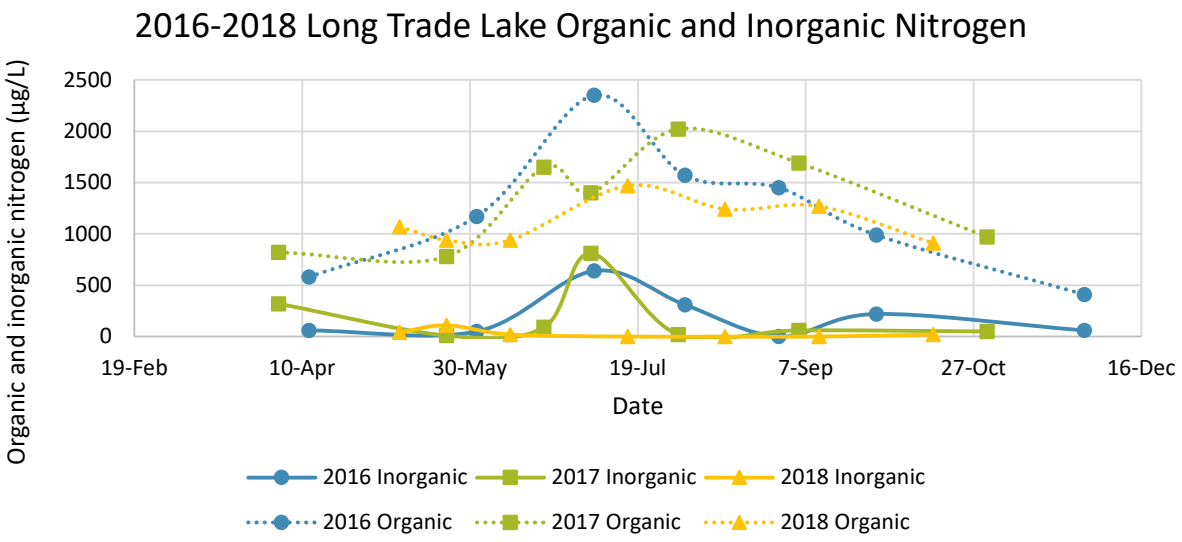
Total Kjeldahl Nitrogen is a measure of organic nitrogen plus ammonium. By subtracting the ammonium concentration from total Kjeldahl nitrogen, the organic nitrogen concentration found in plants and algae can be found.

Growing season average organic nitrogen on Long Trade Lake was 1,506 µg/L in 2016, 1,508 µg/L in 2017, and 1,172 µg/L in 2018.

Summer index period (July 15-September 15) average organic nitrogen on Long Trade Lake was 1,510 µg/L in 2016, 1,855 µg/L in 2017, and 1,327 µg/L in 2018.

Organic nitrogen was greatest in July across all sampling years.




2016-2018 Long Trade Lake Organic and Inorganic Nitrogen
Organic and inorganic nitrogen (µg/L)
2500
2000
1500
1000
500
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
Date
2016 Inorganic
2017 Inorganic
2018 Inorganic
2016 Organic
2017 Organic
2018 Organic

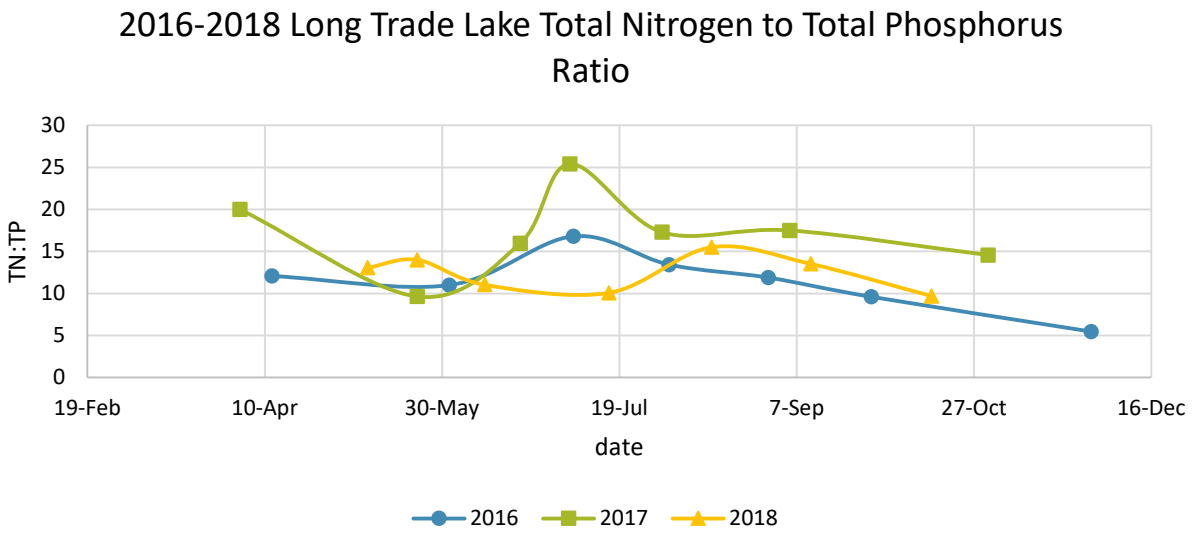
Total Nitrogen to Total Phosphorus Ratio

The total nitrogen to total phosphorus ratio (TN:TP) is a calculation that depicts which nutrient limits algae growth in a lake.

Lakes are considered nitrogen limited, or sensitive to the amount of nitrogen inputs, when TN:TP ratios are less than 10. Only about 10% of Wisconsin lakes are limited by nitrogen. In contrast, lakes are considered phosphorus limited, or sensitive to the amount of phosphorus inputs into a lake, when the TN:TP ratio is above 15. Lakes with values between 10 and 15 are considered transitional. In transitional lakes it is impossible to determine which nutrient, either nitrogen or phosphorus, is limiting algae growth.

Total nitrogen is found by adding nitrate/nitrite to total Kjeldahl nitrogen. As previously mentioned, nitrate/nitrite concentrations were below the limit of detection or less than 100 µg/L on all but two sampling dates. As a result, total nitrogen is largely reflective of TKN.

In 2016 and 2018, Long Trade Lake was in a transitional state for the majority of the growing season. In 2017, Long Trade Lake was largely in a phosphorus limited state. Over the course of the study, Long Trade Lake was in a transitional state 48% of the time. The lake was phosphorus limited more often than nitrogen limited (33% compared with 19%).



Chlorophyll a

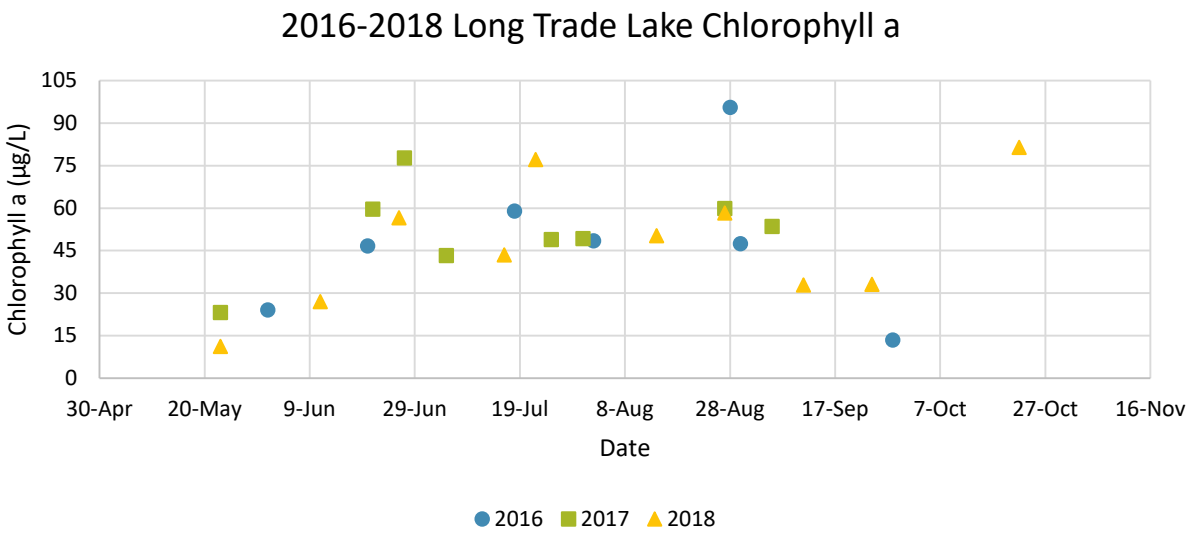
Chlorophyll a is a pigment in plants and algae that is necessary for photosynthesis and is an indicator of water quality in a lake. Chlorophyll a gives a general indication of the amount of algae growth in a lake, with greater values for chlorophyll a indicating greater amounts of algae. However, since chlorophyll a is present in sources other than algae— such as decaying plants— it does not serve as a direct indicator of algae biomass.

Chlorophyll a seems to have the greatest impact on water clarity when levels exceed 30 µg/L. Lakes which appear clear generally have chlorophyll a levels less than 15 µg/L.

Chlorophyll a was less than 15 µg/L on two sampling dates and between 15 and 30 µg/L on three sampling dates. The remaining nine samples were above 30 µg/L. The July 6th, 2016 sample was 922 µg/L and is excluded from the graph below.

Growing season average surface phosphorus on Long Trade Lake was 211 µg/L in 2016, 46 µg/L in 2017, and 33 µg/L in 2018.

Summer index period (July 15-September 15) average surface phosphorus on Long Trade Lake was 48 µg/L in 2016, 51 µg/L in 2017, and 42 µg/L in 2018.



Trophic State Index

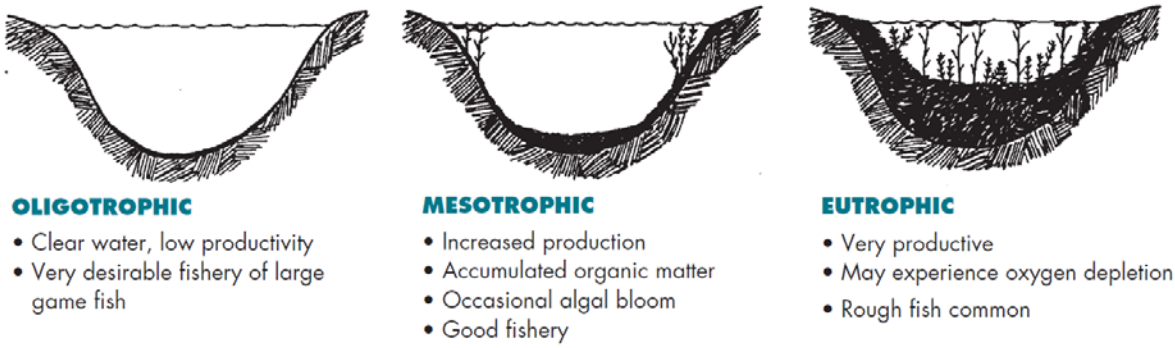
Lakes are divided into three categories based on their trophic states: oligotrophic, eutrophic, and mesotrophic. These categories reflect a lake's nutrient and clarity level and serve as an indicator of water quality. Each category is designed to serve as an overall interpretation of a lake's primary productivity.

Oligotrophic lakes are generally clear, deep, and free of weeds and large algae blooms. These types of lakes are often poor in nutrients and are unable to support large populations of fish. However, oligotrophic lakes can develop a food chain capable of supporting a desirable population of large game fish.

Eutrophic lakes are generally high in nutrients and support a large number of plants and animals. They are usually very productive and subject to frequent algae blooms. Eutrophic lakes often support large fish populations, but are susceptible to oxygen depletion.

Mesotrophic lakes lie between oligotrophic and eutrophic lakes. They usually have good fisheries and occasional algae blooms.

All lakes experience a natural aging process which causes a change from an oligotrophic to a eutrophic state. Human influences that introduce nutrients into a lake (agriculture, lawn fertilizers, and septic systems) can accelerate the process by which lakes age and become eutrophic.



[10]

A common method of determining a lake's trophic state is to compare total phosphorus (important for algae growth), chlorophyll a (an indicator of the amount of algae present), and secchi disk readings (an indicator of water clarity). Although many factors influence these relationships, the link between total phosphorus, chlorophyll a, and secchi disk readings is the basis of comparison for the trophic state index (TSI).

[10] Figure from Understanding Lake Data (G3582), UW-Extension, Byron Shaw, Christine Mechenich, and Lowell Klessig, 2004

TSI is determined using a mathematic formula and ranges from 0 to 110. Lakes with the lowest numbers are oligotrophic and lakes with the highest values are eutrophic.

Three equations for summer index period TSI were examined for Long Trade Lake.

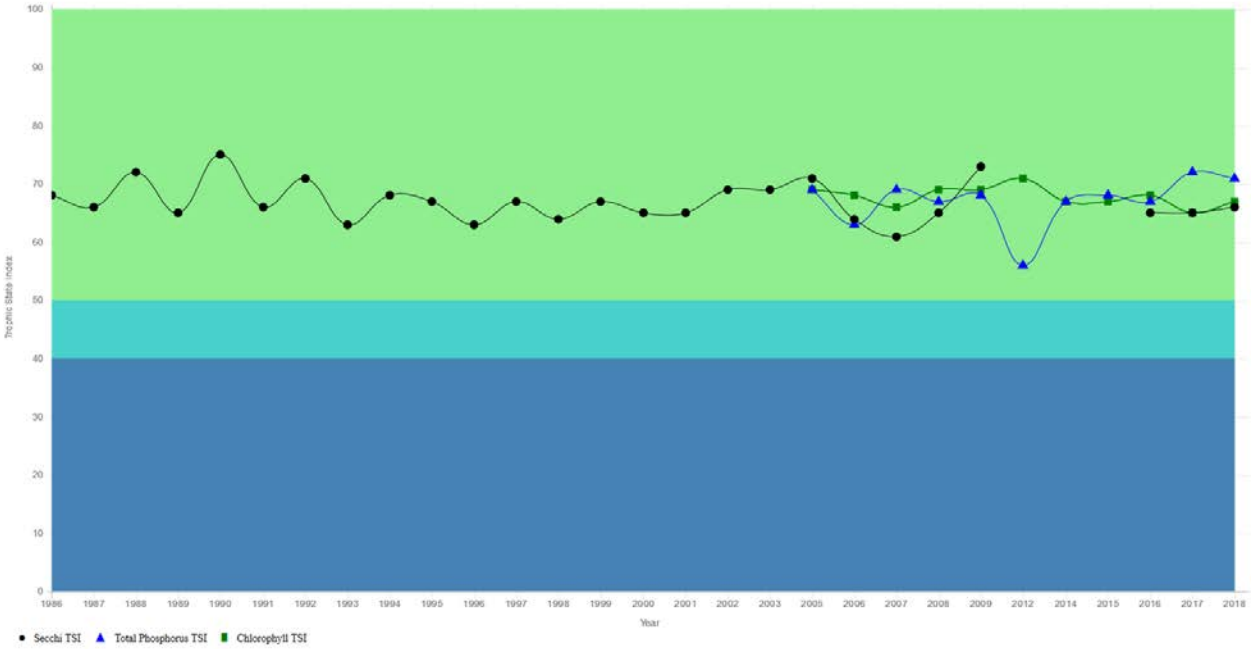
TSI (P) = 14.42 * Ln [TP] + 4.15 (where total phosphorus is in µg/L)
TSI (C) = 30.6 + 9.81 Ln [Chlor-a] (where chlorophyll a is in µg/L)
TSI (S) = 60-14.41 * Ln [Secchi] (where secchi depth is in meters)

Long Trade Lake 2016, 2017, and 2018 respectively
Average summer index period TSI (total phosphorus) = 74, 72, and 72
Average summer index period TSI (chlorophyll a) = 69, 69, and 67
Average summer index period TSI (secchi depth) = 65, 65, and 66
Average summer index period TSI = 69, 68, and 68 = Eutrophic

TSI	General Description
<30	**Oligotrophic** clear water, high dissolved oxygen throughout the year/lake
30-40	**Oligotrophic** clear water, possible periods of oxygen depletion in the lower depths of the lake
40-50	**Mesotrophic** moderately clear water, increasing chance of anoxia near the bottom of the lake in summer, fully acceptable for all recreation/aesthetic uses
50-60	**Mildly eutrophic** decreased water clarity, anoxic near the bottom, may have macrophyte problem, warm-water fisheries only
60-70	**Eutrophic** blue-green algae dominance, scums possible, prolific aquatic plant growth, full body recreation may be decreased
70-80	**Hypereutrophic** heavy algal blooms possible throughout the summer, dense algae and macrophytes
>80	Algal scums, summer fish kills, few aquatic plants due to algal shading, rough fish dominate

Monitoring the trophic state index of a lake gives stakeholders a method by which to gauge lake productivity over time. TSI data exists for Long Trade Lake for 1986-2003, 2005-2009, 2012, and 2014-2018. In general, the historic data indicates a eutrophic state in Long Trade Lake with a minority of data points indicating a hypereutrophic or mildly eutrophic state.

Trophic State Index Graph: Long Trade Lake - Deep Hole-South Basin - Polk County



Phytoplankton

Algae, also called phytoplankton, are microscopic plants that convert sunlight and nutrients into biomass. They can live on bottom sediments and substrate, in the water column, and on plants and leaves. Algae are the primary producers in an aquatic ecosystem and can vary in form. Zooplankton, are small aquatic organisms that feed on algae. The size and shape of algae determine which types of zooplankton—if any—can consume them.

Algae have short life cycles. As a result, changes in water quality are often reflected by changes in the algal community within a few days or weeks. The number and types of algae in a waterbody can provide useful information for environmental monitoring programs, impairment assessments, and the identification of best management strategies.

The types of algae in a lake will change over the course of a year. Typically, there is less algae in winter and spring because of ice cover and cold temperatures. As a lake warms up and sunlight increases, algae communities begin to increase, particularly diatoms. Their short life span quickly cycles the nutrients in a lake and affects nutrient dynamics.

The types of algae present in a lake are influenced by environmental factors like climate, phosphorus, nitrogen, silica and other nutrient content, carbon dioxide, grazing, substrate, and other factors in the lake. When high levels of nutrients are available, blue green algae often become predominant and create light limited conditions for other groups of algae. Additionally, under nitrogen limited conditions, blue green algae have a competitive advantage over other algae because of their unique ability to fix nitrogen from the atmosphere.

Chlorophyll a is a pigment in plants and algae that is necessary for photosynthesis. Chlorophyll a gives a general indication of the amount of algae growth in the water column; however, it is not directly correlated with algae biomass. To obtain accurate algae data, composite samples from a two meter water column were collected monthly, preserved with glutaraldehyde, placed on ice, and sent to UW-Oshkosh for identification and enumeration of algae species. Sampling was conducted in 2016, 2017, and 2018.

Lake samples were concentrated when necessary by aspirating the middle depth of sample placed in tall beakers for over 24 hours. This allowed cells to either sink to the bottom or float to the surface and thereby avoided any inadvertent cell removal. Samples were enumerated using a Palmer-Maloney nanoplankton counting chamber and an Olympus BX40 research microscope at 400x magnification which allows for calculations of cell densities (cells/ml). At

least 400 cells were counted and identified to genus using Prescot (1952)[11], Taft and Taft (1971)[12], and Wehr and Sheath (2003)[13] as the main taxonomic guides[14].

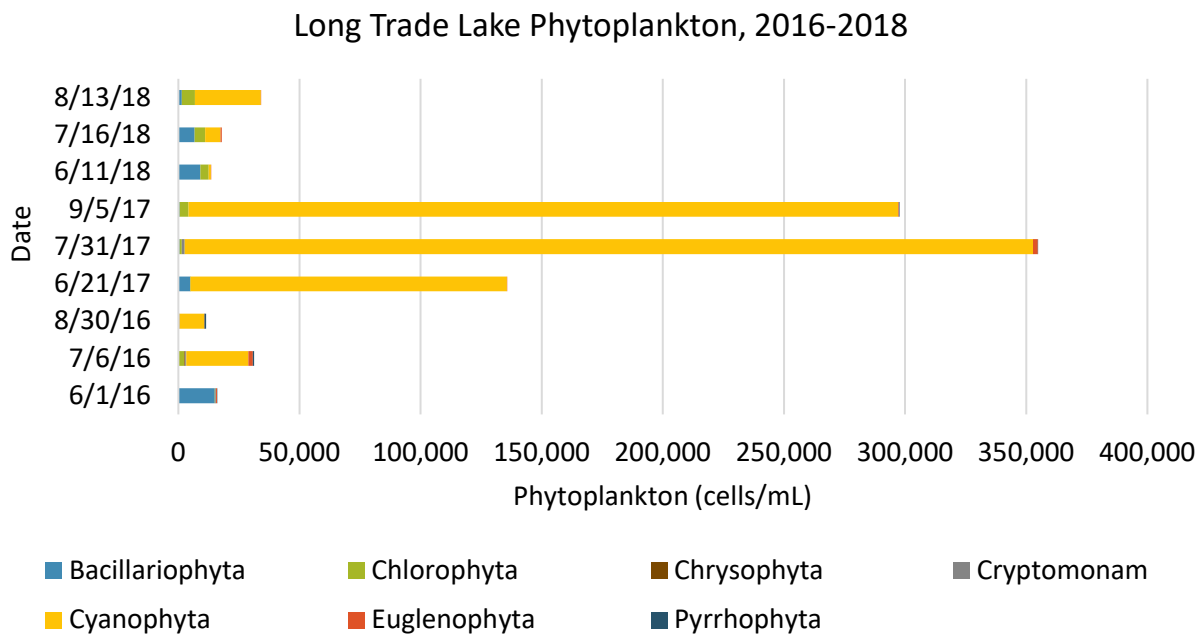
Algae were identified to the lowest taxonomic level, and a relative concentration and cell count was made to describe the algae community throughout the growing season. This method of sampling also allows the identification of any species of concern which might be present.

There are twelve divisions of algae found in typical lakes of Wisconsin. Seven divisions were found in Long Trade Lake. The division Pyrrhophyta was only present in Long Trade Lake in 2016.

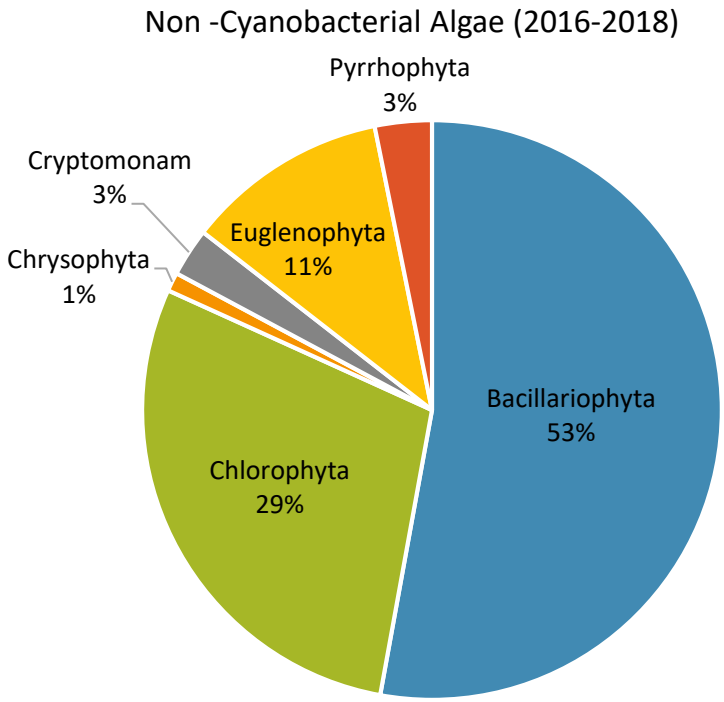
Algal Class	Common Name	Characteristics
Bacillariophyta	Diatoms	Sensitive to chloride, pH, color, and total phosphorus in water. As total phosphorus increases, diatoms decrease. Generally larger in size. Tend to be highly present in spring and late fall.
Chlorophyta	Green algae	Provide high nutritional value to consumers. Can be filamentous and intermingle with macrophytes.
Chrysophyta	Golden brown algae	A genus of single-celled algae in which the cells are ovoid. Contain chlorophyll *a*, c_1 and c_2, generally masked by abundant accessory pigment, fucoxanthin, imparting distinctive golden color to cells.
Cryptophyta	Cryptomonads	Bloom forming, are not known to produce any toxins and are used to feed small zooplankton. Cryptomonads frequently dominate the phytoplankton assemblages of the Great Lakes.
Cyanophyta	Blue green algae	Prevail in nutrient-rich standing waters. Blooms can be toxic to zooplankton, fish, livestock, and humans. Can be unicellular, colonial, planktonic, or filamentous. Can live on almost any substrate. More prevalent in late to mid-summer.
Euglenophyta	Euglenoids	Commonly found in freshwater that is rich in organic materials. Most are unicellular.
Pyrrhophyta	Dinoflagellates	Have starch food reserves and serve as food for grazers.

[11] Prescott, G.W. 1952. Algae of the western great lakes area. Otto Koeltz Science Publishers. Koenigstein. Germany.
[12] Taft, C.E., and Taft, C.W. 1971. The algae of western Lake Erie. Bulletin of Ohio Biological Survey. 4(1). College of Biological Sciences, Ohio State University. Columbus, OH.
[13] Wehr, J.E., and Sheath, R.G. (eds) 2003. Freshwater algae of North America. Ecology and Classification. Academic Press. New York, NY.
[14] Methods from Wisconsin lakes report: analysis of phytoplankton samples from Lotus Lake, Pipe Lake, North Pipe Lake, and Long Trade Lake during May to September 2016 by Dr. Robert Pillsbury

On all sampling dates, with the exception of 6/1/16, blue-green algae (cyanophyta) were the most abundance division of algae in Long Trade Lake.



Of the other groups of algae present in Long Trade Lake, the diatoms (bacillariophyta) and the green algae (chlorophyta) formed the largest components of the non-cyanobacteria algal community (53% and 29%, respectively).



Of the diatoms present in the system, *Fragilaria crotonensis* had the highest cell density count. *Aulacoseira granulata* and *Synedra spp*. were the most commonly sampled species and are also indicative of a eutrophic system. *A. granulata* is a common diatom found in high nutrient, eutrophic systems

Other classes of algae varied form sample to sample and year to year not showing any specific patterns.

Blue Green Algae Toxin Risk

Blue green algae, or cyanobacteria, have been around for billions of years and typically bloom during the summer months. However, blue-green algae blooms become more frequent as a result of increased nutrient concentrations.

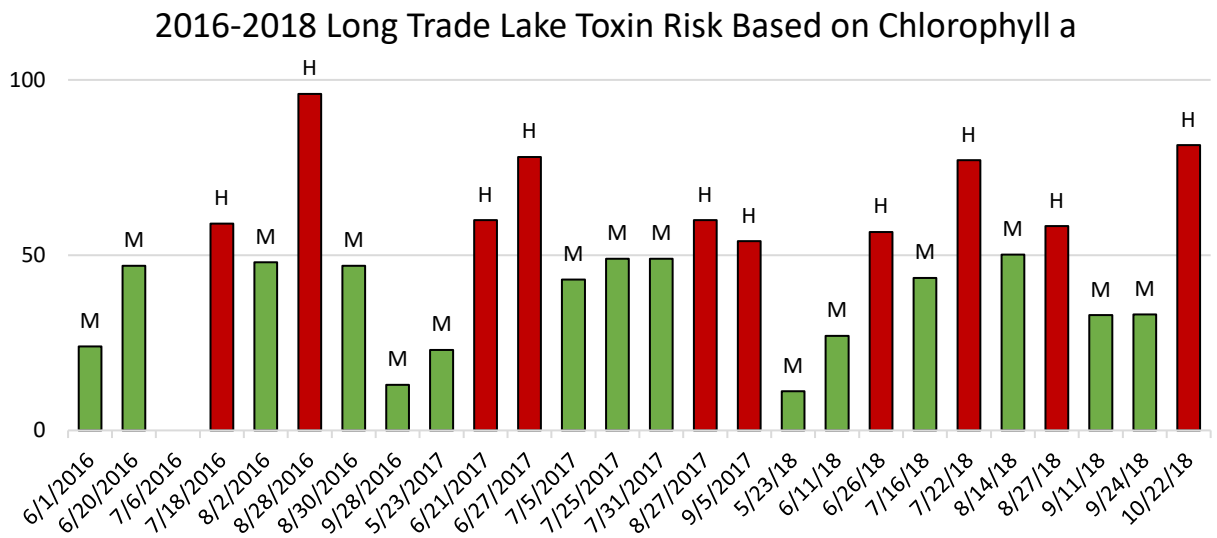
In addition to the negative aesthetics posed by algae, blue green algae are of specific concern because of their ability to produce toxins, that when ingested or inhaled, can cause short and long term health effects. Effects range from tingling, burning, numbness, drowsiness, and dermatitis to liver or respiratory failure possibly leading to death. Toxin producing groups such as *Dolichospermum crissum*, *Aphanizomenon flos-aquae*, *Microcystis aeruginosa*, and *Planktolyngbya spp.* were common during the sampling season. Toxin data was not collected as part of this study.

It is not known which environmental conditions cause the production of cyanotoxins, but scientists have found that when blue green algae is present at concentrations over 100,000 cells/mL toxin production is more likely to occur.

Federal guidelines for blue green algae cell densities and chlorophyll concentrations do not exist. The Wisconsin Harmful Algal Bloom (HAB) Surveillance Program uses guidelines of the World Health Organization to determine risks from blue green algae.

Blue green algae cell density (cells/mL)	Chlorophyll a (µg/L)	Risk
Less than 20,000	Less than 10	**Low**
20,000 to 100,000	10 to 50	**Moderate**
Greater than 100,000	Greater than 50	**High**

The toxin risk from blue green algae varied over the course of each year and among the three years of the study. Based on chlorophyll a, the risk of toxin production was moderate on 60% of the sampling dates and high on 40% of the sampling dates. Based on blue green algae cell density, the risk of toxin production was low on 56% of the sampling dates, moderate on 11% of the sampling dates, and high on 33% of the sampling dates. Blue green algae cell density was an order of magnitude greater in 2017 as compared to 2016 and 2018.


2016-2018 Long Trade Lake Toxin Risk Based on Chlorophyll a
100
50
0
M
M
H
M
H
M
M
H
M
M
H
H
M
M
M
H
H
M
M
H
M
H
M
H
M
M
H
6/1/2016
6/20/2016
7/6/2016
7/18/2016
8/2/2016
8/28/2016
8/30/2016
9/28/2016
5/23/2017
6/21/2017
6/27/2017
7/5/2017
7/25/2017
7/31/2017
8/27/2017
9/5/2017
5/23/18
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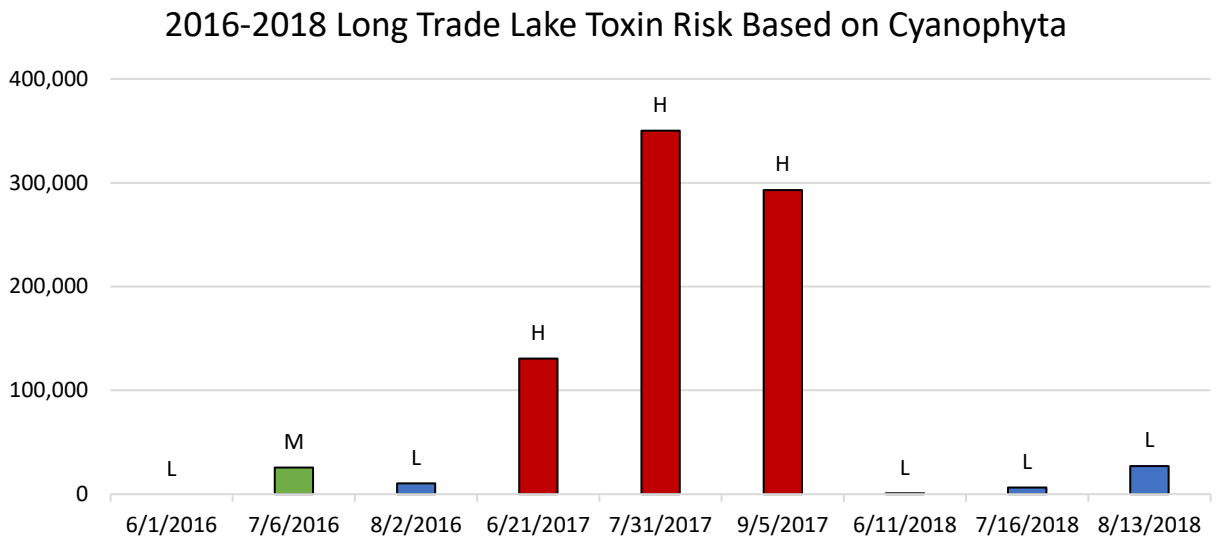
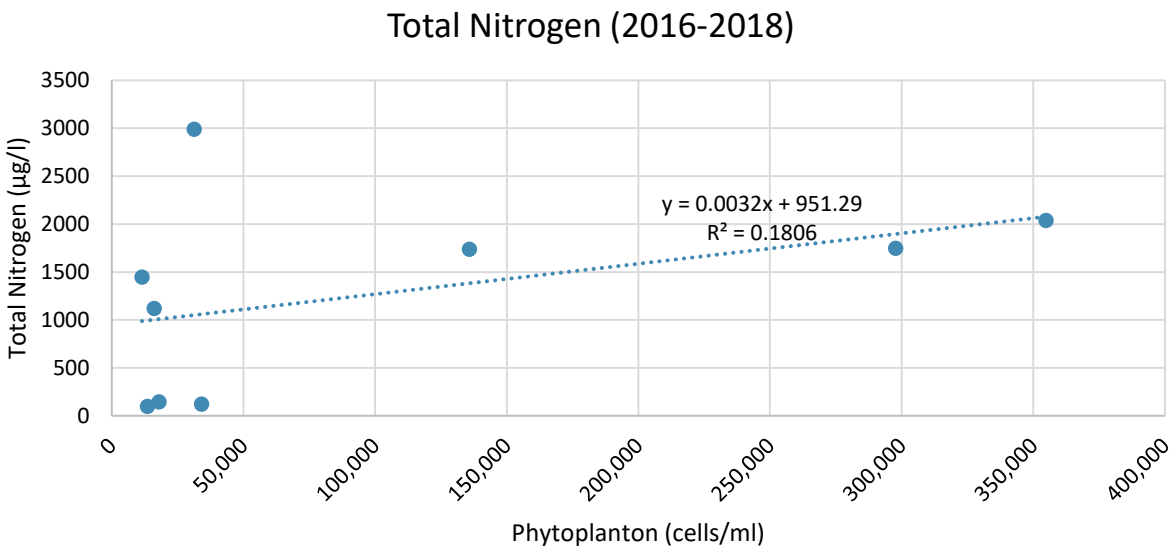
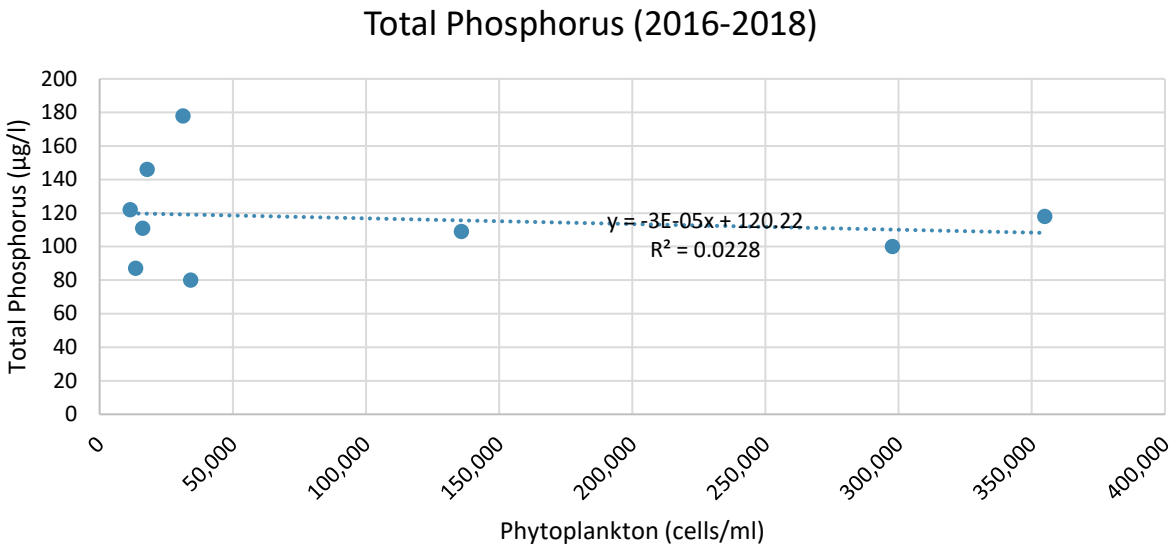
9/24/18
10/22/18


2016-2018 Long Trade Lake Toxin Risk Based on Cyanophyta
400,000
300,000
200,000
100,000
0
L
M
L
H
H
H
L
L
L
6/1/2016
7/6/2016
8/2/2016
6/21/2017
7/31/2017
9/5/2017
6/11/2018
7/16/2018
8/13/2018

Although neither relationship is very strong, it appears that nitrogen may have more of an influence on phytoplankton than phosphorus. Likely an increase in either nutrient could cause changes in algae composition and density.





Tributary Monitoring

The Polk County Land and Water Resources Department and volunteers of the Round Trade Lake Improvement Association collected data on the tributaries of Long Trade Lake.

Land and Water Resources Department Data Collection

Flow data was collected bi-weekly at each tributary with a March McBirney Flo-Mate ™ velocity flowmeter at the following four sites: Trade River at 280th (inlet), Trade River-downstream of CTH Z (outlet), Trade River at 200th Street, and Butternut Creek at 200th Street. At each foot interval across each of the tributaries depth (feet) and velocity (m/s) were measured. Grab samples were collected once a month on each tributary. Samples were analyzed at the Water and Environmental Analysis Lab for total phosphorus and soluble reactive phosphorus.

The phosphorus data collected is specific to date and location and can be used to theoretically determine how much phosphorus is entering and leaving Long Trade Lake through tributaries. Values for phosphorus influxes are established by multiplying the phosphorus concentration at a specific location by the volume of water that moves through a specific location, or the discharge in cubic feet per second. To determine the average instantaneous load of phosphorus (in mg/s), the average phosphorus concentration is multiplied by the average seasonal discharge. Units are then converted and expressed as pounds per year.

The analysis of this data allows for areas of phosphorus loading to be identified. Once areas of phosphorus loading are identified, the land use and geology of these areas can be investigated for their total phosphorus contribution and best management recommendations can be made.

Site	Total Phosphorus (µg/L)	Discharge (l/s)	Phosphorus (pounds/year)
2016 Inlet at 280th Ave	157	1,379	15,066
2017 Inlet at 280th Ave	120	1,630	13,611
2018 Inlet at 280th Ave	114	1,530	12,131
2016 Outlet at CTH Z	104	1,132	8,187
2017 Outlet at CTH Z	97	1,806	12,188
2018 Outlet at CTH Z	92	1,770	11,329
2016 Trade at 200th St	185	836	10,762
2017 Trade at 200th St	119	911	7,538
2018 Trade at 200th St	116	662	5,344
2016 Butternut at 200th St	87	359	2,173
2017 Butternut at 200th St	69	574	2,753
2018 Butternut at 200th St	86	496	2,965

Site	2016-2018 Average Phosphorus (pounds/year)
Trade at 280th Ave	13,603
Outlet at CTH Z	10,568
Trade at 200th St	7,881
Butternut at 200th St	2,630

As averaged over the three years of the study, 13,603 pounds of phosphorus are entering Long Trade Lake through the inlet and 10,568 pounds of phosphorus are leaving the lake through the outlet. Two main systems contribute to the inlet: the Trade River and Butternut Creek. The Trade River is contributing about three times more phosphorus to Long Trade Lake as compared to Butternut Creek.

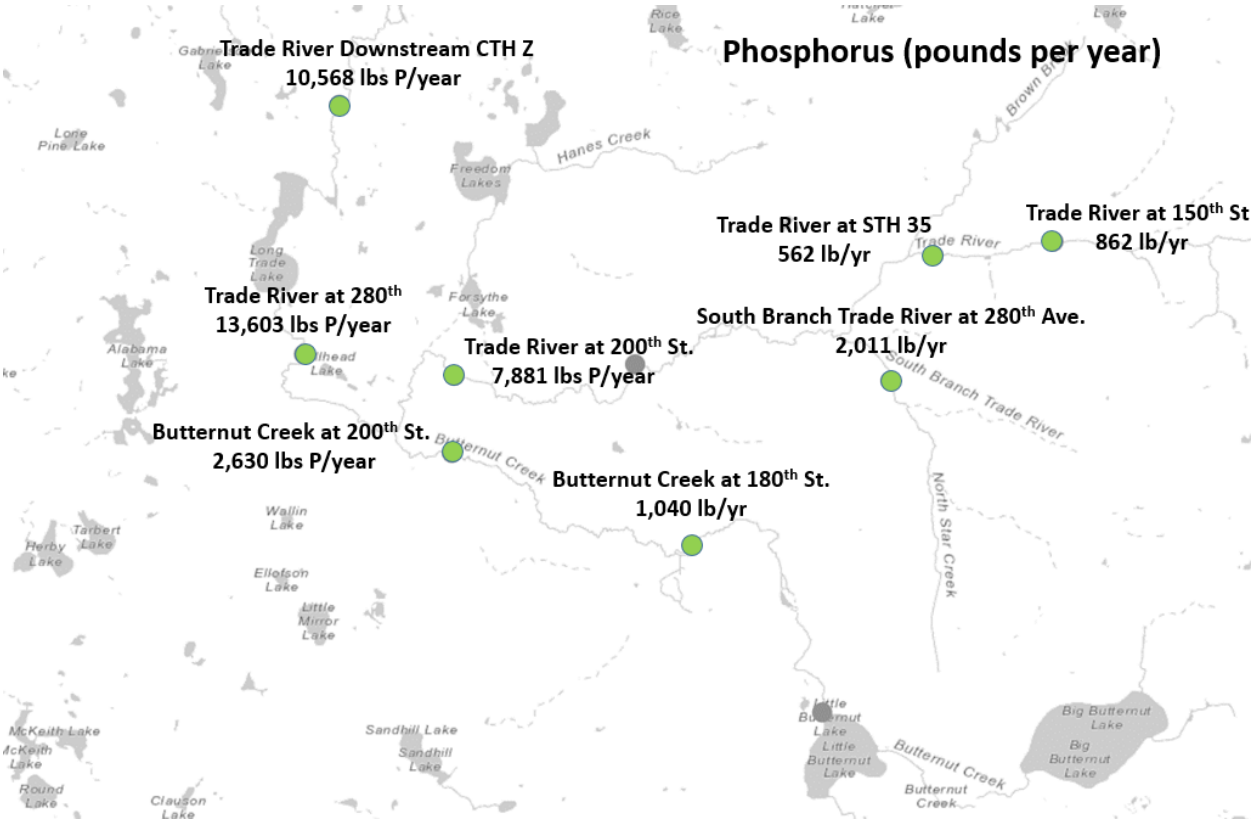
Round Trade Lake Improvement Association Data Collection

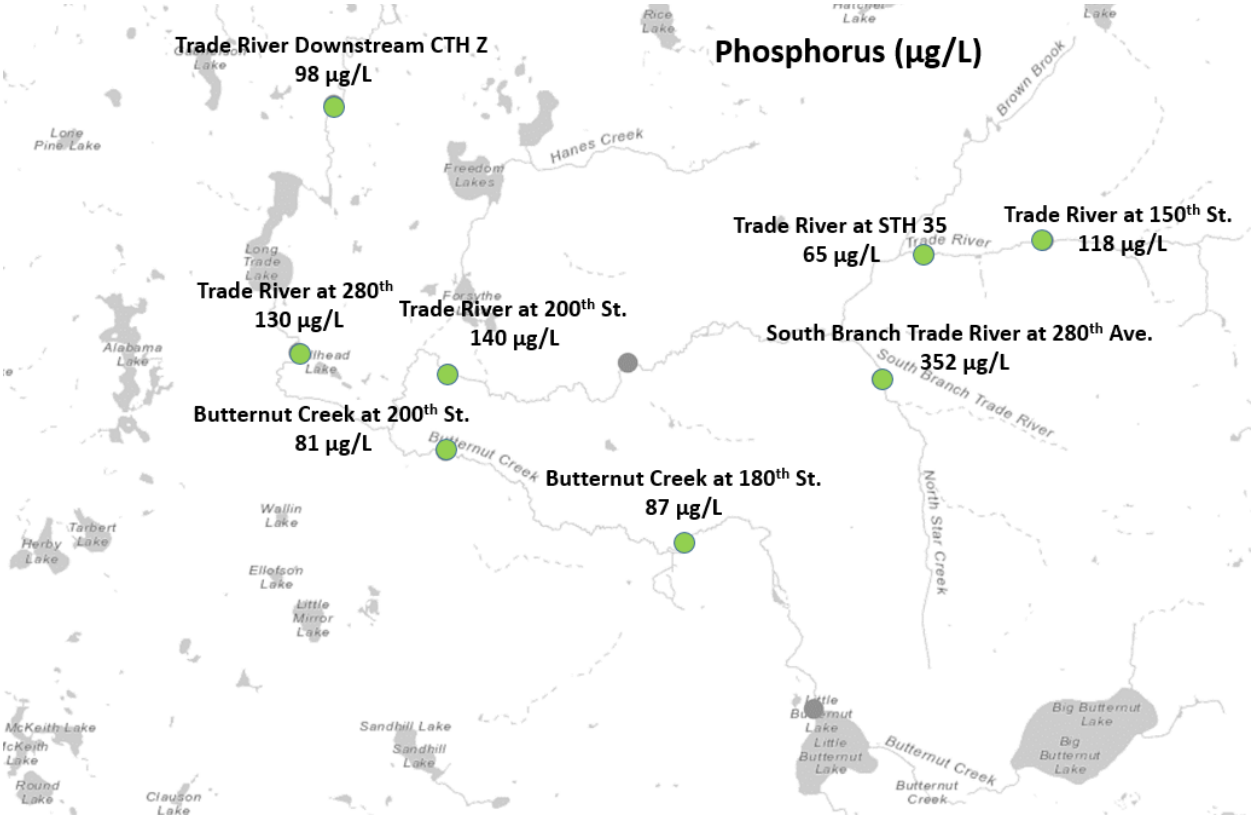
Volunteers of the Round Trade Lake Improvement Association completed the Water Action Volunteers (WAV) protocol at a total of nine tributary sites: Trade River at 280th (inlet), Trade River-downstream of CTH Z (outlet), Trade River at 200th Street, Butternut Creek at 200th Street, Butternut Creek at 180th Street, Butternut Creek at CTH N, South Branch Trade River at 280th Avenue, Trade River 2.5 Miles West of STH 35, and Trade River at STH 35. In August of 2016 the Trade River at STH 35 site was replaced with the Trade River at 150th Street site due to the presence of a beaver dam.

Three sites (South Branch Trade River at 280th Ave, Butternut Creek at 180th Street, and Trade River at STH 35/Trade River at 150th Street) were sampled for phosphorus. In 2017 the South Branch Trade River at 280th Avenue site was removed for phosphorus sampling by the WAV coordinator because total phosphorus criteria were exceeded in 2016. Stream flow was also calculated at each of the sites, allowing a phosphorus load in pounds per year to be calculated. Of the two sites flowing to the Trade River at 200th Street sampling site, more phosphorus is being contributed from the South Branch Trade River. This sampling site (South Branch Trade River at 280th Ave) is located downstream of the outflow for the Village of Luck municipal wastewater system.

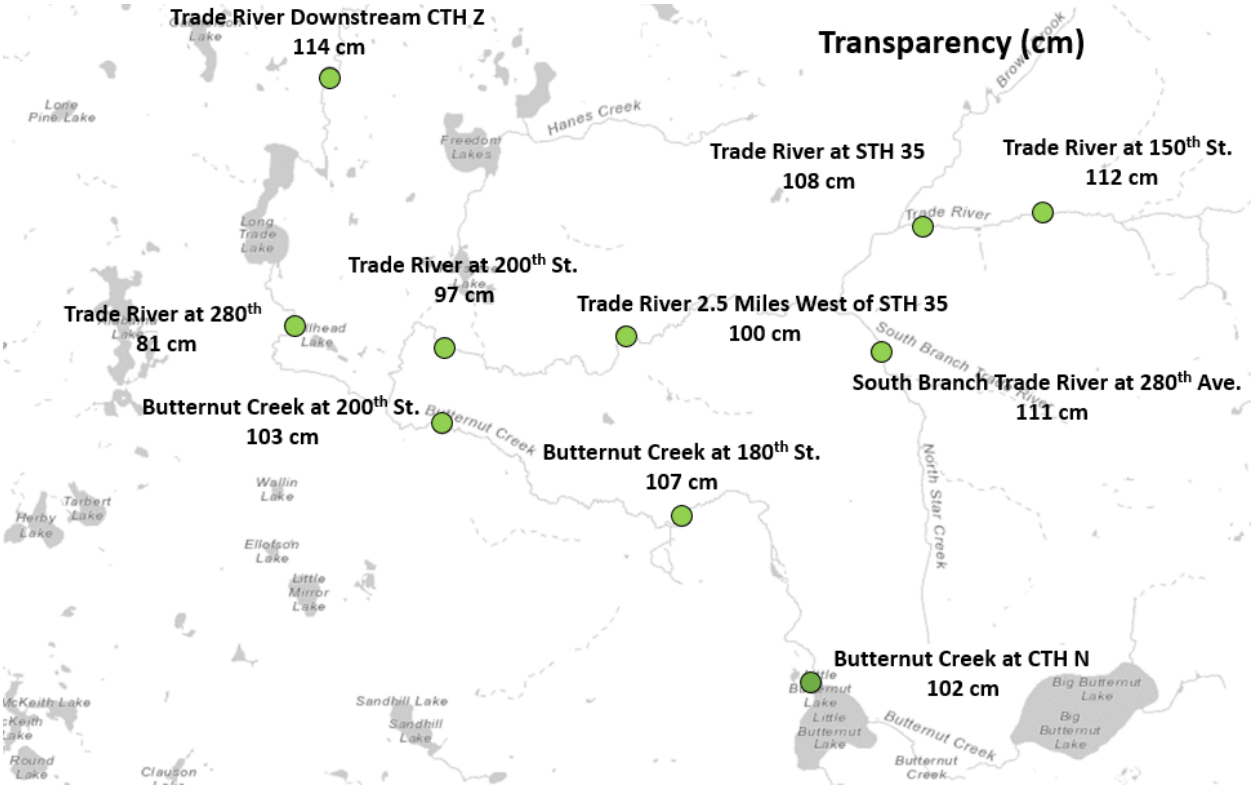
Site	Total Phosphorus (µg/L)	Discharge (l/s)	Phosphorus (pounds/year)
2016 South Branch Trade River at 280th	352	82	2,011
2016 Trade River at STH 35	65	124	562
2016 Trade River at 150th Street	123	151	1,292
2017 Trade River at 150th Street	133	94	867
2018 Trade River at 150th Street	94	65	426
2016 Butternut Creek at 180th	112	170	1,324
2017 Butternut Creek at 180th	62	161	696
2018 Butternut Creek at 180th	86	184	1,101

Site	2016-2018 Average Phosphorus (pounds/year)
South Branch Trade River at 280th	2,011
Trade River at STH 35	562
Trade River at 150th Street	862
Butternut Creek at 180th	1,040

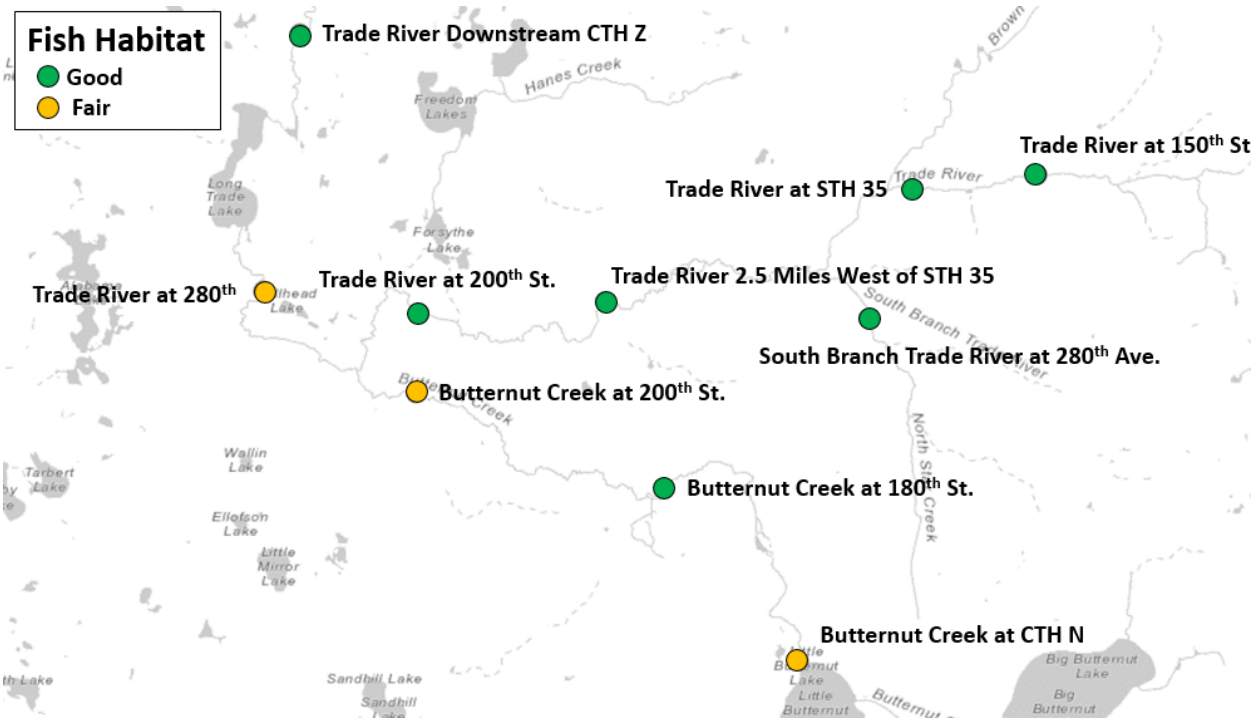



Phosphorus (µg/L)
Trade River Downstream CTH Z
98 µg/L
Trade River at STH 35
65 µg/L
Trade River at 150th St.
118 µg/L
Trade River at 280th
130 µg/L
Trade River at 200th St.
140 µg/L
South Branch Trade River at 280th Ave.
352 µg/L
Butternut Creek at 200th St.
81 µg/L
Butternut Creek at 180th St.
87 µg/L
Hanes Creek
Brown Brook
Trade River
South Branch Trade River
North Star Creek
Butternut Creek
Freedom Lakes
Long Trade Lake
Alabama Lake
Wallin Lake
Ellefson Lake
Little Mirror Lake
Sandhill Lake
McKeith Lake
Round Lake
Clauson Lake
Big Butternut Lake
Little Butternut Lake

WAV volunteers also measured transparency which is a measure of water clarity. The transparency tube used by most volunteers is 120 cm. As a result, the maximum value for transparency will be 120 cm.



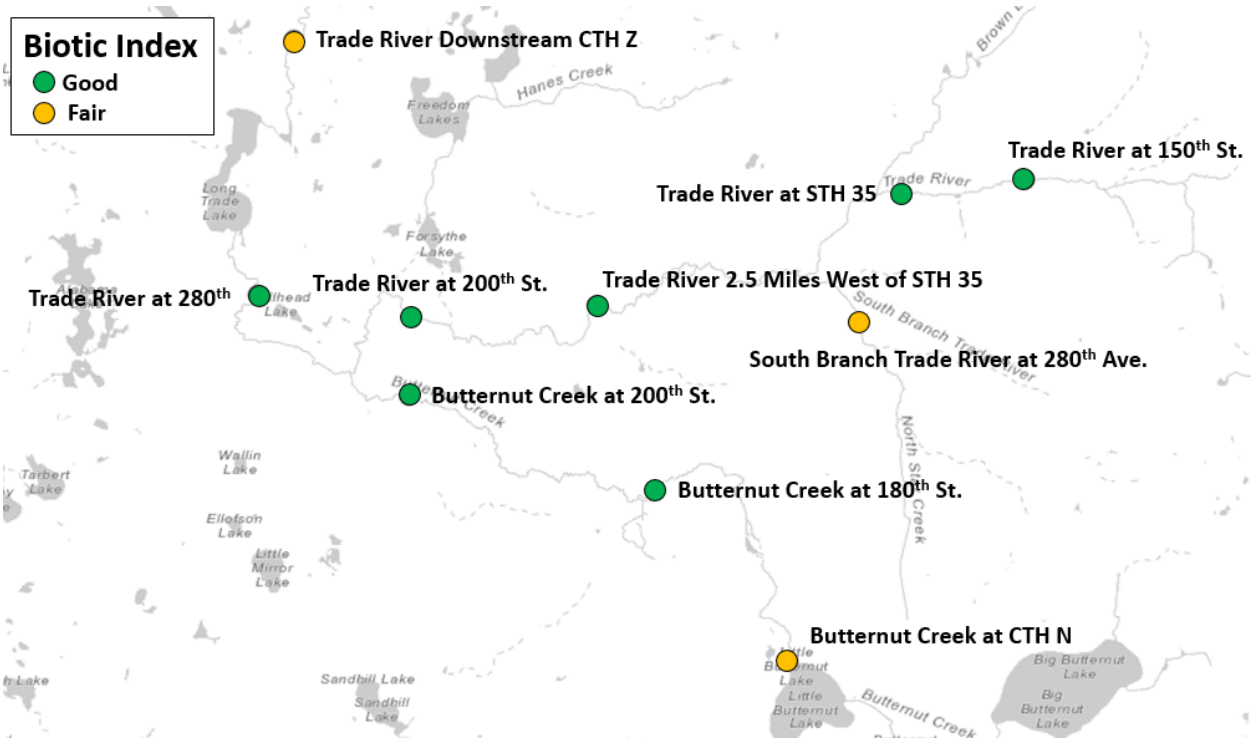
WAV volunteers characterized habitat based on the same qualitative habitat assessment used by WDNR biologists which focuses on fish health. Riparian area, banks, pools, riffles, width and depth, substrates, fish cover, bends and the thalweg, or main area of flow are all assessed. Streams are given a habitat rating of excellent, good, fair, or poor. Seven of the sites were characterized as good and three of the sites were characterized as fair.



Volunteers also measured dissolved oxygen at each site. Dissolved oxygen levels below 2 mg/L generally don't support aquatic life and most fish and many insects are unable to tolerate levels below 4-5 mg/L for a sustained period of time. Levels above 7 mg/L are amenable to cold-water species such as trout. Average dissolved oxygen levels were above 7 mg/L at all sites.

A biotic index was also assigned to each of the streams sampled by WAV volunteers based on the types of aquatic macroinvertebrates found in each stream. The index works by assigning different levels of tolerance for pollution to the different kinds of macroinvertebrates. The WAV citizen monitoring index separates macroinvertebrate into four pollution tolerance categories: tolerant, semi-tolerant, semi-sensitive, and sensitive. From this data, streams are characterized as good, fair, or poor. Seven of the sites were characterized as good and three of the sites were characterized as fair.

An aquatic macroinvertebrate workshop with LWRD staff was held on June 23rd, 2017.



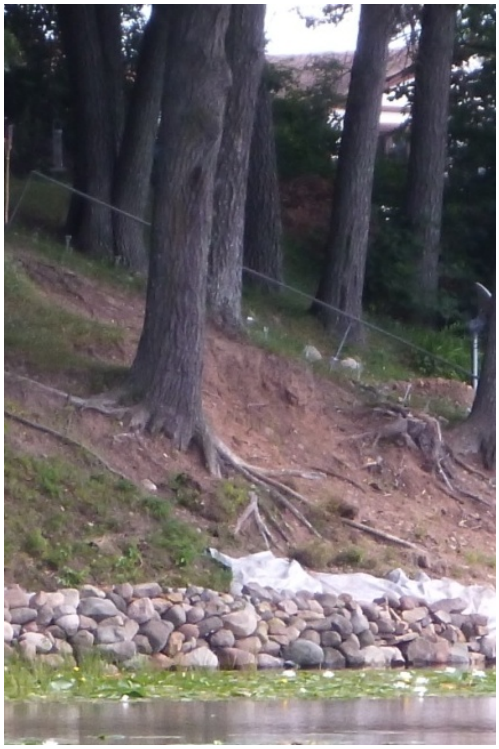
WAV data was taken from the station reports, Understanding the Stream Monitoring Data Report, for each site.

Village of Luck Municipal Wastewater System

The Village of Luck municipal wastewater system is located upstream of the South Branch Trade River at 280th sampling site. Discharge data for pounds of phosphorus per year is available for 2013 to 2018. Discharge concentrations of phosphorus have decreased since 2013, with values being lowest in 2018.

Year	2013	2014	2015	2016	2017	2018
Phosphorus (lbs/year)	946	1,008	1,161	804	838	418

Land Use and Water Quality



The health of water resources depends largely on the decisions that landowners make on their properties. When waterfront lots are developed, a shift from native plants and trees to impervious surfaces and lawn often occurs. Impervious surfaces are hard, man-made surfaces such as rooftops, paved driveways, and concrete patios that make it impossible for rainwater to infiltrate into the ground.

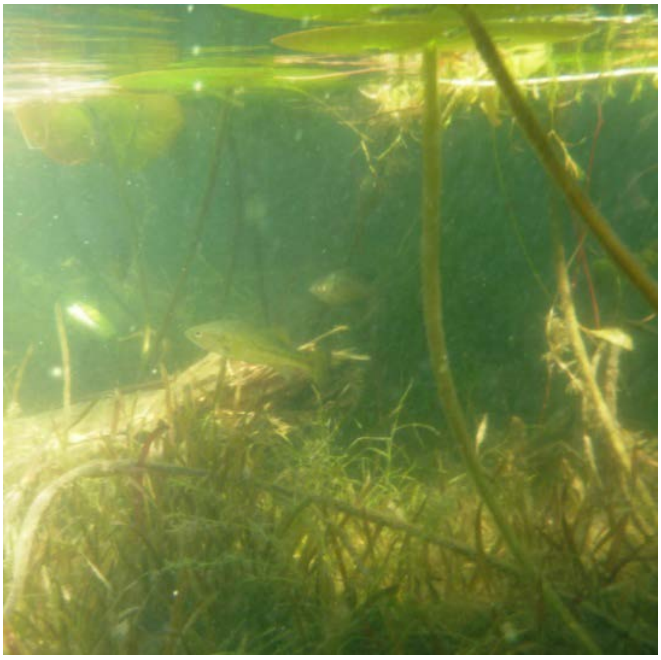
By making it impossible for rainwater to infiltrate into the soil, impervious surfaces increase the volume of rainwater that washes over the soil surface and runs off directly into lakes and streams. Rainwater runoff can carry pollutants such as sediment, lawn fertilizers, and car oils directly into a lake. Native vegetation can slow the speed of rainwater, giving it time to soak into the soil where it is filtered by soil microbes.

In extreme precipitation events, erosion and gullies can result. The signs of erosion are unattractive and can cause decreases in property values. Sediment can also have negative impacts on aquatic life. Fish eggs will die when covered with sediment and sediment influxes to a lake can decrease water clarity making it difficult for predator fish species to locate food.

Increases in impervious surfaces and lawns cause a loss of habitat for birds and other wildlife. Over ninety percent of all lake life is born, raised, and fed in the area where land and water meet. Overdeveloped shorelines remove critical habitat which species such as loons, frogs, songbirds, ducks, otters, and mink depend on. Impervious surfaces and lawns can be thought of as biological desserts which lack food and shelter for birds and wildlife. Nuisance species such as Canada geese favor lawns over taller native grasses and flowers. Lawns provide geese with a ready food source (grass) and a sense of security from predators (open views).

Additionally, fish species depend on the area where land and water meet for spawning. The removal of coarse woody habitat, or trees and branches that fall into a lake, cause decreases in habitat for fish and aquatic organisms.

Common lawn species, such as Kentucky bluegrass, are often dependent on chemical fertilizers and require mowing. Excess chemical fertilizers are washed directly into the adjacent water during precipitation events. The phosphorus and other nutrients in fertilizers, which produce lush vegetative growth on land, are the same nutrients which fuel algae blooms and decrease



water clarity in a lake. Additionally, since common lawn species have very shallow root systems, when lawns are located on steep slopes, soil capacity is reduced and the impacts of erosion can be intensified.

Avoiding establishing lawns can provide direct positive impacts on lake water quality. The creation of a buffer zone of native grasses, wildflowers, shrubs, and trees where the land meets the water can provide numerous benefits for water quality and restore valuable bird and wildlife habitat.

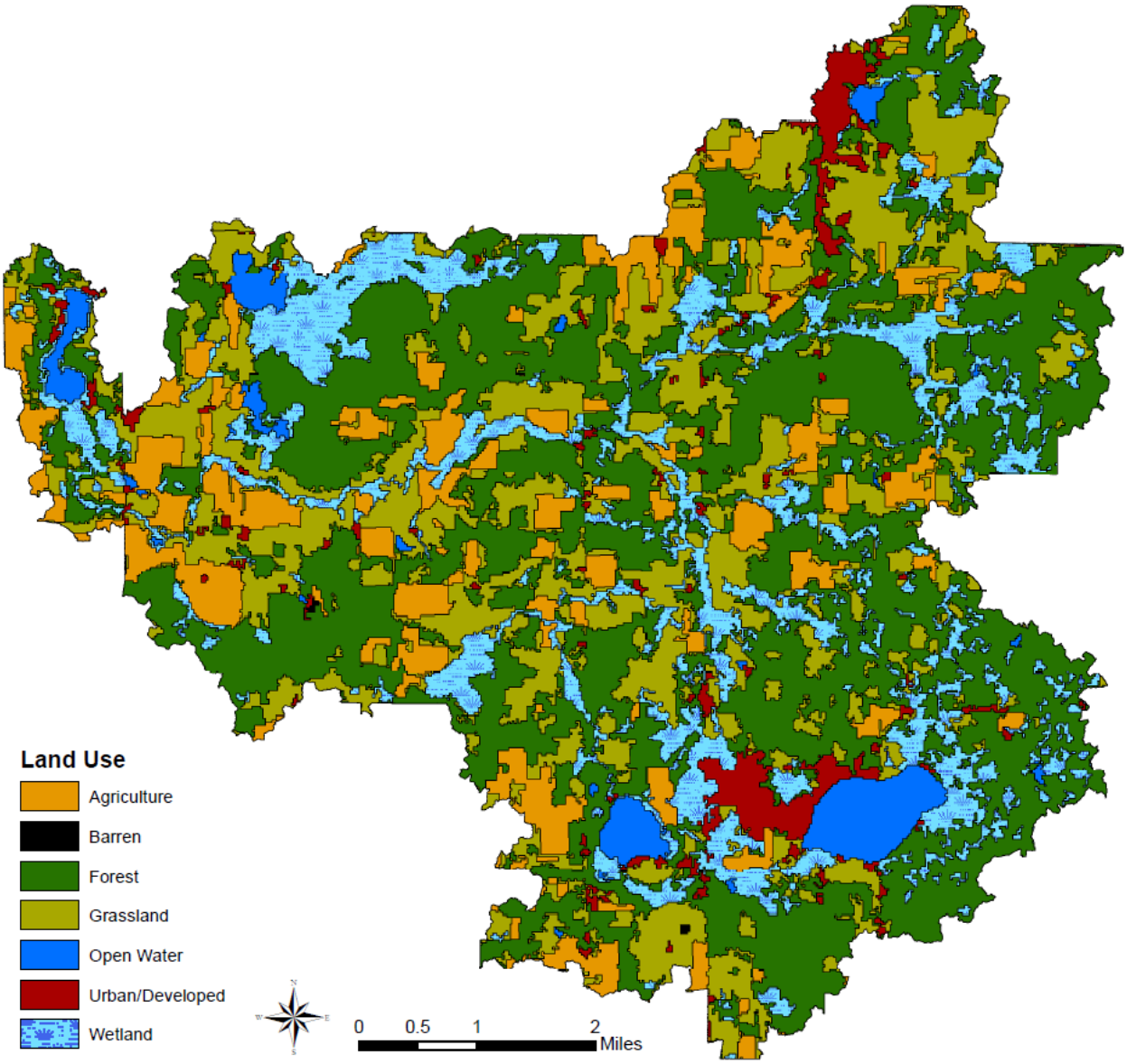
In Polk County, all new constructions on lakeshore properties require that a shoreland protection area be in place. A shoreland protection area is required to be 35 feet in depth as measured from the ordinary high water mark, which is defined as the point on the bank or shore up to which the water leaves a distinct mark (erosion, change in vegetation, etc.). These rules are in place largely to protect water quality and also provide benefits in terms of natural beauty, and bird and wildlife viewing opportunities. Additionally, shoreline protection areas allow for a 35 feet per 100 feet of shoreline viewing corridor which can be established as lawn.

Land Use in the Long Trade Lake Watershed

The area of land that drains to a lake is called a watershed. Land use in the Long Trade Lake watershed was delineated using WISLAND 2 satellite derived data and aerial photos from 2014.

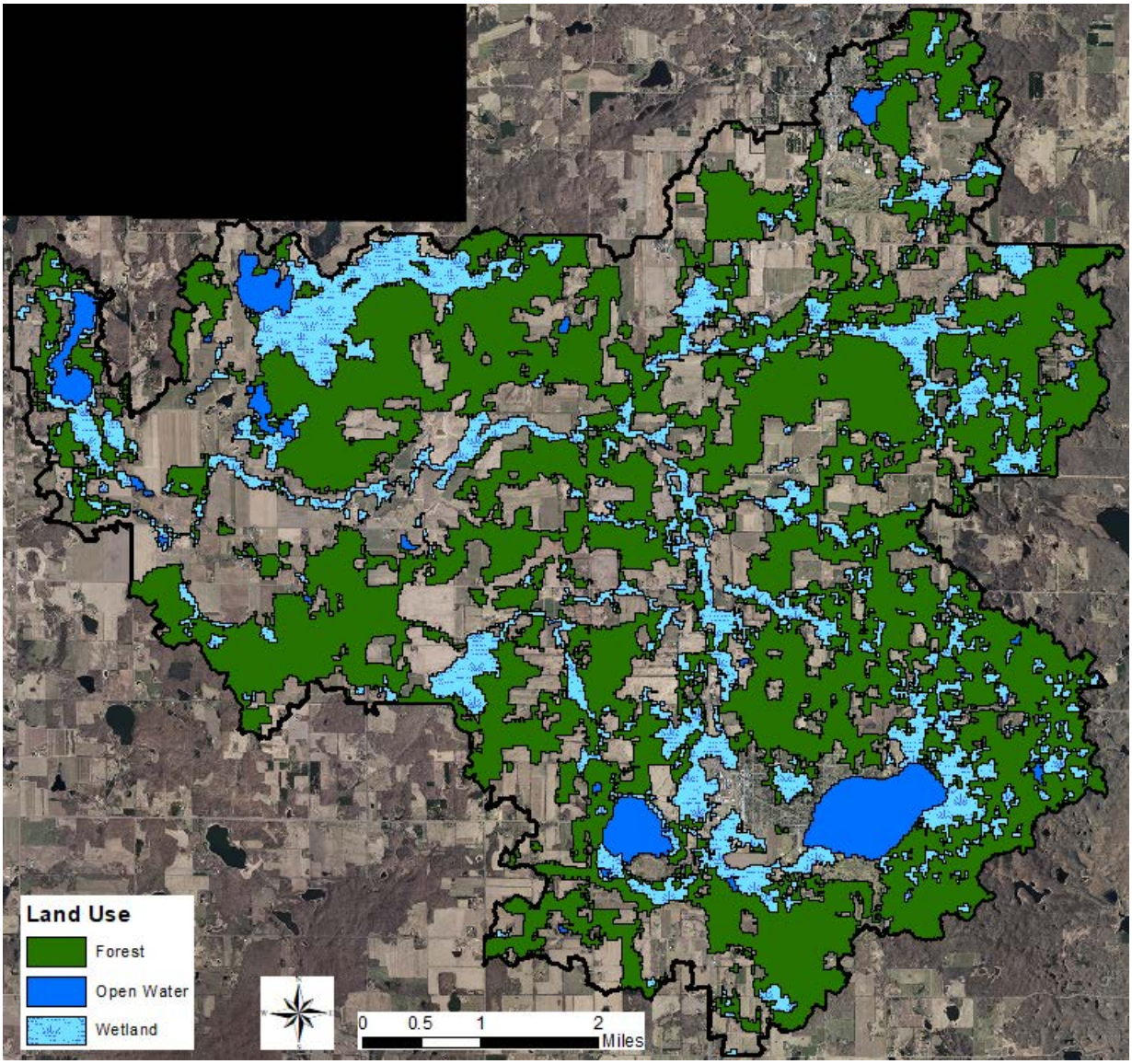
The most common land use in the Long Trade Lake watershed is forest (44%), followed by grassland (24%), wetland (15%), agriculture (11%), developed (3%), and open water (3%).

Land Use	Acres	Acres (%)
Forest	12,846	44%
Grassland	6,891	24%
Wetland	4,241	15%
Agriculture	3,361	11%
Developed	969	3%
Open Water	913	3%
Barren	7	0%
Total	**29,228**	**100%**



Areas Providing Water Quality Benefits to Long Trade Lake

Natural areas such as forests and wetlands allow for more infiltration of precipitation when compared with conventional tilled row cropped fields and developed residential sites containing lawns, rooftops, sidewalks, and driveways. This occurs because dense vegetation lessens the impact of raindrops on the soil surface, thereby reducing erosion and allowing for greater infiltration of water. Additionally, wetlands provide extensive benefits through their ability to filter nutrients and allow sediments to settle out before reaching lakes and rivers. In the Long Trade Lake watershed 44% of the land use is forest and 15% is wetland.



Shoreline Inventory

A shoreline inventory was completed using methodology developed by the University of Wisconsin Stevens Point Center for Watershed Science and Education. Land and Water Resources Department, with assistance from volunteers with the Round Trade Lake Improvement Association, completed the Shoreland Vegetation Survey and Shoreland Disturbance Survey Above and Below the Ordinary High Water Mark on September 21st, 2017.

In the Shoreland Vegetation Survey, the general shoreline condition was characterized as disturbed or undisturbed, the dominant short vegetation ground condition was determined[15], the presence or absence of each short shoreland vegetation ground condition was characterized, and it was established if tall shoreland vegetation is present or absent.

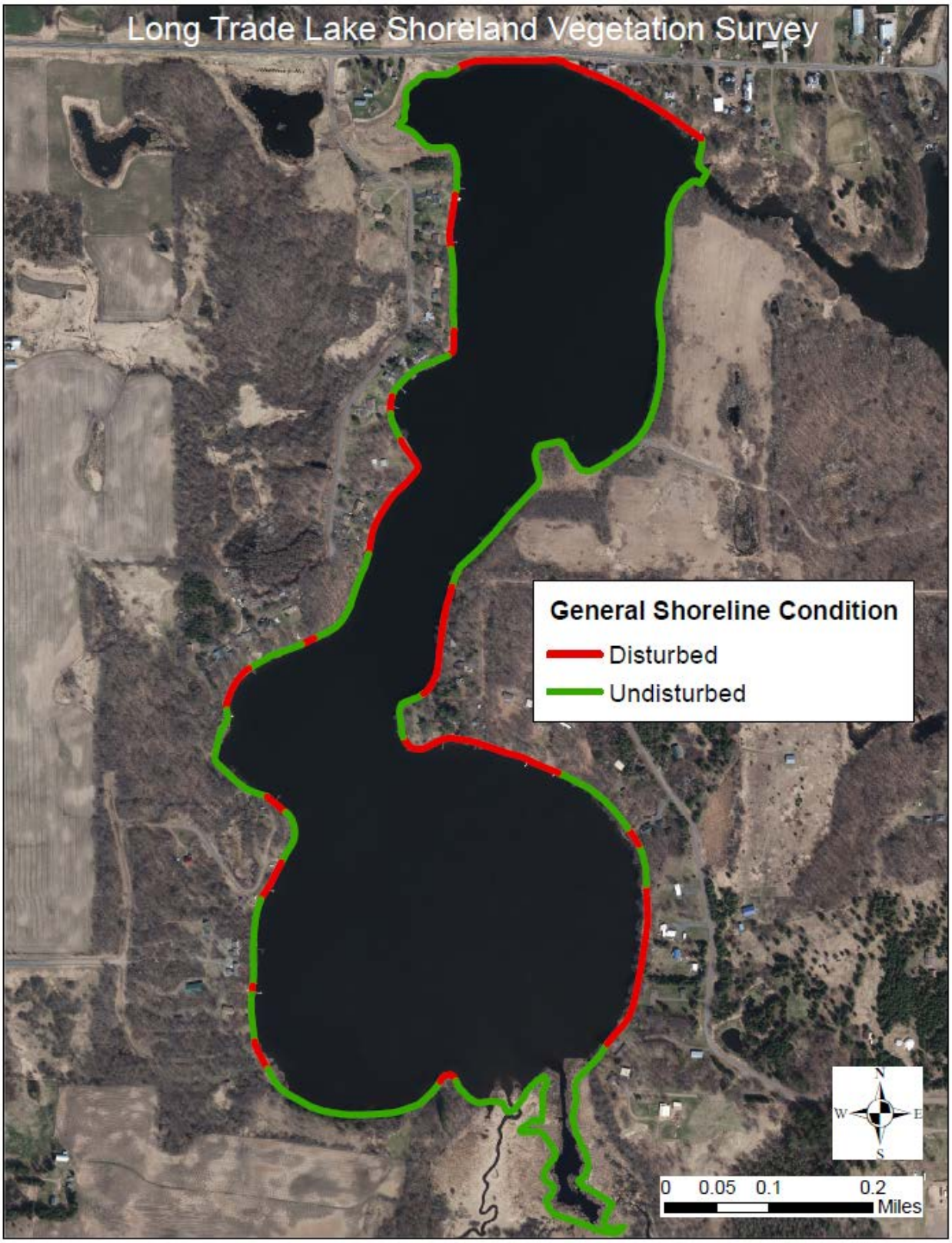
Using the Shoreland Vegetation Survey and Shoreland Disturbance Survey Above and Below the Ordinary High Water Mark, the survey established the presence of shoreland alterations[16], determined presence of erosion (undercut banks/slumping and furrows/gullies), characterized the areas below the ordinary high water mark[17], and documented culvert size, shape, and material.

[15] Short shoreland vegetation ground conditions include: organic-leaf pack/needles, barren/bare dirt (erosion), new shoreland restoration, mowed vegetation, short un-mowed vegetation < 3 feet tall, and impervious surface

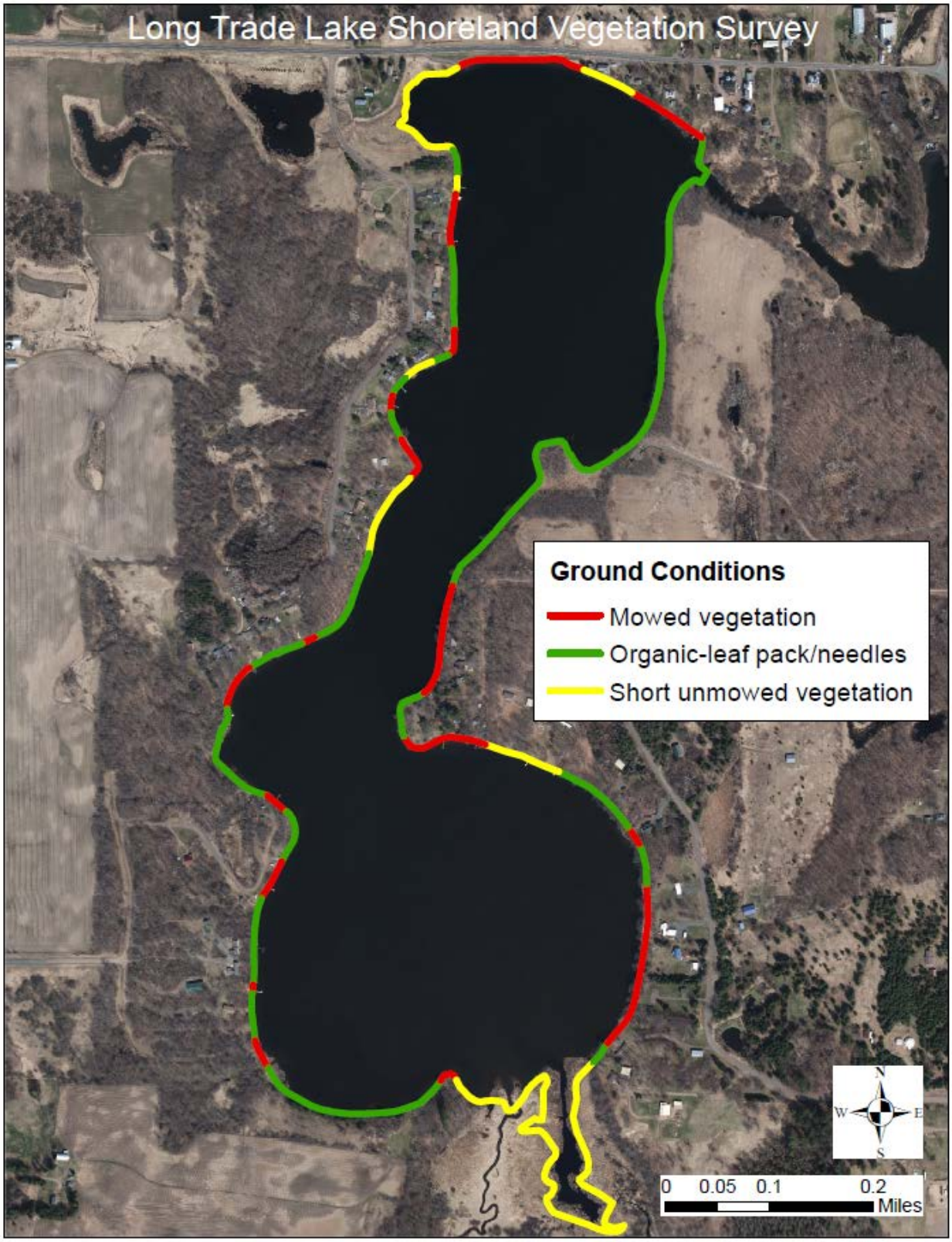
[16] Shoreland alterations include: dock/pier, seawall, rip-rap, artificial beach, boat landing, and dam/spillway

[17] The presence of the following were characterized for the area below the ordinary high water mark: cut/mowed area >30 feet wide, tilled/erosion, motor vehicle tire imprints, and woody structure

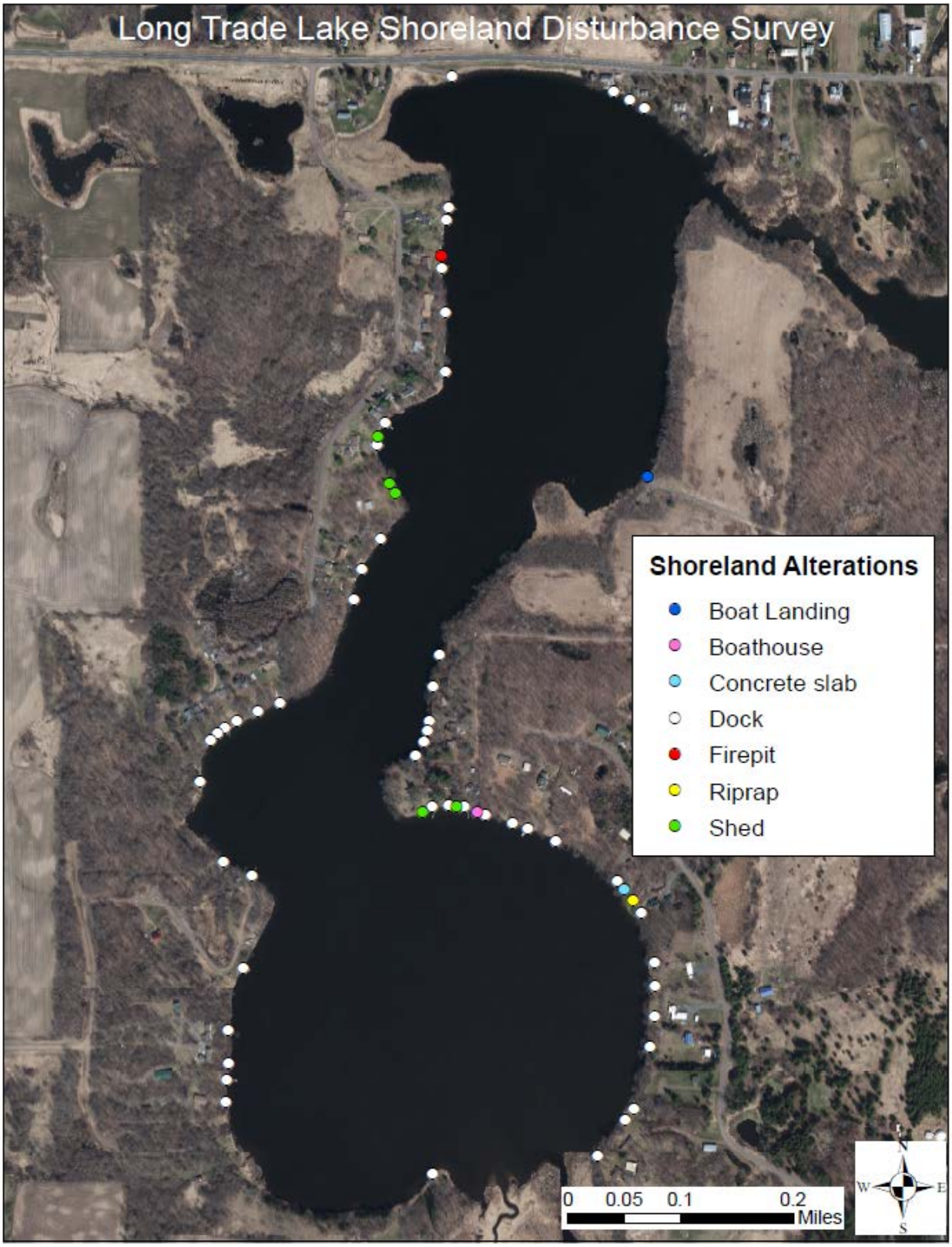
The shoreline of Long Trade Lake is primarily undisturbed (68%) as compared to disturbed (32%).



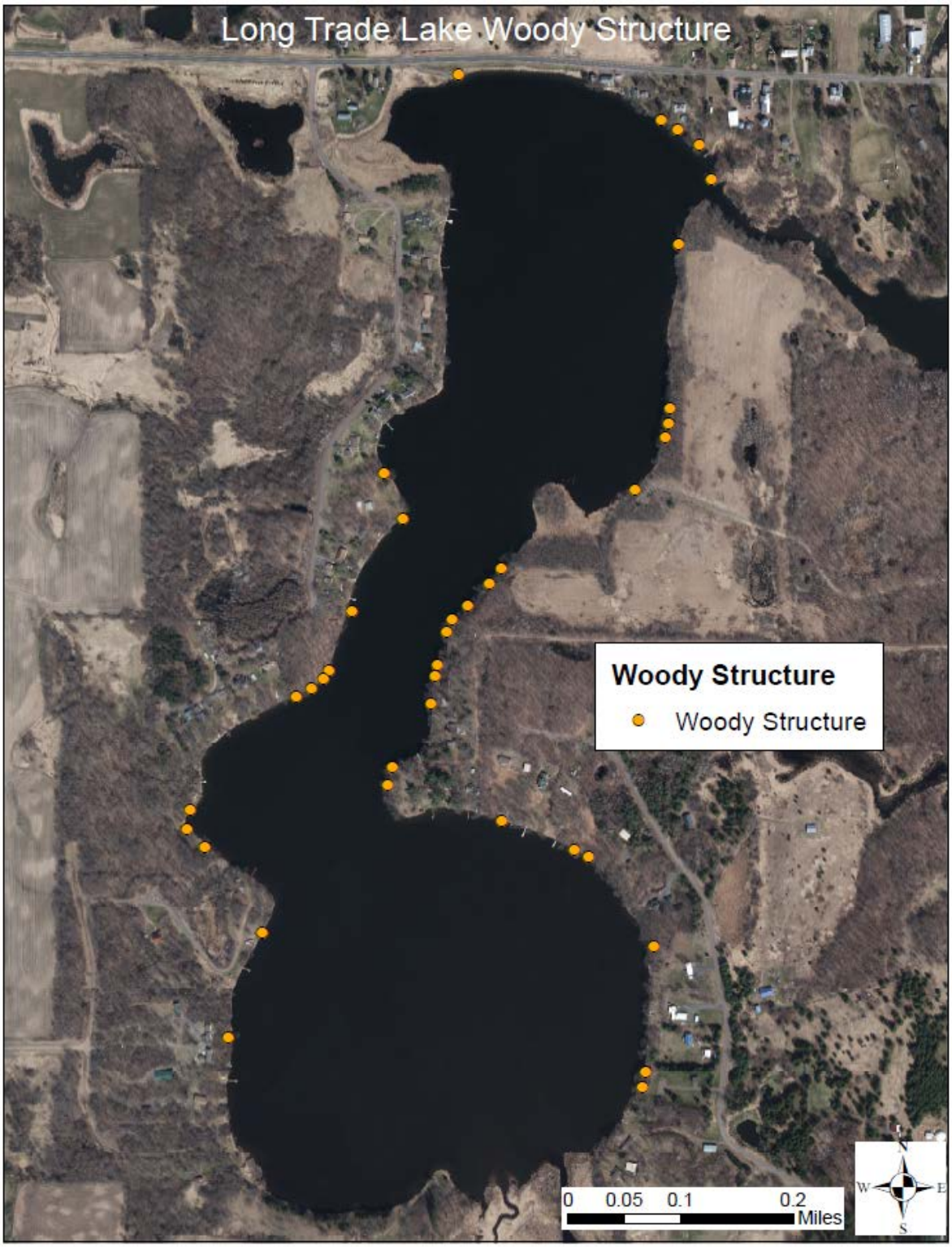
The dominant shoreland vegetation and ground cover on Long Trade Lake was organic-leaf pack/needles (46%) followed by short un-mowed vegetation (28%), mowed vegetation (26%).



The shoreline inventory also characterized disturbances around Long Trade Lake. There were a total of fifty-one docks, five sheds, one boat house, one boat landing, one concrete slab, one fire pit, and one stretch of riprap along the shoreline of Long Trade Lake.

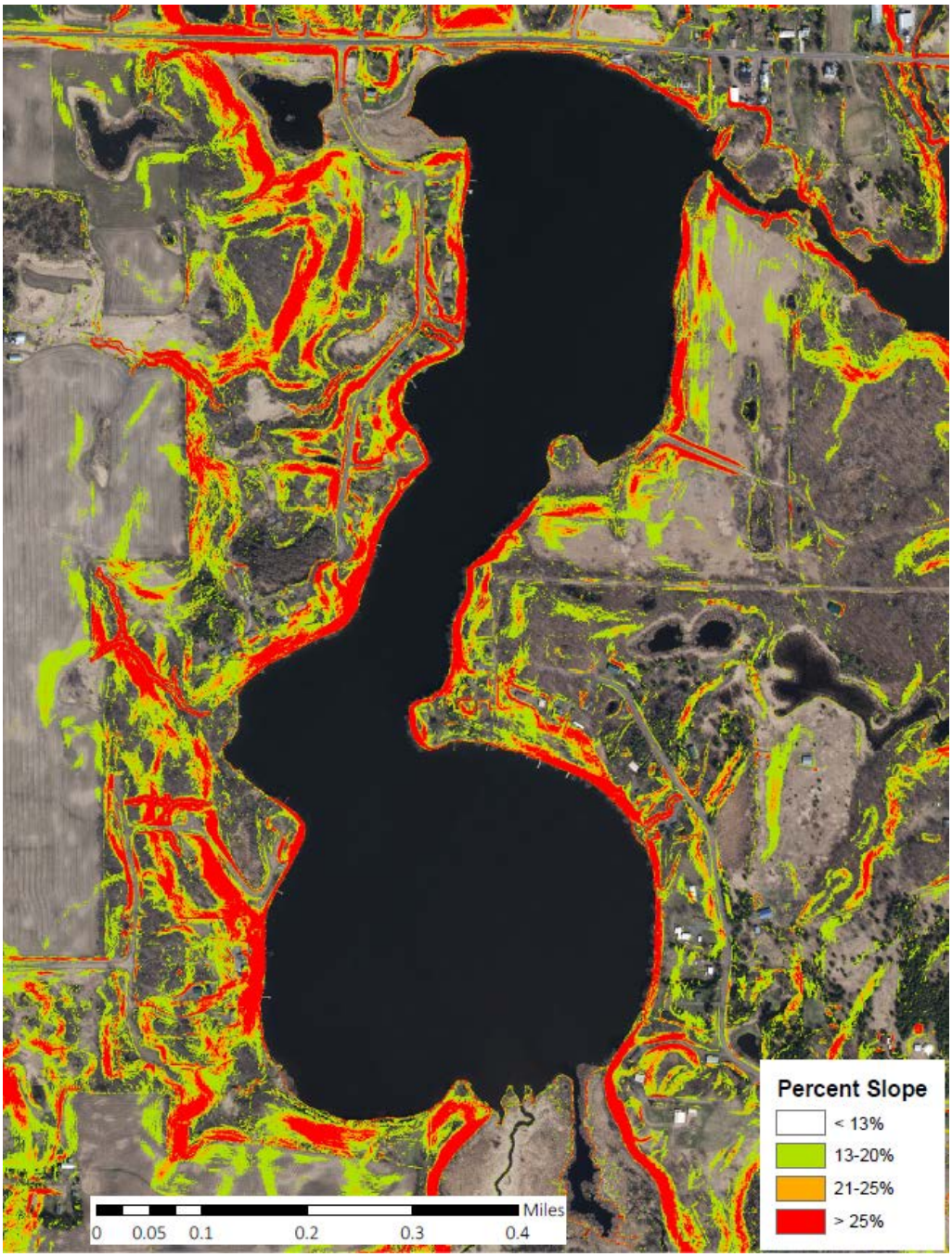


There were thirty-eight trees, or coarse woody structures, along the shoreline of Long Trade Lake (about ten trees per mile of shoreline). When trees fall into a lake, fish and aquatic organisms use them as habitat. Over time, humans have greatly reduced the number of trees along the shoreline of lakes. Undeveloped lakes have nearly 900 logs per mile of shoreline.



Slope

Steep slopes occur in areas where the gradient of land is 13% or greater. Areas having steep slopes can be categorized into three levels: 13-20%, 21-25%, and greater than 25%. Much of the shoreline on Long Trade Lake has a slope greater than 25%. A slope map can be used to prioritize areas that are prone to erosion and would benefit from perennial vegetation. Areas of likely gully erosion can also be identified from a slope map. Establishment of perennial vegetation will require landowner participation and in the case of gully erosion, it is likely an engineer would need to be hired to address problem areas.



No-till and Cover Crop Inventory

A land use inventory was conducted across the watershed to assess the current use of agricultural conservation practices. Conservation practices of interest for this study were no-till planting and cover crops. LWRD staff completed windshield surveys to inventory the two types of conservation practices. This inventory acts as a tool to document current adoption of these practices, gauge the potential to expand the use of conservation practices, and determine potential reductions in phosphorus, nitrogen, and sediment loss.

No-till planting is a conservation practice that plants agricultural seed without the need for tillage. Soil tillage is a common agricultural practice used to loosen soil, incorporate crop residue, and prepare a suitable seed bed. However, tillage also promotes the potential of soil erosion and nutrient runoff. Tillage breaks soil structure, inhibits the process of soil aggregation, and reduces surface crop residue. This exposes the soil to the erosive forces of wind and water. Soil erosion from agricultural landscapes can be a major source of sediment and nutrients in lakes and rivers causing decreased water quality. The adoption of no-till planting can dramatically reduce the potential for soil erosion and nutrient loss thus minimizing agriculture's impact on water quality.

Planting cover crops is another conservation practice that can lead to improvements in water quality. Cover crops are plants that are grown outside of the main production crop specifically for their benefits to the soil or main crop. The primary benefit of cover crops is the reduction of erosion. Cover crops reduce erosion because the vegetation and roots protect the soil from early spring and late fall rains when the primary crop is not growing. Besides reducing erosion, cover crops can increase infiltration, capture unused nutrients, build soil structure, promote soil bacteria and fungi growth, break compaction layers, suppress weeds, and provide many other benefits to the soil and environment. These benefits can lead to less runoff from agricultural fields and reduce the negative impact on water quality.

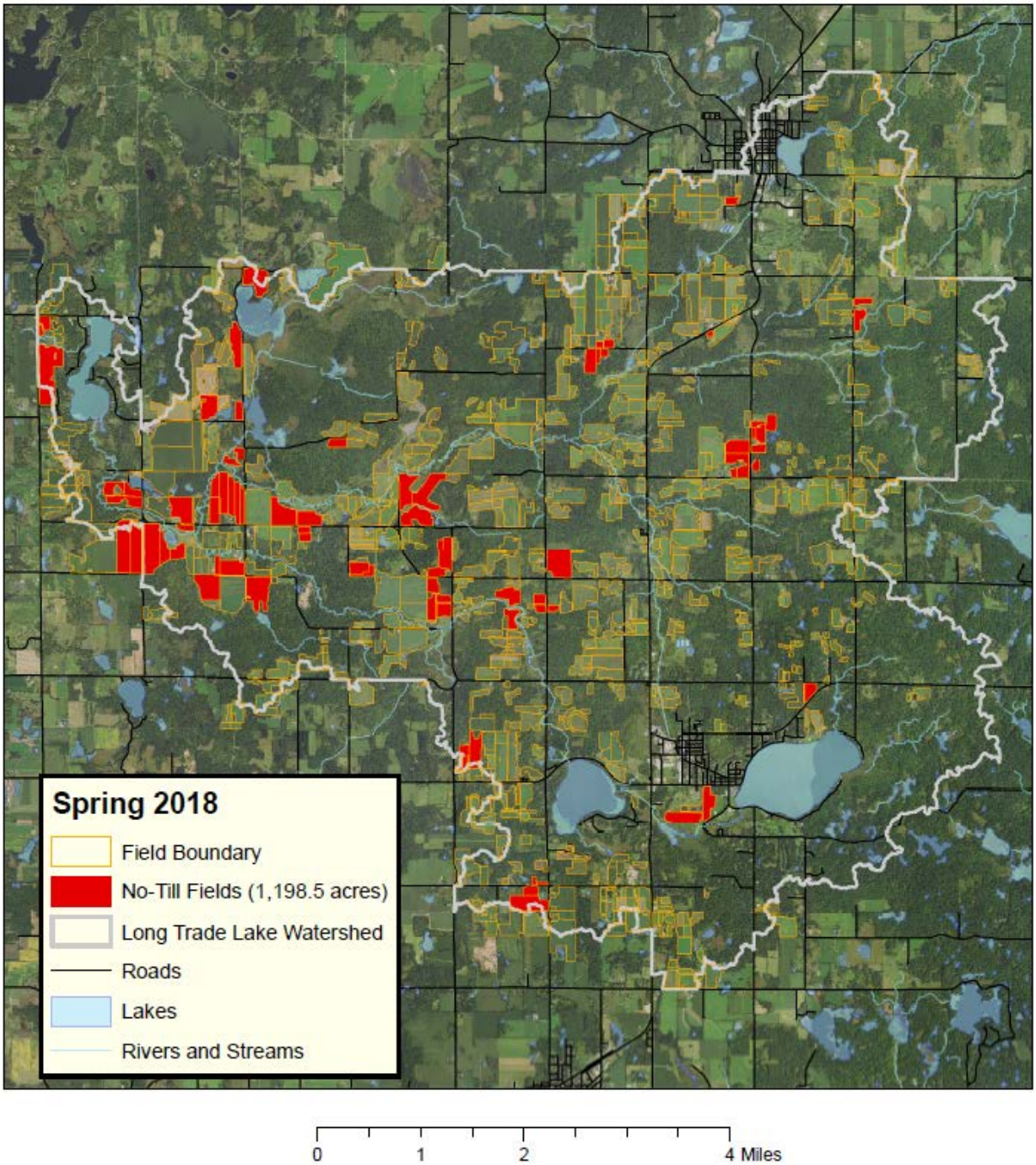
The watershed for Long Trade Lake consists of 29,228 acres of land of which 7,496 acres were identified as agricultural land use (corn, soybean, alfalfa/grass forage, and pasture). The 2018 spring no-till survey identified 1,199 acres of no-till. This represents 16% of the agricultural land in the watershed. The 2018 fall cover crop survey completed following the harvest season identified 46 acres of cover crops. This represents 0.6% of the agricultural land in the watershed.

The Spreadsheet Tool for Estimating Pollutant Loads (STEPL) can be used to calculate pollutant reductions that can be achieved by implementing different agricultural best management practices. STEPL calculates that implementing no-till can reduce phosphorus loss by 1.87 lbs/acre, nitrogen by 3.49 lbs/acre, and sediment by 0.45 tons/acre. Planting cover crops can reduce phosphorus loss by 0.47 lbs/acre, nitrogen by 1.67 lbs/acre, and sediment by 0.045

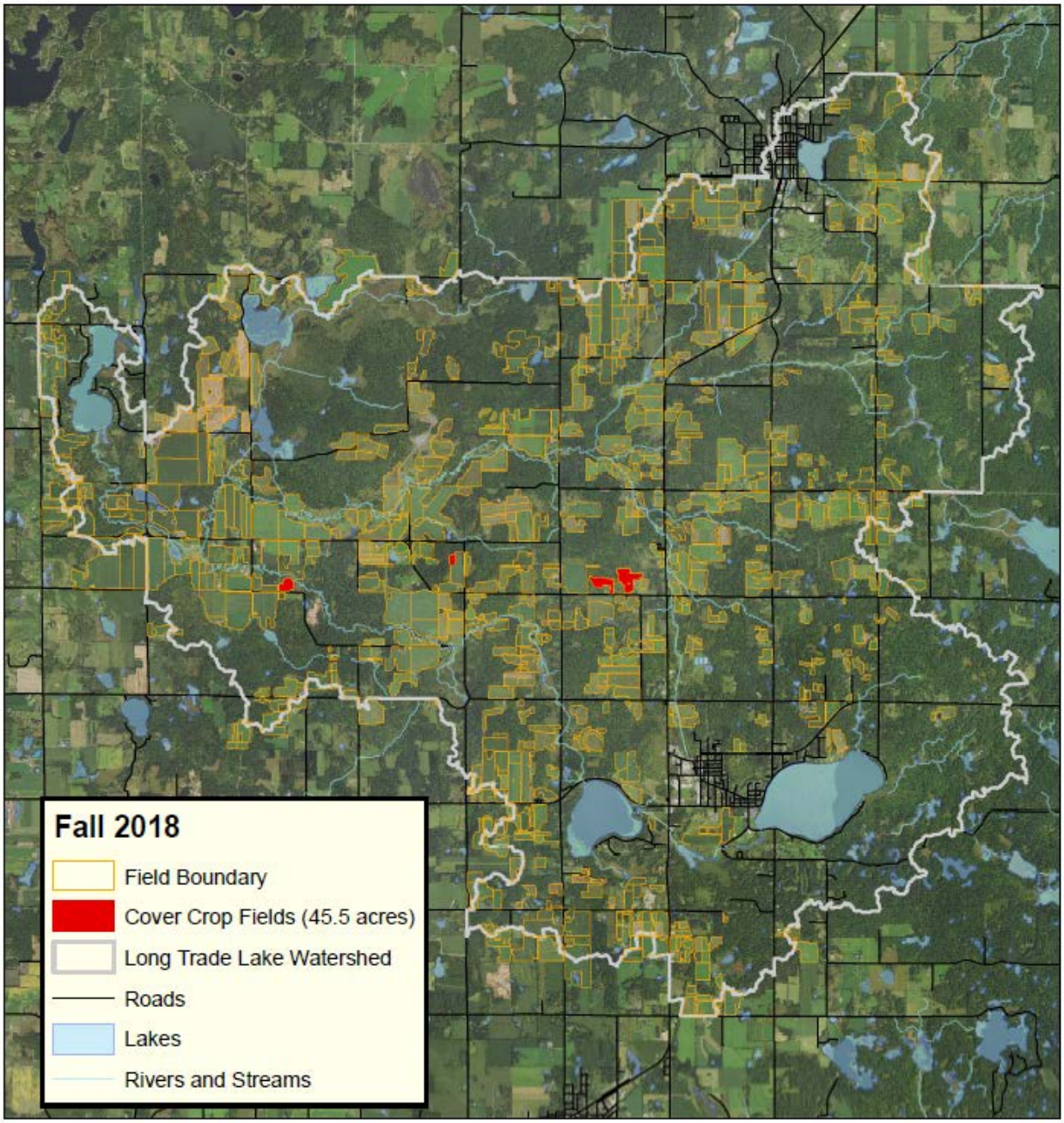
tons/acre. Based on the 2018 no-till and cover crop inventories, conservation practices in the Long Trade Lake Watershed have reduced inputs to Long Trade by 2,262.6 lbs of phosphorus, 4,260.8 lbs of nitrogen, and 541.3 tons of sediment.

This land use survey represents a one year snapshot of two conservation practices being used in the Long Trade Watershed. The acres of no-till or cover crop may fluctuate yearly based on multiple factors. Future inventories could be used to gauge long term implementation and trends in practice adoption. Agricultural producers may also be using other practices to reduce erosion or nutrient loss that were not inventoried with this study. Outreach to agricultural producers about how conservation practices can be implemented into their operation is one way to obtain the nutrient and sediment reduction goals of this lake management plan.

Long Trade Lake Watershed
No-Till Inventory



Long Trade Lake Watershed
Cover Crop Inventory

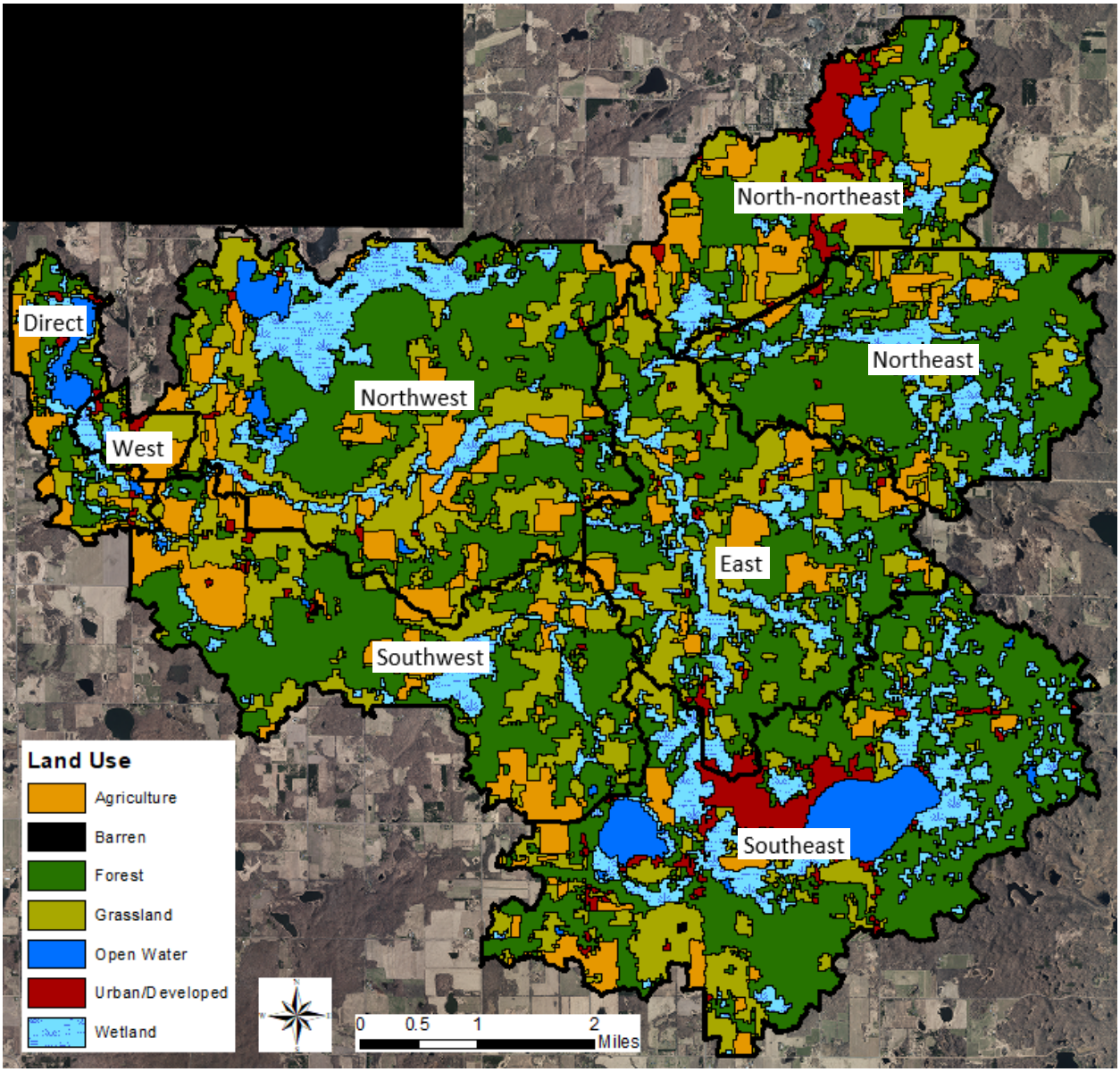


0 1 2 4 Miles

Subwatershed Modeling

Due to the large size of the watershed of Long Trade Lake, land use and phosphorus loads for each of the sub-watersheds were calculated in order to prioritize where the Association should allocate efforts and/or money when available.

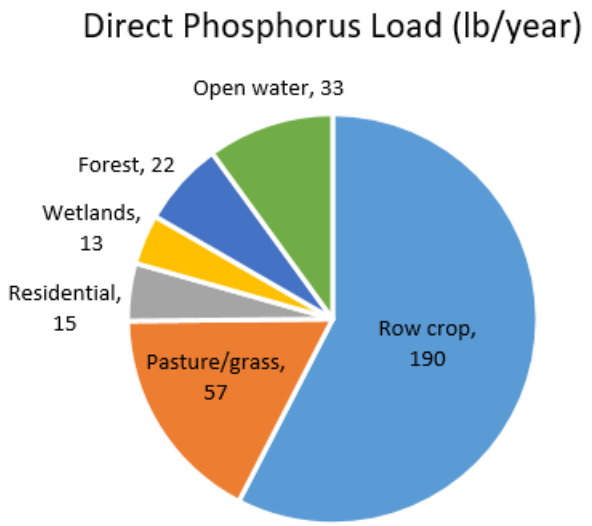
In order to delineate the watershed and sub watersheds for Long Trade Lake, the ArcGIS Spatial Analyst Toolbox was used to manipulate LiDAR data and satellite derived land cover from WISLAND to model the hydrological conditions and flow patterns entering Long Trade Lake. The Wisconsin Lake Modeling Suite (WiLMS) was then used to model current conditions for Long Trade Lake, verify monitoring, and estimate land use nutrient loading for the watersheds. Phosphorus is the key parameter in the modeling scenarios used in WiLMS because it is the limiting nutrient for algae growth in most lakes.

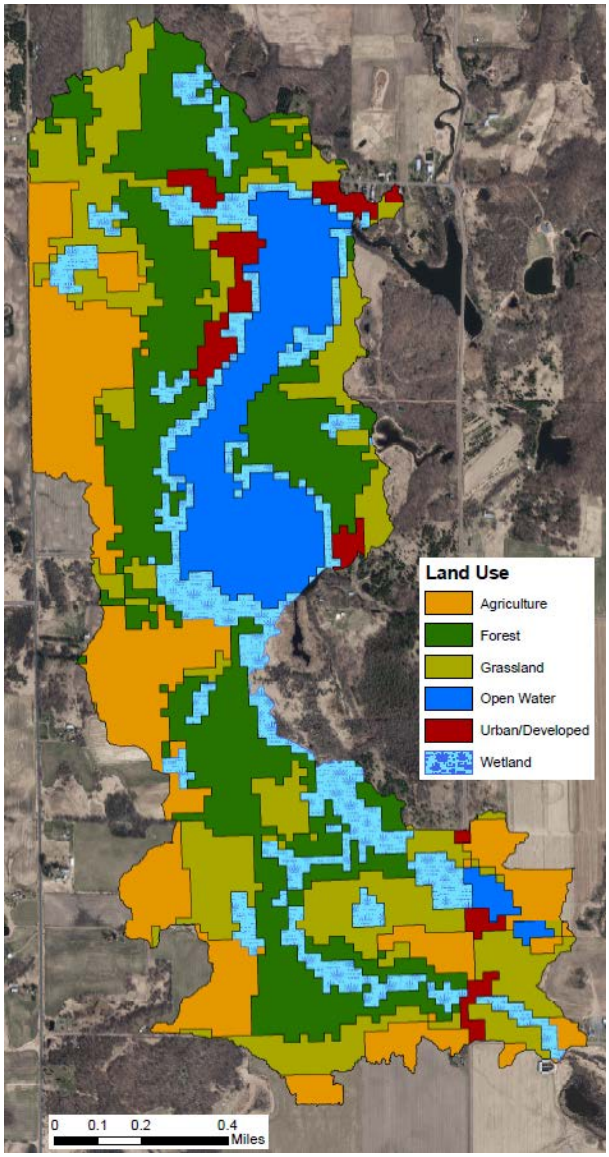


The direct subwatershed includes Long Trade Lake and the land that most closely surrounds the lake. This is typically the area most easily managed by lake organizations since it includes the shoreline property owned by members.

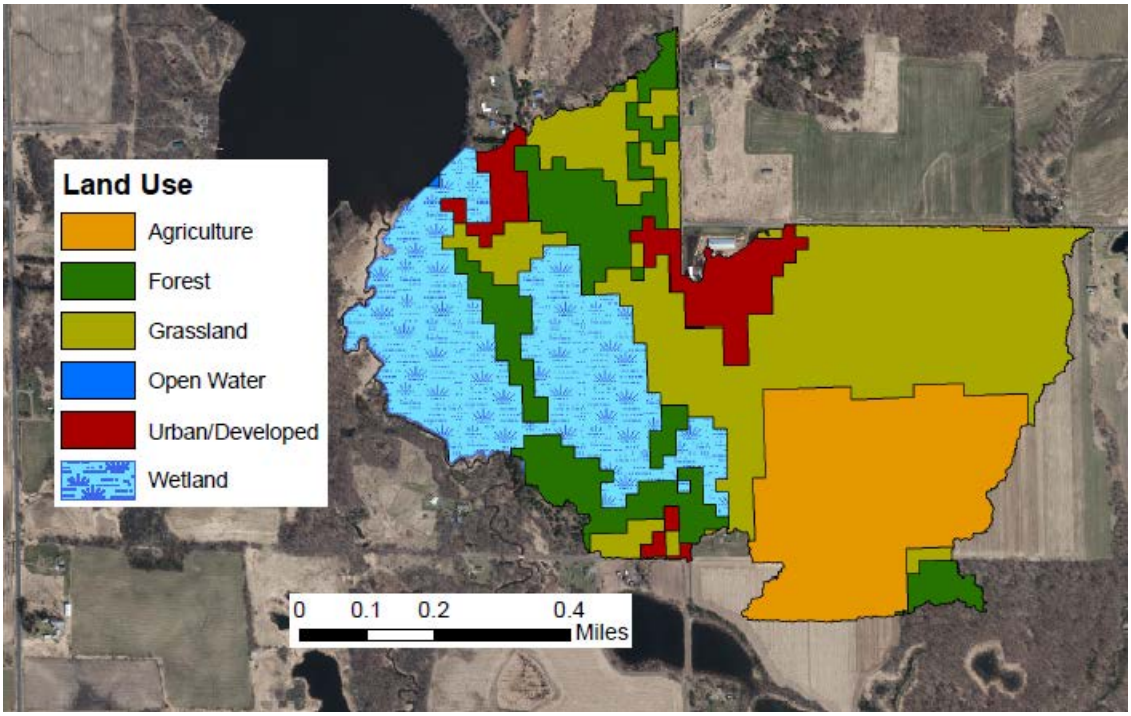
Direct Subwatershed Land Use

Land Use	Acres	Phosphorus Load (lb/year)	Phosphorus Load (%)
Row crop	213	190	57.3
Pasture/grass	217	57	17.5
Residential	34	15	4.6
Wetlands	147	13	4
Forest	285	22	6.9
Open water	120	33	9.7
Total	**1,016**	**330**	**100**

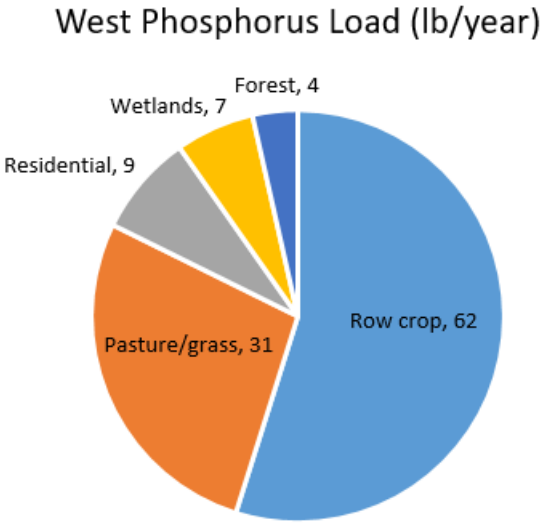




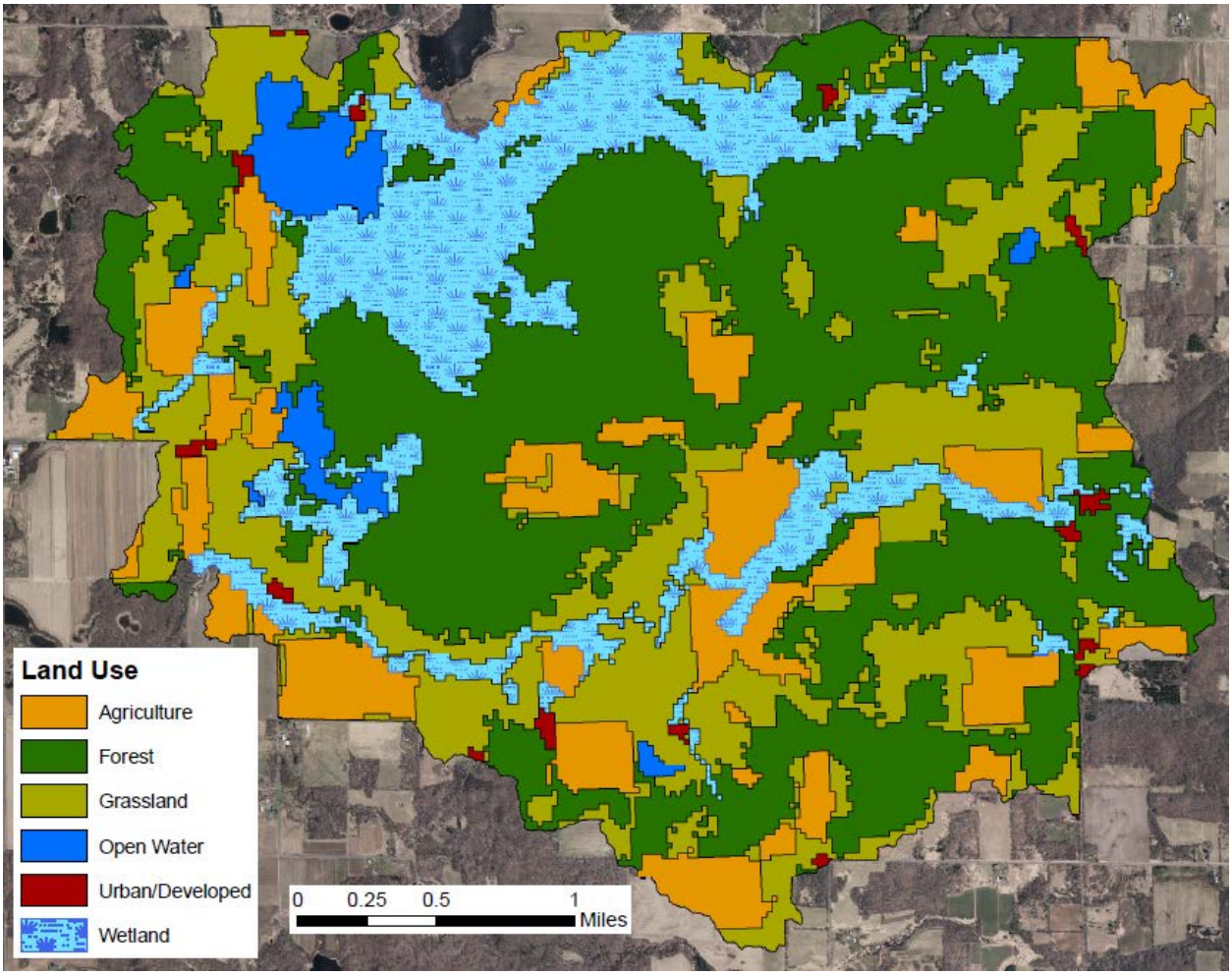
The west subwatershed is the next land mass most easily managed by the Association. This is a small subwatershed that drains directly to the lake's main inlet. There is a possibility for partnerships in land management in this watershed because of the close proximity to the lake.



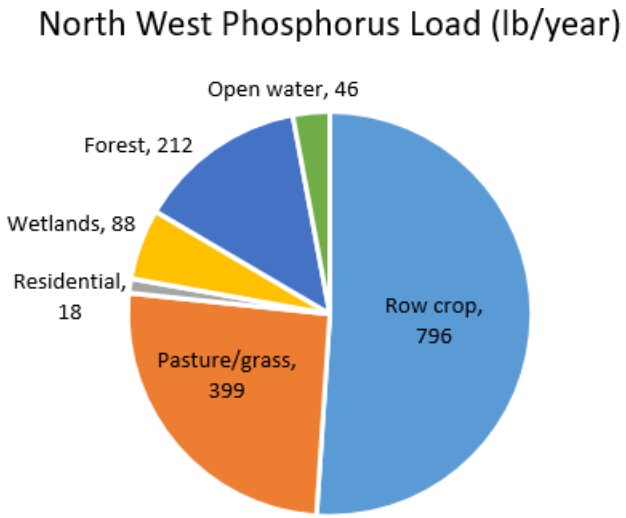
West Subwatershed Land Use			
Land Use	**Acres**	**Phosphorus Load (lb/year)**	**Phosphorus Load (%)**
Row crop	69	62	54.6
Pasture/grass	117	31	27.8
Residential	21	9	8.3
Wetlands	77	7	6.1
Forest	46	4	3.3
Total	**330**	**113**	**100.1**



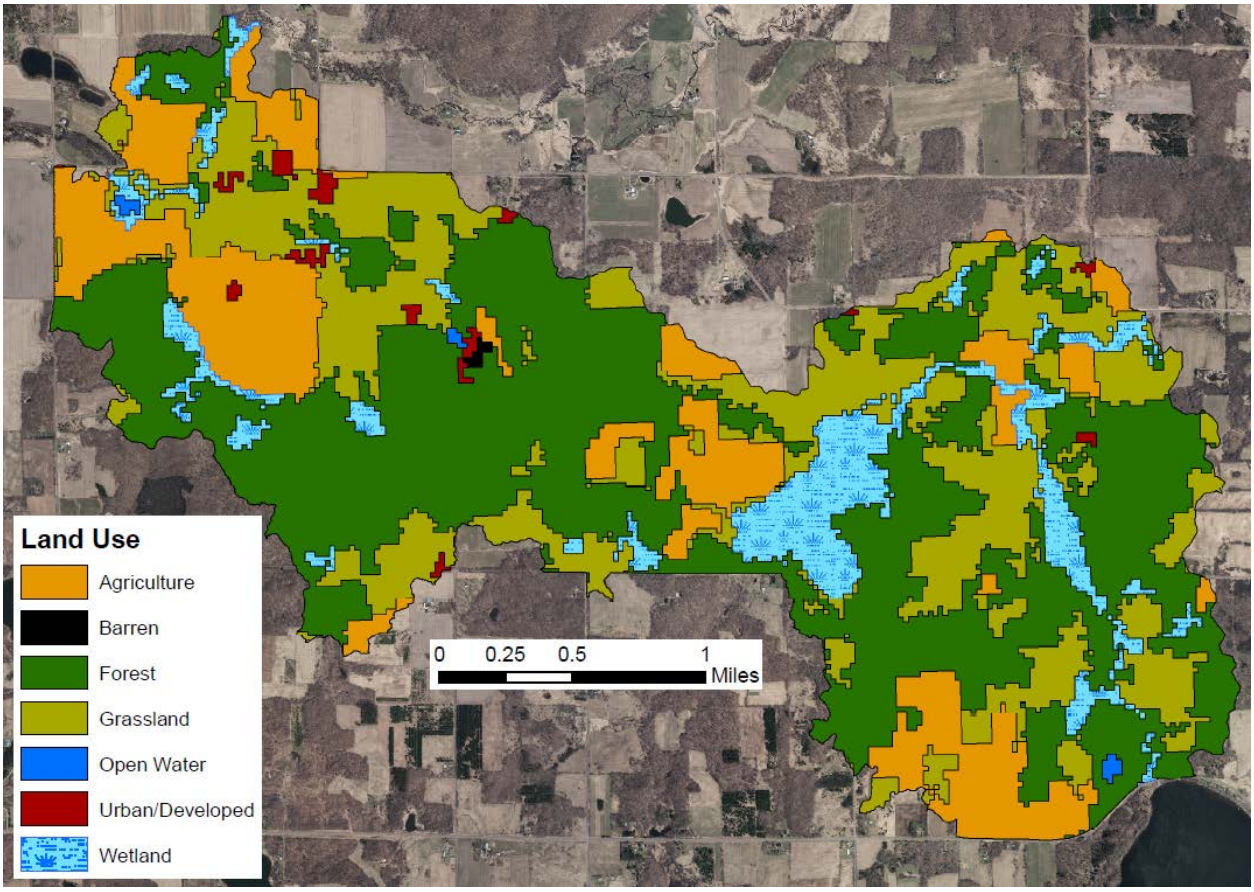
Moving west and north of the northwest subwatershed is a substantial watershed with an area of almost 6,300 acres.



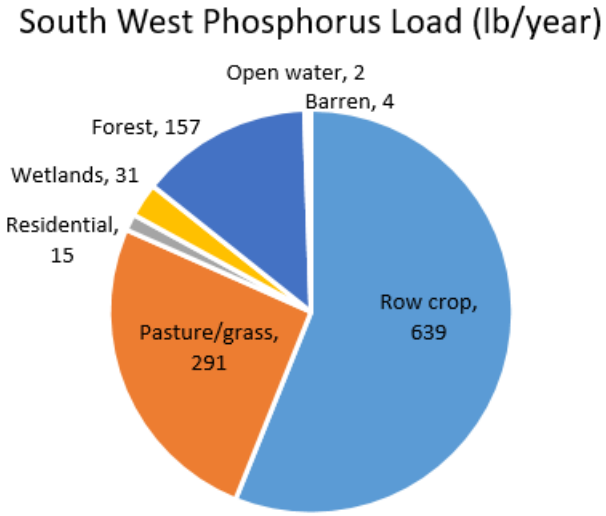
North West Subwatershed Land Use			
Land Use	**Acres**	**Phosphorus Load (lb/year)**	**Phosphorus Load (%)**
Row crop	893	796	51.1
Pasture/grass	1,489	399	25.6
Residential	42	18	1.2
Wetlands	996	88	5.7
Forest	2,636	212	13.6
Open water	169	46	2.9
Total	**6,225**	**1,559**	**100.1**



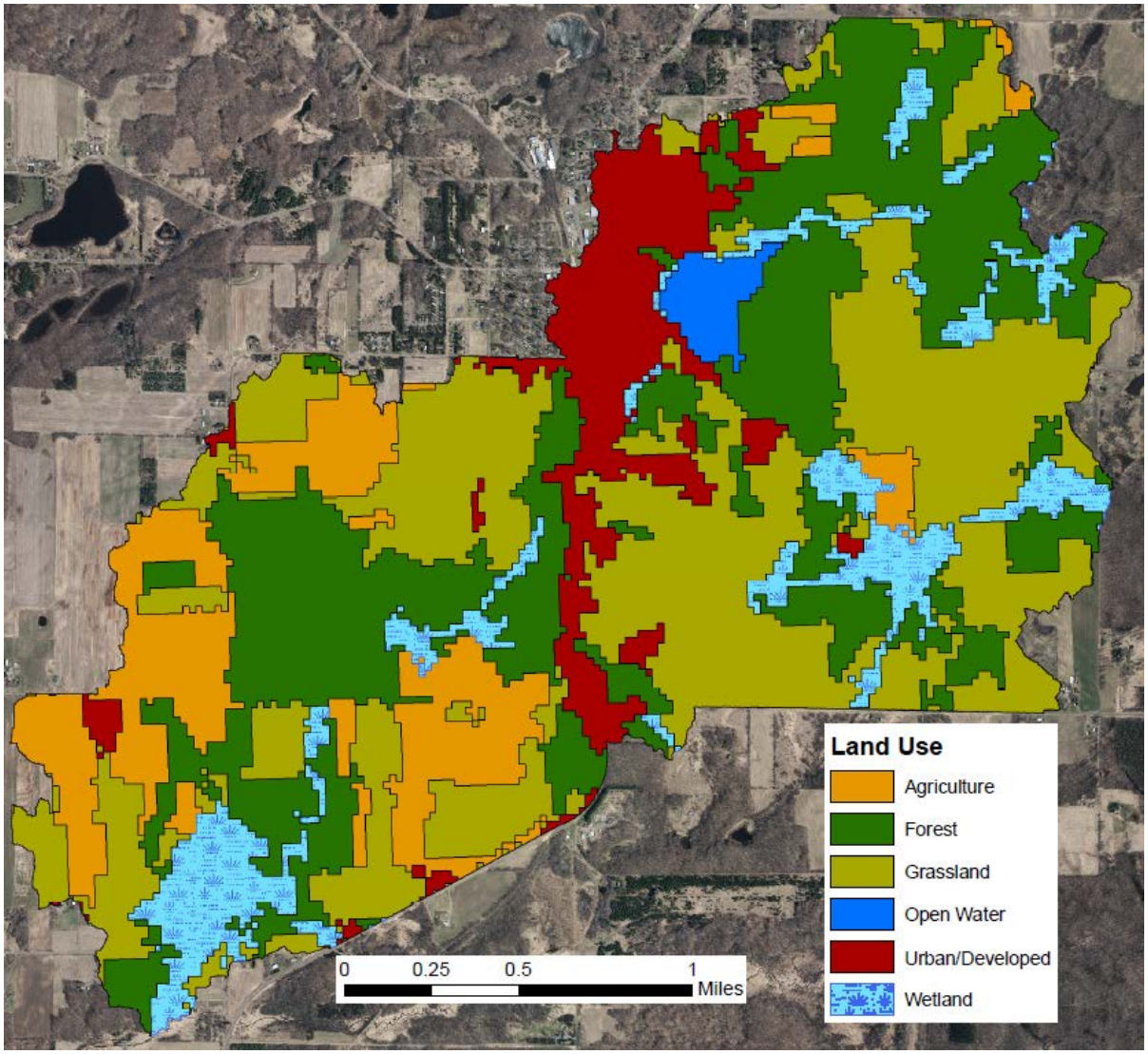
The southwest subwatershed is also a large subwatershed to Long Trade Lake, though smaller than the northwest subwatershed it still has a phosphorus load of approximately 1,100 pounds annually.



South West Subwatershed Land Use			
Land Use	**Acres**	**Phosphorus Load (lb/year)**	**Phosphorus Load (%)**
Row crop	717	639	56.1
Pasture/grass	1,086	291	25.5
Residential	36	15	1.4
Wetlands	352	31	2.8
Forest	1,936	157	13.6
Open water	9	2	0.2
Barren	4	4	0.3
Total	**4,140**	**1139**	**99.9**

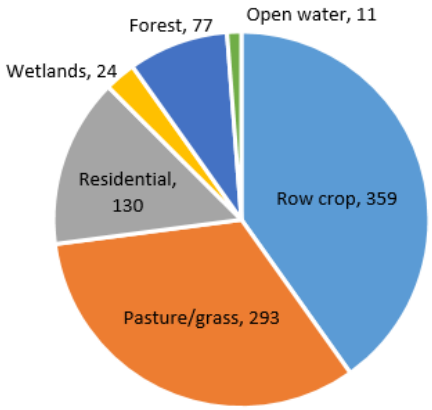


The north-northeast subwatershed has a phosphorus load of nearly 900 pounds. However, this assessment does not explicitly include the contribution from the Frederic waste water discharge, nor the storm water contributions coming from the village.

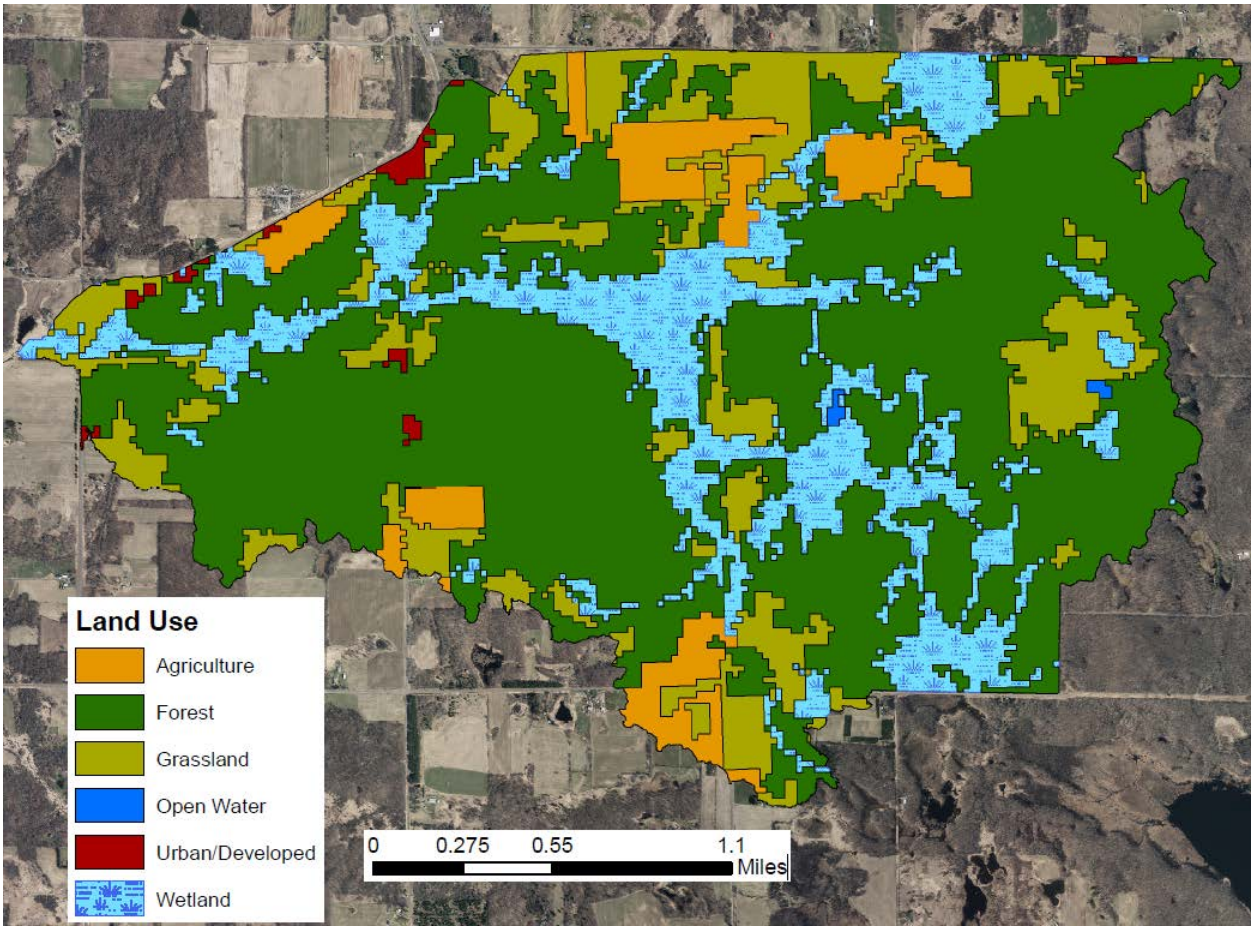


North-North East Subwatershed Land Use			
Land Use	**Acres**	**Phosphorus Load (lb/year)**	**Phosphorus Load (%)**
Row crop	403	359	40.1
Pasture/grass	1,097	293	32.7
Residential	293	130	14.6
Wetlands	278	24	2.8
Forest	964	77	8.6
Open water	42	11	1.3
Total	**3,077**	**894**	**100.1**

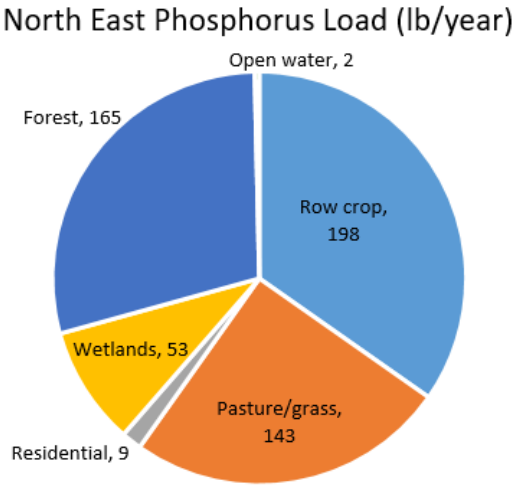
North-North East Phosphorus Load (lb/year)



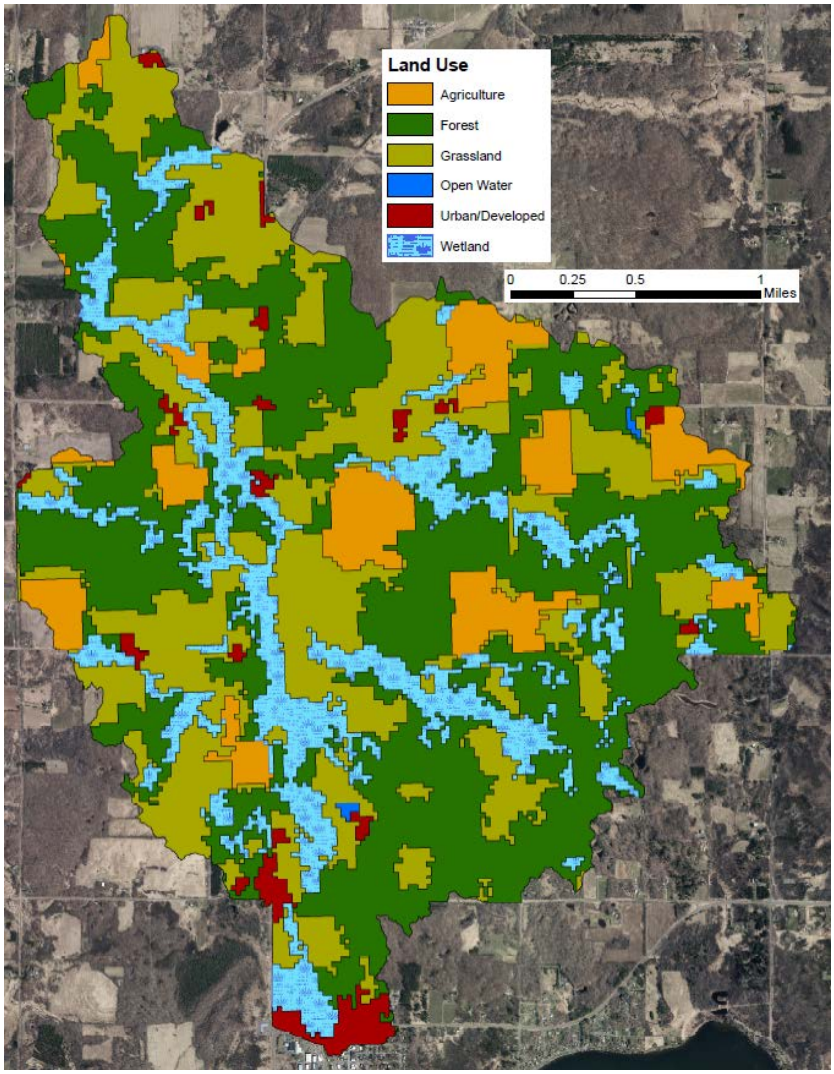
The northeast subwatershed of Long Trade Lake has a total phosphorus load of nearly 600 pounds annually.



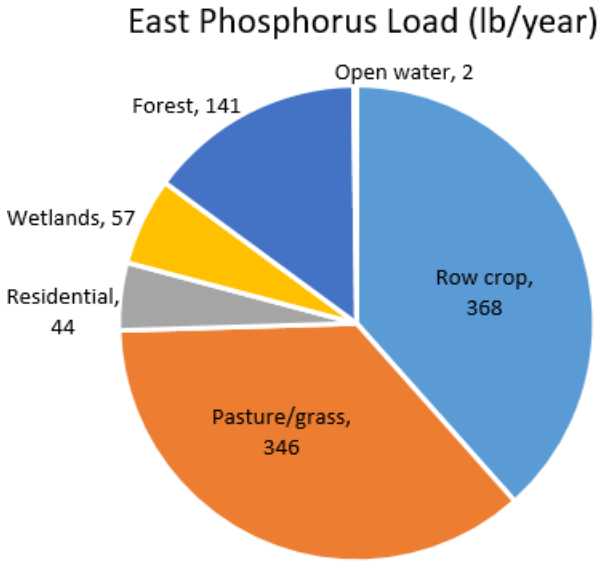
North East Subwatershed Land Use			
Land Use	**Acres**	**Phosphorus Load (lb/year)**	**Phosphorus Load (%)**
Row crop	223	198	34.8
Pasture/grass	537	143	25.1
Residential	21	9	1.6
Wetlands	601	53	9.4
Forest	2,055	165	28.8
Open water	5	2	0.2
Total	**3,442**	**570**	**99.9**



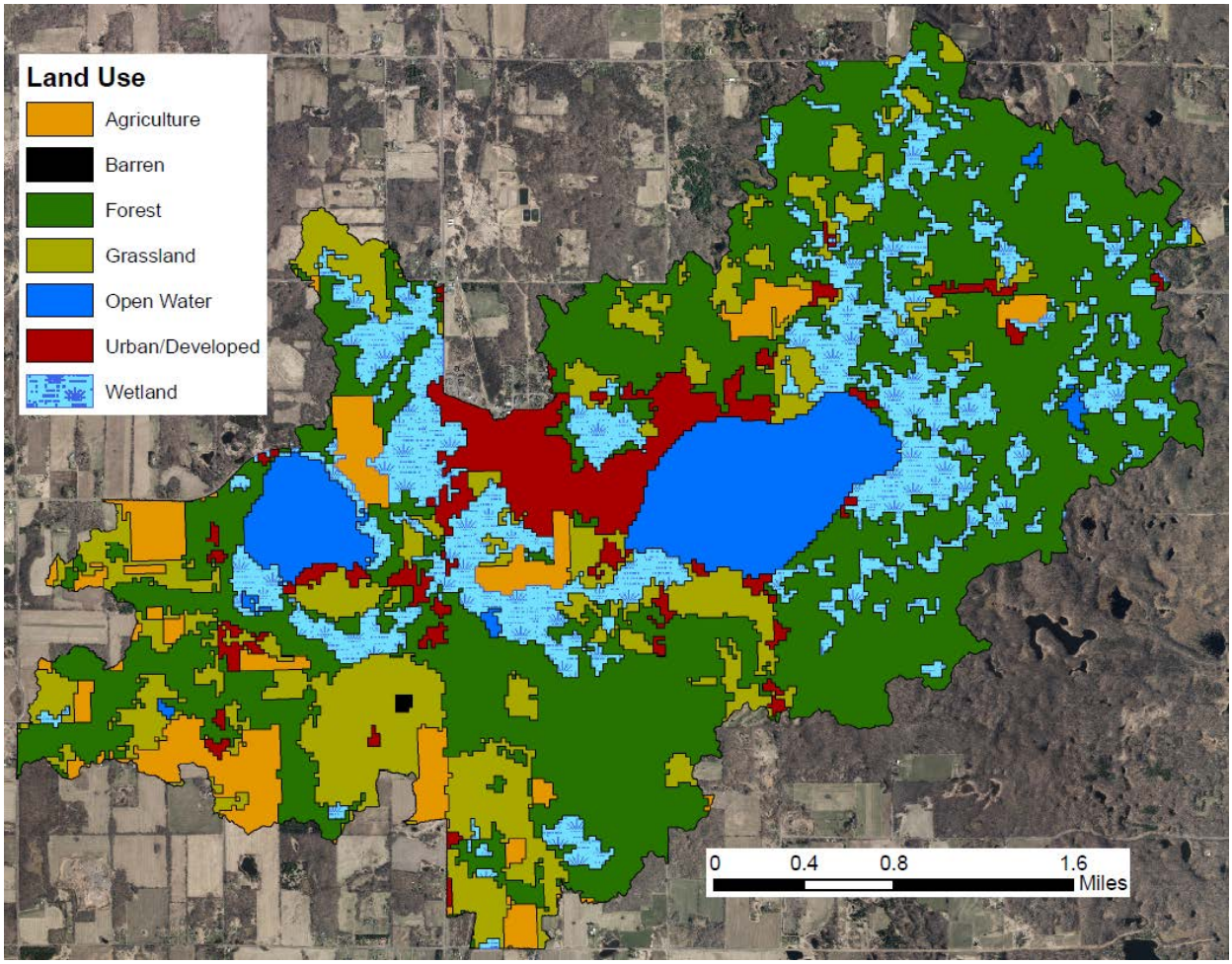
The east subwatershed has a large percentage of land that is wetland and grassland, so it may not be as large as a contributor to the lake's phosphorus budget as the model suggests.



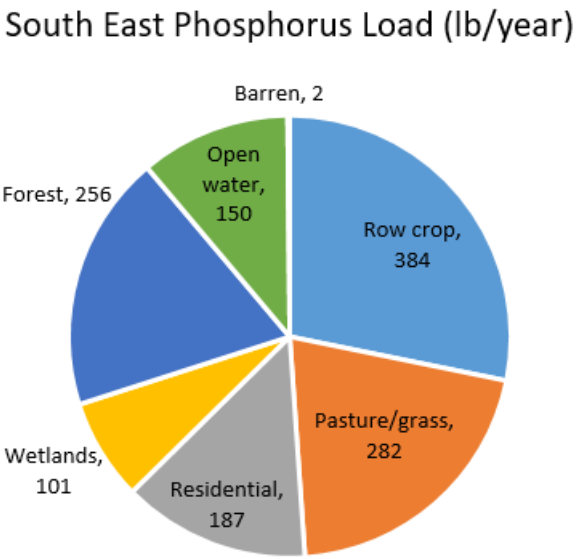
East Subwatershed Land Use			
Land Use	**Acres**	**Phosphorus Load (lb/year)**	**Phosphorus Load (%)**
Row crop	413	368	38.4
Pasture/grass	1,294	346	36.1
Residential	101	44	4.7
Wetlands	651	57	6.1
Forest	1,749	141	14.6
Open water	5	2	0.1
Total	**4,213**	**958**	**100**



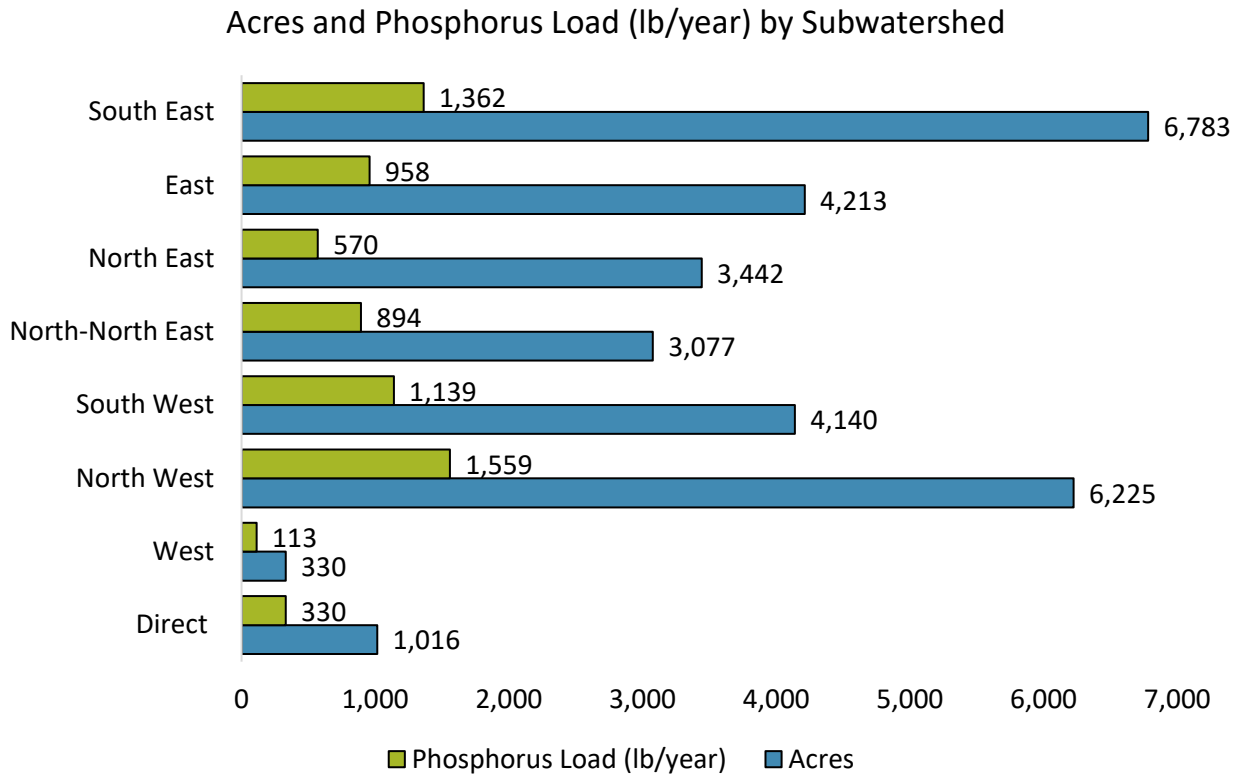
The final watershed modeled in this study was the southeast subwatershed. This subwatershed encompasses most of the village of Luck, Big Butternut and Little Butternut Lakes, and the Village of Luck's wastewater treatment facility.



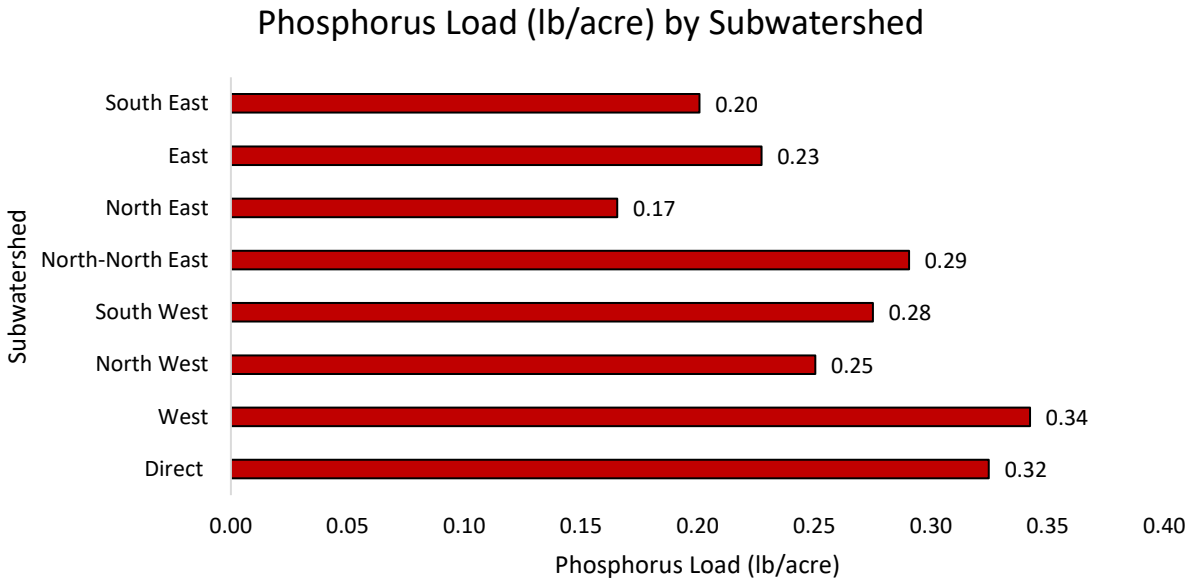
South East Subwatershed Land Use			
Land Use	**Acres**	**Phosphorus Load (lb/year)**	**Phosphorus Load (%)**
Row crop	430	384	28.1
Pasture/grass	1,052	282	20.7
Residential	421	187	13.8
Wetlands	1,140	101	7.5
Forest	3,174	256	18.7
Open water	563	150	11.1
Barren	3	2	0.2
Total	**6,783**	**1,362**	**100.1**



In general, as the size of the watershed increases, the phosphorus load increases.



However, when the data is normalized to show the phosphorus load as pounds per acres, it shows a different picture. It appears that the Association should focus watershed improvement efforts on the direct and west subwatersheds.



Watershed Modeling and Nutrient Reductions

Land use and phosphorus load for the Long Trade Lake watershed were calculated. Watershed modeling was used to estimate the external (or land based) inputs of phosphorus to the lake and the internal (or lake based) sediment inputs of phosphorus to the lake. However, since models can only make estimates, the outputs from modeling scenarios need to be compared with actual in-lake water quality data.

Based on average evaporation, precipitation, and runoff coefficients for Polk County soils and land use, WiLMS determined the annual nonpoint source load of phosphorus to Long Trade Lake under several scenarios for each year of the study and the combined data from the three years of the study. WiLMS determined the annual phosphorus load to Long Trade Lake as 6,942 pounds per year. Since the model for 2017 was closest to the measured in-lake data, that scenario was used for modeling efforts.

The internal load for Long Trade Lake was estimated using four different methods. Overall, the internal load was calculated as 21 pounds or 0.3% of the total phosphorus budget in 2017. Internal loading is predicted to be insignificant and unlikely to be a controlling factor for either the nutrient budget or phytoplankton dynamics in Long Trade Lake.

The data was used to select the 1981 Canfield-Bachmann Natural Lake Model as the model with the best fit. In 2017, the observed in-lake phosphorus values were within 1% of the modeled values. (99mg/m^3 and 98mg/m^3, respectively).

Models can be used to predict many different scenarios and can be useful to guide management decisions. The 1981 Canfield-Bachmann Natural Lake Model was used to predict Long Trade Lake's response to nutrient reductions. A 65% reduction in the non-point source load to Long Trade Lake would be necessary to remove Long Trade Lake from the Impaired Waters List. A 28% reduction would be necessary to remove Long Trade Lake from the Impaired Waters List if the lake was classified as a stream.

Non-point source reduction	**Areal loading (mg/m^2/yr)**	**Total loading (lb)**	**Predicted total phosphorus (µg/L)**	**Predicted chlorophyll (µg/L)**	**Predicted secchi depth (m)**
0%	5187.26	6941.9	99.5	26.3	0.8
28%	3744.47	5011.1	74.5	8.3	1.8
65%	1837.93	2459.6	39.1	7.4	2.1

Agricultural Land Use Best Management Practices Reductions

The Spreadsheet Tool for Estimating Pollutant Loads (STEPL) was used to calculate pollutant reductions achieved by implementing agricultural best management practices[18]. Areal loading was calculated based on the pollutant reductions for cover crops and conservation tillage (greater than or equal to 60% residue) and input into the Canfield Bachman 1981 Natural Lake Model.

If 100% of the cropped land in the Long Trade Lake watershed was converted to cover crops, the in-lake total phosphorus concentration would be reduced to 82 µg/L.

If 100% of the cropped land in the Long Trade Lake watershed was converted to reduced tillage, the in-lake total phosphorus concentration would be reduced to 73 µg/L.

[18] Cover crops = 32% reduction and conservation tillage (greater than or equal to 60% residue)

Tributary Reductions

The inlet as it enters Long Trade Lake is not currently meeting the aquatic life use impairment threshold of 75 µg/L. If the inlet was meeting the state standard the annual phosphorus load to Long Trade Lake would be reduced by half.

Year	Actual Total Phosphorus (µg/L)	Actual Phosphorus (pounds/year)	Reduced Total Phosphorus (µg/L)	Reduced Phosphorus (pounds/year)
2016	157	15,066	75	7,197
2017	120	13,611	75	8,507
2018	114	12,131	75	7,981

Polk County Ordinances

One way the Polk County Board establishes policy is by adopting ordinances. Ordinances are local laws prescribing rules of conduct and are enforced by county officials. Ordinances become a permanent part of the governmental code and may be amended from time to time. Once policy has been approved by the county board of supervisors through plans, budgets, ordinances, and resolutions, it is the responsibility of county staff to implement the decisions of the board. Ordinances relevant to the Long Trade Lake Management Plan are administered by the Land and Water Resources Department and the Department of Land Information Zoning and are briefly summarized below.

Land and Water Resources Department

Manure and Water Quality Management Ordinance

The purpose of this ordinance is to enhance public health, prosperity, and welfare by protecting ground and surface water resources by promoting the proper storage and management of animal waste, including the prohibitions found in NR151.08.

Storm Water Management and Erosion Control Ordinance

The general purpose of this ordinance is to establish regulatory requirements for land development and land disturbing activities aimed to minimize the threats to public health, safety, welfare, and the natural resources in Polk County from construction site erosion and post-construction storm water runoff.

Nonmetallic Mining Reclamation Ordinance

The purpose and goal of this ordinance is to ensure the effective reclamation of nonmetallic mining sites after mining operations have ceased. This ordinance adopts and implements the uniform statewide standards for nonmetallic mining reclamation required by Section 295 of Wisconsin Statute and contained in Wisconsin Administrative Code NR 135. The ordinance in effect means that any proposed nonmetallic mining site (sand, gravel, or other nonmetallic minerals) is required to receive an approved reclamation permit to begin nonmetallic mining operations in Polk County. The permit also requires the development of an approved site specific reclamation plan and for the operator to post financial assurance to guarantee the completion of reclamation.

Illegal Transport of Aquatic Plants and Invasive Animals Ordinance

The purpose of this ordinance is to prevent the spread of aquatic invasive species in Polk County and surrounding waterbodies in order to protect property values and the property tax base and ensure quality recreational opportunities. It requires all plants and invasive animals be removed from a boat and trailer prior to entering a public roadway.

Land Information-Zoning

Comprehensive Land Use Ordinance

The purpose of this ordinance is to promote and protect public health, safety, and other aspects of the general welfare. Further purposes of this ordinance are to: aid in the implementation of provisions of the county comprehensive plan; promote planned and orderly land use development; protect property values and the property tax base; fix reasonable dimensional requirements to which buildings, structures, and lots shall conform; prevent overcrowding of the land; advance uses of land in accordance with its character and suitability; provide property with access to adequate sunlight and clean air; aid in protection of groundwater and surface water; preserve water quality, shorelands, and wetlands; protect the beauty of landscapes; conserve flora and fauna habitats; preserve and enhance the county's rural characteristics; protect vegetative shore cover; promote safety and efficiency in the county's road transportation system; define the duties and powers of certain county officers and administrative bodies relative to the application, administration, and enforcement of the ordinance; and prescribe penalties in the form of civic forfeitures for violations of this ordinance and to facilitate enforcement of the provisions of this ordinance by injunctive relief.

Shoreland Protection Ordinance

The purpose of these shoreland regulations is to ensure the proper management and development of the shoreland of all navigable lakes, ponds, flowages, rivers, and streams in the unincorporated areas of Polk County. The intent of these regulations is to further the maintenance of safe and healthful conditions; prevent and control water pollution; protect spawning ground for fish and aquatic life; control building sites, placement of structures, and land uses; and preserve shore cover and natural beauty.

Private Sewage System Ordinance

The underlying principles of this ordinance are basic goals in environment, health, and safety accomplished by proper siting, design, installation, inspection, maintenance, and management of private on-site waste treatment systems and non-plumbing sanitary systems.

Subdivision Ordinance

The purpose of this ordinance is to regulate and control subdivision development within Polk County to promote public health, safety, general welfare, water quality, and aesthetics. This purpose can be accomplished by requiring an orderly layout and use of land, providing safe access to highways, roads and streets, facilitating adequate provision of water, sewer, transportation and surface drainage systems and parks, playgrounds, and other public facilities.

Lower St. Croix Riverway Ordinance

The purpose of this ordinance is to promote the public health, safety, and general welfare of the public by: reducing the adverse effects of overcrowding and poorly planned shoreline and

bluff area development; preventing soil erosion and pollution and contamination of surface water and groundwater; providing sufficient space on lots for sanitary facilities; minimizing flood damage; maintaining property values; and preserving and maintaining the exceptional scenic, cultural, and natural characteristics of the water and related land of the Lower St. Croix Riverway in a manner consistent with the National Wild and Scenic Rivers Act, the Federal Lower St. Croix River Act of 1972, and the Wisconsin Lower St. Croix River Act.

Floodplain Ordinance

This ordinance is intended to regulate floodplain development in order to minimize the potential for damage, the expenditure of public funds for flood control projects, and interruptions to businesses or other land uses.

Related Plans

The Long Trade Lake Management Plan is meant to direct the activities of the Round Trade Lake Improvement Association through the development of goals, objectives, and activities for a five year timeframe.

However, the planning process is not unique to Long Trade Lake and many organizations have plans with goals, objectives, and activities which are related to or align with those of the Long Trade Lake Management Plan.

Lake St. Croix Total Maximum Daily Load (TMDL) Implementation Plan, 2013

The St. Croix Lake TMDL plan calls for a 38% reduction in the human-caused phosphorus carried to the rivers and streams of the basin, and eventually entering the St. Croix River and Lake St. Croix. The TMDL sets goals for each watershed in the basin, based on land cover and land uses practices. It also sets a cap on the amount of phosphorus that can be discharged each year by wastewater treatment plants serving communities and industries in the St. Croix Basin. Polk County's phosphorus load is 160,976 pounds of phosphorus per year, which is the largest of any county in the basin.

Subwatershed	Acres in Basin	Loading (lbs/year)	TMDL Load Reduction
Apple	303,298	84,087	28,493
Clam	74,533	14,393	3,733
Trade	60,563	11,607	3,098
Trout	46,172	14,599	5,099
Willow	26,821	9,055	3,350
Wolf	69,725	21,339	7,310
Wood	24,301	5,897	1,676

The Squaw Lake, Lake Mallalieu, and Cedar Lake TMDL also exist within the boundary of the Lake St. Croix TMDL. The Squaw Lake and Cedar Lake TMDL boundary includes land in Polk and St. Croix County and the Lake Mallalieu TMDL includes land in St. Croix, Polk, and Barron County.

Agriculture and Farmland Preservation Plan, 2014

Under Chapter 91, a county must have a certified farmland preservation plan. The Polk County Agricultural and Farmland Preservation Plan identifies the county's goals and policies related to farmland preservation and agricultural development and identifies farmland preservation areas, agricultural enterprise areas, and areas for development within the next 15 years.

Polk County Aquatic Invasive Species Strategic Plan, 2015-2020

This plan provides an overview of aquatic invasive species in Polk County and includes an implementation plan to direct aquatic invasive species work.

Goal 1. Prevent the introduction, establishment, and spread of AIS in Polk County waterbodies
Goal 2. Control populations of aquatic invasive species
Goal 3. Monitor Polk County waterbodies for AIS and document results
Goal 4. Provide AIS information and education in Polk County and surrounding areas
Goal 5. Sustain the implementation of the plan

Polk County Comprehensive Plan, 2009-2029

The Polk County Comprehensive Plan presents a vision for the future of Polk County, with long-range goals, objectives, and policies for housing, transportation, utilities and community facilities, economic development, intergovernmental cooperation, land use, energy and sustainability, and agricultural, natural, and cultural resources.

St. Croix-Red Cedar Cooperative Weed Management Area Strategic Management Plan, 2017

The St. Croix Red Cedar (SCRC) Cooperative Weed Management Area (CWMA) is a partnership of local, state, tribal, and federal agencies, businesses, nonprofits, community organizations, and individuals. Formed in 2013, the group combats invasive species in Washburn, Barron, Burnett, Polk, and St. Croix Counties in northwestern Wisconsin. The SCRC CWMA fosters multi-generational awareness of invasive species and works to prevent and limit their intrusive impacts through partnerships.

Goal 1. Raise public awareness about invasive species through education and outreach efforts
Goal 2. Develop an early detection and management framework
Goal 3. Maintain and build organizational capacity

Polk County Outdoor Recreation Plan, 2014-2019

This plan assesses the existing recreation system in Polk County, identifies recreation needs based upon public input and recreation standards, sets forth goals and objectives to be used as guidelines in formulating recreation plans, and establishes recommendations for improving the recreation system over the next five years.

Polk County Forest Comprehensive Land Use Plan, 2006-2020

The County Forest Comprehensive Land Use Plan seeks to use sustainable forest management practices to protect forestry resources for present and future ecological and socioeconomic needs.

State of the St. Croix Basin, 2002

The Wisconsin Department of Natural Resources prepared the State of the St. Croix Basin in

March 2002. The report describes the status of land and water resources in the Wisconsin portion of the basin. Goals for the St. Croix Basin include maintaining and improving water and air quality; maintaining diverse, rich shoreland habitat; preserving large contiguous blocks of forestland; working with the agricultural community to minimize non-point runoff; and working with cities, villages, towns, and counties to help stem urban sprawl.

St. Croix National Scenic Riverway Management Plans

A Cooperative Management Plan was completed for the Lower St. Croix National Scenic Riverway in 2002 and a General Management Plan for the Upper St. Croix and Namekagon Rivers was completed in 1998. The plans describe the direction the National Park Service intends to follow to manage the upper and lower riverways for the next 15-20 years.

Lake Management Plans

Lake studies identify challenges and threats to a lake's health along with opportunities for improvement. These studies identify practices already being implemented by watershed residents to improve water quality and areas providing benefits to a lake's ecosystem. Additionally, these studies quantify practices or areas on the landscape, or within the lake, which have the potential to negatively impact the health of a lake and identify best management practices for improvement.

The end product of most lake studies is a lake management plan which identifies goals, objectives, and action items to either maintain or improve the health of a lake. These goals should be realistic based on inherent lake and watershed characteristics (lake size, depth, land use, etc.) and should align with the goals of watershed stakeholders. Lake management plans are designed to be working documents that are used to guide the actions that take place to manage a specific lake. Additionally, having an approved lake management plan allows lake organizations to apply for WDNR funding to implement improvement projects.

WDNR approved Comprehensive Lake Management Plans are usually updated every five years and exist for the following Polk County Lakes:
Pipe and North Pipe Lakes 2018-2023
Lotus Lake 2018-2022
Big Blake Lake 2016-2021
Long Lake 2017-2022
Loveless Lake 2016-2021
Bone Lake 2015-2020
Big Round Lake 2015-2020
Church Pine, Round, and Big Lakes 2013-2018
Apple River Flowage 2013-2018

Aquatic Plant Management Plans

In many cases an Aquatic Plant Management plan is required to apply for a permit to remove, add, or control aquatic plants. Generally, Aquatic Plant Management Plans describe the lake, present the aquatic plant management circumstances for a lake, and propose a set of goals and actions for managing aquatic plants in the lake.

WDNR approved Comprehensive Aquatic Plant Management Plans are updated every five years and exist for the following Polk County Lakes:
Long Lake 2017-2022
Apple River Flowage 2017-2022
Deer Lake 2017-2022
White Ash Lakes 2017-2022
Staples Lake 2016-2021
Balsam Lake 2015-2020
Church Pine, Round, and Big Lakes 2015-2020
Lake Wapogasset/Bear Trap Lake 2015-2020
Amery Lakes 2014-2019
Bone Lake 2013-2018

Priority Watershed Plans

Priority watershed plans have been completed for the Balsam Branch Watershed, Horse Creek Watershed, and the Osceola Creek Watershed. Priority watershed planning provided a funding mechanism in the 1980s to begin implementing water quality and habitat improvement activities in these watersheds. Through the Priority Watershed Planning program, the WDNR ranked watersheds for nonpoint source problems to identify high priority areas under the state's Nonpoint Source Pollution Abatement Program. Today the WDNR uses these watershed and waterbody rankings to direct funding decisions in the Targeted Runoff Management Grant Program and identify specific work tasks needed in the watershed.

Implementation Plan Development

Lake management plans help protect natural resource systems by encouraging partnerships between concerned citizens, lakeshore residents, watershed residents, agency staff, and diverse organizations. They identify concerns of importance and set realistic goals, objectives, and action items to address each concern. Additionally, lake management plans identify roles and responsibilities for meeting each goal and provide a timeline for implementation.

Lake management plans are living documents which are under constant review and adjustment depending on the condition of a lake, available funding, level of volunteer commitments, and the needs of lake stakeholders.

The vision statement, guiding principles, and lake management plan goals presented below were created through collaborative efforts using current and past water quality data and a series of four meetings by the Round Trade Lake Improvement Association Plan Committee. Key study details were presented to the Round Trade Lake Improvement Association over the course of the project. Additionally, the draft vision statement, guiding principles, and lake management plan goals were presented and opened up for comment at the 2019 Association Annual Meeting.

The draft plan was posted on the Polk County Land and Water Resources Department website and opened for a 30 day public comment period ending on December 16th, 2019. A notice of public comment was published in the Inter-County Leader on November 6th, 2019. No public comments were received. The plan was approved by the Round Trade Lake improvement Association on Saturday, September 21st, 2019 and by the Wisconsin Department of Natural Resources on ***.

Implementation Plan

Vision: an overall statement for what you want Long Trade Lake to look like

Long Trade Lake will take a proactive approach to ensure a quiet lake with a diversity of habitats that support fishing, wildlife, recreation, and quality of life

Goal 1. Improve water quality to reduce nuisance algae blooms

Goal 2. Protect, maintain, and enhance fish and wildlife habitat while enhancing the natural scenic beauty of Long Trade Lake

Goal 3. Provide information and education with the intent of changing stakeholder behaviors to protect Long Trade Lake

Goal 4. Sustain the implementation of the plan by evaluating the progress of lake management efforts

Goal 5. Implement the goals of the Long Trade Lake Aquatic Plant Management Plan

Goal 1. Improve water quality to reduce nuisance algae blooms

A. Engage the agricultural community as a partner in reducing watershed runoff
    1. Meet once a year with the Polk County Land and Water Resources Department to identify recommended actions and discuss options to ensure the activities below are implemented
    2. Meet with cooperating landowners to address gully erosion issues around the lake
    3. Incentivize best management practices such as cover crops, no till, and nutrient management
    4. Incentivize the adoption of nutrient management plans on the agricultural lands within the watershed
    5. Invite the agricultural community to Association meetings to share protection efforts led by the association
    6. Share learning events, provide incentives for BMPs, and maintain a working relationship with the agricultural community where possible
    7. Recognize agricultural producers who have taken steps to reduce watershed runoff

B. Use the Healthy Lakes program to install best practices (native plantings, diversion, rock infiltration, and rain gardens) to reduce phosphorus loads from the residential land uses around Long Trade Lake
    1. Provide information to homeowners regarding each practice and how it is related to improved water quality and reduced algae growth
    2. Identify homeowners interested in installing best practices by using the 2016 shoreline inventory and slope map to target efforts
    3. Apply for and implement a Healthy Lakes Grant application
    4. Highlight best practices as demonstration projects
    5. Install WDNR signs at Healthy Lakes project sites

C. Develop a working relationship with the Villages of Luck and Frederic as a first step towards determining and addressing the impacts of the waste water treatment plant on water quality

D. Identify areas of stream bank erosion and determine if landowners are willing to take steps to address problem sites

E. Reduce the release of phosphorus from the sediments of Long Trade Lake
    1. Ensure residents and visitors are aware of the slow-no-wake requirements within 100 feet of the shoreline
    2. Work with Polk County to install landing signage related to power loading

F. Upgrade non-compliant septic systems by engaging and educating shoreline property owners
    1. Implement a septic study to ensure that all septic systems are in code compliance
    2. Cost share the replacement of failing septic systems

Goal 2. Protect, maintain, and enhance fish and wildlife habitat while enhancing the natural scenic beauty of Long Trade Lake

A. Maintain and enhance desirable populations of fish by installing habitat improvement projects
    1. Set up a meeting with the fisheries biologist to determine locations for fish sticks and other habitat improvements
    2. Identify property owners interested in installing fish sticks and other habitat improvements
    3. Prepare a healthy lakes grant application to fund the installation of fish sticks and other habitat improvements such as shoreline restoration
    4. Meet with the fisheries biologist to determine if natural reproduction is occurring and determine options for stocking

B. Maintain and expand habitat for fish and wildlife
    1. Increase native plantings on Long Trade Lake, see Goal 1B
    2. Identify undeveloped, highly erodible, and/or ecologically sensitive land
    3. Promote slow-no-wake requirements, see Goal 1E1
    4. Prevent the introduction and spread of invasive species, see Goal 5

C. Voice concerns related to CAFO's and related new livestock operations in the Long Trade Lake Watershed
    1. Attend Town Board and County Board meetings to ensure the concerns of the Association are heard
    2. Seek professional council regarding ordinance development to limit nuisance impacts of CAFO's, including nutrient runoff and nuisance odor

D. Engage shoreline property owners in improving fish and wildlife habitat by developing and delivering educational messages including:
    1. Leaving fallen trees in the lake
    2. Preventing erosion on the lakeshore with best management practices
    3. Establishing no-mow areas on the lakeshore
    4. Native plantings benefit fish, wildlife, and pollinators

E. Engage shoreline property owners in creating a lake lifestyle that promotes quality of life by developing and delivering educational messages including:
    1. Observing slow-no-wake near shore
    2. Purchasing light shields to reduce light pollution
    3. Observing quiet hours early in the morning and late in the evening
    4. Promoting development that blends in with the natural landscape

Goal 3. Provide information and education with the intent of changing stakeholder behaviors to protect Long Trade Lake

A. Use a variety of methods to convey educational information including:

    Newsletters or direct mailings
    Social media (email, Facebook, website)
    Guest speakers
    Events for kids
    Workshops
    Demonstration/tours
    Welcome packets for new homeowners

B. Choose a topic of focus for each year based on priority activities of this plan

C. Develop and deliver an educational message each year

Goal 4. Sustain the implementation of the plan by evaluating the progress of lake management efforts

A. Design and implement a plan to ensure that goals are met
    1. Form committees to develop an action plan for each goal of this plan
    2. Brainstorm and find ways to increase volunteer commitment
    3. Document actions completed, in progress, or not completed
    4. Determine steps to move towards completing goals
    5. Identify current and future barriers to implementing the plan
    6. Report progress to Association members
    7. Reach out to partner groups that have a stake in Long Trade Lake: Town of Laketown, Town of Luck, Town of West Sweden, Village of Luck, Village of Frederic, St. Croix River Association, National Park Service, etc.
    8. Seek funding to implement the plan

B. Continue current data collection efforts to evaluate progress
    1. Ensure that a volunteer is in place each year to collect phosphorus, chlorophyll, and secchi data using the WDNR CLMN protocol
    2. Ensure that a volunteer is in place each year to monitor aquatic invasive species using the WDNR AIS CLMN protocol

C. Expand data collection efforts depending on needs
    1. Repeat the 2016-2018 water quality study in five to ten years
    2. Implement the WAV protocol to collect phosphorus data on inlets and outlets
    3. Determine residential and agricultural soil test phosphorus values
    4. Collect algae and toxin data
    5. Determine nutrient inputs from septic systems and holding tanks using tracers, see Goal 1F
    6. Determine areas of high internal loading in the shallow areas of the lake (cores)
    7. Determine groundwater phosphorus contributions to the lake using stable isotopes
    8. Determine historical water quality conditions (decadal sediment core)

D. Evaluate the costs, benefits, and feasibility of forming a District
    1. Form a committee to gather information on becoming a Lake District
    2. Present information to residents regarding the pros and cons of becoming a Lake District
    3. Draft Lake District boundaries
    4. Gather membership support for forming a Lake District

Goal 5. Implement the goals of the Long Trade Lake Aquatic Plant Management Plan

Goal 1. Promote and support aquatic plant management strategies that will control the spread of aquatic invasive species without negatively impacting native vegetation in Long Trade Lake

Goal 2. Reduce the threats that existing AIS will leave the lake, that new aquatic invasive species will be introduced into the lake, and that new AIS introduced to the lake will go undetected in the lake

Goal 3. Promote and support nearshore and riparian best management practices that will improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Long Trade Lake

Goal 4. Develop a Comprehensive Lake Management Plan for Long Trade Lake

Goal 5. Complete appropriate and on-going tracking, monitoring, and management strategy modification to allow for thorough evaluation of management actions, and determinations that those management actions are on target, on track, on schedule, on budget, and within expected parameters

Goal 6. Encourage and engage lake residents and visitors to be active lake stewards

Goal 7. Implement the Long Trade Lake Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement

Acronyms used for partners in the following implementation table
WDNR = Wisconsin Department of Natural Resources
LWRD = Polk County Land and Water Resources Department
RTLIA = Round Trade Lake Improvement Association
CON = Consultant

Acronyms used for funding sources in the following implementation table
LPL = WDNR Lake Planning Grant Program
LPR = WDNR Lake Protection Grant Program
LPR-HL = WDNR Healthy Lakes Grant Program
AEPP = WDNR Aquatic Invasive Species Grant Program

	Priority	$ Estimate	Volunteer hours	Partners with RTLIA	Funding sources
Goal 1. Improve water quality to reduce nuisance algae blooms					
A. Engage the agricultural community as a partner in reducing watershed runoff	**High**				**LPR**
1. Meet once a year with the Polk County LWRD to identify recommended actions and discuss options to ensure the activities below are implemented				LWRD	
2. Meet with cooperating landowners to address gully erosion issues around the lake				LWRD	
3. Incentivize best management practices such as cover crops, no till, and nutrient management					
4. Incentivize the adoption of nutrient management plans on the agricultural lands within the watershed					
5. Invite the agricultural community to Association meetings to share protection efforts led by the association					
6. Share learning events, provide incentives for BMPs, and maintain a working relationship with the agriculture community where possible					
7. Recognize agricultural producers who have taken steps to reduce watershed runoff					
B. Use the Healthy Lakes program to install best practices (native plantings, diversion, rock infiltration, and rain gardens) to reduce phosphorus loads from the residential land uses around Long Trade Lake	**Medium**	**Grant: $1,000/ HL project; 33% match**	**100-200 hrs/yr**		**LPR-HL**
1. *Provide information to homeowners regarding each practice and how it is related to improved water quality and reduced algae growth*					
2. *Identify homeowners interested in installing best practices by using the 2016 shoreline inventory to target efforts*					
3. Apply for and implement a Healthy Lakes Grant application					
4. Highlight best practices as demonstration projects					
5. Install WDNR signs at Healthy Lakes project sites					
C. Develop a working relationship with the Villages of Luck and Frederic as a first step towards determining and addressing the impacts of the waste water treatment plant on water quality	**Low**				
D. Identify areas of stream bank erosion and determine if landowners are willing to take steps to address problem sites	**Low**				
E. Reduce the release of phosphorus from the sediments of Long Trade Lake	**High**				
1. Ensure residents and visitors are aware of the slow-no-wake requirements within 100 feet of the shoreline					
2. Work with Polk County to install landing signage related to power loading					

F. Upgrade non-compliant septic systems by engaging and educating shoreline property owners	**High**				
1. Implement a septic study to ensure that all septic systems are in code compliance				LWRD, CON	
2. Cost share the replacement of failing septic systems					

	Priority	**$ Estimate**	**Volunteer hours**	**Partners with RTLIA**	**Funding sources**
Goal 2. Protect, maintain, and enhance fish and wildlife habitat while enhancing the natural scenic beauty of Long Trade Lake					
A. Maintain and enhance desirable populations of fish by installing habitat improvement projects	**High**				**LPR-HL**
1. Set up a meeting with the fisheries biologist to determine locations for fish sticks and other habitat improvements			3 hrs	WDNR	
2. Identify property owners interested in installing fish sticks and other habitat improvements			3 hrs		
3. Prepare a healthy lakes grant application to fund the installation of fish sticks and other habitat improvements such as shoreline restoration			40 hrs		
4. Meet with the fisheries biologist to determine if natural reproduction is occurring and determine options for stocking			3 hrs	WDNR	
B. Maintain and expand habitat for fish and wildlife	**Medium**				
1. Increase native plantings on Long Trade Lake, see Goal 1B					LPR-HL
2. Identify undeveloped, highly erodible, and/or ecologically sensitive land				CON, LWRD	
3. Promote slow-no-wake requirements, see Goal 1E1					
4. Prevent the introduction and spread of invasive species (see APM goal)				WDNR, LWRD	AEPP
C. Voice concerns related to CAFO's and related new livestock operations in the Long Trade Lake Watershed	**High**		**50-100 hrs/yr**		
1. Attend Town Board and County Board meetings to ensure the concerns of the Association are heard					
2. Seek professional council regarding ordinance development to limit nuisance impacts of CAFO's, including nutrient runoff and nuisance odor					
D. Engage shoreline property owners in improving fish and wildlife habitat by developing and delivering educational messages including:	**Medium**		**10-50 hrs/yr**		
1. Leaving fallen trees in the lake					

2. Preventing erosion on the lakeshore with best management practices					
3. Establishing no-mow areas on the lakeshore					
4. Native plantings benefit fish, wildlife, and pollinators					
E. Engage shoreline property owners in creating a lake lifestyle that promotes quality of life by developing and delivering educational messages including:	**Medium**		**10-50 hrs/yr**		
1. Observing slow-no-wake near shore					
2. Purchasing light shields to reduce light pollution					
3. Observing quiet hours early in the morning and late in the evening					
4. Promoting development that blends in with the natural landscape					

	Priority	**$ Estimate**	**Volunteer hours**	**Partners with RTLIA**	**Funding sources**
Goal 3. Provide information and education with the intent of changing stakeholder behaviors to protect Long Trade Lake	**High**		**10-50 hrs/yr**		
A. Use a variety of methods to convey educational information including: Newsletters, direct mailings, social media (email, Facebook, website),guest speakers, events for kids, workshops, demonstration/tours, welcome packets for new homeowners					
B. Choose a topic of focus for each year based on priority activities of this plan					
C. Develop and deliver an educational message each year					

	Priority	**$ Estimate**	**Volunteer hours**	**Partners with RTLIA**	**Funding sources**
Goal 4. Sustain the implementation of the plan by evaluating the progress of lake management efforts					
A. Design and implement a plan to ensure that goals are met	**High**		**50-100 hrs/yr**		
1. Design and implement a plan to ensure that goals are met					
2. Brainstorm and find ways to increase volunteer commitment					
3. Document actions completed, in progress, or not completed					
4. Determine steps to move towards completing goals					
5. Identify current and future barriers to implementing the plan					
6. Report progress to association members					

7. Reach out to partner groups that have a stake in Long Trade Lake: Town of Laketown, Town of Luck, Town of West Sweden, Village of Luck, Village of Frederic, St. Croix River Association, National Park Service, etc.					
8. Seek funding to implement the plan					
B. Continue current data collection efforts to evaluate progress	**High**				
1. Ensure that a volunteer is in place each year to collect phosphorus, chlorophyll, and secchi data using the WDNR CLMN protocol			40 hrs/yr	WDNR	
2. Ensure that a volunteer is in place each year to monitor aquatic invasive species using the WDNR AIS CLMN protocol			2 hrs/mo	WDNR, LWRD	
C. Expand data collection efforts depending on needs	**Medium**			**CON, LWRD**	**LPL**
1. Repeat the 2016-2018 water quality study in five to ten years		Grant: $25,000; 33% match			
2. Implement the WAV protocol to collect phosphorus data on inlets and outlets			2 hrs/mo	WDNR	
3. Determine residential and agricultural soil test phosphorus values		$15-30/sample			
4. Collect algae and toxin data		Algae: $65 + SH	2 hrs/mo		
5. Determine nutrient inputs from septic systems and holding tanks using tracers, see Goal 1F		$9,000			
6. Determine areas of high internal loading in the shallow areas of the lake (cores)					
7. Determine groundwater phosphorus contributions to the lake using stable isotopes		$15,000			
8. Determine historical water quality conditions (decadal sediment core)		$15,000			
D. Evaluate the costs, benefits, and feasibility of forming a District	**Low**		**100+**		
1. Form a committee to gather information on becoming a Lake District					
2. Present information to residents regarding the pros and cons of becoming a Lake District					
3. Draft Lake District boundaries					
4. Gather membership support for forming a Lake District					

Goal 5. Implement the goals of the Long Trade Lake Aquatic Plant Management Plan					
See Aquatic Plant Management Plan					

Long Trade Lake Management Plan

Lake Level and Precipitation

Appendix A:

Date	Lake level	Elevation	Precipitation
5/7/2016	4.94	971.87	0
5/8/2016	4.92	971.85	0
5/9/2016	4.92	971.85	0
5/10/2016	4.92	971.85	0.04
5/11/2016	4.92	971.85	0.1
5/12/2016	4.93	971.86	0.12
5/13/2016	4.94	971.87	0.04
5/14/2016	4.93	971.86	0
5/15/2016	4.92	971.85	0
5/16/2016	4.91	971.84	0
5/17/2016	4.91	971.84	0
5/18/2016	4.9	971.83	0
5/19/2016	4.9	971.83	0
5/20/2016	4.9	971.83	0
5/21/2016	4.9	971.83	0
5/22/2016	4.88	971.81	0
5/23/2016	4.86	971.79	0
5/24/2016	4.91	971.84	0.54
5/25/2016	4.91	971.84	0
5/26/2016	4.98	971.91	0.76
5/27/2016	4.95	971.88	0
5/28/2016	4.93	971.86	0.17
5/29/2016	4.93	971.86	0.09
5/30/2016	4.92	971.85	0
5/31/2016	4.9	971.83	0
6/1/2016	4.9	971.83	0.05
6/2/2016	4.89	971.82	0
6/3/2016	4.89	971.82	0
6/4/2016	4.93	971.86	0.33
6/5/2016	4.96	971.89	0.23
6/6/2016	4.93	971.86	0.03
6/7/2016	4.92	971.85	0.09
6/8/2016	4.89	971.82	0
6/9/2016	4.89	971.82	0
6/10/2016	4.88	971.81	0
6/11/2016	4.9	971.83	0.04
6/12/2016	4.88	971.81	0
6/13/2016	4.86	971.79	0.04
6/14/2016	4.86	971.79	0
6/15/2016	4.9	971.83	0.72
6/16/2016	4.91	971.84	0.03
6/17/2016	4.89	971.82	0
6/18/2016	4.88	971.81	0
6/19/2016	4.87	971.8	0
6/20/2016	4.86	971.79	0
6/21/2016	4.84	971.77	0
6/22/2016	4.84	971.77	0
6/23/2016	4.88	971.81	0.73
6/24/2016	4.87	971.8	0
6/25/2016	4.86	971.79	0
6/26/2016	4.96	971.89	1.22
6/27/2016	4.93	971.86	0
6/28/2016	4.9	971.83	0
6/29/2016	4.88	971.81	0
6/30/2016	4.88	971.81	0
7/1/2016	4.86	971.79	0.14
7/2/2016	4.86	971.79	0
7/3/2016	4.86	971.79	0
7/4/2016	4.84	971.77	0
7/5/2016	4.84	971.77	0
7/6/2016	4.84	971.77	0.15
7/7/2016	4.86	971.79	0.05
7/8/2016	4.84	971.77	0.01
7/9/2016	4.84	971.77	0.02
7/10/2016	4.85	971.78	0.25
7/11/2016	4.85	971.78	0.12
7/12/2016	5.2	972.13	3.33
7/13/2016	5.46	972.39	0
7/14/2016	5.28	972.21	0
7/15/2016	5.06	971.99	0.28
7/16/2016	4.96	971.89	0.11
7/17/2016	4.94	971.87	0
7/18/2016	4.98	971.91	0
7/19/2016	4.98	971.91	0
7/20/2016	4.98	971.91	0
7/21/2016	5.02	971.95	0.44
7/22/2016	5	971.93	0.01
7/23/2016	4.94	971.87	0
7/24/2016	4.98	971.91	1.24
7/25/2016	5	971.93	0
7/26/2016	4.94	971.87	0
7/27/2016	4.9	971.83	0
7/28/2016	4.97	971.9	0.41
7/29/2016	5	971.93	0
7/30/2016	4.94	971.87	0
7/31/2016	4.91	971.84	0
8/1/2016	4.92	971.85	0
8/2/2016	4.92	971.85	0
8/3/2016	4.94	971.87	0.09
8/4/2016	4.98	971.91	0.06

8/5/2016	4.96	971.89	0.13
8/6/2016	4.98	971.91	0
8/7/2016	4.96	971.89	0
8/8/2016	4.96	971.89	0
8/9/2016	4.95	971.88	0
8/10/2016	4.94	971.87	0
8/11/2016	5.08	972.01	1.81
8/12/2016	5.12	972.05	0
8/13/2016	4.99	971.92	0.05
8/14/2016	4.94	971.87	0
8/15/2016	4.92	971.85	0
8/16/2016	4.94	971.87	0.02
8/17/2016	4.96	971.89	0.45
8/18/2016	4.96	971.89	0
8/19/2016	5.02	971.95	0.74
8/20/2016	5	971.93	0.16
8/21/2016	4.95	971.88	0.22
8/22/2016	4.92	971.85	0
8/23/2016	4.9	971.83	0
8/24/2016	4.94	971.87	0.2
8/25/2016	4.92	971.85	0
8/26/2016	4.92	971.85	0
8/27/2016	4.92	971.85	0
8/28/2016	4.94	971.87	0.24
8/29/2016	4.94	971.87	0
8/30/2016	5.04	971.97	1.69
8/31/2016	5	971.93	0.01
9/1/2016	4.96	971.89	0
9/2/2016	4.91	971.84	0
9/3/2016	4.88	971.81	0
9/4/2016	4.88	971.81	0
9/5/2016	4.94	971.87	0.59
9/6/2016	5.2	972.13	1.43
9/7/2016	5.46	972.39	0.17
9/8/2016	5.4	972.33	0
9/9/2016	5.08	972.01	0
9/10/2016	5	971.93	0.05
9/11/2016	4.94	971.87	0
9/12/2016	4.9	971.83	0
9/13/2016	4.92	971.85	0
9/14/2016	4.92	971.85	0
9/15/2016	4.9	971.83	0
9/16/2016	4.96	971.89	0.31
9/17/2016	4.96	971.89	0.16
9/18/2016	4.95	971.88	0
9/19/2016	4.94	971.87	0

9/20/2016	4.94	971.87	0.08
9/21/2016	4.92	971.85	0
9/22/2016	4.96	971.89	0.44
9/23/2016	4.97	971.9	0
9/24/2016	4.94	971.87	0.04
9/25/2016	4.94	971.87	0.07
9/26/2016	4.94	971.87	0.3
9/27/2016	4.93	971.86	0
9/28/2016	4.95	971.88	0.23
9/29/2016	4.94	971.87	0
9/30/2016	4.94	971.87	0
10/1/2016	4.93	971.86	0
10/2/2016	4.92	971.85	0
10/3/2016	4.92	971.85	0
10/4/2016	4.9	971.83	0
10/5/2016	4.91	971.84	0.3
10/6/2016	4.92	971.85	0
10/7/2016	4.94	971.87	1.43
10/8/2016	4.92	971.85	0
10/9/2016	5.09	972.02	0
10/10/2016	4.98	971.91	0
10/11/2016	4.95	971.88	0
10/12/2016			0.05
10/13/2016	4.92	971.85	0
10/14/2016			0
10/15/2016			0
10/16/2016			0
10/17/2016			1.63
10/18/2016			0.21
10/19/2016			0
10/20/2016			0
			25.29
			167 days

Date	Lake level	Elevation	Precipitation
4/10/2017			0.2
4/11/2017			snow
4/12/2017			0
4/13/2017			0.18
4/14/2017			0
4/15/2017			0.08
4/16/2017			0.57
4/17/2017			0
4/18/2017			0.05
4/19/2017			0.11
4/20/2017			0.55
4/21/2017			0.04
4/22/2017			0
4/23/2017			0
4/24/2017			0
4/25/2017			0
4/26/2017			0.72
4/27/2017			0.22
4/28/2017			0
4/29/2017			0
4/30/2017			0
5/1/2017			0.99
5/2/2017			0.32
5/3/2017			0
5/4/2017			0
5/5/2017			0
5/6/2017	4.48	971.96	0
5/7/2017	4.46	971.94	0
5/8/2017	4.4	971.88	0
5/9/2017	4.38	971.86	0.03
5/10/2017	4.32	971.8	0
5/11/2017	4.31	971.79	0
5/12/2017	4.3	971.78	0
5/13/2017	4.3	971.78	0
5/14/2017	4.29	971.77	0
5/15/2017	4.28	971.76	0
5/16/2017	4.34	971.82	0.55
5/17/2017	4.44	971.92	0.38
5/18/2017	4.62	972.1	1.1
5/19/2017	4.78	972.26	0.02
5/20/2017	4.62	972.1	0
5/21/2017	4.68	972.16	0.95
5/22/2017	4.78	972.26	0.1
5/23/2017	4.66	972.14	0.02
5/24/2017	4.58	972.06	0
5/25/2017	4.54	972.02	0
5/26/2017	4.5	971.98	0.04
5/27/2017	4.48	971.96	0
5/28/2017	4.46	971.94	0
5/29/2017	4.42	971.9	0.06
5/30/2017	4.42	971.9	0.11
5/31/2017	4.4	971.88	0.02
6/1/2017	4.38	971.86	0
6/2/2017	4.36	971.84	0
6/3/2017	4.34	971.82	0
6/4/2017	4.34	971.82	0
6/5/2017	4.34	971.82	0
6/6/2017	4.32	971.8	0
6/7/2017	4.3	971.78	0
6/8/2017	4.3	971.78	0.06
6/9/2017	4.3	971.78	0
6/10/2017	4.28	971.76	0
6/11/2017	4.28	971.76	0
6/12/2017	4.38	971.86	0.69
6/13/2017	4.37	971.85	0.02
6/14/2017	4.38	971.86	0.35
6/15/2017	4.45	971.93	0
6/16/2017	4.4	971.88	0
6/17/2017	4.36	971.84	0.01
6/18/2017	4.36	971.84	0.29
6/19/2017	4.37	971.85	0.04
6/20/2017	4.36	971.84	0.04
6/21/2017	4.36	971.84	0
6/22/2017	4.36	971.84	0.02
6/23/2017	4.36	971.84	0.13
6/24/2017	4.33	971.81	0.02
6/25/2017	4.34	971.82	0.02
6/26/2017	4.32	971.8	0.04
6/27/2017	4.31	971.79	0.09
6/28/2017	4.32	971.8	0.08
6/29/2017	4.36	971.84	0.38
6/30/2017	4.38	971.86	0.65
7/1/2017	4.44	971.92	0.75
7/2/2017	4.42	971.9	0.01
7/3/2017	4.46	971.94	0
7/4/2017	4.32	971.8	0
7/5/2017	4.3	971.78	0
7/6/2017	4.4	971.88	1.36
7/7/2017	4.65	972.13	0.03
7/8/2017	4.58	972.06	0

7/9/2017	4.46	971.94	0.11
7/10/2017	4.39	971.87	0.16
7/11/2017	4.35	971.83	0
7/12/2017	4.6	972.08	2.13
7/13/2017	4.86	972.34	0.02
7/14/2017	4.64	972.12	0
7/15/2017	4.45	971.93	0
7/16/2017	4.42	971.9	0
7/17/2017	4.34	971.82	0
7/18/2017	4.41	971.89	0.89
7/19/2017	4.46	971.94	0.26
7/20/2017	4.41	971.89	0
7/21/2017	4.38	971.86	0
7/22/2017	4.36	971.84	0.12
7/23/2017	4.36	971.84	0
7/24/2017	4.35	971.83	0
7/25/2017	4.32	971.8	0.06
7/26/2017	4.32	971.8	0.06
7/27/2017	4.34	971.82	0
7/28/2017	4.32	971.8	0
7/29/2017	4.3	971.78	0
7/30/2017	4.3	971.78	0
7/31/2017	4.27	971.75	0
8/1/2017	4.25	971.73	0
8/2/2017	4.26	971.74	0
8/3/2017	4.3	971.78	0.77
8/4/2017	4.3	971.78	0.28
8/5/2017	4.3	971.78	0.07
8/6/2017	4.3	971.78	0
8/7/2017	4.26	971.74	0
8/8/2017	4.27	971.75	0
8/9/2017	4.24	971.72	0
8/10/2017	4.27	971.75	0.43
8/11/2017	4.29	971.77	0
8/12/2017	4.28	971.76	0
8/13/2017	4.25	971.73	0
8/14/2017	4.28	971.76	0.42
8/15/2017	4.3	971.78	0.02
8/16/2017	4.27	971.75	0
8/17/2017	4.34	971.82	0.69
8/18/2017	4.39	971.87	0.08
8/19/2017	4.38	971.86	0
8/20/2017	4.28	971.76	0
8/21/2017	4.29	971.77	0
8/22/2017	4.26	971.74	0.02
8/23/2017	4.27	971.75	0

8/24/2017	4.28	971.76	0.23
8/25/2017	4.25	971.73	0
8/26/2017	4.29	971.77	0.62
8/27/2017	4.35	971.83	0.36
8/28/2017	4.35	971.83	0.04
8/29/2017	4.31	971.79	0
8/30/2017	4.28	971.76	0
8/31/2017	4.28	971.76	0
9/1/2017	4.26	971.74	0
9/2/2017	4.25	971.73	0.06
9/3/2017	4.27	971.75	0
9/4/2017	4.27	971.75	0
9/5/2017	4.26	971.74	0.16
9/6/2017	4.26	971.74	0.04
9/7/2017	4.26	971.74	0.06
9/8/2017	4.27	971.75	0.01
9/9/2017	4.25	971.73	0
9/10/2017	4.25	971.73	0
9/11/2017	4.26	971.74	0.01
9/12/2017	4.28	971.76	0
9/13/2017	4.26	971.74	0
9/14/2017	4.26	971.74	0
9/15/2017	4.25	971.73	0
9/16/2017	4.23	971.71	0
9/17/2017	4.23	971.71	0
9/18/2017	4.23	971.71	0
9/19/2017	4.23	971.71	0.05
9/20/2017	4.26	971.74	0.39
9/21/2017	4.26	971.74	0.01
9/22/2017	4.26	971.74	0.22
9/23/2017	4.27	971.75	0
9/24/2017	4.25	971.73	0
9/25/2017	4.27	971.75	0.39
9/26/2017	4.28	971.76	0.2
9/27/2017	4.29	971.77	0.03
9/28/2017	4.26	971.74	0
9/29/2017	4.27	971.75	0
9/30/2017	4.25	971.73	0
10/1/2017	4.26	971.74	0.04
10/2/2017	4.25	971.73	0.29
10/3/2017	4.59	972.07	3.37
10/4/2017	4.66	972.14	0.05
10/5/2017			0
10/6/2017			0.02
10/7/2017			0.29
10/8/2017			0

10/9/2017			0
10/10/2017			0.01
10/11/2017			0
10/12/2017			0
10/13/2017			0
10/14/2017			0
10/15/2017			0.42
10/16/2017			0
10/17/2017			0
10/18/2017			0.16
10/19/2017			0.08
10/20/2017			0
10/21/2017			0
10/22/2017			0
10/23/2017			0
10/24/2017			0
10/25/2017			0
10/26/2017			0
10/27/2017			0.08
10/28/2017			0.12
10/29/2017			0
10/30/2017			0.03
10/31/2017			0
			26.92
			205 days

Date	Lake level	Elevation	Precipitation
4/30/2018			0.05
5/1/2018			0.01
5/2/2018			0
5/3/2018	4.32	971.97	0
5/4/2018	4.32	971.97	0
5/5/2018	4.32	971.97	0
5/6/2018	4.28	971.93	0
5/7/2018	4.22	971.87	0
5/8/2018	4.22	971.87	0
5/9/2018	4.24	971.89	0.04
5/10/2018	4.24	971.89	0.07
5/11/2018	4.24	971.89	0
5/12/2018	4.22	971.87	0
5/13/2018	4.19	971.84	0
5/14/2018	4.18	971.83	0
5/15/2018	4.18	971.83	0
5/16/2018	4.16	971.81	0
5/17/2018	4.16	971.81	0
5/18/2018	4.14	971.79	0
5/19/2018	4.14	971.79	0
5/20/2018	4.14	971.79	0
5/21/2018	4.14	971.79	0
5/22/2018	4.14	971.79	0
5/23/2018	4.14	971.79	0
5/24/2018	4.14	971.79	0
5/25/2018	4.14	971.79	0.03
5/26/2018	4.14	971.79	0
5/27/2018	4.14	971.79	0
5/28/2018	4.14	971.79	0.01
5/29/2018	4.16	971.81	0.72
5/30/2018	4.2	971.85	0.16
5/31/2018	4.36	972.01	0.63
6/1/2018	4.3	971.95	0
6/2/2018	4.24	971.89	0.34
6/3/2018	4.28	971.93	0.66
6/4/2018	4.25	971.9	0
6/5/2018	4.2	971.85	0
6/6/2018	4.22	971.87	0.49
6/7/2018	4.22	971.87	0
6/8/2018	4.2	971.85	0
6/9/2018	4.18	971.83	0
6/10/2018	4.18	971.83	0
6/11/2018	4.18	971.83	0.09
6/12/2018	4.18	971.83	0
6/13/2018	4.18	971.83	0
6/14/2018	4.16	971.81	0
6/15/2018	4.14	971.79	0
6/16/2018	4.14	971.79	0
6/17/2018	4.24	971.89	1.23
6/18/2018	4.36	972.01	0.64
6/19/2018	4.42	972.07	0
6/20/2018	4.3	971.95	0.02
6/21/2018	4.24	971.89	0
6/22/2018	4.2	971.85	0
6/23/2018	4.2	971.85	0
6/24/2018	4.18	971.83	0
6/25/2018	4.18	971.83	0
6/26/2018	4.34	971.99	1.98
6/27/2018	4.52	972.17	0.02
6/28/2018	4.36	972.01	0
6/29/2018	4.3	971.95	0
6/30/2018	4.24	971.89	0
7/1/2018	4.22	971.87	0
7/2/2018	4.42	972.07	0.89
7/3/2018	4.36	972.01	0.01
7/4/2018	4.28	971.93	0.01
7/5/2018	4.24	971.89	0.28
7/6/2018	4.22	971.87	0
7/7/2018	4.2	971.85	0
7/8/2018	4.2	971.85	0
7/9/2018	4.2	971.85	0.06
7/10/2018	4.18	971.83	0
7/11/2018	4.16	971.81	0
7/12/2018	4.5	972.15	3.19
7/13/2018	4.86	972.51	1.05
7/14/2018	5.22	972.87	0.01
7/15/2018	4.84	972.49	0
7/16/2018	4.42	972.07	0
7/17/2018	4.38	972.03	0
7/18/2018	4.32	971.97	0
7/19/2018	4.28	971.93	0
7/20/2018	4.28	971.93	0.08
7/21/2018	4.26	971.91	0.03
7/22/2018	4.24	971.89	0
7/23/2018	4.22	971.87	0
7/24/2018	4.22	971.87	0
7/25/2018	4.22	971.87	0.01
7/26/2018	4.2	971.85	0.09
7/27/2018	4.22	971.87	0.18
7/28/2018	4.2	971.85	0.01

7/29/2018	4.2	971.85	0
7/30/2018	4.2	971.85	0
7/31/2018	4.2	971.85	0
8/1/2018	4.18	971.83	0.08
8/2/2018	4.18	971.83	0
8/3/2018	4.18	971.83	0
8/4/2018	4.2	971.85	0.55
8/5/2018	4.22	971.87	0
8/6/2018	4.2	971.85	0
8/7/2018	4.18	971.83	0
8/8/2018	4.18	971.83	0.02
8/9/2018	4.18	971.83	0
8/10/2018	4.22	971.87	0.01
8/11/2018	4.2	971.85	0
8/12/2018	4.16	971.81	0
8/13/2018	4.16	971.81	0
8/14/2018	4.16	971.81	0
8/15/2018	4.18	971.83	0.83
8/16/2018	4.18	971.83	0
8/17/2018	4.14	971.79	0
8/18/2018	4.12	971.77	0
8/19/2018	4.14	971.79	0
8/20/2018	4.14	971.79	0.02
8/21/2018	4.14	971.79	0.03
8/22/2018	4.14	971.79	0.01
8/23/2018	4.14	971.79	0
8/24/2018	4.18	971.83	0.26
8/25/2018	4.26	971.91	0.3
8/26/2018	4.3	971.95	0.5
8/27/2018	4.36	972.01	0.01
8/28/2018	4.36	972.01	1.22
8/29/2018	4.32	971.97	0.02
8/30/2018	4.2	971.85	0
8/31/2018	4.16	971.81	0
9/1/2018	4.16	971.81	0.02
9/2/2018	4.18	971.83	0
9/3/2018	4.2	971.85	0.08
9/4/2018	4.2	971.85	0.02
9/5/2018	4.36	972.01	1.27
9/6/2018	4.28	971.93	0.02
9/7/2018	4.26	971.91	0
9/8/2018	4.2	971.85	0
9/9/2018	4.18	971.83	0
9/10/2018	4.18	971.83	0
9/11/2018	4.18	971.83	0
9/12/2018	4.18	971.83	0

9/13/2018	4.18	971.83	0
9/14/2018	4.18	971.83	0
9/15/2018	4.18	971.83	0
9/16/2018	4.18	971.83	0.19
9/17/2018	4.16	971.81	0
9/18/2018	4.2	971.85	0.3
9/19/2018	4.22	971.87	0.05
9/20/2018	4.24	971.89	0
9/21/2018	4.36	972.01	1.52
9/22/2018	4.46	972.11	0.05
9/23/2018	4.3	971.95	0
9/24/2018	4.3	971.95	0
9/25/2018	4.28	971.93	0.54
9/26/2018	4.32	971.97	0.1
9/27/2018	4.3	971.95	0.03
9/28/2018	4.26	971.91	0
9/29/2018	4.24	971.89	0
9/30/2018	4.24	971.89	0
10/1/2018	4.22	971.87	0
10/2/2018	4.22	971.87	0
10/3/2018	4.22	971.87	0.13
10/4/2018	4.22	971.87	0.06
10/5/2018	4.22	971.87	0.24
10/6/2018	4.22	971.87	0.05
10/7/2018	4.22	971.87	0.01
10/8/2018	4.22	971.87	0.12
10/9/2018	4.26	971.91	0.37
10/10/2018	4.4	972.05	1.16
10/11/2018	4.6	972.25	0.21
10/12/2018			0.05
10/13/2018			0

Long Trade Lake Management Plan

Chemical Data

Appendix B:

Long Trade Lake, Deep hole-surface								
All units mg/L								
Date	Total Suspended Solids	Nitrate+Nitrite	Chloride	Ammonium	Total Kjeldahl Nitrogen	Phosphorus-Soluble Reactive	Phosphorus-Total	Chlorophyll a
4/12/2016	ND	ND	9.5	0.06	0.64	0.012	0.053	
6/1/2016	9	ND	11.1	0.05	1.22	0.011	0.111	0.024
7/6/2016	5	ND	4.6	0.64	2.99	0.058	0.178	0.922
8/2/2016	11	ND	31.6	0.31	1.88	0.023	0.140	0.048
8/30/2016	13	ND	11.5	ND	1.45	0.015	0.122	0.047
9/28/2016	11	ND	11.5	0.22	1.21	0.052	0.126	0.013
11/29/2016	ND	ND	10.0	0.06	0.47	0.015	0.086	
4/3/2017	6	0.3	10.9	0.02	0.84	0.007	0.057	
5/23/2017	6	ND	8.3	0.01	0.79	0.028	0.082	0.0232
6/21/2017	11	ND	11.4	0.09	1.74	0.001	0.109	0.0596
7/5/2017	9	0.8	22.7	0.01	1.41	0.005	0.087	0.0432
7/31/2017	14	ND	10.9	0.02	2.04	ND	0.118	0.0492
9/5/2017	12	ND	12.0	0.06	1.75	0.003	0.100	0.0535
10/31/2017	15	ND	12.9	0.05	1.02	0.005	0.070	
5/9/2018	7	ND	9.1	0.04	1.11	0.008	0.085	
5/23/2018	ND	ND	9.7	0.11	1.05	0.013	0.075	11.200
6/11/2018	7	ND	9.9	0.02	0.96	0.009	0.087	27.000
7/16/2018	12	ND	6.9	ND	1.47	0.027	0.146	43.500
8/14/2018	11	ND	9.1	ND	1.24	0.006	0.080	50.200
9/11/2018	8	ND	11.8	ND	1.27	0.007	0.094	32.900
10/15/2018	9	ND	11.6	0.02	0.93	0.011	0.096	

Long Trade Lake, Deep hole-bottom		
All units mg/L		
Date	Phosphorus-Soluble Reactive	Phosphorus-Total
6/1/2016	0.078	0.304
7/6/2016	0.007	0.095
8/2/2016	0.154	0.200
8/30/2016	0.041	0.115
9/28/2016	0.060	0.097
5/23/2017	0.046	0.094
6/21/2017	0.113	1.870
7/5/2017	0.339	0.750
7/31/2017	0.357	0.785
9/5/2017	0.007	0.130
5/23/2018	0.014	0.196
6/11/2018	0.075	0.272
7/16/2018	0.149	0.290
8/14/2048	0.445	0.674
9/11/2018	0.040	0.199

Long Trade Lake, Inlet at 280th Ave		
All units mg/L		
Date	Phosphorus-Soluble Reactive	Phosphorus-Total
6/1/2016	0.080	0.113
7/6/2016	0.076	0.132
8/2/2016	0.138	0.156
8/30/2016	0.089	0.273
9/28/2016	0.062	0.113
5/23/2017	0.033	0.080
6/21/2017	0.085	0.168
7/5/2017	0.077	0.141
7/31/2017	0.069	0.121
9/5/2017	0.056	0.091
5/23/2018	0.027	0.061
6/11/2018	0.053	0.134
7/16/2018	0.049	0.151
8/14/2018	0.039	0.075
9/11/2018	0.057	0.151

Long Trade Lake, Outlet downstream CTH Z		
All units mg/L		
Date	Phosphorus-Soluble Reactive	Phosphorus-Total
6/1/2016	0.025	0.058
7/6/2016	0.055	0.088
8/2/2016	0.061	0.101
8/30/2016	0.049	0.178
9/28/2016	0.061	0.097
5/23/2017	0.014	0.100
6/21/2017	0.035	
7/5/2017	0.043	0.081
7/31/2017	0.051	0.105
9/5/2017	0.010	0.101
5/23/2018	0.027	0.084
6/11/2018	0.029	0.087
7/16/2018	0.023	0.123
8/14/2018	0.051	0.095
9/11/2018	0.014	0.070

Long Trade Lake, Trade River at 200th Street		
All units mg/L		
Date	Phosphorus-Soluble Reactive	Phosphorus-Total
6/1/2016	0.086	0.108
7/6/2016	0.089	0.138
8/2/2016	0.180	0.189
8/30/2016	0.144	0.327
9/28/2016	0.091	0.161
5/23/2017	0.052	0.084
6/21/2017	0.097	0.151
7/5/2017	0.085	0.142
7/31/2017	0.079	0.124
9/5/2017	0.062	0.096
5/23/2018	0.037	0.062
6/11/2018	0.071	0.116
7/16/2018	0.150	0.205
8/14/2018	0.032	0.083
9/11/2018	0.075	0.112

Long Trade Lake, Butternut Creek at 200th Street		
All units mg/L		
Date	Phosphorus-Soluble Reactive	Phosphorus-Total
6/1/2016	0.043	0.073
7/6/2016	0.040	0.078
8/2/2016	0.075	0.120
8/30/2016	0.038	0.108
9/28/2016	0.019	0.057
5/23/2017	0.018	0.087
6/21/2017	0.038	0.073
7/5/2017	0.041	0.075
7/31/2017	0.029	0.063
9/5/2017	0.025	0.047
5/23/2018	0.022	0.057
6/11/2018	0.024	0.104
7/16/2018	0.008	0.110
8/14/2018	0.028	0.056
9/11/2018	0.012	0.101

Long Trade Lake Management Plan

Physical Data

Appendix C:

Long Trade Lake, Deep Hole												
Date	Depth (m)	Dissolved oxygen (mg/L)	pH	Temp (oC)	Specific Conductance	Conductivity	TDS	Salinity	ORP	Secchi (ft)	Comments	
4/12/2016	0	5.61	8.93	4.86	107	66	53	0.05	-1.7	3.5 ft.	KH, JW, clear cool, slight breeze,	
	1	5.95	8.91	4.82	107	66	54	0.05	6.8		turnover	
	2	5.75	8.8	4.77	108	66	54	0.05	11.3			
	3	5.94	8.73	4.76	116	72	58	0.05	14.6			
	4	5.62	8.65	4.75	114	70	57	0.05	17.4			
6/1/2016	0	3.13	8.82	19.51	108	97	55	0.05	3.9	3 ft.	KH, KF, JW	
	1	3.44	8.71	19.51	109	98	55	0.05	7.1		meter calibrated 3.9 meters, algae, breeze,	
	2	3.57	8.62	19.25	115	103	57	0.05	12.5		cool, overcast, water brown	
	3	1.95	8.18	19.15	119	106	60	0.06	17.3			
	3.75	0	7.14	13.23	133	103	67	0.06	-3.9			
6/14/2016	0	2.57	9.87	21.74	128	120	64	0.06	6.9	2.5	KA, KF, calm, overcast, 11:30 am	
	1	3.75	9.77	21.41	130	121	65	0.06	9.8		slight, blue-green algae bloom at boat landing	
	2	3.54	9.61	21.31	132	123	66	0.06	12.8			
	3	0	8.18	18.97	149	132	75	0.07	14.2			
	3.75	0	7.39	15.56	168	138	84	0.08	11.3			
7/6/2016	0	17.46	11.51	23.57						2.5	KA, KF, JW, hot, humid, sunny	
	1	15.98	11.5	23.49							slight breeze, 11:00 am	
	2	13.44	11.4	23.32							storm last night,	
	3	5.88	10.76	22.57							slight blue green algae bloom	
	4	0.97	9.46	19.13								
7/18/2016	0									2.5	KA, KF, 10:20am, sunny calm,	
	1			probe out of battery, out w/Roger and Vicki							probe, returned and fixed	
	2											
	3											
	4											
7/19/2016	0	14.71	9.86	25.45	153	154	76	0.07	90.03	1.5	KA, KF, JW	
	1	7.94	8.89	23.98	160	157	80	0.07	73.7		Sunny, calm, 10:15 am	

	2	5.21	8.45	23.01	157	151	79	0.07	61.5			
	3	2.04	7.86	22.04	164	155	82	0.08	51.6		algae blooms	
	4	0	7	21	177	163	89	0	33.2			
8/2/2016	0	18.68	9.48	26.03	203	207	101	0.09	95.5	2.25	KA, JW, KF, cloudy, light breeze	
	1	17	9.4	25.86	203	206	101	0.09	94.9			
	2	4.52	8.03	24.26	214	211	107	0.1	90.7			
	3	0	7.6	22.88	214	205	107	0.1	83.01			
	4	0	7.09	21.46	241	224	120	0.11	75.1			
8/18/2016	0	19.25	10.24	25.36	170	171	85	0.08	32.6	2.75	KA, EW sunny calm	
	1	17.91	9.98	25.19	172	173	86	0.08	26.6			
	2	7.44	9.15	24.12	182	179	91	0.09	5.3			
	3	0	8.25	23.47	188	183	94	0.09	-35.9			
	4	0	6.95	21.69	230	217	117	0.11	-46.5			
8/30/2016	0	13.39	9.22	22.37	192	183	96	0.09	-12.6	2.5	KA, JW, 10:25 am	
	1	12.8	9.05	22.28	194	184	97	0.09	-13.6		algae scum at landing	
	2	11.11	8.88	22.08	197	186	98	0.09	-16.1			
	3	6.11	8.22	21.17	205	190	103	0.10	-27.5			
	4	0.01	7.59	20.34	212	193	106	0.10	-74.3			
9/12/2016	0	10.8	8.07	20.17	198	179	99	0.09	-33.5	3	KA/JW, windy, sunny	
	1	10.72	7.96	20.12	198	179	99	0.09	-25.5			
	2	10.65	7.93	20.07	200	182	100	0.09	-21.4			
	3	11.09	7.92	20.03	204	185	102	0.1	-20			
	4	10.23	7.85	19.98	201	182	100	0.09	-20.1			
9/28/2016	0	11.96	7.88	15.27	214	174	106	0.1	-80.6	2.5	KA/JW, cool, overcast,	
	1	10.72	7.86	15.22	218	177	109	0.1	-65.5		slight breeze, 11:24 am	
	2	10.84	7.85	18.15	216	175	108	0.1	-58.2			
	3	9.39	7.73	14.66	220	177	110	0.1	-54.9			
	4	9.33	7.61	14.46	218	174	109	0.1	-49.1			
11/29/2016	0	7.78	9.28	3.61	153	91	76	0.07	-103.5	4	KA/JW, cold, overcast,	
	1	7.92	9.21	3.61	149	89	74	0.07	-94.5		slight breeze	
	2	8.6	9.15	3.61	146	87	73	0.07	-88			
	3	9.6	9.09	3.61	146	86	73	0.07	-83.9			
	4	9.96	9.05	3.63	145	86	72	0.07	-80.4			
4/3/2017	0	17.11	8.6	7.17	188	124	94	0.09	-96	3	KA/JW, cold, overcast, calm	

	1	15.53	8.58	7.11	186	123	93	0.09	-96.1		10:30 AM	
	2	14.88	8.53	7.01	186	122	93	0.09	-93.9		Turnover	
	3	16.06	8.44	6.93	184	121	92	0.09	-91.4			
	4	13.51	8.16	6.63	185	121	93	0.09	-89.5			
5/23/2017	0		9.07	13.27	135	105	68	0.06	-157.9	3	KA/JW, cloudy, slight breeze	
	1		8.85	12.81	136	105	68	0.06	-156.8		11:35AM	
	2		8.64	12.09	135	102	68	0.06	-158.2			
	3		8.47	11.66	126	95	64	0.06	-159.6			
	4		8.4	10.96	128	94	64	0.06	-161.8			
	4.2		7.96	10.84	128	94	64	0.06	-161			
6/6/2017	0	5.04	9.52	22.29	160	152	80	0.07	-164.2	3.5	KA, JW, CS	
	1	5.03	9.45	22.06	156	147	78	0.07	-157.1		10:50AM	
	2	4.93	9.03	21.37	161	150	81	0.08	-136.2		Sunny , light breeze	
	3	0	7.64	14.51	157	127	79	0.07	-179.7			
	4	0	7.08	11.78	163	122	82	0.08	-129.5			
6/21/2017	0	10.84	9.95	22.62	144	137	72	0.07	-171.9	2.5	KA,JW,CS	
	1	9.49	9.73	21.96	144	136	72	0.07	-174.5		Sunny, light breeze ,slight	
	2	6.65	9.22	21.32	151	141	76	0.07	-183		algae bloom	
	3	0.08	8.1	19.16	158	140	79	0.07	-248.6			
	4	0	7.28	13.74	172	135	86	0.08	-314.9			
7/5/2017	0	8.69	9.62	23.54	117	114	58	0.05	-175.3		JW,CS	
	1	8.62	9.6	23.44	117	114	59	0.05	-171.8			
	2	7.88	9.53	23.37	121	117	60	0.06	-171.2			
	3	0	8.5	19.23	123	110	62	0.06	-246.8			
	4	0	7.4	16.06	142	114	71	0.07	-327.5			
7/19/2017	0	9.63	9.28	23.86	171	165	85	0.08	-186.3	2	KA,JW,CS	
	1	7.73	8.98	23.25	168	163	84	0.08	-187		Sunny, light breeze, warm	
	2	5.71	8.96	23.03	186	180	94	0.09	-188.7			
	3	0.31	8.17	21.54	193	180	96	0.09	-235.1			
	4	0	7.22	18	233	205	116	0.11	-418			
7/31/2017	0	16.62	9.71	25.33	130	131	65	0.06	-170.1	2	CS, KA	
	1	9.13	9.41	25.02	134	134	67	0.06	-169.2		Clear and sunny	
	2	0	8.32	22.95	150	144	75	0.08	-245.7		with an algae bloom	
	3	0	7.63	20.63	161	148	81	0.08	-409.1			

	4	0	6.85	17.79	216	186	108	0.1	352.1			
8/15/2017	0	19.46	9.41	23.48	146	142	73	0.07	-162.6	1.75	KA, DC	
	1	17.26	9.54	22.49	142	135	71	0.07	-150.8		calm, slightly cloudy,	
	2	10.18	9.23	20.92	146	134	73	0.07	-170.5		algae bloom at landing	
	3	4.12	8.11	19.88	152	137	76	0.07	-188.9		many dead crappies	
	4	0	6.87	18.76	192	169	96	0.09	-380.2		78oF, 2:15PM	
9/5/2017	0	10.37	8.92	18.81	145	128	72	0.07	-193.3	2.25	KA/JW	
	1	10.62	8.9	18.82	150	133	75	0.07	-191.3		cool, overcast, light breeze	
	2	10.42	8.95	18.82	152	134	76	0.07	-190.9			
	3	9.79	9.14	18.82	151	133	76	0.07	-190.7			
	4	7.88	8.55	17.77	152	131	76	0.07	195.4			
10/25/2017	0	12.1	9.99	10.84	352	256	174	0.17	-247.1	2	jw, ka	
	1	9.94	9.65	10.49	328	238	164	0.16	-246.5		cold, calm, sunny	
	2	9.79	9.59	10.32	336	243	168	0.16	-242.4		slight algae bloom	
	3	9.88	9.88	10.26	354	255	177	0.17	-238		in middle-stained brown	
	4	7.71	9.41	9.25	364	255	182	0.18	-235.7			
10/31/2017	0	11.25	9.34	4.92	230	142	115	0.11	-137.5	3	ka,jw	
	1	11.24	9.5	4.93	227	141	114	0.11	-153.9		cold, overcast, slight breeze,	
	2	10	9.45	4.95	224	139	112	0.11	-150.7		brown stain water	
	3	10.97	9.42	4.93	221	137	111	0.11	-151.5		snowing.	
	4	10.88	9.38	4.94	233	144	117	0.11	-151.1			
5/9/2018	0	9.99	7.72	14.56	137	110	68	0.06	29	3.5	jw, dc	
	1	10.09	8.07	14.52	136	109	68	0.06	-2.2		sunny, cool	
	2	9.5	8.38	14.38	133	106	67	0.06	-21.9			
	3	4.56	7.92	11.3	134	99	66	0.06	-38.9			
	4	0	7.75	7.34	134	89	67	0.06	-44.3			
5/23/2018	0	7.8	8.99	18.77	184	162	92	0.09	28	4.5	BE, JW. cool, 50/50 sun/cloud,	
	1	7.44	8.41	18.6	180	158	90	0.08	27.2		south wind 5-10mph	
	2	7.34	8.51	18.42	178	156	89	0.08	12.8			
	3	1.15	8.61	14.41	175	140	87	0.08	0.9			
	4	0	8.21	9.83	164	117	82	0.08	-72.3			
6/11/2018	0	3.82	8.39	20.77	178	164	89	0.08	-133.6	4.5	BE, JW. Hot, overcast,	
	1	3.7	8.6	20.75	176	162	88	0.08	-136.7		prefrontal conditions	
	2	3.11	8.48	19.53	177	159	88	0.08	-139.7			

	3	0	8	18.07	178	155	90	0.09	-176.3			
	4	0	7.49	15.57	197	162	99	0.09	-434.6			
6/27/2018	0	6.55	8.69	22.93	128	123	64	0.06	-160.4	3	DC, BE, overcast	
	1	5.94	9.15	22.49	134	128	67	0.06	-156.8		Early afternoon	
	2	3.81	8.91	21.54	133	125	67	0.06	-156.3			
	3	2.06	8.58	21.22	133	124	67	0.06	-161			
	4	0	7.81	18.66	151	133	76	0.07	-195.7			
	4.5	0	7.01	15	171	139	86	0.08	-272.3			
7/16/2018	0	7.69		26.2						2	be,ka,jw.	
	1	2.67		24.2							sunny breezy	
	2	0.26		22.8								
	3	0.2		20.2								
	4	0.16		18.6								
	4.5	0.15		20.5								
7/30/2018	0	14.19		25.3						1.5	be, ka, jw	
	1	14.69		24.2								
	2	1.67		22.8								
	3	4.95		21.8								
	4	0.21		19.8								
8/13/2018	0	10.39		27.1						2	be, ka jw	
	1	10.53		26.9								
	2	0.7		23.7								
	3	0.32		21.5								
	4	0.23		19.4								
8/30/2018	0	6.81	7.97	20.9	170	156	85	0.08	170.9	2.5		
	1	6.68	8	20.8	169	155	84	0.08	178.4			
	2	6.51	8.17	20.7	166	152	83	0.08	128.4			
	3	6.48	7.99	20.6	168	154	84	0.08	153.8			
	4	1.4	7.86	19.3	168	153	84	0.08	174.1			
	4.5	0.24	7.89	19.2	166	152	83	0.08	165.9			
9/11/2018	0	8.6	8.61	20.14	158	153	79	0.07	147.5	2.5		
	1	8.52	8.62	20.03	160	145	80	0.08	154.9			
	2	8.08	8.35	19.82	162	140	81	0.08	154.5			
	3	7.88	8.3	19.74	164	148	82	0.08	167.1			

	4	3.58	7.71	18.18	173	151	86	0.08	184.9			
10/15/2018	0	9.84	7.9	6.4						2.5	ka,jw	
	1	9.82	8.04	6.4								
	2	9.78	8.1	6.4								
	3	9.73	8.09	6.4								
	4	9.72	8.04	6.4								

Long Trade Lake, Inlet at 280th Ave				
Date	Foot	Depth (ft)	Flow (m/s)	
6/1/2016	0	0.1	0.05	KA, KF, JW,
	1	0.7	0.8	BE 10:05
	2	0.7	1.11	
	3	0.7	1.17	
	4	1.8	1.25	
	5	0.8	1.21	
	6	0.8	1.14	
	7	0.9	1.19	
	8	0.8	0.94	
	9	0.8	1.04	
	10	0.8	0.95	
	11	0.7	1.18	
	12	0.6	1.06	
	13	0.6	1.02	
	14	0.5	1.25	
	15	0.6	1.25	
	16	0.5	1.21	
	17	0.6	1.24	
	18	0.7	1.04	
	19	0.4	0.09	
6/14/2016	0	0.6	0.21	KA, KF
	1	0.7	0.66	1:00
	2	0.7	0.93	
	3	0.8	1.23	
	4	0.8	1.05	
	5	0.8	1.03	
	6	0.7	0.95	
	7	0.7	0.91	
	8	0.6	0.95	
	9	0.5	1.08	
	10	0.5	1	
	11	0.5	1.03	
	12	0.5	0.98	
	13	0.5	1.09	
	14	0.5	1.09	
	15	0.5	1.09	
	16	0.5	1.09	
	17	0.6	0.93	
	18	0.7	0.53	
7/6/2016	0	0.1	0	tree down
	1	0.35	0.36	in river
	2	0.4	0.74	
	3	0.4	0.72	sand
	4	0.6	0.42	bottom
	5	0.75	0.58	slight bank
	6	0.7	0.75	erosion
	7	0.6	1	
	8	0.6	1.02	
	9	0.5	1.13	
	10	0.5	1.24	
	11	0.5	1.12	
	12	0.5	1.04	
	13	0.5	0.91	
	14	0.5	0.92	
	15	0.5	1.07	
	16	0.4	1.09	
	17	0.4	1.18	
	18	0.4	1.25	
	19	0.4	1.09	
	20	0.6	0.97	
	21	0.4	0.66	
	22	0.2	0.06	
7/19/2016	0	0.1	0	KA, KF, JW
	1	0.4	0.87	9:30 am
	2	0.6	0.9	
	3	0.5	1.17	
	4	0.5	1.09	
	5	0.5	0.92	
	6	0.4	0.61	
	7	0.7	0.81	
	8	0.8	1.15	
	9	0.8	1.25	
	10	0.8	1.21	
	11	0.7	1.46	
	12	0.7	1.69	
	13	0.7	1.36	
	14	0.6	1.34	
	15	0.5	1.45	
	16	0.4	1.36	
	17	0.4	1.38	
	18	0.4	1.37	
	19	0.4	1.28	
	20	0.4	1.26	
	21	0.3	0.95	
	22	0.3	0.53	
8/2/2016	0	0.2	0.09	KA, KF
	1	0.4	0.65	JW
	2	0.5	0.79	
	3	0.5	0.95	

	4	0.5	0.67	
	5	0.5	0.7	
	6	0.5	1.09	
	7	0.7	0.78	
	8	0.8	1.04	
	9	0.8	1.07	
	10	0.7	0.98	
	11	0.7	1.12	
	12	0.6	1.22	
	13	0.6	1.04	
	14	0.5	1.17	
	15	0.5	0.94	
	16	0.5	1.28	
	17	0.5	1.38	
	18	0.5	1.48	
	19	0.5	1.4	
	20	0.5	1.2	
	21	0.3	0.67	
	22	0.2	0.1	
8/18/2016	0	0.1	0	KA, EW
	1	0.5	0.49	
	2	0.5	0.81	
	3	0.5	0.99	
	4	0.6	1.04	
	5	0.5	0.91	
	6	0.5	0.69	
	7	0.7	1.05	
	8	0.9	1.33	
	9	0.9	0.92	
	10	0.9	1.01	
	11	0.8	1.26	
	12	0.6	1.22	
	13	0.6	1.2	
	14	0.7	1.27	
	15	0.7	1.34	
	16	0.7	1.27	
	17	0.6	1.24	
	18	0.6	1.13	
	19	0.5	1.43	
	20	0.5	1.38	
	21	0.4	1.28	
	22	0.4	1.06	
8/30/2016	0	0.5	0.04	KA, JW
	1	0.7	0.41	9:45
	2	0.9	0.8	
	3	0.9	0.99	

	4	0.9	1.11	
	5	0.9	1.13	
	6	1.1	1.32	
	7	1.2	0.49	
	8	1.2	1.17	
	9	1.2	1.36	
	10	1.2	1.15	
	11	1.2	1.37	
	12	1.2	1.38	
	13	1	1.26	
	14	1	1.28	
	15	0.9	1.35	
	16	1	1.45	
	17	0.9	1.47	
	18	0.9	1.48	
	19	0.9	1.44	
	20	0.9	1.37	
	21	0.9	1.2	
	22	0.8	0.44	
	23	0.4	0.04	
9/12/2016	0	0.2	0.12	KA, JW
	1	0.5	0.88	10:00am
	2	0.6	1.07	
	3	0.6	1.11	
	4	0.6	1.2	
	5	0.7	0.68	
	6	0.8	1.12	
	7	0.6	1.38	
	8	1	1.18	
	9	1	1.11	
	10	1	1.21	
	11	1	1.22	
	12	0.8	1.2	
	13	0.8	1.21	
	14	0.8	1.55	
	15	0.7	1.39	
	16	0.6	1.39	
	17	0.4	1.29	
	18	0.4	1.25	
	19	0.3	1.1	
	20	0.3	1	
	21	0.4	0.89	
	22	0.4	0.52	
9/28/2016	0	0.2	0.07	KA, JW
	1	0.6	0.63	10:45 AM
	2	0.8	0.92	

	3	0.8	1.1	
	4	0.8	1.13	
	5	0.9	1.07	
	6	0.9	0.99	
	7	1	1.38	
	8	1.1	1.44	
	9	1.1	1.21	
	10	1.2	1.17	
	11	1.2	1.17	
	12	1.2	1.09	
	13	1.1	1.01	
	14	1.1	1.14	
	15	0.9	1.21	
	16	0.8	1.31	
	17	0.8	1.2	
	18	0.8	1.01	
	19	0.7	1.07	
	20	0.6	0.96	
	21	0.6	0.77	
	22	0.7	0.53	
	23	0.5	0.2	
5/23/2017	0	0.7	0.06	KA/JW
	1	1.1	0.98	10:48am
	2	1.5	1.46	
	3	1.5	1.43	
	4	1.5	1.56	
	5	1.6	1.72	
	6	1.7	1.7	
	7	1.7	1.78	
	8	1.8	1.71	
	9	1.8	1.94	
	10	1.7	1.98	
	11	1.7	1.74	
	12	1.9	1.83	
	13	1.9	1.7	
	14	2	1.71	
	15	1.9	1.59	
	16	1.9	1.7	
	17	1.8	1.72	
	18	1.8	1.63	
	19	1.8	1.52	
	20	1.8	1.38	
	21	2	1.27	
	22	1.9	1.74	
	23	1.9	1.48	
	24	1.2	1.17	

	24.5	0.6	0.29	
6/6/2017	0	0.3	0.39	KA, JW,
	1	0.6	1.07	CS 11:45
	2	0.7	1.1	
	3	0.7	1.24	
	4	0.7	1.23	
	5	0.8	1.39	
	6	0.8	1.29	
	7	0.9	1.17	
	8	0.9	1.33	
	9	0.8	1.44	
	10	0.8	1.38	
	11	0.7	1.45	
	12	0.7	1.34	
	13	0.8	1	
	14	0.7	1.19	
	15	0.9	1.18	
	16	0.7	0.71	
	17	0.5	1.18	
	18	0.5	1.19	
	19	0.5	0.98	
	20	0.3	1.1	
	21	0.5	0.69	
	22	0.3	0.87	
	23	0.2	0.02	
6/21/2017	0	0.5	0.66	KA,JW,
	1	0.6	0.84	CS
	2	0.6	0.9	
	3	0.6	0.98	
	4	0.6	1.22	
	5	0.5	0.42	
	6	0.6	0.38	
	7	0.8	0.54	
	8	0.8	1.08	
	9	0.8	1.11	
	10	0.7	1.05	
	11	0.7	1.05	
	12	0.7	1.03	
	13	0.7	0.89	
	14	0.6	1.06	
	15	0.7	1.18	
	16	0.7	1.06	
	17	0.6	1.24	
	18	0.7	1.04	
	19	0.6	1.26	
	20	0.5	1.39	

	21	0.4	0.69	
7/5/2017	0	0.3	0.73	
	1	0.3	0.9	
	2	0.3	1.04	
	3	0.5	1.25	
	4	0.5	1.37	
	5	0.5	1.21	
	6	0.5	1.94	
	7	0.5	1.11	
	8	0.6	1.21	
	9	0.6	1.28	
	10	0.7	0.94	
	11	0.7	1.08	
	12	0.7	1.18	
	13	0.7	1.18	
	14	0.7	1	
	15	0.5	0.55	
	16	0.4	0.54	
	17	0.5	1.39	
	18	0.5	1.19	
	19	0.6	0.95	
	20	0.5	0.99	
	21	0.3	0.82	
7/19/2017	0	0.5	0.62	
	1	0.9	0.86	
	2	1	1.04	
	3	0.9	1.2	
	4	0.9	1.26	
	5	0.8	1.21	
	6	0.9	1.32	
	7	1.1	1.02	
	8	1.3	1.36	
	9	1.4	1.19	
	10	1.1	1.55	
	11	1.1	1.39	
	12	1.2	1.44	
	13	1.1	1.38	
	14	1.1	1.31	
	15	1	1.47	
	16	1	1.48	
	17	1	1.34	
	18	0.9	1.47	
	19	0.9	1.61	
	20	0.6	1.49	
	21	0.6	1.34	
	22	0.7	1.06	

	23	0.5	0.44	
7/31/2017	0	0.1	0.02	
	1	0.5	1.01	
	2	0.5	0.89	
	3	0.5	1.11	
	4	0.5	1.07	
	5	0.5	1.03	
	6	0.5	0.96	
	7	0.6	1.05	
	8	0.6	1.07	
	9	0.7	1.08	
	10	0.6	1.26	
	11	0.6	1.16	
	12	0.6	1.01	
	13	0.8	1.05	
	14	0.7	1.16	
	15	0.7	0.86	
	16	0.5	0.83	
	17	0.4	0.94	
	18	0.4	1.04	
	19	0.4	0.73	
	20	0.4	0.81	
	21	0.3	0.41	
	22	0.4	0.8	
	23	0.3	0.45	
8/15/2017	0	0.1	0.17	
	1	0.4	0.22	
	2	0.5	0.68	
	3	0.5	0.83	
	4	0.4	0.93	
	5	0.4	1.12	
	6	0.4	0.95	
	7	0.5	0.82	
	8	0.7	0.91	
	9	0.7	1.17	
	10	0.7	1.16	
	11	0.7	0.97	
	12	0.6	1.36	
	13	0.7	1.27	
	14	0.7	1.16	
	15	0.7	1.16	
	16	0.7	1.01	
	17	0.7	1.15	
	18	0.7	0.96	
	19	0.6	0.95	
	20	0.6	1.13	

	21	0.6	1.27	
	22	0.6	1.07	
	23	0.1	0.02	
9/5/2017	0	0.2	0.16	KA/JW
	1	0.4	0.87	10:50am
	2	0.3	1.13	
	3	0.4	0.84	
	4	0.4	1.05	
	5	0.4	1.23	
	6	0.4	0.95	
	7	0.5	0.57	
	8	0.7	1.04	
	9	0.5	1.05	
	10	0.5	1.21	
	11	0.6	1.04	
	12	0.5	0.96	
	13	0.5	0.98	
	14	0.5	0.86	
	15	0.4	1.1	
	16	0.4	1.11	
	17	0.5	1.14	
	18	0.5	1.08	
	19	0.3	1.21	
	20	0.5	0.94	
	21	0.4	0.89	
	22	0.2	0.33	
5/23/2018	0	0.2	0.6	jw, be
	1	0.5	0.83	
	2	0.4	0.87	
	3	0.5	1.14	
	4	0.5	1.13	
	5	0.6	1.2	
	6	0.7	1.05	
	7	0.8	1.28	
	8	0.6	1.36	
	9	0.6	1.4	
	10	0.5	1.3	
	11	0.5	1.21	
	12	0.6	1.26	
	13	0.6	1.17	
	14	0.5	0.99	
	15	0.4	0.98	
	16	0.3	0.95	
	17	0.3	0.91	
	18	0.3	0.96	
	19	0.3	1.09	

	20	0.4	0.9	
	21	0.2	0.23	
6/11/2018	0	0.2	0.08	jw, be
	1	0.3	1.04	
	2	0.6	1.28	
	3	0.5	1.35	
	4	0.5	1.35	
	5	0.5	1.31	
	6	0.5	1.03	
	7	0.6	1.12	
	8	0.6	1.04	
	9	0.7	1.31	
	10	0.7	1.15	
	11	0.7	1.27	
	12	0.7	1.24	
	13	0.7	1.35	
	14	0.6	1.28	
	15	0.7	1.26	
	16	0.7	1.31	
	17	0.7	1.03	
	18	0.6	1.17	
	19	0.6	0.92	
	20	0.8	0.95	
	21	0.6	0.72	
	22	0.2	0.2	
6/27/2018	0	2.2	1.14	
	1	2.4	1.83	
	2	1.8	2.04	
	3	1.8	1.97	
	4	1.8	2.18	
	5	1.9	2.1	
	6	1.7	2	
	7	1.6	1.7	
	8	1.4	1.86	
	9	1.4	2.08	
	10	1.3	1.53	
	11	1	1.92	
	12	1	1.66	
	13	1	2.1	
	14	1.2	1.67	
	15	1.3	0.82	
	16	1.5	1.1	
	17	1.5	1.71	
	18	1.5	1.51	
	19	1.2	0.82	
7/16/2018	0	1	0.48	ka,be,jw

	1	1.2	1.04	
	2	1.4	1.1	
	3	1.5	1.28	
	4	1.5	1.42	
	5	1.6	1.62	
	6	1.5	1.65	
	7	1.6	1.74	
	8	1.4	1.54	
	9	1.4	1.41	
	10	1.4	1.63	
	11	1.4	1.77	
	12	1.4	1.61	
	13	1.3	1.62	
	14	1.4	1.32	
	15	1.4	1.44	
	16	1.4	1.47	
	17	1.4	1.55	
	18	1.4	1.53	
	19	1.4	1.47	
	20	1.5	1.2	
	21	1.5	1.27	
	22	1.3	1.19	
7/30/2018	0	0.2	0.39	be, ka, jw
	1	0.4	0.56	10.55am
	2	0.6	0.68	
	3	0.6	0.71	
	4	0.7	0.76	
	5	0.7	0.84	
	6	0.6	0.86	
	7	0.6	1.02	
	8	0.6	1.12	
	9	0.6	1.09	
	10	0.6	1.19	
	11	0.6	1.22	
	12	0.6	0.98	
	13	0.6	1.23	
	14	0.6	1.09	
	15	0.6	1.17	
	16	0.5	1.02	
	17	0.5	1.04	
	18	0.5	1.05	
	19	0.5	0.89	
	20	0.5	0.68	
	21	0.6	0.72	
	22	0.1	0.13	
8/13/2018	0	0.2	0.54	be, ka, jw

	1	0.3	0.73	
	2	0.4	0.85	
	3	0.4	0.74	
	4	0.4	0.62	
	5	0.5	0.94	
	6	0.5	0.91	
	7	0.5	1.05	
	8	0.5	0.94	
	9	0.5	0.96	
	10	0.5	1.01	
	11	0.5	1.09	
	12	0.5	1.22	
	13	0.5	1.21	
	14	0.4	1.08	
	15	0.4	1.42	
	16	0.3	1.27	
	17	0.3	0.88	
	18	0.3	0.84	
	19	0.3	0.51	
	20	0.2	0.02	
8/30/2018	0	0.2	0.18	jw, ka
	1	0.4	0.86	
	2	0.5	1.09	
	3	0.6	1.19	
	4	0.6	1.18	
	5	0.6	1.16	
	6	0.6	1.25	
	7	0.6	1.1	
	8	0.7	1.4	
	9	0.6	1.6	
	10	0.6	1.58	
	11	0.7	1.46	
	12	0.6	1.65	
	13	0.5	1.55	
	14	0.4	1.52	
	15	0.3	1.18	
	16	0.2	0.91	
	17	0.2	1.02	
	18	0.2	0.75	
	19	0.1	0.57	
	20	0.1	0.37	
	21	0.1	0.35	
	22	0.2	0.2	
9/11/2018	0	0.2	0.2	jw, ka
	1	0.5	0.73	
	2	0.6	0.89	

	3	0.7	1.16	
	4	0.6	1.06	
	5	0.6	0.97	
	6	0.7	1.17	
	7	0.7	0.95	
	8	0.7	1.3	
	9	0.7	1.31	
	10	0.6	1.18	
	11	0.6	1.26	
	12	0.5	1.22	
	13	0.5	1.16	
	14	0.4	1.16	
	15	0.4	1.27	
	16	0.4	1.17	
	17	0.4	1.31	
	18	0.3	1.32	
	19	0.3	1.12	
	20	0.3	0.91	
	21	0.2	0.49	
	22	0.2	0.15	
	23	0.1	0.03	

Long Trade Lake, Trade River at 200th Street				
Date	Foot	Depth (ft)	Flow (m/s)	
6/1/2016	0	0.7	0.32	KA, KF, JW
	1	0.9	1.11	12:50pm
	2	1	2.13	
	3	0.8	1.97	
	4	0.7	1.36	
	5	0.7	1.65	
	6	0.6	1.55	
	7	0.4	1.53	
	8	0.4	1.3	
	9	0.4	0.91	
6/14/2016	1	0.6	0.39	KA KF
	2	0.8	1.09	1:14pm
	3	0.8	1.74	
	4	0.8	1.8	
	5	0.7	1.75	
	6	0.7	1.03	
	7	0.6	1.13	
	8	0.5	1.04	
	9	0.4	1.23	
	10	0.3	0.91	
	11	0.1	0.03	
7/6/2016	0	1.1	0.64	KA, KF
	1	1.1	1.46	JW
	2	1	1.63	
	3	0.8	1.5	
	4	0.5	1.38	
	5	0.6	1.07	
	6	0.5	0.94	
	7	0.5	0.69	
	8	0.4	0.39	
7/14/2016	0	0.8	0.12	12:05pm
	1	0.8	0.15	KA, KF
	2	1	1.42	
	3	1	1.99	
	4	0.8	0.95	
	5	0.7	1.02	
	6	0.6	1.31	
	7	0.6	1.22	
	8	0.7	1.08	
	9	0.5	0.93	
8/2/2016	0	0.7	0.21	KA,KF,JW
	1	0.9	1.24	10:25
	2	0.9	1.54	
	3	0.9	1.76	
	4	0.9	1.37	
	5	0.9	1.32	
	6	0.7	0.63	
	7	0.9	0.74	
	8	0.8	0.88	
	9	0.2	0	
8/18/2016	1	0.4	0.7	KA/EW
	2	0.7	0.97	
	3	0.7	0.37	
	4	0.7	1.28	
	5	0.5	1.29	
	6	0.7	1.48	
	7	0.9	1.79	
	8	1	1.64	
	9	0.9	1.44	
	10	0.4	0.8	
8/30/2016	0	1.1	0.04	KA/JW
	1	1.3	0.88	11:30am
	2	1.4	2.5	
	3	1.4	2.73	
	4	1.3	3.12	
	5	1.2	2.71	
	6	1.1	2.18	
	7	1.1	2.31	
	8	1.1	1.47	
	9	0.9	0.9	
9/12/2016	0	0.8	0.06	KA/JW
	1	1	0.5	
	2	1.1	2.03	
	3	0.9	1.87	
	4	0.9	1.81	
	5	0.8	1.38	
	6	0.7	1.37	
	7	0.7	1.25	
	8	0.7	0.88	
	9	0.5	0.84	
	9.5	0.5	0.32	
9/28/2016	0	0.5	0.07	
	1	0.8	0.19	
	2	1.1	1.13	
	3	1.1	2.13	
	4	1.2	2.43	
	5	1.1	2.37	
	6	0.8	2.22	

	7	0.9	1.95	
	8	0.8	1.54	
	9	0.8	1.17	
	10	0.7	0.96	
5/23/2017	0	1.8	0.05	
	1	2.2	2.37	
	2	2.1	2.14	
	3	1.8	2.31	
	4	1.8	1.95	
	5	1.6	2.18	
	6	1.3	2.28	
	7	1.1	2.16	
	8	1	1.65	
	9	0.7	0.64	
	10	0.4	0.14	
6/6/2017	0	0.9	0	
	1	1.2	1.19	
	2	2.1	1.51	
	3	1.9	1.25	
	4	1.4	1.18	
	5	1.1	0.85	
	6	0.8	0.93	
	7	0.6	0.62	
	8	0.5	0.15	
	9	0.2	0.02	
6/21/2017	0	0.2	0.05	
	1	0.4	0.39	
	2	0.5	0.85	
	3	0.8	0.96	
	4	1	1.13	
	5	1.3	1.31	
	6	2	1.44	
	7	2.2	1.18	
	8	1.5	1.31	
7/19/2017	0	1.9	1.87	
	1	1.8	1.87	
	2	1.5	2.04	
	3	1.2	1.53	
	4	1.1	1.68	
	5	1	1.49	
	6	0.7	0.93	
	7	0.5	0.53	
	8	0.3	0.05	
7/31/2017	0	2	0.03	
	1	2	0.99	
	2	2.2	1.19	

	3	2.1	1.11	
	4	2	1.04	
	5	1.2	0.97	
	6	0.6	0.84	
	7	0.6	0.41	
	8	0.4	0.32	
	9	0.2	0.07	
8/15/2017	0	0.1	0.03	
	1	1	0.28	
	2	1.1	0.21	
	3	1.2	1.24	
	4	1.2	1.68	
	5	1.1	1.73	
	6	1.1	1.56	
	7	0.8	1.2	
	8	0.7	1.07	
	9	0.6	0.61	
	10	0.4	0.31	
	11	0.1	0.02	
9/5/2017	0	1	0.06	
	1	1.1	0.59	
	2	1.5	1.17	
	3	1.5	1.65	
	4	1.4	1.27	
	5	1.4	1.07	
	6	1.2	0.95	
	7	0.8	0.68	
	8	0.7	0.34	
	9	0.4	0.12	
	10	0.3	0.06	
5/23/2018	0	1.7	1.71	
	1	1.7	1.35	
	2	1.5	0.95	
	3	1.2	1.24	
	4	0.9	0.71	
	5	0.7	0.33	
	6	0.6	0.23	
	7	0.4	0.03	
	8	0.2	0	
6/11/2018	0	0.2	0	
	1	0.3	0.03	
	2	0.5	0.02	
	3	0.6	0.08	
	4	0.8	0.44	
	5	1	0.75	
	6	1.2	1.2	

	7	1.5	0.93	
	8	1.6	1.7	
	9	1.6	1.24	
6/27/2018	0	0.4	0	
	1	0.5	0.4	
	2	0.6	2.2	
	3	1	2.91	
	4	1.1	3.05	
	5	1.2	2.69	
	6	1	2.21	
	7	0.8	3.02	
	8	0.5	1.43	
7/16/2018	0	0.5	0.1	be,ka,jw
	1	0.6	0.92	
	2	0.6	1.09	
	3	0.6	1.39	
	4	0.6	1.32	
	5	0.8	1.48	
	6	1	1.65	
	7	1.1	1.95	
	8	1.1	2.04	
	9	1.1	1.75	
	10	0.8	0.93	
7/30/2018	0	1.5	1.25	be, ka, jw
	1	1.5	0.99	
	2	1.4	0.96	
	3	1.2	1.01	
	4	0.9	0.85	
	5	0.6	0.43	
	6	0.5	0.26	
	7	0.4	0.12	
	8	0.2	0	
	9	0.1	0	
8/13/2018	0	0.4	0.06	be, ka, jw
	1	2	0.55	12:03pm
	2	1.9	0.57	
	3	1.3	0.97	
	4	1.9	0.9	
	5	0.9	0.76	
	6	0.7	0.45	
	7	0.5	0.26	
	8	0.3	0.19	
	9	0.2	0.06	
	10	0.1	0	
8/30/2018	0	1.6	1.15	jw, ka

	1	1.5	1.21	
	2	1.5	1.63	
	3	1.2	1.39	
	4	1	1.02	
	5	0.7	0.74	
	6	0.5	0.36	
	7	0.4	0.33	
	8	0.4	0.13	
	9	0.3	0.05	
9/11/2018	0	1.5	1.01	jw, ka
	1	1.5	0.86	
	2	1.3	1.11	
	3	1	0.93	
	4	0.7	0.63	
	5	0.6	0.29	
	6	0.5	0.16	
	7	0.4	0.13	
	8	0.3	0	

Long Trade Lake, Butternut Creek at 200th Street				
Date	Foot	Depth (ft)	Flow (m/s)	
6/1/2016	0	0.7	0	KA,KF,JW
	1	1	0.35	1:00pm
	2	1	1.66	
	3	0.8	0.83	
	4	0.9	1.05	
	5	0.6	0.76	
	6	0.5	0.24	
	7	0.1	0	
6/14/2016	0	0.4	0	KA KF
	1	0.6	0	1:30PM
	2	1	0.85	
	3	0.9	0.93	
	4	0.5	0.64	
	5	0.6	0.86	
	6	0.6	0.65	
	7	0.4	0.31	
	8	0.1	0	
7/6/2016	0	0.7	0.16	KA,KF,JW
	1	1	0.71	
	2	0.8	0.91	
	3	0.6	0.92	
	4	0.5	0.69	
	5	0.3	0.33	
	6	0.2	0.13	
	7	0.1	0	
7/19/2016	0	1.1	0.12	
	1	1	0.93	
	2	1	1.64	
	3	0.9	1.69	
	4	0.7	1.35	
	5	0.4	0.4	
	6	0.2	0.09	
	7	0.1	0	
8/2/2016	0	1	0.18	KA,KF,JW
	1	1	1.44	10:00 AM
	2	1	1.74	
	3	1.1	1.37	
	4	0.9	0.72	
	5	0.7	0.04	
	6	0.6	0	
	7	0.4	0.05	
8/18/2016	1	0.6	0.02	KA/EW
	2	0.7	0.07	
	3	0.9	0.46	
	4	1	1.74	
	5	1.2	1.89	
	6	1.5	0.89	
	7	0.8	0.23	
	8	0.8	0	
8/30/2016	0	0.2	0	KA/JW
	1	0.3	0	
	2	0.7	0.16	
	3	0.9	1.04	
	4	1.2	1.84	
	5	1.2	2.16	
	6	1.2	1.77	
	7	1.1	1.61	
	8	1.1	0.37	
9/12/2016	0	1	0.31	
	1	1	0.84	
	2	1.1	1.35	
	3	1.1	1.73	
	4	1	0.92	
	5	0.9	0.67	
	6	0.4	0.29	
9/28/2016	0	1.1	0.08	
	1	1.3	0.4	
	2	1.3	1	
	3	1.3	1.18	
	4	1.2	1.55	
	5	1	0.08	
	6	0.8	0.03	
5/23/2017	0	1	0.14	
	1	1.2	1.06	
	2	1.1	2.14	
	3	1.1	2.29	
	4	1.3	2.43	
	5	1.4	2.88	
	6	1.5	2.4	
	7	1.3	2	
	8	0.4	1.19	
	9	0.2	0.1	
6/6/2017	0	0.5	0.01	
	1	0.5	0.84	
	2	0.6	1.97	
	3	0.7	2.26	
	4	0.8	3.05	
	5	0.8	2.74	

	6	0.7	1.51	
	7	0.5	0.14	
	8	0.1	0	
6/21/2017	0	0.9	0.85	
	1	0.8	2.11	
	2	0.6	2.08	
	3	0.6	1.94	
	4	0.6	1.63	
	5	0.5	0.91	
7/19/2017	0	0.5	0.57	
	1	0.7	1.32	
	2	0.9	2.33	
	3	1	2.47	
	4	1	2.04	
	5	1.1	1.58	
	6	1	0.88	
7/31/2017	0	0.1	0	
	1	0.4	0.31	
	2	0.5	1.02	
	3	0.5	1.98	
	4	0.7	2.25	
	5	0.6	2.13	
	6	0.6	0.86	
	7	0.5	0	
8/15/2017	0	0.3	0.06	
	1	0.5	0.05	
	2	0.6	0.41	
	3	0.5	1.7	
	4	0.5	1.71	
	5	0.6	1.76	
	6	0.4	0.56	
	7	0.3	0.06	
9/5/2017	0	0.5	0.04	
	1	0.6	0.05	
	2	0.6	0.21	
	3	0.4	1.67	
	4	0.5	1.65	
	5	0.5	1.78	
	6	0.5	0.45	
	7	0.3	0	
5/23/2018	0	0.9	0.3	JW,BE
	1	0.7	0.64	
	2	0.6	1.09	
	3	0.5	1.51	
	4	0.4	1.04	
	5	0.2	0.54	

	6	0.1	0	
6/11/2018	0	1	0.06	
	1	1.2	1.46	
	2	0.8	2.62	
	3	0.8	2.64	
	4	0.7	1.05	
	5	0.6	1.02	
	6	0.4	0.58	
6/27/2018	0	2	2.3	
	1	1.9	2.2	
	2	1.8	1.76	
	3	1.6	1.89	
	4	1.4	2.06	
	5	1	1.81	
	6	0.9	1.69	
	7	0.7	1.03	
	8	0.7	0.8	
	9	0.2	0.24	
7/16/2018	0	0.2	0.09	be,ka,j
	1	0.6	0.94	
	2	0.7	2.53	
	3	1	2.41	
	4	1	2.84	
	5	1.1	2.32	
	6	0.9	1.18	
	7	0.5	1.49	
7/30/2018	0	0.2	0.45	be, ka, jw
	1	0.4	2.43	
	2	0.5	2.41	
	3	0.6	2.36	
	4	0.6	1.87	
	5	0.5	1.28	
	6	0.1	0.68	
8/13/2018	0	0.2	0.24	be, ka, jw
	1	0.3	1.29	
	2	0.5	2.01	
	3	0.6	2.24	
	4	0.6	1.01	
	5	0.2	0	
8/30/2018	0	0.2	0.03	jw, ka
	1	0.5	0.18	
	2	0.5	1.12	
	3	0.6	1.95	
	4	0.6	1.56	
	5	0.6	0.51	

	6	0.6	0.09	
9/11/2018	0	0.1	0.01	jw, ka
	1	0.3	0	
	2	0.5	1.99	
	3	0.7	2.36	
	4	0.7	1.98	
	5	0.7	0.68	
	6	0.4	0	

Long Trade Lake, Outlet downstream CTH Z				
Date	Foot	Depth (ft)	Flow (m/s)	
6/1/2016	0	0.1	0.02	KA, KF, JW
	1	0.2	0.01	11:38
	2	0.3	0.07	
	3	0.3	0.25	
	4	0.3	0.23	
	5	0.4	0.06	
	6	0.1	0.43	
	7	0.7	0.42	
	8	0.5	1.08	
	9	0.5	0.81	
	10	0.9	0.97	
	11	0.9	1.44	
	12	1	1.21	
	13	0.9	0.86	
	14	0.8	0.75	
	15	1	0.85	
	16	1	0.45	
	17	1.1	0.94	
	18	0.5	1.42	
	19	0.9	0.74	
	20	0.8	0.82	
	21	0.7	0.85	
	22	0.6	0.64	
	23	0.5	0.83	
	24	0.5	0.85	
	25	0.6	0.01	
	26	0.7	0.2	
	27	0.6	0.82	
	28	0.4	0.8	
	29	0.1	0.06	
6/14/2016	0	0.1	0	KA, KF
	1	0.1	0.05	12:00 pm
	2	0.1	0.02	
	3	0.2	0.14	
	4	0.3	0.07	
	5	0.1	0.3	
	6	0.5	0.05	
	7	0.4	0.59	
	8	0.6	0.68	
	9	0.8	0.45	
	10	0.7	0.54	
	11	0.8	1.05	
	12	0.9	0.91	
	13	0.8	0.32	
	14	0.9	0.93	
	15	0.9	0.16	
	16	0.9	1.06	
	17	0.9	1.08	
	18	0.7	0.36	
	19	0.7	0.83	
	20	0.7	0.79	
	21	0.3	0.69	
	22	0.4	0.56	
	23	0.3	0.71	
	24	0.5	0.37	
	25	0.3	0.69	
	26	0.5	0.19	
	27	0.4	0.82	
	28	0.2	0.3	
7/6/2016	0	0.2	0.07	KA, KF, JW
	1	0.4	0.46	11:45am
	2	0.6	0.46	
	3	0.7	0.42	
	4	0.8	0.53	
	5	0.8	0.24	
	6	0.8	0.18	
	7	0.9	0.09	
	8	0.9	0.17	
	9	0.6	1.14	
	10	0.8	0.84	
	11	1	0.14	
	12	1	1.23	
	13	1	0.01	
	14	1	0.5	
	15	0.9	0.58	
	16	0.8	0.24	
	17	0.7	0.75	
	18	0.5	0.83	
	19	0.6	0.31	

	20	0.4	0.59	
	21	0.5	0.31	
	22	0.5	0.24	
	23	0.4	0.21	
	24	0.3	0.32	
	25	0.2	0.17	
	26	0.4	0.08	
	27	0.2	0.02	
	28	0.2	0.16	
	29	0.2	0.1	
7/19/2016	0	0.1	0	KA, KF
	1	0.1	0.8	11:32 am
	2	0.3	0.34	
	3	0.3	0.54	
	4	0.2	0.44	
	5	0.3	0.41	
	6	0.2	0.21	
	7	0.5	0.44	
	8	0.8	0.56	
	9	0.7	0.51	
	10	0.9	0.28	
	11	0.8	1.25	
	12	1	1.09	
	13	0.8	0.61	
	14	0.9	1.01	
	15	1	0.86	
	16	0.4	1	
	17	1	1.16	
	18	0.9	1.15	
	19	0.9	0.76	
	20	0.8	0.94	
	21	0.6	0.59	
	22	0.4	0.81	
	23	0.5	0.63	
	24	0.5	0.76	
	25	0.2	0.43	
	26	0.5	0.59	
	27	0.6	0.92	
	28	0.4	0.49	
	29	0.2	0.13	
8/2/2016	0	0.1	0	KA, KF, JW

	1	0.1	0.14	11:10am
	2	0.2	0.16	
	3	0.3	0.26	
	4	0.4	0.18	
	5	0.2	0.25	
	6	0.4	0.11	
	7	0.5	0.29	
	8	0.7	0.6	
	9	0.6	0.38	
	10	0.6	0.56	
	11	0.9	0.66	
	12	0.9	1.16	
	13	1	0.42	
	14	0.9	0.74	
	15	0.9	0.98	
	16	1	0.54	
	17	0.8	1.29	
	18	0.9	0.99	
	19	0.8	1.1	
	20	0.7	0.62	
	21	0.7	0.86	
	22	0.5	0.64	
	23	0.4	0.82	
	24	0.3	0.28	
	25	0.5	0.38	
	26	0.4	0.7	
	27	0.4	0.82	
	28	0.3	0.25	
8/18/2016	0	0.4	0.32	KA, EW
	1	0.7	0.77	
	2	0.7	0.98	
	3	0.8	0.66	
	4	0.5	0.43	
	5	0.8	0.67	
	6	0.7	0.63	
	7	0.8	0.57	
	8	0.9	0.59	
	9	1.1	1.11	
	10	1	0.81	
	11	0.6	1.38	
	12	1.1	0.88	

	13	1.2	0.48	
	14	1.2	0.48	
	15	1.1	0.46	
	16	1.2	1.08	
	17	1	1.2	
	18	1.1	0.98	
	19	1.1	1.05	
	20	0.8	1.15	
	21	0.9	0.71	
	22	0.7	0.44	
	23	0.6	0.76	
	24	0.6	0.58	
	25	0.6	0.59	
	26	0.5	0.61	
	27	0.4	0.69	
	28	0.5	0.53	
	29	0.4	0.28	
8/30/2016	0	0.3	0.07	11:10AM
	1	0.8	0.59	
	2	1.1	0.92	
	3	1.2	0.72	
	4	1.2	0.75	
	5	1.1	0.76	
	6	1.1	0.73	
	7	1.1	1.03	
	8	1.2	0.85	
	9	1.4	0.81	
	10	1.5	0.69	
	11	1.5	0.83	
	12	1.5	0.88	
	13	1.6	0.86	
	14	1.7	0.81	
	15	1.6	0.77	
	16	1.7	0.74	
	17	1.6	0.72	
	18	1.6	1.03	
	19	1.5	1.02	
	20	1.5	0.91	
	21	1.5	0.75	
	22	1.4	0.81	
	23	1.1	0.73	

	24	1.1	0.85	
	25	1	0.83	
	26	0.9	0.88	
	27	0.9	0.84	
	28	0.8	0.79	
	29	0.7	0.8	
	30	0.7	0.49	
	31	0.5	0.14	
9/12/2016	0	0.3	0.19	
	1	0.6	0.45	
	2	0.8	0.71	
	3	0.9	0.84	
	4	0.9	0.62	
	5	1	0.17	
	6	1	0.63	
	7	0.9	0.67	
	8	1	0.53	
	9	1.1	0.78	
	10	1.2	0.71	
	11	1.2	0.88	
	12	1.2	0.73	
	13	1.3	0.48	
	14	1.3	0.26	
	15	1.3	0.51	
	16	1.3	0.67	
	17	1.2	1.08	
	18	1.2	0.67	
	19	1	1	
	20	0.7	0.98	
	21	0.8	1	
	22	1	0.82	
	23	0.9	0.59	
	24	0.8	0.63	
	25	0.7	0.59	
	26	0.5	0.66	
	27	0.6	0.47	
	28	0.6	0.61	
	29	0.6	0.51	
	30	0.4	0.24	
	31	0.3	0.03	
9/28/2016	0	0.4	0.06	

	1	0.6	0.47	
	2	0.8	0.74	
	3	1	0.78	
	4	1.1	0.55	
	5	1.1	0.69	
	6	1	0.49	
	7	1.1	0.29	
	8	1.2	0.15	
	9	1.2	0.79	
	10	1.1	1.06	
	11	1.3	0.83	
	12	1.3	0.06	
	13	0.5	0.81	
	14	1.1	0.81	
	15	1.3	0.67	
	16	1.2	0.77	
	17	0.9	1.01	
	18	1.1	0.9	
	19	0.7	0.95	
	20	0.9	0.71	
	21	0.9	0.78	
	22	0.9	0.31	
	23	0.8	0.38	
	24	0.8	0.53	
	25	0.8	0.55	
	26	0.7	0.54	
	27	0.7	0.41	
	28	0.6	0.27	
	29	0.7	0.4	
	30	0.5	0.27	
	31	0.2	0.1	
5/23/2017	0	1	0.03	
	1	1.4	0.02	
	2	1.7	1.34	
	3	1.7	1.69	
	4	1.8	1.61	
	5	1.9	1.69	
	6	1.9	1.51	
	7	1.9	1.49	
	8	2	1.02	
	9	2	1.75	

	10	1.1	1.47	
	11	2	1.75	
	12	2.1	0.99	
	13	2.1	1.54	
	14	2.1	1.37	
	15	2	2.02	
	16	1.9	1.75	
	17	1.9	1.44	
	18	2	1.71	
	19	1.8	1.84	
	20	1.8	1.33	
	21	1.8	1.57	
	22	1.6	1.66	
	23	1.7	1.62	
	24	1.6	1.33	
	25	1.6	1.55	
	26	1.6	1.64	
	27	1.5	1.36	
	28	1.5	1.62	
	29	1.5	1.46	
	30	1.3	1.05	
	31	1	0.54	
6/6/2017	0	0.2	0.33	
	1	0.4	0.42	
	2	0.4	0.37	
	3	0.4	0.37	
	4	0.4	0.47	
	5	0.5	0.53	
	6	0.5	0.48	
	7	0.6	0.47	
	8	0.6	0.71	
	9	0.7	0.87	
	10	0.7	0.71	
	11	0.8	1.18	
	12	0.9	1.15	
	13	1	0.79	
	14	1	0.94	
	15	1	0.84	
	16	1.1	0.92	
	17	1	0.41	
	18	1	1.34	

	19	1	1.62	
	20	1	1.18	
	21	1	0.42	
	22	0.9	0.21	
	23	1	1.01	
	24	1	0.81	
	25	0.8	0.65	
	26	0.7	0.86	
	27	0.6	0.97	
	28	0.5	0.47	
6/21/2017	0	0.2	0.08	KA,JW,CS
	1	0.2	0.06	10:32AM
	2	0.2	0.1	
	3	0.4	0.21	
	4	0.5	0.26	
	5	0.6	0.22	
	6	0.7	0.34	
	7	0.5	0.56	
	8	0.7	0.86	
	9	0.7	0.68	
	10	1	0.56	
	11	1.1	1.11	
	12	1.1	1.39	
	13	1.1	0.68	
	14	1.1	0.83	
	15	1.1	0.62	
	16	1	1.08	
	17	1	1.53	
	18	1	0.94	
	19	1	1.1	
	20	0.8	0.94	
	21	0.6	0.58	
	22	0.6	0.67	
	23	0.7	0.7	
	24	0.6	0.48	
	25	0.6	0.36	
	26	0.7	0.62	
	27	0.6	0.68	
	28	0.5	0.48	
	29	0.3	0.09	
7/19/2017	0	0.7	0.59	

	1	0.7	0.83	
	2	0.8	1.01	
	3	0.7	0.71	
	4	0.8	0.31	
	5	0.8	0.76	
	6	0.9	0.91	
	7	1	0.97	
	8	1.1	1.2	
	9	1.2	0.99	
	10	1.3	0.96	
	11	0.4	1.36	
	12	1.3	1.14	
	13	1.6	0.81	
	14	0.4	0.55	
	15	0.3	0.6	
	16	0.5	0.97	
	17	1.5	1.03	
	18	1.5	1.06	
	19	1.5	0.88	
	20	1.4	0.85	
	21	1.3	0.99	
	22	1.2	1.01	
	23	1	1.07	
	24	1.2	0.85	
	25	1.3	0.99	
	26	1.2	1.05	
	27	1.1	0.89	
	28	1	0.81	
	29	0.9	0.37	
	30	0.5	0.11	
7/31/2017	0	0.2	0	
	1	0.2	0.01	
	2	0.2	0.1	
	3	0.3	0.13	
	4	0.4	0.12	
	5	0.4	0.2	
	6	0.5	0.27	
	7	0.6	0.55	
	8	0.6	0.63	
	9	0.8	0.42	
	10	0.9	0.62	

	11	1	0.67	
	12	1	1.04	
	13	1	0.77	
	14	1	0.69	
	15	1	0.72	
	16	0.9	0.52	
	17	0.9	0.97	
	18	0.9	1.12	
	19	0.9	0.92	
	20	0.8	0.96	
	21	0.7	0.71	
	22	0.6	0.58	
	23	0.6	0.51	
	24	0.5	0.51	
	25	0.5	0.13	
	26	0.6	0.36	
	27	0.6	0.68	
	28	0.3	0.43	
	29	0.2	0.03	
8/15/2017	0	0.1	0	
	1	0.4	0.1	
	2	0.6	0.33	
	3	0.5	0.39	
	4	0.6	0.34	
	5	0.6	0.28	
	6	0.6	0.28	
	7	0.7	0.42	
	8	0.6	0.57	
	9	0.8	0.54	
	10	1	0.47	
	11	0.9	0.87	
	12	0.7	1.1	
	13	0.9	1.02	
	14	1.2	1.23	
	15	1.2	0.48	
	16	1.1	0.29	
	17	1.1	0.26	
	18	1.1	0.46	
	19	1.1	0.84	
	20	1.2	0.55	
	21	1	1	

	22	0.8	0.81	
	23	0.8	0.5	
	24	0.9	0.42	
	25	0.9	0.41	
	26	0.5	0.61	
	27	0.7	0.64	
	28	0.7	0.69	
	29	0.7	0.61	
	30	0.6	0.16	
	31	0.1	0.04	
9/5/2017	0	0.2	0.06	
	1	0.4	0.44	
	2	0.5	0.71	
	3	0.6	0.48	
	4	0.7	0.42	
	5	0.7	0.45	
	6	0.8	0.59	
	7	0.8	0.08	
	8	0.7	0.64	
	9	0.6	0.49	
	10	0.9	0.61	
	11	0.5	0.86	
	12	0.9	0.55	
	13	1	0.41	
	14	1	0.31	
	15	0.9	0.21	
	16	0.7	0.42	
	17	1.1	0.37	
	18	0.9	0.69	
	19	0.6	0.59	
	20	0.8	0.45	
	21	0.8	0.39	
	22	0.6	0.35	
	23	0.6	0.24	
	24	0.6	0.26	
	25	0.5	0.18	
	26	0.4	0.22	
	27	0.4	0.13	
	28	0.4	0.13	
	29	0.3	0.09	
	30	0.3	0.08	

5/23/2018	0	0.2	0.1	JW, BE
	1	0.7	0.9	
	2	0.8	0.82	
	3	0.8	0.92	
	4	0.8	0.84	
	5	0.7	0.68	
	6	0.7	0.67	
	7	0.8	0.95	
	8	0.9	1.29	
	9	1	1.04	
	10	0.8	0.92	
	11	1	0.64	
	12	1	0.72	
	13	1.1	0.67	
	14	1.1	0.65	
	15	1.1	1.03	
	16	1	0.89	
	17	0.8	0.8	
	18	0.7	0.58	
	19	0.7	0.54	
	20	0.6	0.41	
	21	0.5	0.51	
	22	0.5	0.42	
	23	0.5	0.43	
	24	0.6	0.34	
	25	0.5	0.29	
	26	0.4	0.21	
	27	0.3	0.11	
	28	0.3	0.15	
	29	0.2	0.01	
6/11/2018	0	0.2	0	be, jw
	1	0.3	0.12	
	2	0.6	0.78	
	3	0.8	1.05	
	4	0.8	0.72	
	5	0.9	0.74	
	6	1	0.76	
	7	0.9	0.2	
	8	0.9	0.45	
	9	0.9	1.19	
	10	1	1.32	

	11	1	0.39	
	12	1	0.29	
	13	1	0.08	
	14	1.1	1.33	
	15	1	0.72	
	16	1	0.86	
	17	1	0.73	
	18	0.8	0.82	
	19	0.7	0.63	
	20	0.5	0.66	
	21	0.6	0.54	
	22	0.6	0.36	
	23	0.6	0.62	
	24	0.6	0.53	
	25	0.6	0.44	
	26	0.5	0.57	
	27	0.6	0.37	
	28	0.5	0.32	
	29	0.5	0.39	
	30	0.2	0.17	
6/27/2018	0	1	0.27	
	1	1.2	1.15	
	2	1.3	1.44	
	3	1.3	1.51	
	4	1.3	0.99	
	5	1.2	1.13	
	6	1.2	1.11	
	7	1.5	1.26	
	8	1.5	1.27	
	9	1.6	1.43	
	10	1.8	1.19	
	11	1.8	1.18	
	12	1.9	0.92	
	13	1.8	1.33	
	14	2	1.49	
	15	1.8	1.23	
	16	1.7	0.9	
	17	1.8	1.22	
	18	1.9	0.94	
	19	1.7	1.16	
	20	1.7	1.02	

	21	1.5	1.37	
	22	1.5	1.01	
	23	1.5	1.03	
	24	1.4	1.14	
	25	1.5	1.21	
	26	1.5	1.08	
	27	1.6	1.43	
	28	1.3	0.77	
	29	1	0.68	
7/16/2018	0	0.7	0.41	high water
	1	1.2	1.12	brown
	2	1.4	1.13	murky
	3	1.4	1.29	sediment
	4	1.5	1.41	
	5	1.5	1.05	
	6	1.5	1.4	
	7	1.4	1.16	
	8	1.8	1.17	
	9	1.5	1.44	
	10	1.5	1.16	
	11	1.8	1.18	
	12	1.7	1.25	
	13	1.7	1.24	
	14	1.8	1.29	
	15	1.7	1.83	
	16	1.8	1.35	
	17	1.6	1.39	
	18	1.6	1.66	
	19	1.6	1.46	
	20	1.4	1.27	
	21	1.5	1.32	
	22	1.5	1.19	
	23	1.4	1.52	
	24	1.3	1.37	
	25	1.3	1.17	
	26	1.2	1.25	
	27	1.1	1.38	
	28	1	0.54	
7/30/2018	0	0.2	0	be, ka,jw
	1	0.4	0.02	
	2	0.5	0.16	

	3	0.5	0.28	
	4	0.4	0.12	
	5	0.5	0.2	
	6	0.5	0.32	
	7	0.6	0.39	
	8	0.6	0.49	
	9	0.6	0.51	
	10	0.7	0.49	
	11	0.7	0.71	
	12	0.8	0.91	
	13	1	0.85	
	14	1	0.92	
	15	1	0.73	
	16	1	1.27	
	17	1	0.79	
	18	0.9	0.64	
	19	0.9	0.72	
	20	0.8	0.91	
	21	0.8	0.97	
	22	0.6	0.95	
	23	0.5	0.67	
	24	0.5	0.79	
	25	0.5	0.83	
	26	0.6	0.51	
	27	0.6	0.58	
	28	0.5	0.71	
	29	0.3	0.62	
8/13/2018	0	0.2	0.01	be, ka, jw
	1	0.2	0.2	
	2	0.3	0.21	
	3	0.3	0.1	
	4	0.5	0.23	
	5	0.5	0.28	
	6	0.6	0.45	
	7	0.6	0.47	
	8	0.6	0.63	
	9	0.8	1.04	
	10	0.8	0.92	
	11	0.8	0.62	
	12	0.8	1.16	
	13	0.6	0.61	

	14	0.6	0.77	
	15	0.6	0.8	
	16	0.6	0.35	
	17	0.6	1.57	
	18	0.6	0.7	
	19	0.5	0.32	
	20	0.4	1.19	
	21	0.4	0	
	22	0.4	0.08	
	23	0.5	0.75	
	24	0.5	1.21	
	25	0.5	0.95	
	26	0.3	0.35	
	27	0.6	0.3	
8/30/2018	0	0.4	0.14	jw, ka
	1	0.8	0.49	
	2	0.9	0.43	
	3	0.8	0.46	
	4	0.8	0.44	
	5	0.9	0.61	
	6	0.9	0.57	
	7	0.9	0.69	
	8	1	0.62	
	9	1	0.46	
	10	1	0.36	
	11	1.1	0.52	
	12	1.2	0.7	
	13	1.1	0.89	
	14	1.2	0.67	
	15	1.1	0.51	
	16	1.2	0.37	
	17	1.3	0.59	
	18	0.9	0.7	
	19	0.8	0.99	
	20	1.2	0.73	
	21	1.3	0.48	
	22	1.3	0.42	
	23	1.1	0.13	
	24	1.1	0.6	
	25	1.1	0.61	
	26	1.1	0.68	

	27	1.1	0.76	
	28	1	0.59	
	29	0.8	0.33	
	30	0.5	0.2	
9/11/2018	0	0.5	0.12	jw, ka
	1	0.6	0.49	
	2	0.6	0.45	
	3	0.6	0.46	
	4	0.6	0.5	
	5	0.6	0.51	
	6	0.7	0.51	
	7	0.8	0.65	
	8	0.9	0.5	
	9	0.9	0.57	
	10	0.9	0.76	
	11	1	0.84	
	12	1.1	0.71	
	13	1.2	0.55	
	14	1.3	0.46	
	15	1.2	0.34	
	16	1.2	0.37	
	17	1.2	0.59	
	18	1.2	0.49	
	19	1.2	0.81	
	20	1	0.73	
	21	0.8	0.59	
	22	0.9	0.61	
	23	0.8	0.52	
	24	0.9	0.67	
	25	0.9	0.55	
	26	0.9	0.73	
	27	0.9	0.57	
	28	0.8	0.29	
	29	0.7	0.2	
	30	0.4	0.39	

Long Trade Lake Management Plan

Phytoplankton

Appendix D:

	Lake	Long Trade	Long Trade	Long Trade
	Year	2016	2016	2016
	Month	June	July	August
	Day	1	6	30
Division	Taxa	cells/ml	cells/ml	cells/ml
Bacillariophyta	Amphora	0.0	0.0	0.0
Bacillariophyta	Asterionella	1019.6	0.0	0.0
Bacillariophyta	Aulacoseira granulata	0.0	0.0	8.6
Bacillariophyta	centric sm	0.0	0.0	0.0
Bacillariophyta	Cocconeis	0.0	0.0	0.0
Bacillariophyta	Cymbella	0.0	0.0	0.0
Bacillariophyta	Fragilaria crotonensis	13866.7	0.0	17.1
Bacillariophyta	Gomhonema	0.0	0.0	0.0
Bacillariophyta	Naviculoid	51.0	0.0	17.1
Bacillariophyta	Nitzschia	0.0	0.0	0.0
Bacillariophyta	Stephanodiscus	51.0	0.0	0.0
Bacillariophyta	Synedra	0.0	0.0	0.0
Bacillariophyta	Tabellaria	0.0	0.0	0.0
Chlorophyta	Actinastrum	0.0	0.0	0.0
Chlorophyta	Ankistrodesmus	0.0	0.0	0.0
Chlorophyta	Arthrodesmus	0.0	0.0	0.0
Chlorophyta	Characium	0.0	0.0	0.0
Chlorophyta	Chlamydomonas	0.0	54.7	17.1
Chlorophyta	Closterium	0.0	0.0	0.0
Chlorophyta	Coccoid greens	0.0	219.0	8.6
Chlorophyta	Coelastrum	0.0	0.0	0.0
Chlorophyta	Cosmarion	0.0	0.0	0.0
Chlorophyta	Crucigenia	0.0	0.0	0.0
Chlorophyta	Cylindrocapsa	0.0	0.0	0.0
Chlorophyta	Dictyosphaerium	0.0	0.0	0.0
Chlorophyta	Elactothrix	0.0	0.0	0.0
Chlorophyta	Euastrum	0.0	0.0	0.0
Chlorophyta	Eudorina	0.0	0.0	51.4
Chlorophyta	Franceia	0.0	0.0	0.0
Chlorophyta	Gloeocystis	0.0	0.0	0.0
Chlorophyta	Kirchneriella	0.0	0.0	0.0
Chlorophyta	Lagerheimia	0.0	0.0	0.0
Chlorophyta	Mougeotia	0.0	0.0	0.0
Chlorophyta	Nephrocytium	0.0	0.0	0.0
Chlorophyta	Oedogonium	0.0	0.0	0.0
Chlorophyta	Oocystis	102.0	54.7	42.9
Chlorophyta	Pandorina	0.0	0.0	0.0
Chlorophyta	Pediastrum	0.0	0.0	0.0
Chlorophyta	Quadrigula	0.0	0.0	0.0
Chlorophyta	Scenedesmus	0.0	219.0	0.0

Chlorophyta	Schroederia	0.0	136.9	25.7
Chlorophyta	Sphaerocystis	0.0	1779.2	51.4
Chlorophyta	Spondylosium	0.0	0.0	0.0
Chlorophyta	Staurastrum	51.0	0.0	0.0
Chlorophyta	Tetraedron	0.0	0.0	0.0
Chrysophyta	Synura	0.0	0.0	0.0
Chrysophyta	Dinobryon	0.0	0.0	0.0
Chrysophyta	Komma Caudata	51.0	438.0	162.9
Chrysophyta	Mallomonas	102.0	0.0	0.0
Chrysophyta	Uroglenopsis	0.0	0.0	0.0
Cryptomonam	Cryptomonas	305.9	383.2	120.0
Cyanophyta	Anabaena	0.0	5748.3	102.9
Cyanophyta	Aphanizomenon flos-aquae	0.0	7774.0	2537.7
Cyanophyta	Aphanocapsa	0.0	0.0	0.0
Cyanophyta	Aphanothece	0.0	0.0	0.0
Cyanophyta	Chroococcus	0.0	0.0	17.1
Cyanophyta	Coelospharium	0.0	9854.3	2400.5
Cyanophyta	Gomphosphaeria	0.0	0.0	0.0
Cyanophyta	Gloeocapsa	0.0	0.0	0.0
Cyanophyta	Merismopedia	0.0	0.0	0.0
Cyanophyta	Microcystis	0.0	2107.7	3180.7
Cyanophyta	Oscillatoria	0.0	0.0	0.0
Cyanophyta	Phormidia	0.0	0.0	0.0
Cyanophyta	Planktolyngbya	0.0	164.2	2057.6
Cyanophyta	Schizothrix	0.0	0.0	0.0
Euglenophyta	Euglena	305.9	1779.2	0.0
Euglenophyta	Trachelomonas	51.0	27.4	8.6
Pyrrhophyta	Ceratium	152.9	328.5	68.6
Pyrrhophyta	Gymnodinium	0.0	219.0	540.1
Pyrrhophyta	Peridinium	0.0	0.0	0.0
	total	16109.8	31287.4	11436.7

Lake		Long Trade	Long Trade	Long Trade
year		**2017**	**2017**	**2017**
date		**June**	**July**	**September**
day		**21**	**31**	**5**
conc factor		**1**	**1**	**1**
transects		**5**	**2**	**4**
% palmer counted		**0.130**	**0.062**	**0.122**
Division	**Taxa**	**cells/ml**	**cells/ml**	**cells/ml**
Bacillariophyta	Amphora	0	0	0
Bacillariophyta	Asterionella	0	0	0
Bacillariophyta	Aulacoseira granulata	0	162	82
Bacillariophyta	centric sm	0	162	247
Bacillariophyta	Cocconeis	0	0	0
Bacillariophyta	Cymbella	0	0	0
Bacillariophyta	Fragilaria crotonensis	4788	0	82
Bacillariophyta	Gomhonema	0	162	0
Bacillariophyta	Naviculoid	0	0	0
Bacillariophyta	Nitzschia	0	0	0
Bacillariophyta	Stephanodiscus	154	0	82
Bacillariophyta	Synedra	0	0	0
Bacillariophyta	Tabellaria	0	0	0
Chlorophyta	Actinastrum	0	0	0
Chlorophyta	Ankistrodesmus	77	0	0
Chlorophyta	Arthrodesmus	0	0	0
Chlorophyta	Characium	0	0	0
Chlorophyta	Chlamydomonas	0	0	164
Chlorophyta	Closterium	0	0	0
Chlorophyta	Coccoid greens	0	324	247
Chlorophyta	Coelastrum	0	647	575
Chlorophyta	Cosmarion	0	0	0
Chlorophyta	Crucigenia	0	0	0
Chlorophyta	Cylindrocapsa	0	0	0
Chlorophyta	Dictyosphaerium	0	0	0
Chlorophyta	Elactothrix	0	0	329
Chlorophyta	Euastrum	0	0	0
Chlorophyta	Eudorina	0	0	0
Chlorophyta	Franceia	0	0	0
Chlorophyta	Gloeocystis	0	0	0
Chlorophyta	Kirchneriella	0	0	0
Chlorophyta	Lagerheimia	0	0	0
Chlorophyta	Mougeotia	0	0	0
Chlorophyta	Nephrocytium	0	0	1068
Chlorophyta	Oedogonium	0	0	0
Chlorophyta	Oocystis	0	0	0
Chlorophyta	Pandorina	0	0	0
Chlorophyta	Pediastrum	0	0	0
Chlorophyta	Quadrigula	0	0	0

Chlorophyta	Scenedesmus	0	0	1315
Chlorophyta	Schroederia	0	0	0
Chlorophyta	Sphaerocystis	0	0	0
Chlorophyta	Spondylosium	0	0	0
Chlorophyta	Staurastrum	0	0	0
Chlorophyta	Tetraedron	0	0	0
Chrysophyta	Synura	0	0	0
Chrysophyta	Dinobryon	0	0	0
Chrysophyta	Komma Caudata	0	0	0
Chrysophyta	Mallomonas	0	0	0
Chrysophyta	Uroglenopsis	0	0	0
Cryptomonam	Cryptomonas	0	1133	0
Cyanophyta	Anabaena	24710	45955	8218
Cyanophyta	Aphanizomenon flos-aquae	104826	254854	186129
Cyanophyta	Aphanocapsa	0	0	0
Cyanophyta	Aphanothece	0	0	0
Cyanophyta	Chroococcus	309	0	0
Cyanophyta	Coelospharium	0	12136	94502
Cyanophyta	Gomphosphaeria	0	0	0
Cyanophyta	Gloeocapsa	0	0	0
Cyanophyta	Merismopedia	0	0	0
Cyanophyta	Microcystis	772	37217	4109
Cyanophyta	Oscillatoria	0	0	0
Cyanophyta	Phormidia	0	0	0
Cyanophyta	Planktolyngbya	0	0	0
Cyanophyta	Schizothrix	0	0	0
Euglenophyta	Euglena	0	162	0
Euglenophyta	Trachelomonas	154	1780	247
Pyrrhophyta	Ceratium	0	162	329
Pyrrhophyta	Gymnodinium	0	0	0
	total	**135792**	**354854**	**297724**
	Bacillariophyta	**4942**	**485**	**493**
	Chlorophyta	**77**	**971**	**3698**
	Chrysophyta	**0**	**0**	**0**
	Cryptomonam	**0**	**1133**	**0**
	Cyanophyta	**130618**	**350162**	**292958**
	Euglenophyta	**154**	**1942**	**247**
	Pyrrhophyta	**0**	**162**	**329**

Lake		Long Trade	Long Trade	Long Trade
year		2018	2018	2018
date		June	July	August
day		11	16	13
Division	**Taxa**	cells/ml	cells/ml	cells/ml
Bacillariophyta	Amphora	0	0	0
Bacillariophyta	Asterionella	258	0	0
Bacillariophyta	Aulacoseira granulata	355	6127	1385
Bacillariophyta	centric sm	65	46	0
Bacillariophyta	Cocconeis	32	0	0
Bacillariophyta	Cymbella	0	0	0
Bacillariophyta	Fragilaria crotonensis	8234	230	0
Bacillariophyta	Frustulia	0	46	0
Bacillariophyta	Gomhonema	0	0	0
Bacillariophyta	Naviculoid	0	92	0
Bacillariophyta	Nitzschia	0	46	0
Bacillariophyta	Reimeria	0	46	0
Bacillariophyta	Stauroneis	0	46	0
Bacillariophyta	Stephanodiscus	97	0	0
Bacillariophyta	Synedra	0	46	0
Bacillariophyta	Tabellaria	0	0	0
Chlorophyta	Actinastrum	0	0	0
Chlorophyta	Ankistrodesmus	0	0	0
Chlorophyta	Arthrodesmus	0	0	0
Chlorophyta	Characium	0	0	0
Chlorophyta	Chlamydomonas	0	322	77
Chlorophyta	Closterium	0	0	0
Chlorophyta	Coccoid greens	65	276	308
Chlorophyta	Coelastrum	0	0	0
Chlorophyta	Cosmarion	65	0	0
Chlorophyta	Crucigenia	0	0	0
Chlorophyta	Cylindrocapsa	0	0	0
Chlorophyta	Dictyosphaerium	0	875	0
Chlorophyta	Elactothrix	0	0	0
Chlorophyta	Euastrum	0	0	0
Chlorophyta	Eudorina	0	967	0
Chlorophyta	Franceia	0	0	0
Chlorophyta	Gloeocystis	0	0	154
Chlorophyta	Kirchneriella	0	0	0
Chlorophyta	Lagerheimia	0	0	0
Chlorophyta	Mougeotia	0	92	154

Chlorophyta	Nephrocytium	65	92	0
Chlorophyta	Oedogonium	0	0	0
Chlorophyta	Oocystis	807	369	923
Chlorophyta	Pandorina	0	0	308
Chlorophyta	Pediastrum	484	0	0
Chlorophyta	Quadrigula	0	0	0
Chlorophyta	Scenedesmus	65	276	77
Chlorophyta	Schroederia	97	46	154
Chlorophyta	Sphaerocystis	1840	1014	3308
Chlorophyta	Spondylosium	0	0	0
Chlorophyta	Staurastrum	0	0	0
Chlorophyta	Tetraedron	0	0	0
Chrysophyta	Dinobryon	0	0	0
Chrysophyta	Komma Caudata	0	46	77
Chrysophyta	Mallomonas	0	0	0
Chrysophyta	Synura	0	0	0
Chrysophyta	Uroglenopsis	0	0	0
Cryptomonam	Cryptomonas	0	0	0
Cyanophyta	Anabaena	0	3133	5000
Cyanophyta	Aphanizomenon flos-aquae	323	2626	11462
Cyanophyta	Aphanocapsa	0	0	0
Cyanophyta	Aphanothece	0	184	0
Cyanophyta	Chroococcus	0	0	0
Cyanophyta	Coelospharium	0	230	1154
Cyanophyta	Gloeocapsa	0	0	0
Cyanophyta	Gomphosphaeria	517	0	308
Cyanophyta	Merismopedia	0	0	0
Cyanophyta	Microcystis	0	184	1462
Cyanophyta	Oscillatoria	129	0	7538
Cyanophyta	Phormidia	0	0	0
Cyanophyta	Planktolyngbya	0	0	0
Cyanophyta	Schizothrix	0	0	231
Euglenophyta	Euglena	0	138	0
Euglenophyta	Leptocliclus?	0	46	0
Euglenophyta	Trachelomonas	32	276	154
Pyrrhophyta	Ceratium	32	0	77
Pyrrhophyta	Gymnodinium	0	0	0
Pyrrhophyta	Peridinium	0	0	0
	total	**13562**	**17921**	**34308**
	Bacillariophyta	9041	6726	1385
	Chlorophyta	3487	4331	5462

	Cyanophyta	969	6358	27154
	Euglenophyta	32	461	154

Long Trade Lake Management Plan

Modeling

Appendix E:

Date: 10/22/2019 Scenario: 13

Lake Id: KAfull2016

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 29228.0 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 19485.3 acre-ft
Lake Surface Area <As>: 150.0 acre
Lake Volume <V>: 1200.0 acre-ft
Lake Mean Depth <z>: 8.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 19526.6 acre-ft/year
Areal Water Load <qs>: 130.2 ft/year
Lake Flushing Rate <p>: 16.27 1/year
Water Residence Time: 0.06 year
Observed spring overturn total phosphorus (SPO): 53 mg/m^3
Observed growing season mean phosphorus (GSM): 135 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	3361.0	0.50	1.00	3.00	43.2	680	1360	4081
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	6891.0	0.10	0.30	0.50	26.6	279	837	1394
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	969.0	0.30	0.50	0.80	6.2	118	196	314
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	4241.0	0.10	0.10	0.10	5.5	172	172	172
Forest	12846.0	0.05	0.09	0.18	14.9	260	468	936
Lake Surface	150.0	0.10	0.30	1.00	0.6	6	18	61

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	54.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.32	2.70	8.64	0.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	3410.3	6941.9	16055.6	100.0
Total Loading (kg)	1546.9	3148.8	7282.8	100.0
Areal Loading (lb/ac-year)	22.74	46.28	107.04	
Areal Loading (mg/m^2-year)	2548.29	5187.26	11997.38	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	3396.2	6895.8	15902.7	99.9
Total NPS Loading (kg)	1540.5	3127.9	7213.4	99.9

Wisconsin Internal Load Estimator

Date: 10/22/2019 Scenario: 2

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 117 mg/m^3
Phosphorus Inflow Concentration: 130.7 mg/m^3
Areal External Loading: 5187.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.26
Observed Phosphorus Retention Coefficient: 0.11
Internal Load: 1076 Lb 488 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 162 mg/m^3
Hypolimnetic Volume: 190.17 acre-ft
Anoxia Sediment Area: 43.92 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: .97 mg/m^3
Hypolimnetic Volume: 288.12 acre-ft
Anoxia Sediment Area: 43.92 acres
Time Period of Stratification: 104 days
Sediment Phosphorus Release Rate: -2.0 mg/m^2-day -5.54E-003 lb/acre-day
Internal Load: -83 Lb -38 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 162 mg/m^3

Hypolimnetic Volume: 190.17 acre-ft
Anoxia Sediment Area: 43.92 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 126 mg/m^3
Lake Volume: 1200.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 43.92 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 27.9 mg/m^2-day 7.57E-002 lb/acre-day
Internal Load: 327 Lb 149 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 43.92 acre
End of Anoxia Anoxic Sediment Area: 43.92 acre
Phosphorus Release Rate As Calculated In Method 2: -2.0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -2.0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 12.9 mg/m^2-day
Period of Anoxia: 104 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	75	174	298
Internal Load: (kg)	34	79	135

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 6942 Lb 3149 kg

	Lb	kg	%
From A Complete Mass Budget:	1076	488	13.4
From Growing Season In Situ Phosphorus Increases:	-83	-38	-1.2
From In Situ Phososphorus Increases In The Fall:	327	149	4.5
From Phososphorus Release Rate and Anoxic Area:	174	79	2.4

Predicted Water Column Total Phosphorus Concentration (ug/l)

Nurnberg+ 1984 Total Phosphorus Model:	Low	Most Likely	High
	0	0	0

Osgood, 1988 Lake Mixing Index: 0
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	0	0	0
Internal Load (kg):	0	0	0
External Load (Lb):	0	0	0
External Load (kg):	0	0	0

Total Load (Lb):	0	0	0
Total Load (kg):	0	0	0

Wisconsin Internal Load Estimator

Date: 10/22/2019 Scenario: 3

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 117 mg/m^3
Phosphorus Inflow Concentration: 130.7 mg/m^3
Areal External Loading: 5187.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.26
Observed Phosphorus Retention Coefficient: 0.11
Internal Load: 1076 Lb 488 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 162 mg/m^3
Hypolimnetic Volume: 190.17 acre-ft
Anoxia Sediment Area: 43.92 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: .97 mg/m^3
Hypolimnetic Volume: 288.12 acre-ft
Anoxia Sediment Area: 43.92 acres
Time Period of Stratification: 104 days
Sediment Phosphorus Release Rate: -2.0 mg/m^2-day -5.54E-003 lb/acre-day
Internal Load: -83 Lb -38 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 162 mg/m^3
Hypolimnetic Volume: 190.17 acre-ft
Anoxia Sediment Area: 43.92 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 126 mg/m^3
Lake Volume: 1200.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 43.92 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 27.9 mg/m^2-day 7.57E-002 lb/acre-day
Internal Load: 327 Lb 149 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 43.92 acre

End of Anoxia Anoxic Sediment Area: 43.92 acre
Phosphorus Release Rate As Calculated In Method 2: -2.0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -2.0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 12.9 mg/m^2-day
Period of Anoxia: 104 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	75	174	298
Internal Load: (kg)	34	79	135

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 6942 Lb 3149 kg

	Lb	kg	%
From A Complete Mass Budget:	1076	488	13.4
From Growing Season In Situ Phosphorus Increases:	-83	-38	-1.2
From In Situ Phososphorus Increases In The Fall:	327	149	4.5
From Phososphorus Release Rate and Anoxic Area:	174	79	2.4

Predicted Water Column Total Phosphorus Concentration (ug/l)

Nurnberg+ 1984 Total Phosphorus Model:	Low	Most Likely	High
	0	0	0

Osgood, 1988 Lake Mixing Index: 0
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	0	0	0
Internal Load (kg):	0	0	0
External Load (Lb):	0	0	0
External Load (kg):	0	0	0
Total Load (Lb):	0	0	0
Total Load (kg):	0	0	0

Phosphorus Prediction and Uncertainty Analysis Module

Date: 10/22/2019 Scenario: 2
Observed spring overturn total phosphorus (SPO): 53.0 mg/m^3
Observed growing season mean phosphorus (GSM): 135.0 mg/m^3
Back calculation for SPO total phosphorus: 66.25 mg/m^3
Back calculation GSM phosphorus: 168.75 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 55.4 kg

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted -Observed (mg/m^3)	% Dif.
Walker, 1987 Reservoir	39	80	186	-55	-41
Canfield-Bachmann, 1981 Natural Lake	52	98	203	-37	-27
Canfield-Bachmann, 1981 Artificial Lake	45	80	148	-55	-41
Rechow, 1979 General	43	88	203	-47	-35
Rechow, 1977 Anoxic	56	115	265	-20	-15
Rechow, 1977 water load<50m/year	36	73	170	-62	-46
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	52	106	245	53	100
Vollenweider, 1982 Combined OECD	39	70	140	-24	-26
Dillon-Rigler-Kirchner	39	79	183	26	49
Vollenweider, 1982 Shallow Lake/Res.	33	61	128	-33	-35
Larsen-Mercier, 1976	51	105	242	52	98
Nurnberg, 1984 Oxic	50	99	226	-36	-27

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	47	151	Tw	6618	GSM
Canfield-Bachmann, 1981 Natural Lake	30	282	FIT	5824	GSM
Canfield-Bachmann, 1981 Artificial Lake	25	230	FIT	8758	GSM
Rechow, 1979 General	49	167	FIT	6066	GSM
Rechow, 1977 Anoxic	68	214	FIT	4635	GSM
Rechow, 1977 water load<50m/year	42	139	P	7232	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	53	211	FIT	1966	SPO
Vollenweider, 1982 Combined OECD	34	134	FIT	5904	ANN
Dillon-Rigler-Kirchner	47	148	P L	2633	SPO
Vollenweider, 1982 Shallow Lake/Res.	30	118	FIT	6729	ANN
Larsen-Mercier, 1976	64	194	P Pin	1991	SPO
Nurnberg, 1984 Oxic	52	192	P L	5418	ANN

Date: 10/22/2019 Scenario: 12

Lake Id: KAfull2017

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 29228.0 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 19485.3 acre-ft
Lake Surface Area <As>: 150.0 acre
Lake Volume <V>: 1200.0 acre-ft
Lake Mean Depth <z>: 8.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 19526.6 acre-ft/year
Areal Water Load <qs>: 130.2 ft/year
Lake Flushing Rate <p>: 16.27 1/year
Water Residence Time: 0.06 year
Observed spring overturn total phosphorus (SPO): 57.0 mg/m^3
Observed growing season mean phosphorus (GSM): 99.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	3361.0	0.50	1.00	3.00	43.2	680	1360	4081
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	6891.0	0.10	0.30	0.50	26.6	279	837	1394
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	969.0	0.30	0.50	0.80	6.2	118	196	314
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	4241.0	0.10	0.10	0.10	5.5	172	172	172
Forest	12846.0	0.05	0.09	0.18	14.9	260	468	936
Lake Surface	150.0	0.10	0.30	1.00	0.6	6	18	61

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	54.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.32	2.70	8.64	0.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	3410.3	6941.9	16055.6	100.0
Total Loading (kg)	1546.9	3148.8	7282.8	100.0
Areal Loading (lb/ac-year)	22.74	46.28	107.04	
Areal Loading (mg/m^2-year)	2548.29	5187.26	11997.38	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	3396.2	6895.8	15902.7	99.9
Total NPS Loading (kg)	1540.5	3127.9	7213.4	99.9

Wisconsin Internal Load Estimator

Date: 10/22/2019 Scenario: 1

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 89 mg/m^3
Phosphorus Inflow Concentration: 130.7 mg/m^3
Areal External Loading: 5187.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.26
Observed Phosphorus Retention Coefficient: 0.32
Internal Load: -411 Lb -186 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 726 mg/m^3
Hypolimnetic Volume: 75.1 acre-ft
Anoxia Sediment Area: 43.92 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 100 mg/m^3
Hypolimnetic Volume: 43.92 acre-ft
Anoxia Sediment Area: 43.92 acres
Time Period of Stratification: 101 days
Sediment Phosphorus Release Rate: -3.4 mg/m^2-day -9.37E-003 lb/acre-day
Internal Load: -136 Lb -62 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 726 mg/m^3

Hypolimnetic Volume: 75.1 acre-ft
Anoxia Sediment Area: 43.92 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 100 mg/m^3
Lake Volume: 1200.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 43.92 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 15.1 mg/m^2-day 4.12E-002 lb/acre-day
Internal Load: 178 Lb 81 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 43.92 acre
End of Anoxia Anoxic Sediment Area: 43.92 acre
Phosphorus Release Rate As Calculated In Method 2: -3.4 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -3.4 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 5.9 mg/m^2-day
Period of Anoxia: 101 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	72	169	290
Internal Load: (kg)	33	77	131

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 6942 Lb 3149 kg

	Lb	kg	%
From A Complete Mass Budget:	-411	-186	-6.3
From Growing Season In Situ Phosphorus Increases:	-136	-62	-2.0
From In Situ Phososphorus Increases In The Fall:	178	81	2.5
From Phososphorus Release Rate and Anoxic Area:	169	77	2.4

Predicted Water Column Total Phosphorus Concentration (ug/l)

Nurnberg+ 1984 Total Phosphorus Model:	Low	Most Likely	High
	40	97	227

Osgood, 1988 Lake Mixing Index: 3.1
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	-411	20.9	169
Internal Load (kg):	-186	9.5	77
External Load (Lb):	3410	6942	16056
External Load (kg):	1547	3149	7283

Total Load (Lb):	3000	6963	16224
Total Load (kg):	1361	3158	7359

Phosphorus Prediction and Uncertainty Analysis Module

Date: 10/22/2019 Scenario: 1
Observed spring overturn total phosphorus (SPO): 57.0 mg/m^3
Observed growing season mean phosphorus (GSM): 99.0 mg/m^3
Back calculation for SPO total phosphorus: 71.25 mg/m^3
Back calculation GSM phosphorus: 123.75 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 9.5 kg

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted -Observed (mg/m^3)	% Dif.
Walker, 1987 Reservoir	39	80	186	-19	-19
Canfield-Bachmann, 1981 Natural Lake	52	98	203	-1	-1
Canfield-Bachmann, 1981 Artificial Lake	45	80	148	-19	-19
Rechow, 1979 General	43	88	203	-11	-11
Rechow, 1977 Anoxic	56	115	265	16	16
Rechow, 1977 water load<50m/year	36	73	170	-26	-26
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	52	106	245	49	86
Vollenweider, 1982 Combined OECD	39	70	140	-8	-10
Dillon-Rigler-Kirchner	39	79	183	22	39
Vollenweider, 1982 Shallow Lake/Res.	33	61	128	-17	-22
Larsen-Mercier, 1976	51	105	242	48	84
Nurnberg, 1984 Oxic	48	97	224	-2	-2

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	47	151	Tw	4853	GSM
Canfield-Bachmann, 1981 Natural Lake	30	282	FIT	4064	GSM
Canfield-Bachmann, 1981 Artificial Lake	25	230	FIT	5614	GSM
Rechow, 1979 General	49	167	FIT	4448	GSM
Rechow, 1977 Anoxic	68	214	FIT	3399	GSM
Rechow, 1977 water load<50m/year	42	139	P	5303	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	53	211	FIT	2115	SPO
Vollenweider, 1982 Combined OECD	34	134	FIT	4702	ANN

Dillon-Rigler-Kirchner	47	148	P L	2831	SPO
Vollenweider, 1982 Shallow Lake/Res.	30	118	FIT	5440	ANN
Larsen-Mercier, 1976	64	194	P Pin	2142	SPO
Nurnberg, 1984 Oxic	51	189	P L	4015	ANN

Date: 10/22/2019 Scenario: 14

Lake Id: KAfull2018

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 29228.0 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 19485.3 acre-ft
Lake Surface Area <As>: 150.0 acre
Lake Volume <V>: 1200.0 acre-ft
Lake Mean Depth <z>: 8.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 19526.6 acre-ft/year
Areal Water Load <qs>: 130.2 ft/year
Lake Flushing Rate <p>: 16.27 1/year
Water Residence Time: 0.06 year
Observed spring overturn total phosphorus (SPO): 85 mg/m^3
Observed growing season mean phosphorus (GSM): 97 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	3361.0	0.50	1.00	3.00	43.2	680	1360	4081
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	6891.0	0.10	0.30	0.50	26.6	279	837	1394
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	969.0	0.30	0.50	0.80	6.2	118	196	314
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	4241.0	0.10	0.10	0.10	5.5	172	172	172
Forest	12846.0	0.05	0.09	0.18	14.9	260	468	936
Lake Surface	150.0	0.10	0.30	1.00	0.6	6	18	61

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	54.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.32	2.70	8.64	0.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	3410.3	6941.9	16055.6	100.0
Total Loading (kg)	1546.9	3148.8	7282.8	100.0
Areal Loading (lb/ac-year)	22.74	46.28	107.04	
Areal Loading (mg/m^2-year)	2548.29	5187.26	11997.38	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	3396.2	6895.8	15902.7	99.9
Total NPS Loading (kg)	1540.5	3127.9	7213.4	99.9

Wisconsin Internal Load Estimator

Date: 10/22/2019 Scenario: 4

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 95 mg/m^3
Phosphorus Inflow Concentration: 130.7 mg/m^3
Areal External Loading: 5187.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.26
Observed Phosphorus Retention Coefficient: 0.27
Internal Load: -92 Lb -42 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 326 mg/m^3
Hypolimnetic Volume: 74.22 acre-ft
Anoxia Sediment Area: 43.92 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 199 mg/m^3
Hypolimnetic Volume: 43.92 acre-ft
Anoxia Sediment Area: 43.92 acres
Time Period of Stratification: 120 days
Sediment Phosphorus Release Rate: -0.9 mg/m^2-day -2.43E-003 lb/acre-day
Internal Load: -42 Lb -19 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 326 mg/m^3

Hypolimnetic Volume: 74.22 acre-ft
Anoxia Sediment Area: 43.92 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 94 mg/m^3
Lake Volume: 1200.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 43.92 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 20.5 mg/m^2-day 5.57E-002 lb/acre-day
Internal Load: 241 Lb 109 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 43.92 acre
End of Anoxia Anoxic Sediment Area: 43.92 acre
Phosphorus Release Rate As Calculated In Method 2: -0.9 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -0.9 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 9.8 mg/m^2-day
Period of Anoxia: 120 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	86	201	344
Internal Load: (kg)	39	91	156

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 6942 Lb 3149 kg

	Lb	kg	%
From A Complete Mass Budget:	-92	-42	-1.3
From Growing Season In Situ Phosphorus Increases:	-42	-19	-0.6
From In Situ Phososphorus Increases In The Fall:	241	109	3.4
From Phososphorus Release Rate and Anoxic Area:	201	91	2.8

Predicted Water Column Total Phosphorus Concentration (ug/l)

Nurnberg+ 1984 Total Phosphorus Model:	Low	Most Likely	High
	46	99	228

Osgood, 1988 Lake Mixing Index: 3.1
Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	-92	99.5	201
Internal Load (kg):	-42	45.1	91
External Load (Lb):	3410	6942	16056
External Load (kg):	1547	3149	7283

Total Load (Lb):	3318	7041	16256
Total Load (kg):	1505	3194	7374

Phosphorus Prediction and Uncertainty Analysis Module

Date: 10/22/2019 Scenario: 3
Observed spring overturn total phosphorus (SPO): 85.0 mg/m^3
Observed growing season mean phosphorus (GSM): 97.0 mg/m^3
Back calculation for SPO total phosphorus: 106.25 mg/m^3
Back calculation GSM phosphorus: 121.25 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 45.1 kg

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted -Observed (mg/m^3)	% Dif.
Walker, 1987 Reservoir	39	80	186	-17	-18
Canfield-Bachmann, 1981 Natural Lake	52	98	203	1	1
Canfield-Bachmann, 1981 Artificial Lake	45	80	148	-17	-18
Rechow, 1979 General	43	88	203	-9	-9
Rechow, 1977 Anoxic	56	115	265	18	19
Rechow, 1977 water load<50m/year	36	73	170	-24	-25
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	52	106	245	21	25
Vollenweider, 1982 Combined OECD	39	70	140	-21	-23
Dillon-Rigler-Kirchner	39	79	183	-6	-7
Vollenweider, 1982 Shallow Lake/Res.	33	61	128	-30	-33
Larsen-Mercier, 1976	51	105	242	20	24
Nurnberg, 1984 Oxic	49	99	226	2	2

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	47	151	Tw	4755	GSM
Canfield-Bachmann, 1981 Natural Lake	30	282	FIT	3969	GSM
Canfield-Bachmann, 1981 Artificial Lake	25	230	FIT	5456	GSM
Rechow, 1979 General	49	167	FIT	4358	GSM
Rechow, 1977 Anoxic	68	214	FIT	3331	GSM
Rechow, 1977 water load<50m/year	42	139	P	5196	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	53	211	FIT	3153	SPO
Vollenweider, 1982 Combined OECD	34	134	FIT	5675	ANN

Dillon-Rigler-Kirchner	47	148	P L	4222	SPO
Vollenweider, 1982 Shallow Lake/Res.	30	118	FIT	6485	ANN
Larsen-Mercier, 1976	64	194	P Pin	3194	SPO
Nurnberg, 1984 Oxic	52	192	P L	3886	ANN

Expanded Trophic Response Module

Date: 10/23/2019 Scenario: 6
Total Phosphorus: 99.52 mg/m^3
Growing Season
Chorophyll a: 0.0 mg/m^3
Secchi Disk Depth: 0.0 m

Wisconsin Statewide Prediction Equations:

	Natural Lakes		Impoundments	
	Stratified	Mixed	Stratified	Mixed
Secchi Disk Depth using Chlorophyll_a:	0.0	0.0	0.0	0.0
Secchi Disk Depth using Total Phosphorus:	1.1	0.6	0.8	0.8
Chlorphyll_a using Total Phosphorus:	17.7	26.1	53.1	28.8

Expanded Trophic Response Module

Date: 10/23/2019 Scenario: 7
Total Phosphorus: 99.52 mg/m^3
Growing Season
Chorophyll a: 0.0 mg/m^3
Secchi Disk Depth: 0.0 m

Wisconsin Regional Prediction Equations:

		Stratified		Mixed	
	Region	Seepage	Drainage	Seepage	Drainage
Use Chlorophyll_a To Predict	South	0.0	0.0	0.0	0.0
Secchi Disk Depth (m)	Central	0.0	0.0	0.0	0.0
	North	0.0	0.0	0.0	0.0
Use Total Phosphorus To	South	1.1	0.7	0.5	0.6
Predict Secchi Disk Depth (m)	Central	2.6	0.3	0.4	No Data
	North	1.6	0.8	1.0	0.7
Use Total Phosphorus To	South	18.8	68.7	29.3	39.1
Predict Chlorophyll_a (mg/m^3))	Central	16.8	205.3	26.7	No Data
	North	8.7	26.3	19.7	12.9

Expanded Trophic Response Module

Date: 10/23/2019 Scenario: 8
Total Phosphorus: 74.52 mg/m^3
Growing Season
Chorophyll a: 0.0 mg/m^3
Secchi Disk Depth: 0.0 m

Wisconsin Statewide Prediction Equations:

	Natural Lakes		Impoundments	
	Stratified	Mixed	Stratified	Mixed
Secchi Disk Depth using Chlorophyll_a:	0.0	0.0	0.0	0.0
Secchi Disk Depth using Total Phosphorus:	1.2	0.7	0.9	0.9
Chlorphyll_a using Total Phosphorus:	15.1	21.6	39.5	23.5

Expanded Trophic Response Module

Date: 10/23/2019 Scenario: 9
Total Phosphorus: 74.52 mg/m^3
Growing Season
Chorophyll a: 0.0 mg/m^3
Secchi Disk Depth: 0.0 m

Wisconsin Regional Prediction Equations:

		Stratified		Mixed	
	Region	Seepage	Drainage	Seepage	Drainage
Use Chlorophyll_a To Predict	South	0.0	0.0	0.0	0.0
Secchi Disk Depth (m)	Central	0.0	0.0	0.0	0.0
	North	0.0	0.0	0.0	0.0
Use Total Phosphorus To	South	1.2	0.8	0.6	0.6
Predict Secchi Disk Depth (m)	Central	2.7	0.4	0.5	No Data
	North	1.8	1.0	1.1	0.8
Use Total Phosphorus To	South	15.6	48.6	23.4	30.5
Predict Chlorophyll_a (mg/m^3))	Central	14.1	133.4	22.2	No Data
	North	8.3	20.9	16.9	12.4

Expanded Trophic Response Module

Date: 10/23/2019 Scenario: 10
Total Phosphorus: 39.17 mg/m^3
Growing Season
Chorophyll a: 0.0 mg/m^3
Secchi Disk Depth: 0.0 m

Wisconsin Statewide Prediction Equations:

	Natural Lakes		Impoundments	
	Stratified	Mixed	Stratified	Mixed
Secchi Disk Depth using Chlorophyll_a:	0.0	0.0	0.0	0.0
Secchi Disk Depth using Total Phosphorus:	1.6	1.1	1.2	1.0
Chlorphyll_a using Total Phosphorus:	10.7	14.2	20.5	15.0

Expanded Trophic Response Module

Date: 10/23/2019 Scenario: 11

Total Phosphorus: 39.17 mg/m^3
Growing Season
Chorophyll a: 0.0 mg/m^3
Secchi Disk Depth: 0.0 m

Wisconsin Regional Prediction Equations:

		Stratified		Mixed	
	Region	Seepage	Drainage	Seepage	Drainage
Use Chlorophyll_a To Predict Secchi Disk Depth (m)	South	0.0	0.0	0.0	0.0
	Central	0.0	0.0	0.0	0.0
	North	0.0	0.0	0.0	0.0
Use Total Phosphorus To Predict Secchi Disk Depth (m)	South	1.5	1.2	0.7	0.7
	Central	2.8	0.7	0.9	No Data
	North	2.1	1.4	1.4	1.1
Use Total Phosphorus To Predict Chlorophyll_a (mg/m^3))	South	10.4	22.5	14.2	17.5
	Central	9.6	51.2	14.7	No Data
	North	7.4	12.5	12.0	11.2

Date: 10/23/2019 Scenario: 15

Lake Id: KAfull2017

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 29228.0 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 19485.3 acre-ft
Lake Surface Area <As>: 150.0 acre
Lake Volume <V>: 1200.0 acre-ft
Lake Mean Depth <z>: 8.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 19526.6 acre-ft/year
Areal Water Load <qs>: 130.2 ft/year
Lake Flushing Rate <p>: 16.27 1/year
Water Residence Time: 0.06 year
Observed spring overturn total phosphorus (SPO): 57.0 mg/m^3
Observed growing season mean phosphorus (GSM): 99.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	3361.0	0.50	.68	3.00	34.1	680	925	4081
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	6891.0	0.10	0.30	0.50	30.8	279	837	1394
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	969.0	0.30	0.50	0.80	7.2	118	196	314
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	4241.0	0.10	0.10	0.10	6.3	172	172	172
Forest	12846.0	0.05	0.09	0.18	17.2	260	468	936
Lake Surface	150.0	0.10	0.30	1.00	0.7	6	18	61

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	54.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.32	2.70	8.64	0.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	3410.3	5982.3	16055.6	100.0
Total Loading (kg)	1546.9	2713.6	7282.8	100.0
Areal Loading (lb/ac-year)	22.74	39.88	107.04	
Areal Loading (mg/m^2-year)	2548.29	4470.22	11997.38	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	3396.2	5936.2	15902.7	99.9
Total NPS Loading (kg)	1540.5	2692.6	7213.4	99.9

Date: 10/23/2019 Scenario: 16

Lake Id: KAfull2017
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 29228.0 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 19485.3 acre-ft
Lake Surface Area <As>: 150.0 acre
Lake Volume <V>: 1200.0 acre-ft
Lake Mean Depth <z>: 8.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 19526.6 acre-ft/year
Areal Water Load <qs>: 130.2 ft/year
Lake Flushing Rate <p>: 16.27 1/year
Water Residence Time: 0.06 year
Observed spring overturn total phosphorus (SPO): 57.0 mg/m^3
Observed growing season mean phosphorus (GSM): 99.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Loading (kg/ha-year) Low	Loading (kg/ha-year) Most Likely	Loading (kg/ha-year) High	Loading %	Loading (kg/year) Low	Loading (kg/year) Most Likely	Loading (kg/year) High
Row Crop AG	3361.0	0.50	.31	3.00	19.1	680	422	4081
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	6891.0	0.10	0.30	0.50	37.9	279	837	1394

HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	969.0	0.30	0.50	0.80	8.9	118	196	314
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	4241.0	0.10	0.10	0.10	7.8	172	172	172
Forest	12846.0	0.05	0.09	0.18	21.2	260	468	936
Lake Surface	150.0	0.10	0.30	1.00	0.8	6	18	61

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	54.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.32	2.70	8.64	0.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	3410.3	4872.8	16055.6	100.0
Total Loading (kg)	1546.9	2210.3	7282.8	100.0
Areal Loading (lb/ac-year)	22.74	32.49	107.04	
Areal Loading (mg/m^2-year)	2548.29	3641.14	11997.38	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	3396.2	4826.7	15902.7	99.9
Total NPS Loading (kg)	1540.5	2189.4	7213.4	99.9

Long Trade Lake Management Plan

Lake Management Plan Development Meetings

Appendix F:

Long Trade Lake Grant Project Summary

Katelin Anderson, Polk County Land & Water Resources, (715) 485-8637, katelin.anderson@co.polk.wi.us

In spring 2016, the Polk County Land and Water Resources Department and the Round Trade Lakes Improvement Association received a 3 year WDNR grant to collect data and develop a comprehensive Lake Management Plan for Long Trade Lake. Long Trade Lake is the first lake in the chain of lakes and practices that improve Long Trade should result in improvements downstream. This study can serve as a template for future studies on Round Lake, Little Trade Lake, and Big Trade Lake.

Data that will be collected with this grant include:

<u>In-lake, inlet, outlet, and tributary samples</u>
In addition to the phosphorus, secchi depth, and chlorophyll data that is collected through the Citizen Lake Monitoring Network (CLMN), this grant allows for the collection of nitrogen, chloride, and total suspended solids samples. This data will help explain which nutrients could fuel algae blooms in the lake. Thank you to Roger and Vicki Breault for completing the CLMN sampling for Long Trade Lake!

Additionally, phosphorus and flow data will be collected on the inlet and outlet of Long Trade Lake, the Trade River, and Butternut Creek. In-lake nutrient samples, paired with inlet/outlet data and land use, will be used to create a nutrient budget to determine which areas are contributing the greatest amount of nutrients to Long Trade Lake.

<u>Algae samples</u>
There are many different species of algae in a lake, not all of which cause problems. Monthly algae samples on Long Trade Lake will indicate which species are present in the lake throughout the summer.

<u>Shoreline inventory</u>
A shoreline inventory will be used to determine the health of the shoreline on Long Trade Lake. This data is important for prioritizing areas of erosion and areas providing benefits to the lakes and will also prioritize sites for future Healthy Lakes Projects.

<u>Lake level monitoring</u>
Measuring lake level and precipitation on a daily basis will show how the lake responds to precipitation. Thanks to Jack Lamont for collecting this data for Long Trade Lake!

<u>Water Action Volunteer (WAV) monitoring and workshop</u>
Volunteers will visit nine tributaries in the Long Trade Lake watershed and collect data for dissolved oxygen, temperature, transparency, stream flow, habitat, and macroinvertebrates. A workshop will also be conducted which focuses on identifying macroinvertebrates. In May, over fifteen volunteers completed the WAV monitoring protocols. If you're interested in getting involved contact Jack or Vicki.

<u>Lake Management Plan (LMP) development</u>
Once all the data has been collected, analyzed, and reported, a series of meetings will be held to develop a LMP for Long Trade Lake. At its simplest, a LMP identifies which actions should be taken by the Association to manage Long Trade Lake for the future.

Grant to study the Trade River Watershed and Long Trade Lake enters third and final year

This year kicks off the third and final year of a study to collect data on the Trade River Watershed and Long Trade Lake. Beginning in 2016, the Polk County Land and Water Resources Department, along with volunteers from the Round Trade Lake Improvement Association, have been collecting data pertaining to water quality, algae, lake level and precipitation, and shoreline health on Long Trade Lake. Additionally, an extensive effort has been made to monitor nine sites on the streams that flow into Long Trade Lake and on to the other lakes that make up the association. At most of the nine sites, a water sample is collected and sent to a lab to be analyzed for phosphorus, the nutrient responsible for algae growth. Flow is also calculated for each stream and, when paired with phosphorus data, allows for the identification of areas of high phosphorus inputs into Long Trade Lake, which are then passed on to the other lakes in the system. Additionally, volunteers collect data to characterize the habitat of the streams and sample for macroinvertebrates (inverts) as part of the statewide Water Action Volunteer (WAV) program. Inverts are easy to sample and have limited mobility, meaning that they are constantly exposed to the conditions in a stream. Different inverts tolerate different levels of pollution and can be used to gauge the health of a particular stream. Specific examples of inverts include: snails, leeches, clams, crayfish, and immature dragonflies and mayflies. Volunteer gatherings twice a year to identify inverts have proven to be fun and rewarding events for lake shore owners. Watch your inbox and future newsletters for identification dates. Don’t miss the opportunity to participate this coming year!

Long Trade Lake Management Plan Development Meeting Invitation

You are receiving this postcard because you are a member of the agricultural community and also a stakeholder in the area's natural resources. You are cordially invited to join us for a kick off meeting to learn more about a water quality study that took place on Long Trade Lake and to begin to set goals for managing Long Trade Lake. A meeting will be held Friday May 24th from 1:30-3:30 PM at the Polk County Government Center in Balsam Lake. Please contact Katelin Anderson with the Polk County Land and Water Resources Department at 715-485-8637 if you plan to attend or if you would like more information.

Long Trade Lake Management Plan Development Committee Meeting 1

Friday, May 24th, 2019
1:30-3:30 PM
Polk County Government Center, Balsam Lake
East Conference Room, second floor

1:30 Introductions, roles, and responsibilities (all)

1:35 Presentation (Polk County Land and Water Resources Department)
- Purpose of the meeting
- Study results and data

2:15 Brainstorming session (Management Plan Committee)
- What do you value about Long Trade Lake?
- What concerns/issues do you have for Long Trade Lake?

3:20 Schedule future meetings—bring your calendar (all)

3:30 Adjourn

Katelin Anderson
(715) 485-8637
katelin.anderson@co.polk.wi.us

Jeremy Williamson
(715) 485-8639
jeremyw@co.polk.wi.us

Long Trade Lake Management Plan Development Rules and Responsibilities

Overall Objective

Develop a Lake Management Plan for Long Trade Lake

A management plan outlines goals and actions that everyone can live with

Ground Rules

Listen to what others are saying
Don't interrupt when others are speaking
Input is heard from everyone
Stay on topic and stick to the agenda

Management Plan Committee Responsibilities

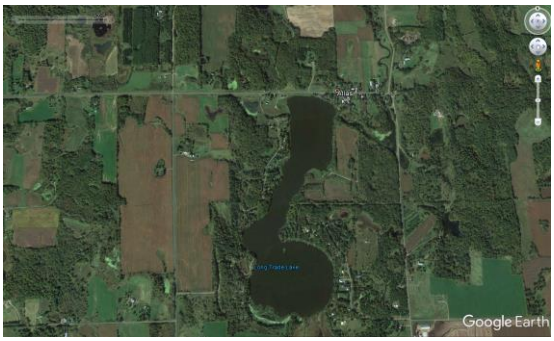
Attend all meetings
Share your knowledge and concerns about Long Trade Lake
Review background information and draft documents
Develop lake management strategies
Decide when draft document is ready to submit to board for approval

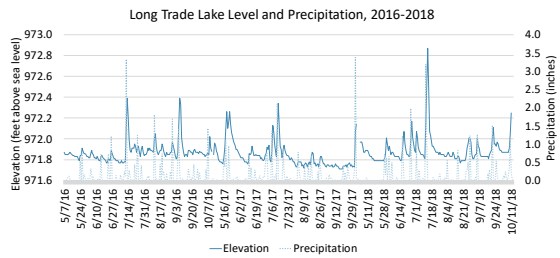
Land and Water Resources Department Responsibilities

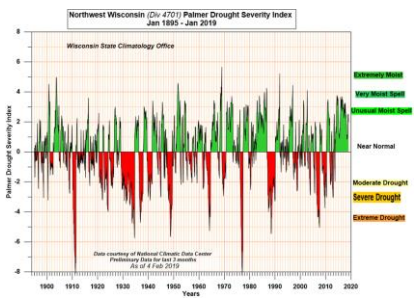
Send out agendas and materials prior to meetings
Keep discussion on track, may need to interrupt to keep discussion focused
Summarize key study findings
Write goals, objectives, and action items for the plan using committee input
Write draft and final plan documents
Submit plan for public comment and WDNR review

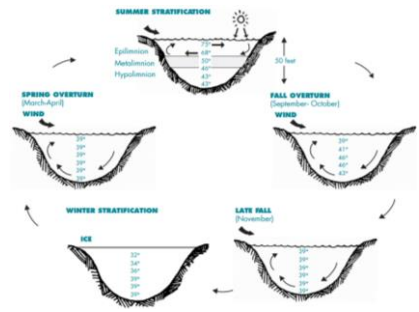
Association Board Member Responsibilities

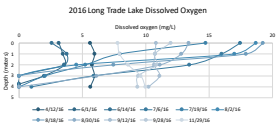
Participate as part of the committee
Review draft Management Plan
Approve draft Management Plan and submit to WDNR <u>or</u> disapprove draft Management Plan and return to committee

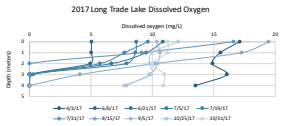

Google Earth

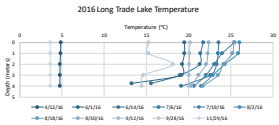

Long Trade Lake Level and Precipitation, 2016-2018
Elevation (feet above sea level)
Precipitation (inches)
Elevation
Precipitation

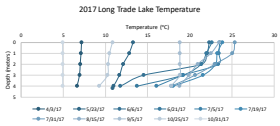

Northwest Wisconsin (Div 4701) Palmer Drought Severity Index
Jan 1895 - Jan 2019
Wisconsin State Climatology Office
Palmer Drought Severity Index
Years
Extremely Moist
Very Moist Spell
Unusual Moist Spell
Near Normal
Moderate Drought
Severe Drought
Extreme Drought
Data courtesy of National Climatic Data Center
Preliminary Data for last 3 months
As of 4 Feb 2019

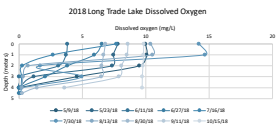

SUMMER STRATIFICATION
Epilimnion
Metalimnion
Hypolimnion
50 feet
SPRING OVERTURN
(March-April)
WIND
FALL OVERTURN
(September- October)
WIND
WINTER STRATIFICATION
ICE
LATE FALL
(November)

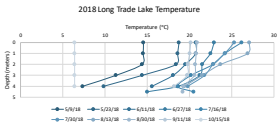

2016 Long Trade Lake Dissolved Oxygen
Dissolved oxygen (mg/L)
Depth (meters)

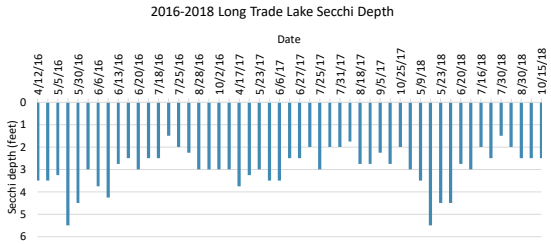

2017 Long Trade Lake Dissolved Oxygen
Dissolved oxygen (mg/L)
Depth (meters)

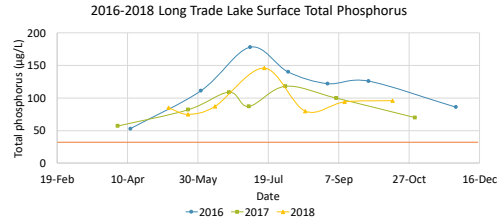

2016 Long Trade Lake Temperature
Temperature (°C)
Depth (meters)

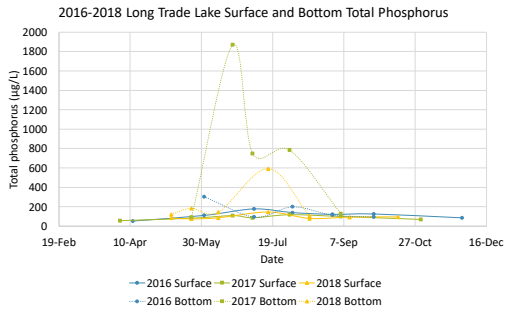

2017 Long Trade Lake Temperature
Temperature (°C)
Depth (meters)

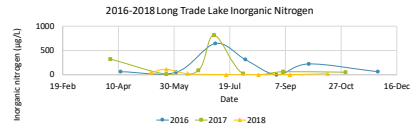

2018 Long Trade Lake Dissolved Oxygen
Dissolved oxygen (mg/L)
Depth (meters)

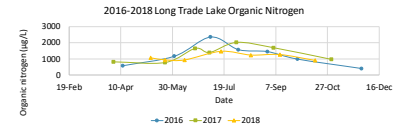

2018 Long Trade Lake Temperature
Temperature (°C)
Depth (meters)

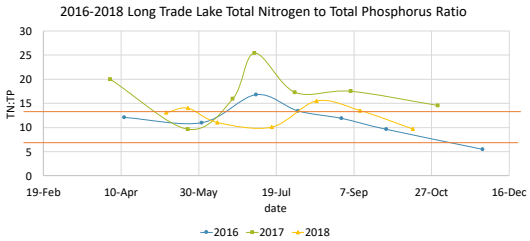

2016-2018 Long Trade Lake Secchi Depth
Date
4/12/16
5/5/16
5/30/16
6/6/16
6/13/16
6/20/16
7/18/16
7/25/16
8/28/16
10/2/16
4/17/17
5/23/17
6/6/17
6/27/17
7/25/17
7/31/17
8/18/17
9/5/17
10/25/17
5/9/18
5/23/18
6/20/18
7/16/18
7/30/18
8/30/18
10/15/18
Secchi depth (feet)
0
1
2
3
4
5
6

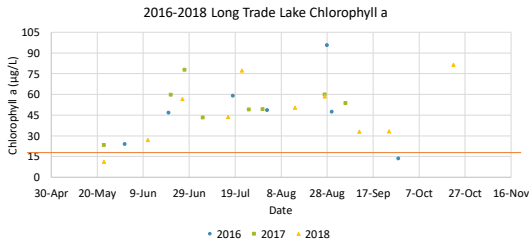

2016-2018 Long Trade Lake Surface Total Phosphorus
Total phosphorus (µg/L)
200
150
100
50
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
Date
2016
2017
2018

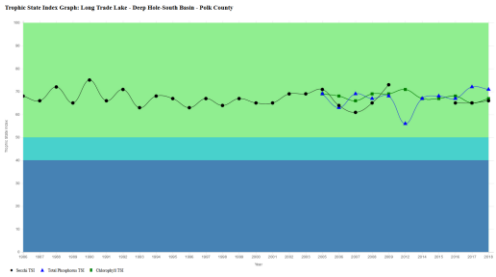

2016-2018 Long Trade Lake Surface and Bottom Total Phosphorus
Total phosphorus (µg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
Date
2016 Surface
2017 Surface
2018 Surface
2016 Bottom
2017 Bottom
2018 Bottom

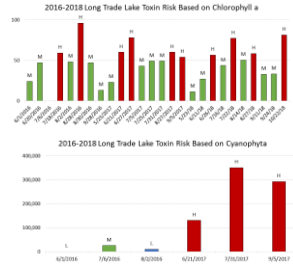

2016-2018 Long Trade Lake Inorganic Nitrogen
Inorganic nitrogen (µg/L)
1000
500
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
Date
2016
2017
2018


2016-2018 Long Trade Lake Organic Nitrogen
Organic nitrogen (µg/L)
3000
2000
1000
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
Date
2016
2017
2018

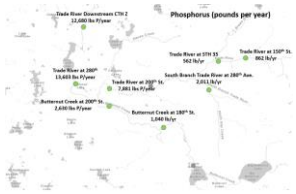

2016-2018 Long Trade Lake Total Nitrogen to Total Phosphorus Ratio
TN:TP
30
25
20
15
10
5
0
19-Feb
10-Apr
30-May
19-Jul
7-Sep
27-Oct
16-Dec
date
2016
2017
2018

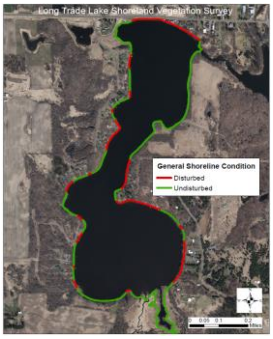

2016-2018 Long Trade Lake Chlorophyll a
Chlorophyll a (µg/L)
105
90
75
60
45
30
15
0
30-Apr
20-May
9-Jun
29-Jun
19-Jul
8-Aug
28-Aug
17-Sep
7-Oct
27-Oct
16-Nov
Date
2016
2017
2018

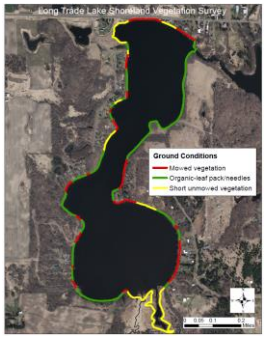


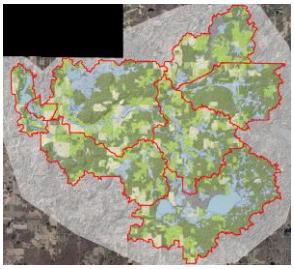


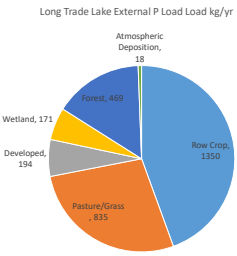
Site	2016-2018 Average Phosphorus (lbs/year)
South Branch Trade River at 280th	2,011
Trade River at STH 35	562
Trade River at 150th Street	862
Butternut Creek at 180th	1,040

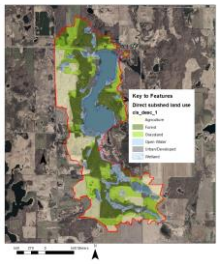


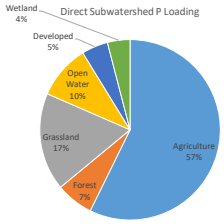


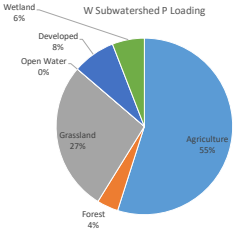


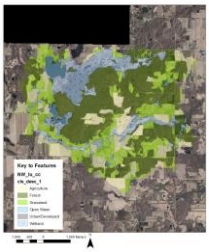


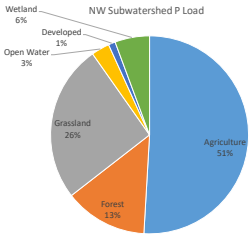


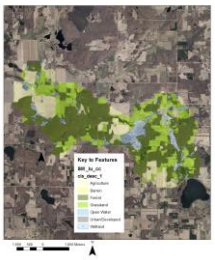


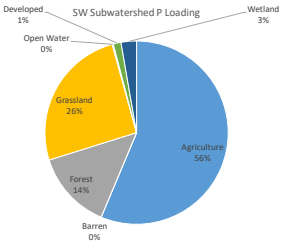

Direct Subwatershed P Loading
Wetland 4%
Developed 5%
Open Water 10%
Grassland 17%
Forest 7%
Agriculture 57%

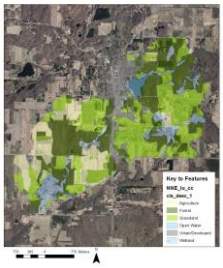

W Subwatershed P Loading
Wetland 6%
Developed 8%
Open Water 0%
Grassland 27%
Forest 4%
Agriculture 55%

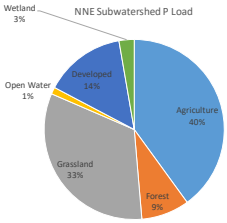


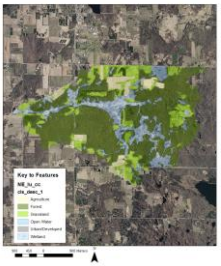

NW Subwatershed P Load
Wetland 6%
Developed 1%
Open Water 3%
Grassland 26%
Forest 13%
Agriculture 51%

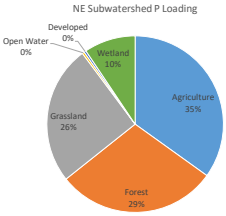


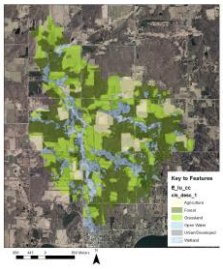

SW Subwatershed P Loading
Developed 1%
Wetland 3%
Open Water 0%
Grassland 26%
Forest 14%
Barren 0%
Agriculture 56%

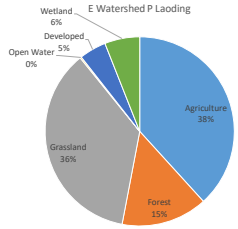


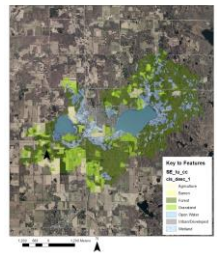

NNE Subwatershed P Load
Wetland 3%
Open Water 1%
Developed 14%
Grassland 33%
Forest 9%
Agriculture 40%

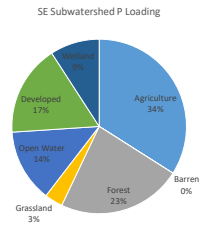


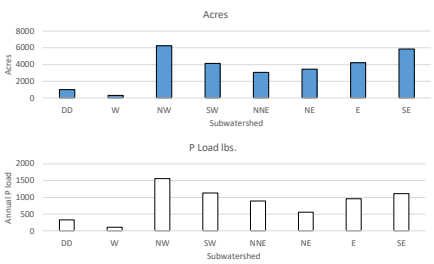

NE Subwatershed P Loading
Developed 0%
Open Water 0%
Wetland 10%
Grassland 26%
Forest 29%
Agriculture 35%

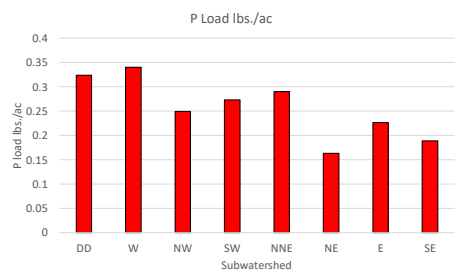






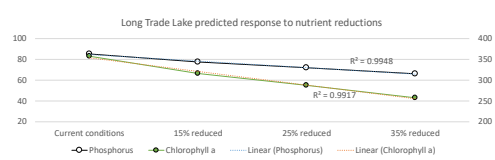


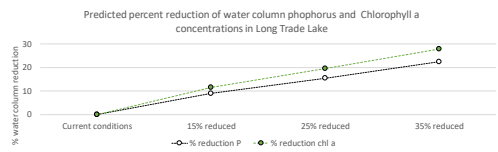




$$P_{inflow} = P_{in-lake} \div \frac{FR}{6 + FR} \qquad case\ 16 = \sqrt{FR} \qquad case\ 26 = 10 \div z$$

$$P = \frac{0.8L}{z\left(0.0569\left(\frac{L}{z}\right)\right)^{0.639} + p}$$





Long Trade Lake Management Plan Development Committee Meeting 2

Friday, June 28th, 2019
1:30-3:30 PM
Polk County Government Center, Balsam Lake
East Conference Room, second floor

1:30 Introductions (all)

1:35 Provide feedback on Draft LMP (Management Plan Committee)

2:30 Presentation (Polk County Zoning Department)
Shoreland Zoning

3:00 Presentation (Polk County Land and Water Resources Department)
Introduction to Conservation Best Management Practices

3:25 Schedule future meeting—bring your calendar (all)

3:30 Adjourn

Katelin Anderson
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Jeremy Williamson
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Zoning Update

Jason Kjeseth, Zoning Administrator
Elizabeth Ullrich, Zoning Specialist
Lori Bodenner, Zoning Technician

Introduction

- Polk County completed a comprehensive rewrite to the Comprehensive Land Use Ordinance on September 15, 2016
- Amended Chapter 18 Subdivision Ordinance effective March 19, 2019

New Zoning Districts

- Residential (R-1)
- Hamlet (H-1)
- Residential-Agricultural 5 (RA-5)
- Agriculture 10 (A-1)
- Agriculture 20 (A-2)
- Farmland Preservation (A-3)
- Natural Resources (N-1)
- General Business and Commercial (B-1)
- Recreational Business and Commercial (B-2)
- Small Business and Commercial (B-3)
- Industrial (I-1)
- Mining (M-1)

Minimum Lot Sizes

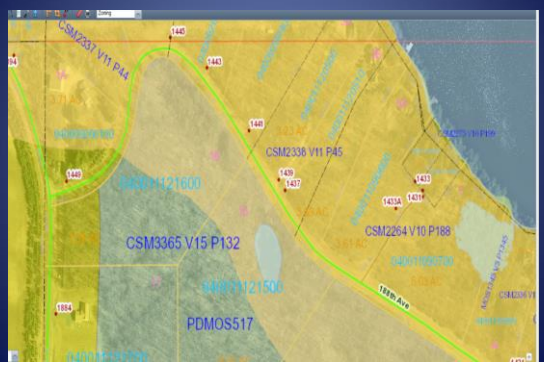
Zoning District	Without public sewer	With public sewer
	Area	
Residential (R-1)	1 acre	
Hamlet (H-1)	30,000 sq. ft.	10,000 sq. ft.
General Business/Commercial (B-1)	1 acre	.5 Acre (21,780 sq. ft.)
Recreational Business/Commercial (B-2), Small Business/Commercial (B-3), Industrial (I-1)	1 acre	
Residential-Agricultural 5 (RA-5)	1 acre min.	Density Standard
		8 dwellings/forty acres
Agricultural 10 (A-1)	1 acre min.	4 dwellings/forty acres
Agricultural 20 (A-2)	1 acre min.	2 dwellings/forty acres
Farmland Preservation (A-3)	35 acres	
Natural Resources (N-1)	1 acre	
Mining District (M-1)	5 acres	

Shoreland		Area	Width(ft.)	Area	Width (ft.)
Shoreland	Non-Riparian	1 acre	100	20,000	90
Shoreland Riparian	Class I	1 acre	100	20,000	90
	Class II	60,000 ft^2	150		
	Class III	100,000 ft^2	250		

How to Calculate

- Take the existing parcel acreage and divide it by the density goal. For example:
  - RA-5= 40 ac/5= 8 lots
  - RA-5= 12 ac/5= 2.4 or 2 lots
  - RA-5= 13 ac/5= 2.6 or 3 lots
  - A-10= 40 ac/10= 4 lots
  - A-20= 40 ac/20= 2 lots
- However, total allowable density cannot be exceeded

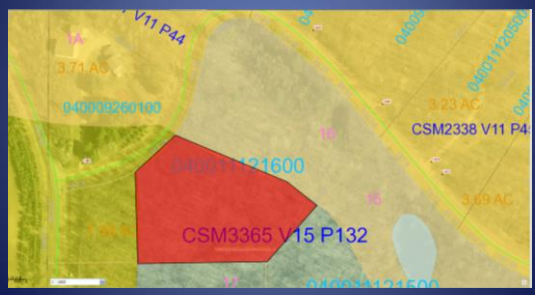
Density Example 1



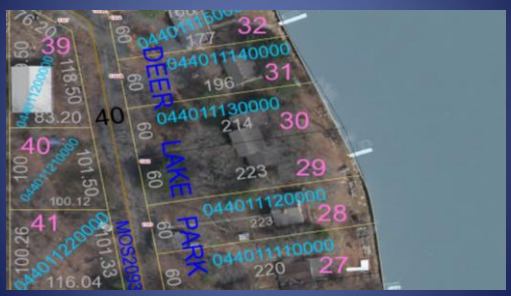
Options for Example

- Total of 7.58 Acres
- Part of the property is zoned R-1, RA-5, and Shoreland
- Most restrictive minimum lot size applies
- 1 Acre lot size allowed in Residential and Shoreland areas
- RA-5 area is 2.8 Acres, so only 1 lot allowed
- R-1 area is just over 1 acre

Possible Division



One parcel number, two lots



Red is a No, Green is a Go

Building Encroachment

- If you have two lots, a CSM or description of the whole parcel must be completed to dissolve interior lot line.
- Can add on to structure as long as addition meets the setback to the interior lot line.

Land Transfers

- Allowed to transfer land between adjoining owners by deed/description if the minimum lot sizes of both parcels are met
- Allowed to transfer equal portions of land between adjoining owners with a CSM for lots **Less** than the minimum lot size.

Transfers by Deed

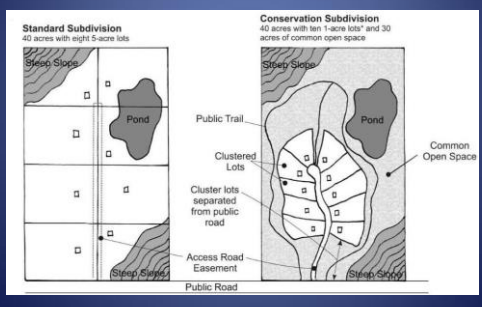
Transfer by Deed

Requires a CSM

Condominium Review

- Not intended to prohibit/limit condo development
- Reviewed like a normal subdivision
- Condominium documents must be submitted along with plat
- Allows county to verify legal descriptions are accurate

Conservation Design Development



Conservation Design Development

- Allows lots to be reduced to ½ acre minimum
- Gives a 25% increase in allowed density (8 dwellings = 10 under CDD)
- Has aesthetic and other requirements

Town Roads

- Roads may be dedicated to the town if they meet the town road specs.
- If private road, each lot shall hold a fractional interest in the private road (i.e. 1/10th interest for a 10 lot subdivision)
- A resolution acknowledging a reduced ROW from the Town Board may be required for a subdivision review if the ROW is less than 66 feet.

Shoreland Zoning

- All the area within 1000′ of a lake or pond and 300′ of a river or stream
- Polk County Zoning regulates land use in these above the ordinary high water mark
- Wisconsin DNR has jurisdiction below the ordinary high water mark

New Shoreland Definitions

- "Shoreland setback area" means an area that is within a certain distance of the ordinary high-water mark in which the construction or placement of structures has been limited or prohibited under an ordinance enacted under this section.
- "Structure" means a principal structure or any accessory structure including a garage, shed, boathouse, sidewalk, stairway, walkway, patio, deck, retaining wall, porch or fire pit.

Building Setbacks

- Required setback is 75′ for all lakes or an average setback if the proposed development qualifies
- All structures are required to meet the setback from the OHWM unless they are identified and qualify as an exempt structure.

Exempt Structures to 75′ Setback

- Boathouses, located in the access & viewing corridor, do not contain plumbing and are not used for human habitation.
- Open-sided and screened structures that satisfy 59.692(1v).
- Fishing rafts under 30.126
- Broadcast signal receivers
- Utility transmission and distribution lines, etc. well pump house covers, POWTS
- Walkways, stairways, or rail systems that are necessary to provide access to the shoreline and are a maximum of 60 inches wide.

Setback Averaging

- Where an existing development pattern exists, the shoreland setback for a proposed principal structure may be reduced to the average shoreland setback of the principal structure on each adjacent lot, but the shoreland setback may not be reduced to less than 35 feet from the OHWM.

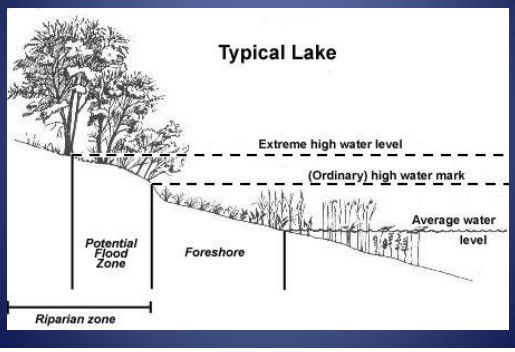
How to measure?

- Measure from the closest part of the structure to the ordinary high water mark for each principle structure on the adjoining lots
- Add the two setbacks together and divide by 2.

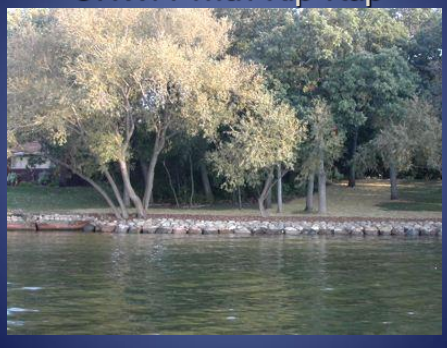
Ordinary High Water Mark

- Surveyors given authority to set OHWM (59.692(1h))
- Polk County has OHWM elevations for some of the larger lakes based off DNR data.
- Could impact whether structures are conforming or nonconforming
- Wetlands can be considered part of lakebed.

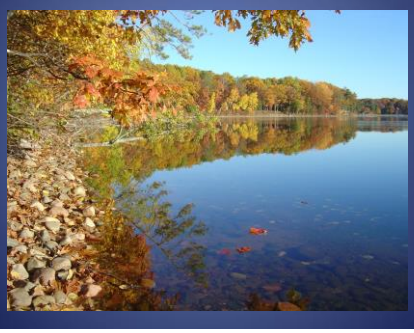
Ordinary High Water Mark



OHWM with Rip Rap



About half way on the Rock



At the Vegetation Break

Wetland = Lakebed

Questions? Comments?

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Elizabeth Ullrich, Zoning Specialist
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Introduction to Conservation Best Management Practices

Polk County LWRD
2019

Agriculture and Water Quality

Agricultural operations large and small have impact to our natural resources. The Polk County Land and Water Resource Department focuses on promoting, planning, design and installation of conservation practices to protect soil health and water quality without compromising profitability.

Conservation Practices

~A facility or practice that is designed to prevent or reduce soil erosion, prevent or reduce non-point source water pollution, or achieve or maintain compliance with soil and water conservation standards. "Conservation practice" includes a nutrient management plan.

WI Dept. Ag. Trade & Consumer Protection ATCP 50.01 (2)

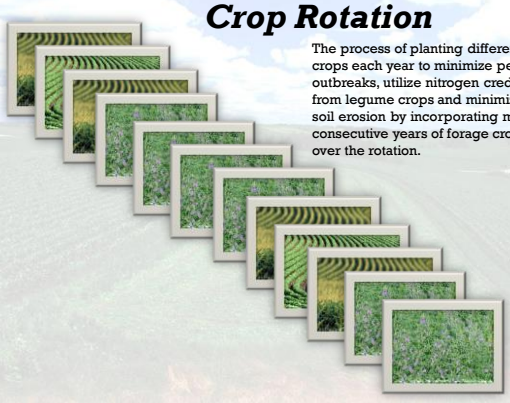
Farming on the Contour

Contour farming is coordinating and planning crop planting and harvesting techniques based on the contour and slope of the land to reduce soil erosion.

- Reduces chemical and nutrient runoff from the property.
- Reduces sediment erosion from the land into streams due to roughness of soil surface impeding the course of surface water.

Photo Courtesy : U of N-Lincoln

Crop Rotation



The process of planting different crops each year to minimize pest outbreaks, utilize nitrogen credits from legume crops and minimize soil erosion by incorporating many consecutive years of forage crops over the rotation.

Conservation Tillage

- No till > 50 % surface residue
- Conservation Tillage > 30% surface residue
- High surface residue prevents soil detachment from droplet impact.

Cover Crops

- Process of planting an additional crop in the fall, following harvest, for the purpose of ground cover until spring planting.
- Planted primarily to manage soil fertility, erosion, and improve soil and water quality.
- Minimize weeds, pests and diseases.
- Promote biodiversity.

Common Cover Crops
-Winter (cereal) Rye
-Winter Wheat
-Clovers
-Oats or Barley

Livestock Fencing

Though this practice is not required by law livestock exclusion from surface waters eliminates soil erosion from cattle traffic by allowing vegetation to stabilize the soil and filter out excess nutrients before entering the surface water.

Nutrient Management

Nutrient Management is defined as the management of the 4R's of Nutrient Management:

Right amount (rate)
Right source
Right placement (method of application)
Right timing of commercial fertilizers, manure, soil amendments, and organic by-products to agricultural landscapes as a source of plant nutrients while protecting local air, soil and water quality.

Animal Waste Storage

- Animal waste containment system to collect manure and other farm waste water.
- Promotes timely land applications of animals waste.
- Prevents runoff and groundwater contamination.

Other BMPs

- Detention and Sedimentation Basins
- Waste storage facility construction
- Wastewater treatment strips
- Heavy use area protection (livestock feeding areas)
- Grassed Waterways
- Riparian Buffers
- Field edge filter strips
- Waste Storage Facility Closure
- Integrated Pest Management
- Prescribed Grazing

Adoption of BMPs

CAN LWRD REQUIRE CITIZENS TO INSTALL OR ADOPT BMPS?

In some cases yes! However, one of Department of Natural Resources NR 151 performance standard prohibitions needs to be present.

- A livestock operation shall have no overflow of manure storage facilities.
- A livestock operation shall have no unconfined manure piles in a water quality management area.
- A livestock operation shall have no direct runoff from a feedlot or stored manure to waters of the state
- A livestock operation may not allow unlimited access by livestock to waters of the state in a location where concentrations of animals prevent the maintenance of adequate sod or self-sustaining vegetative cover.

We typically use a voluntary approach to BMP installation!

Adoption of BMPs

Programs with compliance requirements

- Working Lands Initiative
- Local Ordinances- Few that address all situations we encounter
- Permit requirements for manure storage or expansion
- NR 151-Not officially adopted in Polk County but we follow the rule in our process
- Offer Cost Share dollars will compliance requirements

NOT MANY OPTIONS!

What can RTLIA do?

To encourage the agriculture community to address water quality concerns.

- Advocate by example and do your part. (We cannot expect someone to do something we wouldn't do ourselves)
- Be proactive not reactive when addressing issues.
- Take your time as water quality issues did not happen overnight, results of your work may be generations away.

Ideas for accomplishing agricultural goals for Long Trade Lake

- Invite Ag producers to the table and hear their perceptions and expectations on water quality.
- Be sensitive to their needs as a business.
- Collectively identify common goals and determine what is feasible.
- Ultimately, form a positive working relationship with the Ag community based on TRUST.

Relationships and Water Quality

Once a positive working relationship between the Lake Association and the agricultural community is formed progress will likely follow.

Water quality projects the Lake Association and the agriculture community could pursue include:

- Watershed phosphorus level assessments (evaluating soil test P levels)
- Land acquisitions for the purpose of buffer areas or sediment basins.
- Providing incentives for those that voluntarily implement practices from the previous list.

Social aspect of Conservation Practice Adoption

Recent efforts towards implementing conservation have shifted towards engagement of the agriculture community through peer to peer learning opportunities.

Most farmer-led groups are voluntarily addressing local resource concerns.

Horse Creek Watershed Council

Mission

The Horse Creek Area Watershed Council is a voluntary, producer-led environmental management program. Our mission is to inspire producers to adopt best management practices dedicated to protecting water quality and improving soil health.

Ultimately, all stakeholders need to realize they are part of the problems and work productively together to be part of the solution!

Questions?

Summary for 9.21.19 Meeting

The Polk County Land and Water Resources Department is in the process of completing a Lake Management Plan for Long Trade Lake. This document summarizes the data that was collected on the lake and its watershed in 2016, 2017, and 2018. This spring and summer a group of stakeholders met with Land and Water staff to identify goals for improving Long Trade Lake. Goals were developed for water quality, fish and wildlife habitat, natural scenic beauty, information and education, and evaluating progress towards meeting the goals of the plan. The goals are included in the draft Lake Management Plan. SEE HANDOUT

The Lake Management Plan will be open for a public comment period (coming soon) and also needs to be approved by the RTLIA Board (hopefully at the September 21st meeting) and WDNR. Once the plan is approved, goals and activities that are included in the plan are eligible for funding through the WDNR Lake Protection Grant Program. This project was funded by a WDNR Lake Planning Grant.