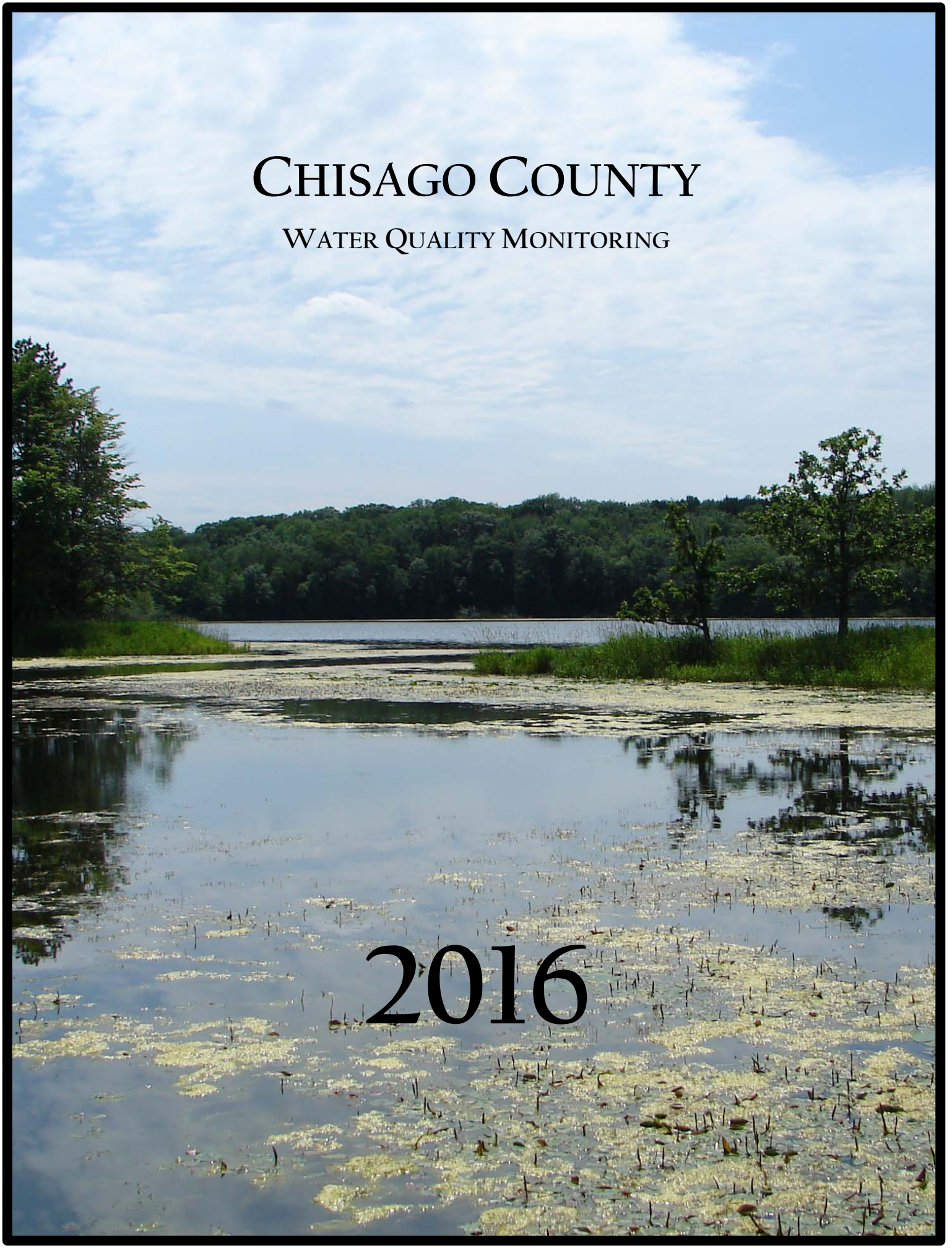


# CHISAGO COUNTY

## WATER QUALITY MONITORING

# 2016

# Table of Contents

# Definitions

Ammonia Nitrogen: An inorganic form of nitrogen contained in fertilizers, septic system effluent, and animal wastes. It is also a product of bacterial decomposition of organic matter. Ammonia nitrogen becomes a concern if high levels of the un-ionized form are present. In this form, it can be toxic to aquatic organisms. The presence of un-ionized ammonia is a function of the ammonia nitrogen concentration, pH, and temperature. Conversion of ammonia nitrogen to nitrite nitrogen by nitrification requires large quantities of oxygen which can kill aquatic organisms due to the lowered dissolved oxygen concentrations in water. The lowest reported limit is 0.07 mg/L. Any samples below 0.07 mg/L are reported as 0.07 mg/L or <0.07 mg/L.

Chlorophyll-a (Chl-a): Photosynthetic pigment found in all green plants and the main pigment in algae. The concentration of Chlorophyll-a is used to estimate the amount of algae in surface water (MPCA). The lower the reading, the clearer the water will be.

Color of Filtered Water: This is a description of the color of the algae which remains after lake water is drawn through a filter. In order to provide an accurate description of the color, which can be compared year to year, the colors of the filtered water are compared to those colors illustrated in the Martha Stewart Living – complete color palette.

Secchi Disk (SD): A measure of water clarity taken with a black and white disk lowered into the water until it disappears, then raised until it barely appears and record a reading. The higher the reading, the clearer the water will be.

Total Phosphorus (TP): A nutrient essential to the growth of all organisms and commonly the limiting factor in the primary productivity of surface water bodies. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particle form. Agricultural drainage, wastewater, and certain industrial discharges are typical source of phosphorus and can contribute to the eutrophication of surface water bodies (MPCA). The lower the reading, the clearer the water will be.

| Physical Condition: Describe the Physical condition of the lake water at your sampling point | |
|---|---|
| 1 | Crystal clear water |
| 2 | Not quite crystal clear-a little algae present/visible |
| 3 | Definite algae, green, yellow, or brown color |
| 4 | High algae levels, limited clarity and/or mild odor apparent |
| 5 | Severely high algae levels with the following: massive floating scums, strong foul odor, fish kill |
| **Recreational Suitability: Describe your opinion of how suitable the lake water is for recreation and aesthetics at your sampling site.** | |
| 1 | Beautiful, could NOT be better |
| 2 | Very minor aesthetic problems; excellent for swimming, boating |
| 3 | Swimming/aesthetic enjoyment slightly impaired because of algae levels |
| 4 | Desire to swim and level of enjoyment of the lake substantially reduced because of the algae levels (would not swim but boating okay) |
| 5 | Swimming and aesthetic enjoyment of the lake nearly impossible due to the algae levels. |

# Trophic Levels

Trophic State Index: A formula used to determine the Trophic Level of a lake. Total Phosphorus, Chlorophyll-a and Secchi Transparency will each have an individual Trophic Level that allows the parameters to be compared to one another when the actual values cannot be compared.

Oligotrophic: Clear water, oxygen throughout the year in the hypolimnion (area below the thermocline or cold layer that separates the upper mixed portion of the lake and the lower calm portion of the lake). Water may be suitable for an unfiltered water supply. Salmon can occupy these lakes.

Mesotrophic: Water is moderately clear, increasing probability of lack of oxygen in the hypolimnion during summer. Iron, manganese, taste, and odor problems worsen. Walleye population may be predominant.

Eutrophic: The hypolimnion is without oxygen the majority of the year. There may be problems with the macrophyte plant population. Blue-green algae blooms may occur. The water supply may have episodes of severe taste and odor. Only warm water fisheries are present. Nuisance macrophytes, algae blooms, and very low transparency may discourage swimming and boating.

Hyper-eutrophic: Dense algae and macrophytes present. Rough fish dominate the fish population. The possibilities of summer fish kills exist.

**Carlson Trophic State Index** (Carlson, R.E. and J. Simpson. 1996. *A Coordinator's Guide to Volunteer Lake Monitoring Methods*. North American Lake Management Society.)

| TSI | <30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | >80 |
|---|---|---|---|---|---|---|---|
| Chl-*a* (µg/L) | <0.95 | 0.95-2.6 | 2.6-7.3 | 7.3-20 | 20-56 | 56-155 | >155 |
| SD (m) | >8 | 8-4 | 4-2 | 2-1 | 0.5-1 | 0.25-0.5 | <0.25 |
| TP (µg/L) | <6 | 6-12 | 12-24 | 24-48 | 48-96 | 96-192 | 192-384 |

# Impairments and Standards

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority ranking for waters on the lists and develop Total Maximum Daily Loads (TMDL) for these waters. A TMDL is a calculation of the maximum amount of pollution that a waterbody can receive and still safely meet water quality standards. (United States Environmental Protection Agency)

The Minnesota Pollution Control Agency (MPCA) has set the standards for Total Phosphorus, Chlorophyll-a, and Secchi Disk Depth for lakes in Minnesota. A lake must have a minimum set of data to prove that it is Impaired (not meeting the MPCA standards) or Not Impaired (does meet the MPCA standards) before it is listed on the 303(d) Impaired Waters list, at which point a TMDL study is required.

# Project Objective

The purpose of the 2016 Chisago County Water Quality and Aquatic Invasive Species Monitoring program is to help achieve goals identified in the Chisago County Local Water Management Plan and the Chisago Lakes Lake Improvement District Water Resource Management Plan.

Chisago County Local Water Management Plan:

Monitoring and Assessment

11. Develop a County wide annual water quality monitoring plan for nutrients, aquatic life, and other parameters to determine ambient water quality concentration trends and loading for all public waters in Chisago County, including lakes with public accesses and the main stems and selected tributaries of Rock Creek, Rush Creek, Goose Creek, Sunrise River, and Lawrence Creek.
12. Implement a County wide lake water quality monitoring plan.
14. Develop an annual water quality monitoring report for Chisago County describing the water resources that were monitored and what parameters they were monitored for. The annual report will provide a complete summary of the monitoring results.

Chisago Lakes Lake Improvement District Water Resource Management Plan:

Goal 1: Preserve, protect, and enhance water quality within the Chisago Chain of Lakes watershed. Objective 2: Annually monitor nutrients, aquatic life, and other parameters to determine water quality concentrations, trends, and loading. The resultant report will provide information about lake water quality and interpretation of trends.

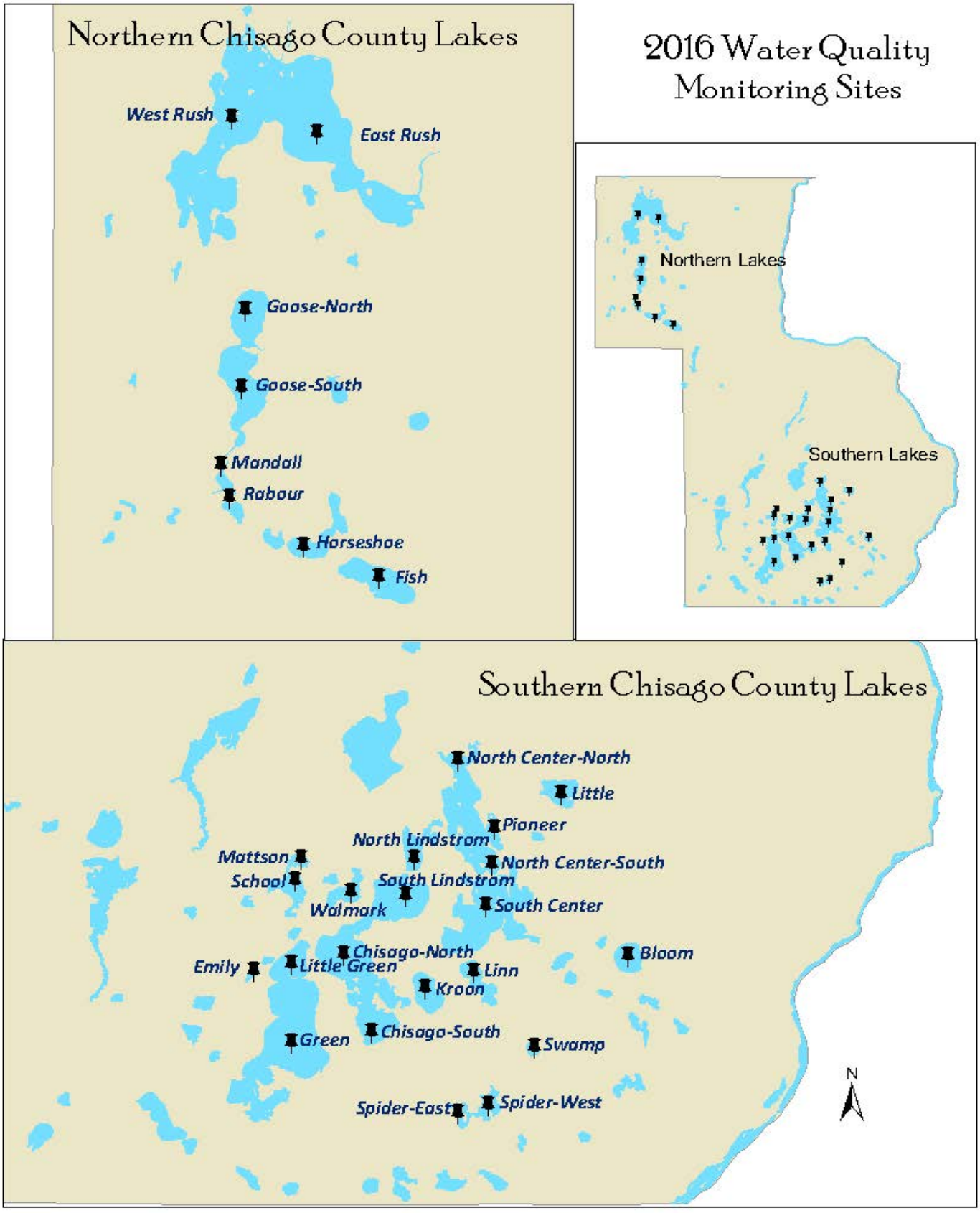
Past water quality monitoring has been useful in determining long term water quality trends. In addition, water quality monitoring data is essential for completing the Total Maximum Daily Load Studies within the County. Continuing the water quality monitoring will help determine progress in obtaining water quality goals.

Twenty-nine lakes were monitored through this program in 2016. Eight lakes were added this season, including Emily, Walmark, School, Swamp, Mattson, Pioneer, Linn, and Bloom. Four lakes (Chisago, North Center, Spider, and Goose) had 2 monitoring locations each. Each lake was monitored 5 times, once a month, May through September. Samples were collected at the deepest part of the lakes.

Graphs represent 2016 data only. In some cases, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015 data is listed below the chart for comparison.


- Thanks to the Chisago Lakes Lake Improvement District and Chisago County Water Plan for providing partial staff and funding for the program.
- Thanks to the Chisago Soil & Water Conservation District for providing review of data, interpretation, submittal to MPCA's EQuIS program, and preparation of this report.
- Special thanks to the Chisago County Sherriff's Department for use of a Water Patrol boat to collect samples.
- Thank you to Greg Anklan, Lisa Bardon, David Gerty, Daniel Lee, Scott Mower, Peter Storlie and Scott Thelen for serving as Volunteer Water Quality monitors and collecting water samples from Pioneer, Walmark, Linn, Emily, Mattson, School, Swamp and Bloom Lakes, respectively. Without the volunteers, we would not be able to collect the water samples and have water quality information on the smaller lakes.

# Monitoring Locations



# Explanation of Parameters

| Parameter | Unit | MPCA Deep Lake Standard** | MPCA Shallow Lake Standard** | Expected Range Chisago County |
|---|---|---|---|---|
| Chlorophyll-a | µg/L | 14.0 | 20.0 | 5.0-22.0 |
| Secchi Disk | Meters | >1.4 | >1.0 | 1.5-3.2 |
| Ammonia Nitrogen* | mg/L | No Standard | No Standard | None |
| *Minimum reporting level 0.01. Samples reported as 0.01 are actually 0.01 or less. | | | | |
| Total Phosphorus | µg/L | 40.0 | 60.0 | 23.0-50.0 |
| A lake that fails to meet two of the three standards (Chlorophyll-a, Secchi Disk, Total Phosphorus) does not meet standards. | | | | |

Source: Heiskary, 1991

**Standards are based on June-September average. Shallow lakes have a maximum depth of 15 feet or less, or more than 80% of the lake is shallow enough to support emergent vegetation (littoral area). Deep lakes are generally more than 15 feet deep and have less than 80% littoral area.

# Lake Classification

| Parameter | Oligotrophic | Mesotrophic | Eutrophic | Hypereutrophic |
|---|---|---|---|---|
| Total Phosphorus (µg/L) | <12 | 13-24 | 24-96 | >96 |
| Chlorophyll-a (µg/L) | <3 | 3-7 | 7-56 | >56 |
| Secchi Transparency (m) | >4.0 | 2.0-4.0 | 2.0-0.5 | <0.5 |

Source: Osgood, 1989b, Osgood, 1989c

# Lake Water Quality Grades

| Grade | Percentile | Total Phosphorus (µg/L) | Chlorophyll-a (µg/L) | Secchi Transparency (m) |
|---|---|---|---|---|
| A | <10 | <23 | <10 | >3.0 |
| B | 10-30 | 23-32 | 10-20 | 2.2-3.0 |
| C | 30-70 | 32-68 | 20-48 | 1.2-2.2 |
| D | 70-90 | 68-152 | 48-77 | 0.7-1.2 |
| F | >90 | >152 | >77 | <0.7 |

Source: Metropolitan Council-pg. 12,
http://www.metrocouncil.org/environment/RiversLakes/Lakes/07IntPurAcknMethResAn.pdf
Grades are based on May-September average.

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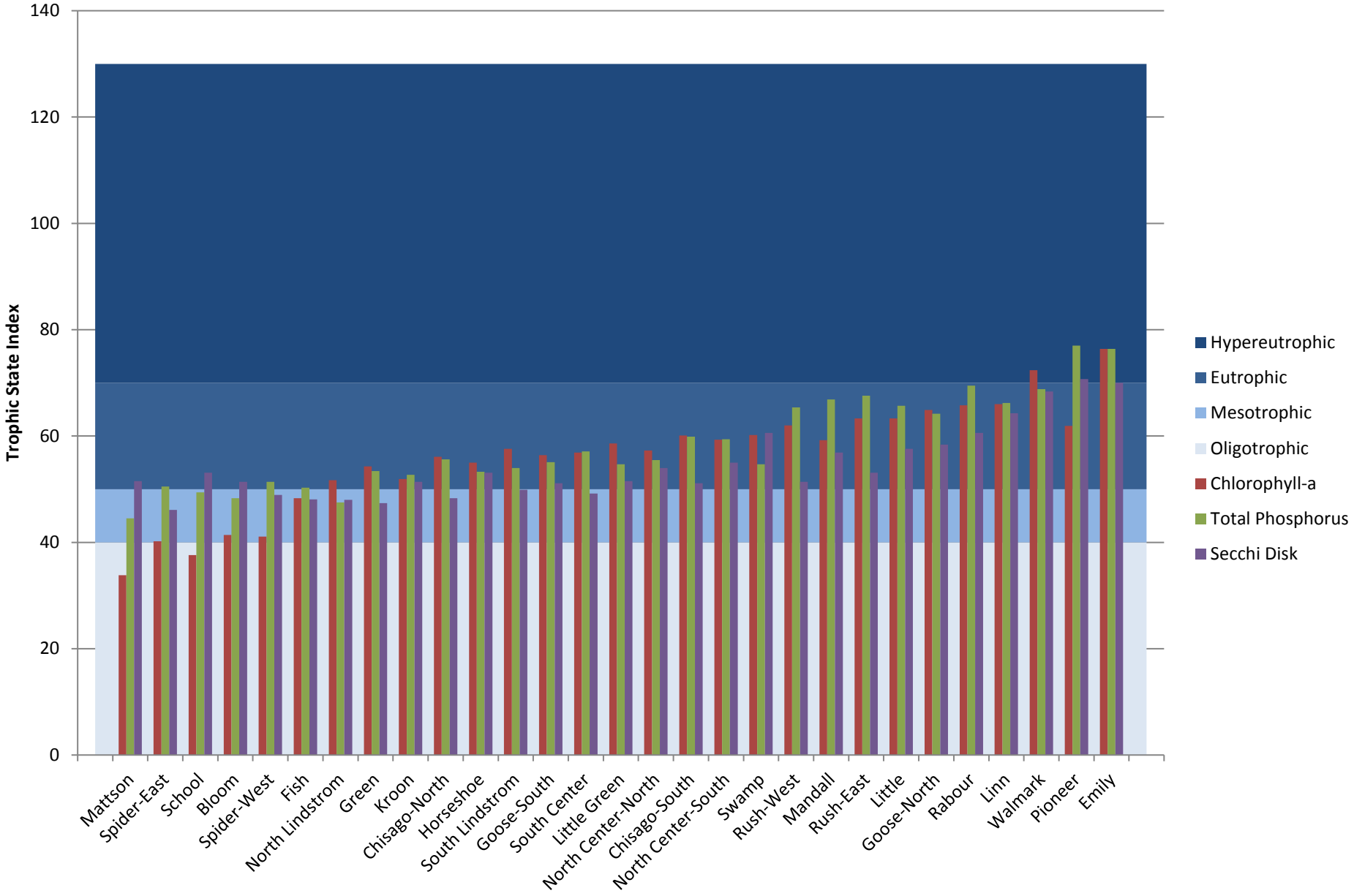
| 2016 Rank | Lake | 2016 Grade | 2015 Grade | 2014 Grade | 2013 Grade | 2012 Grade | 2011 Grade | Trophic State Index | Chlorophyll-a (ug/L) | Total Phosphorus (ug/L) | Secchi Disk (meters) | Classification | Shallow versus Deep | Meets MPCA Standards |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mattson | A-** | - | - | - | - | - | 43.4 | 1.4 | 17.0 | 1.8 | Mesotrophic | S | Y |
| 2 | Spider-East | B | C | C+ | C | C | C | 45.6 | 2.8 | 25.5 | 2.7 | Mesotrophic | S | Y |
| 3 | School | B** | - | - | - | - | - | 46.7 | 2.1 | 20.8 | 1.6 | Mesotrophic | S | Y |
| 4 | Bloom | A- | - | - | - | - | - | 47.0 | 3.4 | 20.5 | 1.8 | Mesotrophic | S | Y |
| 5 | Spider-West | B | B- | C+ | B | B-C | - | 47.1 | 3.1 | 26.5 | 2.0 | Mesotrophic | S | Y |
| 6 | Fish | B | B | B | B | B | - | 47.4 | 4.4 | 17.0 | 2.6 | Mesotrophic | D | Y |
| 7 | North Lindstrom | A- | B | B | B | C | B | 49.1 | 10.5 | 21.8 | 1.9 | Mesotrophic | D | Y |
| 8 | Green | B | C | C+ | C | C-B | C | 51.7 | 13.7 | 34.8 | 1.9 | Eutrophic | D | Y |
| 9 | Kroon | B | B | B | B | C | B | 52.0 | 10.7 | 31.8 | 1.5 | Eutrophic | D | Y |
| 10 | Chisago-North | B | B | C+ | C | C | B | 53.3 | 16.5 | 40.0 | 1.7 | Eutrophic | D | N |
| 11 | Horseshoe | B | C | C | C | C | - | 53.8 | 14.7 | 36.0 | 1.3 | Eutrophic | D | N |
| 12 | South Lindstrom | B | B | C+ | C | C | B | 53.8 | 19.3 | 36.0 | 1.6 | Eutrophic | D | Y |
| 13 | Goose-South | C | C | D | C | C | - | 54.2 | 15.8 | 35.8 | 1.8 | Eutrophic | D | Y |
| 14 | South Center | B | B | C+ | C | C | C | 54.4 | 17.6 | 27.0 | 1.6 | Eutrophic | D | Y |
| 15 | Little Green | C | C | B- | C | C-D | C | 54.9 | 21.5 | 37.3 | 1.5 | Eutrophic | D | Y |
| 16 | North Center-North | C | C | C | C | C | C | 55.6 | 18.3 | 39.5 | 1.2 | Eutrophic | S | Y |
| 17 | Chisago-South | C | C | C | D | D | C | 57.0 | 25.0 | 55.8 | 1.6 | Eutrophic | S | Y |
| 18 | North Center-South | C | C | C+ | C | C | C | 57.9 | 22.6 | 50.3 | 1.0 | Eutrophic | S | N |
| 19 | Swamp | C-** | - | - | - | - | - | 58.5 | 25.0 | 32.8 | 0.9 | Eutrophic | S | N |
| 20 | Rush-West | C | C | D+ | C | D | - | 59.6 | 29.5 | 81.5 | 1.3 | Eutrophic | D | N |
| 21 | Mandall | C | C | D | - | - | - | 61.0 | 21.9 | 90.3 | 1.0 | Eutrophic | D | N |
| 22 | Rush-East | C | C | D | C | D | - | 61.3 | 34.9 | 97.3 | 0.9 | Eutrophic | D | N |
| 23 | Little | C | C | D | C | D | C- | 62.2 | 33.8 | 74.8 | 1.0 | Eutrophic | D | N |
| 24 | Goose-North | C | C | D | D | C | - | 62.5 | 40.6 | 73.5 | 0.9 | Eutrophic | S | N |
| 25 | Rabour | D | C | D | - | - | - | 65.3 | 43.1 | 106.8 | 0.6 | Eutrophic | D | N |
| 26 | Linn | D | - | - | - | - | - | 65.5 | 43.7 | 79.0 | 0.7 | Eutrophic | S | N |
| 27 | Walmark | D | - | - | - | - | - | 69.8 | 81.2 | 92.0 | 0.5 | Eutrophic | S | N |
| 28 | Pioneer | F+ | - | - | - | - | - | 69.9 | 30.5 | 183.3 | 0.4 | Hyper-eutrophic | S | N |
| 29 | Emily | F | - | - | - | - | - | 74.3 | 107.0 | 165.0 | 0.4 | Hyper-eutrophic | S | N |

*Shaded cells do not meet the Water Quality Standards in 2016

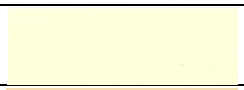
**Shallow lakes where Secchi disk readings are taken from the lake bottom may result in an artificially low grade for Secchi Disk Depth, which can influence the overall grade.

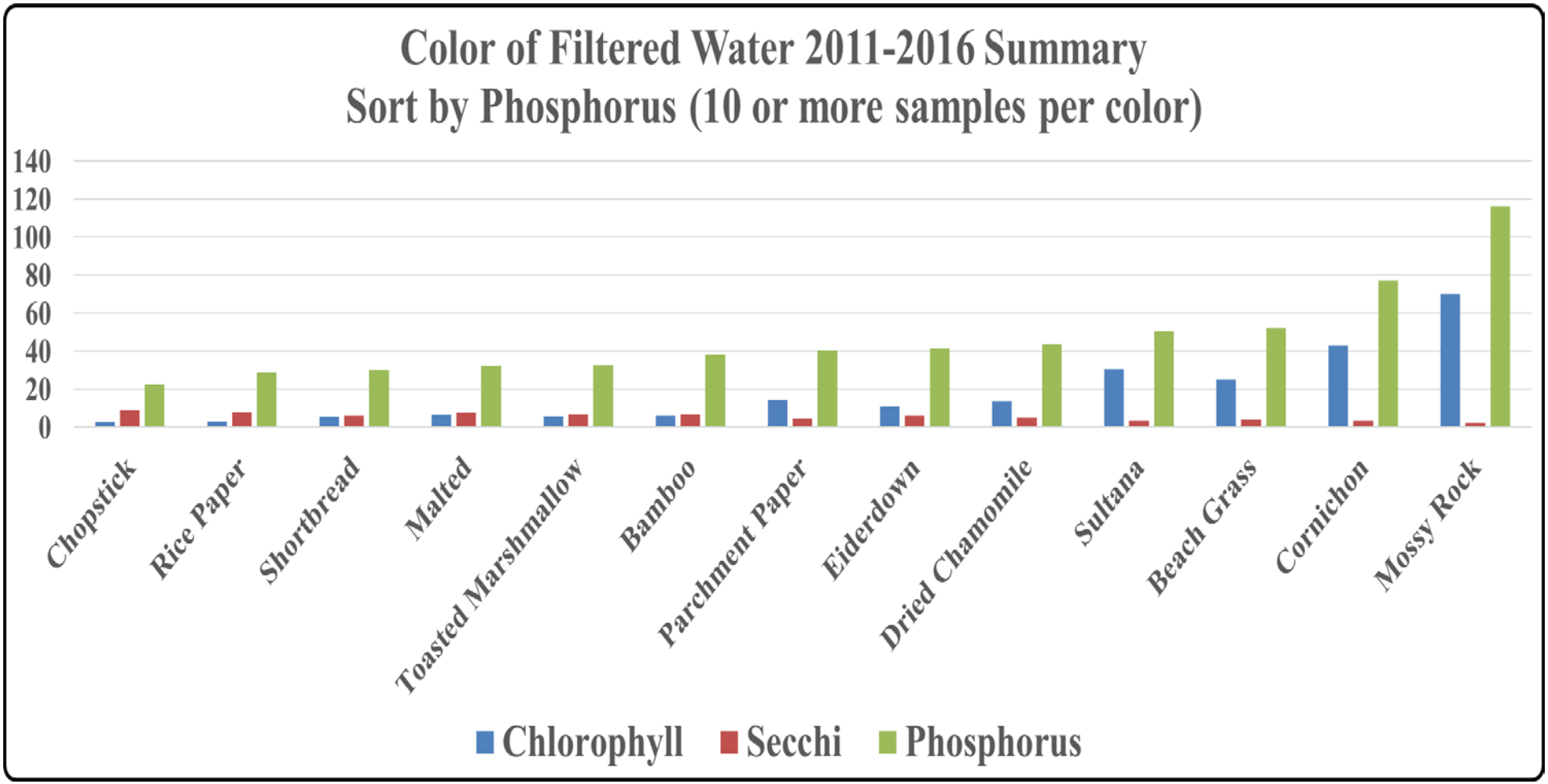
# Lake Classification Chart



# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The following chart is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

| Color Name | | Chlorophyll-a Concentrations (average µg/L) | Secchi Transparency (average M) | Phosphorus Concentrations (average µg/L) | Number of Samples |
|---|---|---|---|---|---|
| Chopstick |  | 2.55 | 9.23 | 22.70 | 29 |
| Rice Paper |  | 2.99 | 7.94 | 28.56 | 17 |
| Shortbread |  | 5.41 | 6.33 | 30.30 | 21 |
| Malted |  | 6.52 | 7.79 | 32.13 | 23 |
| Toasted Marshmallow |  | 5.71 | 7.08 | 32.81 | 32 |
| Bamboo |  | 6.07 | 7.00 | 38.42 | 12 |
| Parchment Paper |  | 14.42 | 4.80 | 40.58 | 40 |
| Eiderdown |  | 10.84 | 6.36 | 41.73 | 11 |
| Dried Chamomile |  | 13.88 | 5.34 | 43.68 | 57 |
| Sultana |  | 30.69 | 3.34 | 50.36 | 31 |
| Beach Grass |  | 25.07 | 4.04 | 52.34 | 127 |
| Cornichon |  | 42.91 | 3.21 | 77.42 | 106 |
| Mossy Rock |  | 70.19 | 2.16 | 116.23 | 15 |

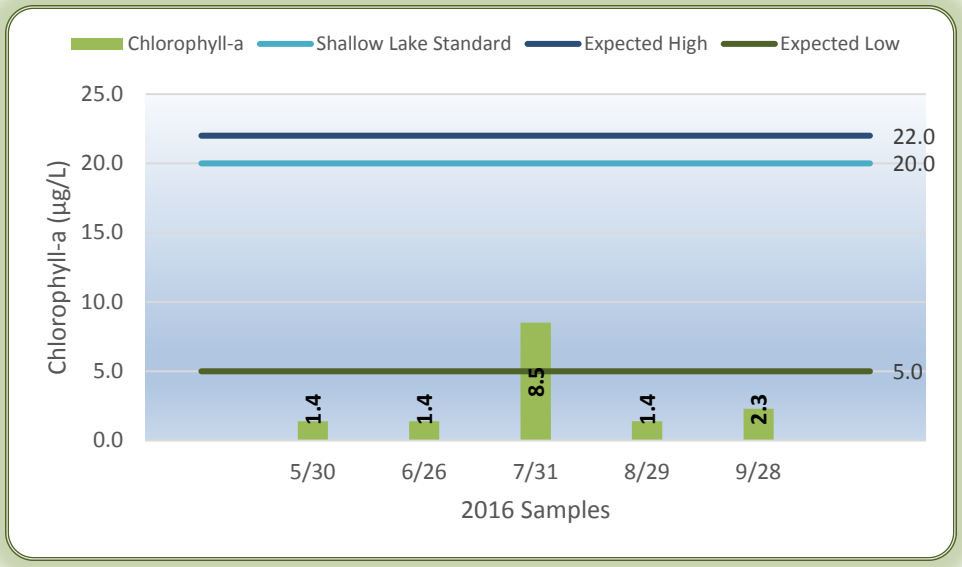

Color of Filtered Water 2011-2016 Summary
Sort by Phosphorus (10 or more samples per color)
140
120
100
80
60
40
20
0
Chopstick
Rice Paper
Shortbread
Malted
Toasted Marshmallow
Bamboo
Parchment Paper
Eiderdown
Dried Chamomile
Sultana
Beach Grass
Cornichon
Mossy Rock
Chlorophyll
Secchi
Phosphorus

# Bloom Lake

Lake 13-0001-00

| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Mesotrophic |
| Overall Lake Quality Grade | A- |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 4 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 41.4 | 51.4 | 48.3 | 47.0 |
| Classification | Mesotrophic | Eutrophic | Mesotrophic | Mesotrophic |
| 2016 Average (May-Sept) | 3.0 µg/L | 1.8 meters | 21.4 µg/L | - |
| Grade | A | C | A | A- |
| MPCA Standard (Shallow) | 20.0 µg/L | >1 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 3.4 µg/L | 1.8 meters | 20.5 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |




## Chlorophyll-a

Bloom Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

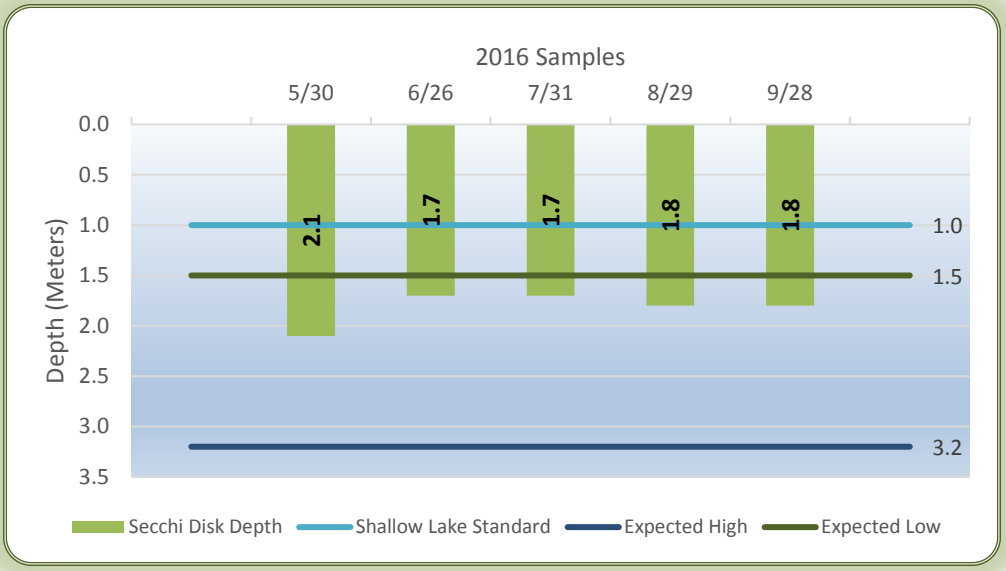
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard (20.0 µg/L) |
|---|---|---|---|---|
| 2009-2015 | No Data | - | No Data | - |
| 2016 | 3.0 | A | 3.4 | Yes |

## Secchi Disk Depth

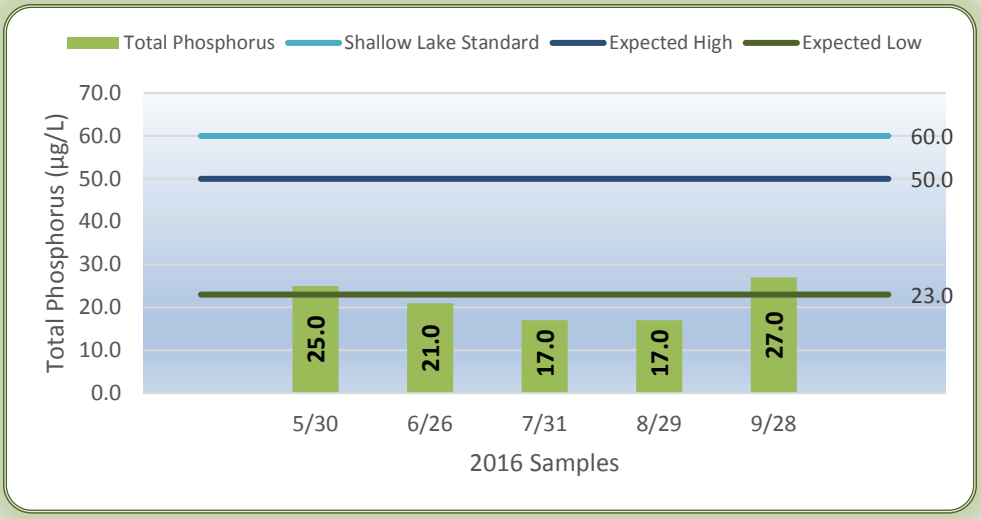
Bloom Lake

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard (>1.0 meter) |
|---|---|---|---|---|
| 2009-2015 | No Data | - | No Data | - |
| 2016 | 1.8 | C | 1.8 | Yes |




# Total Phosphorus

Bloom Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

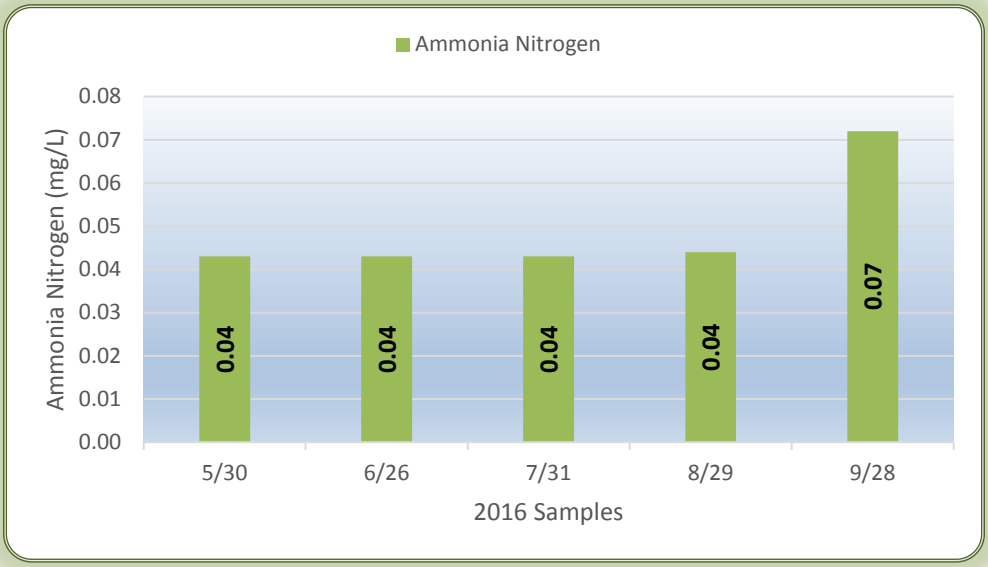
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard (60.0 µg/L) |
|---|---|---|---|---|
| 2009-2015 | No Data | - | No Data | - |
| 2016 | 21.4 | A | 20.5 | Yes |

# Ammonia Nitrogen

Bloom Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average mg/L | |
|---|---|
| 2009-2015 | No Data |
| 2016 | 0.05 |

Bloom Lake

General Observations

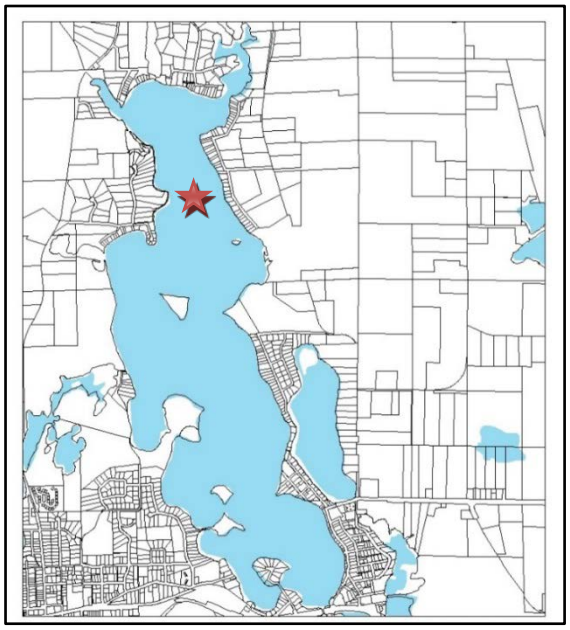
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Toasted Marshmallow | |
| June | 3<br>Medium Algae | 2<br>Good | Shortbread | |
| July | 3<br>Medium Algae | 2<br>Good | Dune | |
| August | 3<br>Medium Algae | 2<br>Good | Toasted Marshmallow | |
| September | 3<br>Medium Algae | 2<br>Good | Shortbread | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

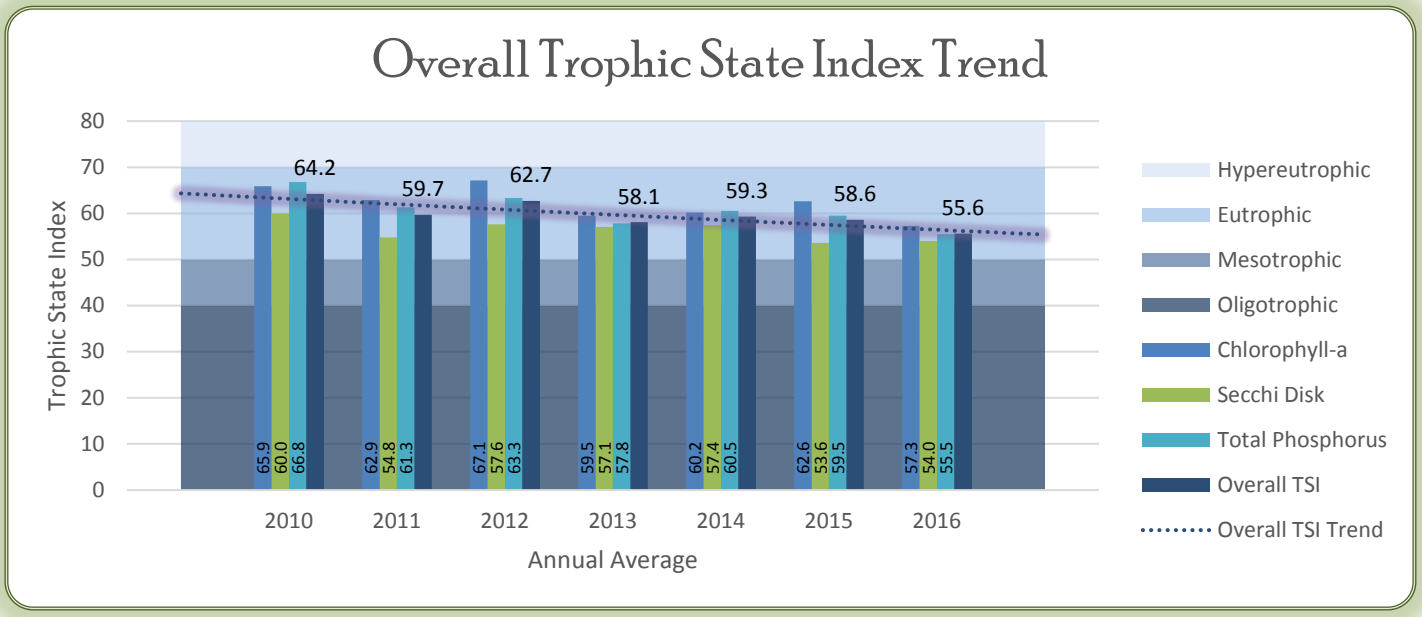
# North Center Lake-North

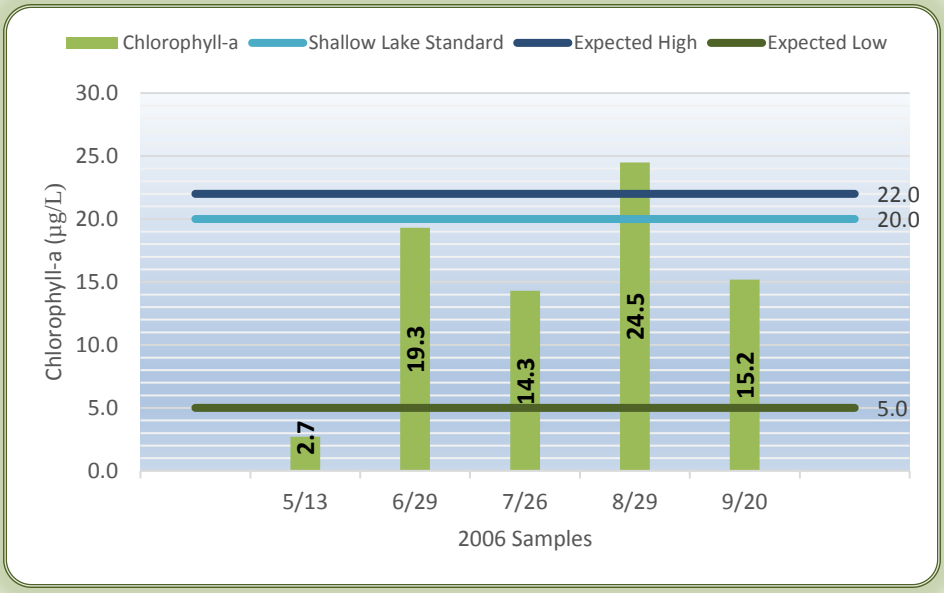
Lake 13-0032-01 Site 202



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 16 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 57.3 | 54.0 | 55.5 | 55.6 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 15.2 µg/L | 1.5 meters | 35.2 µg/L | - |
| Grade | B | C | C | C |
| MPCA Standard (Shallow) | 20.0 µg/L | >1 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 18.3 µg/L | 1.2 meters | 39.5 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





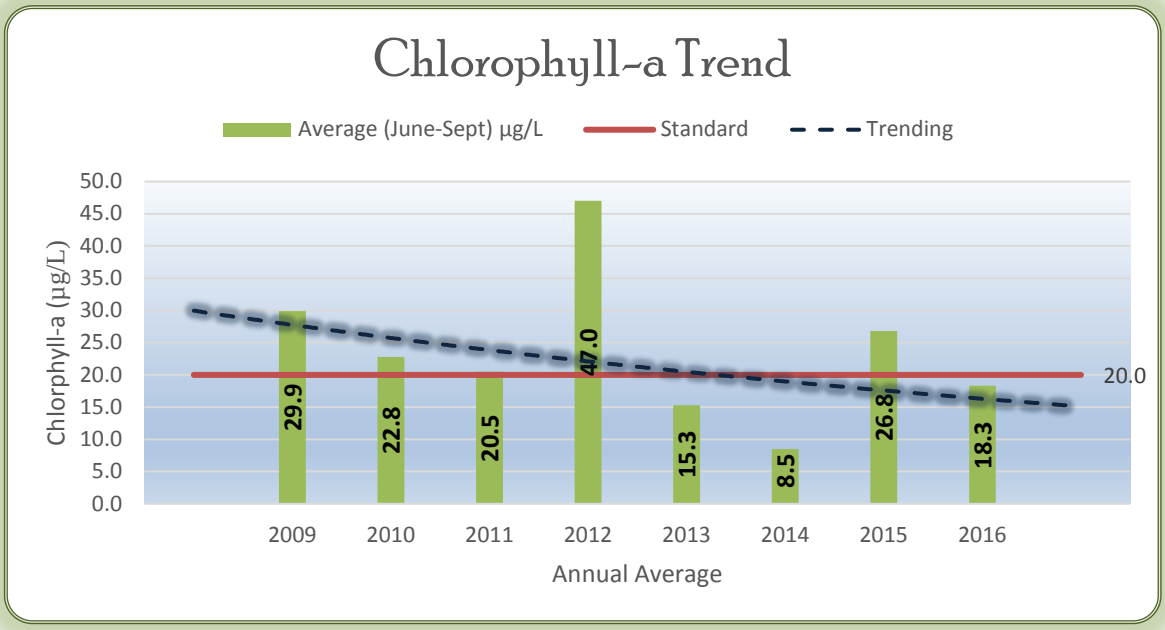

# Chlorophyll-a

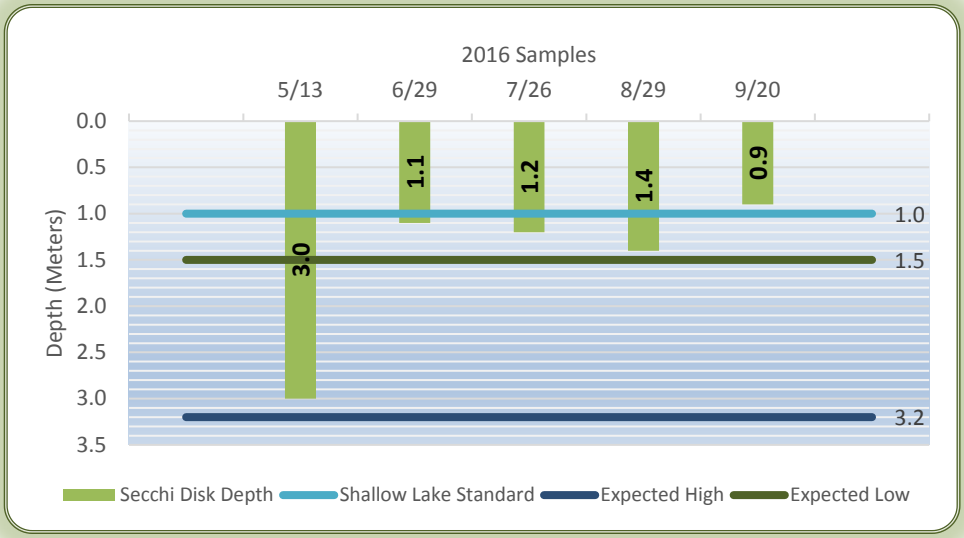
## North Center Lake-North

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 24.9 | 19.5 | 17.2 | 38.4 | 14.4 | 7.4 | 23.6 | 15.2 |
| Grade | C | B | B | C | B | A | C | B |
| June-Sept Average (µg/L) | 29.9 | 22.8 | 20.5 | 47.0 | 15.3 | 8.5 | 26.8 | 18.3 |
| Meets Standard (20.0 µg/L) | No | No | No | No | Yes | Yes | No | Yes |





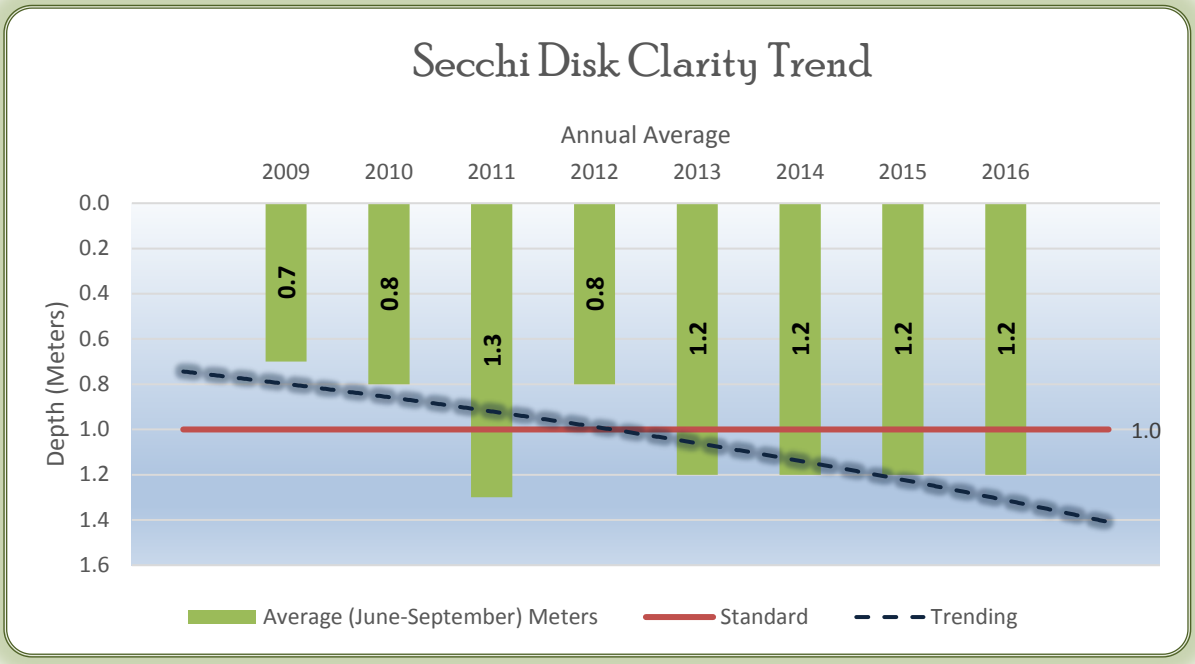

# Secchi Disk Depth

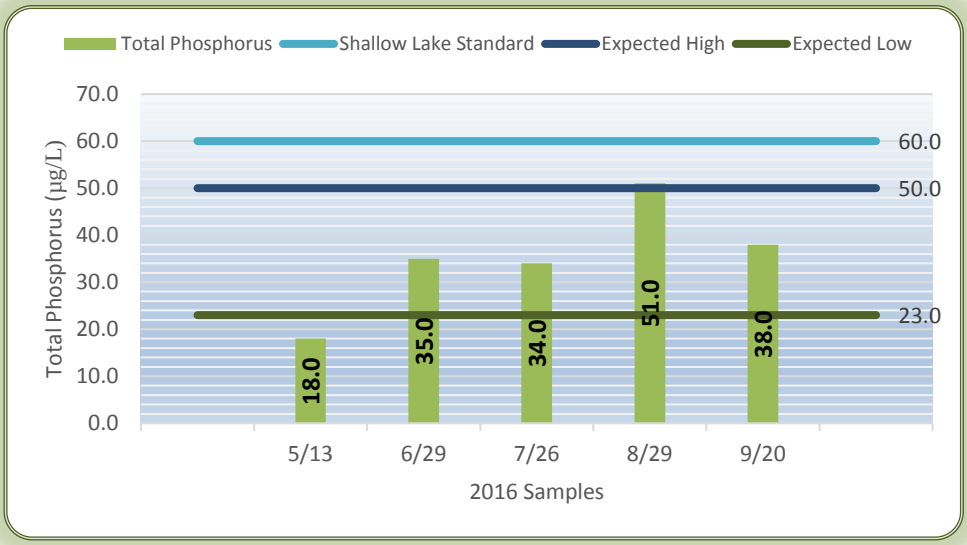
## North Center Lake-North

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meter) | 0.9 | 1.1 | 1.4 | 1.2 | 1.2 | 1.2 | 1.6 | 1.5 |
| Grade | D | D | C | C-D | C-D | C-D | C | C |
| June-Sept Average (Meter) | 0.7 | 0.8 | 1.3 | 0.8 | 1.2 | 1.2 | 1.2 | 1.2 |
| Meets Standard (>1.0 Meter) | No | No | Yes | No | Yes | Yes | Yes | Yes |





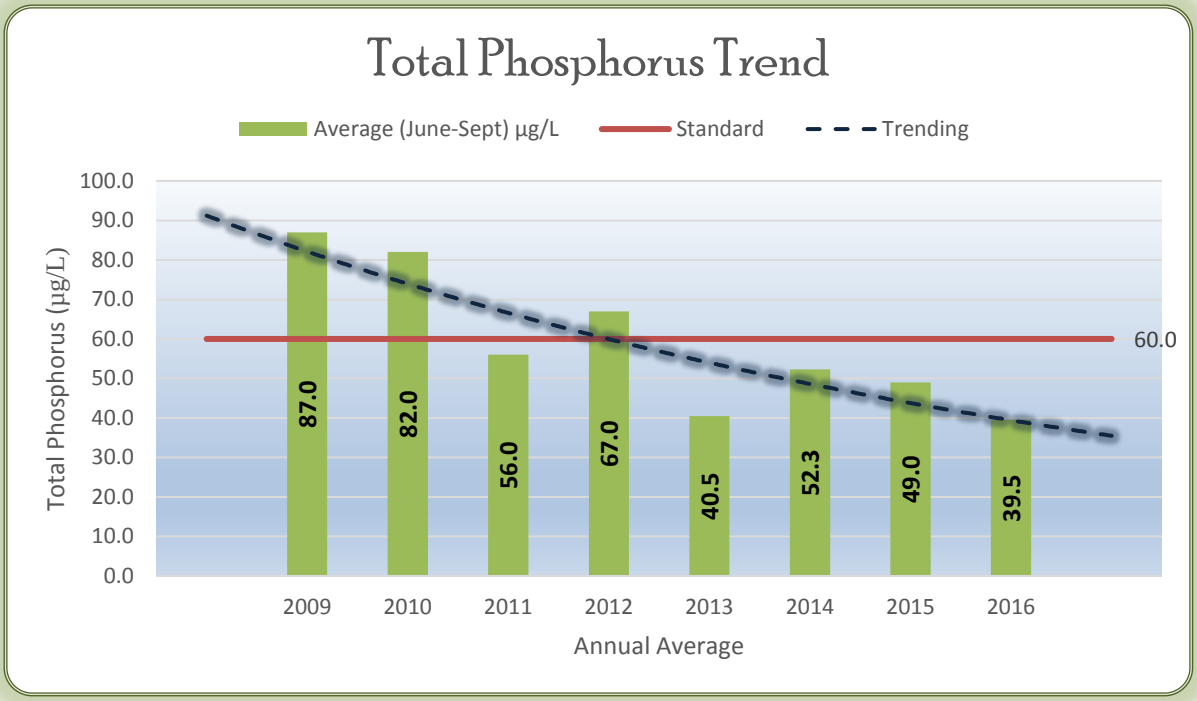

# Total Phosphorus

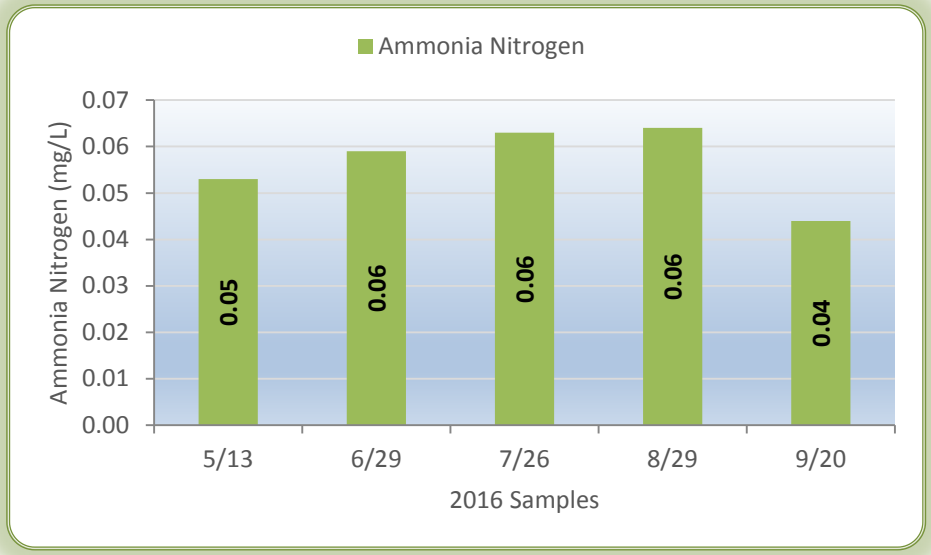
## North Center Lake-North

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 80.0 | 74.0 | 52.6 | 60.6 | 41.2 | 49.6 | 46.4 | 35.2 |
| Grade | D | D | C | C | C | C | C | C |
| June-Sept Average (µg/L) | 87.0 | 82.0 | 56.0 | 67.0 | 40.5 | 52.3 | 49.0 | 39.5 |
| Meets Standard (60.0 µg/L) | No | No | Yes | No | Yes | Yes | Yes | Yes |





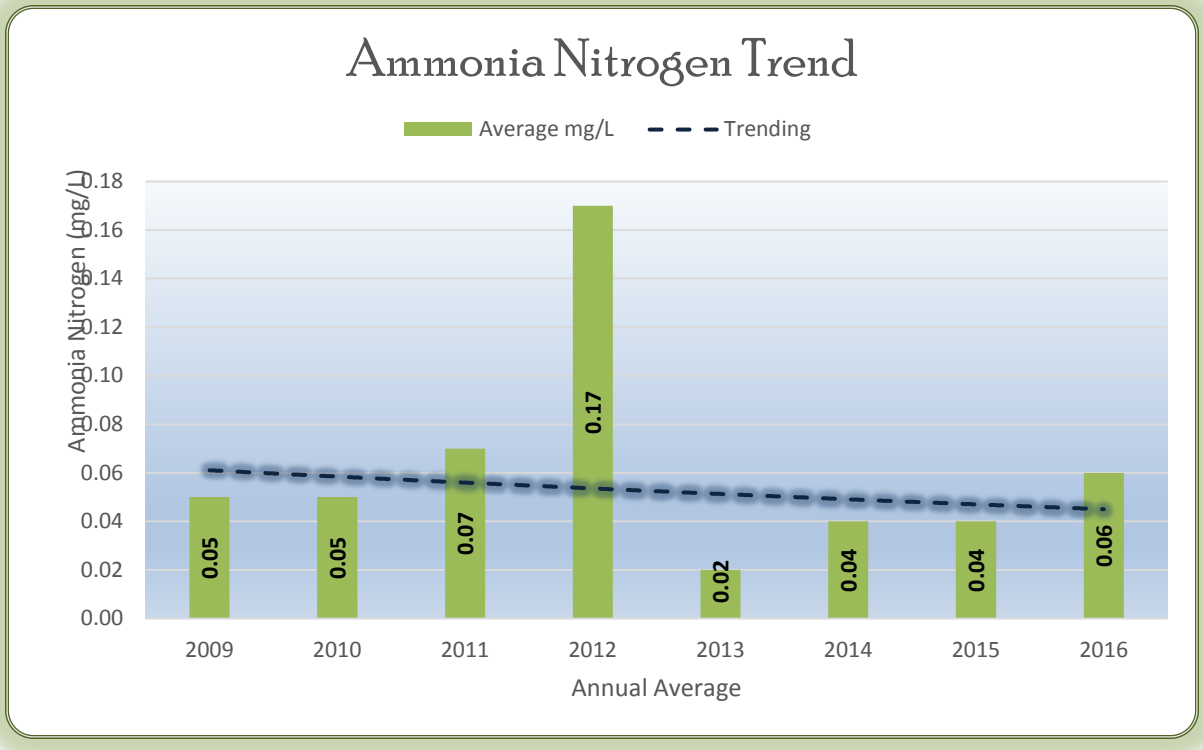

# Ammonia Nitrogen

## North Center Lake-North

Expected Range:
None

Shallow Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | <0.05 | <0.05 | 0.07 | 0.17 | 0.02 | 0.04 | 0.04 | 0.06 |



General Observations
North Center Lake–North

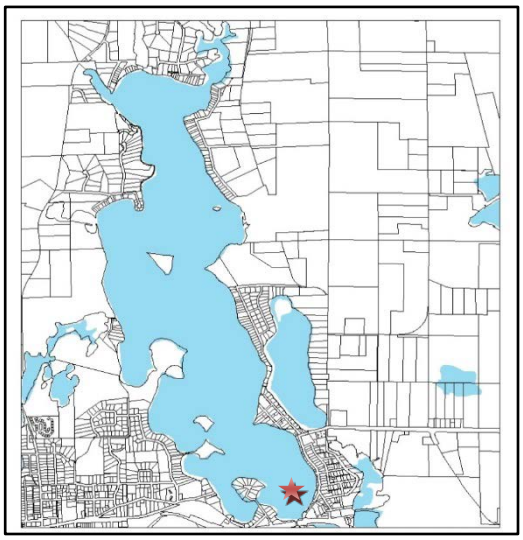
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Chopstick | |
| June | 3<br>Medium Algae | 3<br>Fair | Sultana | |
| July | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| August | 4<br>High Algae | 4<br>Poor | Beach Grass | |
| September | 4<br>High Algae | 4<br>Poor | Calabash | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll–a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll–a, Secchi transparency, and Phosphorus.

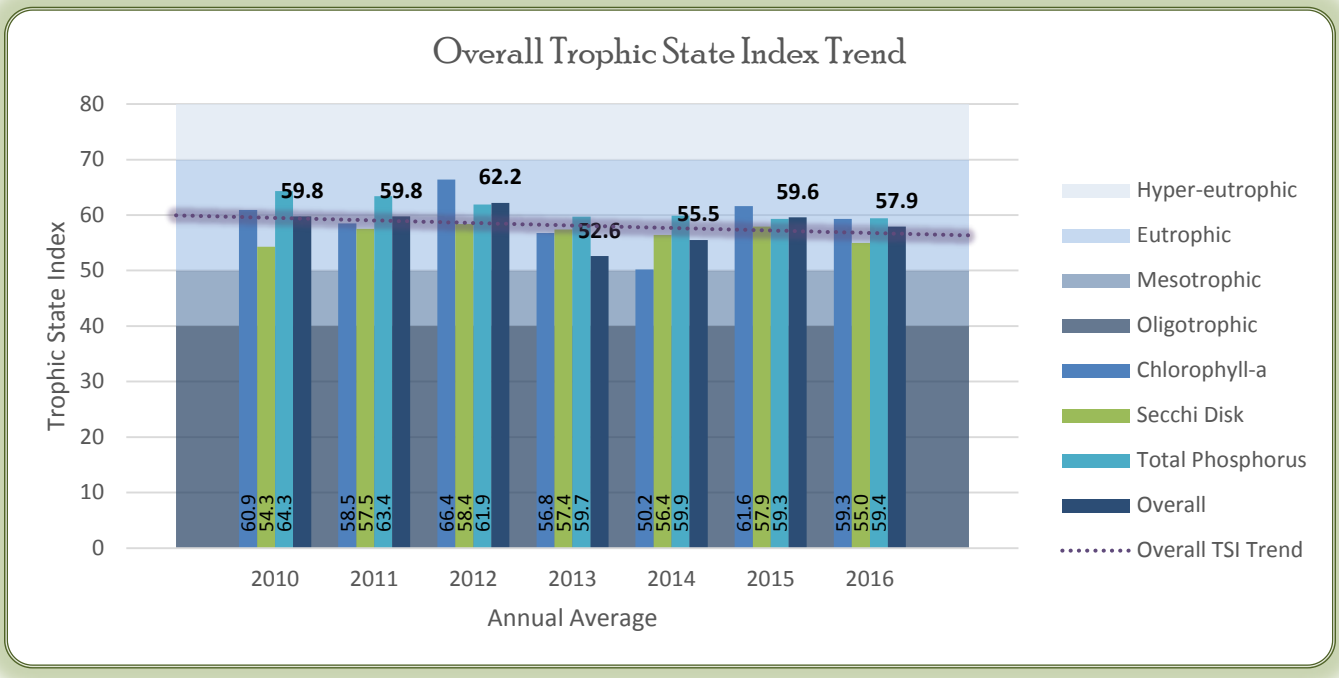
# North Center Lake-South

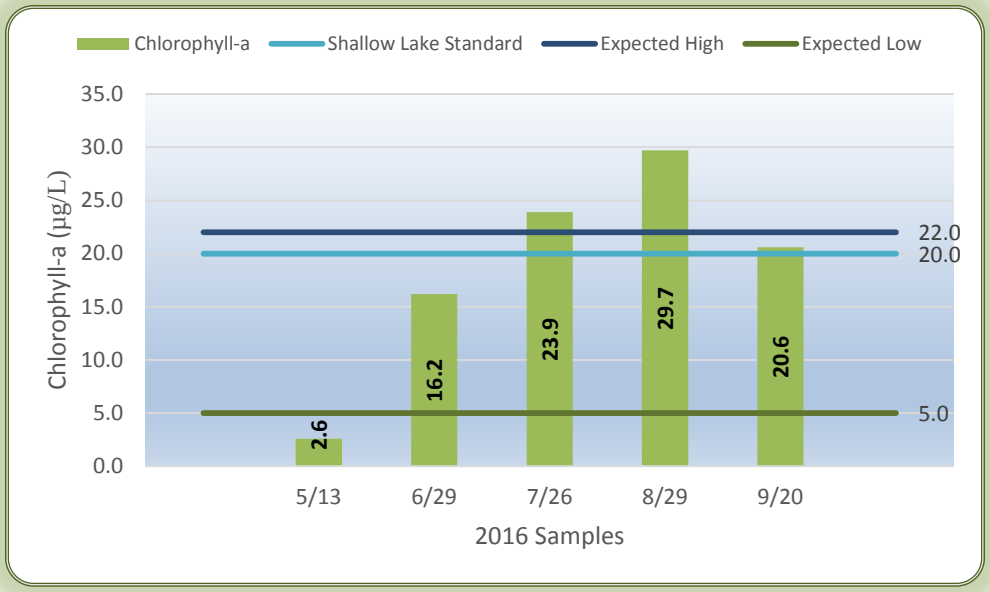
Lake 13-0032-01 Site 201



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | No |
| 2016 Ranking | 18 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 59.3 | 55.0 | 59.4 | 57.9 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 18.6 µg/L | 1.4 meters | 46.0 µg/L | - |
| Grade | B | C | C | C |
| MPCA Standard (Shallow) | 20.0 µg/L | >1 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 22.6 µg/L | 1.0 meter | 50.3 µg/L | - |
| Meets Standard | No | No | Yes | No |





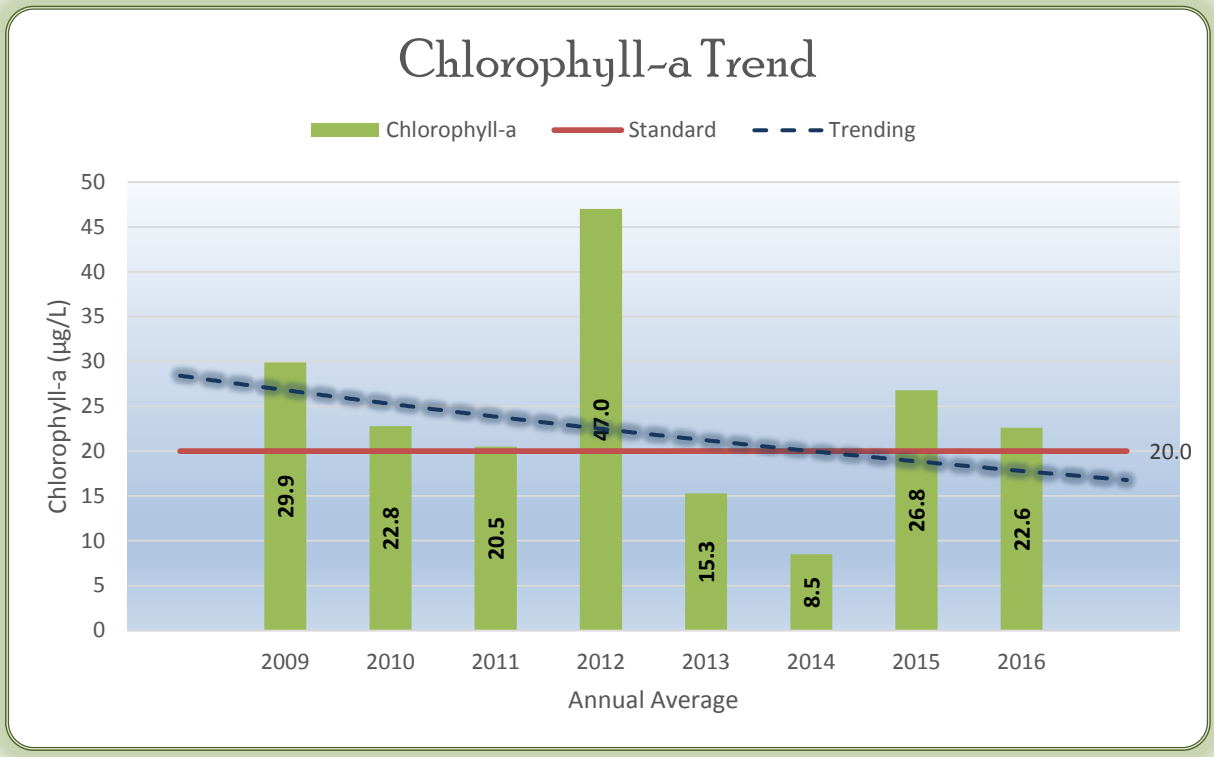

# Chlorophyll-a

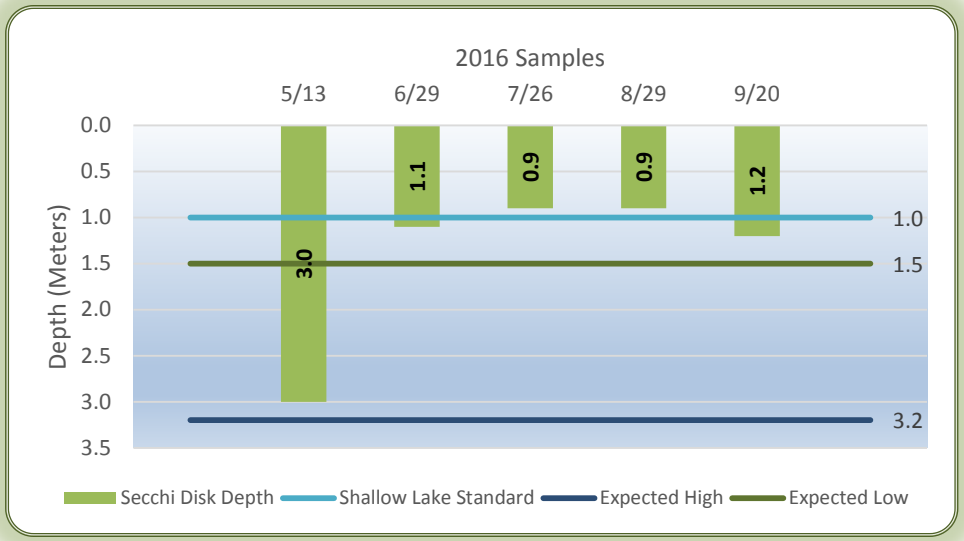
North Center Lake-South

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 24.9 | 19.5 | 17.2 | 38.4 | 14.4 | 7.4 | 23.6 | 18.6 |
| Grade | C | B | B | C | B | A | C | B |
| June-Sept Average (µg/L) | 29.9 | 22.8 | 20.5 | 47.0 | 15.3 | 8.5 | 26.8 | 22.6 |
| Meets Standard (20.0 µg/L) | No | No | No | No | Yes | Yes | No | No |





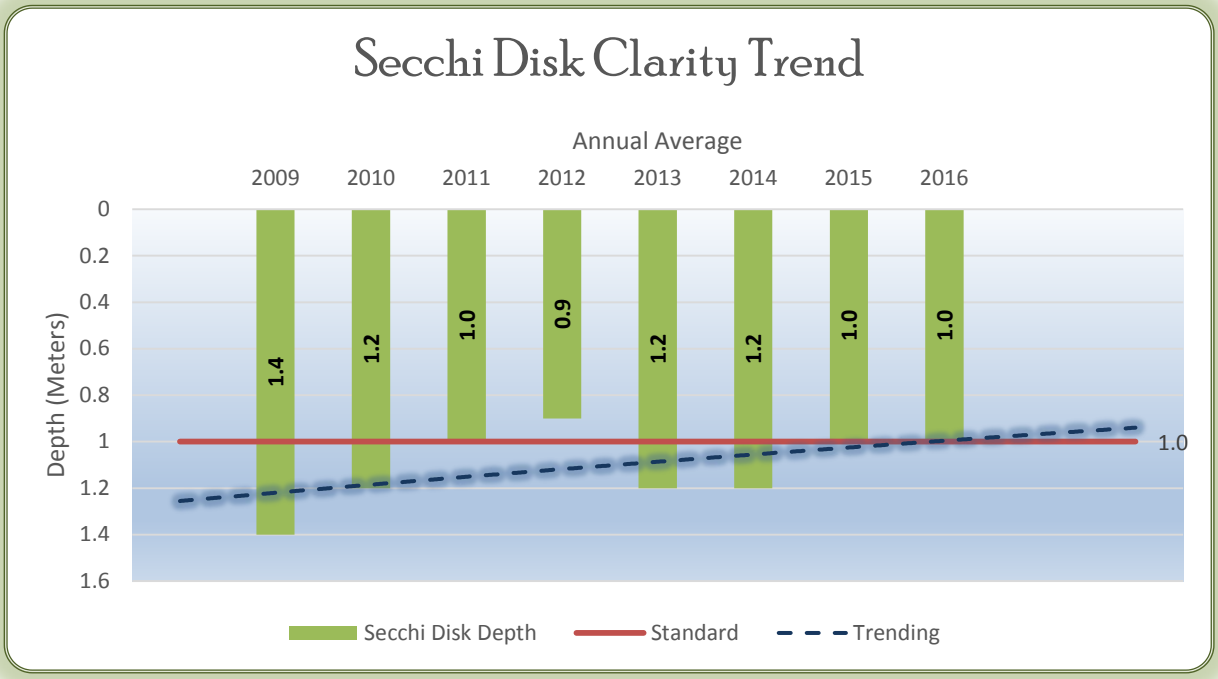

# Secchi Disk Depth

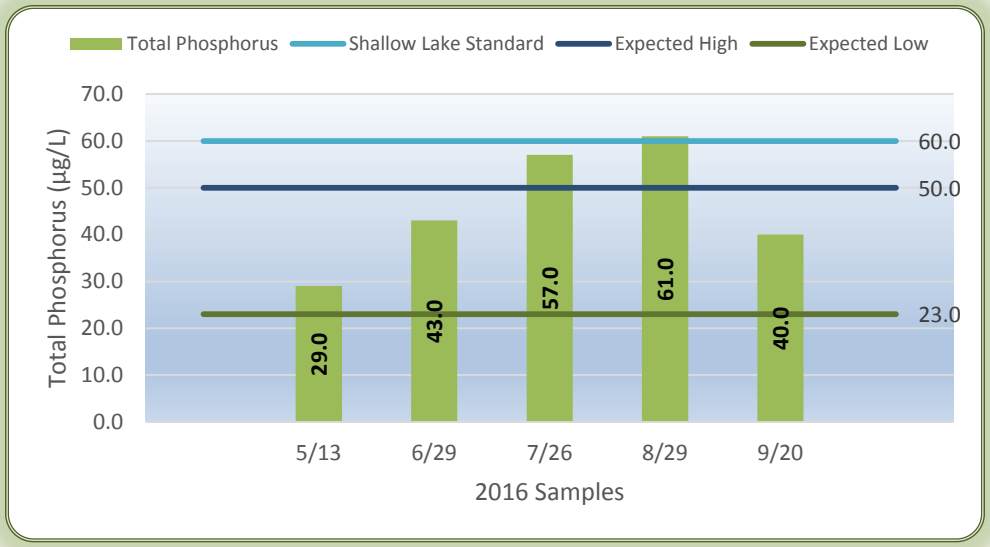
North Center Lake-South

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meter) | 1.6 | 1.4 | 1.2 | 1.1 | 1.2 | 1.3 | 1.2 | 1.4 |
| Grade | C | C | C-D | D | C-D | C | C-D | C |
| June-Sept Average (Meter) | 1.4 | 1.2 | 1.0 | 0.9 | 1.2 | 1.2 | 1.0 | 1.0 |
| Meets Standard (>1.0 Meter) | Yes | Yes | No | No | Yes | Yes | No | No |





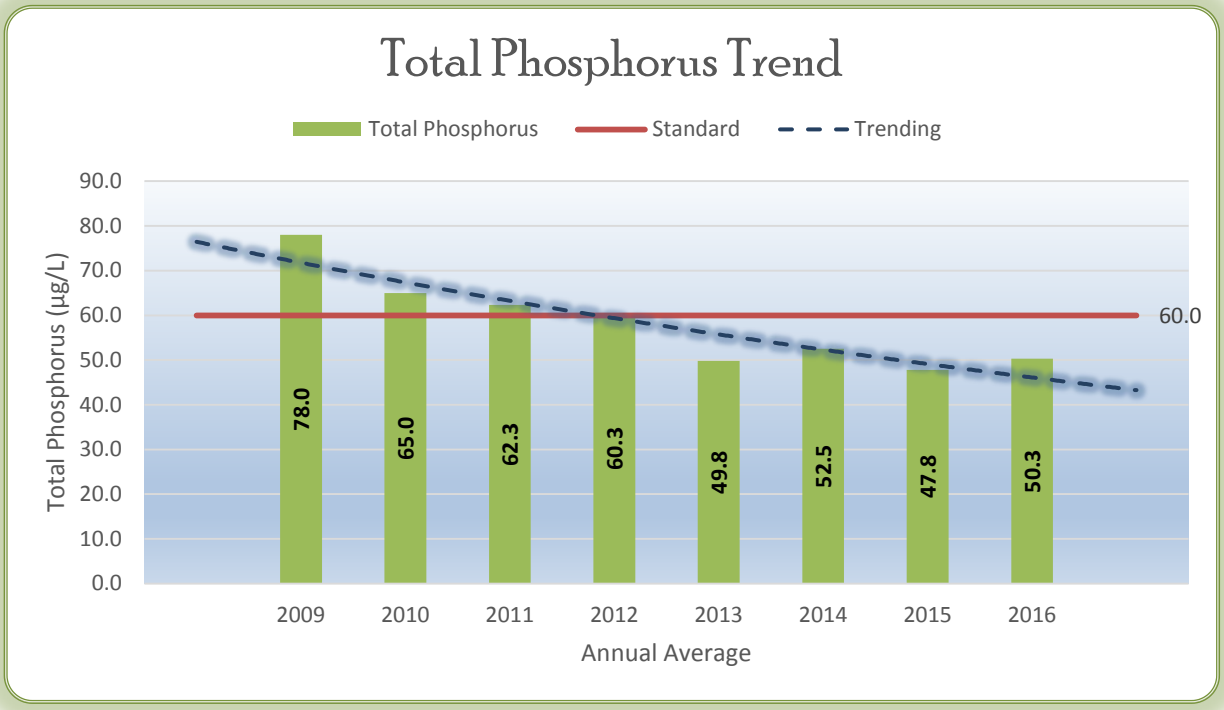

# Total Phosphorus

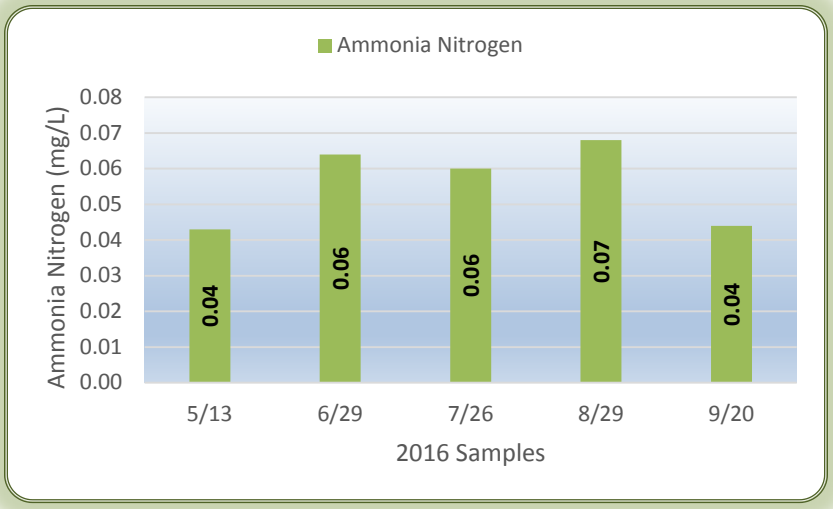
North Center Lake-South

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 70.0 | 60.0 | 61.0 | 54.8 | 47.2 | 47.8 | 45.8 | 46.0 |
| Grade | D | C | C | C | C | C | C | C |
| June-Sept Average (µg/L) | 78.0 | 65.0 | 62.3 | 60.3 | 49.8 | 52.5 | 47.8 | 50.3 |
| Meets Standard (60.0 µg/L) | No | No | No | No | Yes | Yes | Yes | Yes |





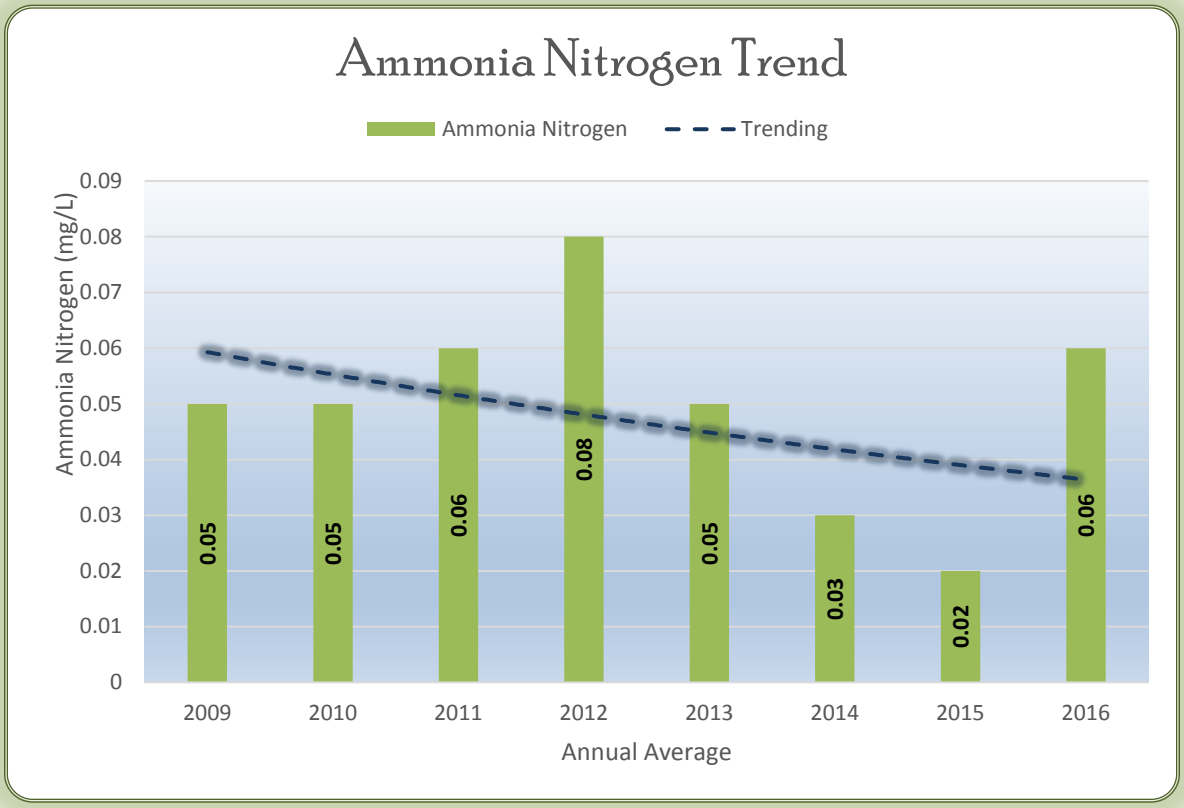

# Ammonia Nitrogen

## North Center Lake-South

Expected Range:
None

Shallow Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | <0.05 | <0.05 | 0.06 | 0.08 | 0.05 | 0.03 | 0.02 | 0.06 |



General Observations
North Center Lake–South

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Chopstick | |
| June | 3<br>Medium Algae | 3<br>Fair | Dried Chamomile | |
| July | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| August | 4<br>High Algae | 4<br>Poor | Sultana | |
| September | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |

# Explanation of Color Classification

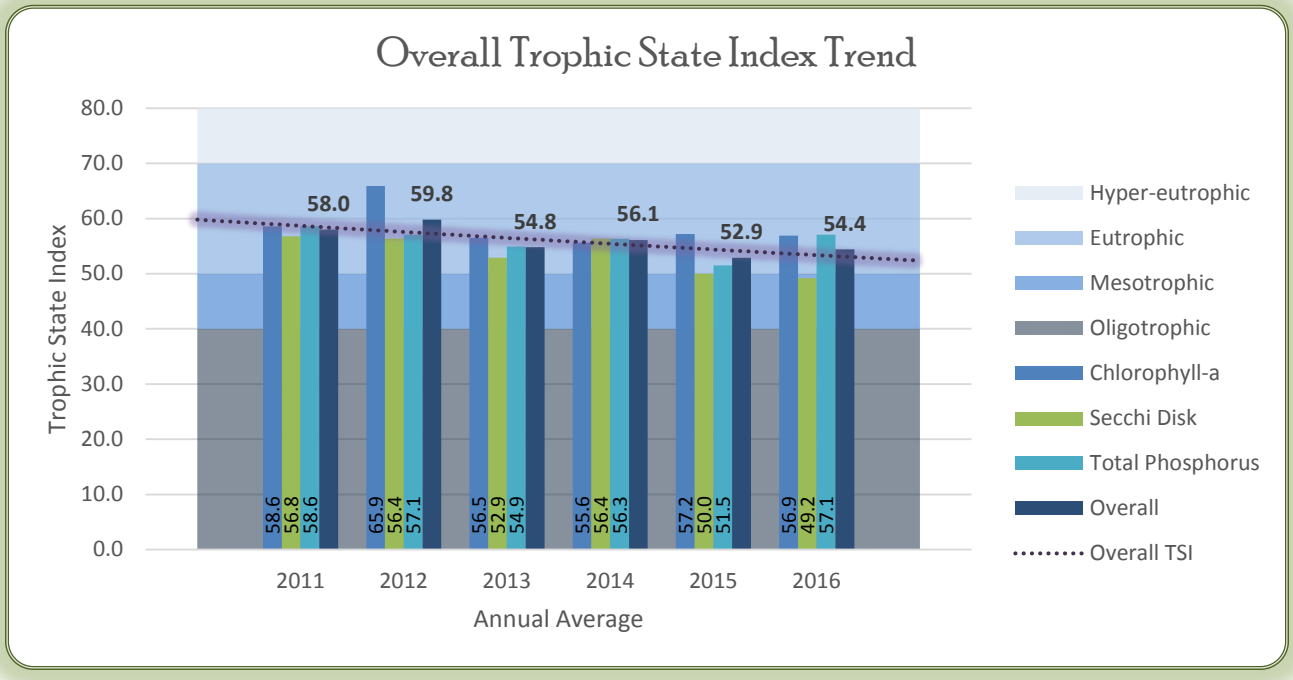
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

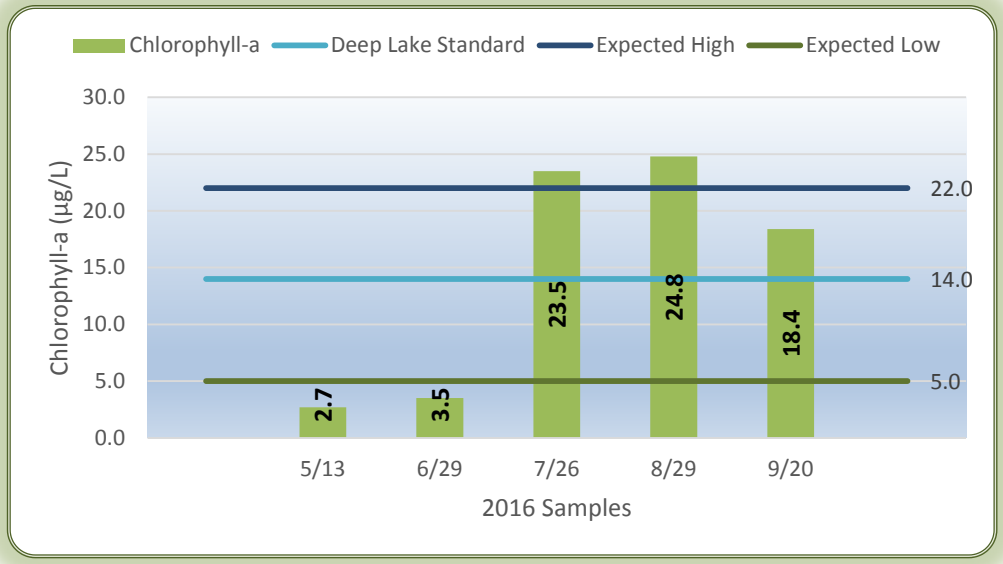
# South Center Lake

Lake 13-0027-00 Site 207

| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 14 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 56.9 | 49.2 | 57.1 | 54.4 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 14.6 µg/L | 2.1 meters | 39.2 µg/L | - |
| Grade | B | C | B | B |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 17.6 µg/L | 1.6 meters | 27.0 µg/L | - |
| Meets Standard | No | Yes | Yes | Yes |





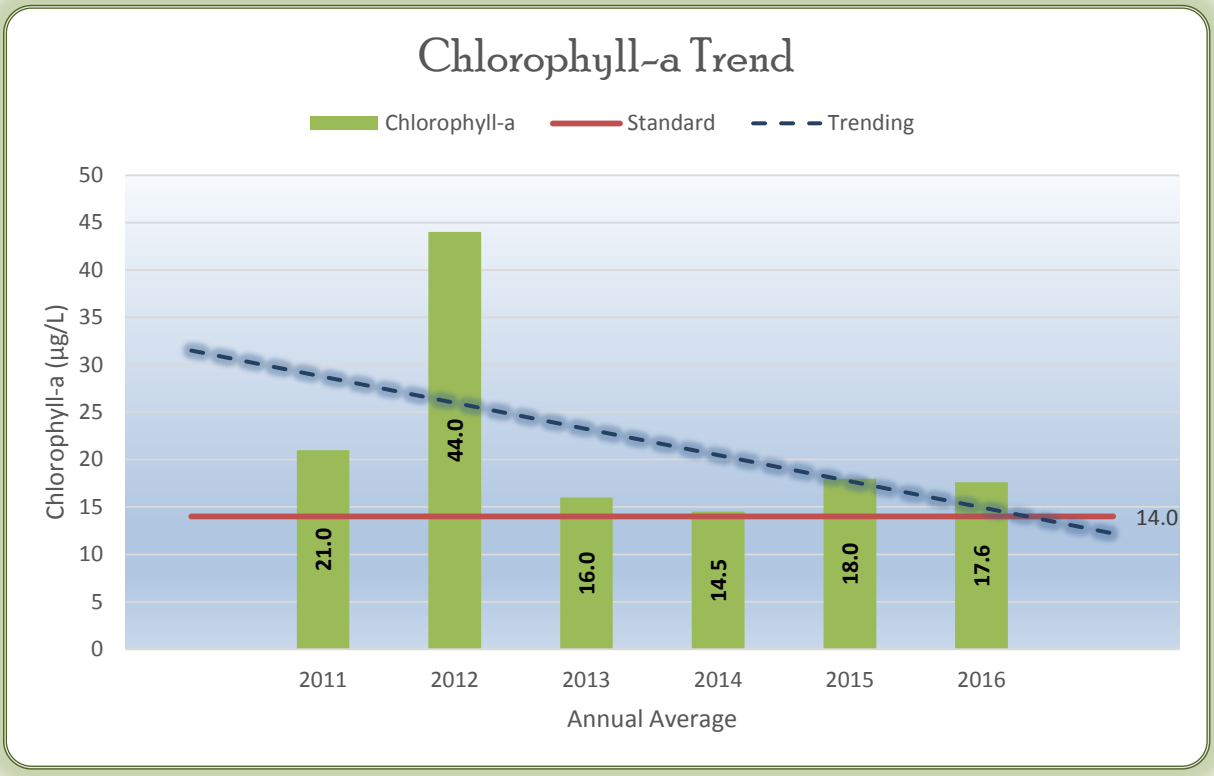

# Chlorophyll-a

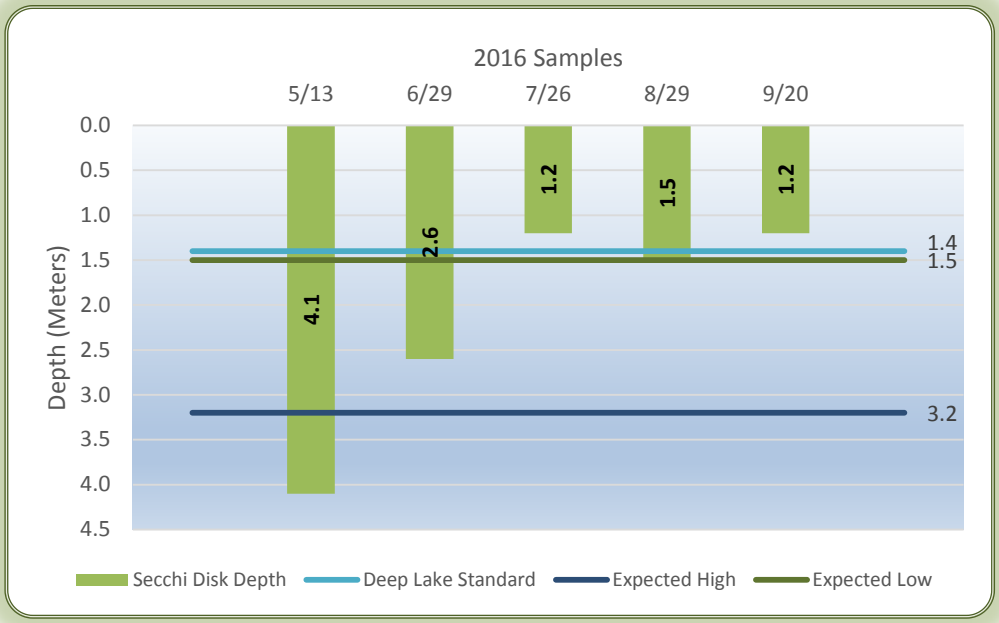
## South Center Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | 17.4 | 36.4 | 14.0 | 12.8 | 15.0 | 14.6 |
| Grade | - | - | B | C | B | B | B | B |
| June-Sept Average (µg/L) | No Data | No Data | 21.0 | 44.0 | 16.0 | 14.5 | 18.0 | 17.6 |
| Meets Standard (14.0 µg/L) | - | - | No | No | No | No | No | No |





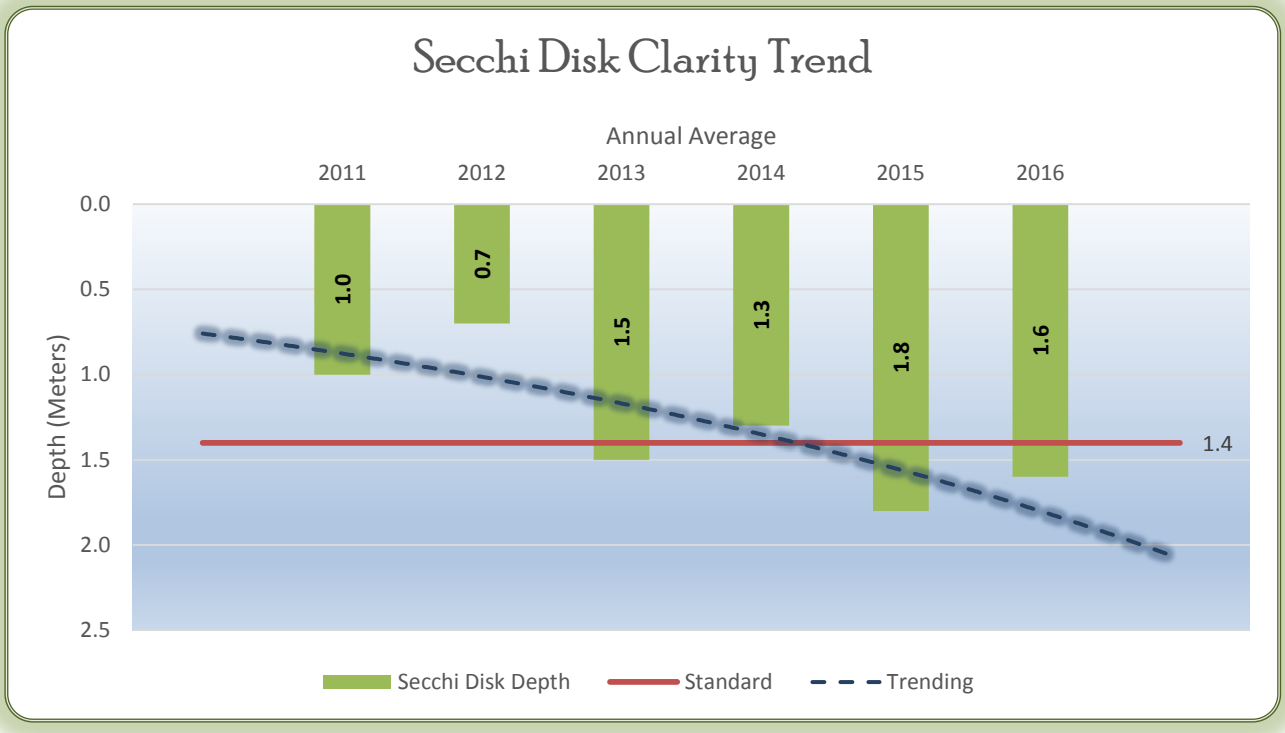

# Secchi Disk Depth

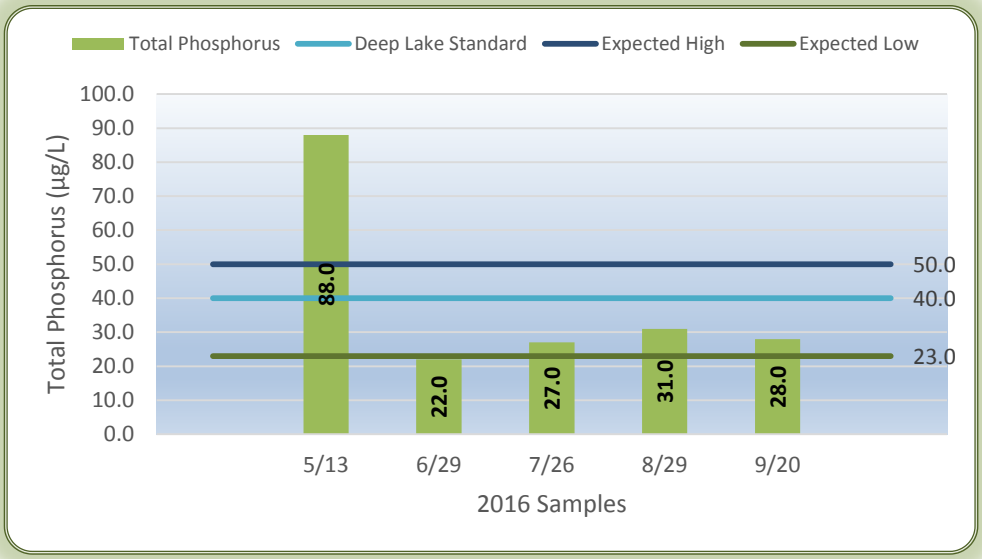
## South Center Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meter) | No Data | No Data | 1.2 | 1.3 | 1.6 | 1.3 | 2.0 | 2.1 |
| Grade | - | - | C-D | C | C | C | C | C |
| June-Sept Average (Meter) | No Data | No Data | 1.0 | 0.7 | 1.5 | 1.3 | 1.8 | 1.6 |
| Meets Standard (>1.4 meters) | - | - | No | No | Yes | No | Yes | Yes |





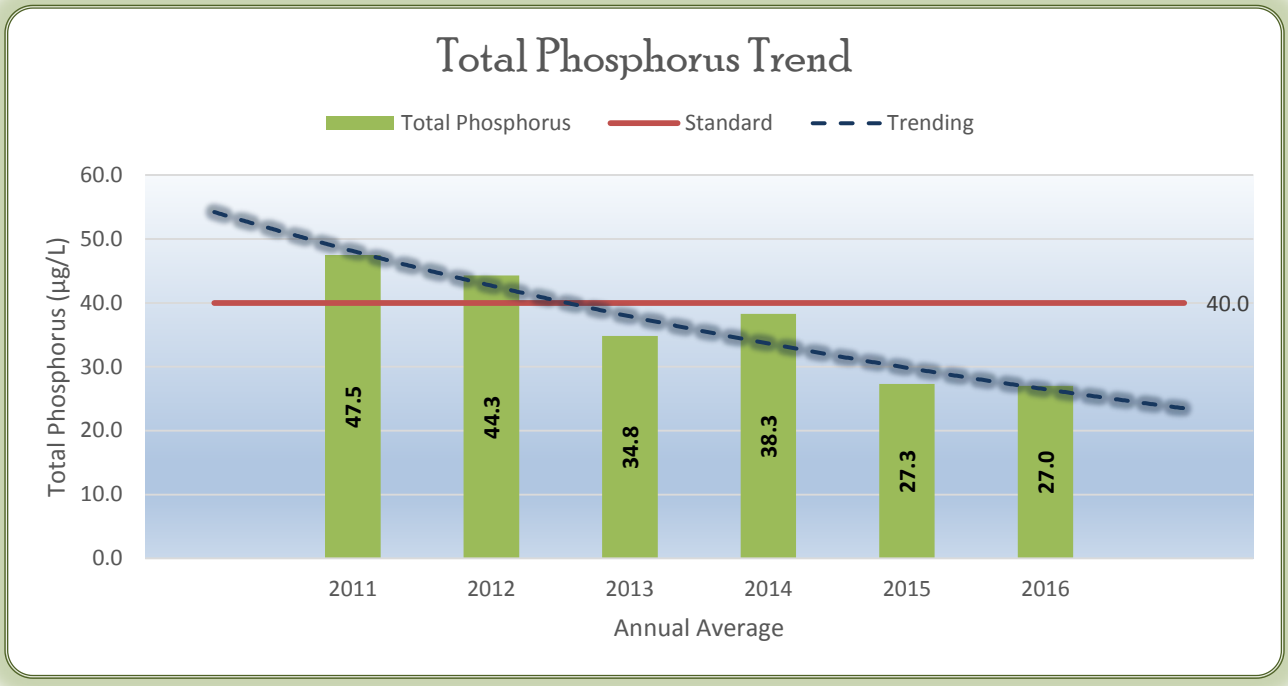

# Total Phosphorus

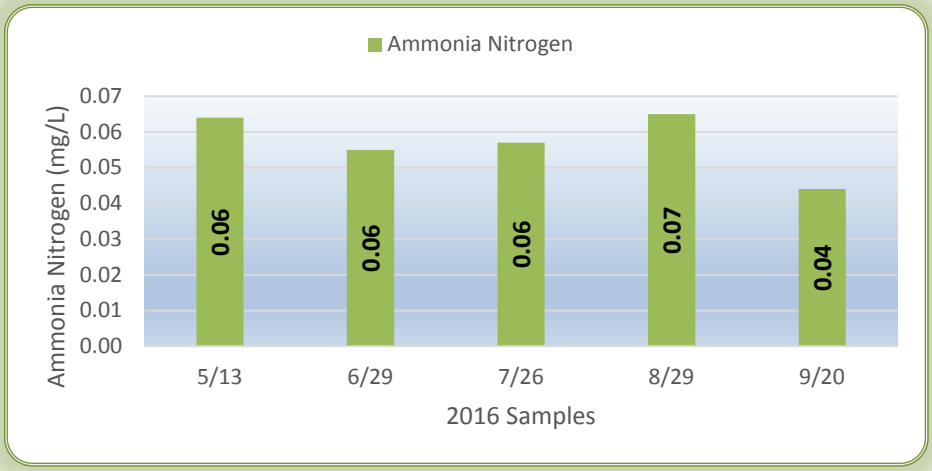
## South Center Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | 43.6 | 39.4 | 33.8 | 37.2 | 26.6 | 39.2 |
| Grade | - | - | C | C | C | C | B | B |
| June-Sept Average (µg/L) | No Data | No Data | 47.5 | 44.3 | 34.8 | 38.3 | 27.3 | 27.0 |
| Meets Standard (40.0 µg/L) | - | - | No | No | Yes | Yes | Yes | Yes |





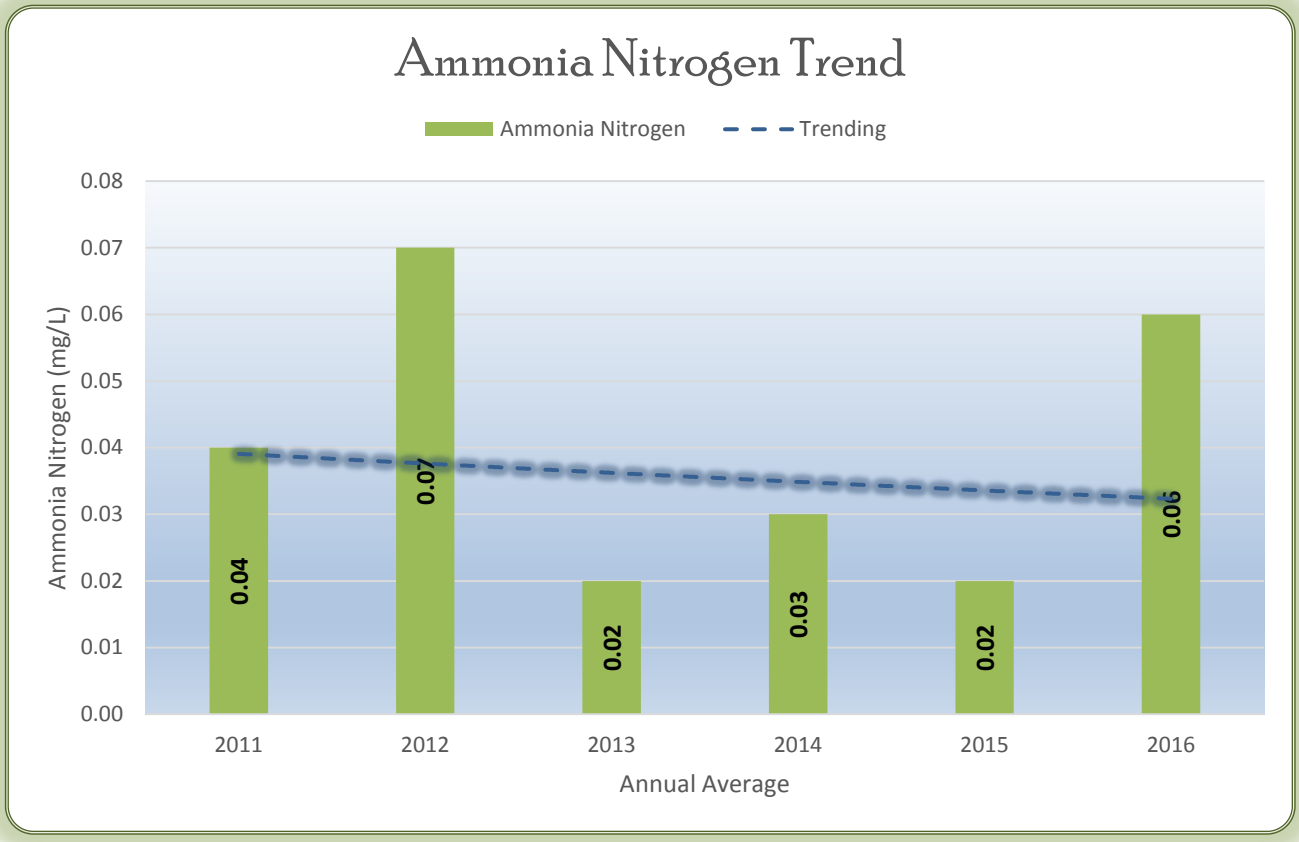

# Ammonia Nitrogen

## South Center Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | 0.04 | 0.07 | 0.02 | 0.03 | 0.02 | 0.06 |



General Observations
South Center Lake

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Heavy Cream | |
| June | 2<br>Low Algae | 2<br>Good | Bamboo | |
| July | 3<br>Medium Algae | 3<br>Fair | Sultana | |
| August | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| September | 3<br>Medium Algae | 3<br>Fair | Cornichon | |

# Explanation of Color Classification

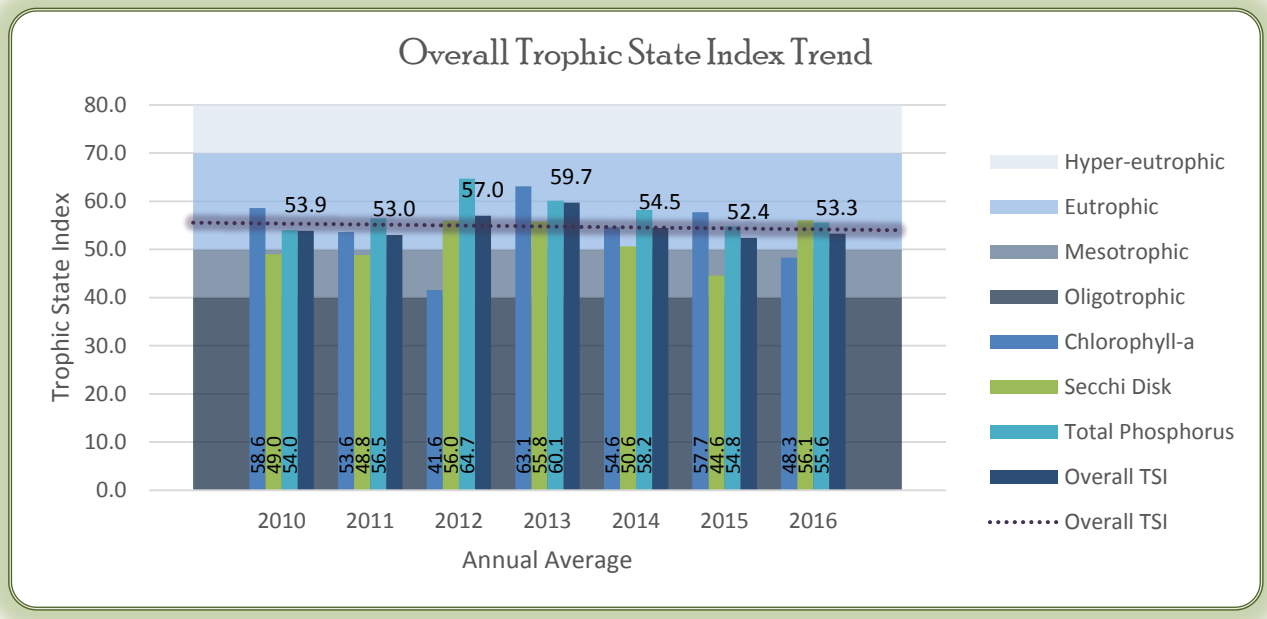
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

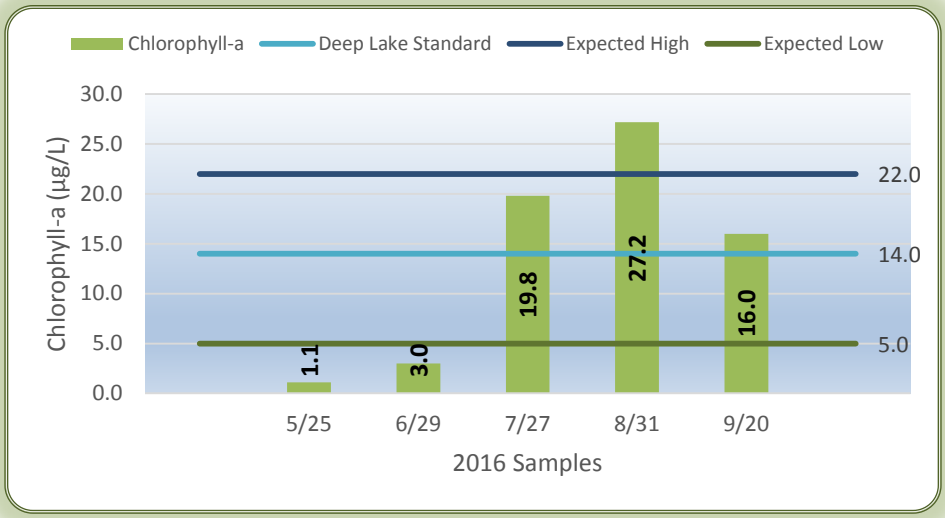
# Chisago Lake-North

Lake 13-0012-01 Site 202

| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | No |
| 2016 Ranking | 10 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 56.1 | 48.3 | 55.6 | 53.3 |
| Classification | Eutrophic | Mesotrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 13.4 µg/L | 2.3 meters | 35.4 µg/L | - |
| Grade | B | B | C | B |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 16.5 µg/L | 1.7 meters | 40.0 µg/L | - |
| Meets Standard | No | Yes | No | No |





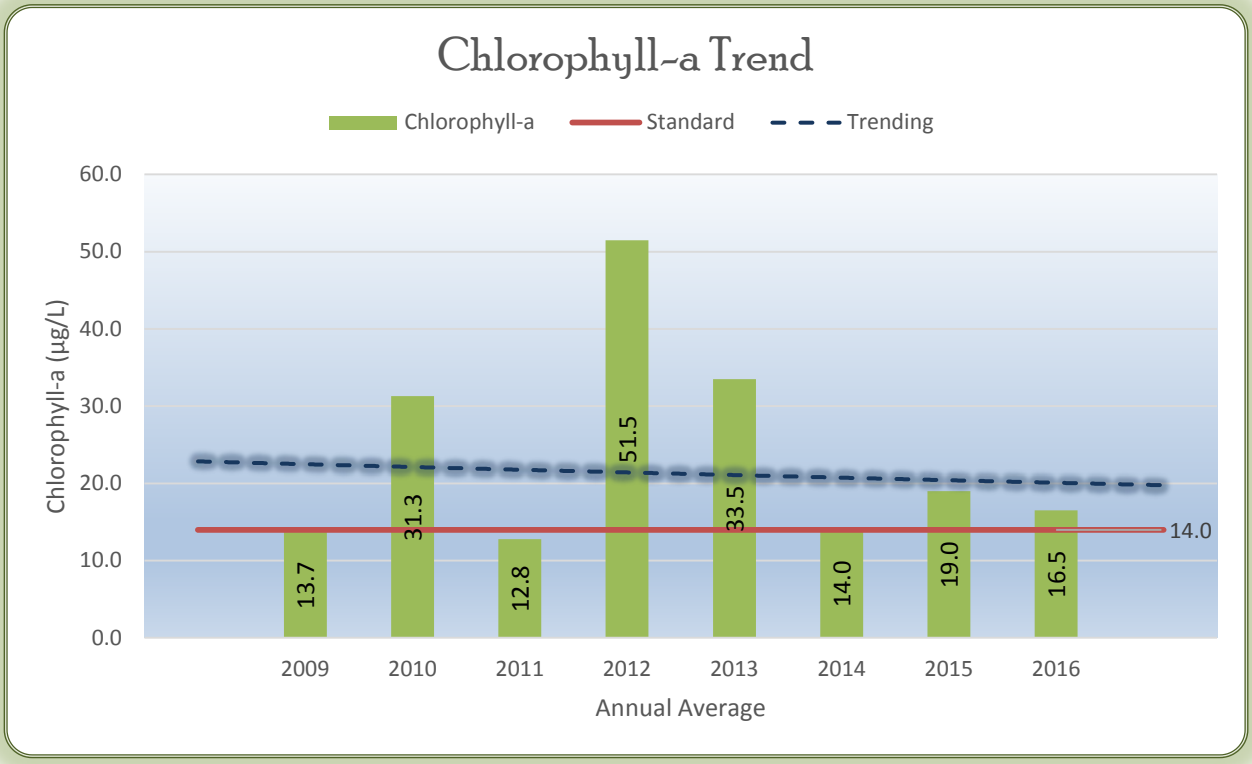

# Chlorophyll-a

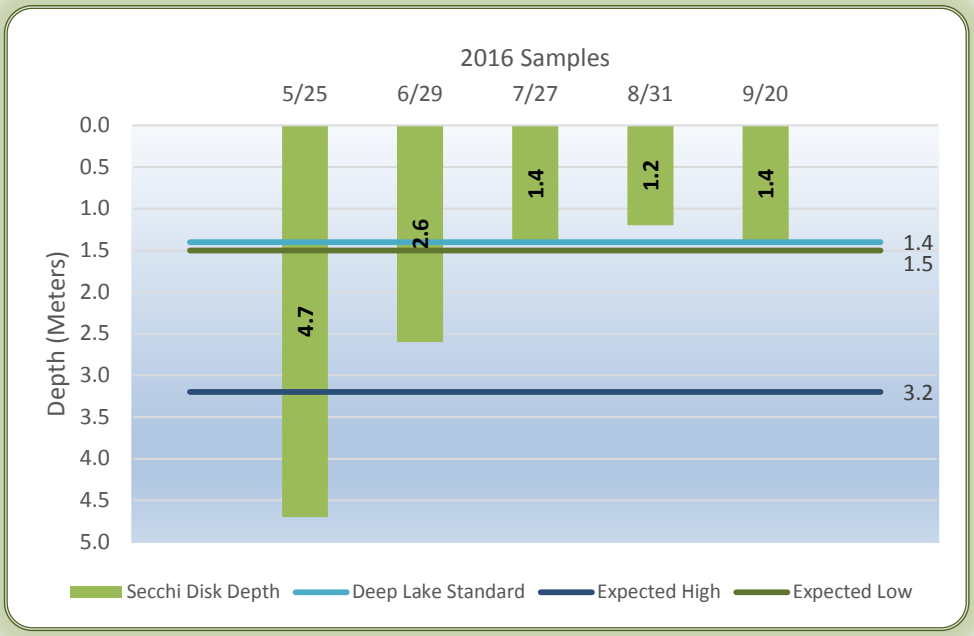
## Chisago Lake-North

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 12.2 | 31.3 | 10.4 | 41.6 | 27.4 | 11.6 | 15.8 | 13.4 |
| Grade | B | C | B | C | C | B | B | B |
| June-Sept Average (µg/L) | 13.7 | 31.3 | 12.8 | 51.5 | 33.5 | 14.0 | 19.0 | 16.5 |
| Meets Standard (14.0 µg/L) | Yes | No | Yes | No | No | Yes | No | No |





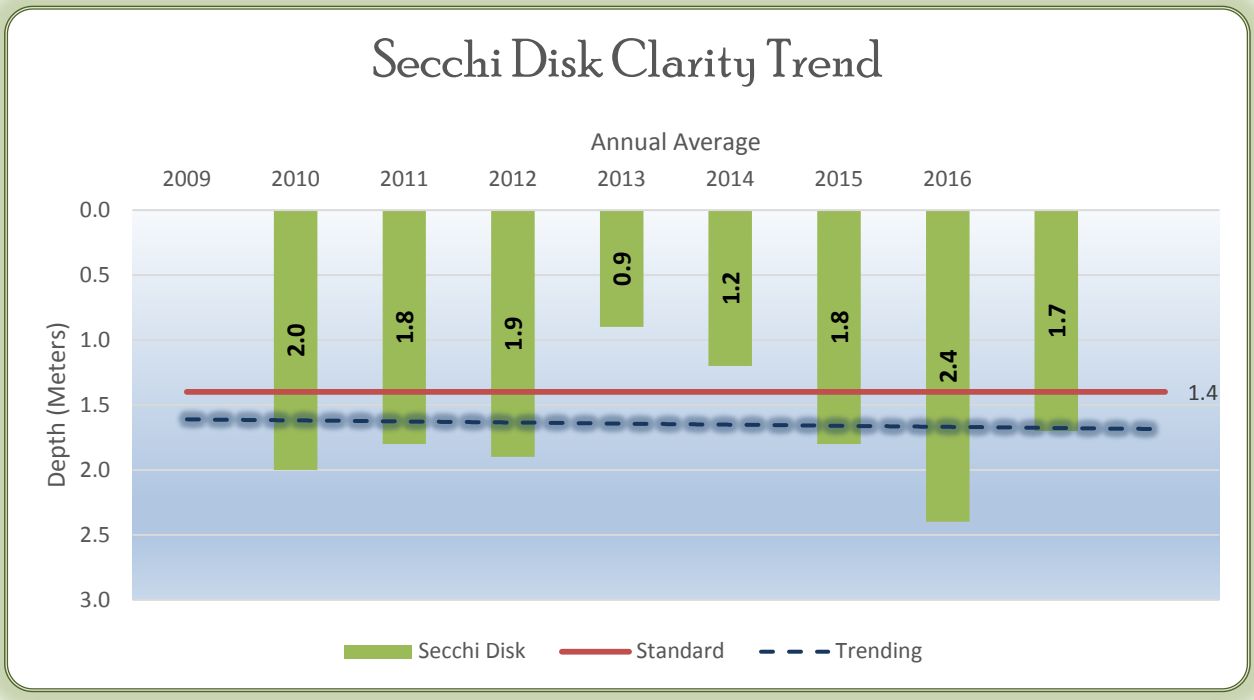

# Secchi Disk Depth

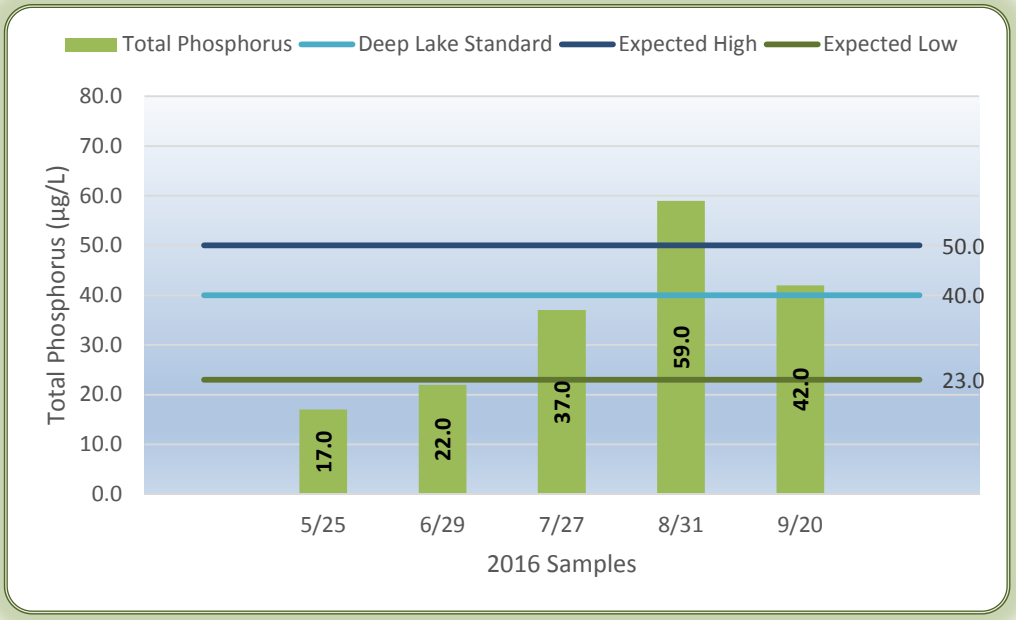
## Chisago Lake-North

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meter) | 2.3 | 1.8 | 2.2 | 1.3 | 1.3 | 1.9 | 2.9 | 2.3 |
| Grade | B | C | C | C | C | C | B | B |
| June-Sept Average (Meter) | 2.0 | 1.8 | 1.9 | 0.9 | 1.2 | 1.8 | 2.4 | 1.7 |
| Meets Standard (>1.4 meters) | Yes | Yes | Yes | No | No | Yes | Yes | Yes |





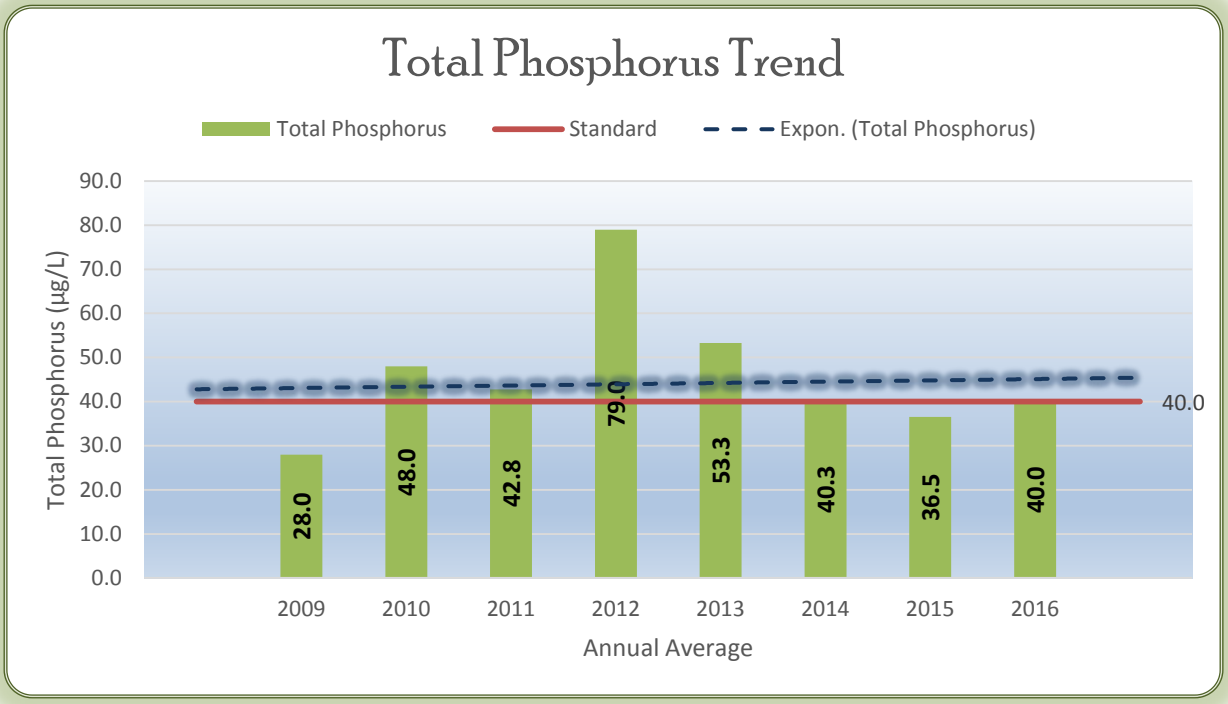

# Total Phosphorus

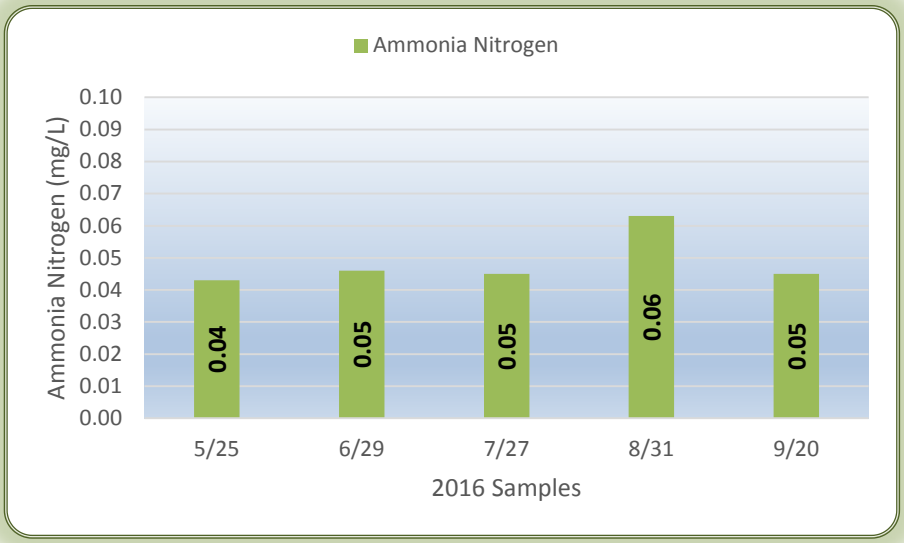
## Chisago Lake-North

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 28.0 | 48.0 | 37.8 | 66.8 | 48.4 | 42.4 | 33.6 | 35.4 |
| Grade | B | C | C | C | C | C | C | C |
| June-Sept Average (µg/L) | 28.0 | 48.0 | 42.8 | 79.0 | 53.3 | 40.3 | 36.5 | 40.0 |
| Meets Standard (40.0 µg/L) | Yes | No | No | No | No | No | Yes | No |





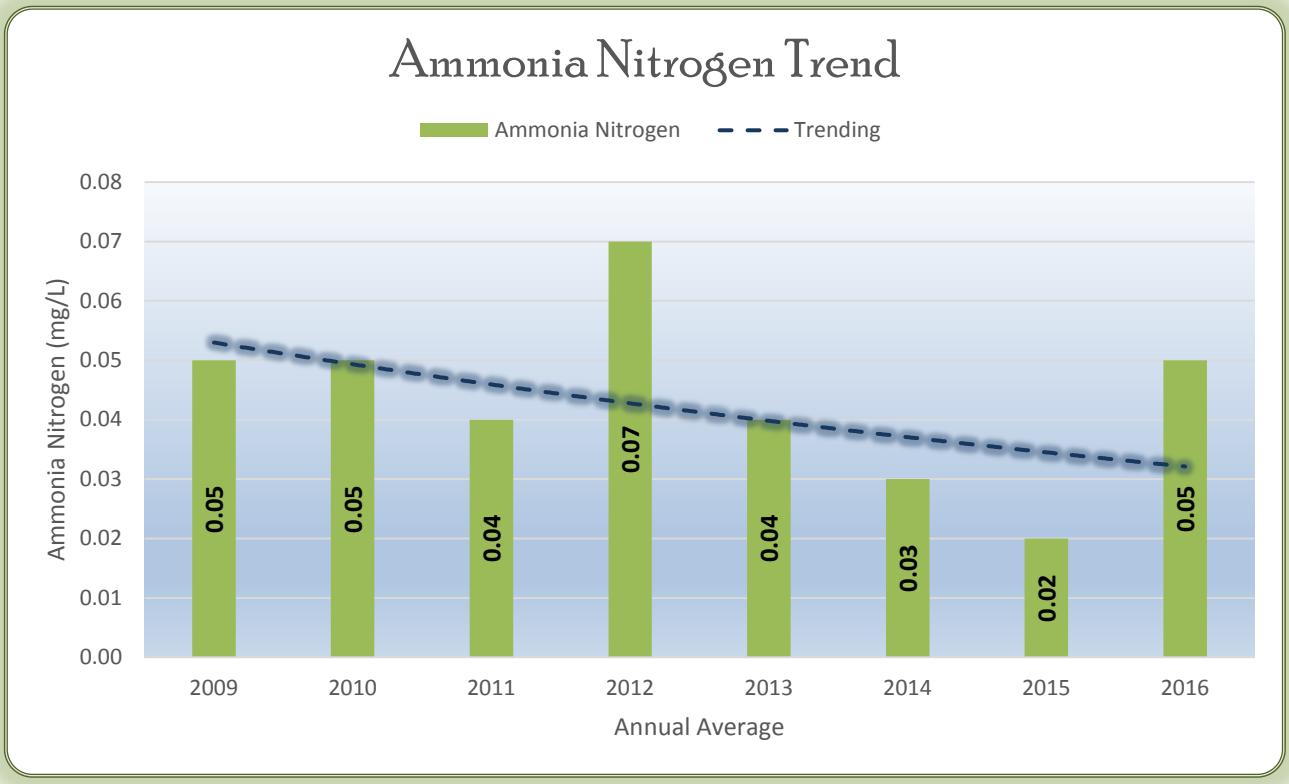

# Ammonia Nitrogen

## Chisago Lake-North

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | <0.05 | <0.05 | 0.04 | 0.07 | 0.04 | 0.03 | 0.02 | 0.05 |



General Observations
Chisago Lake–North

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Heavy Cream | |
| June | 2<br>Low Algae | 2<br>Good | Bamboo | |
| July | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| August | 4<br>High Algae | 4<br>Poor | Cornichon | |
| September | 3<br>Medium Algae | 3<br>Fair | Sultana | |

# Explanation of Color Classification

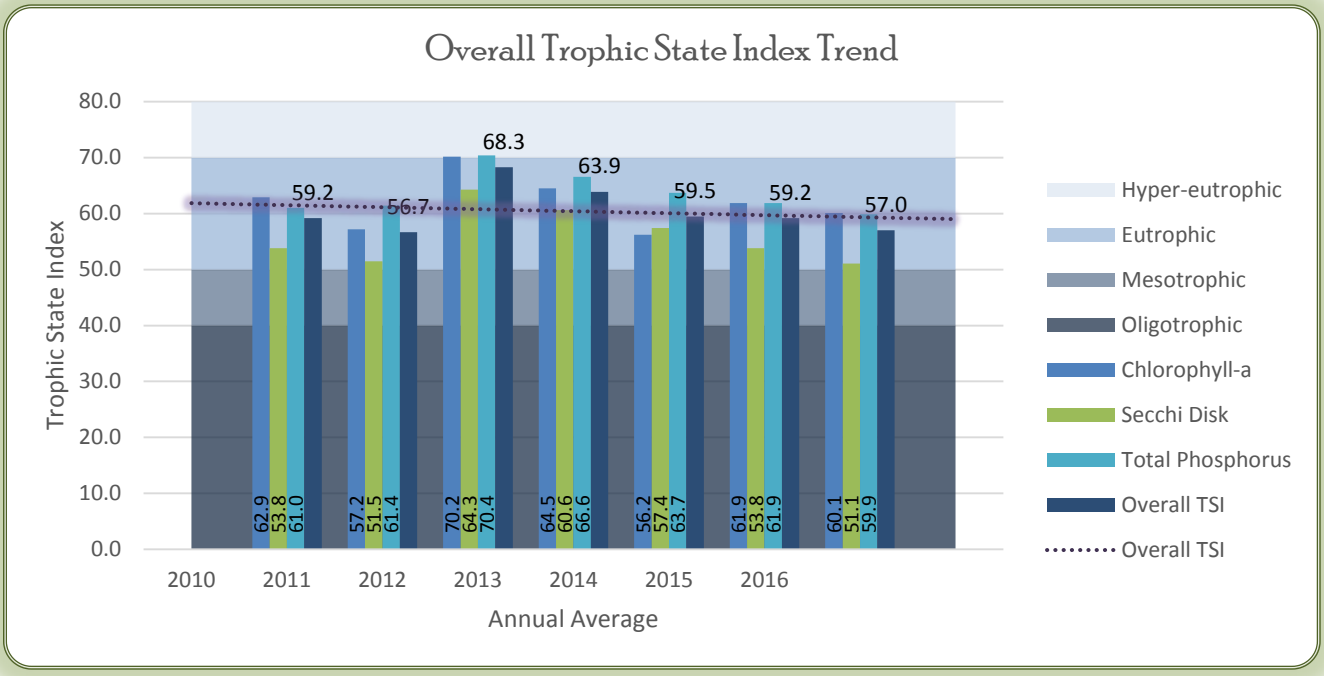
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll–a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll–a, Secchi transparency, and Phosphorus.

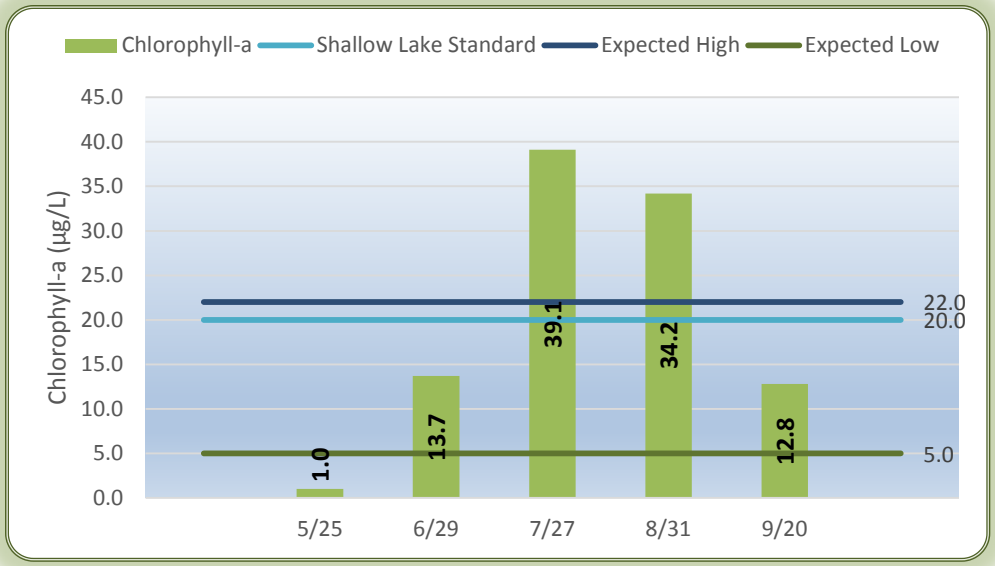
# Chisago Lake-South

Lake 13-0012-02 Site 201

| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 17 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 60.1 | 51.1 | 59.9 | 57.0 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 20.2 µg/L | 1.9 meters | 47.8 µg/L | - |
| Grade | C | C | C | C |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 25.0 µg/L | 1.6 meters | 55.8 µg/L | - |
| Meets Standard | No | Yes | Yes | Yes |





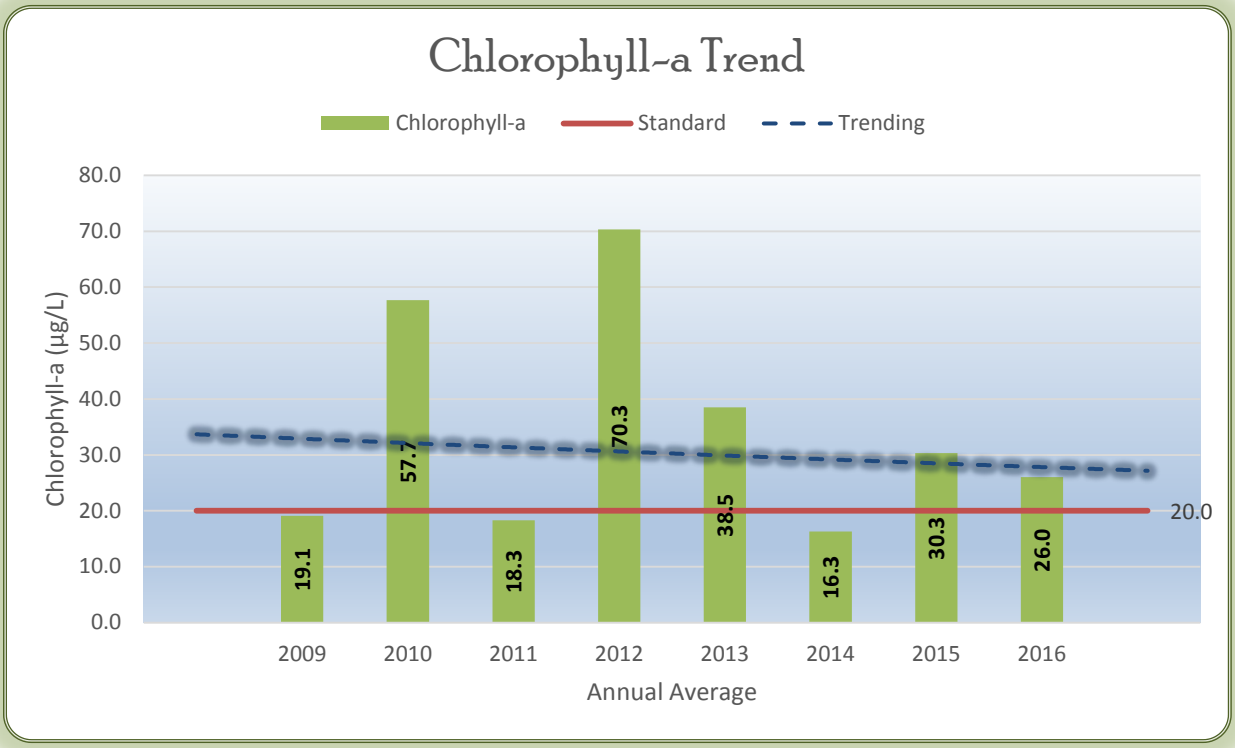

# Chlorophyll-a

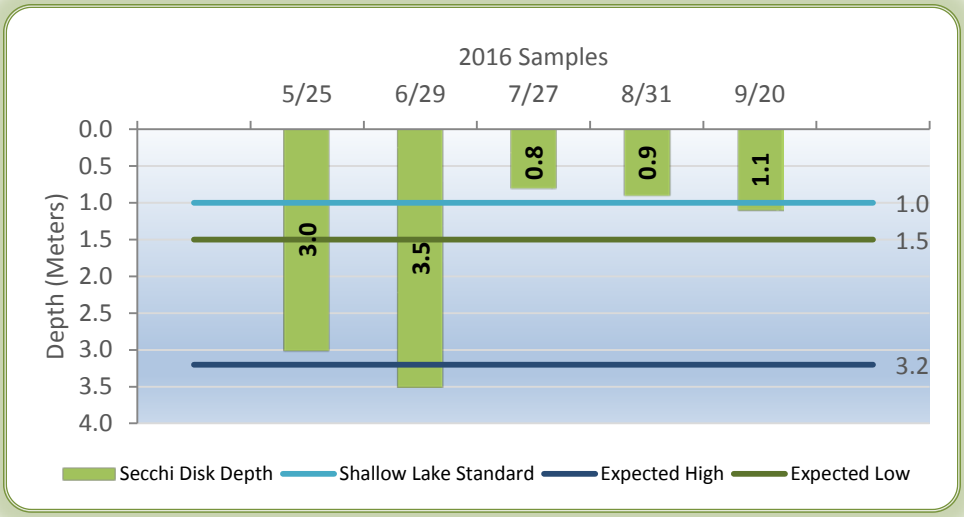
## Chisago Lake-South

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 15.8 | 42.6 | 15.0 | 56.8 | 31.8 | 13.6 | 24.4 | 20.2 |
| Grade | B | C | B | D | C | B | C | C |
| June-Sept Average (µg/L) | 19.1 | 57.7 | 18.3 | 70.3 | 38.5 | 16.3 | 30.3 | 26.0 |
| Meets Standard (20.0 µg/L) | Yes | No | Yes | No | No | Yes | No | No |





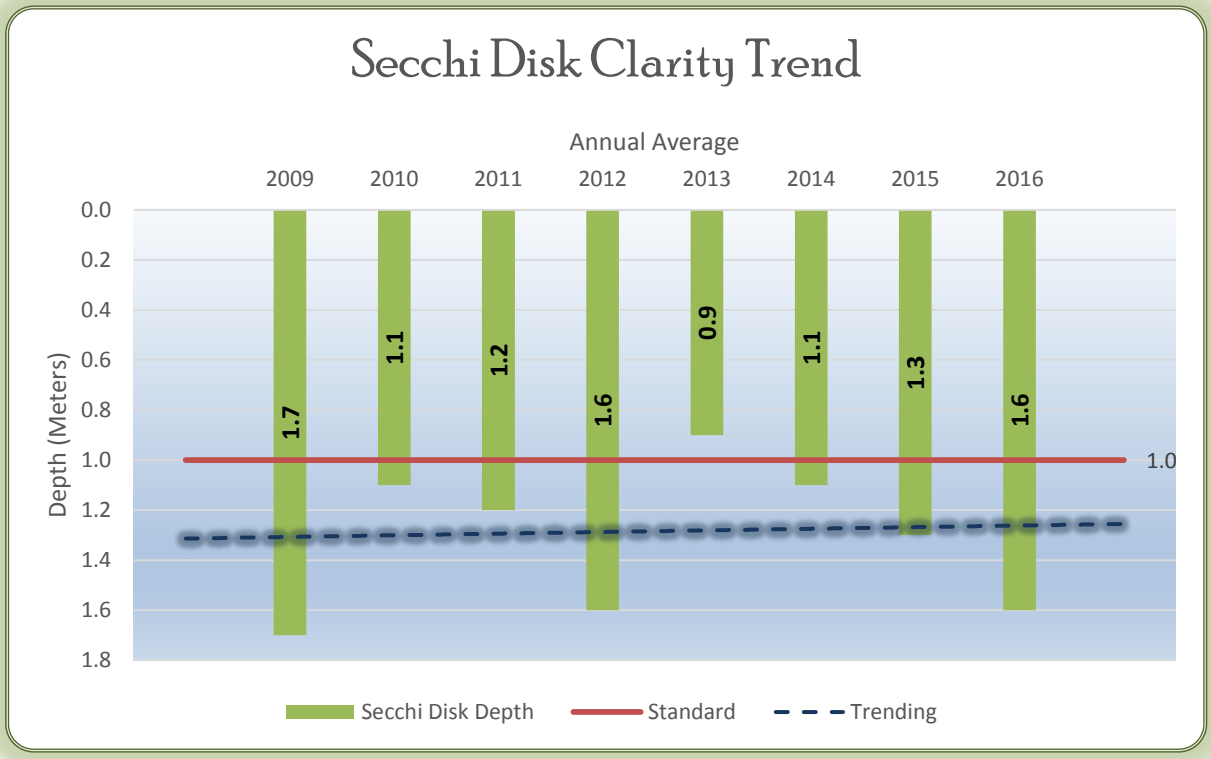

# Secchi Disk Depth

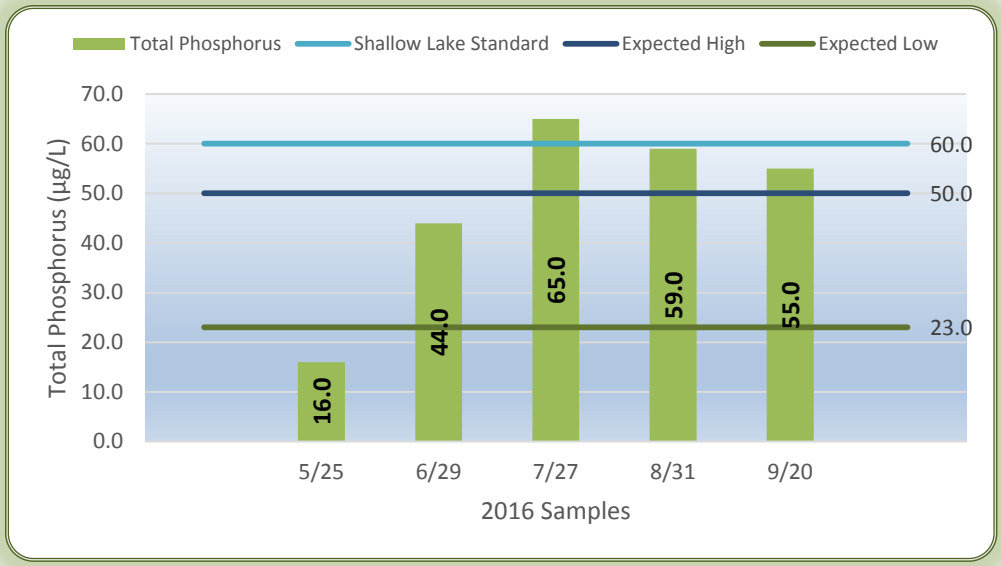
## Chisago Lake-South

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meter) | 1.8 | 1.3 | 1.8 | 2.4 | 1.0 | 1.2 | 1.5 | 1.9 |
| Grade | C | C | C | B | D | C-D | C | C |
| June-Sept Average (Meter) | 1.7 | 1.1 | 1.2 | 1.6 | 0.9 | 1.1 | 1.3 | 1.6 |
| Meets Standard (>1.0 meters) | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes |





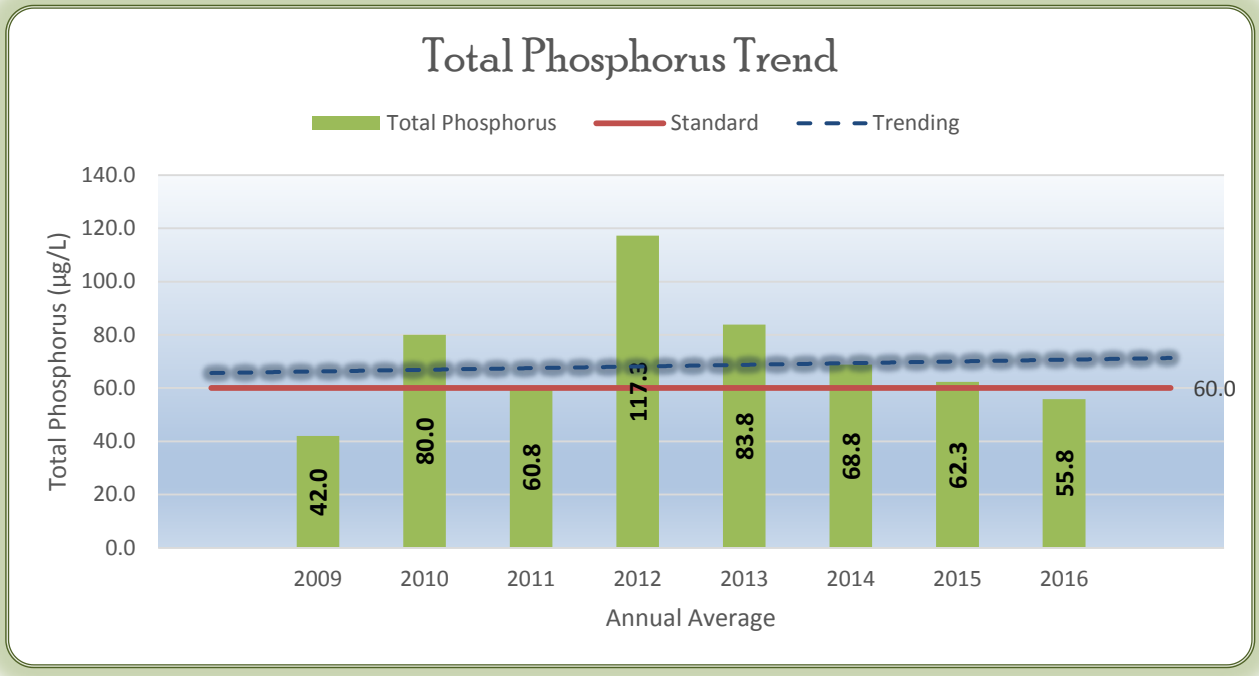

# Total Phosphorus

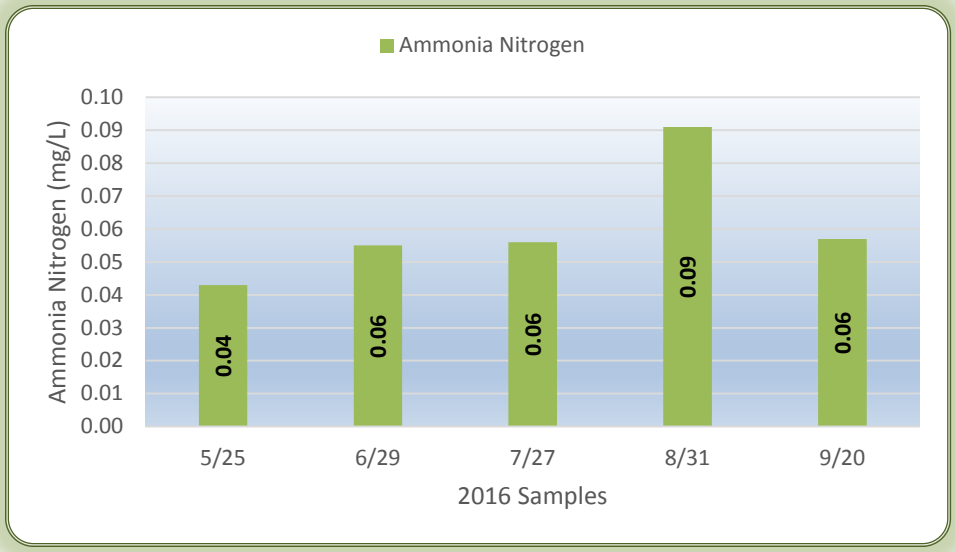
## Chisago Lake-South

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 38.0 | 69.0 | 52.8 | 99.0 | 76.0 | 62.2 | 55.0 | 47.8 |
| Grade | C | D | C | D | D | C | C | C |
| June-Sept Average (µg/L) | 42.0 | 80.0 | 60.8 | 117.3 | 83.8 | 68.8 | 62.3 | 55.8 |
| Meets Standard (60.0 µg/L) | Yes | No | No | No | No | No | No | Yes |



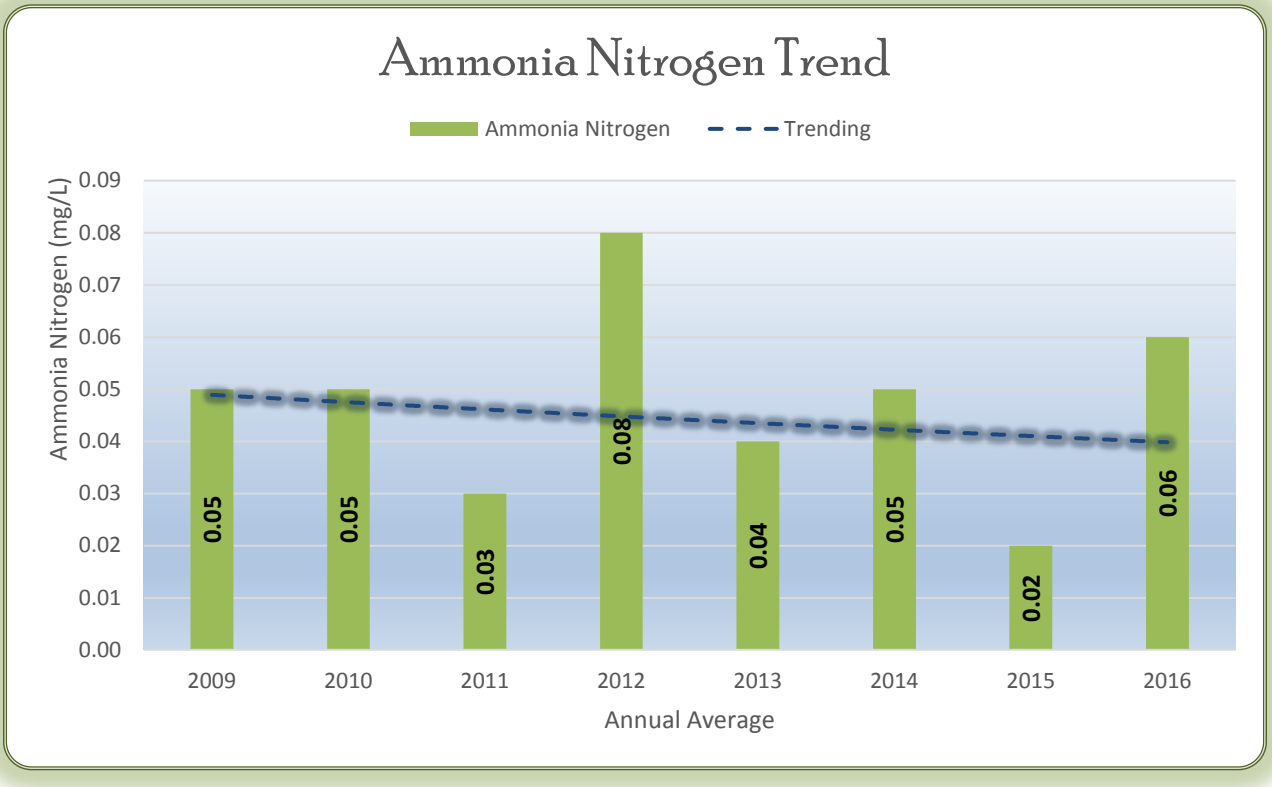



# Ammonia Nitrogen

## Chisago Lake-South

Expected Range:
None
Shallow Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | <0.05 | <0.05 | 0.03 | 0.08 | 0.04 | 0.05 | 0.02 | 0.06 |



General Observations
Chisago Lake-South

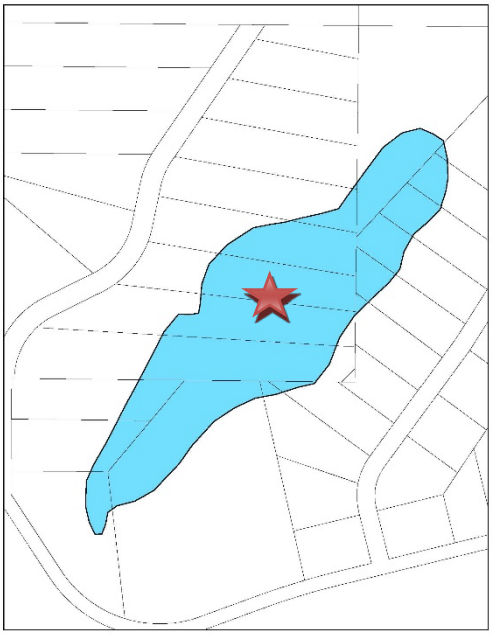
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Macadamia | |
| June | 3<br>Medium Algae | 3<br>Fair | Sultana | |
| July | 4<br>High Algae | 4<br>Poor | Sultana | |
| August | 4<br>High Algae | 4<br>Poor | Beach Grass | |
| September | 3<br>Medium Algae | 3<br>Fair | Cornichon | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

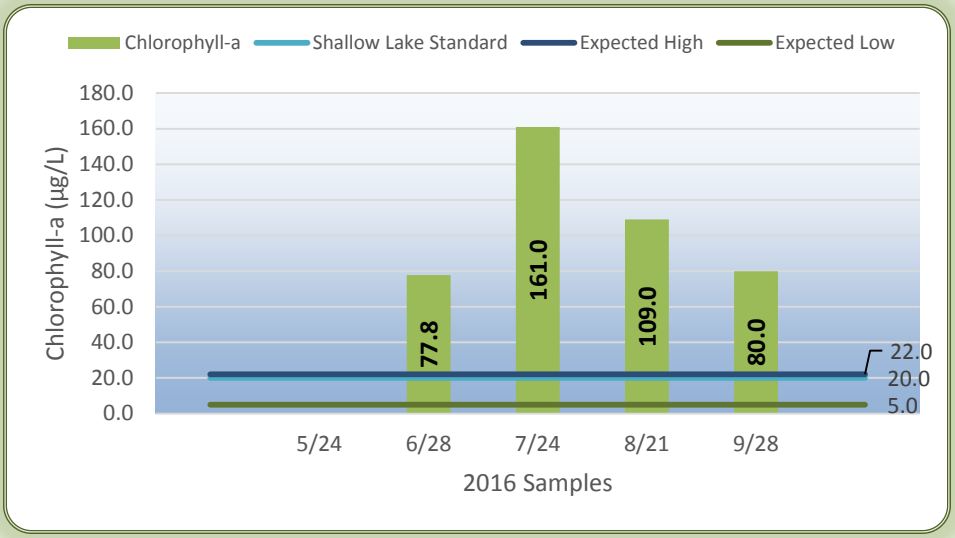
# Lake Emily

13-0046-00 Site 201



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Hyper-Eutrophic |
| Overall Lake Quality Grade | F |
| Meets MPCA Standards | No |
| 2016 Ranking | 29 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 76.4 | 70.0 | 76.4 | 74.3 |
| Classification | Hyper-Eutrophic | Eutrophic | Hyper-Eutrophic | Hyper-Eutrophic |
| 2016 Average (May-Sept) | 107.0 µg/L | 0.5 meters | 150.2 µg/L | - |
| Grade | F | F | D | F |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 107.0 µg/L | 0.4 meters | 165.0 µg/L | - |
| Meets Standard | No | No | No | No |




## Chlorophyll-a

Lake Emily

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
22.0 µg/L

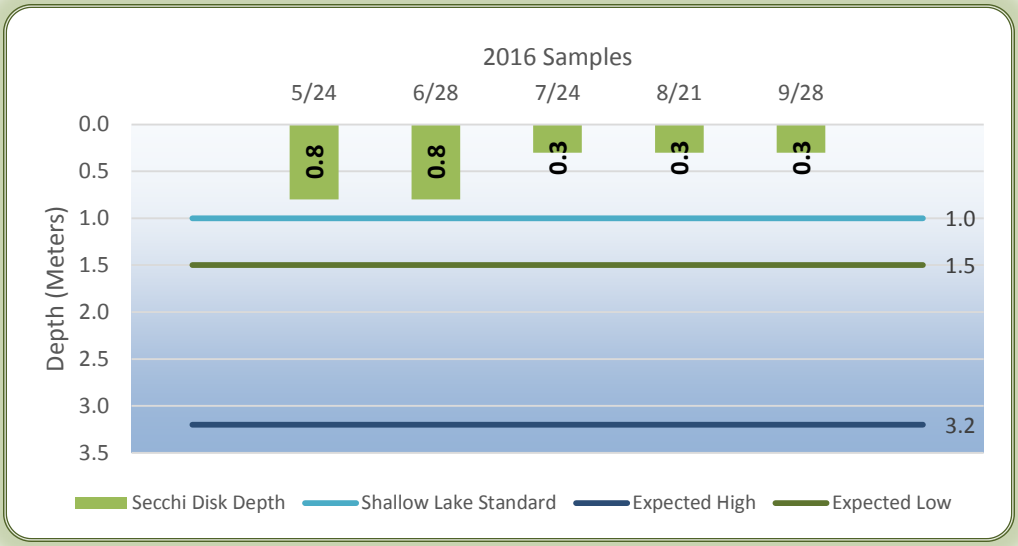
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard (20.0 µg/L) |
|---|---|---|---|---|
| 2008 | 87.1 | F | 93.6 | No |
| 2009 | 180.9 | F | 202.5 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 107.0 | F | 107.0 | No |

## Secchi Disk Depth

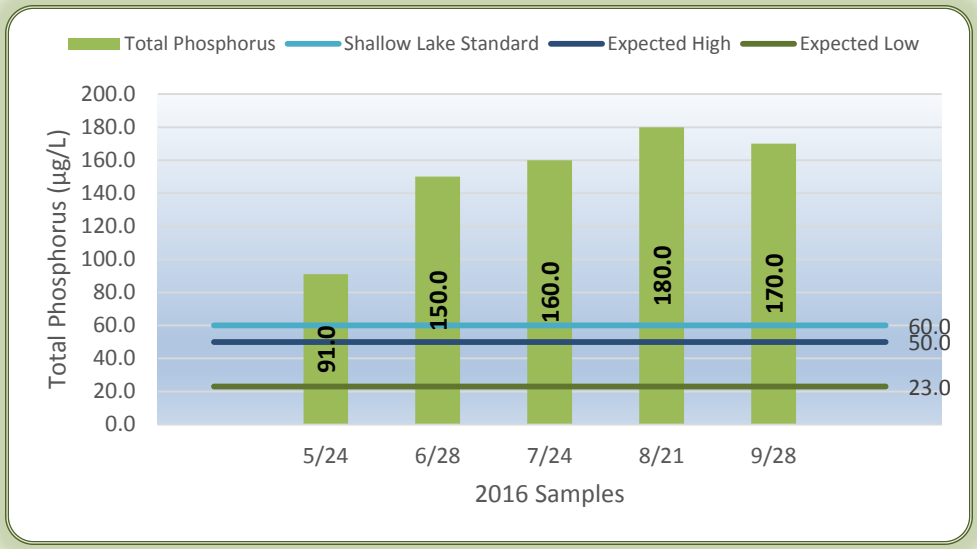
Lake Emily

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
<1.0 meter




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard (>1.0 meter) |
|---|---|---|---|---|
| 2008 | 0.4 | F | 0.3 | No |
| 2009 | 0.3 | F | 0.3 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 0.5 | F | 0.4 | No |




## Total Phosphorus

Lake Emily

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

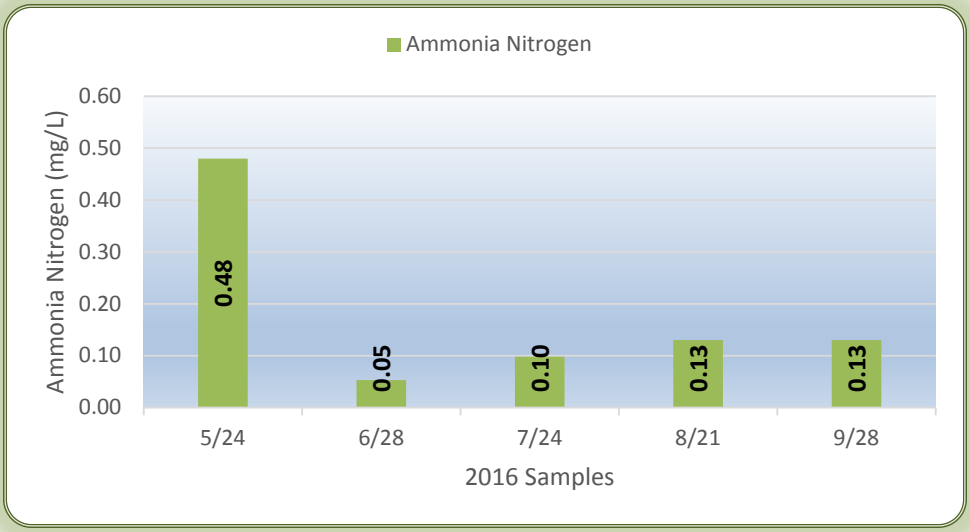
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard (60.0 µg/L) |
|---|---|---|---|---|
| 2008 | 341.0 | F | 341.1 | No |
| 2009 | 330.8 | F | 332.9 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 150.2 | F | 165.0 | No |

## Ammonia Nitrogen

Lake Emily

Expected Range:
None

Shallow Lake Standard:
None




| Average µg/L | |
|---|---|
| 2008-2015 | No Data |
| 2016 | 0.18 |

General Observations
Lake Emily

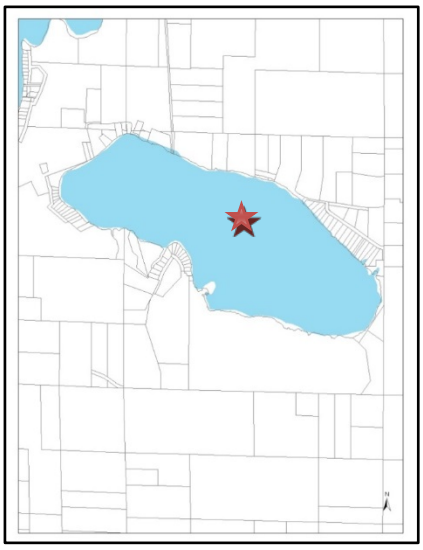
| Month | Physical Condition | Recreational Suitability | Color of Filtered Water | Color |
|---|---|---|---|---|
| May | 3 Medium Algae | 4 Poor | Cornbread | |
| June | 3 Medium Algae | 4 Poor | Dried Chamomile | |
| July | 3 Medium Algae | 4 Poor | Cornichon | |
| August | 4 Severe Algae | 5 Very Poor | Cornichon | |
| September | 4 Severe Algae | 5 Very Poor | Cornichon | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

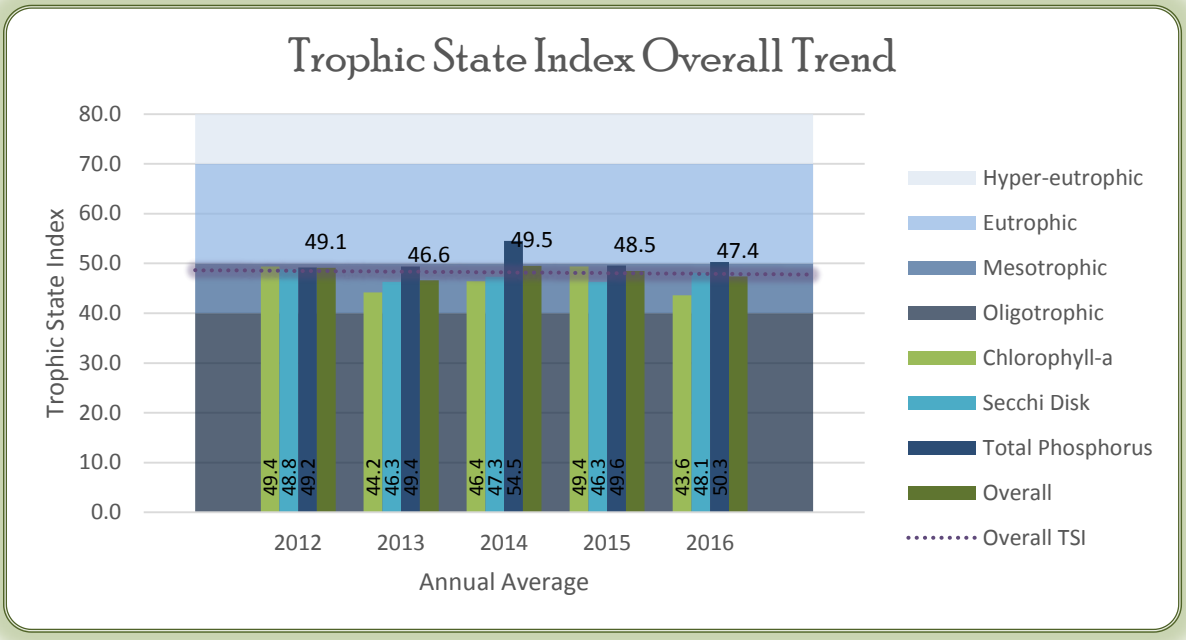
# Fish Lake

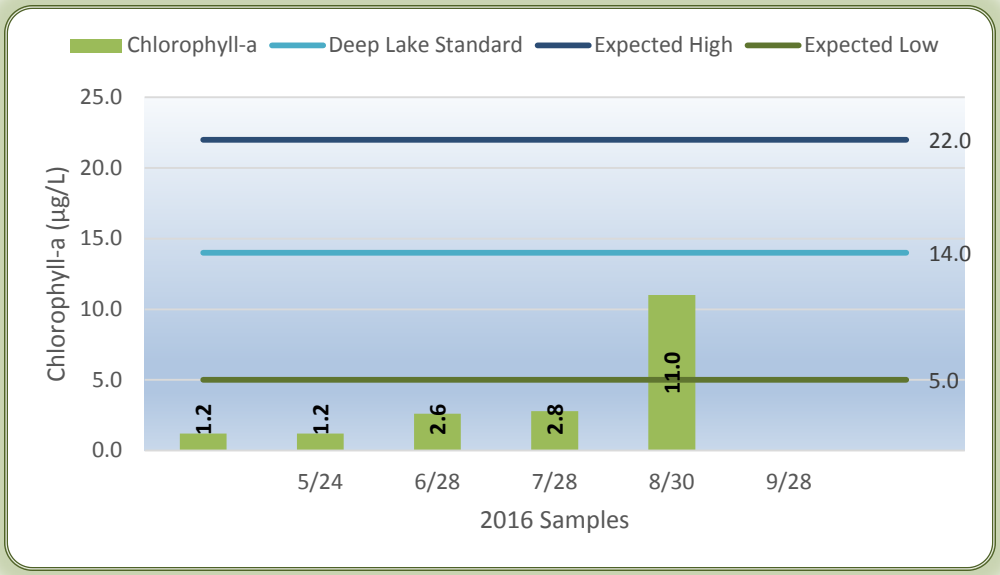
Lake 13-0068-00 Site 101



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Mesotrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 6 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 43.6 | 48.1 | 50.3 | 47.4 |
| Classification | Mesotrophic | Mesotrophic | Eutrophic | Mesotrophic |
| 2016 Average (May-Sept) | 3.8 µg/L | 2.3 meters | 24.6 µg/L | - |
| Grade | A | B | B | B |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 4.4 µg/L | 2.6 meters | 17.0 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





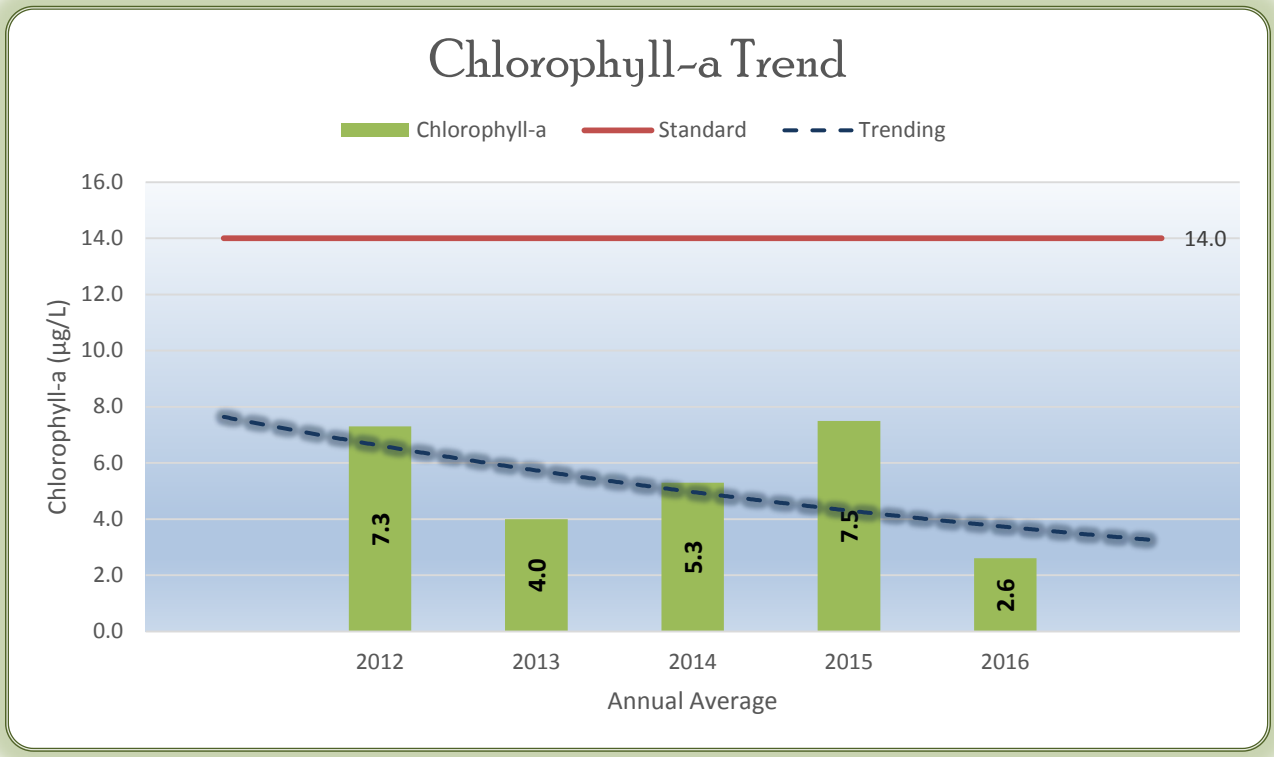

# Chlorophyll-a

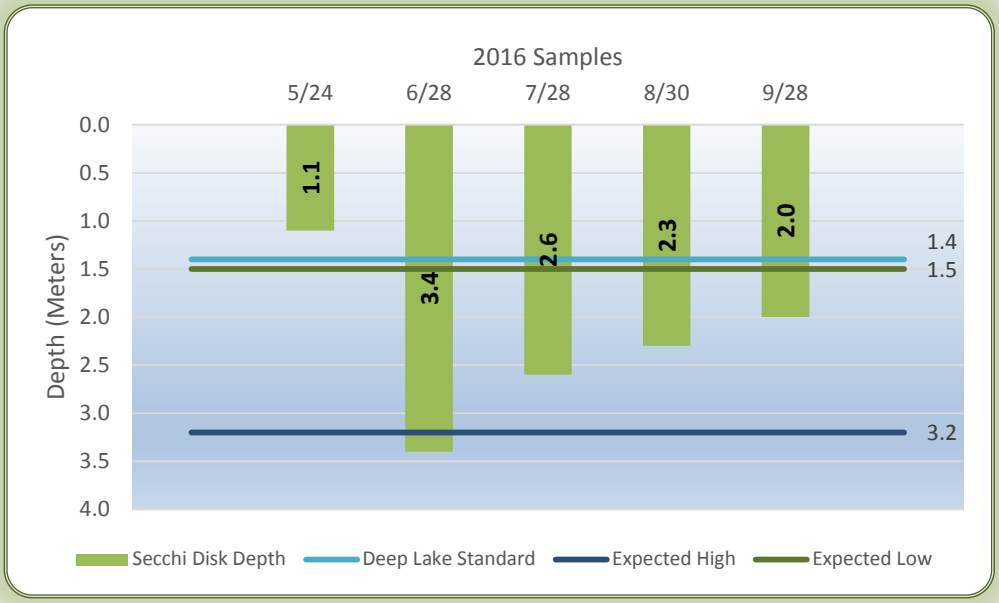
## Fish Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 6.8 | 4.0 | 5.0 | 6.8 | 3.8 |
| Grade | - | - | - | A | A | A | A | A |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 7.3 | 4.0 | 5.3 | 7.5 | 2.6 |
| Meets Standard (14.0 µg/L) | - | - | - | Yes | Yes | Yes | Yes | Yes |





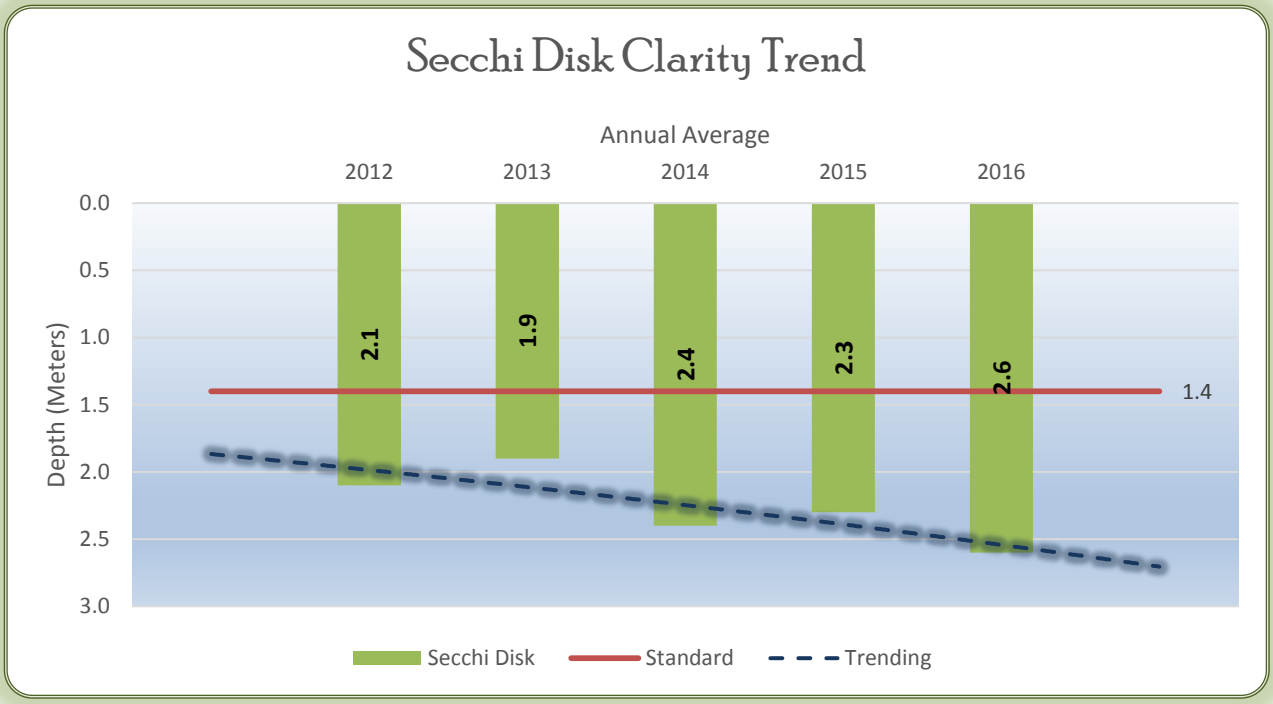

# Secchi Disk Depth

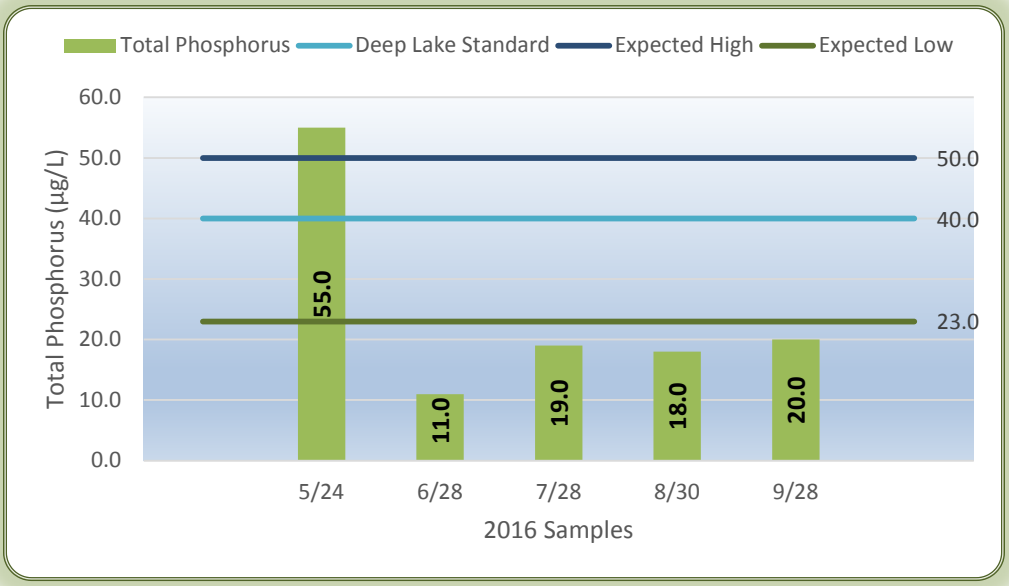
## Fish Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | No Data | 2.7 | 2.6 | 2.4 | 2.6 | 2.3 |
| Grade | - | - | - | B-C | B | B | B | B |
| June-Sept Average (Meters) | No Data | No Data | No Data | 2.1 | 2.9 | 2.4 | 2.3 | 2.6 |
| Meets Standard (>1.4 meters ) | - | - | - | Yes | Yes | Yes | Yes | Yes |





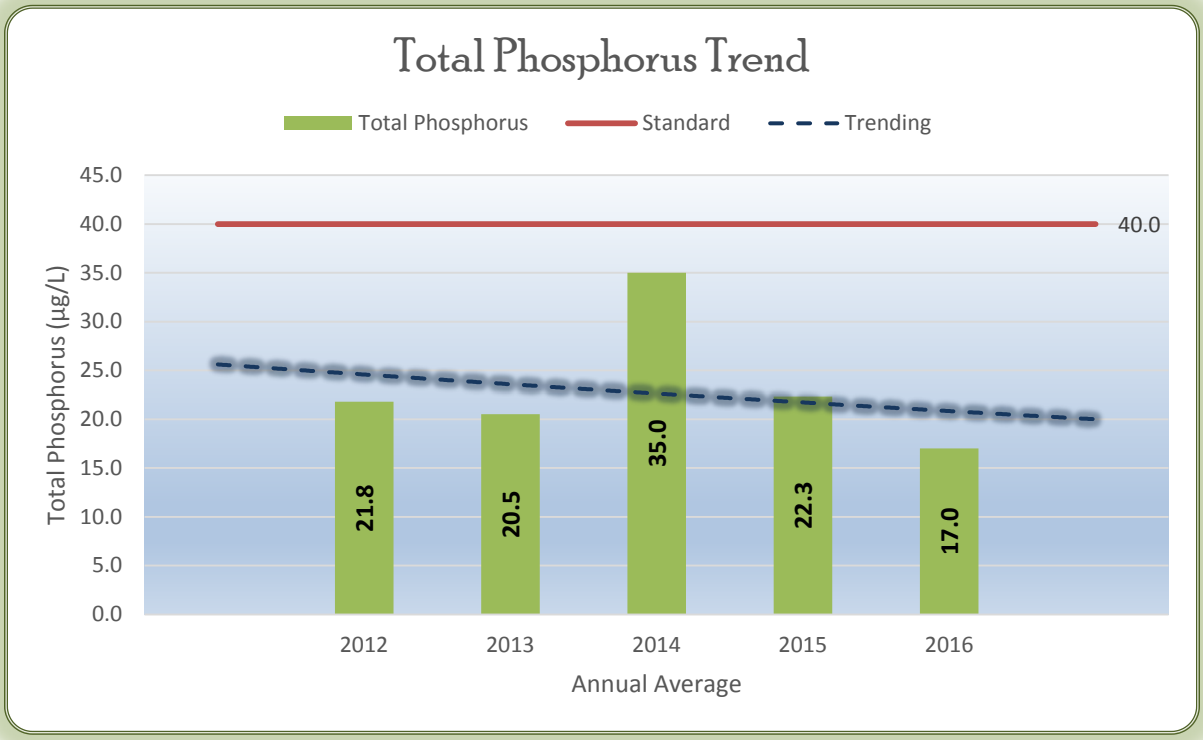

# Total Phosphorus

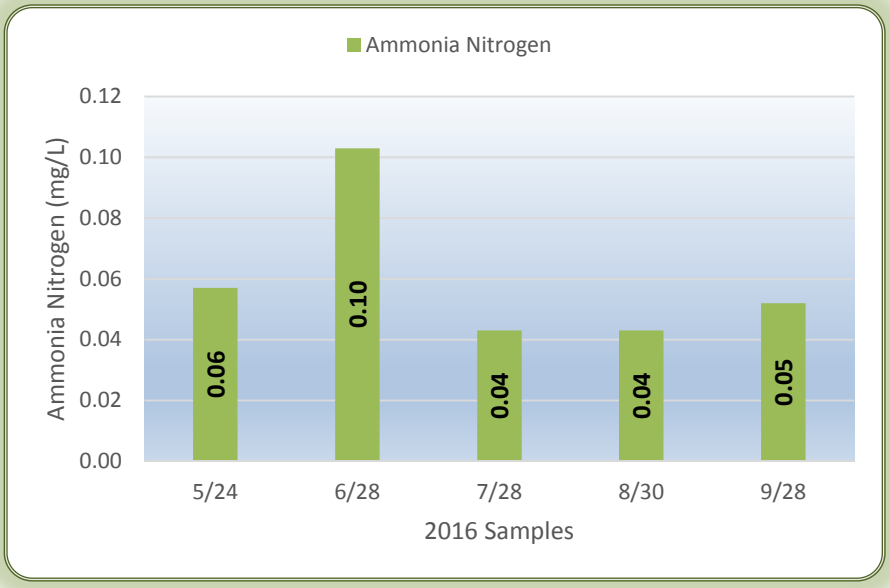
## Fish Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 22.8 | 23.0 | 32.8 | 23.4 | 24.6 |
| Grade | - | - | - | A | B | C | B | B |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 21.8 | 20.5 | 35.0 | 22.3 | 17.0 |
| Meets Standard (40.0 µg/L) | - | - | - | Yes | Yes | Yes | Yes | Yes |





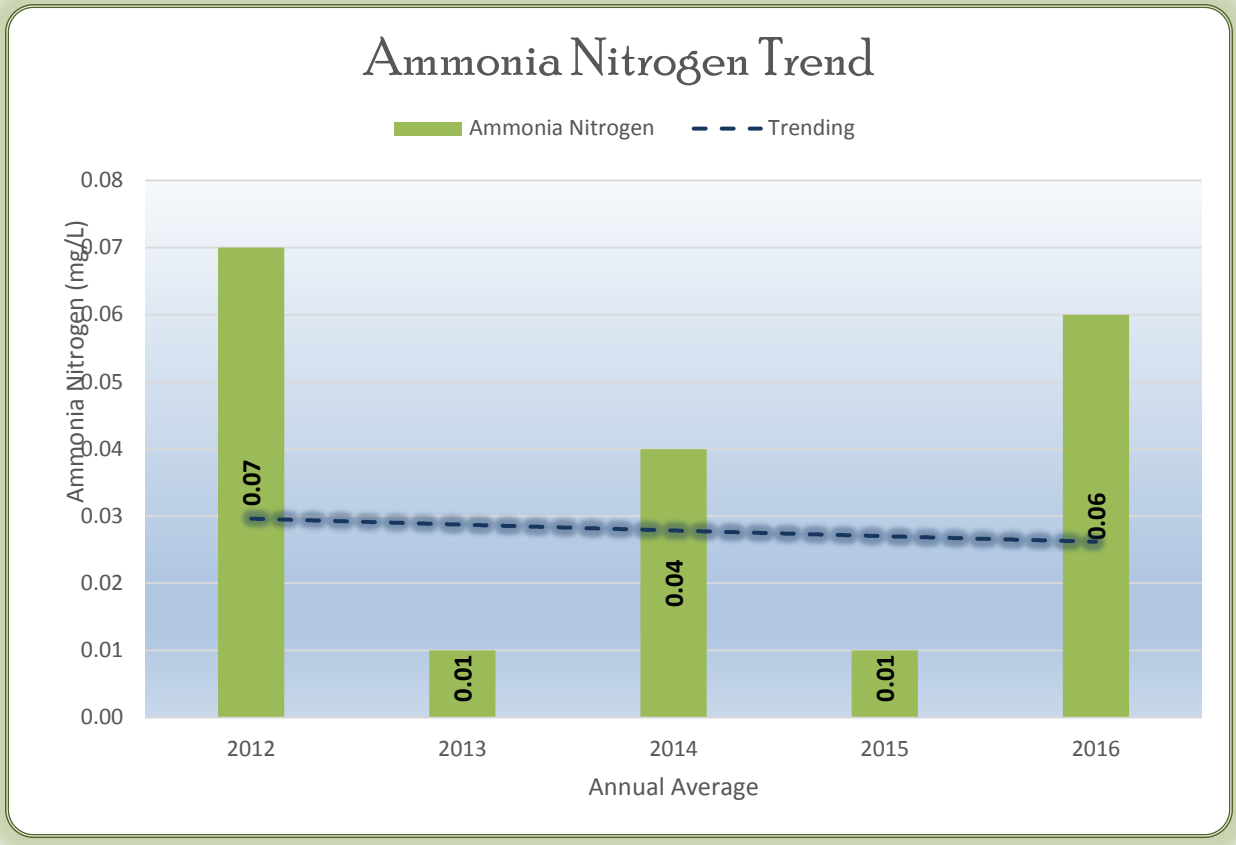

# Ammonia Nitrogen

## Fish Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | No Data | 0.07 | 0.01 | 0.04 | 0.01 | 0.06 |



General Observations
Fish Lake

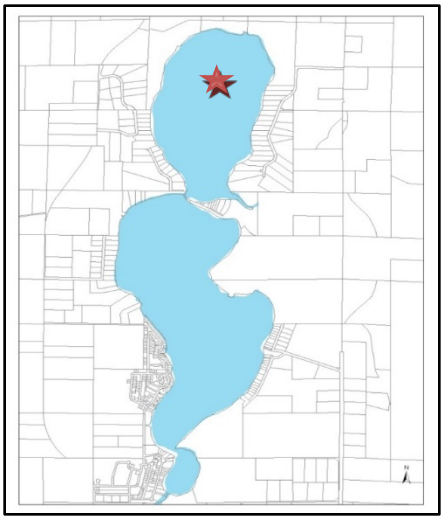
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Chopstick | |
| June | 1<br>Clear | 1<br>Very Good | Chopstick | |
| July | 2<br>Low Algae | 2<br>Good | Dried Chamomile | |
| August | 1<br>Clear | 1<br>Very Good | Parchment Paper | |
| September | 2<br>Low Algae | 2<br>Good | Dune | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

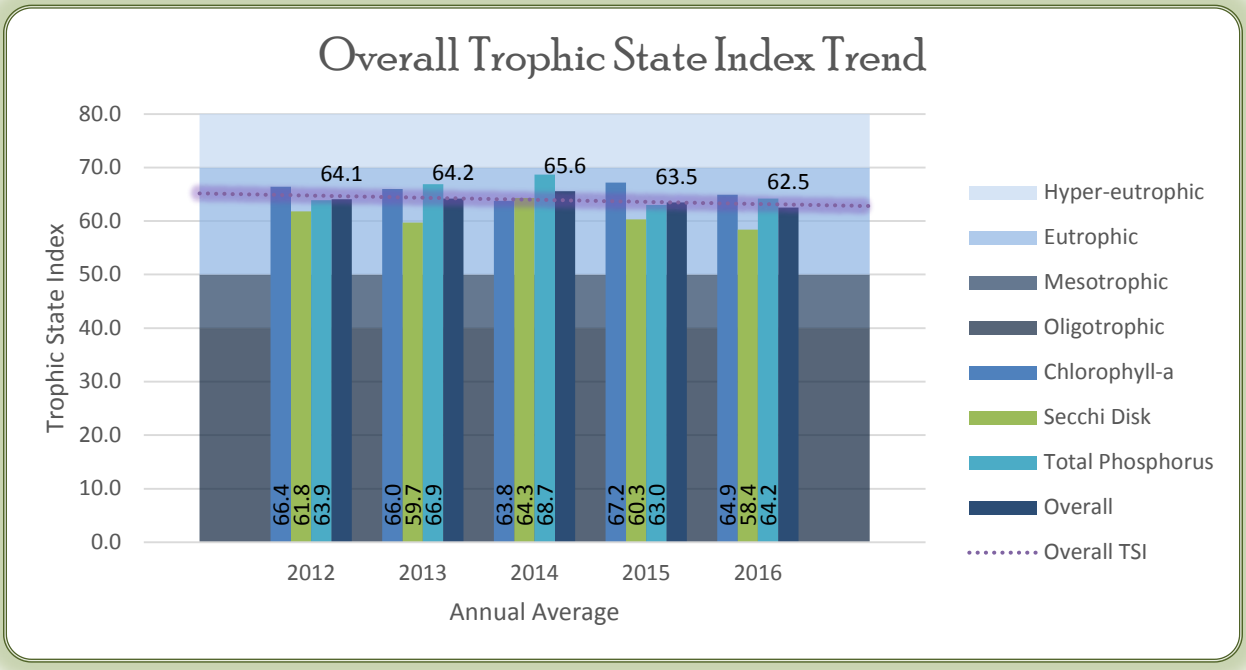
# Goose Lake-North

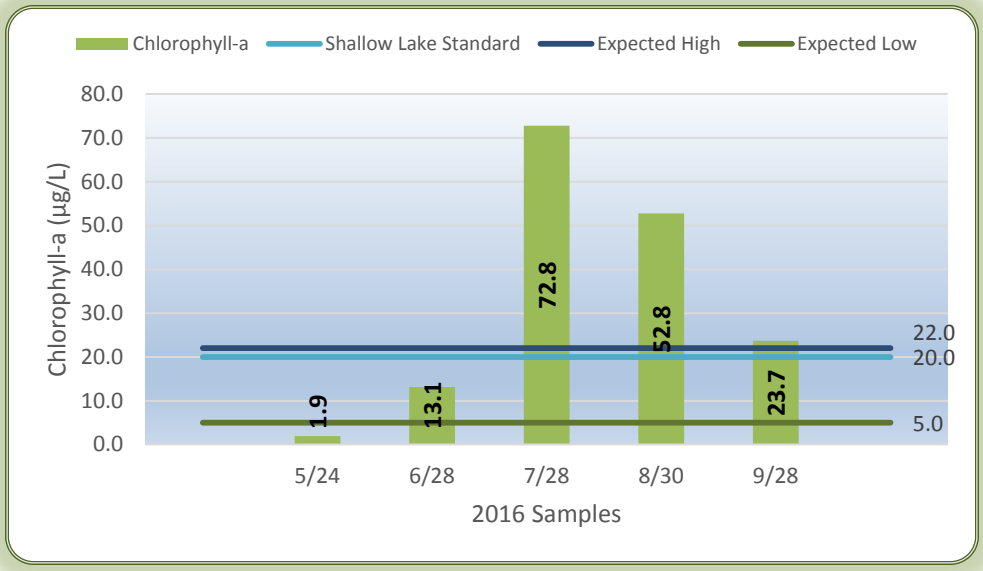
Lake 13-0083-01 Site 202



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | No |
| 2016 Ranking | 24 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 64.9 | 58.4 | 64.2 | 62.5 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 32.9 µg/L | 1.1 meters | 64.4 µg/L | - |
| Grade | C | D | C | C |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 40.6 µg/L | 0.9 meters | 73.5 µg/L | - |
| Meets Standard | No | No | No | No |





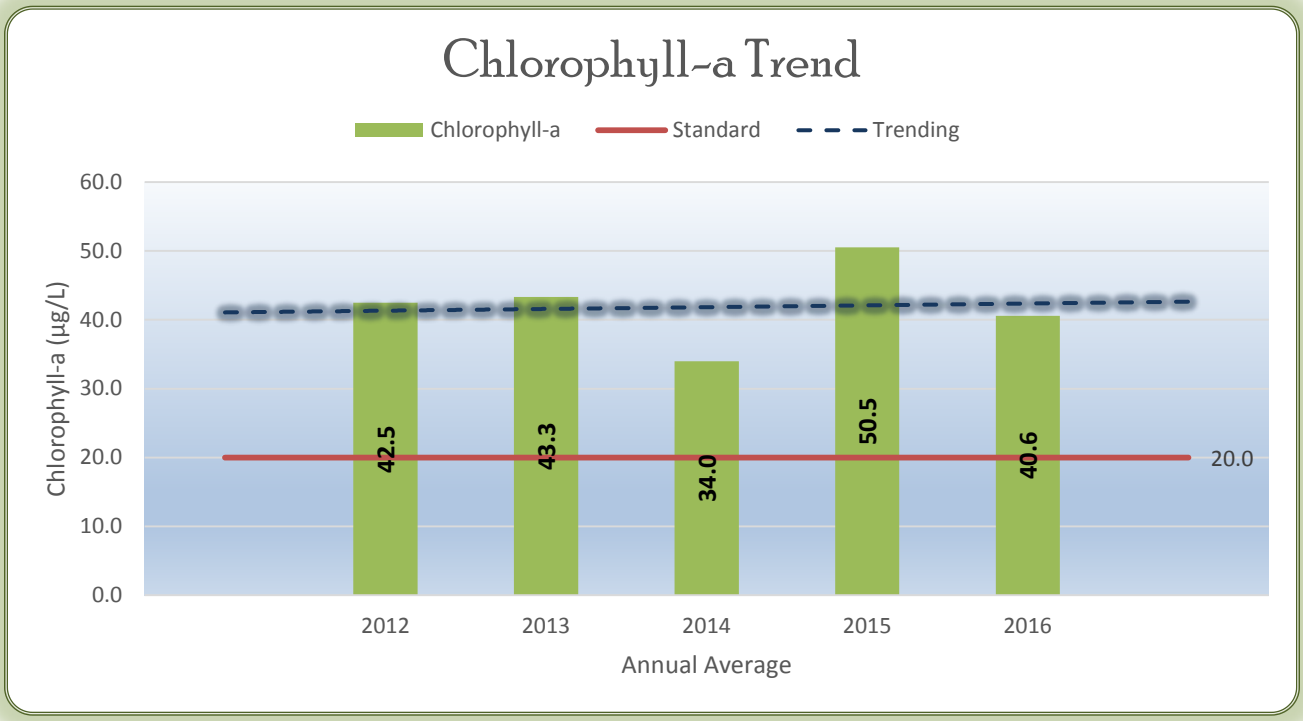

# Chlorophyll-a

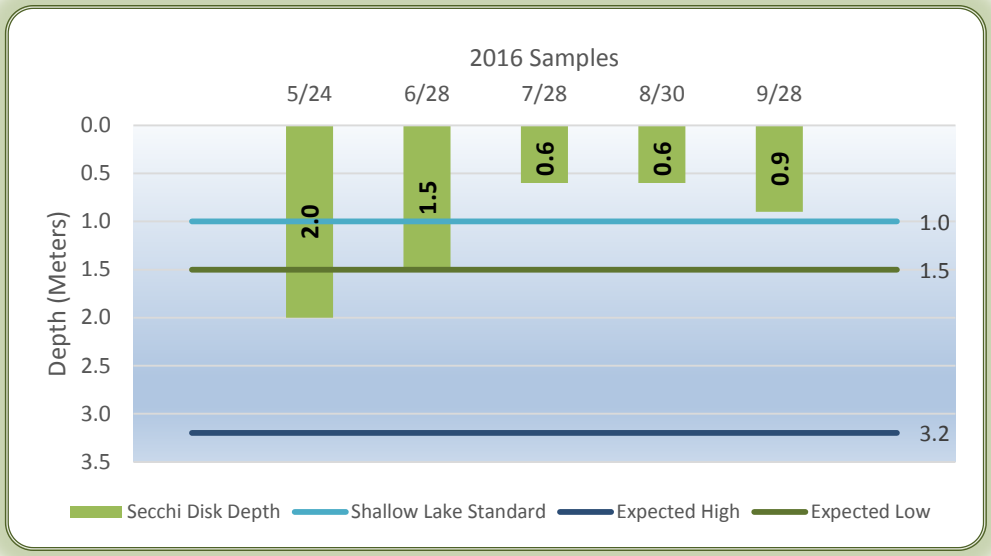
## Goose Lake-North

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 38.6 | 37.0 | 29.6 | 41.8 | 32.9 |
| Grade | - | - | - | C | C | C | C | C |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 42.5 | 43.3 | 34.0 | 50.5 | 40.6 |
| Meets Standard (20.0 µg/L) | - | - | - | No | No | No | No | No |





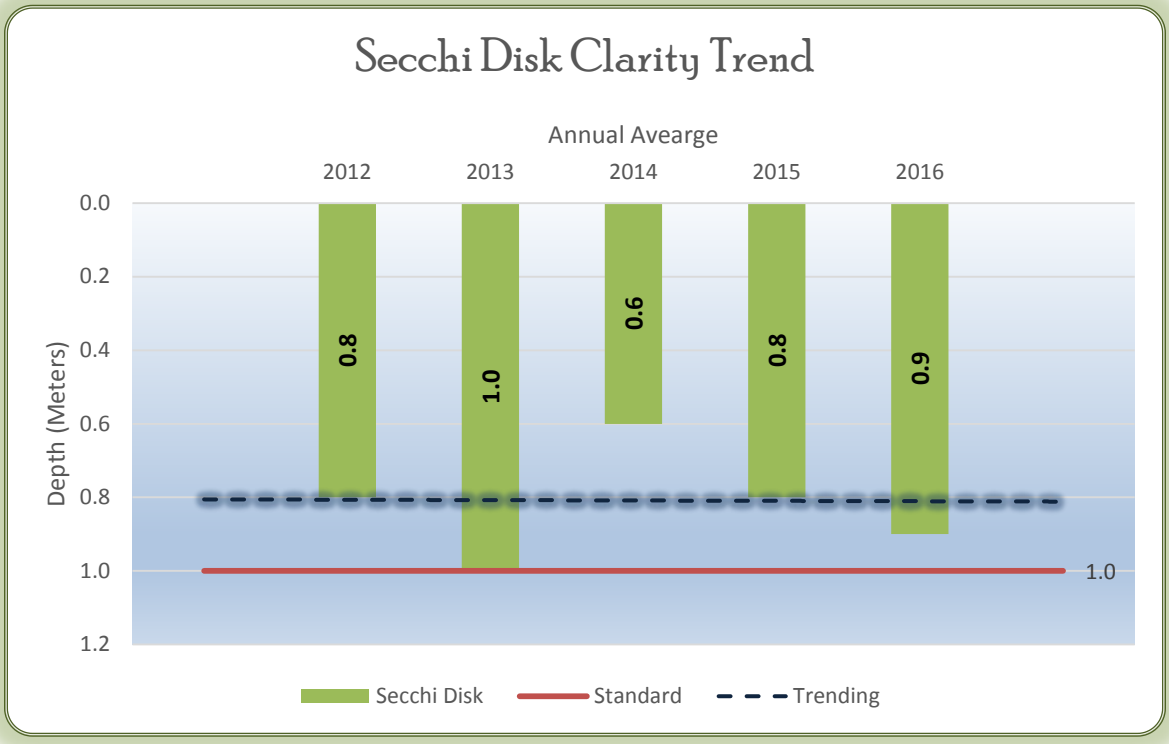

# Secchi Disk Depth

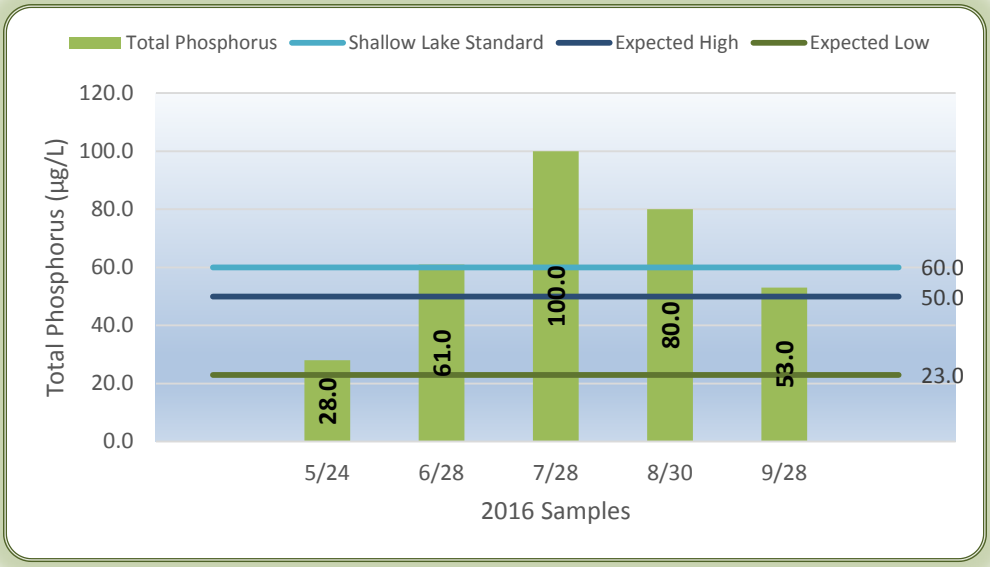
## Goose Lake-North

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | No Data | 0.9 | 1.0 | 0.7 | 1.0 | 1.1 |
| Grade | - | - | - | D | D | D-F | D | D |
| June-Sept Average (Meters) | No Data | No Data | No Data | 0.8 | 1.0 | 0.6 | 0.8 | 0.9 |
| Meets Standard (>1.0 meter) | - | - | - | No | No | No | No | No |





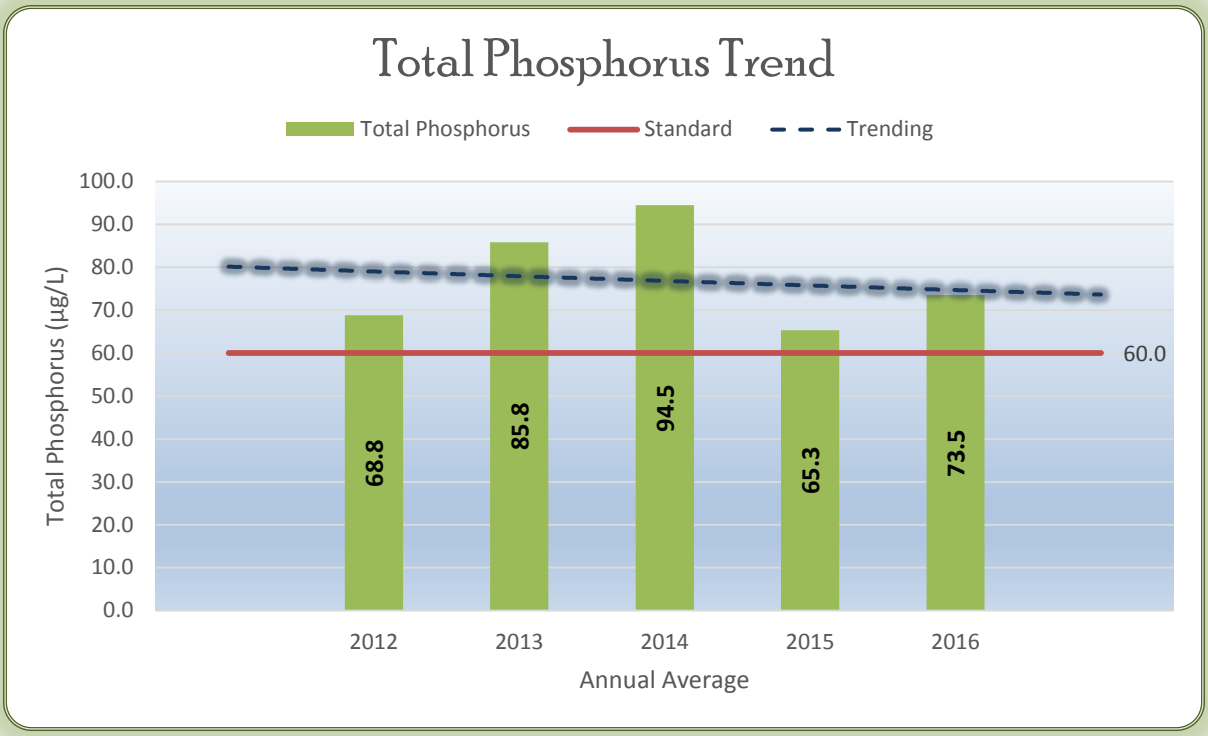

# Total Phosphorus

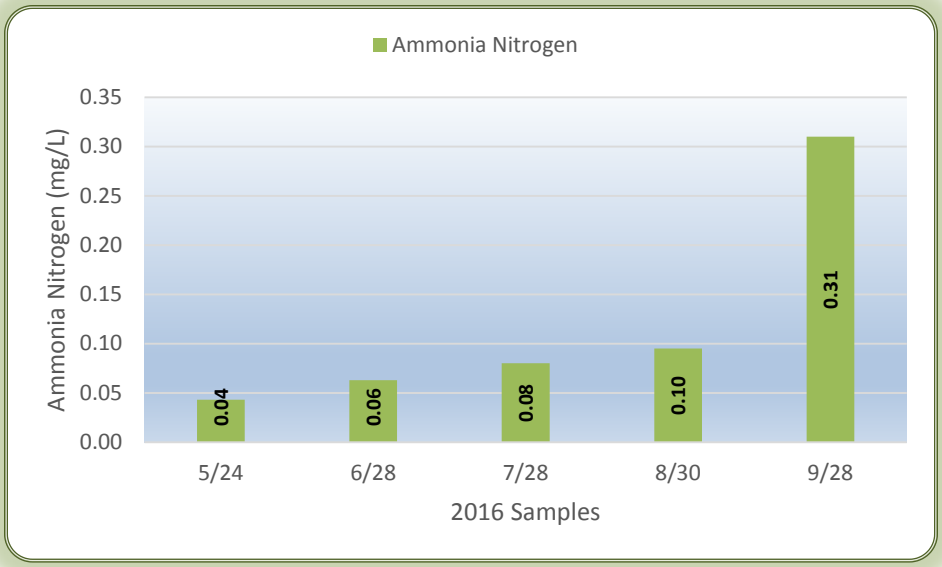
## Goose Lake-North

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 63.2 | 77.6 | 88.0 | 59.2 | 64.2 |
| Grade | - | - | - | C | D | D | C | C |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 68.8 | 85.8 | 94.5 | 65.3 | 73.5 |
| Meets Standard (60.0 µg/L) | - | - | - | No | No | No | No | No |





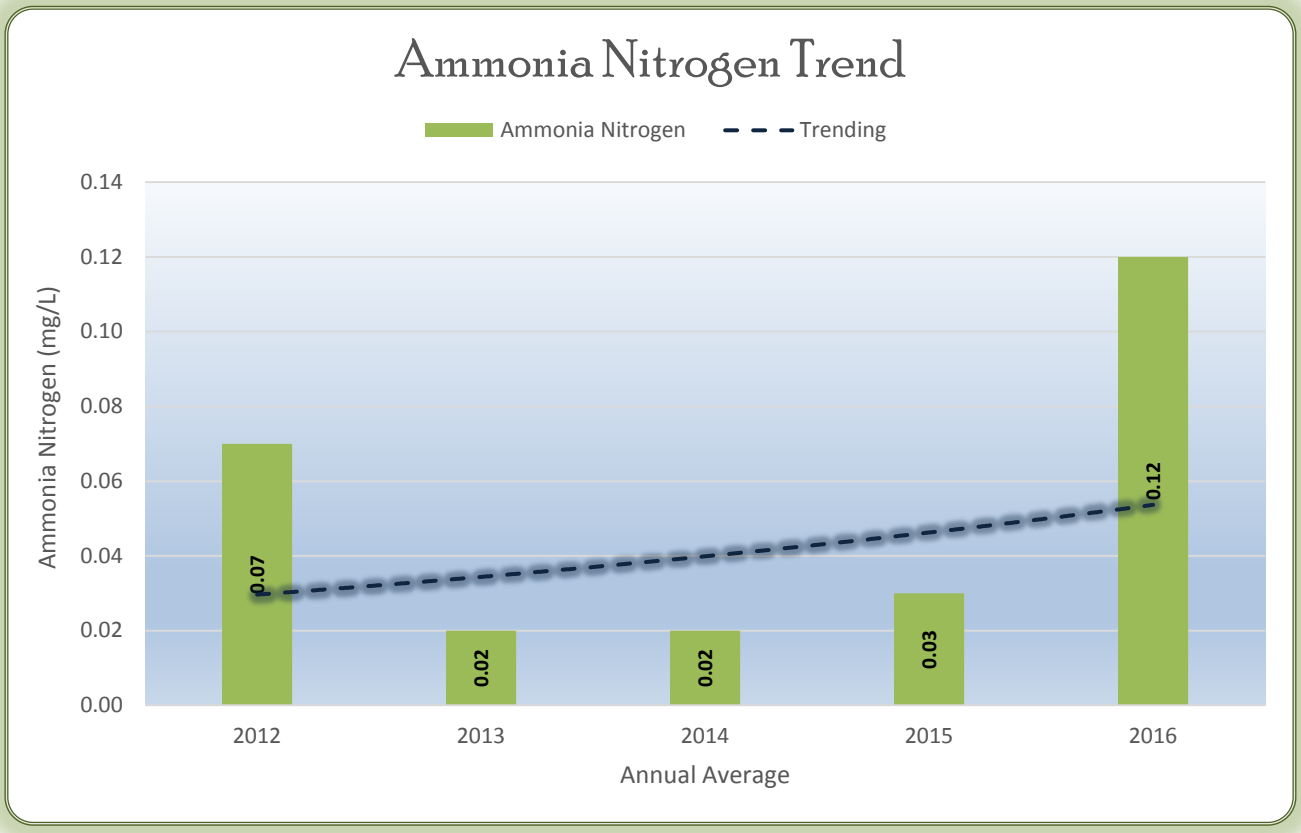

# Ammonia Nitrogen

## Goose Lake-North

Expected Range:
None

Shallow Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | No Data | 0.07 | 0.02 | 0.02 | 0.03 | 0.12 |



General Observations
Goose Lake~North

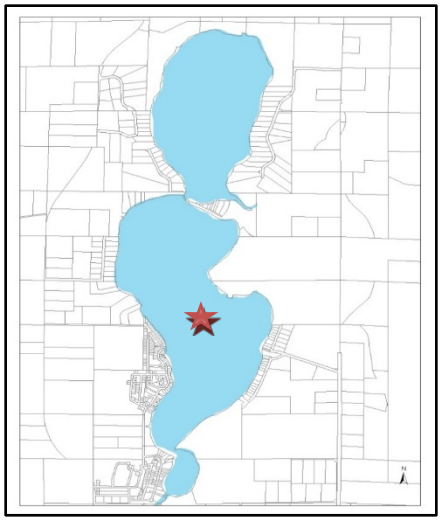
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Malted | |
| June | 3<br>Medium Algae | 3<br>Fair | Calabash | |
| July | 4<br>High Algae | 4<br>Poor | Mossy Rock | |
| August | 4<br>High Algae | 4<br>Poor | Cornichon | |
| September | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll~a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll~a, Secchi transparency, and Phosphorus.

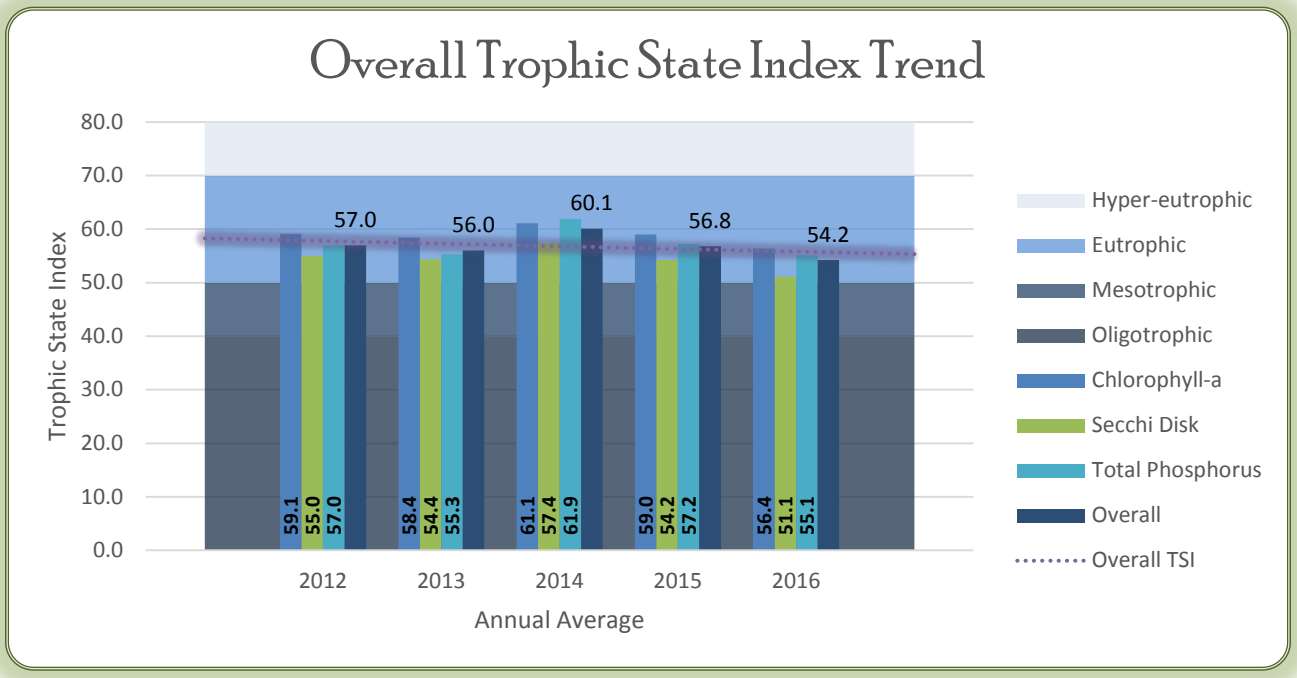
# Goose Lake-South

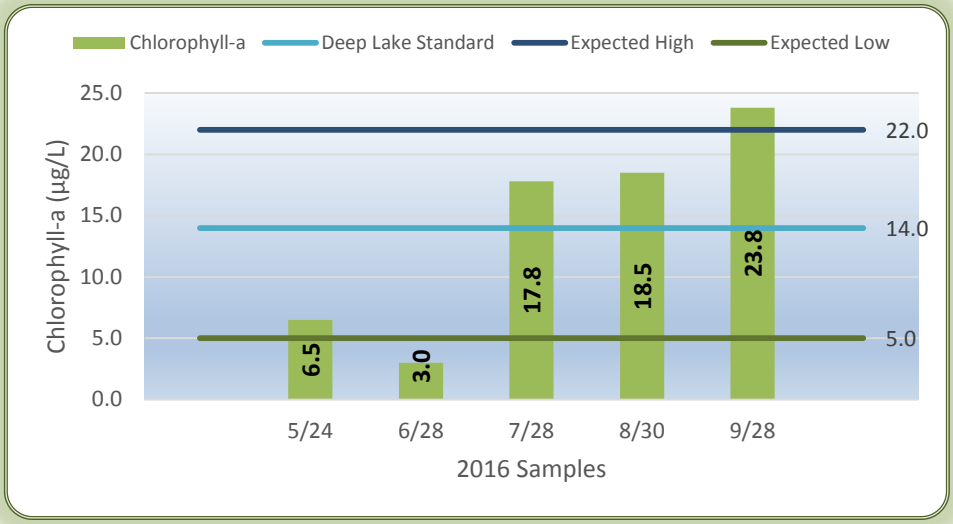
Lake 13-0083-02 Site 201



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 13 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 56.4 | 51.1 | 55.1 | 54.2 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 13.9 µg/L | 1.9 meters | 34.2 µg/L | - |
| Grade | B | C | C | C |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 15.8 µg/L | 1.8 meters | 35.8 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





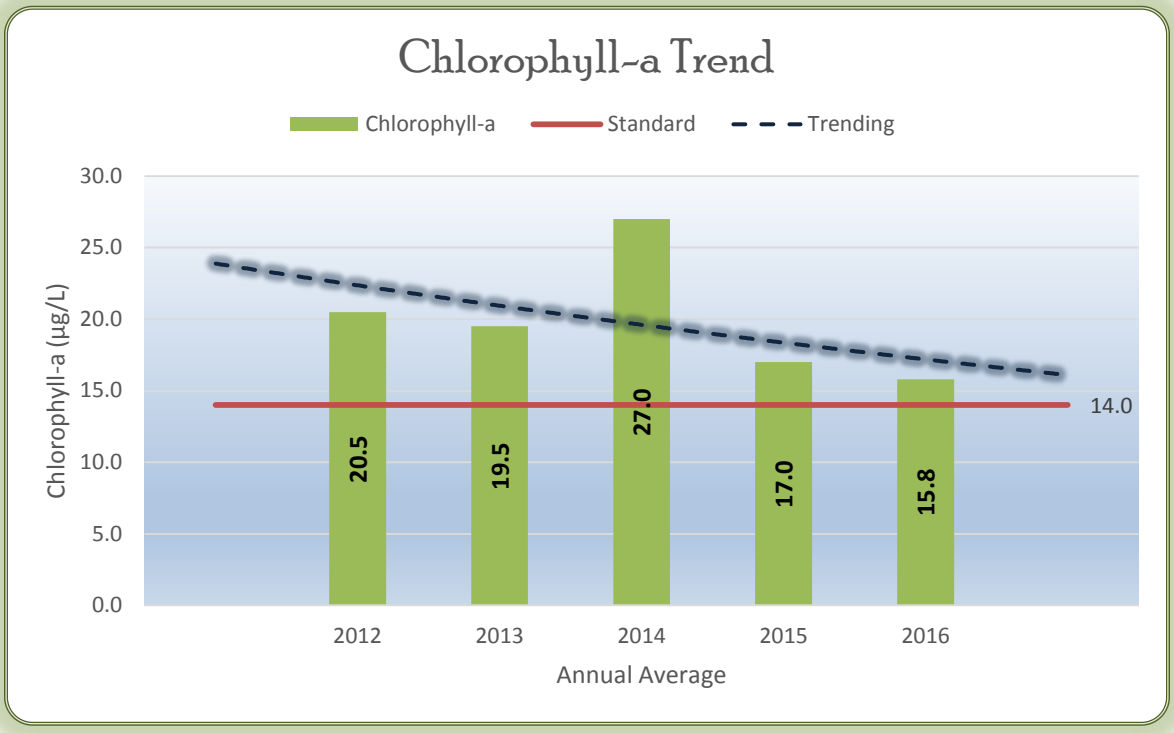

# Chlorophyll-a

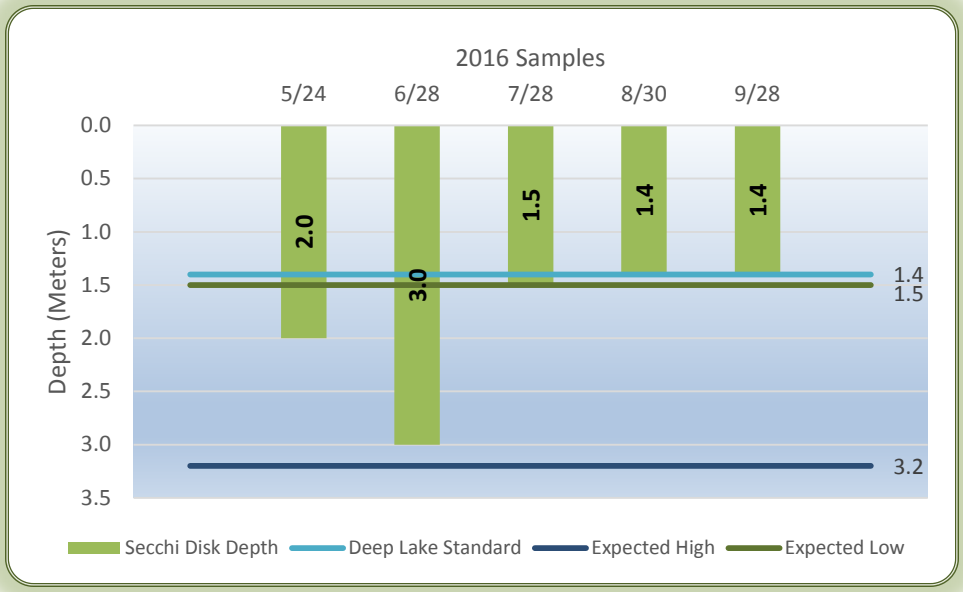
## Goose Lake-South

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 18.2 | 17.0 | 22.4 | 18.0 | 13.9 |
| Grade | - | - | - | B | B | C | B | B |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 20.5 | 19.5 | 27.0 | 17.0 | 15.8 |
| Meets Standard (14.0 µg/L) | - | - | - | No | No | No | No | No |





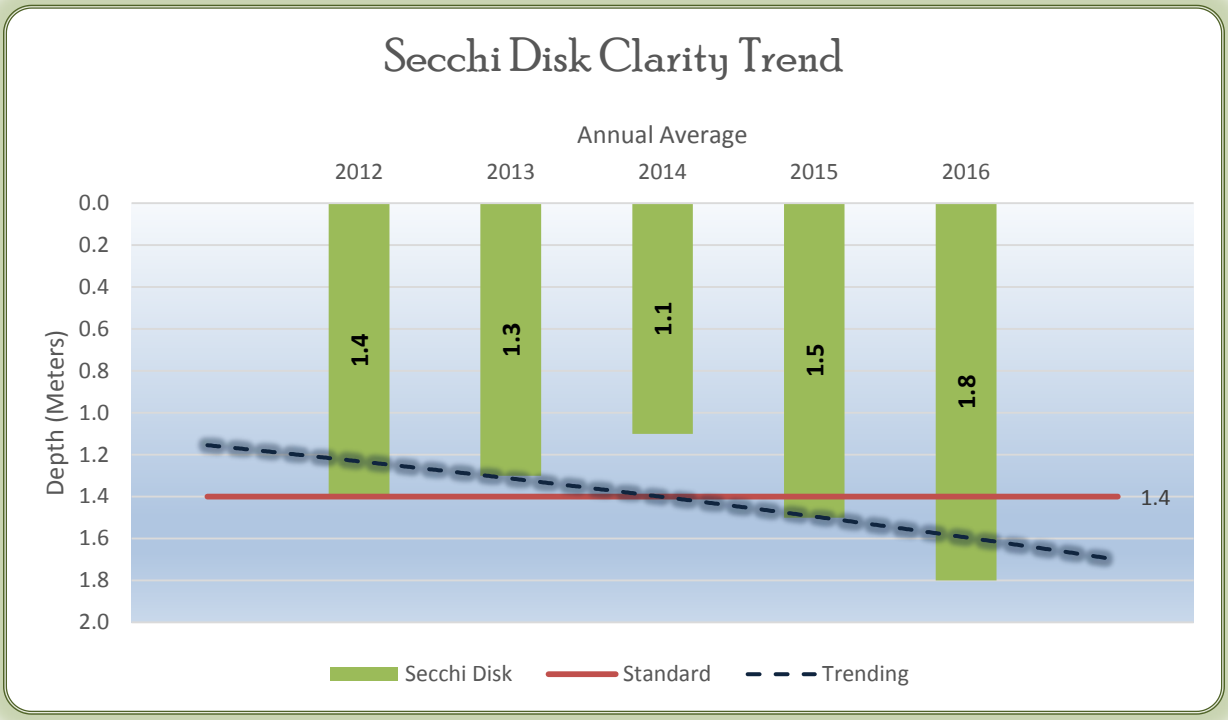

# Secchi Disk Depth

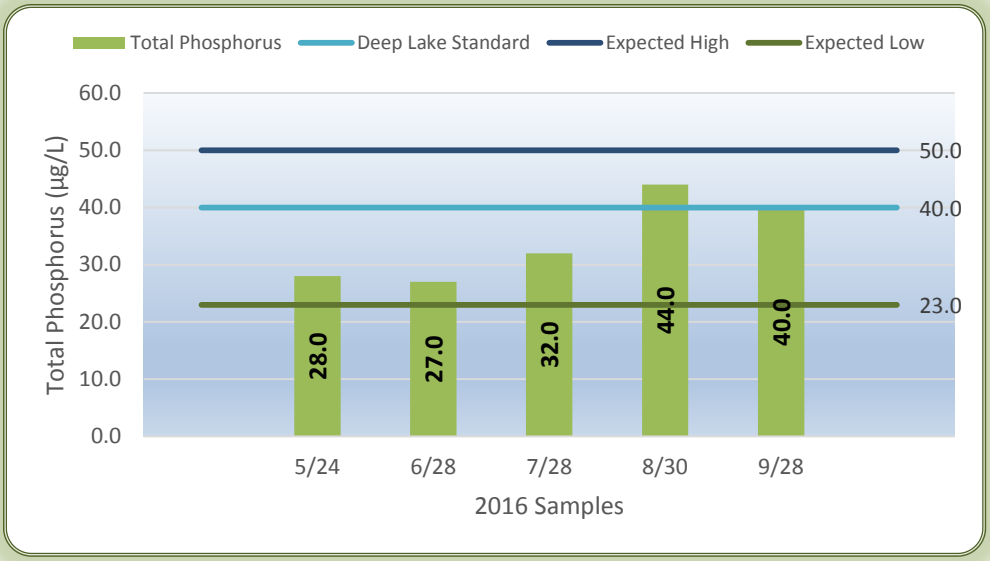
## Goose Lake-South

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | No Data | 1.4 | 1.5 | 1.2 | 1.5 | 1.9 |
| Grade | - | - | - | C | C | C | C | C |
| June-Sept Average (Meters) | No Data | No Data | No Data | 1.4 | 1.3 | 1.1 | 1.5 | 1.8 |
| Meets Standard (>1.4 meters ) | - | - | - | Yes | No | No | Yes | Yes |





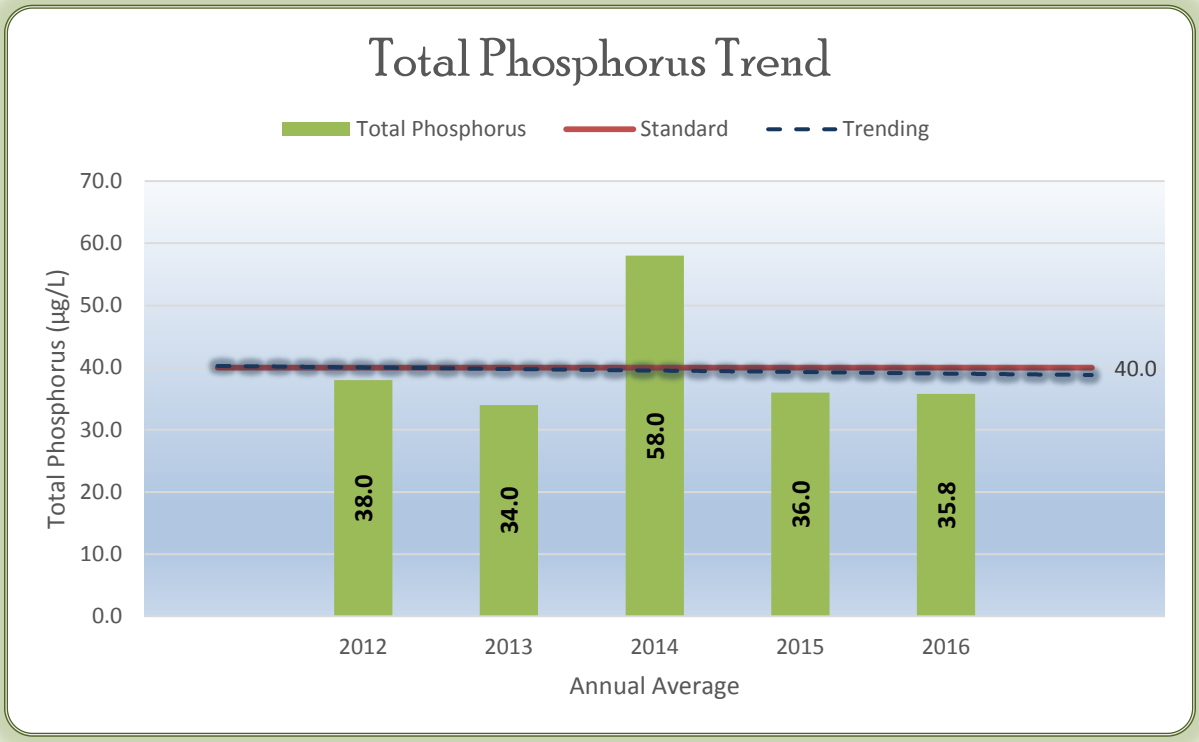

# Total Phosphorus

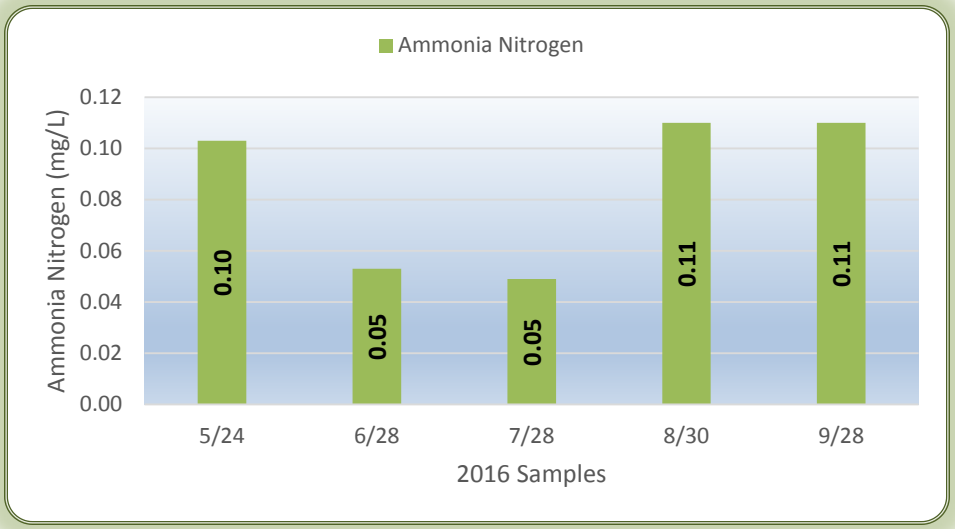
## Goose Lake-South

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 39.0 | 34.8 | 54.8 | 39.6 | 34.2 |
| Grade | - | - | - | C | C | C | C | C |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 38.0 | 34.0 | 58.0 | 36.0 | 35.8 |
| Meets Standard (40.0 µg/L) | - | - | - | Yes | Yes | No | Yes | Yes |





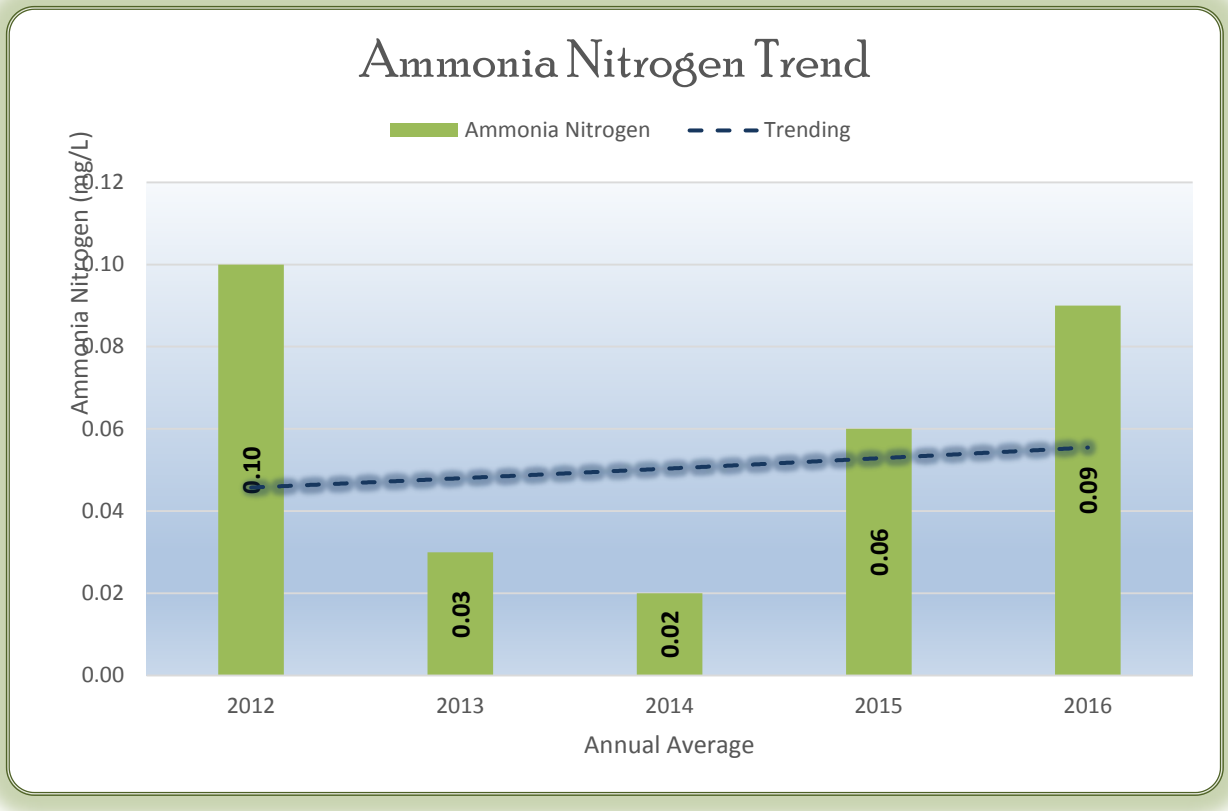

# Ammonia Nitrogen

## Goose Lake-South

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | No Data | 0.10 | 0.03 | 0.02 | 0.06 | 0.09 |



General Observations
Goose Lake–South

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Beach Grass | |
| June | 2<br>Low Algae | 2<br>Good | Malted | |
| July | 3<br>Medium Algae | 3<br>Fair | Sultana | |
| August | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| September | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |

# Explanation of Color Classification

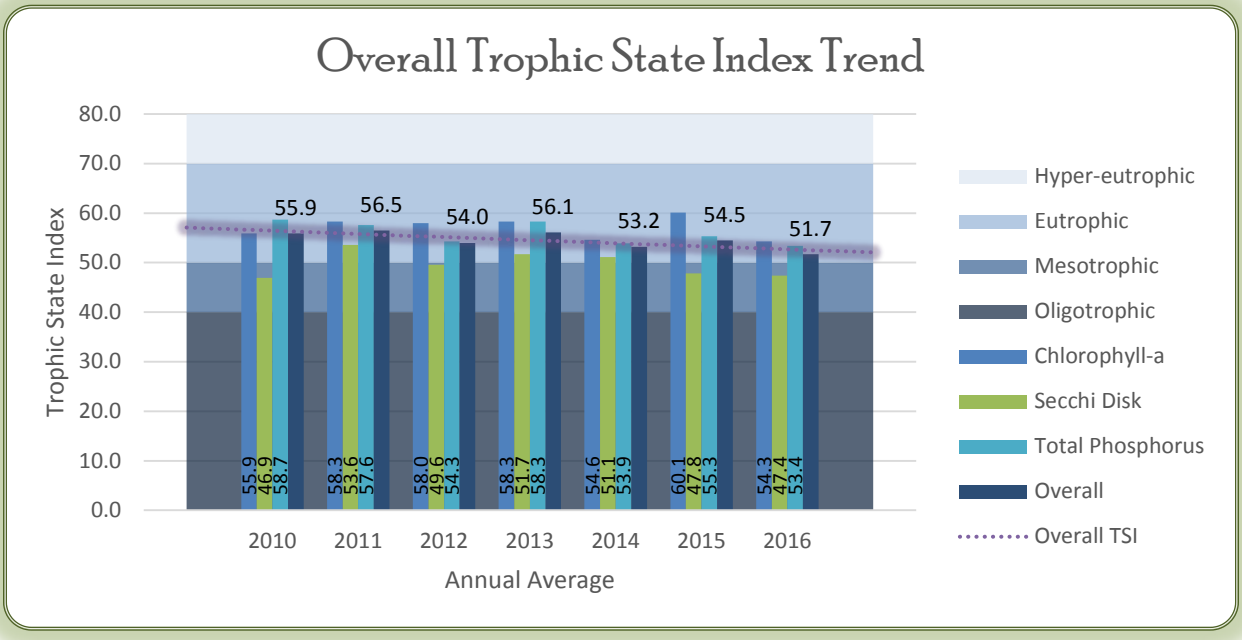
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll–a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll–a, Secchi transparency, and Phosphorus.

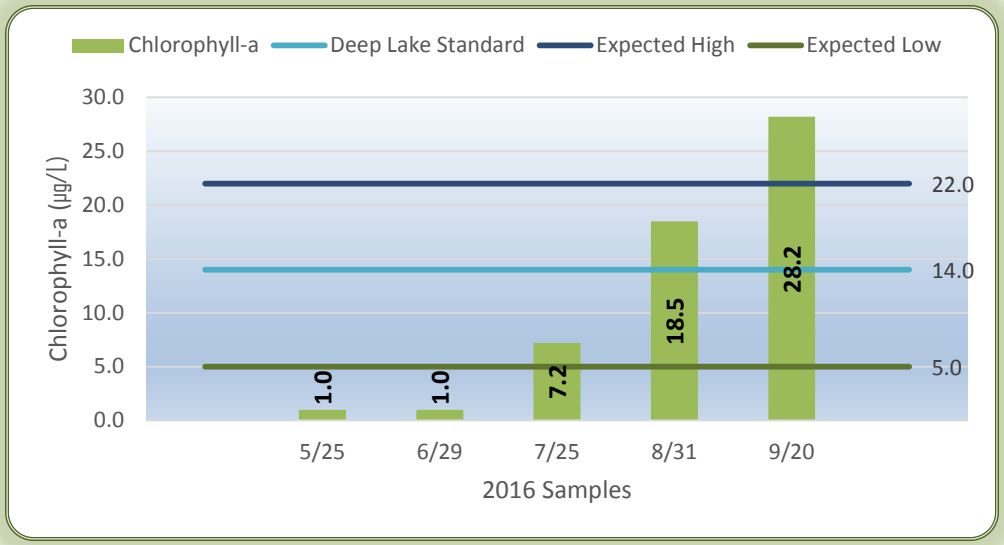
# Green Lake

Lake 13-0041-02 Site 202

| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 8 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 54.3 | 47.4 | 53.4 | 51.7 |
| Classification | Eutrophic | Mesotrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 11.2 µg/L | 2.4 meters | 30.4 µg/L | - |
| Grade | B | B | B | B |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 13.7 µg/L | 1.9 meters | 34.8 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





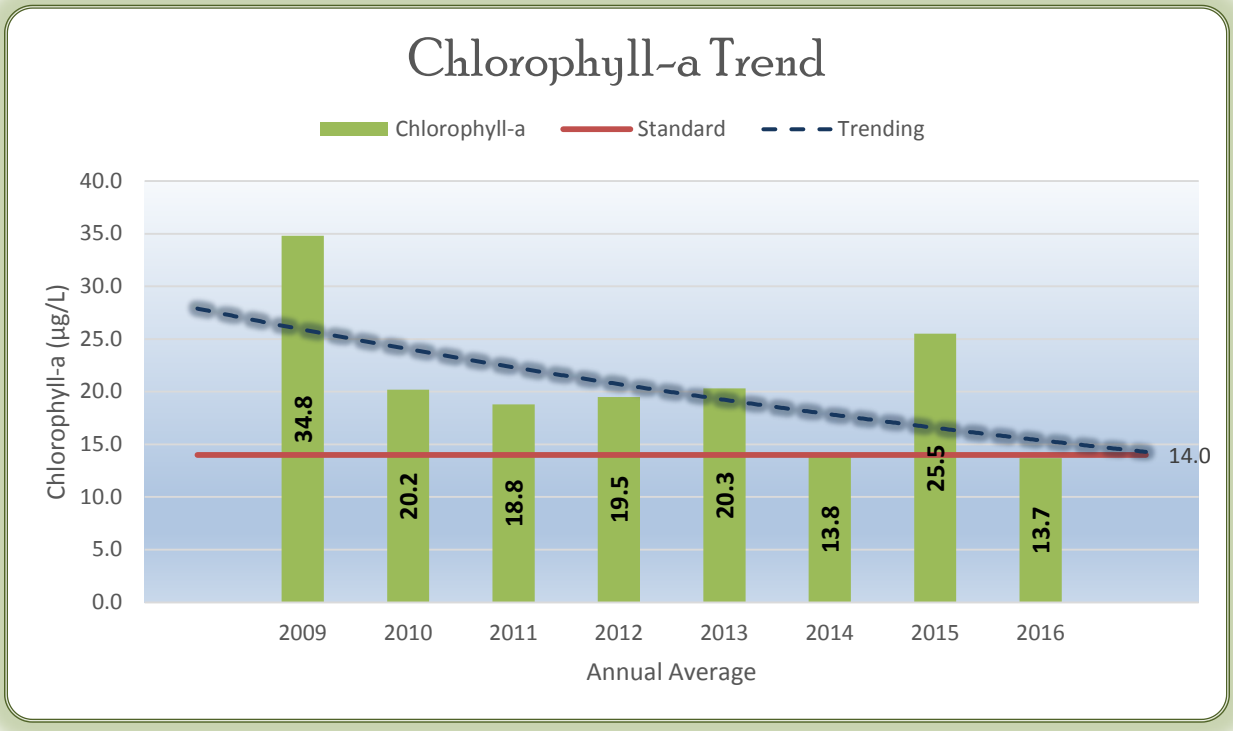

# Chlorophyll-a

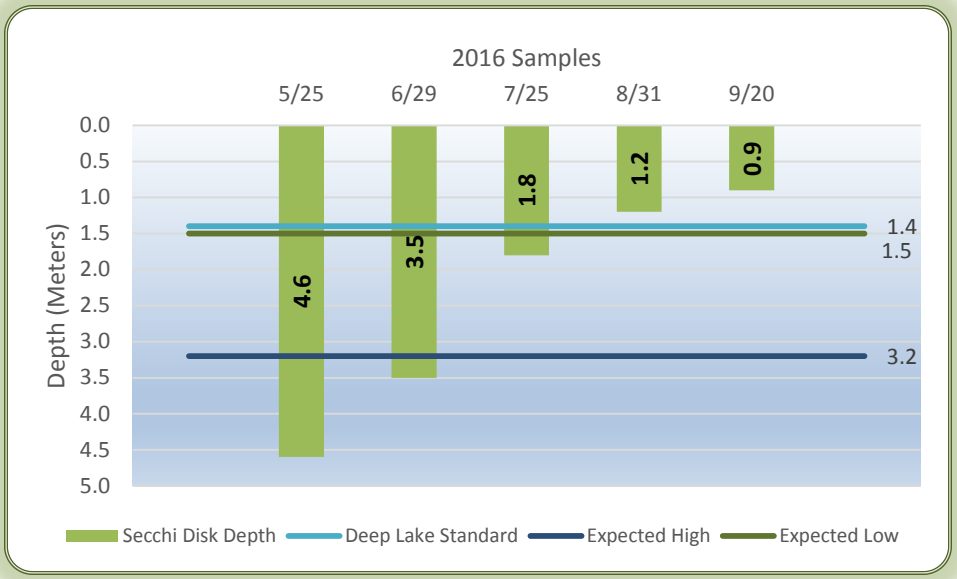
## Green Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 28.4 | 14.0 | 16.8 | 16.4 | 16.8 | 11.6 | 20.1 | 11.2 |
| Grade | C | B | B | B | B | B | C | B |
| June-Sept Average (µg/L) | 34.8 | 20.2 | 18.8 | 19.5 | 20.3 | 13.8 | 25.5 | 13.7 |
| Meets Standard (14.0 µg/L) | No | No | No | No | No | Yes | No | Yes |





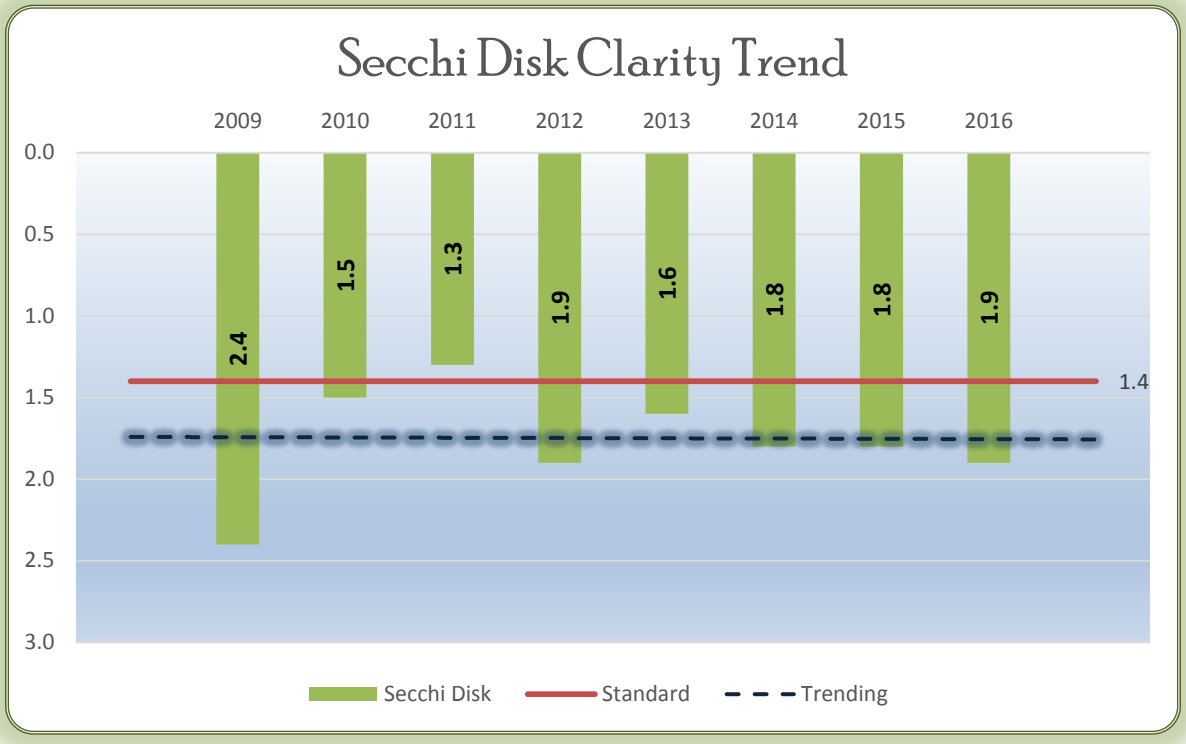

# Secchi Disk Depth

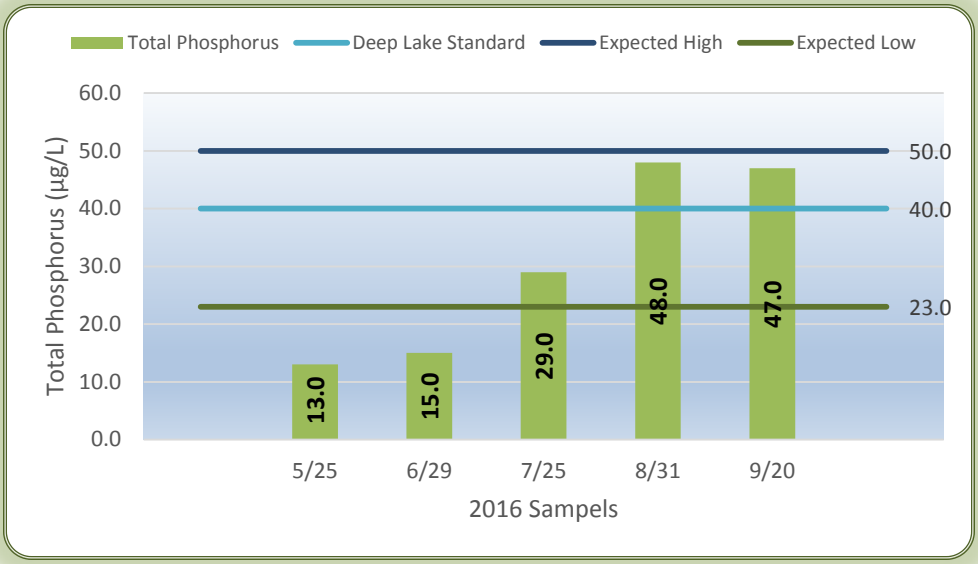
## Green Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | 2.5 | 2.4 | 1.6 | 2.1 | 1.8 | 1.9 | 2.3 | 2.4 |
| Grade | B | B | C | C | C | C | B | B |
| June-Sept Average (Meters) | 2.4 | 1.5 | 1.3 | 1.9 | 1.6 | 1.8 | 1.8 | 1.9 |
| Meets Standard (>1.4 meters ) | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes |





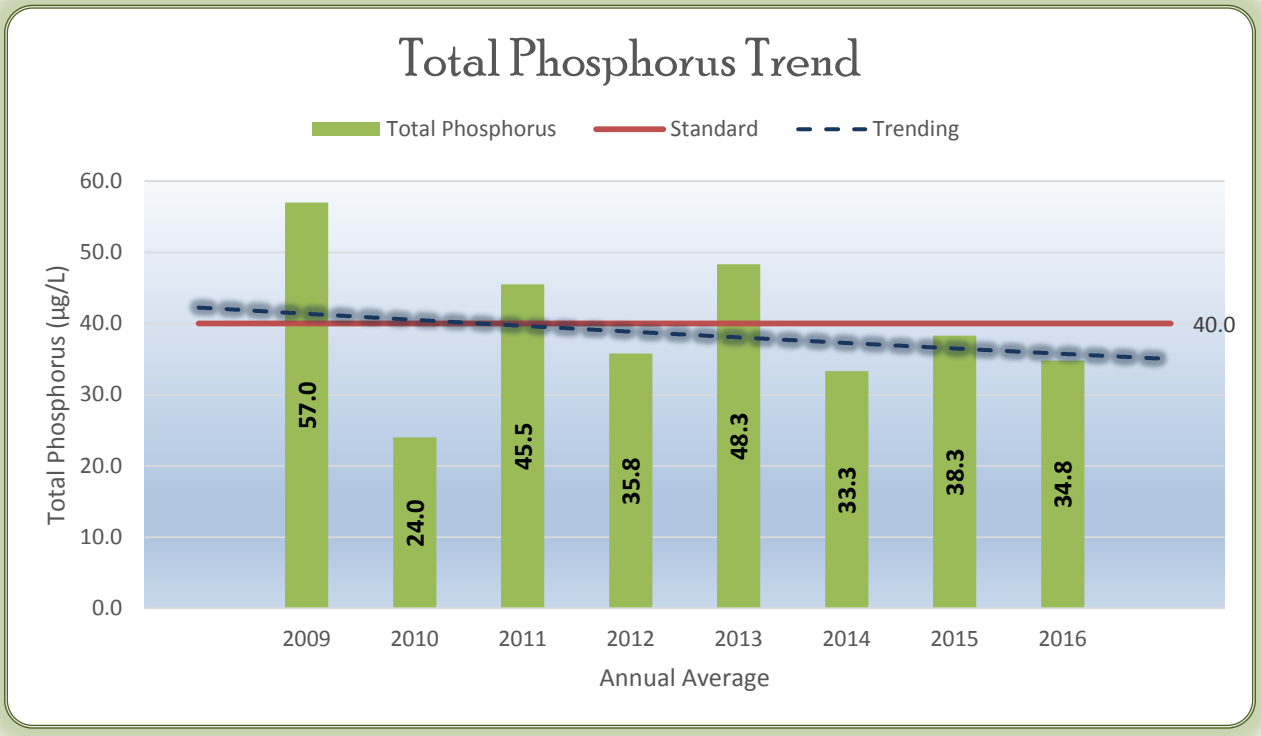

# Total Phosphorus

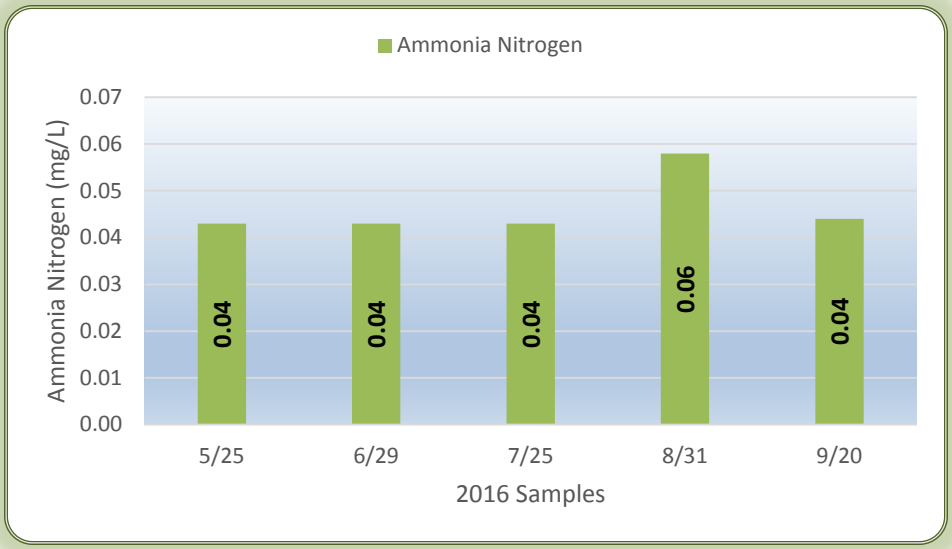
## Green Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 51.0 | 22.0 | 40.6 | 32.4 | 42.6 | 31.4 | 34.6 | 30.4 |
| Grade | C | A | C | B-C | C | C | C | B |
| June-Sept Average (µg/L) | 57.0 | 24.0 | 45.5 | 35.8 | 48.3 | 33.3 | 38.3 | 34.8 |
| Meets Standard (40.0 µg/L) | No | Yes | No | Yes | No | Yes | Yes | Yes |





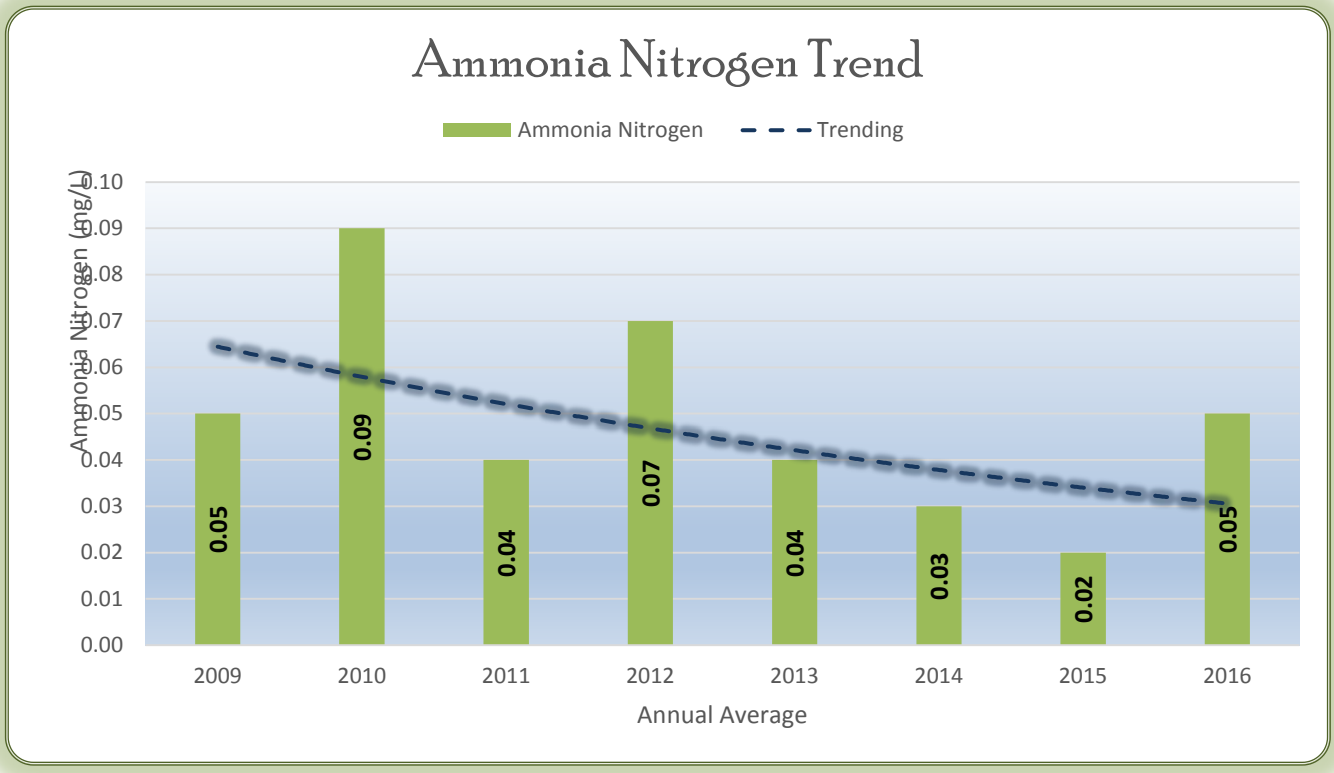

# Ammonia Nitrogen

## Green Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | <0.05 | 0.09 | 0.04 | 0.07 | 0.04 | 0.03 | 0.02 | 0.05 |



General Observations
Green Lake

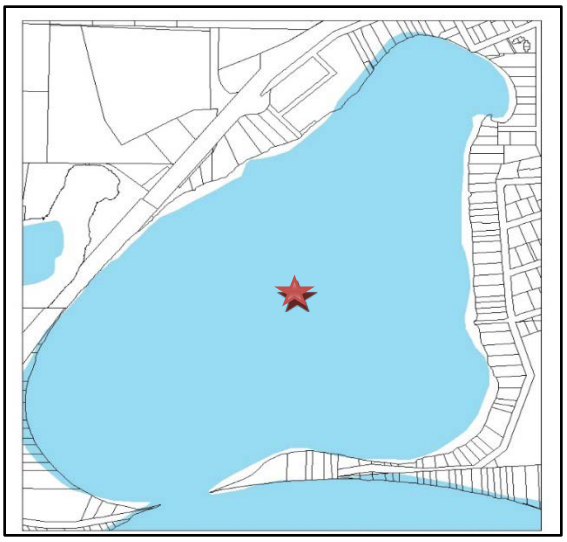
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Heavy Cream | |
| June | 1<br>Clear | 1<br>Very Good | Chopstick | |
| July | 3<br>Medium Algae | 3<br>Fair | Dried Chamomile | |
| August | 4<br>High Algae | 4<br>Poor | Mossy Rock | |
| September | 4<br>High Algae | 4<br>Poor | Eiderdown | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

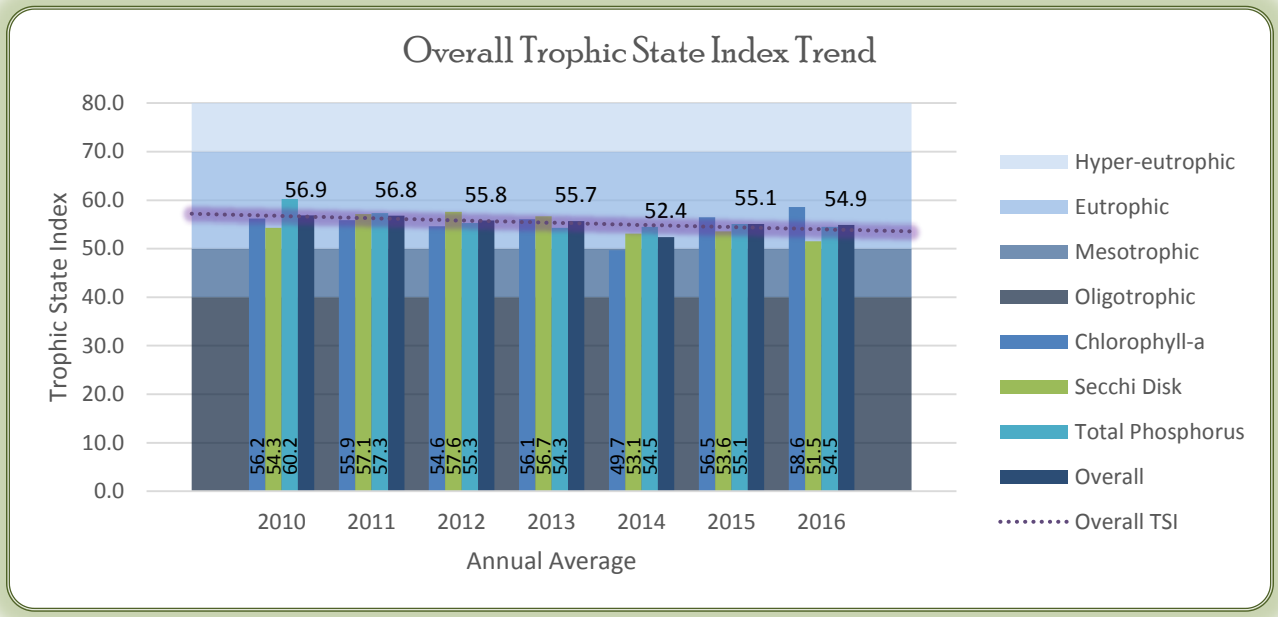
# Little Green Lake

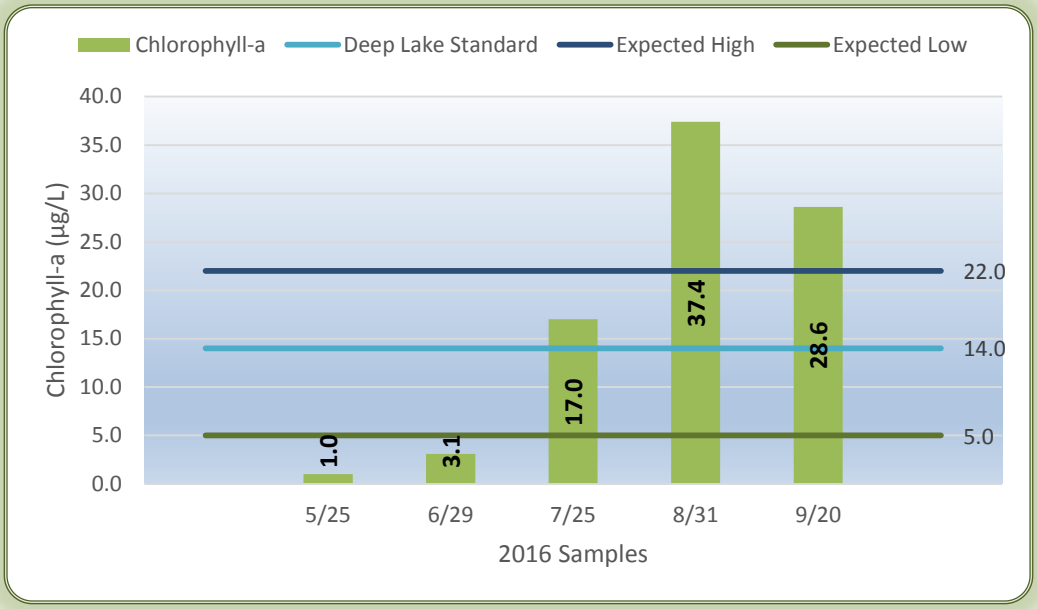
Lake 13-0041-01 Site 202



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 15 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 58.6 | 51.5 | 54.5 | 54.9 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 17.4 µg/L | 1.8 meters | 33.2 µg/L | - |
| Grade | B | C | C | C |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 21.5 µg/L | 1.5 meters | 37.3 µg/L | - |
| Meets Standard | No | Yes | Yes | Yes |





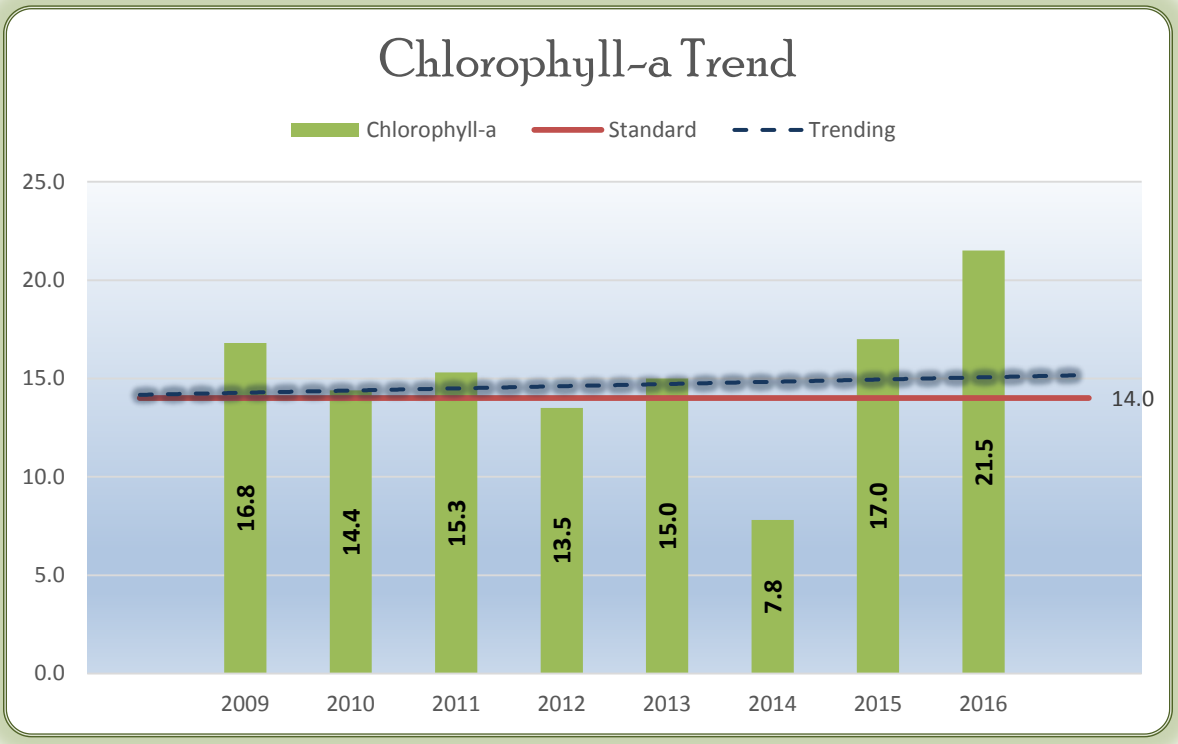

# Chlorophyll-a

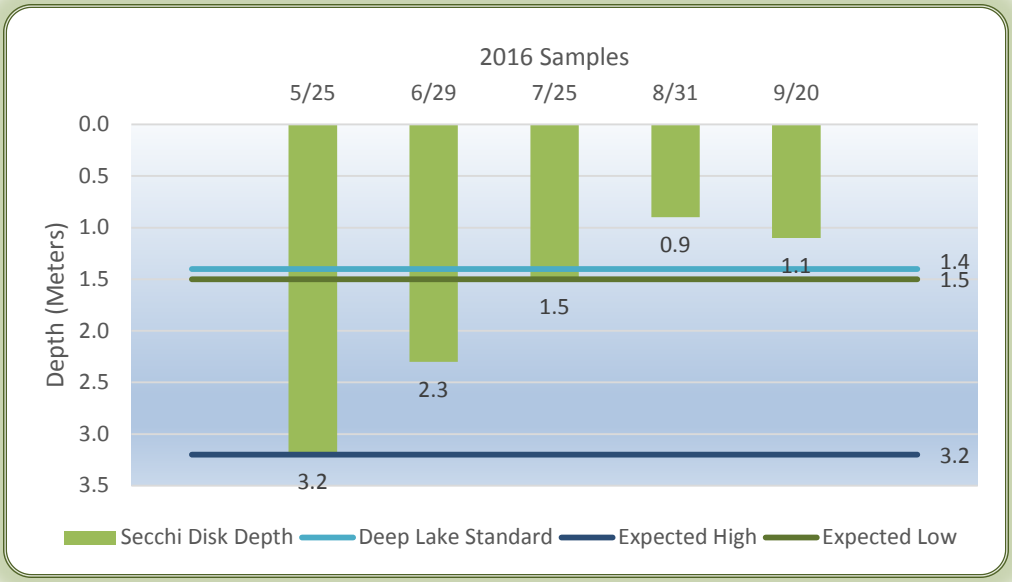
## Little Green Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 14.6 | 10.0 | 13.2 | 11.6 | 13.4 | 7.0 | 14.0 | 17.4 |
| Grade | B | B | B | B | B | A | B | B |
| June-Sept Average (µg/L) | 16.8 | 14.4 | 15.3 | 13.5 | 15.0 | 7.8 | 17.0 | 21.5 |
| Meets Standard (14.0 µg/L) | No | No | No | Yes | No | Yes | No | No |






# Secchi Disk Depth

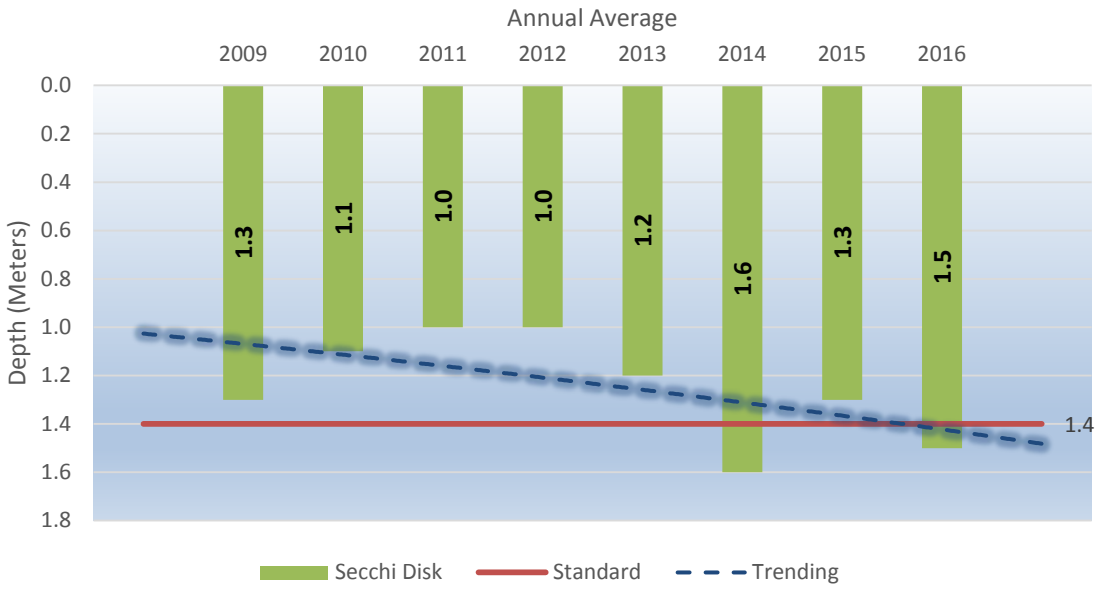
## Little Green Lake

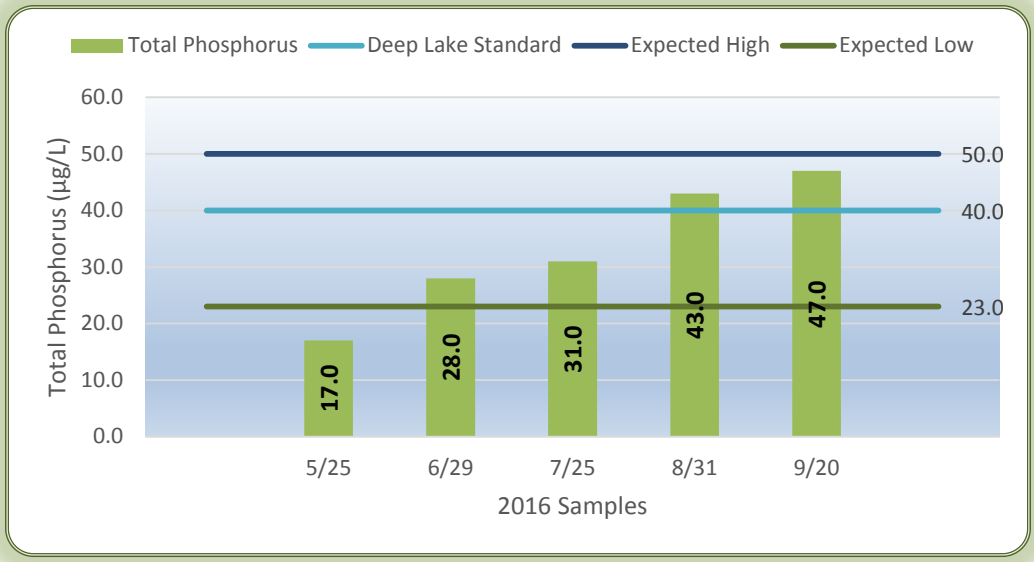
Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | 1.4 | 1.8 | 1.2 | 1.2 | 1.3 | 1.6 | 1.6 | 1.8 |
| Grade | C | C | C-D | C-D | C | C | C | C |
| June-Sept Average (Meters) | 1.3 | 1.1 | 1.0 | 1.0 | 1.2 | 1.6 | 1.3 | 1.5 |
| Meets Standard (>1.4 meters ) | No | No | No | No | No | Yes | No | Yes |

## Secchi Disk Clarity Trend





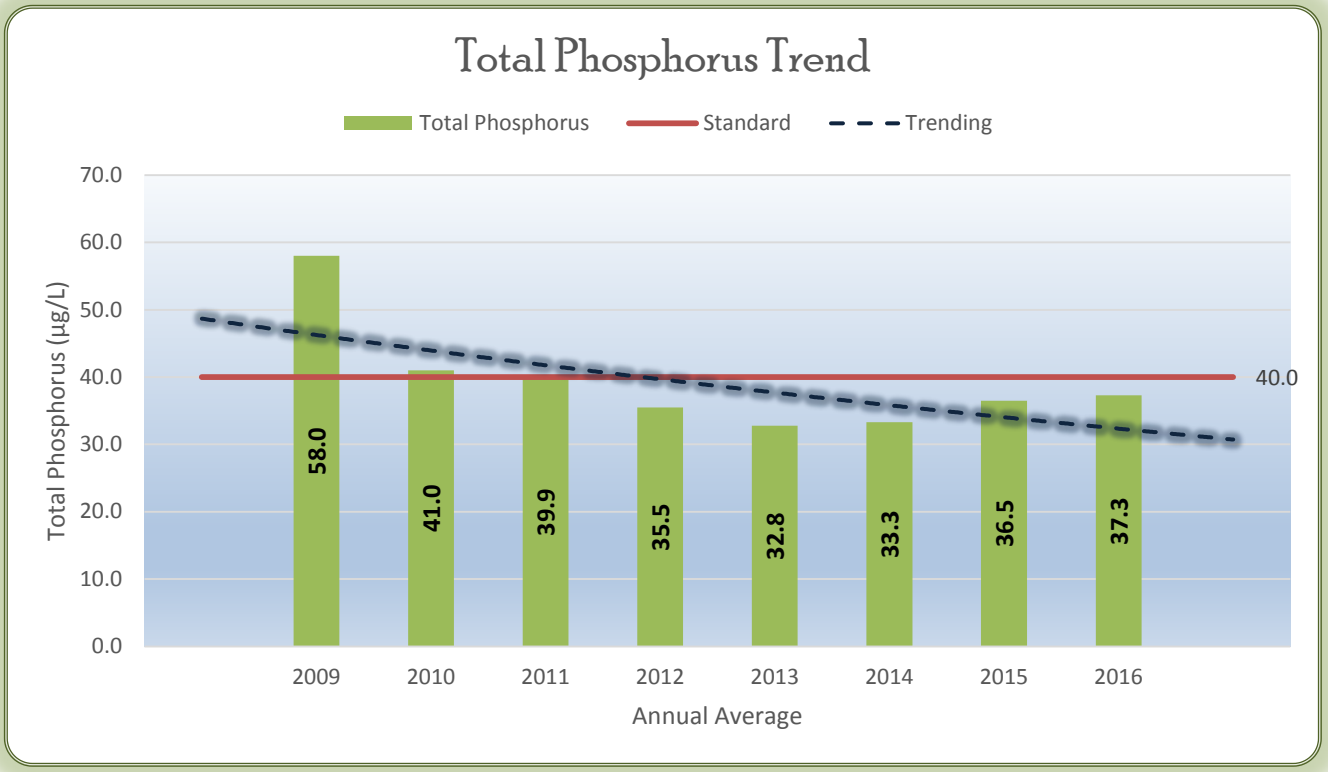

# Total Phosphorus

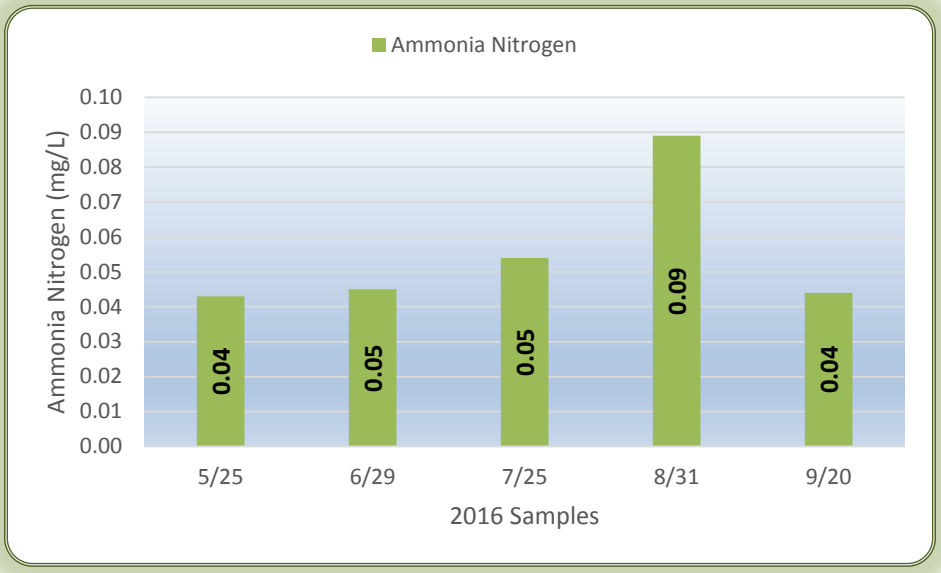
## Little Green Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 54.0 | 32.0 | 40.0 | 34.6 | 32.4 | 32.8 | 34.2 | 33.2 |
| Grade | C | B-C | C | C | C | C | C | C |
| June-Sept Average (µg/L) | 58.0 | 41.0 | 39.9 | 35.5 | 32.8 | 33.3 | 36.5 | 37.3 |
| Meets Standard (40.0 µg/L) | No | No | Yes | Yes | Yes | Yes | Yes | Yes |





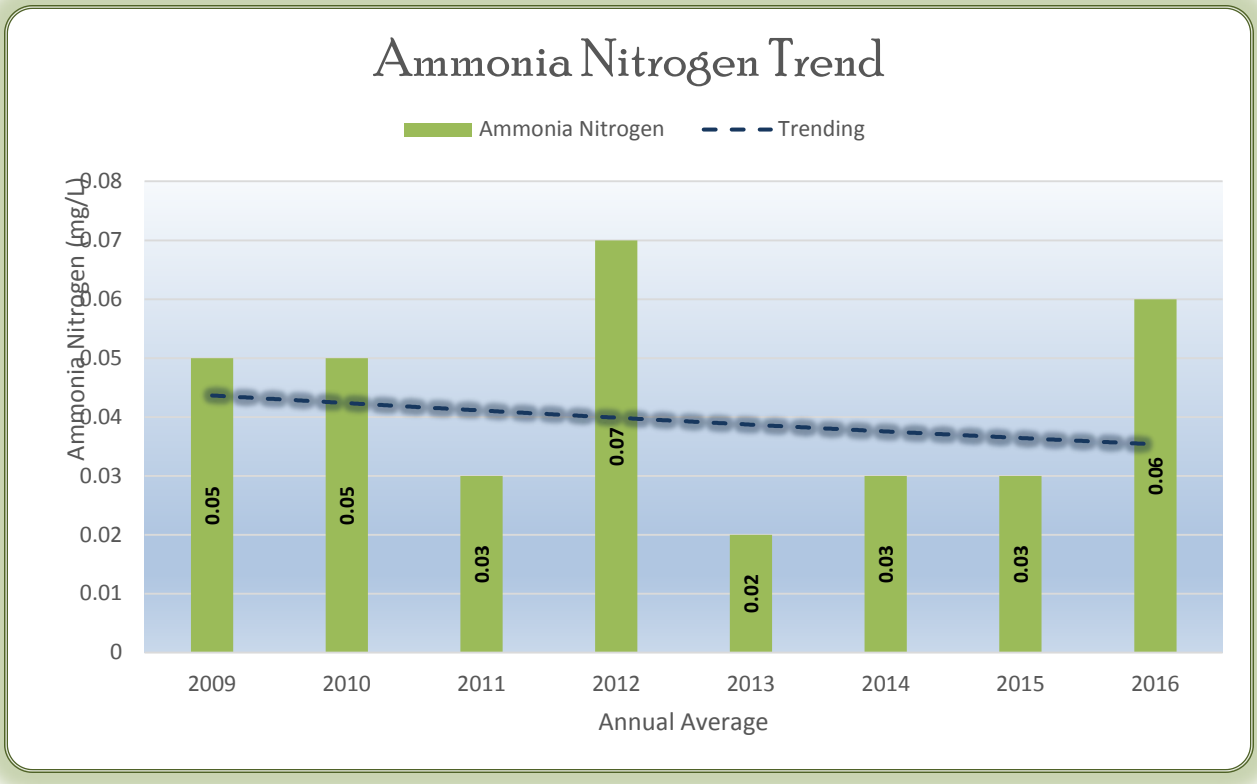

# Ammonia Nitrogen

## Little Green Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | <0.05 | <0.05 | 0.03 | 0.07 | 0.02 | 0.03 | 0.03 | 0.06 |



General Observations
Little Green Lake

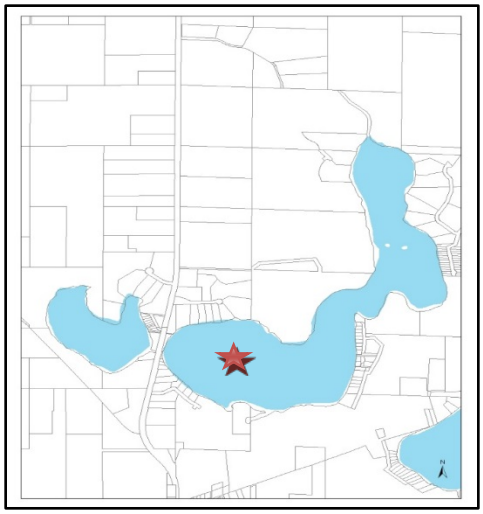
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Chopstick |  |
| June | 2<br>Low Algae | 2<br>Good | Malted |  |
| July | 3<br>Medium Algae | 3<br>Fair | Cornichon |  |
| August | 4<br>High Algae | 4<br>Poor | Sultana |  |
| September | 4<br>High Algae | 4<br>Poor | Cornichon |  |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

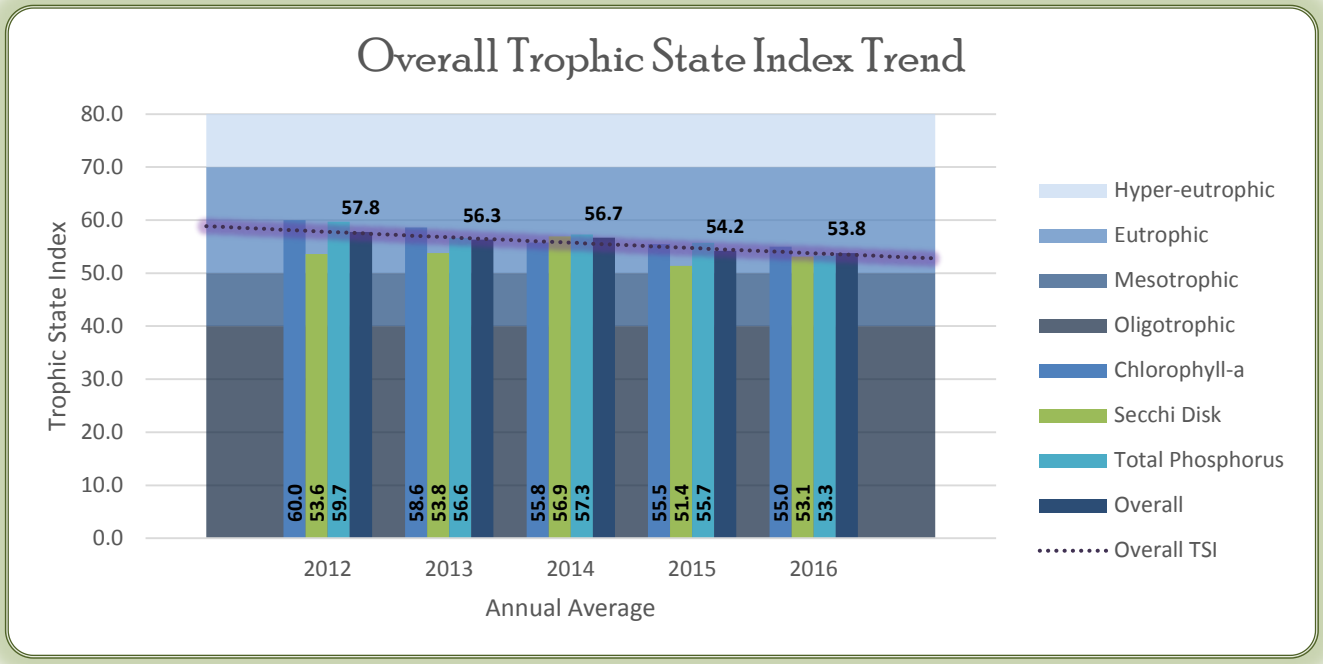
# Horseshoe Lake

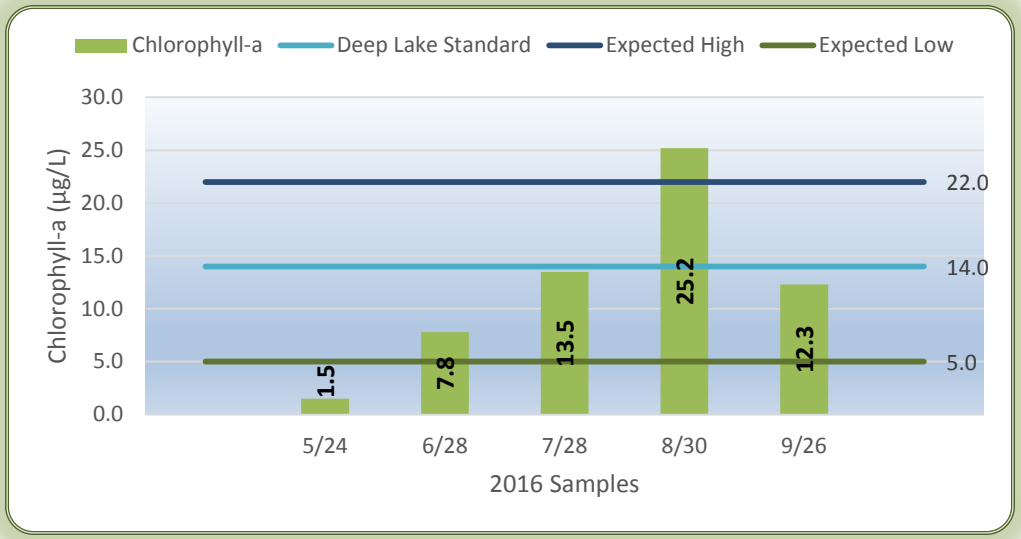
Lake 13-0073-00 Site 201



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | No |
| 2016 Ranking | 11 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 55.0 | 53.1 | 53.3 | 53.8 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 12.1 µg/L | 1.6 meters | 30.2 µg/L | - |
| Grade | B | C | B | B |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 14.7 µg/L | 1.3 meters | 36.0 µg/L | - |
| Meets Standard | No | No | Yes | No |





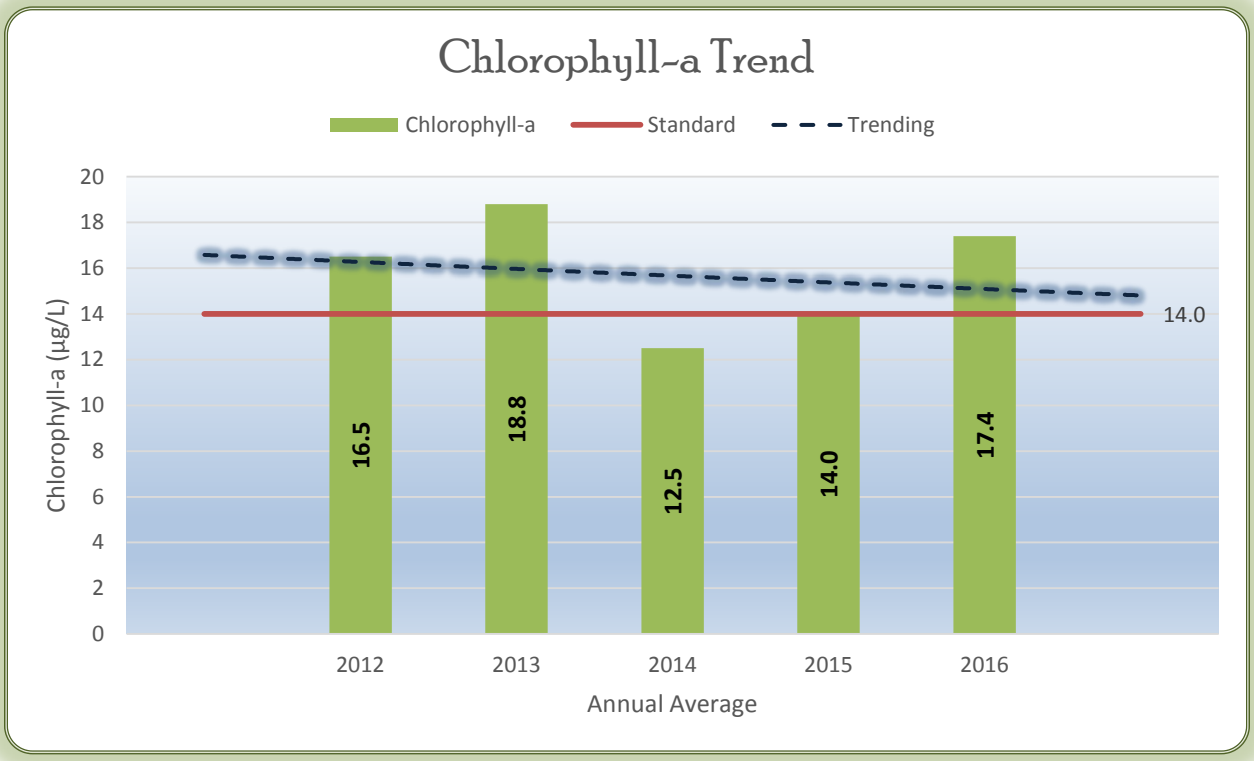

# Chlorophyll-a

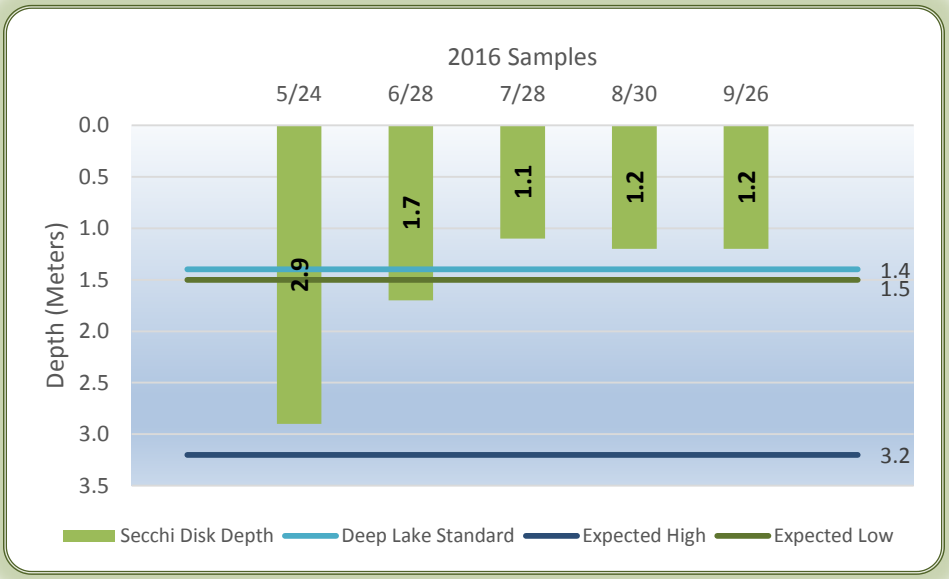
## Horseshoe Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 20.0 | 17.4 | 13.0 | 12.6 | 12.1 |
| Grade | - | - | - | B-C | B | B | B | B |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 16.5 | 18.8 | 12.5 | 14.0 | 17.4 |
| Meets Standard (14.0 µg/L) | - | - | - | No | No | Yes | Yes | No |





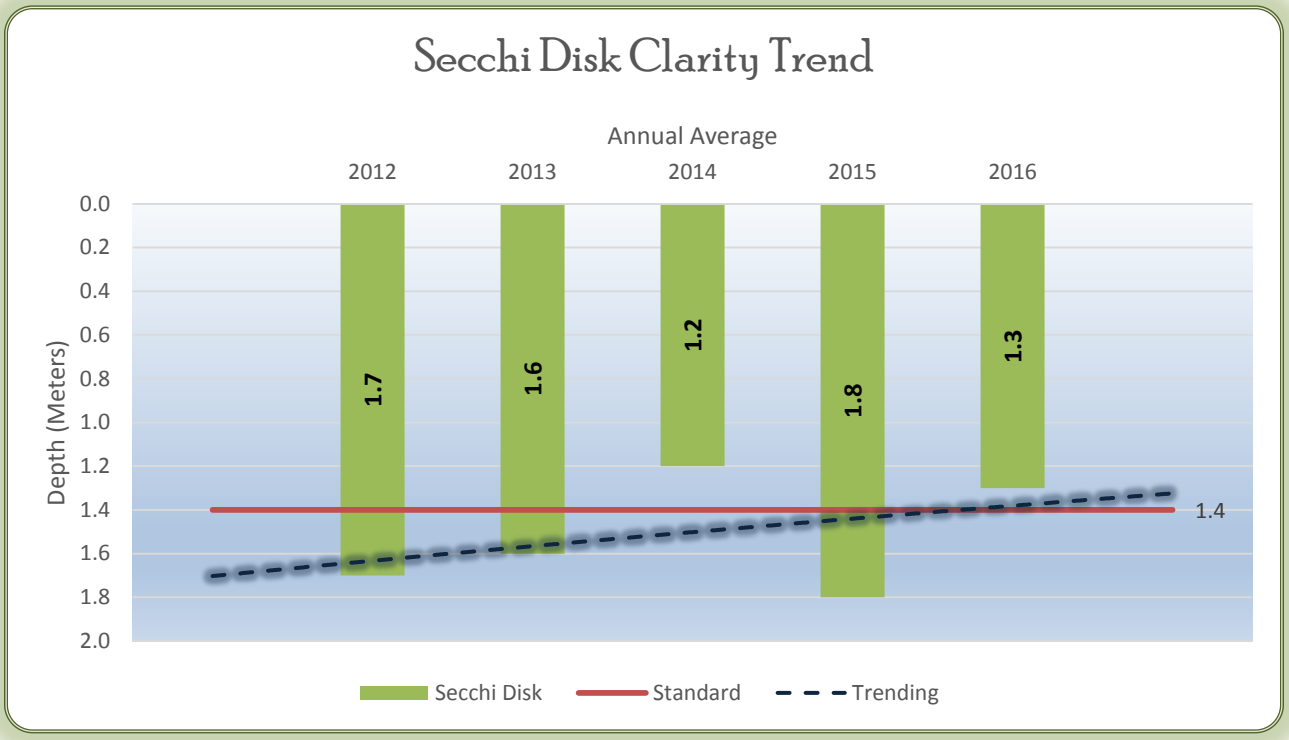

# Secchi Disk Depth

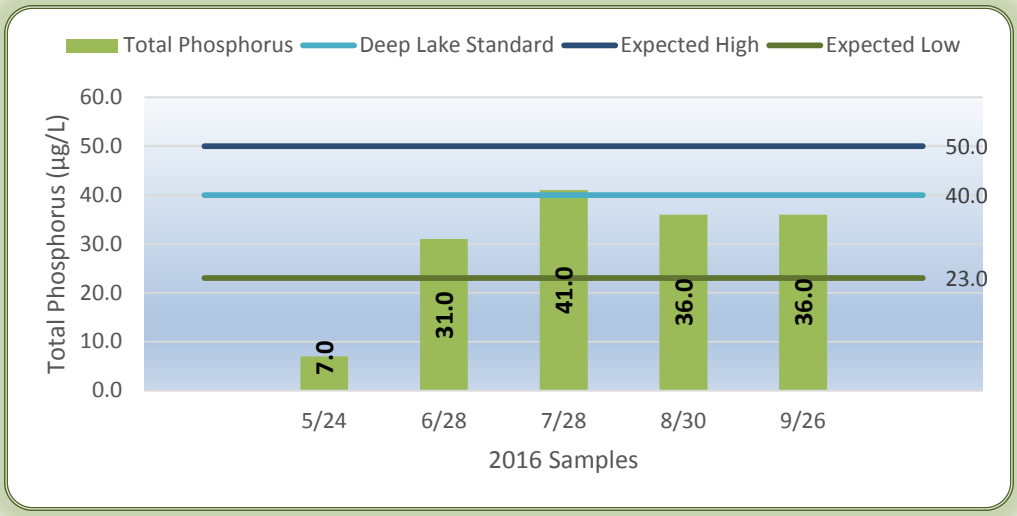
## Horseshoe Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | No Data | 1.6 | 1.5 | 1.2 | 1.8 | 1.6 |
| Grade | - | - | - | C | C | C-D | C | C |
| June-Sept Average (Meters) | No Data | No Data | No Data | 1.7 | 1.6 | 1.2 | 1.8 | 1.3 |
| Meets Standard (>1.4 meters ) | - | - | - | Yes | Yes | No | Yes | No |





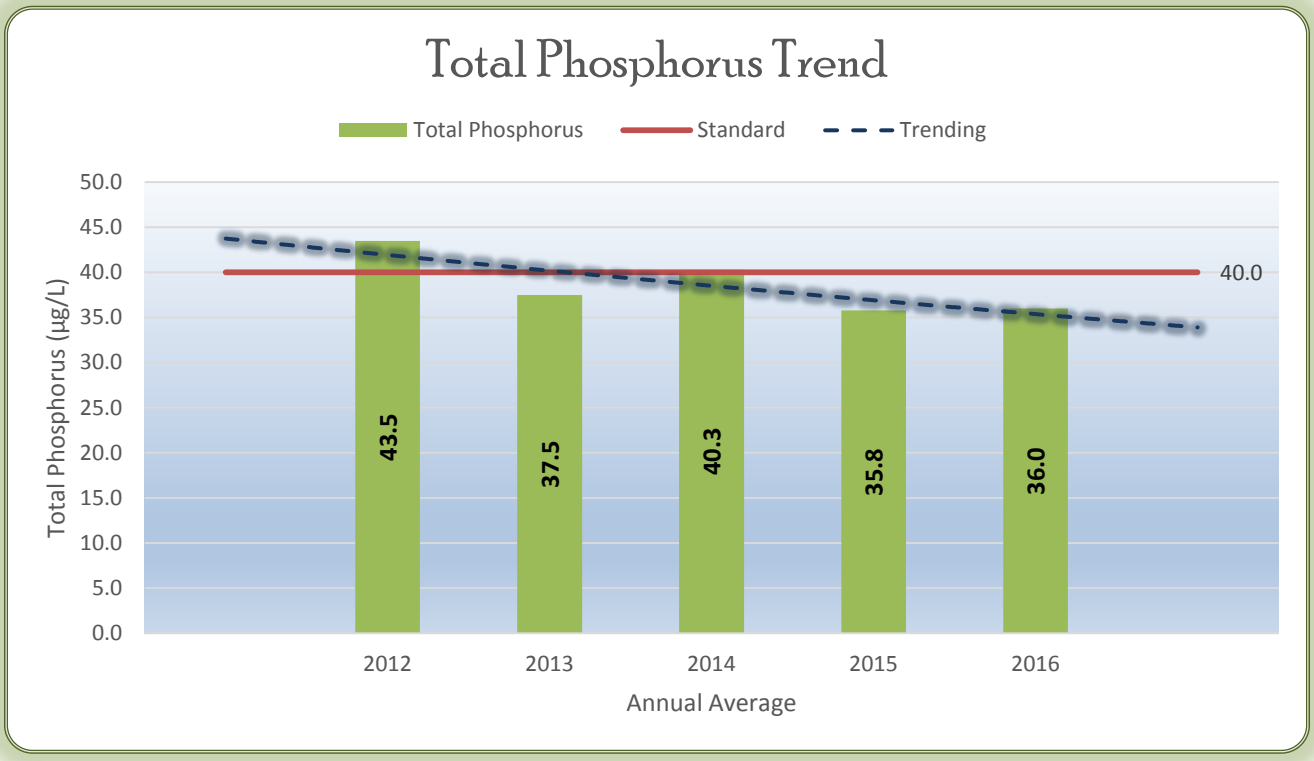

# Total Phosphorus

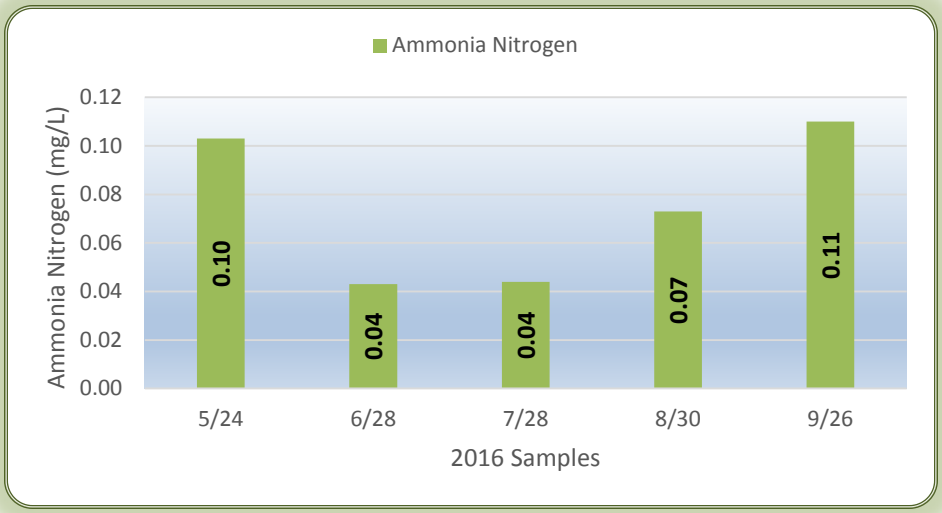
## Horseshoe Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 47.0 | 38.0 | 40.0 | 35.8 | 30.2 |
| Grade | - | - | - | C | C | C | C | B |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 43.5 | 37.5 | 40.3 | 35.8 | 36.0 |
| Meets Standard (40.0 µg/L) | - | - | - | No | Yes | No | Yes | Yes |





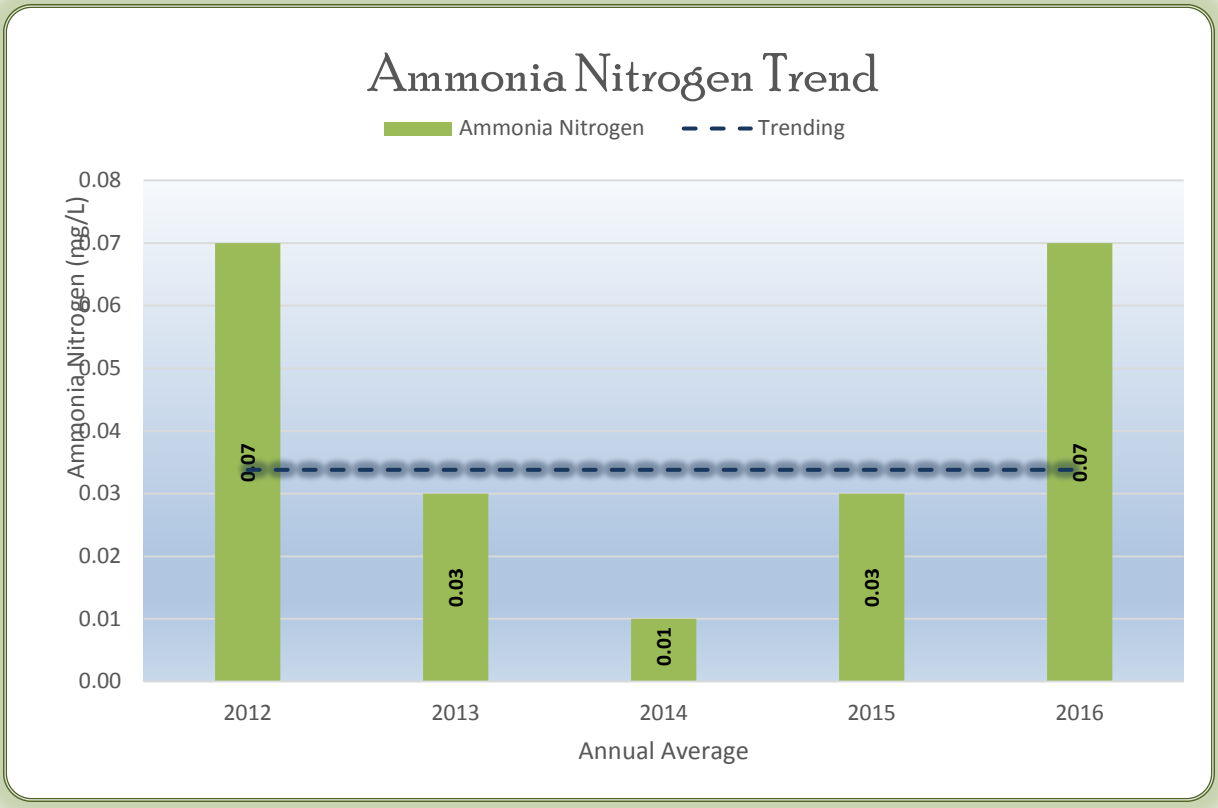

# Ammonia Nitrogen

## Horseshoe Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | No Data | 0.07 | 0.03 | 0.01 | 0.03 | 0.07 |



General Observations
Horseshoe Lake

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Malted | |
| June | 2<br>Low Algae | 2<br>Good | Dried Chamomile | |
| July | 3<br>Medium Algae | 3<br>Fair | Cornichon | |
| August | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| September | 3<br>Medium Algae | 3<br>Fair | Dried Chamomile | |

# Explanation of Color Classification

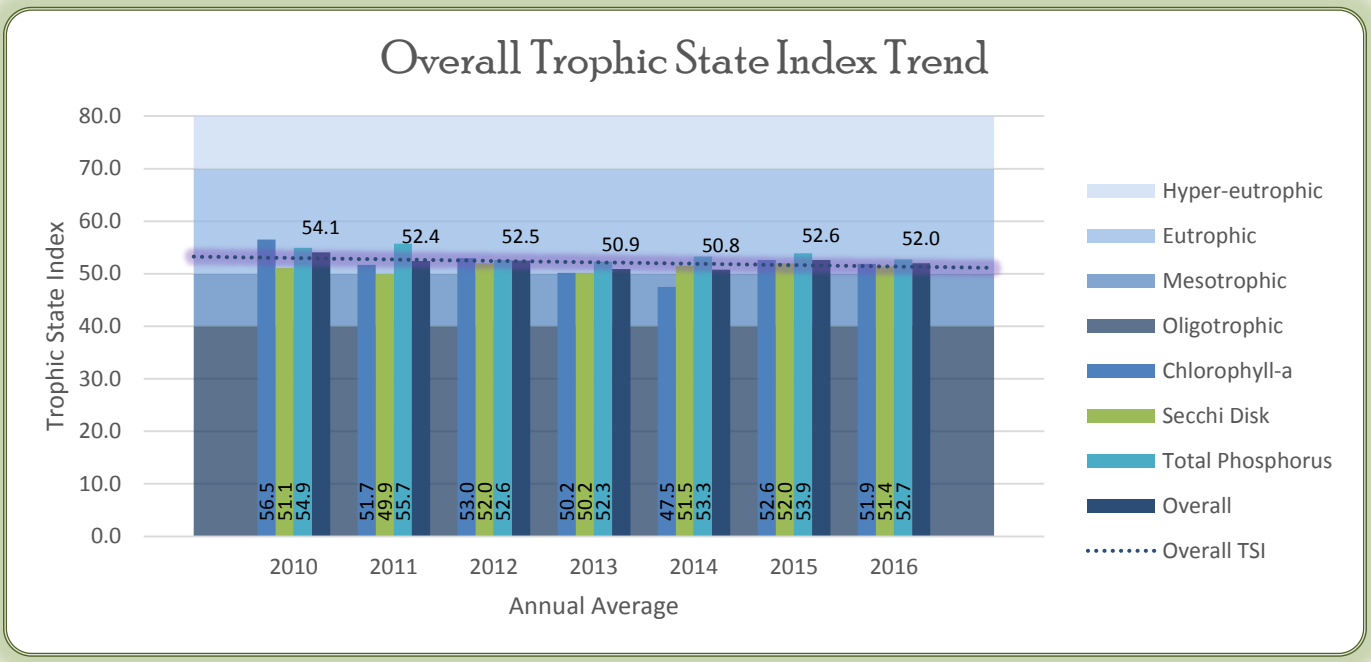
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

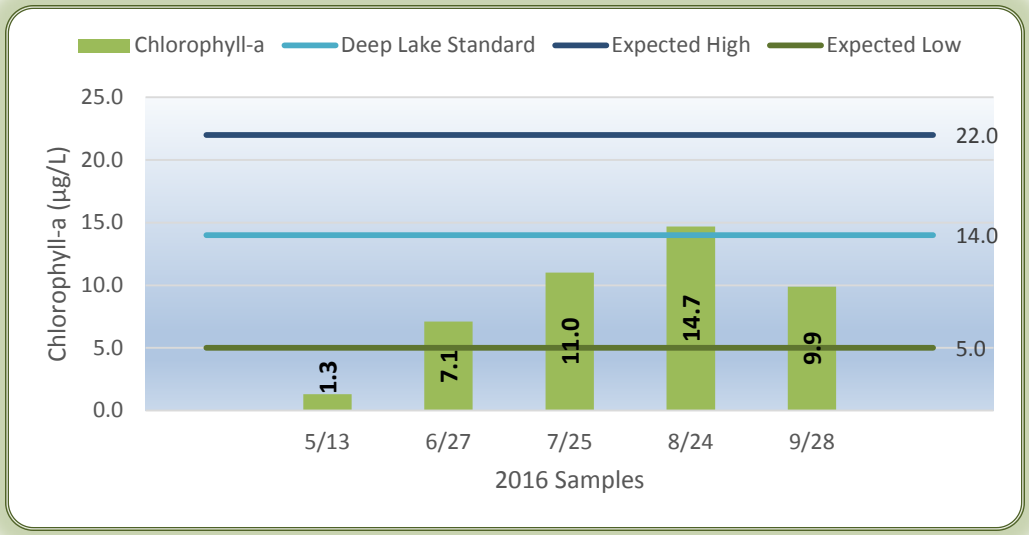
# Kroon Lake

Lake 13-0013-00 Site 202

| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 9 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 51.9 | 51.4 | 52.7 | 52.0 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 8.8 µg/L | 1.8 meters | 29.0 µg/L | - |
| Grade | A | C | B | B |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 10.7 µg/L | 1.5 meters | 31.8 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





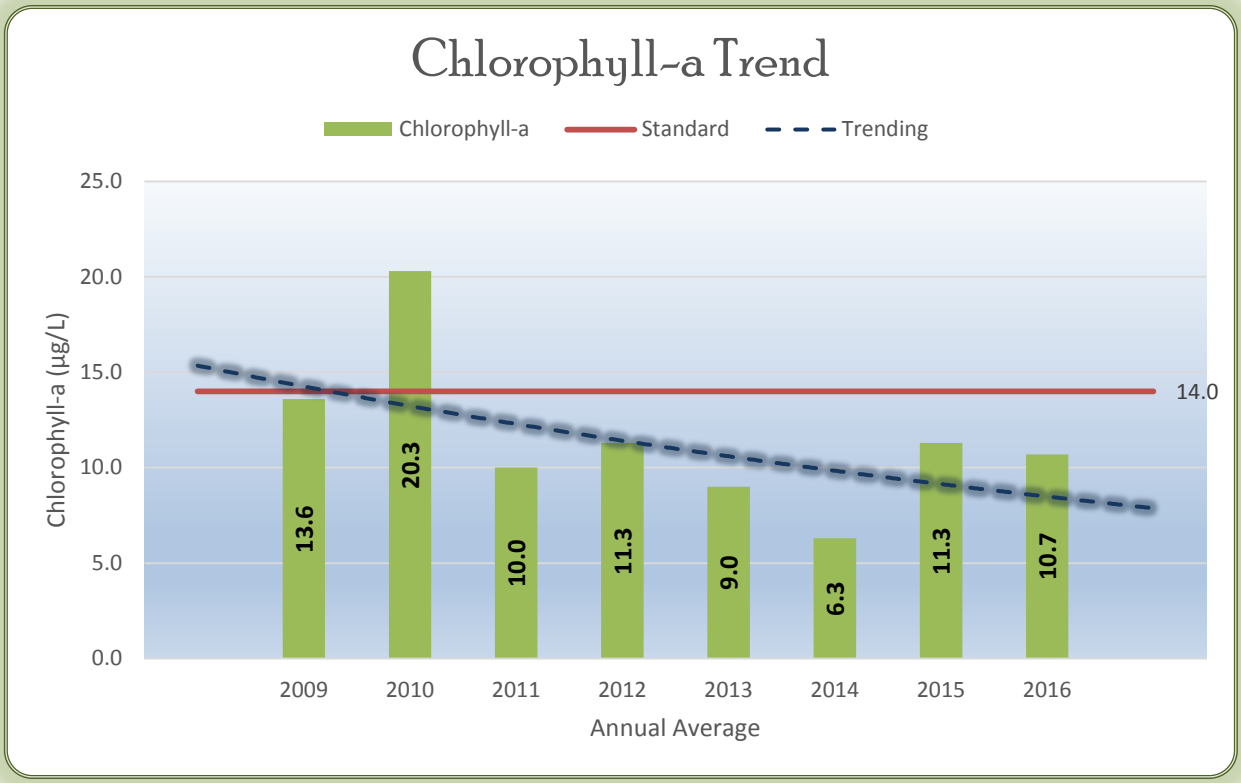

# Chlorophyll-a

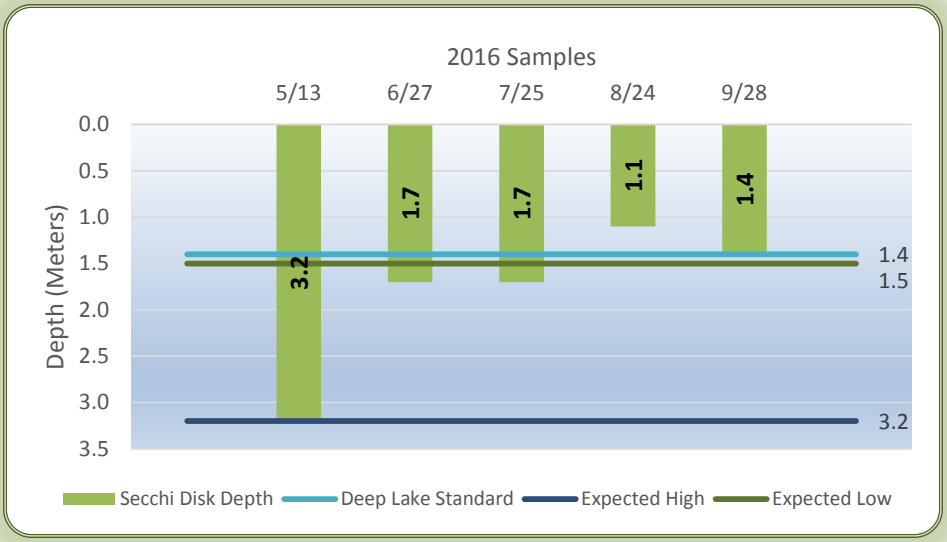
## Kroon Lake

**Expected Range:**
5.0-22.0 µg/L

**Deep Lake Standard:**
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 10.8 | 20.3 | 8.6 | 9.8 | 7.4 | 5.6 | 9.4 | 8.8 |
| Grade | B | C | A | A | A | A | A | A |
| June-Sept Average (µg/L) | 13.6 | 20.3 | 10.0 | 11.3 | 9.0 | 6.3 | 11.3 | 10.7 |
| Meets Standard (14.0 µg/L) | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes |





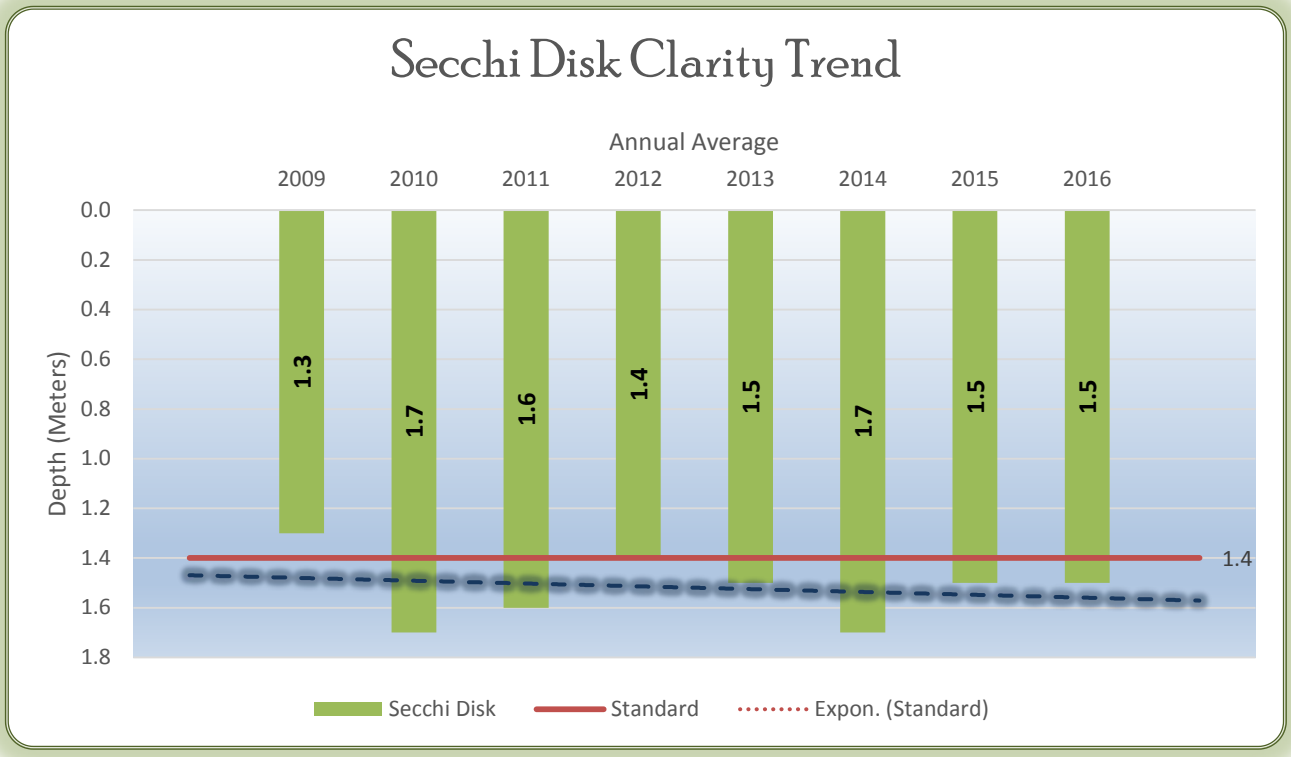

# Secchi Disk Depth

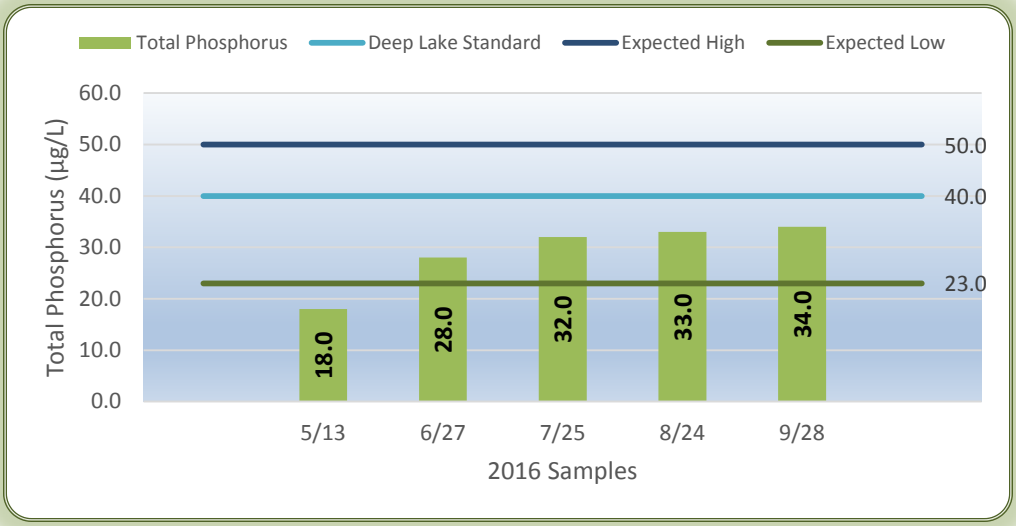
## Kroon Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | 1.9 | 1.7 | 2.0 | 1.7 | 2.0 | 1.8 | 1.7 | 1.8 |
| Grade | C | C | C | C | C | C | C | C |
| June-Sept Average (Meters) | 1.3 | 1.7 | 1.6 | 1.4 | 1.5 | 1.7 | 1.5 | 1.5 |
| Meets Standard (>1.4 meters ) | No | Yes | Yes | No | Yes | Yes | Yes | Yes |





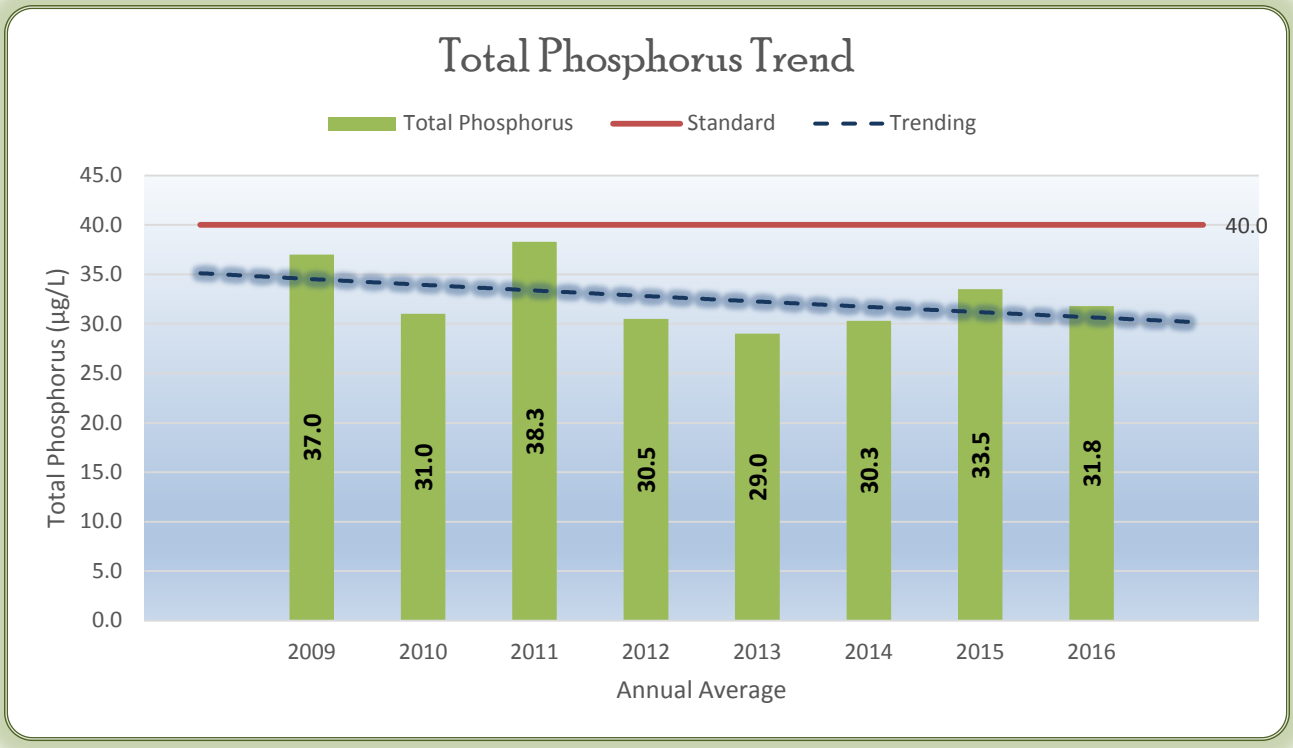

# Total Phosphorus

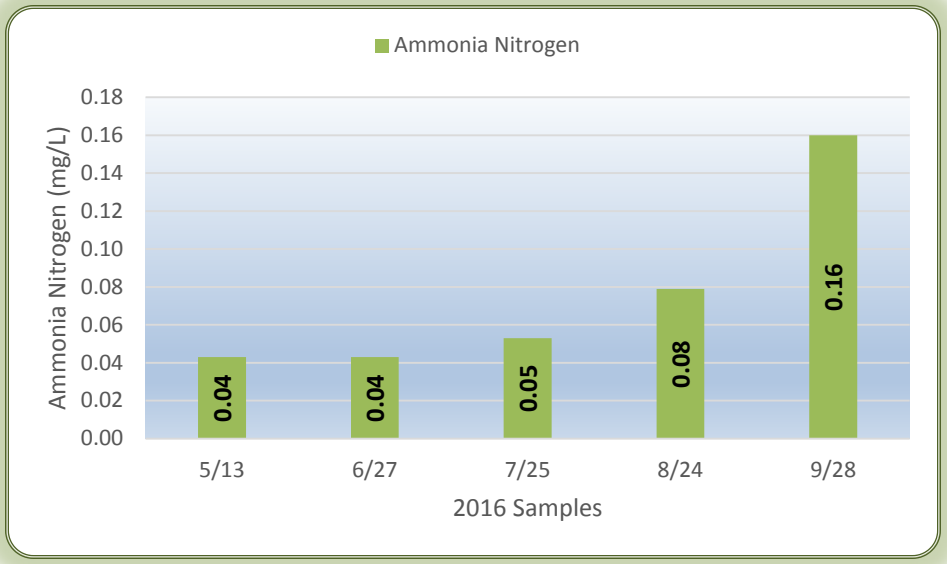
## Kroon Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 35.0 | 31.0 | 35.6 | 28.8 | 28.2 | 30.2 | 31.6 | 29.0 |
| Grade | C | B | C | B | B | B | B | B |
| June-Sept Average (µg/L) | 37.0 | 31.0 | 38.3 | 30.5 | 29.0 | 30.3 | 33.5 | 31.8 |
| Meets Standard (40.0 µg/L) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |





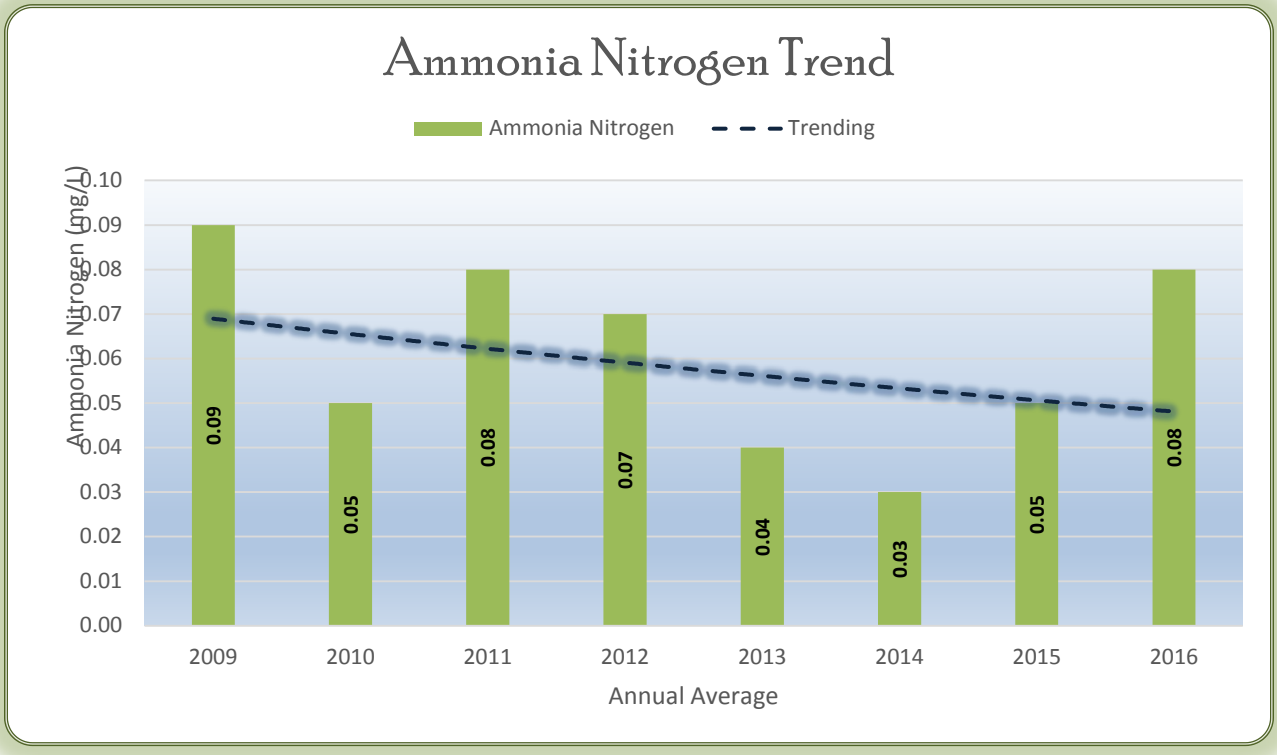

# Ammonia Nitrogen

## Kroon Lake

**Expected Range:**
None

**Deep Lake Standard:**
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | 0.09 | <0.05 | 0.08 | 0.07 | 0.04 | 0.03 | 0.05 | 0.08 |



General Observations
Kroon Lake

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Malted |  |
| June | 2<br>Low Algae | 2<br>Good | Dried Chamomile |  |
| July | 3<br>Medium Algae | 3<br>Fair | Dried Chamomile |  |
| August | 3<br>Medium Algae | 3<br>Fair | Beach Grass |  |
| September | 2<br>Low Algae | 2<br>Good | Dried Chamomile |  |

# Explanation of Color Classification

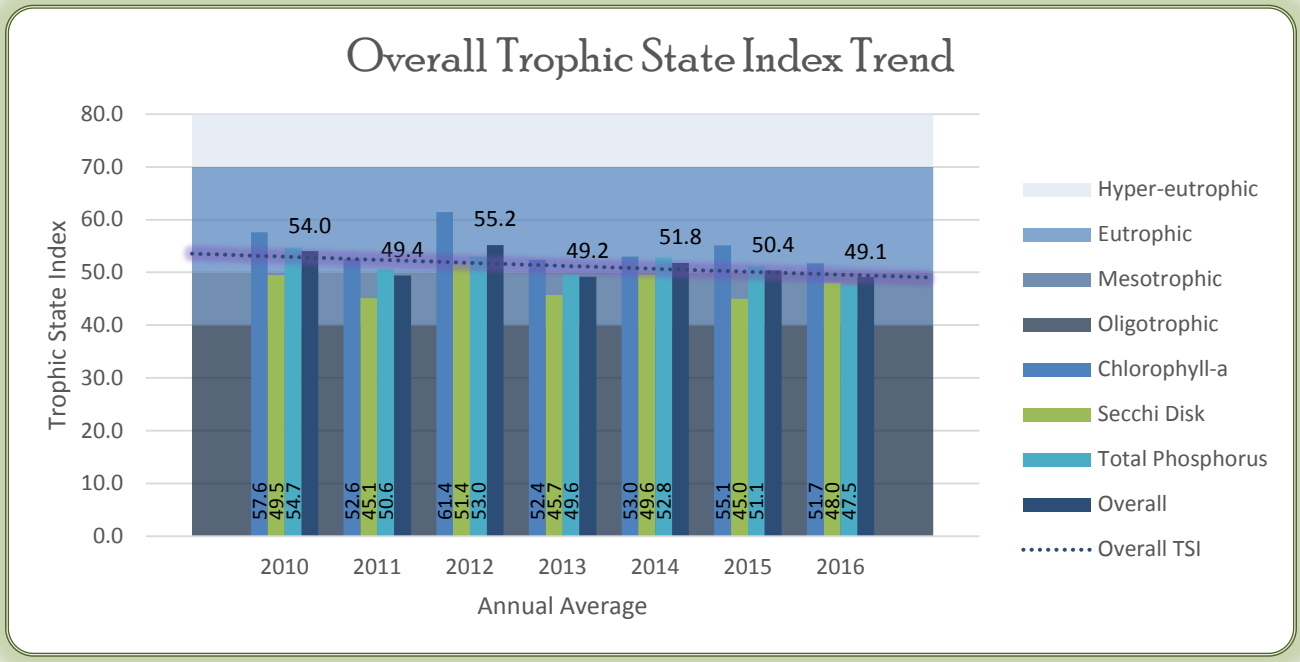
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

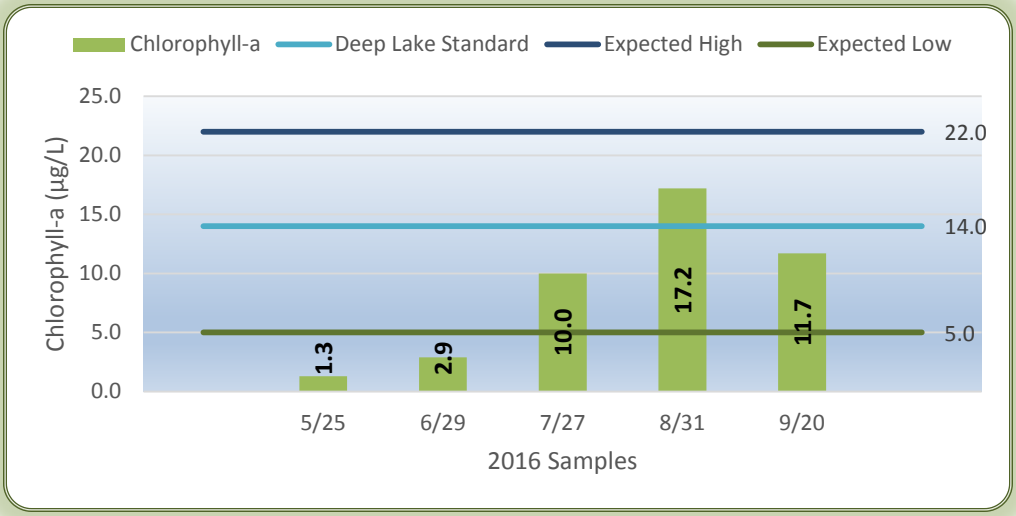
# North Lindstrom Lake

Lake 13-0035-00 Site 201

| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Mesotrophic |
| Overall Lake Quality Grade | A- |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 7 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 51.7 | 48.0 | 47.5 | 49.1 |
| Classification | Eutrophic | Mesotrophic | Mesotrophic | Mesotrophic |
| 2016 Average (May-Sept) | 8.6 µg/L | 2.3 meters | 20.2 µg/L | - |
| Grade | A | B | A | A- |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 10.5 µg/L | 1.9 meters | 21.8 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





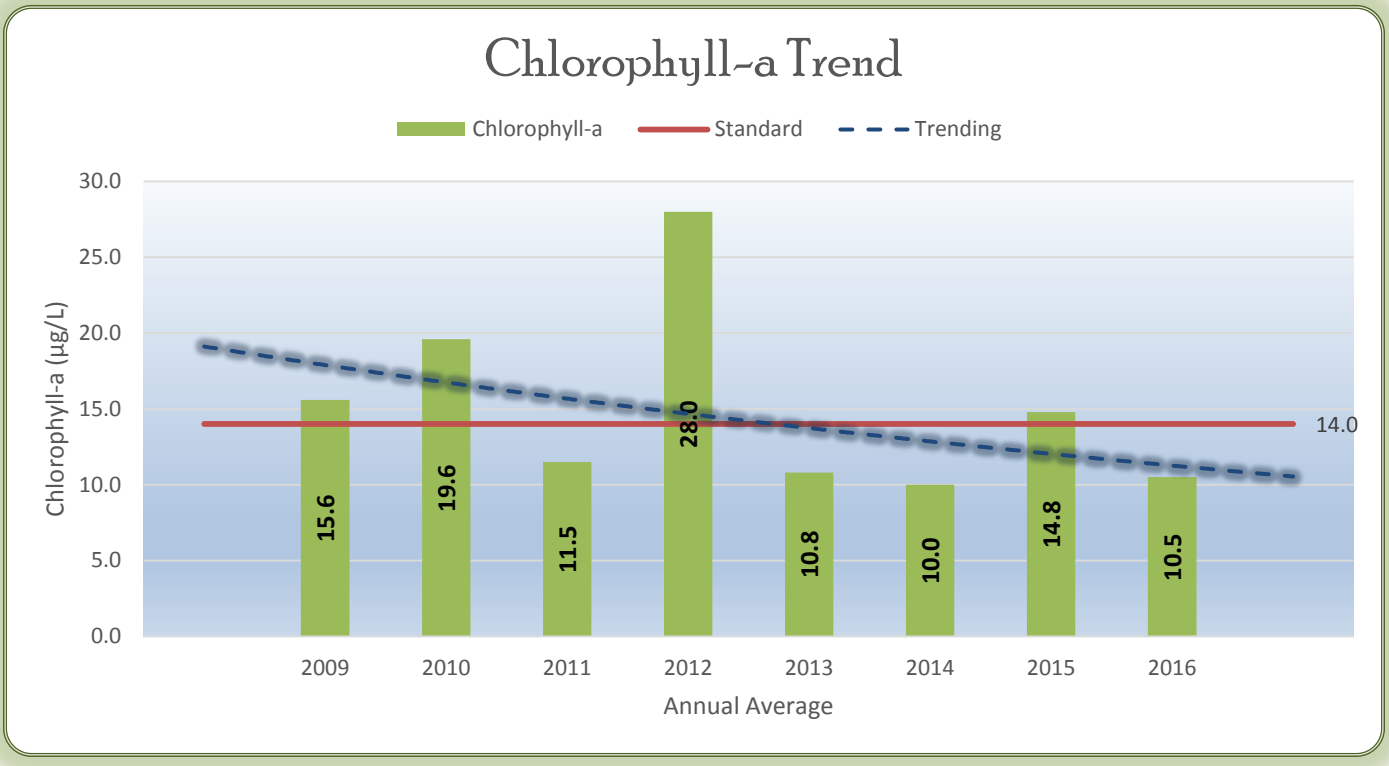

# Chlorophyll-a

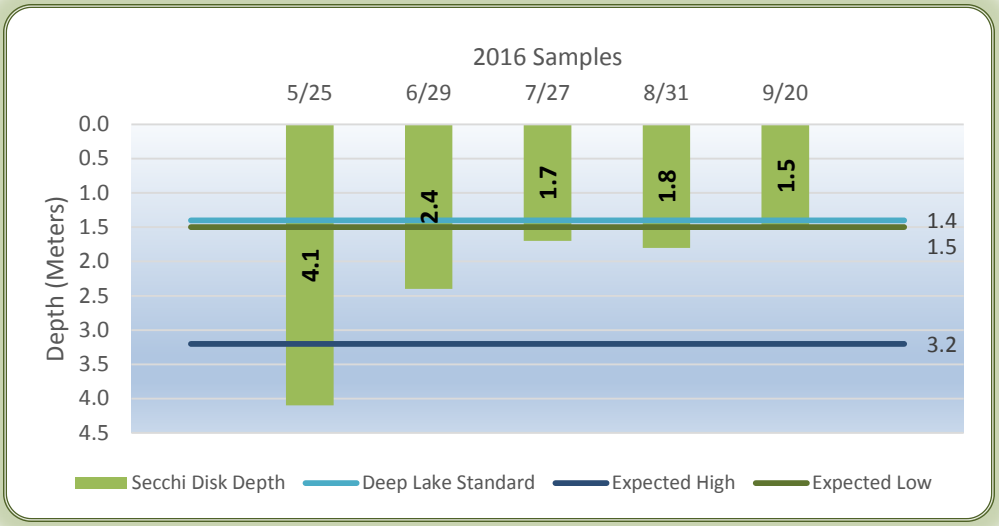
## North Lindstrom Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 14.0 | 17.7 | 9.4 | 23.0 | 9.2 | 9.8 | 12.2 | 8.6 |
| Grade | B | B | A | C | A | A | B | A |
| June-Sept Average (µg/L) | 15.6 | 19.6 | 11.5 | 28.0 | 10.8 | 12.0 | 14.8 | 10.5 |
| Meets Standard (14.0 µg/L) | No | No | Yes | No | Yes | Yes | No | Yes |





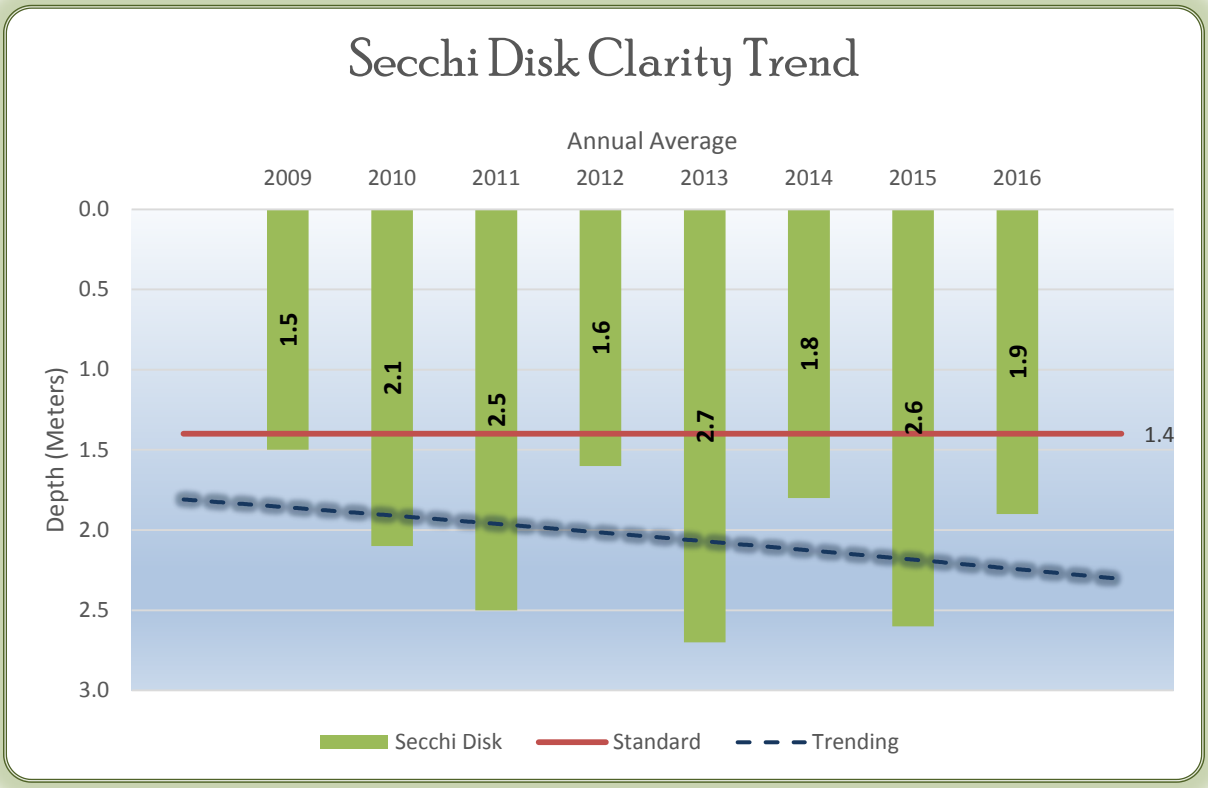

# Secchi Disk Depth

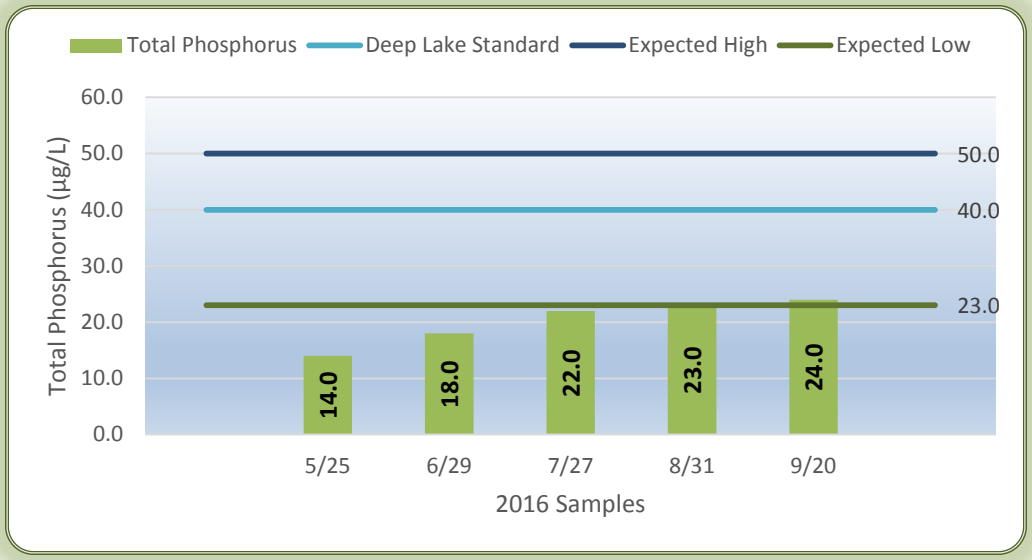
## North Lindstrom Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | 2.0 | 2.1 | 2.8 | 1.8 | 2.7 | 2.1 | 2.8 | 2.3 |
| Grade | C | C | B | C | B | C | B | B |
| June-Sept Average (Meters) | 1.5 | 2.1 | 2.5 | 1.6 | 2.7 | 1.8 | 2.6 | 1.9 |
| Meets Standard (>1.4 meters ) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |





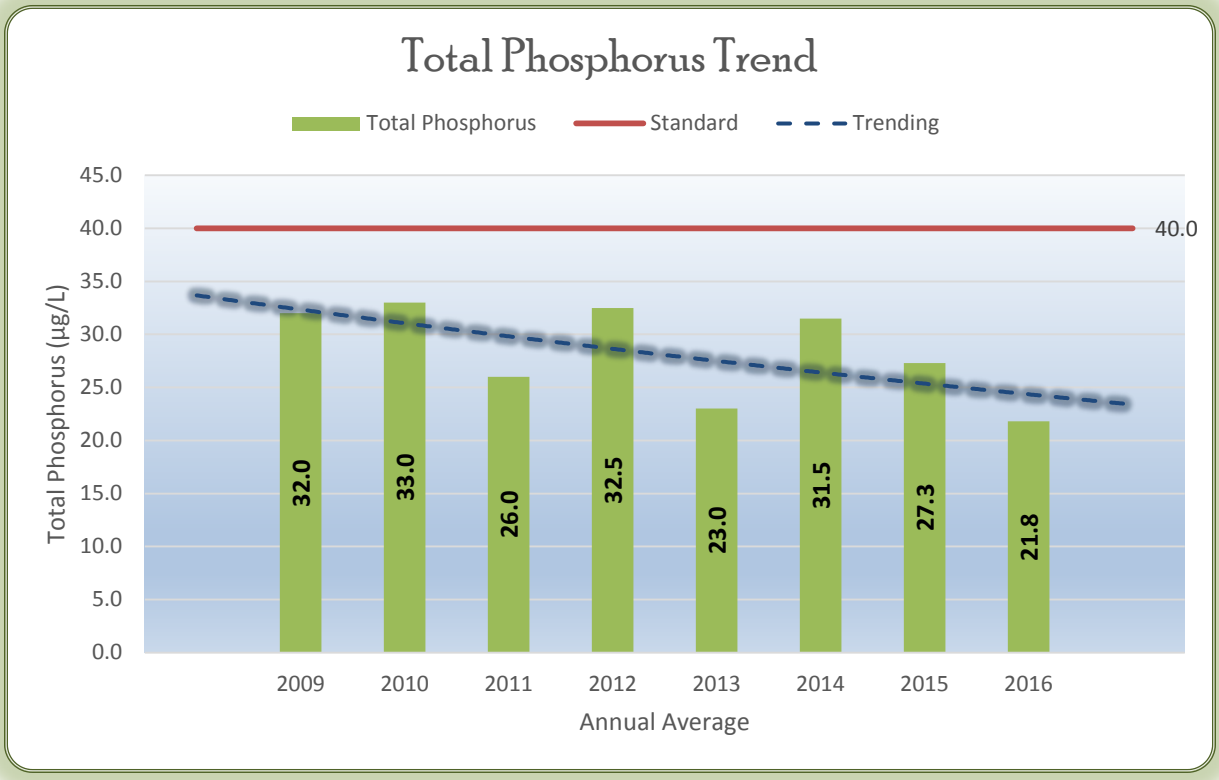

# Total Phosphorus

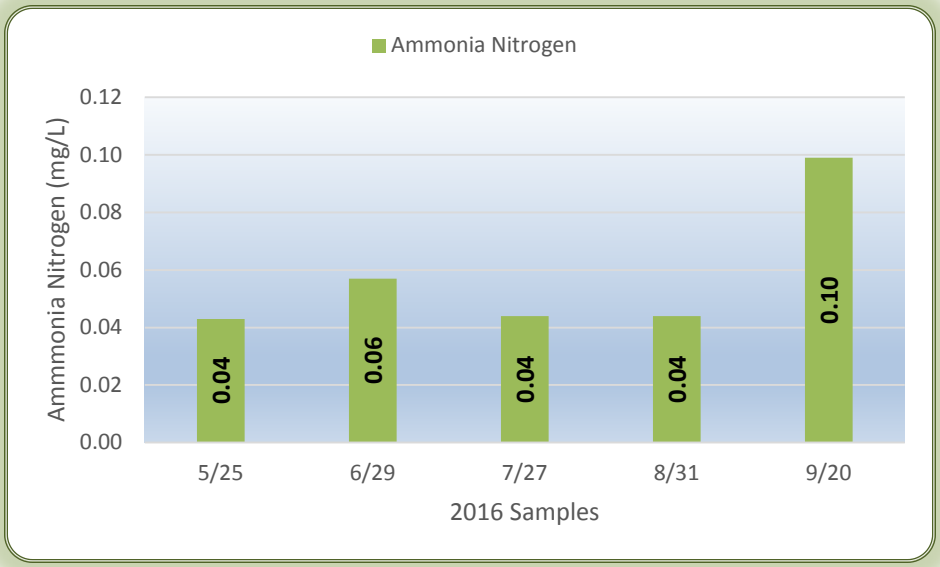
## North Lindstrom Lake

Expected Range
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 33.0 | 34.0 | 25.0 | 29.6 | 23.4 | 29.2 | 26.0 | 20.2 |
| Grade | C | C | B | B | B | B | B | A |
| June-Sept Average (µg/L) | 32.0 | 33.0 | 26.0 | 32.5 | 23.0 | 31.5 | 27.3 | 21.8 |
| Meets Standard (40.0 µg/L) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |





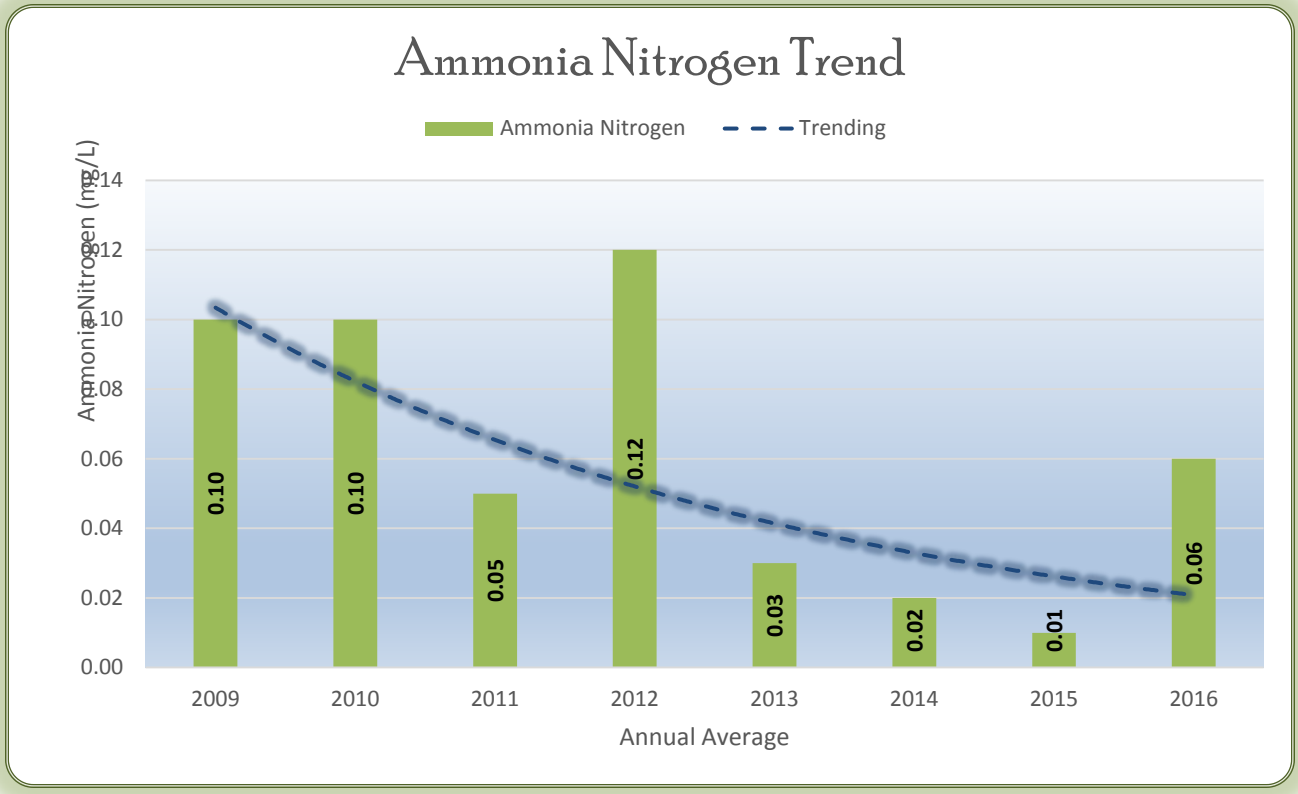

# Ammonia Nitrogen

## North Lindstrom Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | 0.10 | 0.10 | 0.05 | 0.12 | 0.03 | 0.02 | 0.01 | 0.06 |



General Observations
North Lindstrom Lake

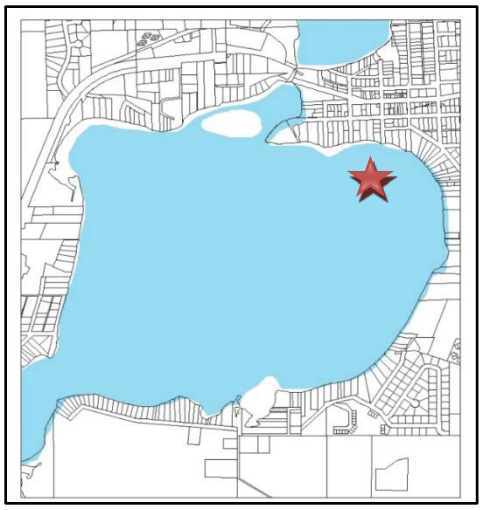
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Macadamia | |
| June | 2<br>Low Algae | 2<br>Good | Bamboo | |
| July | 2<br>Low Algae | 2<br>Good | Malted | |
| August | 2<br>Low Algae | 2<br>Good | Calabash | |
| September | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

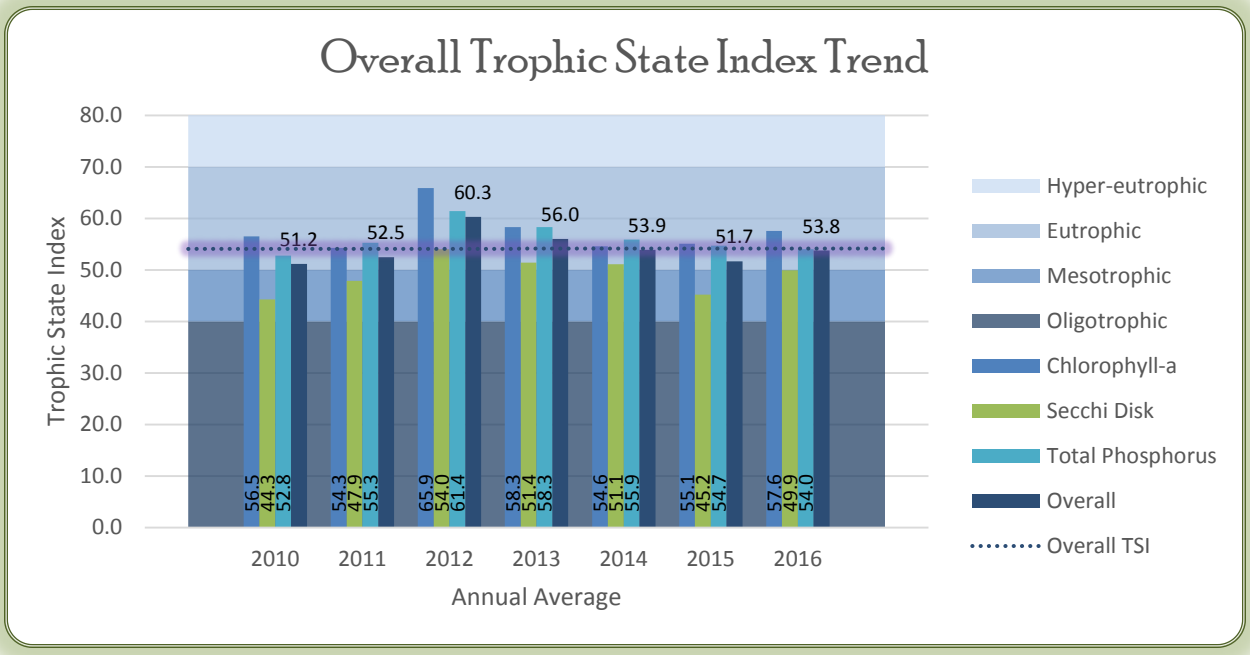
# South Lindstrom Lake

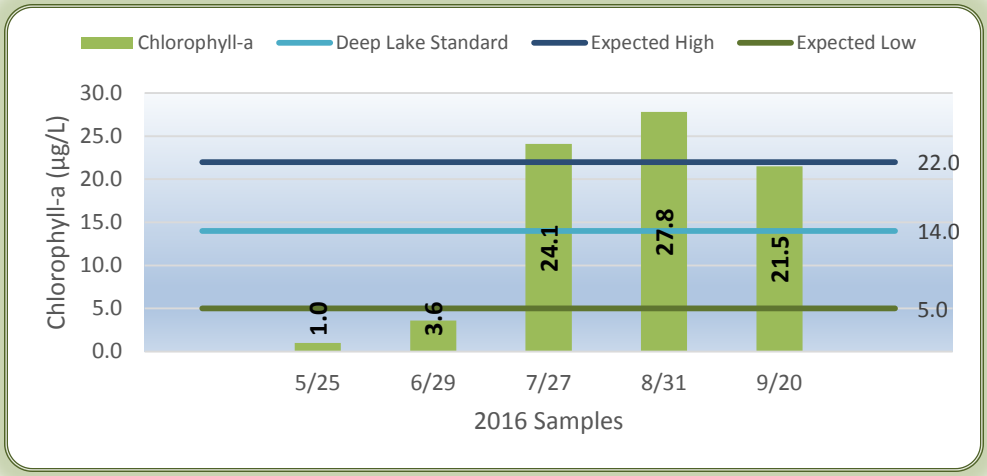
Lake 13-0028-00 Site 203



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 12 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 57.6 | 49.9 | 54.0 | 53.8 |
| Classification | Eutrophic | Mesotrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 15.6 µg/L | 2.0 meters | 31.8 µg/L | - |
| Grade | B | C | B | B |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 19.3 µg/L | 1.6 meters | 36.0 µg/L | - |
| Meets Standard | No | Yes | Yes | Yes |





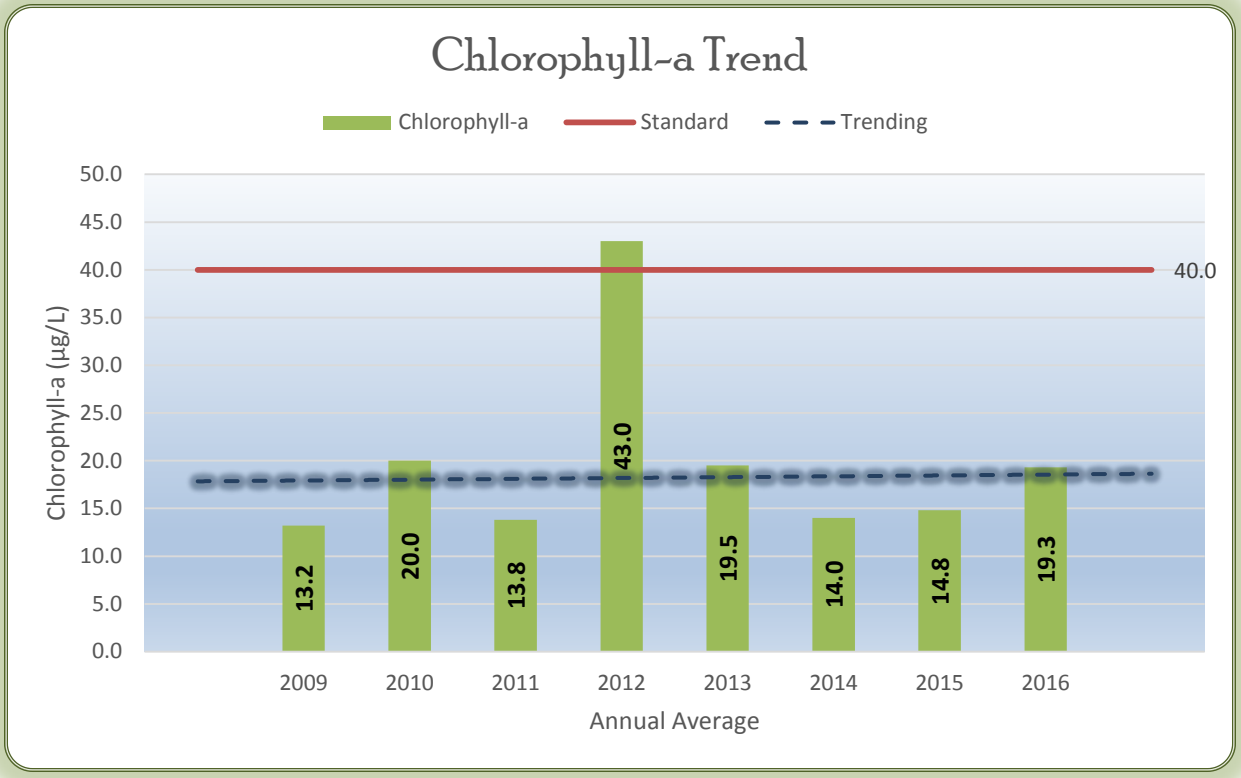

# Chlorophyll-a

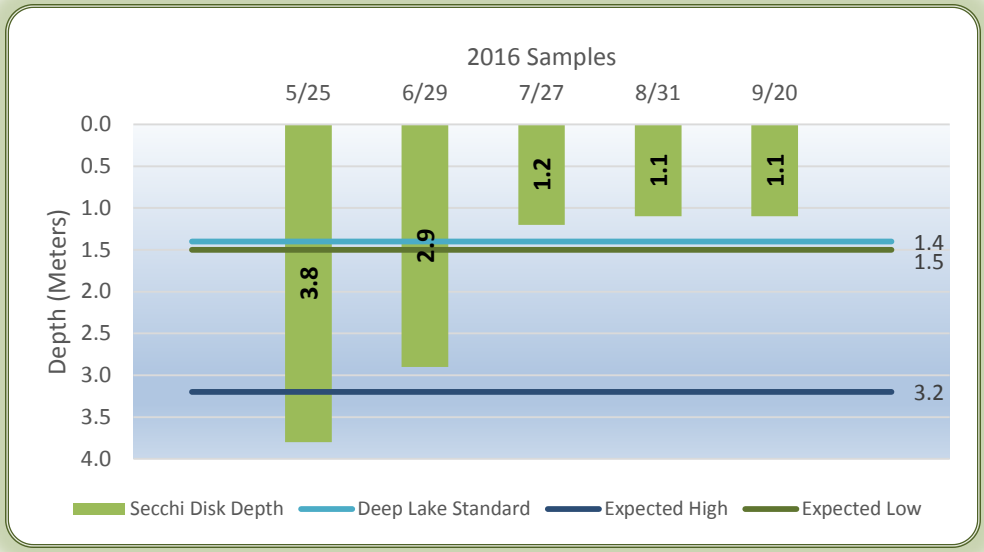
## South Lindstrom Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 11.8 | 20.0 | 11.2 | 35.0 | 16.8 | 11.6 | 12.2 | 15.6 |
| Grade | B | B | B | C | B | B | B | B |
| June-Sept Average (µg/L) | 13.2 | 20.0 | 13.8 | 43.0 | 19.5 | 14.0 | 14.8 | 19.3 |
| Meets Standard (14.0 µg/L) | Yes | No | Yes | No | No | Yes | No | No |





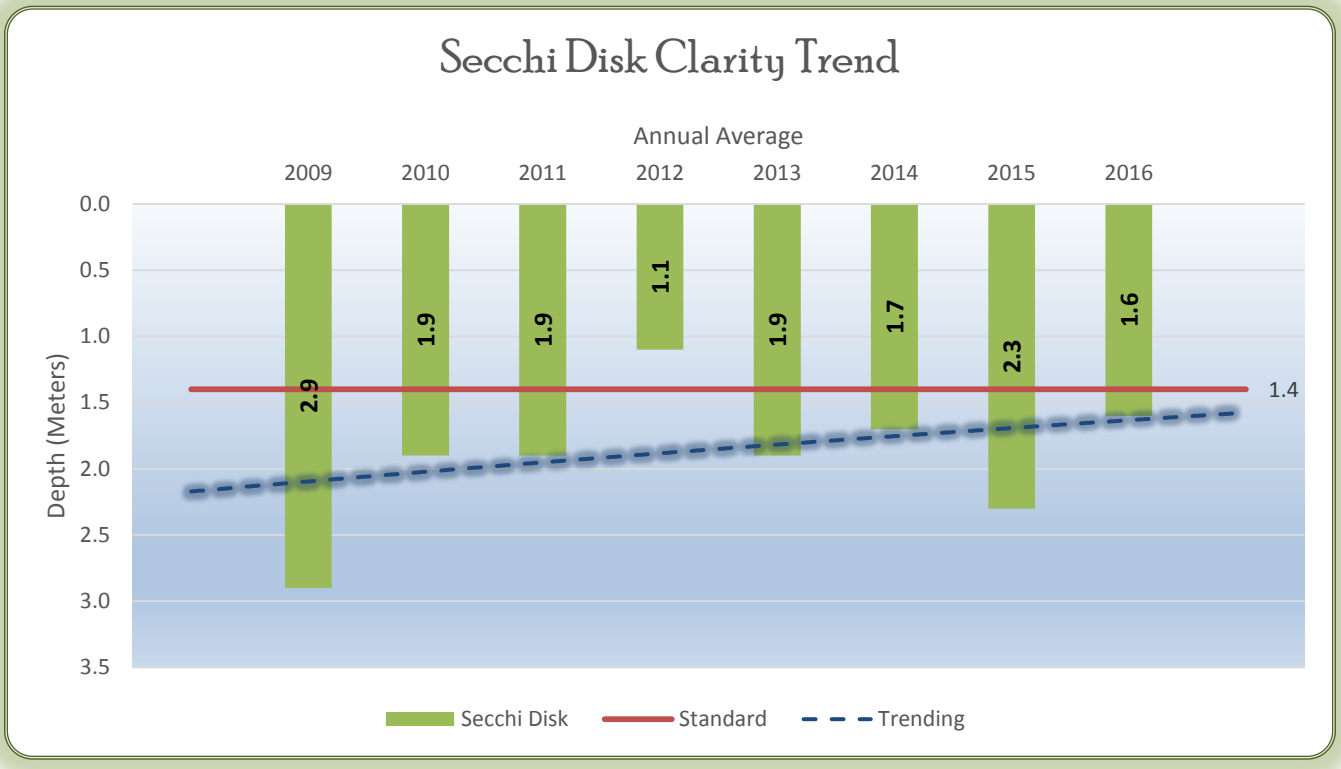

# Secchi Disk Depth

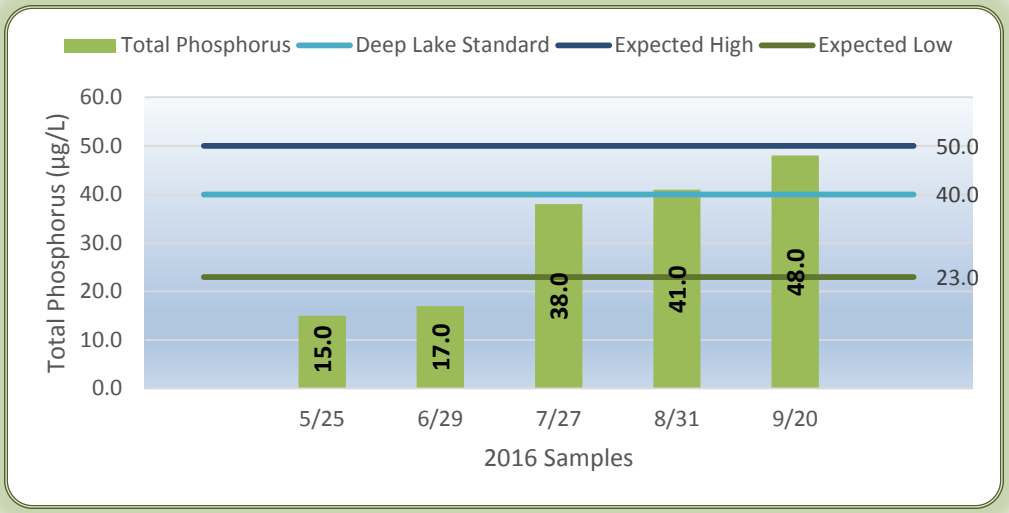
## South Lindstrom Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | 3.3 | 1.9 | 2.3 | 1.5 | 1.8 | 1.9 | 2.8 | 2.0 |
| Grade | A | C | B | C | C | C | B | C |
| June-Sept Average (Meters) | 2.9 | 1.9 | 1.9 | 1.1 | 1.9 | 1.7 | 2.3 | 1.6 |
| Meets Standard (>1.4 meters ) | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |





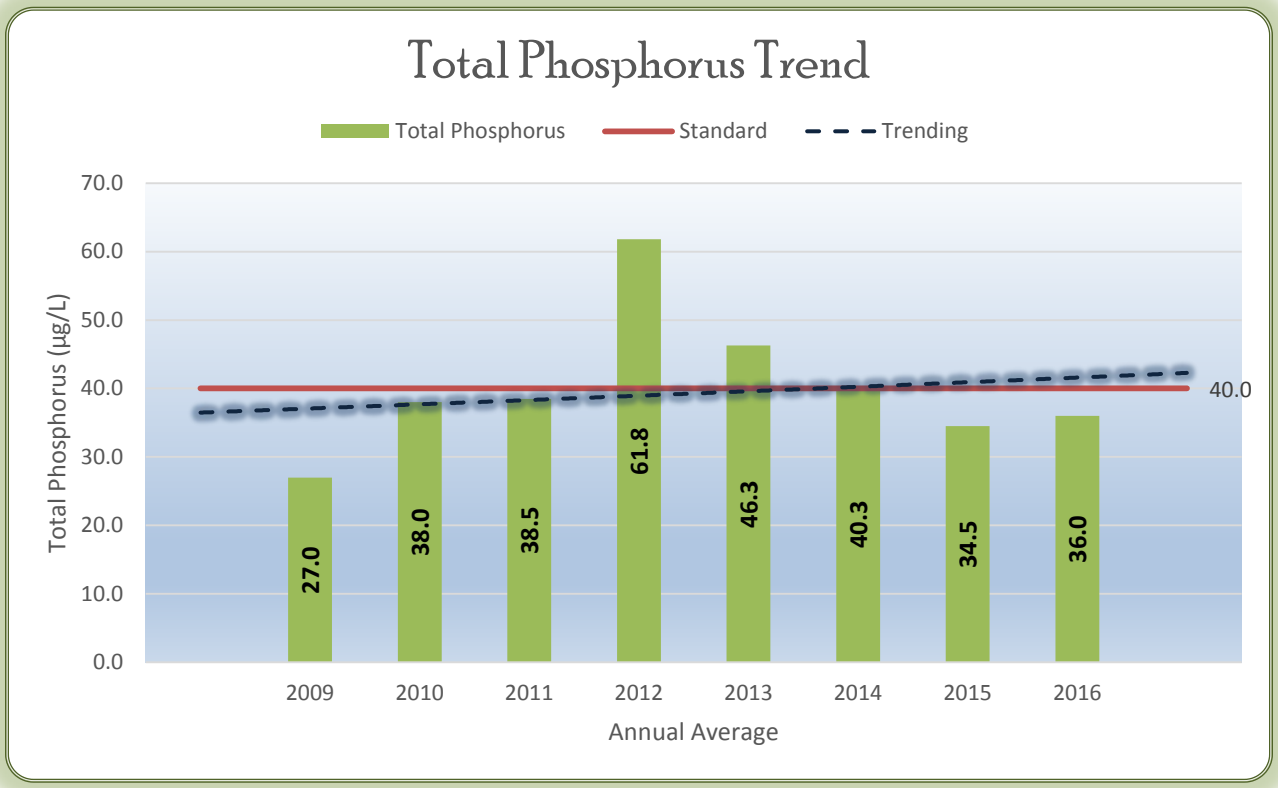

# Total Phosphorus

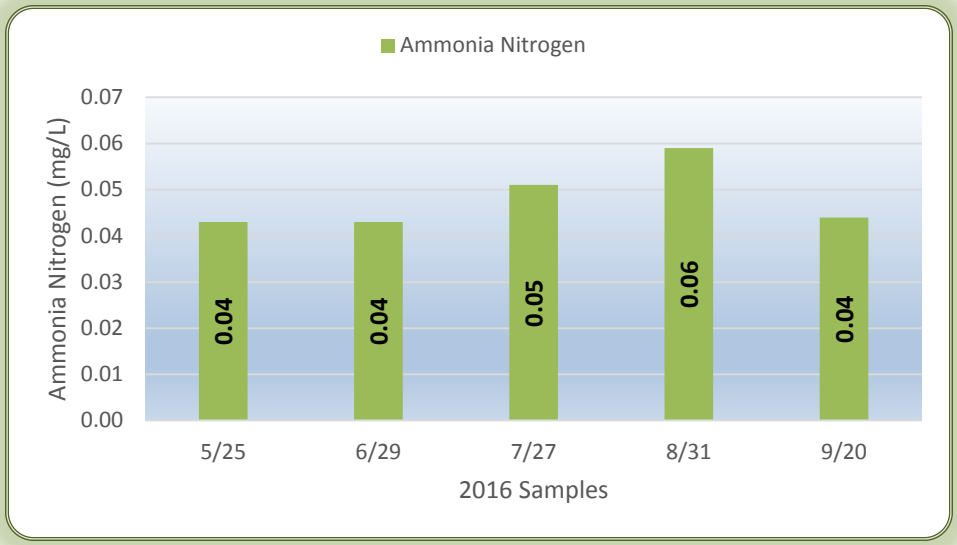
## South Lindstrom Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 26.0 | 38.0 | 34.6 | 53.0 | 42.6 | 36.2 | 33.2 | 31.8 |
| Grade | B | C | C | C | C | C | C | B |
| June-Sept Average (µg/L) | 27.0 | 38.0 | 38.5 | 61.8 | 46.3 | 40.3 | 34.5 | 36.0 |
| Meets Standard (40.0 µg/L) | Yes | Yes | Yes | No | No | No | Yes | Yes |





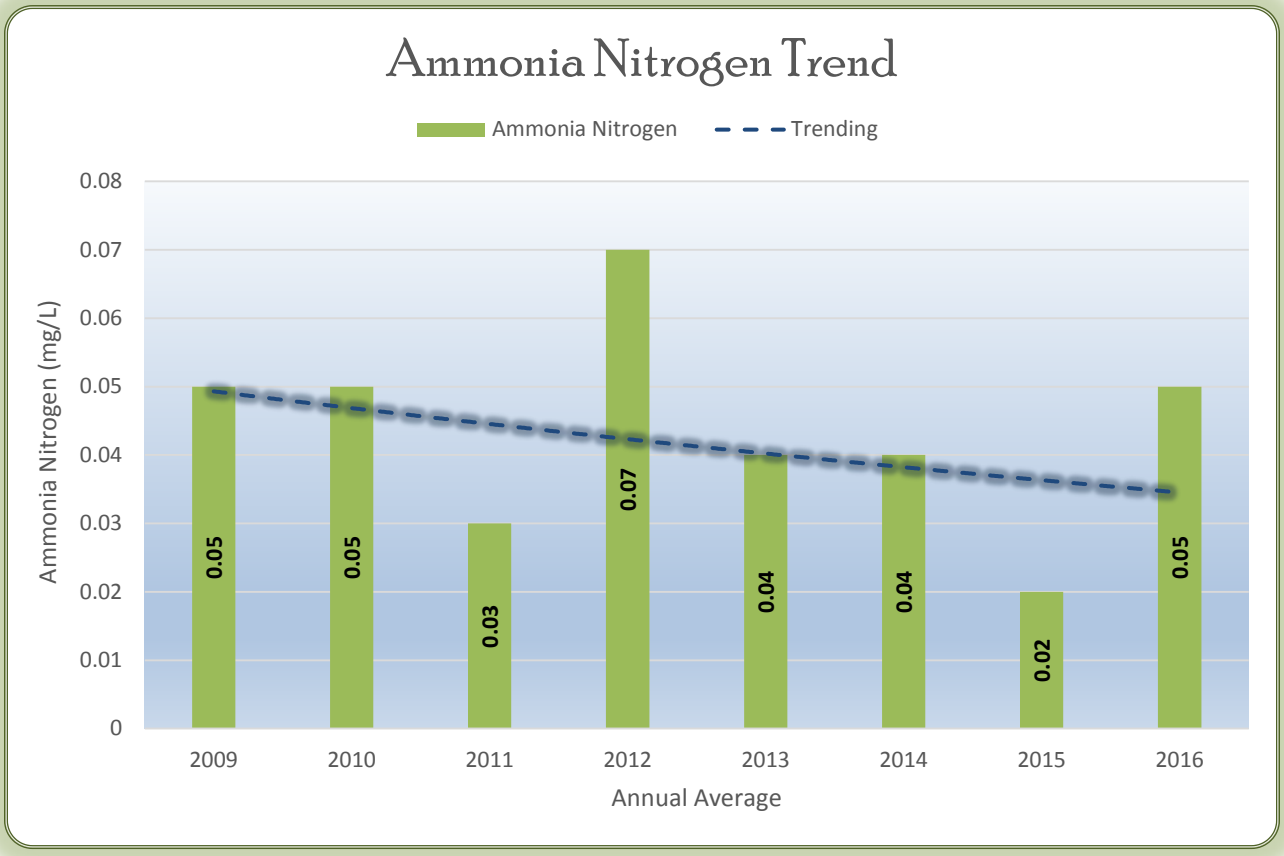

# Ammonia Nitrogen

## South Lindstrom Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | <0.05 | <0.05 | 0.03 | 0.07 | 0.04 | 0.04 | 0.02 | 0.05 |



General Observations
South Lindstrom Lake

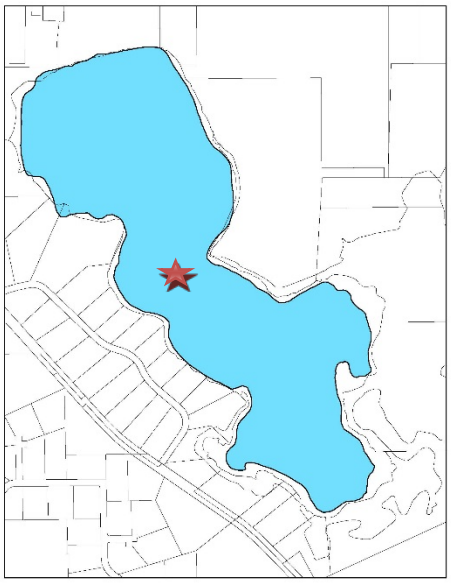
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Macadamia | |
| June | 2<br>Low Algae | 2<br>Good | Chopstick | |
| July | 3<br>Medium Algae | 3<br>Fair | Sultana | |
| August | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| September | 4<br>High Algae | 4<br>Poor | Beach Grass | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

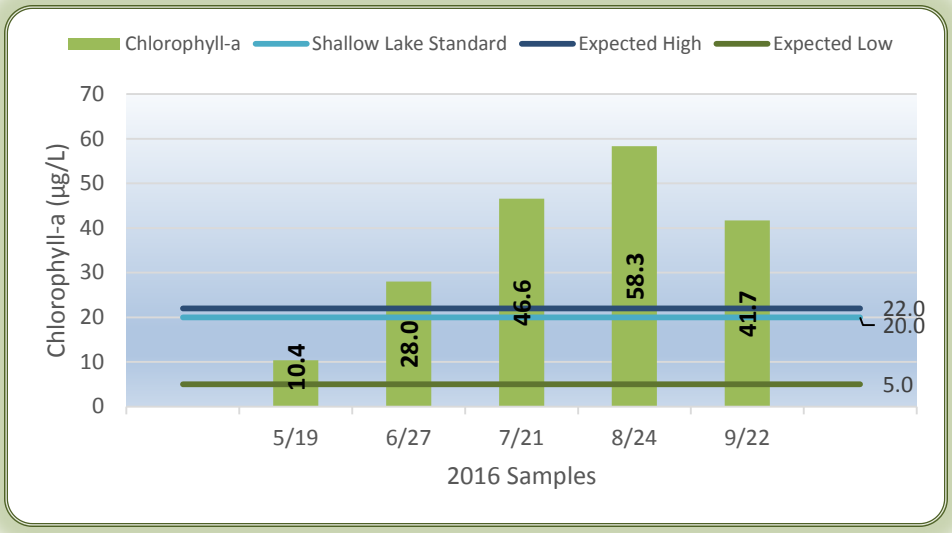
# Linn Lake

Lake 13-0014-00 Site 201



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | D |
| Meets MPCA Standards | No |
| 2016 Ranking | 26 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 66.0 | 63.3 | 66.2 | 65.5 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 37.0 µg/L | 0.7 meters | 74.0 µg/L | - |
| Grade | C | D | D | D |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 43.7 µg/L | 0.7 meters | 79.0 µg/L | - |
| Meets Standard | No | No | No | No |




## Chlorophyll-a

Linn Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

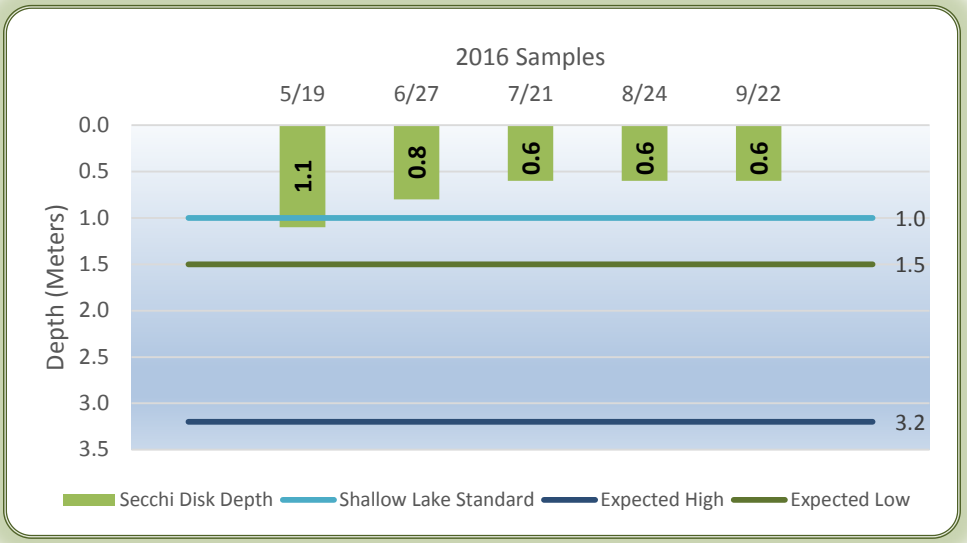
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 20.0 µg/L |
|---|---|---|---|---|
| 2008 | 61.0 | D | 61.0 | No |
| 2009 | 106.6 | F | 118.3 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 37.0 | C | 43.7 | No |

## Secchi Disk Depth

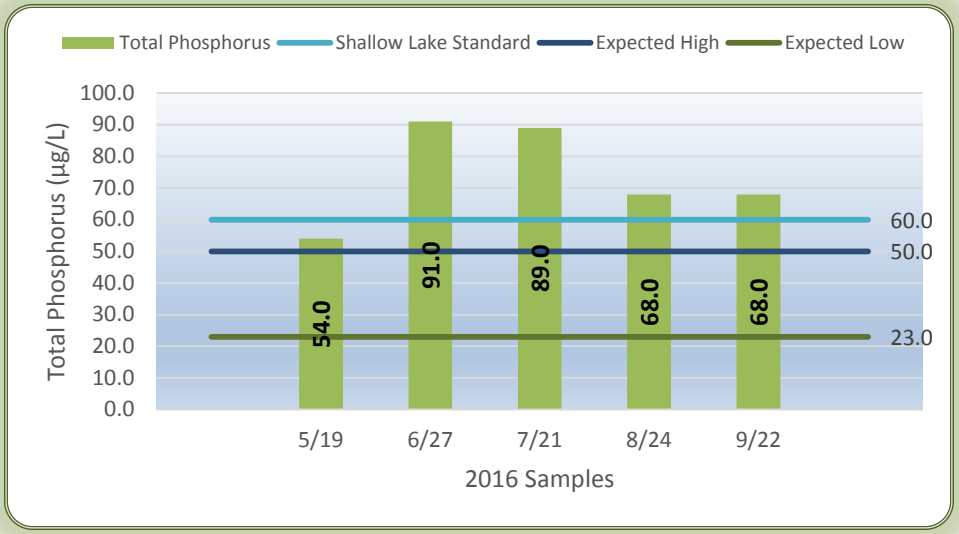
Linn Lake

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1.0 meter |
|---|---|---|---|---|
| 2008 | 0.4 | F | 0.4 | No |
| 2009 | 0.4 | F | 0.4 | No |
| 2010-2015 | No Data | - | Not Data | - |
| 2016 | 0.7 | D | 0.7 | No |




## Total Phosphorus

Linn Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

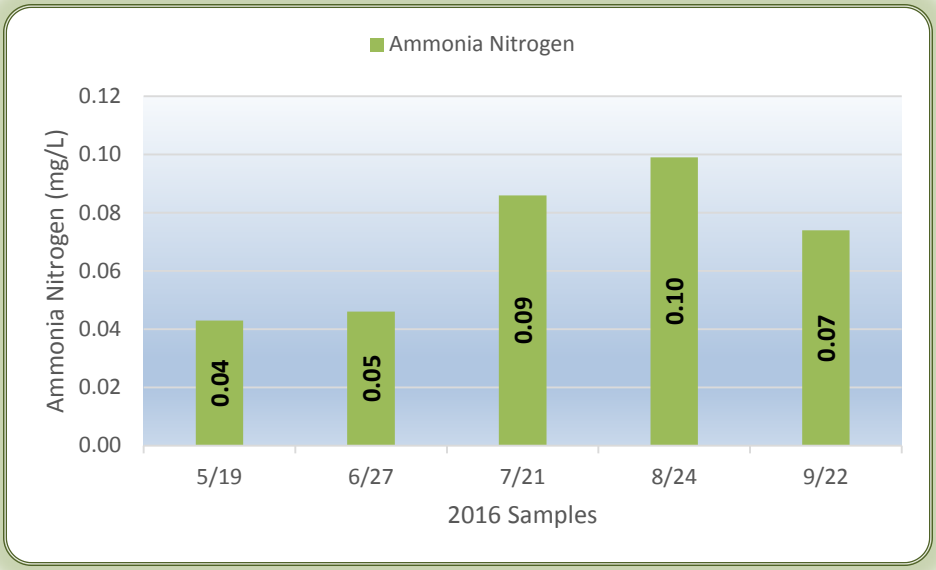
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 60.0 µg/L |
|---|---|---|---|---|
| 2008 | 213.0 | F | 213.2 | No |
| 2009 | 221.8 | F | 222.0 | No |
| 2010-2015 | No Data | - | Not Data | - |
| 2016 | 74.0 | D | 79.0 | No |

## Ammonia Nitrogen

Linn Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average °F | |
|---|---|
| 2008-2015 | No Data |
| 2016 | 70.8 |

General Observations
Linn Lake

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 3<br>Medium Algae | 4<br>Poor | Carton |  |
| June | 3<br>Medium Algae | 4<br>Poor | Cornucopia |  |
| July | 3<br>Medium Algae | 4<br>Poor | Cornichon |  |
| August | 3<br>Medium Algae | 4<br>Poor | Dried Chamomile |  |
| September | 3<br>Medium Algae | 4<br>Poor | Cornucopia |  |

# Explanation of Color Classification

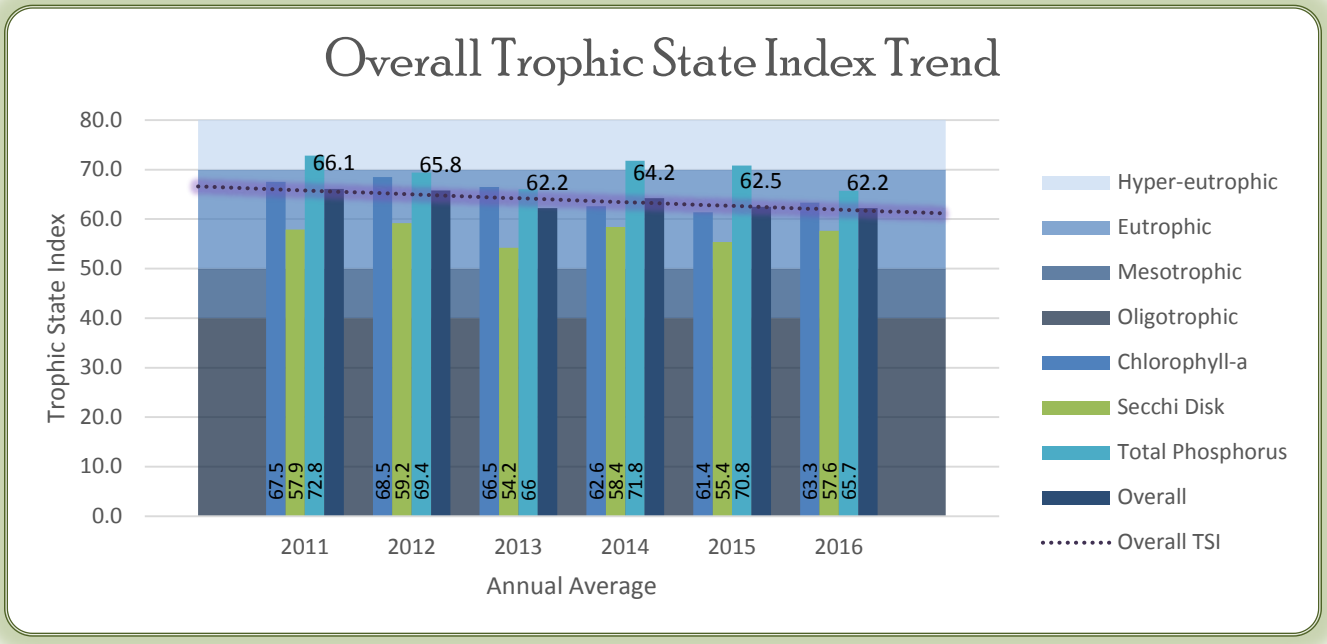
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

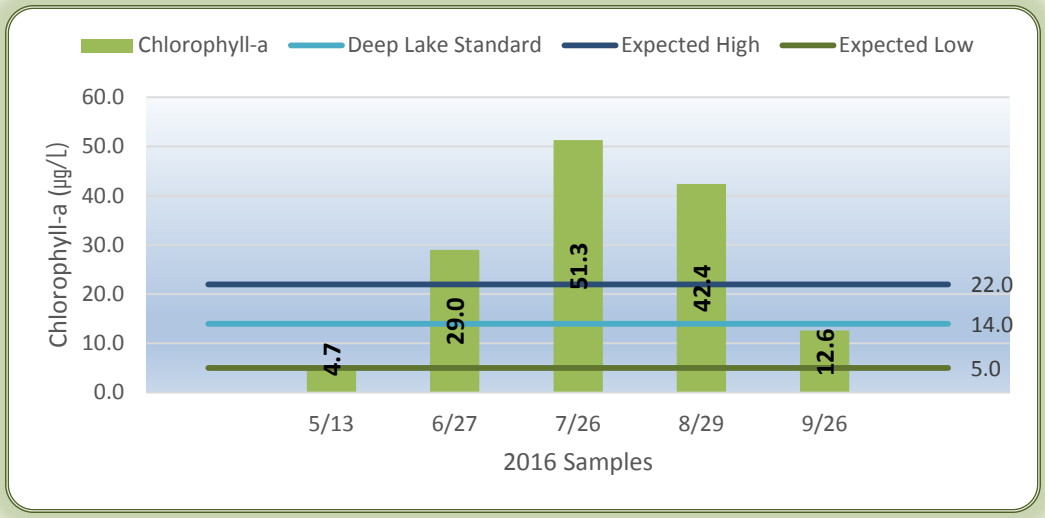
# Little Lake

Lake 13-0033-00 Site 201

| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | No |
| 2016 Ranking | 23 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 63.3 | 57.6 | 65.7 | 62.2 |
| Classification | Eutrophic | Eutrophic | Hyper-eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 28.0 µg/L | 1.2 meters | 71.2 µg/L | - |
| Grade | C | C | D | C |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 33.8 µg/L | 1.0 meter | 74.8 µg/L | - |
| Meets Standard | No | No | No | No |





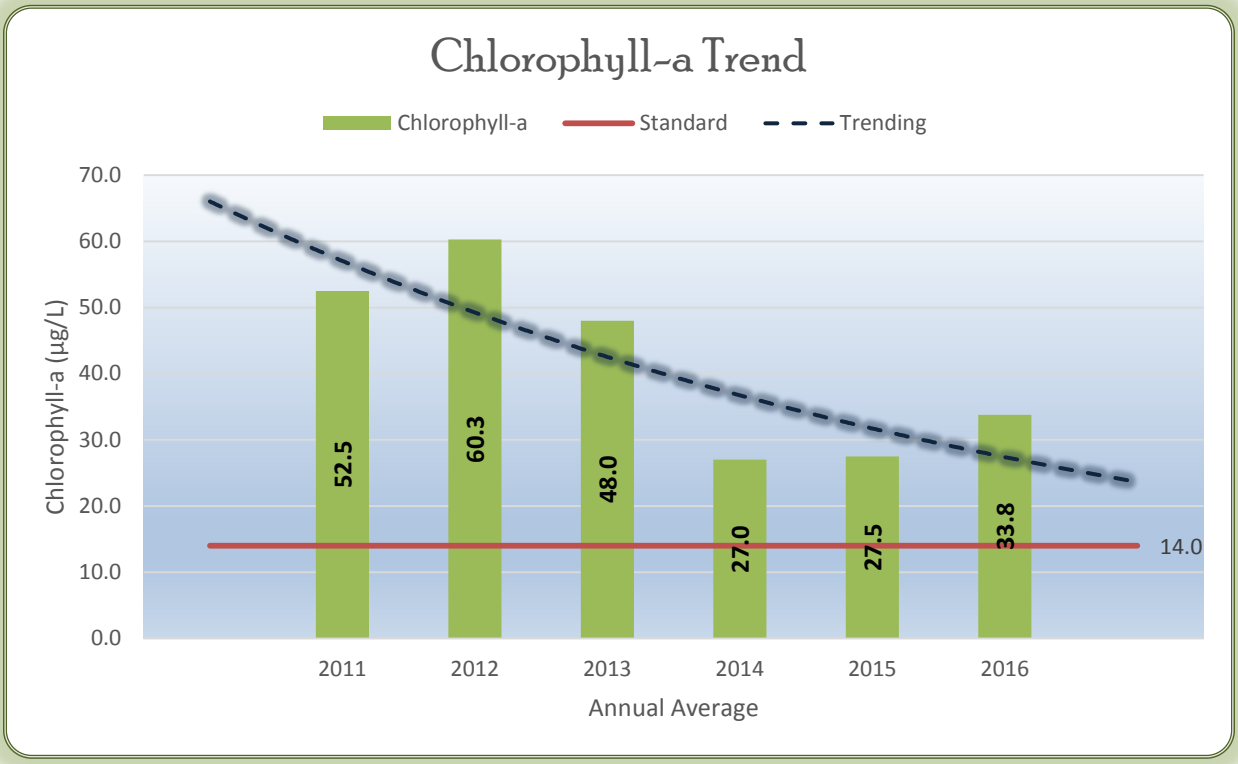

# Chlorophyll-a

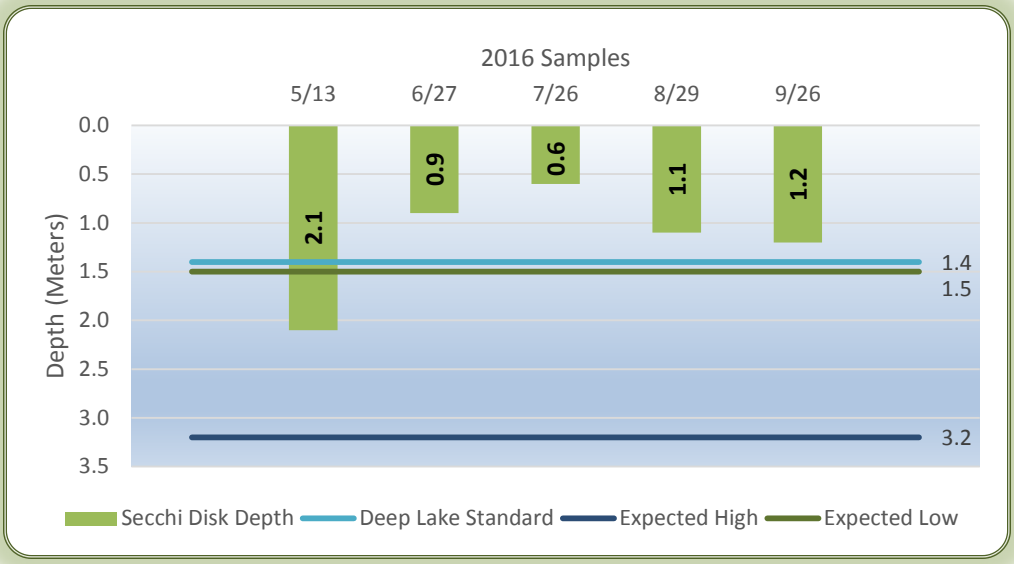
## Little Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | 43.2 | 49.0 | 38.8 | 26.0 | 23.2 | 28.0 |
| Grade | - | - | C | D | C | C | C | C |
| June-Sept Average (µg/L) | No Data | No Data | 52.5 | 60.3 | 48.0 | 27.0 | 27.5 | 33.8 |
| Meets Standard (14.0 µg/L) | - | - | No | No | No | No | No | No |





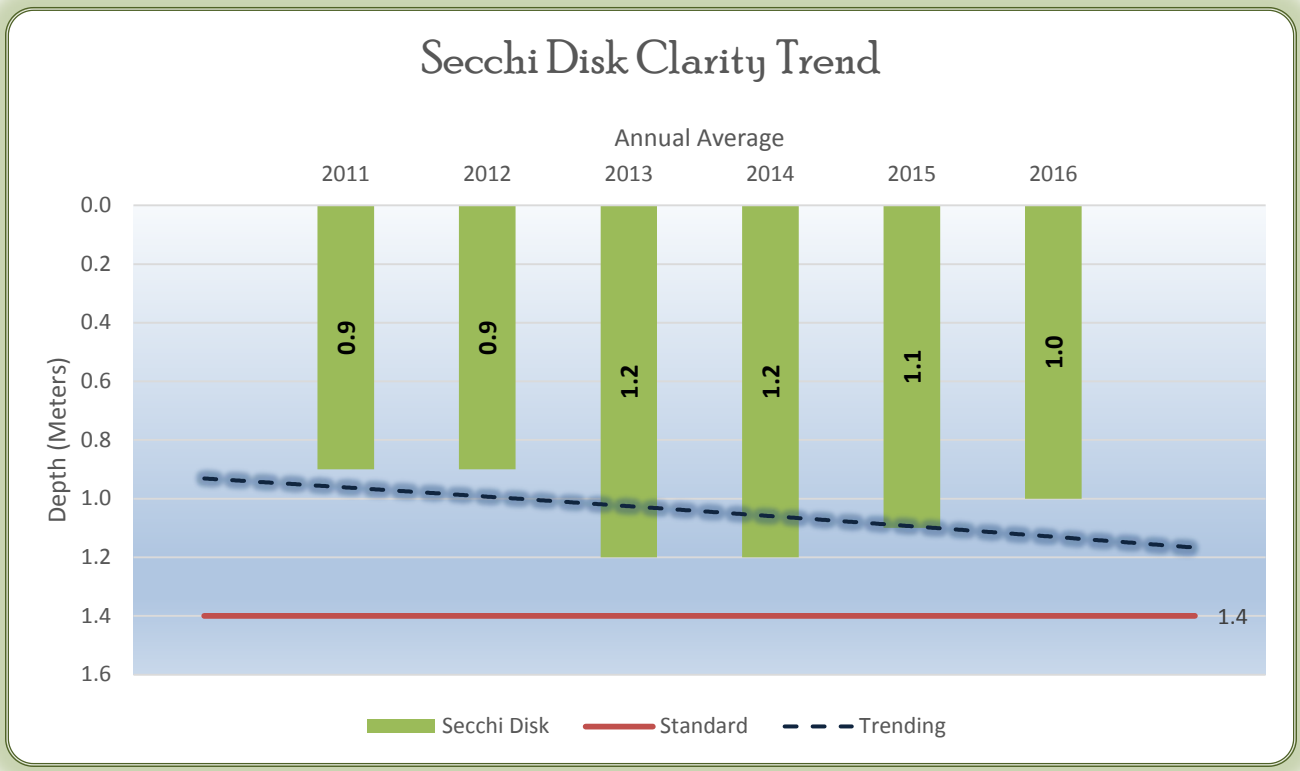

# Secchi Disk Depth

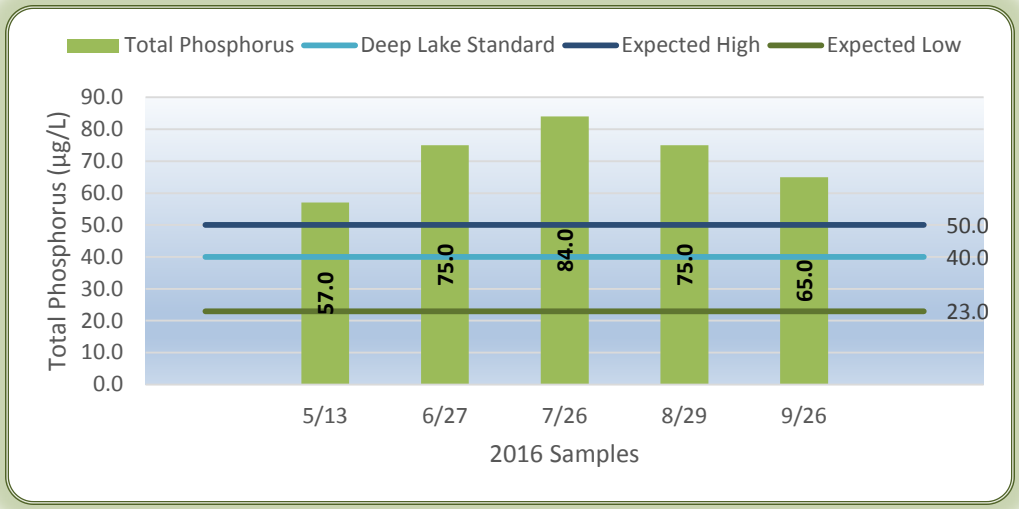
## Little Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | 1.2 | 1.8 | 1.5 | 1.1 | 1.4 | 1.2 |
| Grade | - | - | C-D | D | C | D | C | C-D |
| June-Sept Average (Meters) | No Data | No Data | 0.9 | 0.9 | 1.2 | 1.2 | 1.1 | 1.0 |
| Meets Standard (>1.4 meters) | - | - | No | No | No | No | No | No |





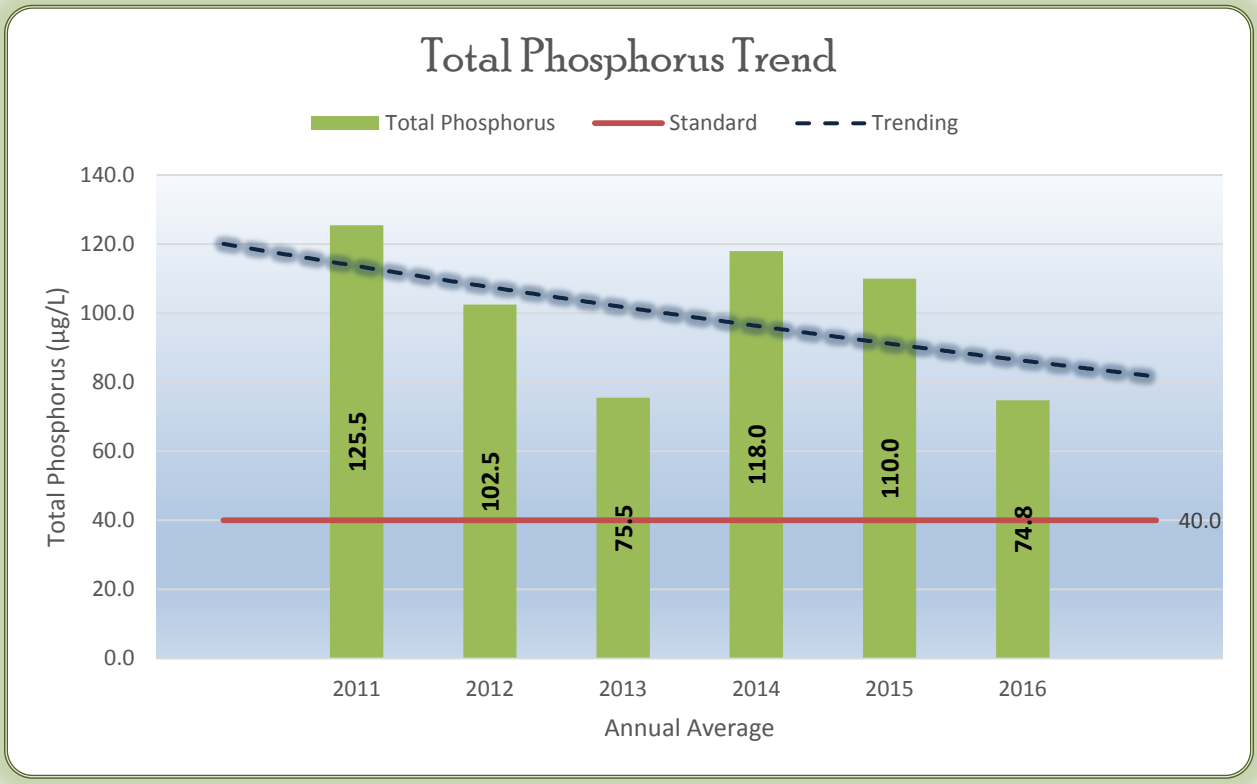

# Total Phosphorus

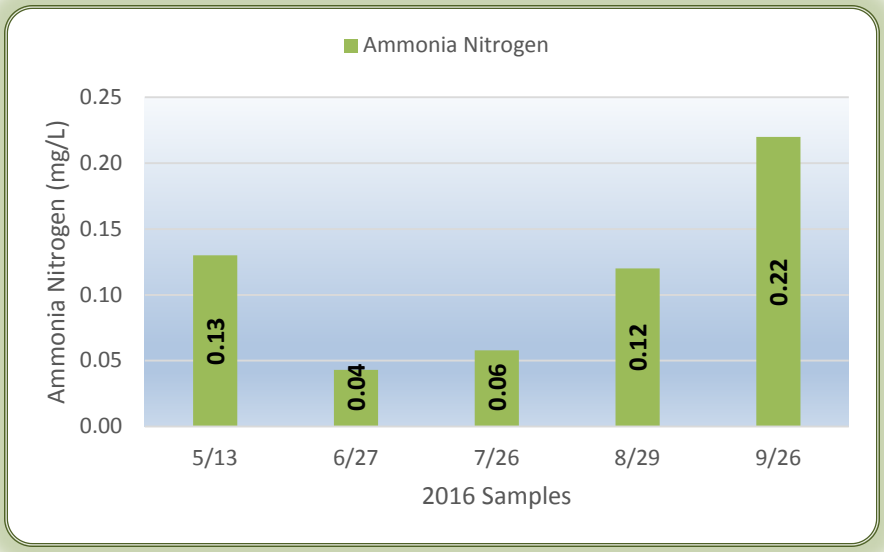
## Little Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | 117.0 | 92.0 | 73.2 | 109.0 | 101.4 | 71.2 |
| Grade | - | - | D | D | D | D | D | D |
| June-Sept Average (µg/L) | No Data | No Data | 125.5 | 102.5 | 75.5 | 118.0 | 110.0 | 74.8 |
| Meets Standard (40.0 µg/L) | - | - | No | No | No | No | No | No |





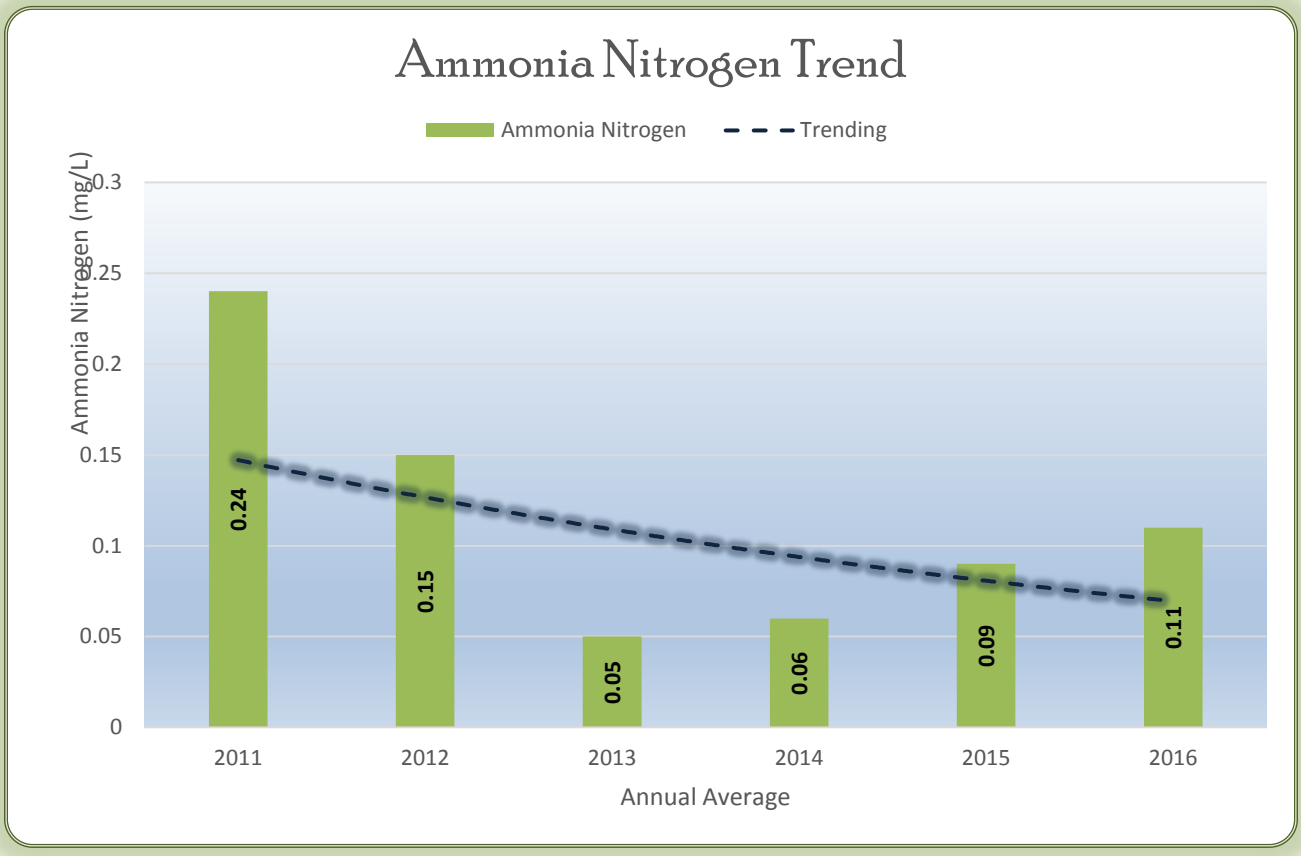

# Ammonia Nitrogen

## Little Lake

**Expected Range:**
None

**Deep Lake Standard:**
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | 0.24 | 0.15 | 0.05 | 0.06 | 0.09 | 0.11 |



General Observations
Little Lake

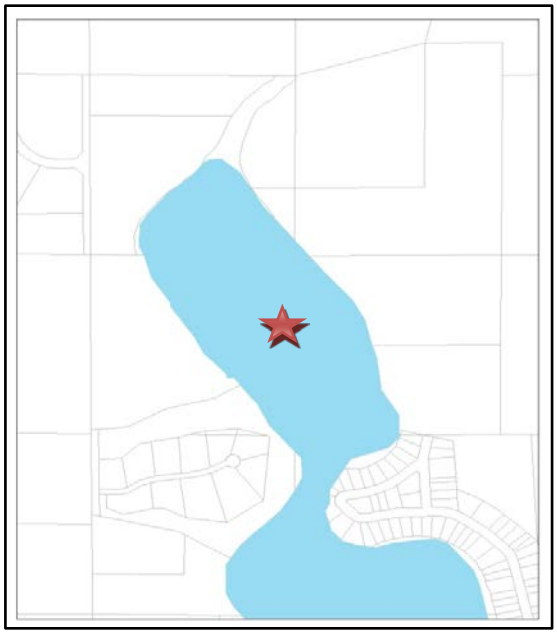
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Malted |  |
| June | 3<br>Medium Algae | 3<br>Fair | Calabash |  |
| July | 4<br>High Algae | 4<br>Poor | Cornichon |  |
| August | 4<br>High Algae | 4<br>Poor | Mossy Rock |  |
| September | 3<br>Medium Algae | 3<br>Fair | Dried Chamomile |  |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

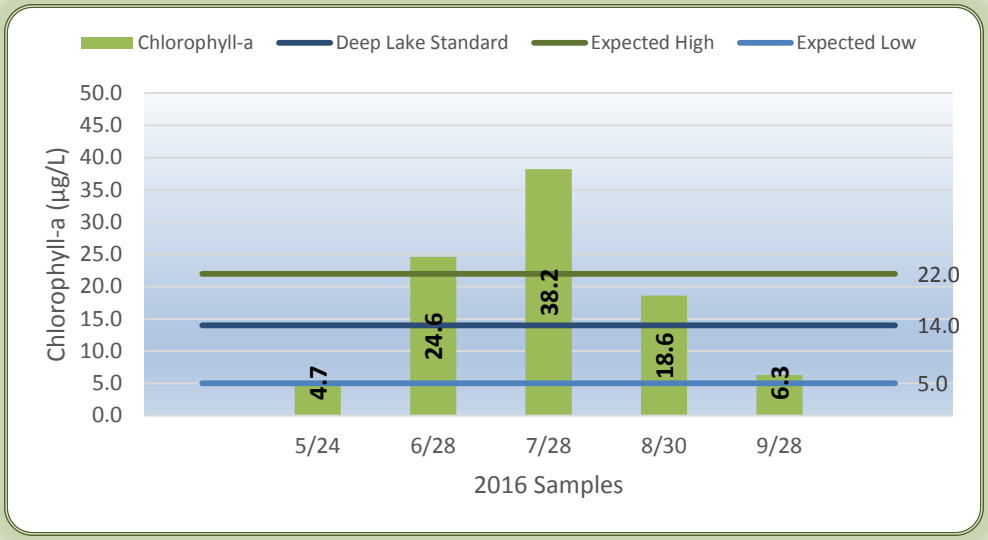
# Mandall Lake

Lake 13-0074-00 Site 201



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | No |
| 2016 Ranking | 21 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 59.2 | 56.9 | 66.9 | 61.0 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 18.5 µg/L | 1.2 meters | 77.6 µg/L | - |
| Grade | B | C-D | D | C |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 21.9 µg/L | 1.0 meter | 90.3 µg/L | - |
| Meets Standard | No | No | No | No |




## Chlorophyll-a

Mandall Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

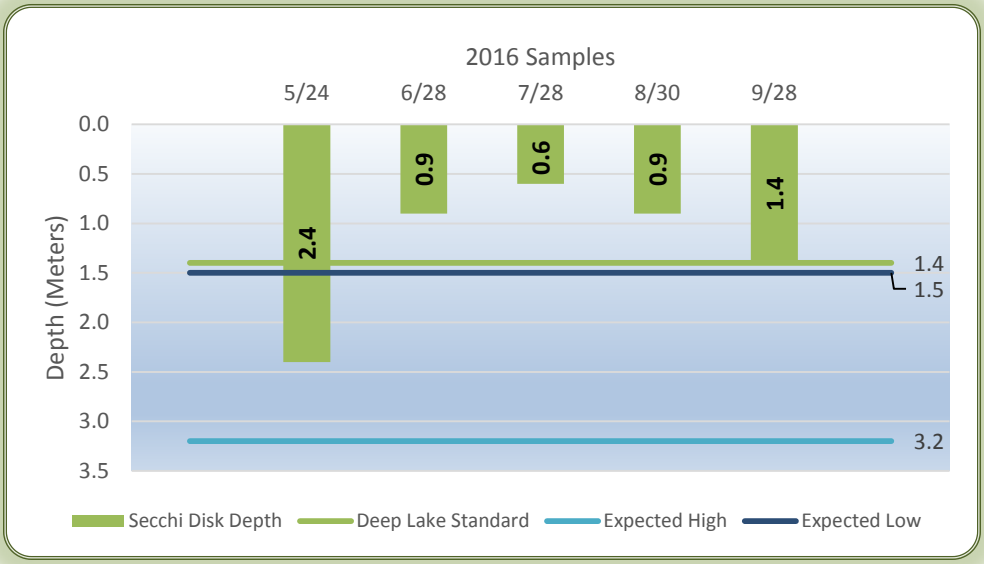
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 14.0 µg/L |
|---|---|---|---|---|
| 2014 | 29.2 | C | 32.3 | No |
| 2015 | 21.2 | C | 24.8 | No |
| 2016 | 18.5 | B | 21.9 | No |

## Secchi Disk Depth

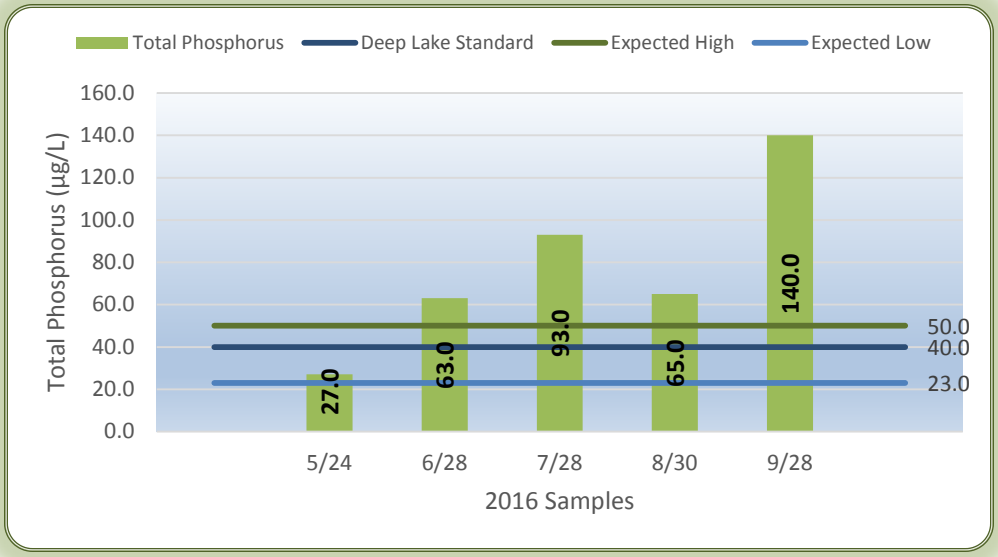
Mandall Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1.4 meters |
|---|---|---|---|---|
| 2014 | 0.9 | D | 0.9 | No |
| 2015 | 1.5 | C | 1.4 | Yes |
| 2016 | 1.2 | C-D | 1.0 | No |




# Total Phosphorus

## Mandall Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

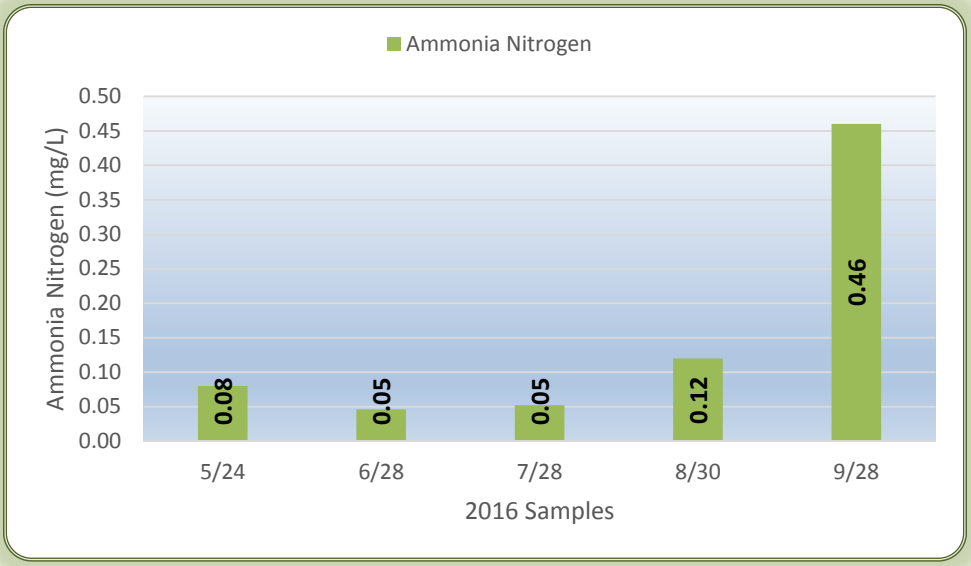
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 40.0 µg/L |
|---|---|---|---|---|
| 2014 | 89.8 | D | 94.3 | No |
| 2015 | 55.0 | C | 58.8 | Yes |
| 2016 | 77.6 | D | 90.3 | No |

# Ammonia Nitrogen

## Mandall Lake

Expected Range:
None

Deep Lake Standard:
None




| | 2009-2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| Average (mg/L) | No Data | 0.04 | 0.04 | 0.15 |

General Observations
Mandall Lake

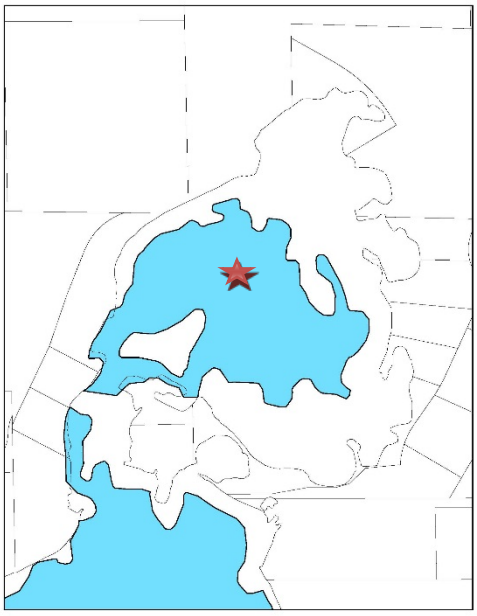
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Malted | |
| June | 3<br>Medium Algae | 3<br>Fair | Calabash | |
| July | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| August | 3<br>Medium Algae | 3<br>Fair | Parchment Paper | |
| September | 3<br>Medium Algae | 3<br>Fair | Short Bread | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

# Mattson Lake

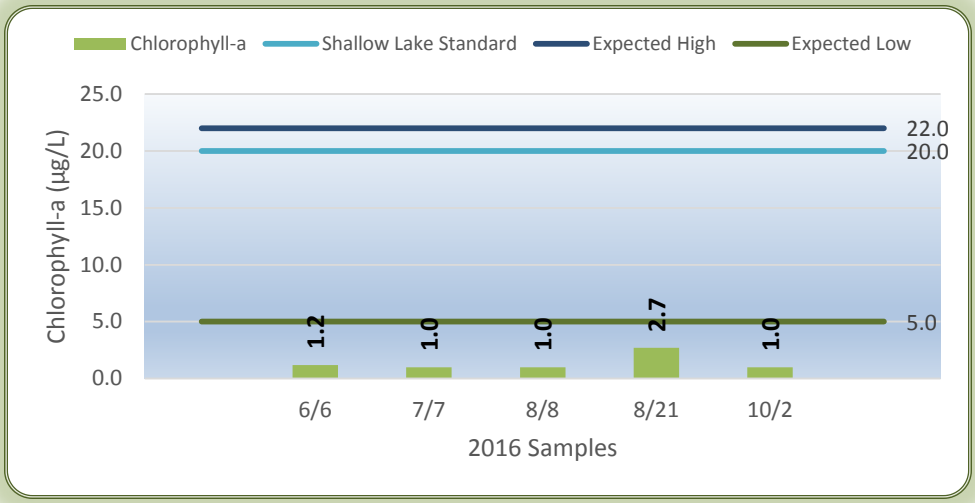
Lake 13-0043-00 Site 201



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Mesotrophic |
| Overall Lake Quality Grade | A- |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 1 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 33.8 | 51.5 | 44.5 | 43.3 |
| Classification | Mesotrophic | Eutrophic | Mesotrophic | Mesotrophic |
| 2016 Average (May-Sept) | 1.4 µg/L | 1.8 meters | 16.4 µg/L | - |
| Grade | A | C* | A | A- |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 1.4 µg/L | 1.8 meters | 17.0 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |

*Grade may be artificially low due to shallow total depth or aquatic vegetation.




## Chlorophyll-a

Mattson Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 20.0 µg/L |
|---|---|---|---|---|
| 2008 | 3.5 | A | 2.0 | Yes |
| 2009 | 3.7 | A | 3.7 | Yes |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 1.4 | A | 1.4 | Yes |

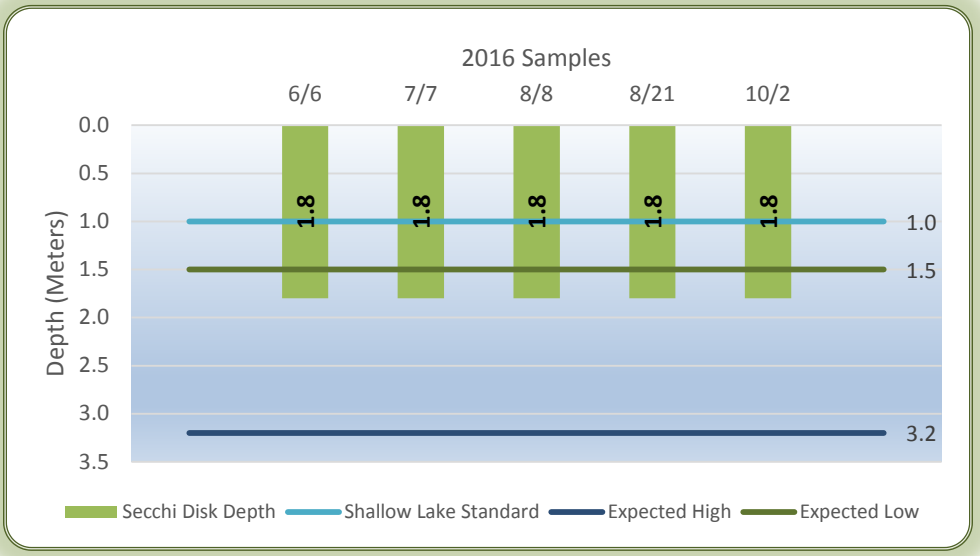
## Secchi Disk Depth

Mattson Lake

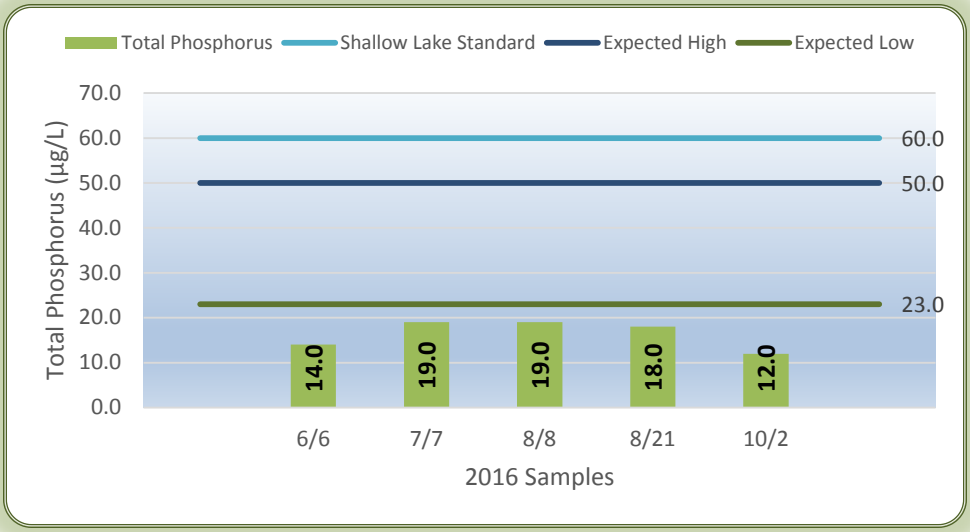
Expected Range:
1.5-2.3 meters

Shallow Lake Standard:
>1.0 meter

*Grades may be artificially low due to shallow total depth or aquatic vegetation.




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1.0 meter |
|---|---|---|---|---|
| 2008 | 2.0 | C* | 2.0 | Yes |
| 2009 | 1.0 | D* | 0.8 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 1.8 | C* | 1.8 | Yes |




# Total Phosphorus

## Mattson Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

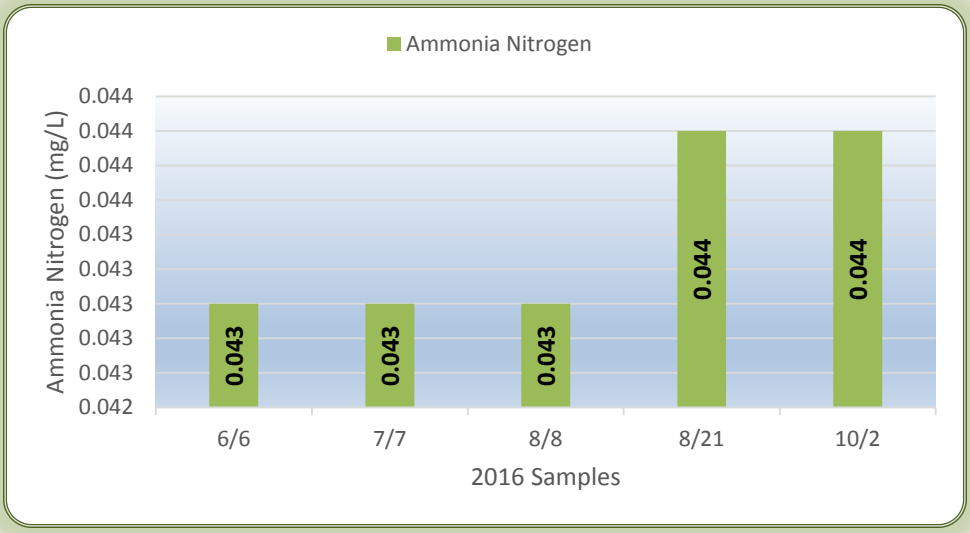
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 60.0 µg/L |
|---|---|---|---|---|
| 2008 | 21.0 | A | 21.0 | Yes |
| 2009 | 26.5 | B | 26.5 | Yes |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 16.4 | A | 17.0 | Yes |

# Ammonia Nitrogen

## Mattson Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average mg/L | |
|---|---|
| 2009-2015 | No Data |
| 2016 | 0.15 |

General Observations
Mattson Lake

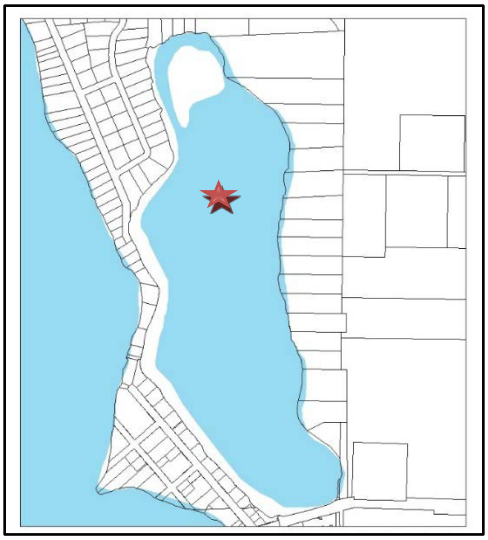
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Lemon Ice | |
| June | 2<br>Low Algae | 3<br>Fair | Dune | |
| July | 1<br>Clear | 2<br>Good | Lemon Ice | |
| August | 1<br>Clear | 2<br>Good | Lemon Ice | |
| September | 1<br>Clear | 2<br>Good | Lemon Ice | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

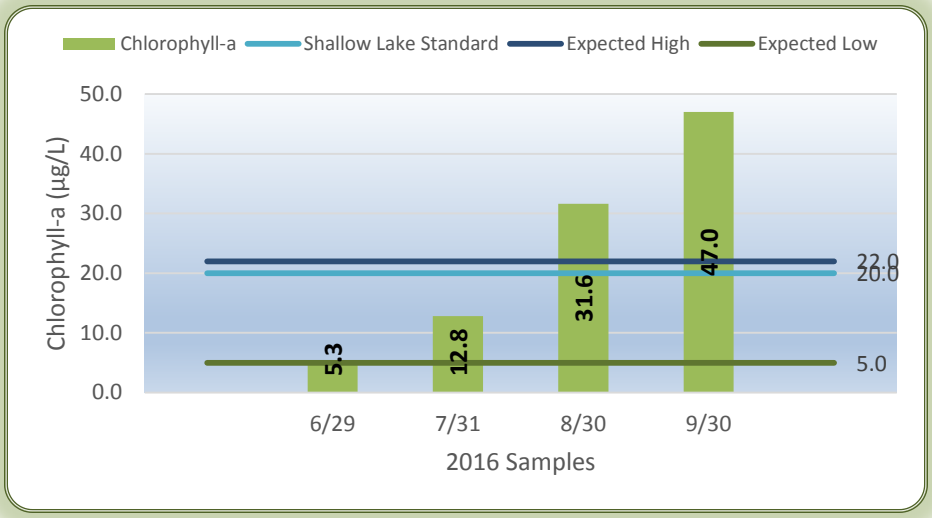
# Pioneer Lake

Lake 13-0034-00 Site 201



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Hyper-Eutrophic |
| Overall Lake Quality Grade | F+ |
| Meets MPCA Standards | No |
| 2016 Ranking | 28 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 61.9 | 70.7 | 77.0 | 69.9 |
| Classification | Eutrophic | Hyper-Eutrophic | Hyper-Eutrophic | Hyper-Eutrophic |
| 2016 Average (May-Sept) | 24.2 µg/L | 0.5 meters | 156.0 µg/L | - |
| Grade | C | F | F | F+ |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 30.5 µg/L | 0.4 meters | 183.3 µg/L | - |
| Meets Standard | No | No | No | No |




## Chlorophyll-a

Pioneer Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

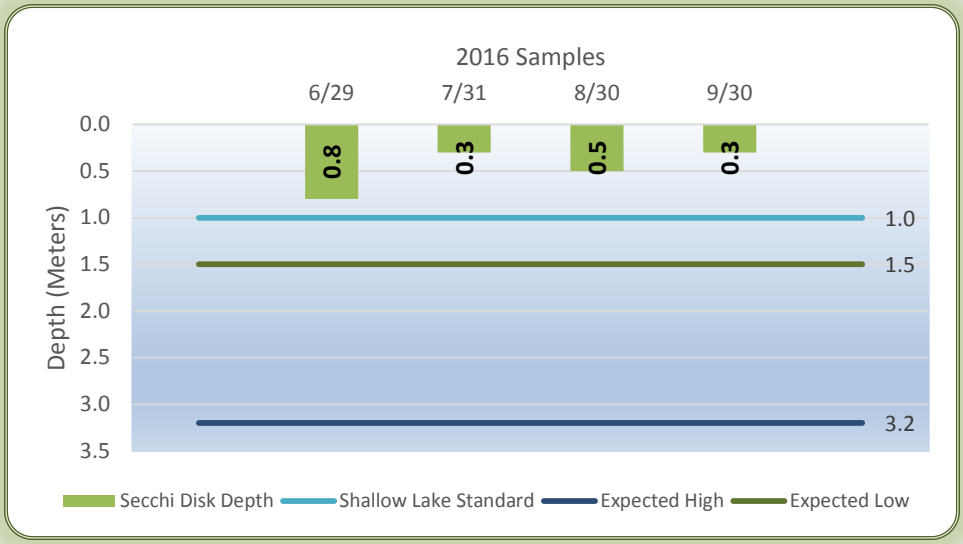
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 20.0 µg/L |
|---|---|---|---|---|
| 2009 | 107.9 | F | 103.3 | No |
| 2010 | 61.5 | D | 61.5 | No |
| 2011-2015 | No Data | - | No Data | - |
| 2016 | 24.2 | C | 30.5 | No |

## Secchi Disk Depth

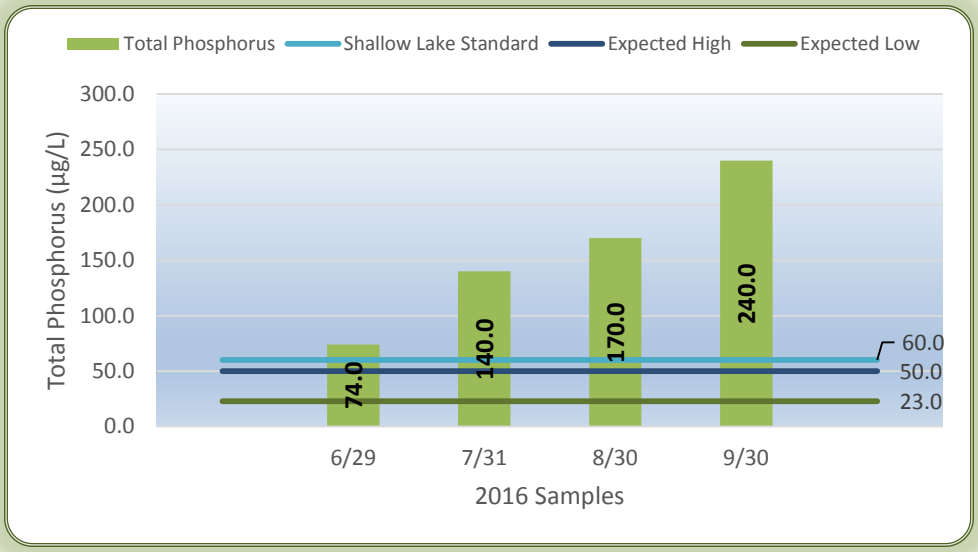
Pioneer Lake

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1.0 meter |
|---|---|---|---|---|
| 2009 | 0.3 | F | 0.2 | No |
| 2010 | 1.2 | C-D | 1.2 | No |
| 2011-2015 | No Data | - | No Data | - |
| 2016 | 0.5 | F | 0.4 | No |




## Total Phosphorus

Pioneer Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

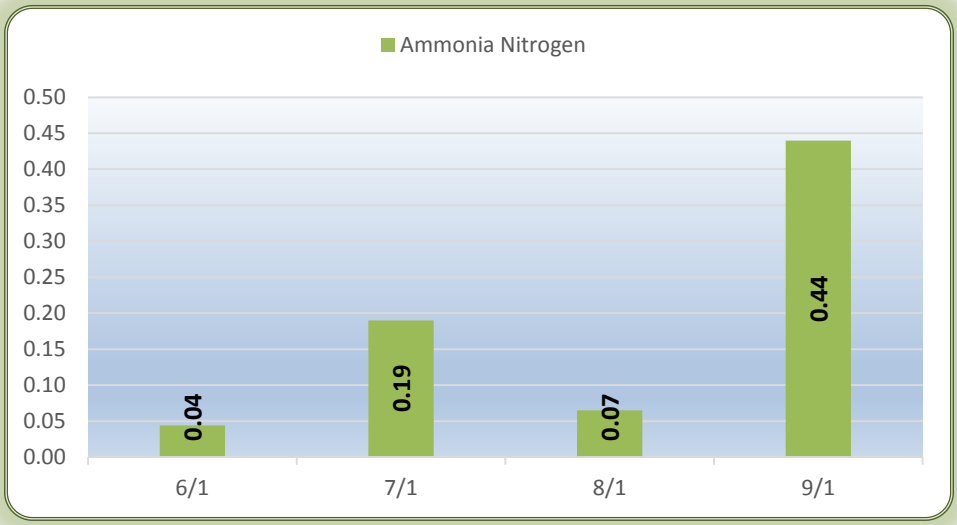
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 60.0 µg/L |
|---|---|---|---|---|
| 2009 | 310.6 | F | 344.6 | No |
| 2010 | 184.5 | F | 184.5 | No |
| 2011-2015 | No Data | - | No Data | - |
| 2016 | 156.0 | F | 183.3 | No |

## Ammonia Nitrogen

Pioneer Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average mg/L | |
|---|---|
| 2009-2015 | No Data |
| 2016 | 0.18 |

General Observations
Pioneer Lake

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | No Data | No Data | No Data | No Data |
| June | 3<br>Medium Algae | 3<br>Fair | Dune |  |
| July | 4<br>High Algae | 4<br>Poor | Cornichon |  |
| August | 3<br>Medium Algae | 3<br>Fair | Sultana |  |
| September | 5<br>Severe Algae | 4<br>Poor | Cornichon |  |

# Explanation of Color Classification

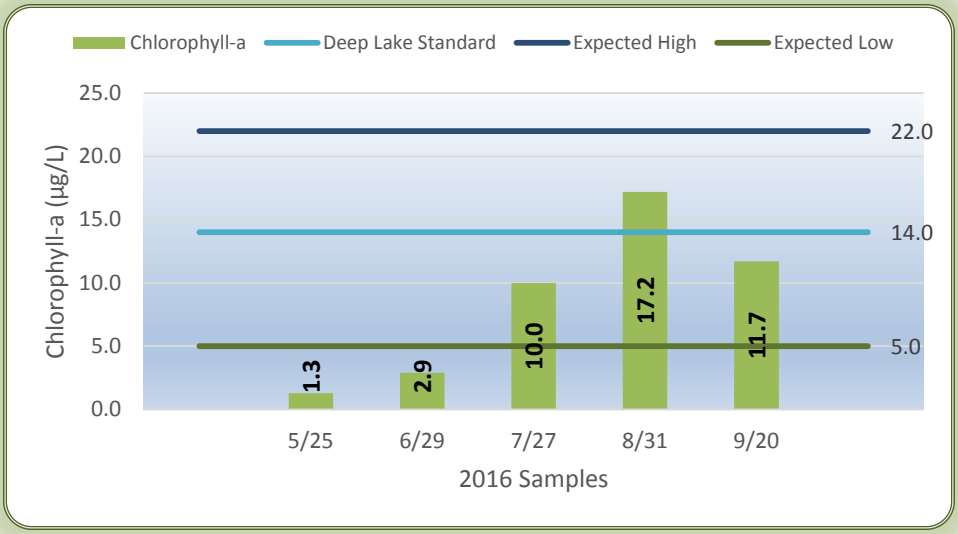
During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

# Rabour Lake

Lake 13-0079-00 Site 201

| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | D |
| Meets MPCA Standards | No |
| 2016 Ranking | 25 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 65.8 | 60.6 | 69.5 | 65.3 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 36.0 µg/L | 1.0 meter | 93.2 µg/L | - |
| Grade | C | D | D | D |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 43.1 µg/L | 0.6 meters | 106.8 µg/L | - |
| Meets Standard | No | No | No | No |




## Chlorophyll-a

Rabour Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

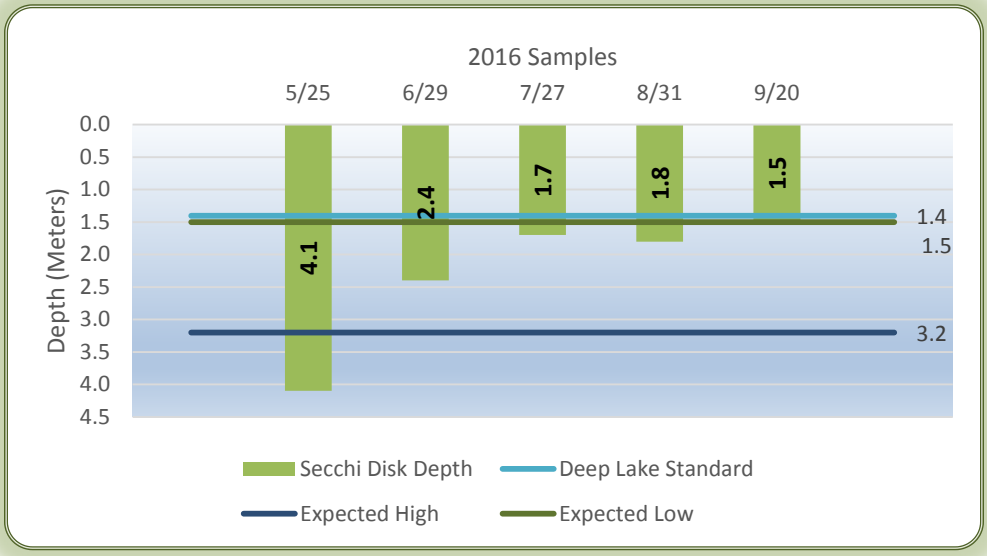
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 20.0 µg/L |
|---|---|---|---|---|
| 2014 | 23.4 | C | 26.3 | No |
| 2015 | 28.4 | C | 33.0 | No |
| 2016 | 36.0 | C | 43.1 | No |

## Secchi Disk Depth

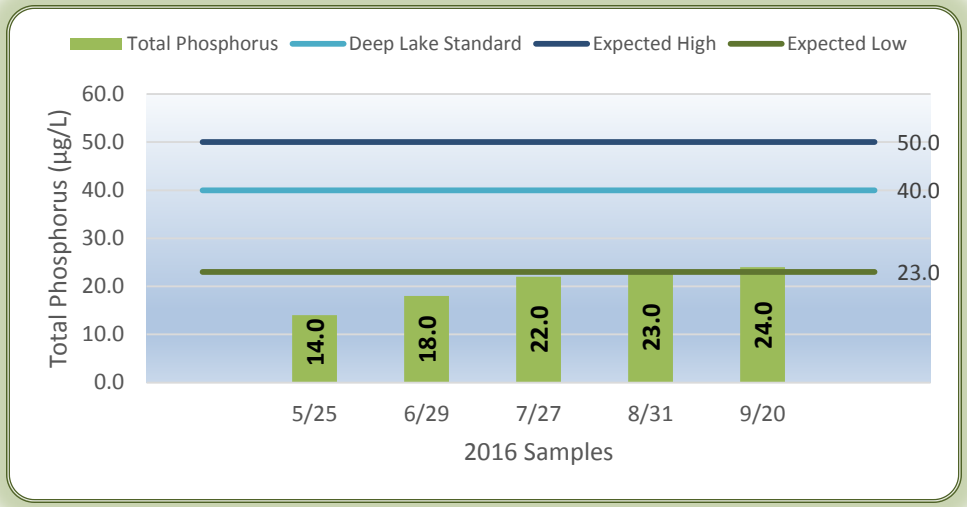
Rabour Lake

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1.0 meter |
|---|---|---|---|---|
| 2009 | 0.9 | D | 0.8 | No |
| 2010 | 1.6 | C | 1.5 | Yes |
| 2011-2015 | No Data | - | No Data | - |
| 2016 | 1.0 | D | 0.6 | No |




# Total Phosphorus

Rabour Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

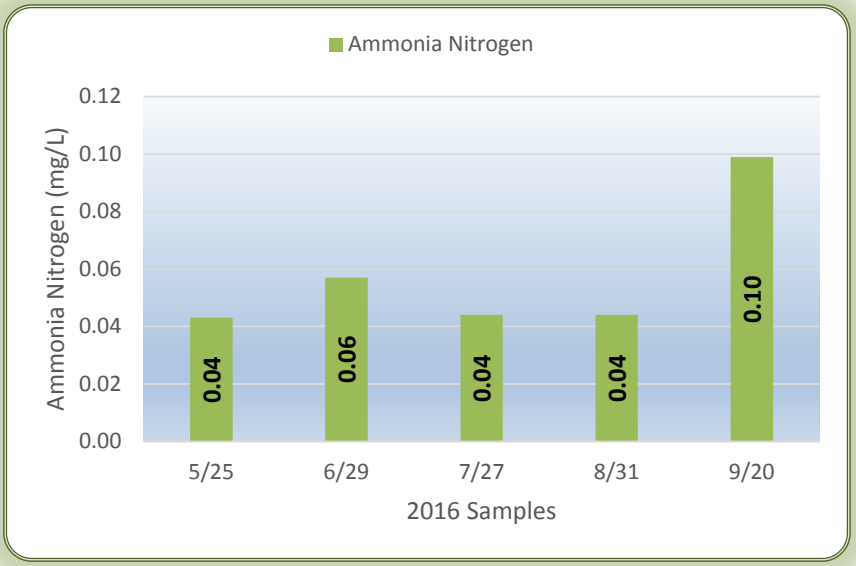
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 60.0 µg/L |
|---|---|---|---|---|
| 2009 | 84.2 | D | 90.5 | No |
| 2010 | 65.4 | C | 68.0 | No |
| 2011-2015 | No Data | - | No Data | - |
| 2016 | 93.2 | D | 106.8 | No |

# Ammonia Nitrogen

Rabour Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average mg/L | |
|---|---|
| 2014 | 0.03 |
| 2015 | 0.05 |
| 2016 | 0.26 |

General Observations
Rabour Lake

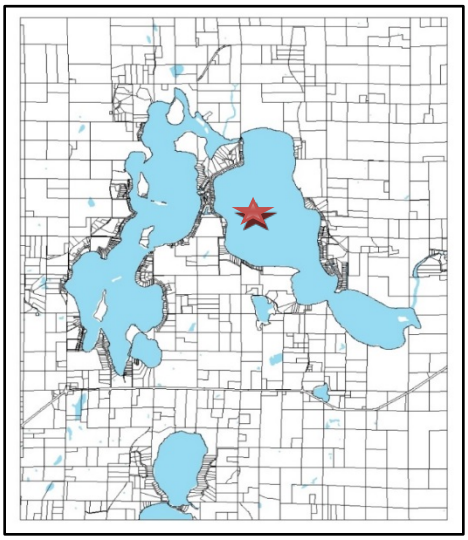
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Malted | |
| June | 3<br>Medium Algae | 3<br>Fair | Bamboo | |
| July | 3<br>Medium Algae | 3<br>Fair | Cornichon | |
| August | 3<br>Medium Algae | 3<br>Fair | Cornichon | |
| September | 4<br>High Algae | 4<br>Poor | Cornichon | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

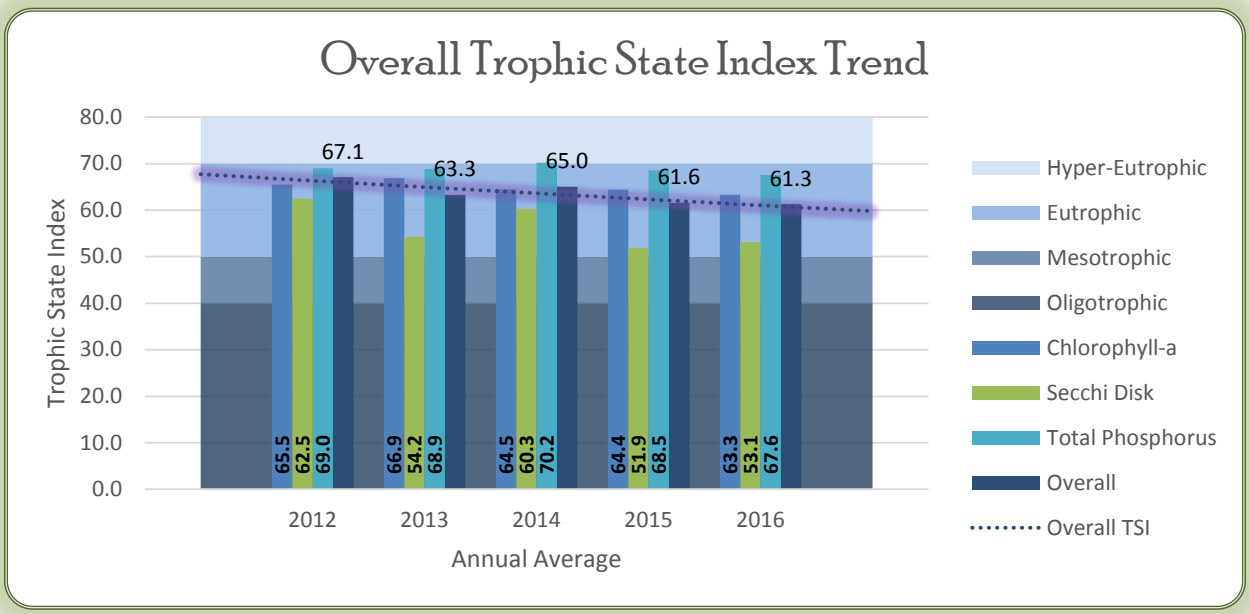
# East Rush Lake

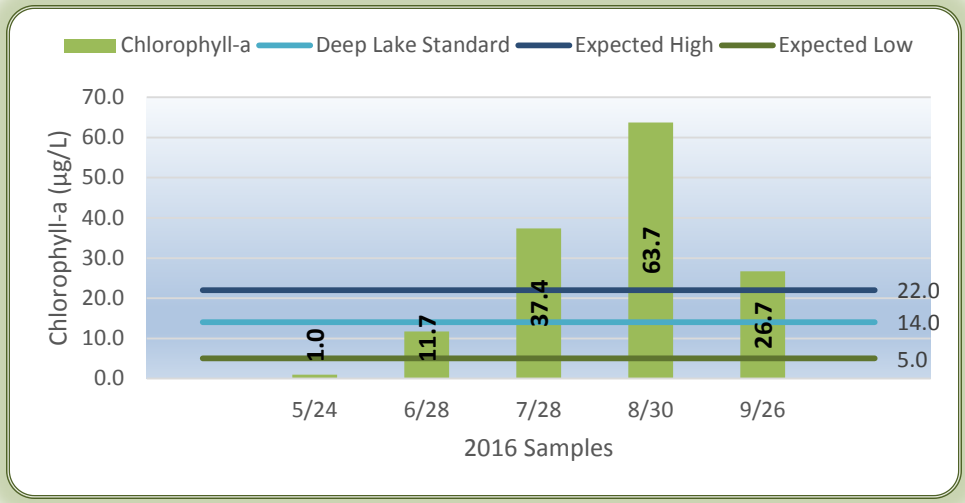
Lake 13-0069-01 Site 207



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | No |
| 2016 Ranking | 22 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 63.3 | 53.1 | 67.6 | 61.3 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 28.1 µg/L | 1.6 meters | 81.2 µg/L | - |
| Grade | C | C | D | C |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 34.9 µg/L | 0.9 meters | 97.3 µg/L | - |
| Meets Standard | No | No | No | No |





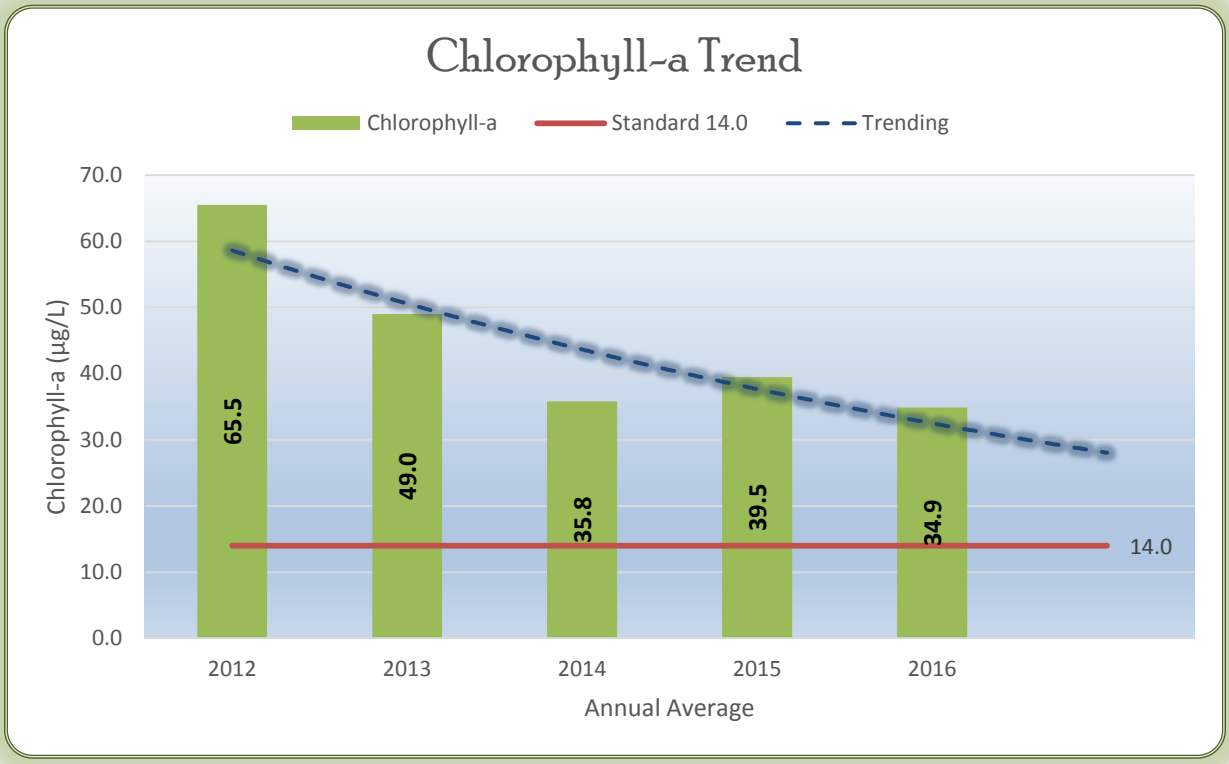

# Chlorophyll-a

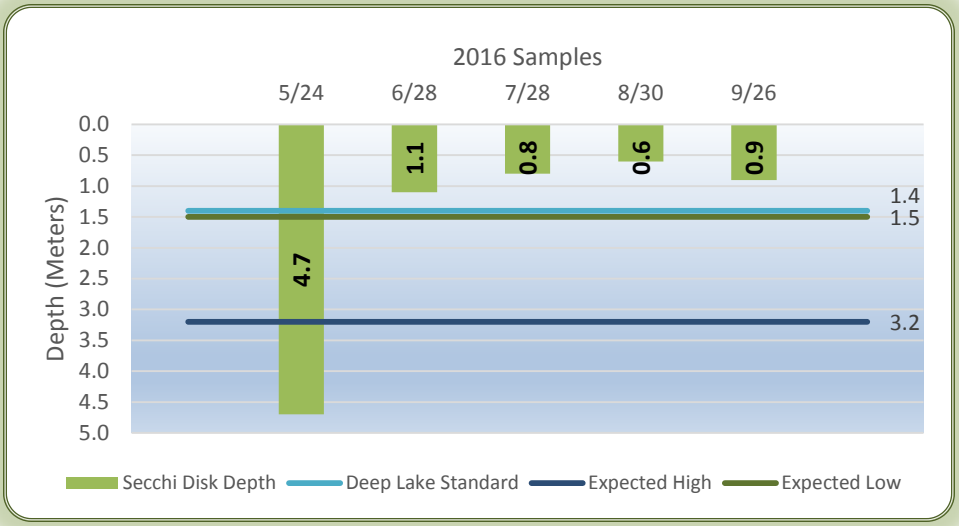
## East Rush Lake

Expected Range:
5.0-22.0 µg/L

Deep Lake Standard:
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 54.4 | 40.4 | 31.6 | 32.0 | 28.1 |
| Grade | - | - | - | D | C | C | C | C |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 65.5 | 49.0 | 35.8 | 39.5 | 34.9 |
| Meets Standard (14.0 µg/L) | - | - | - | No | No | No | No | No |





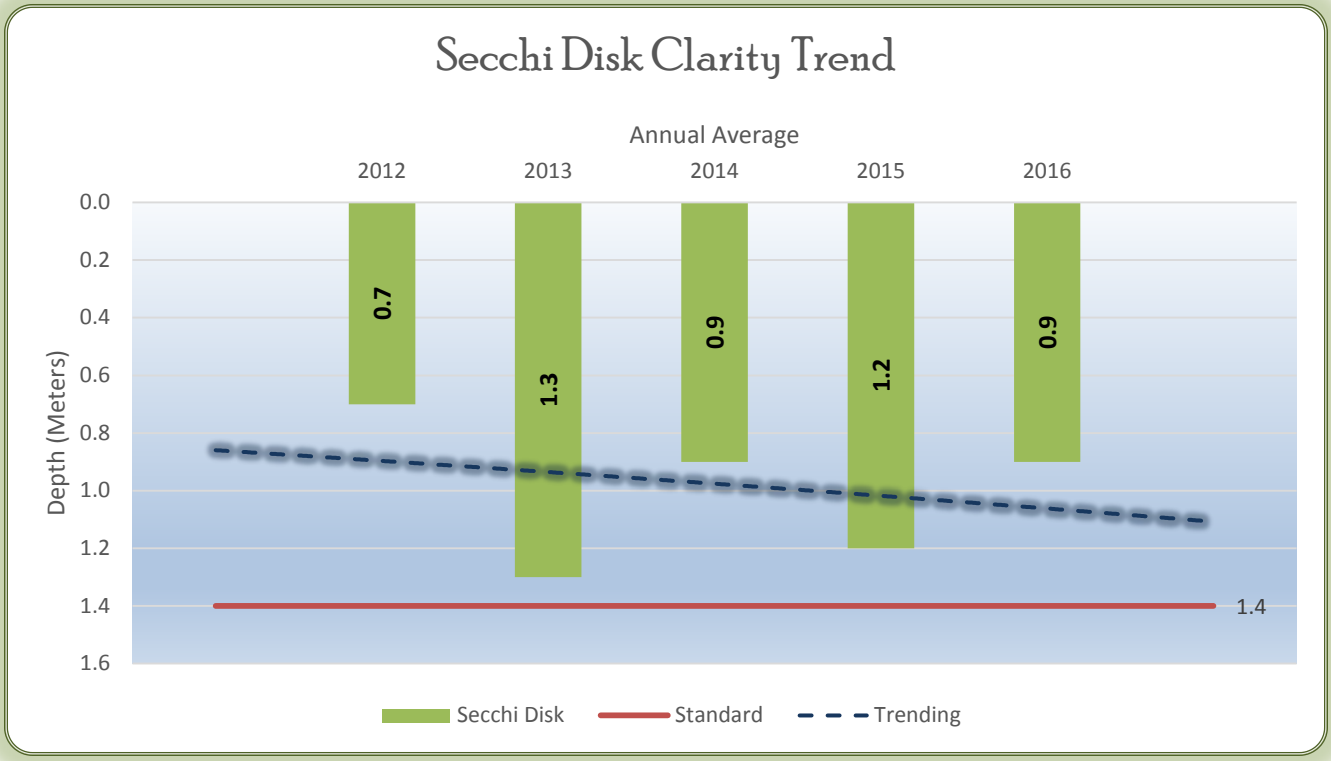

# Secchi Disk Depth

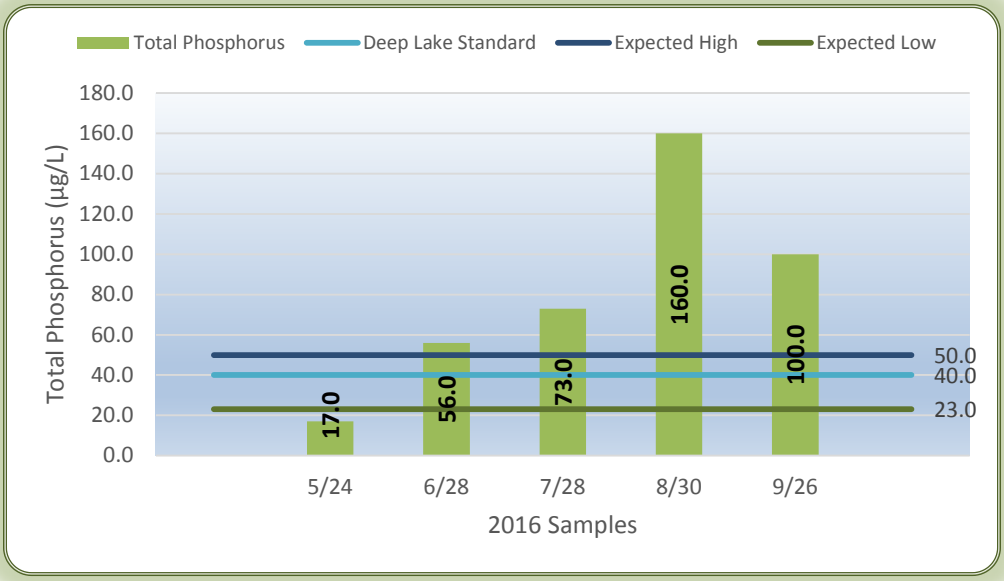
## East Rush Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | No Data | 0.8 | 1.5 | 1.0 | 1.8 | 1.6 |
| Grade | - | - | - | D | C | D | C | C |
| June-Sept Average (Meters) | No Data | No Data | No Data | 0.7 | 1.3 | 0.9 | 1.2 | 0.9 |
| Meets Standard (>1.4 meters) | - | - | - | No | No | No | No | No |





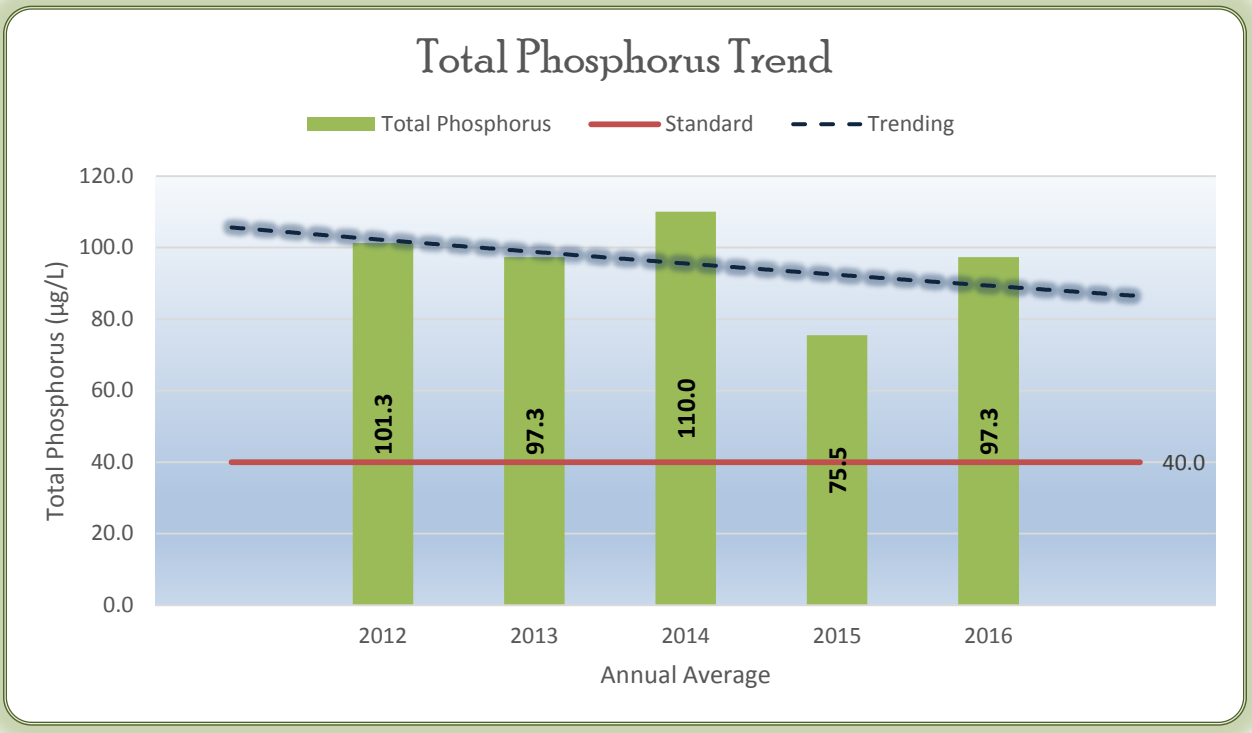

# Total Phosphorus

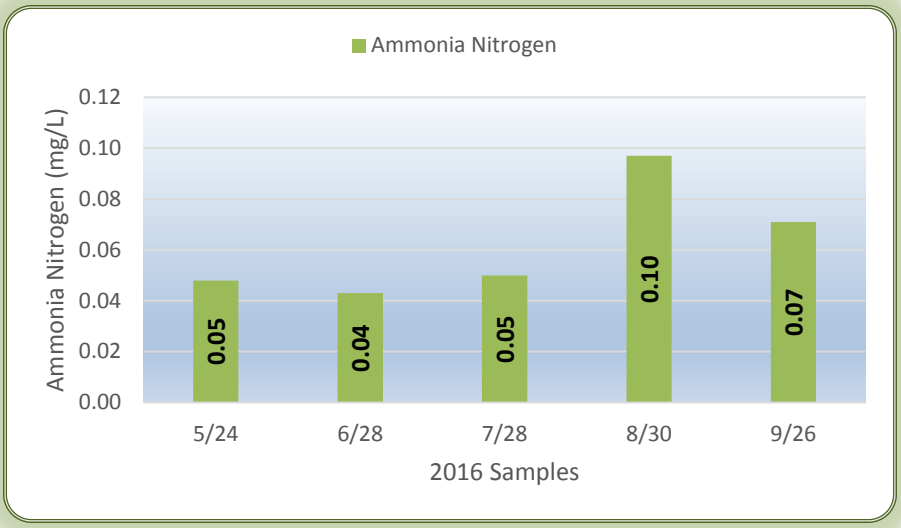
## East Rush Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 90.0 | 89.0 | 97.2 | 86.4 | 81.2 |
| Grade | - | - | - | D | D | D | D | D |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 101.3 | 97.3 | 110.0 | 75.5 | 97.3 |
| Meets Standard (40.0 µg/L) | - | - | - | No | No | No | No | No |





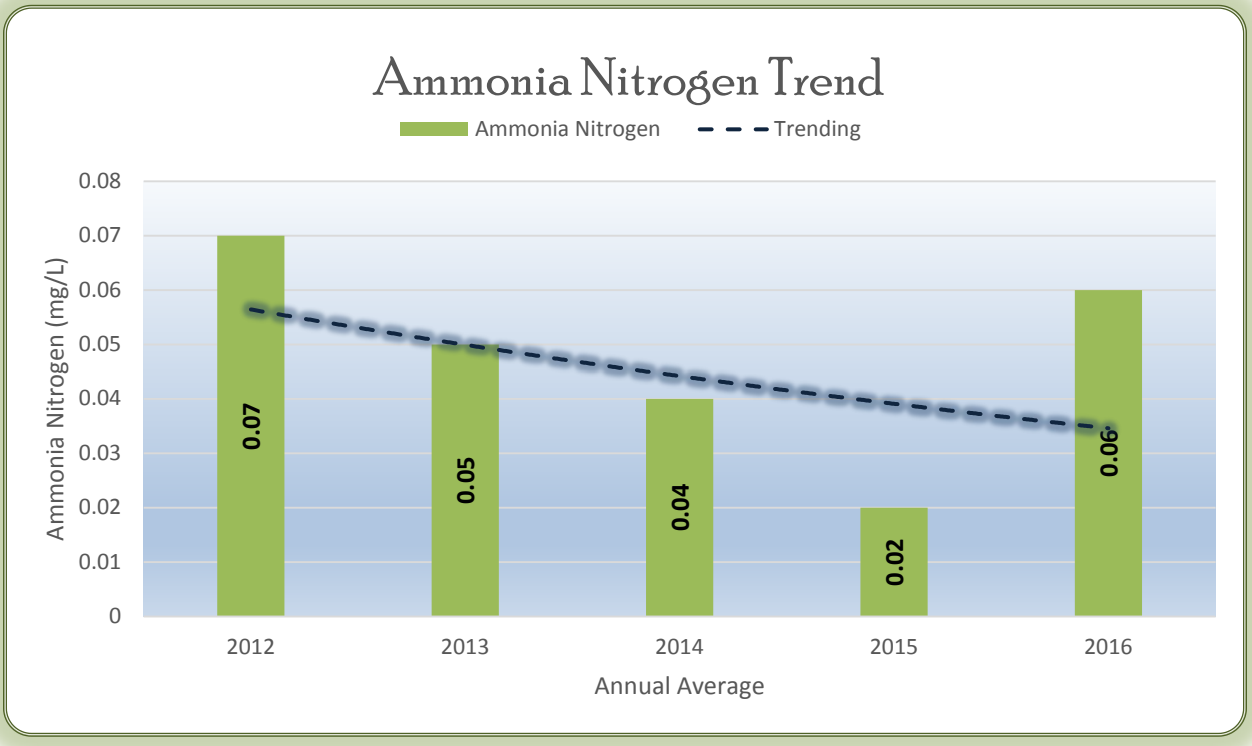

# Ammonia Nitrogen

## East Rush Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | No Data | 0.07 | 0.05 | 0.04 | 0.02 | 0.06 |

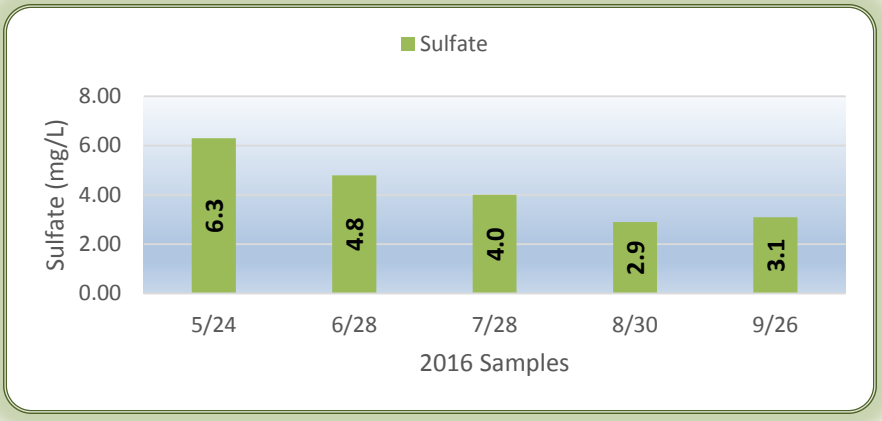


## General Observations
## East Rush Lake

*See Page 14 for explanation of color classification

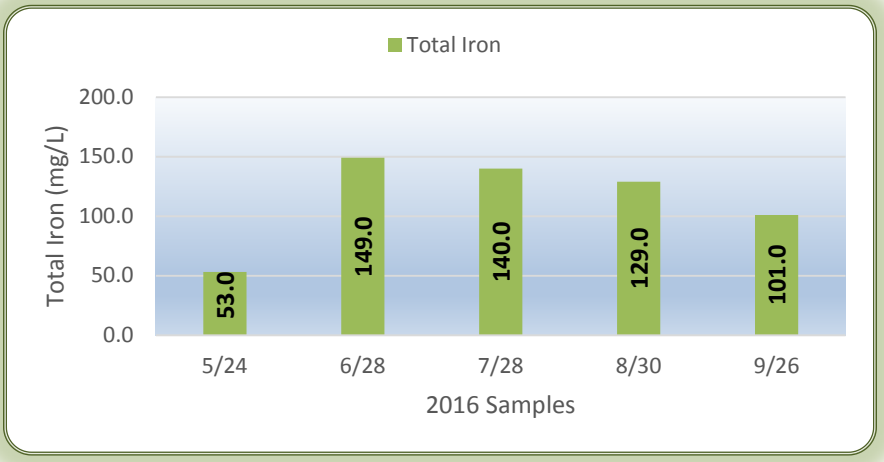
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper* | Color* |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Macadamia | |
| June | 3<br>Medium Algae | 3<br>Fair | Cornucopia | |
| July | 4<br>High Algae | 4<br>Poor | Cornichon | |
| August | 5<br>Severe Algae | 5<br>Very Poor | Mossy Rock | |
| September | 4<br>High Algae | 4<br>Poor | Beach Grass | |

East Rush Lake | Sulfate | Expected Range: None | Deep Lake Standard: None




| Average mg/L | |
|---|---|
| 2015 | 5.18 |
| 2016 | 4.22 |

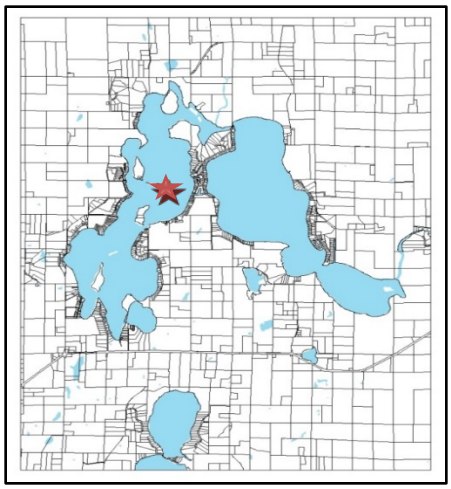
East Rush Lake | Total Iron | Expected Range: None | Deep Lake Standard: None




| Average mg/L | |
|---|---|
| 2015 | 0.07 |
| 2016 | 114.4 |

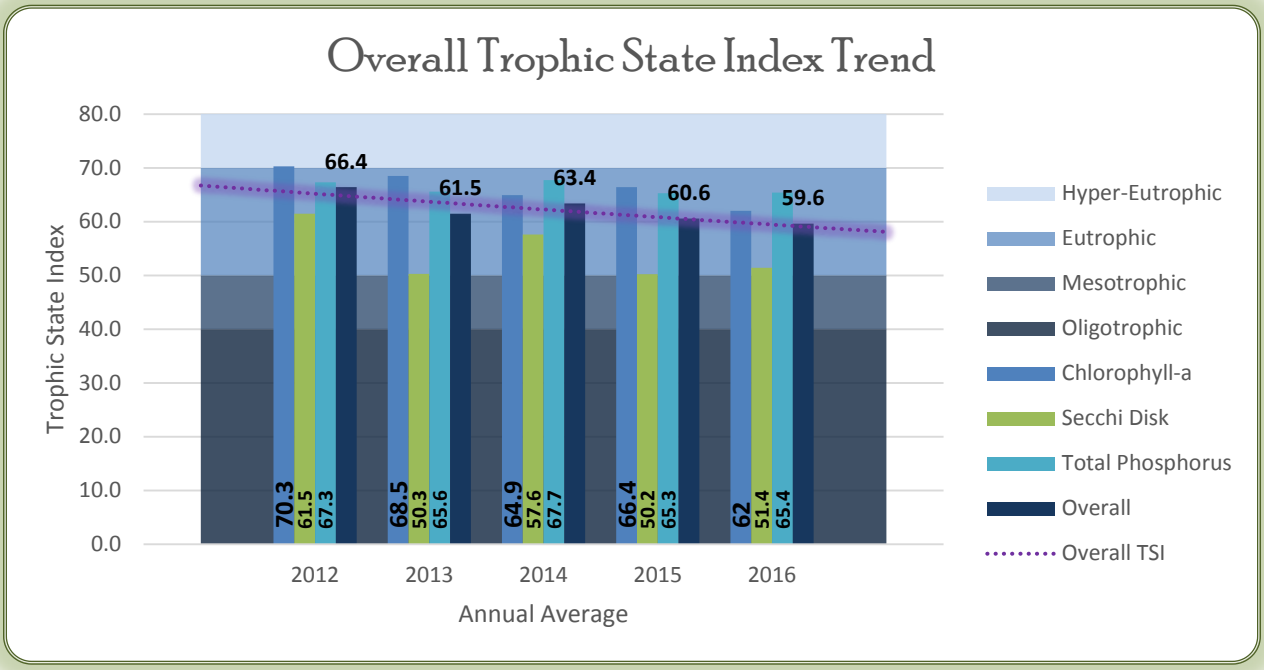
# West Rush Lake

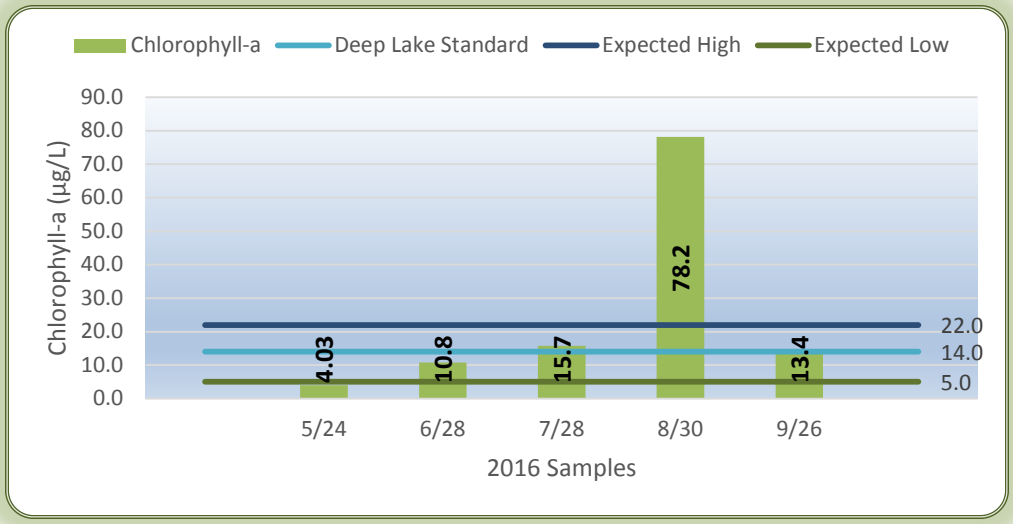
Lake 13-0069-02 Site 204



| 2016 Report Card: Deep Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C |
| Meets MPCA Standards | No |
| 2016 Ranking | 20 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 62.0 | 51.4 | 65.4 | 59.6 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 24.4 µg/L | 1.8 meters | 65.4 µg/L | - |
| Grade | C | C | D | C |
| MPCA Standard (Deep) | 14.0 µg/L | >1.4 meters | 40.0 µg/L | - |
| 2016 Average (June-Sept) | 29.5 µg/L | 1.3 meters | 81.5 µg/L | - |
| Meets Standard | No | No | No | No |





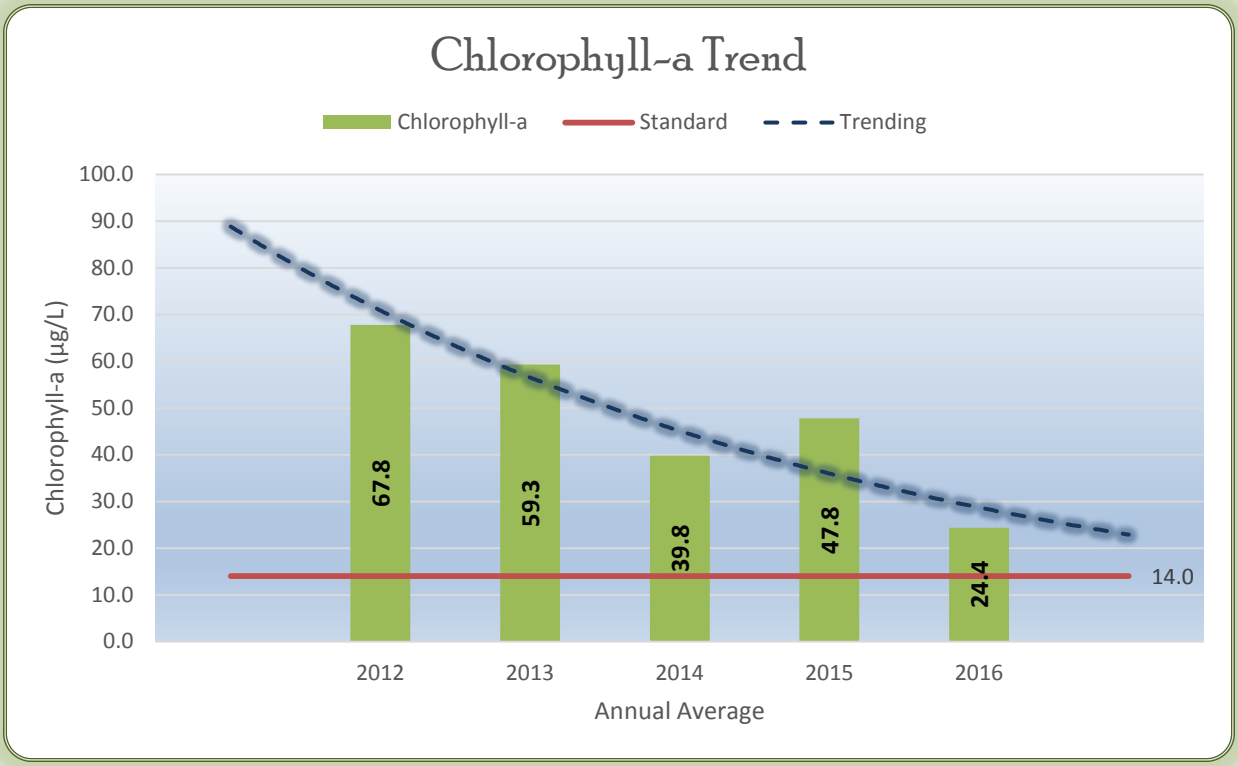

# Chlorophyll-a

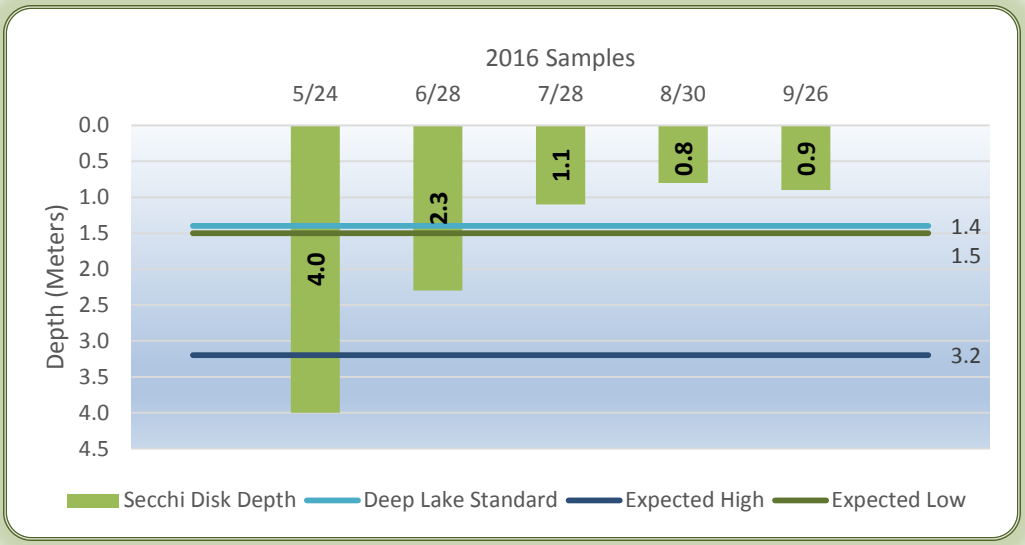
## West Rush Lake

**Expected Range:**
5.0-22.0 µg/L

**Deep Lake Standard:**
14.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 57.2 | 47.6 | 33.0 | 38.6 | 24.4 |
| Grade | - | - | - | D | C | C | C | C |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 67.8 | 59.3 | 39.8 | 47.8 | 29.5 |
| Meets Standard (14.0 µg/L) | - | - | - | No | No | No | No | No |





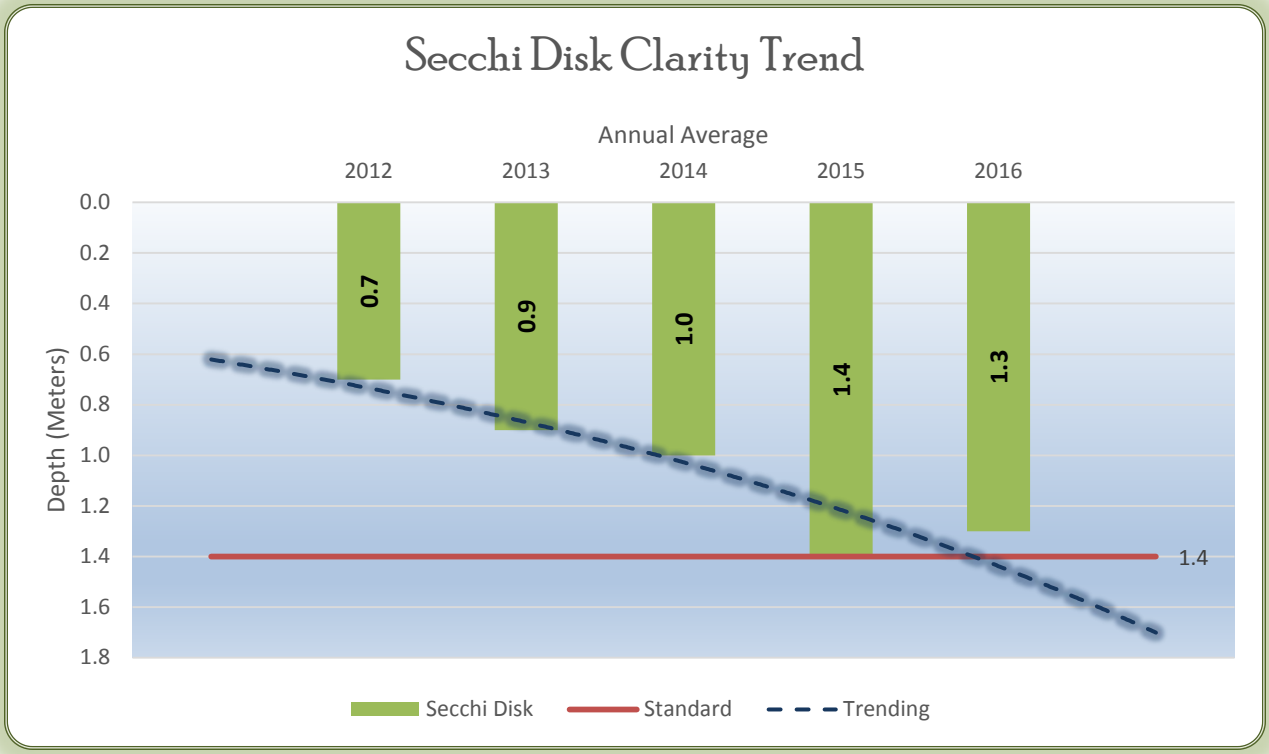

# Secchi Disk Depth

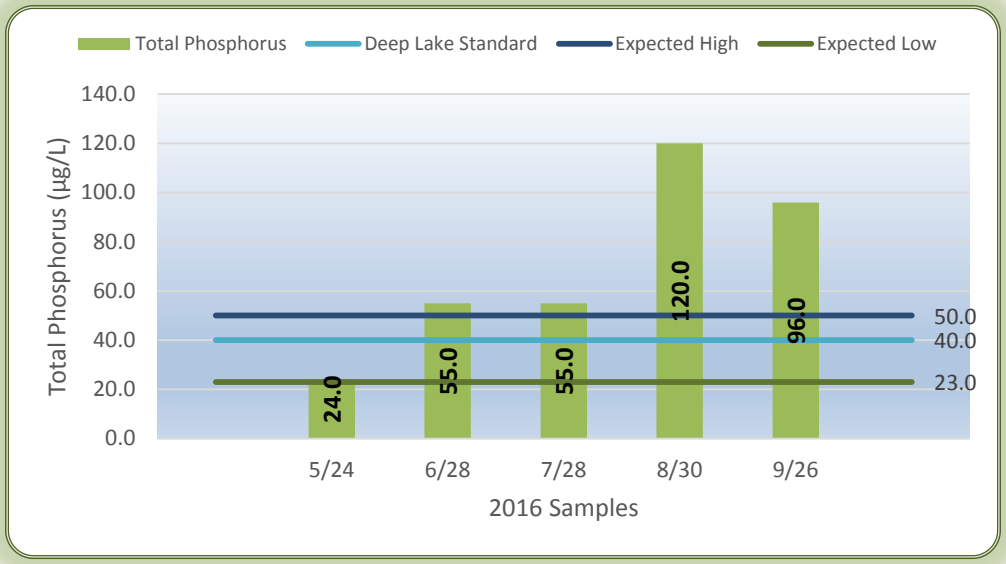
West Rush Lake

Expected Range:
1.5-3.2 meters

Deep Lake Standard:
>1.4 meters

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | No Data | 0.9 | 2.0 | 1.2 | 2.0 | 1.8 |
| Grade | - | - | - | D | C | C-D | C | C |
| June-Sept Average (Meters) | No Data | No Data | No Data | 0.7 | 0.9 | 1.0 | 1.4 | 1.3 |
| Meets Standard (>1.4 meters) | - | - | - | No | No | No | No | No |





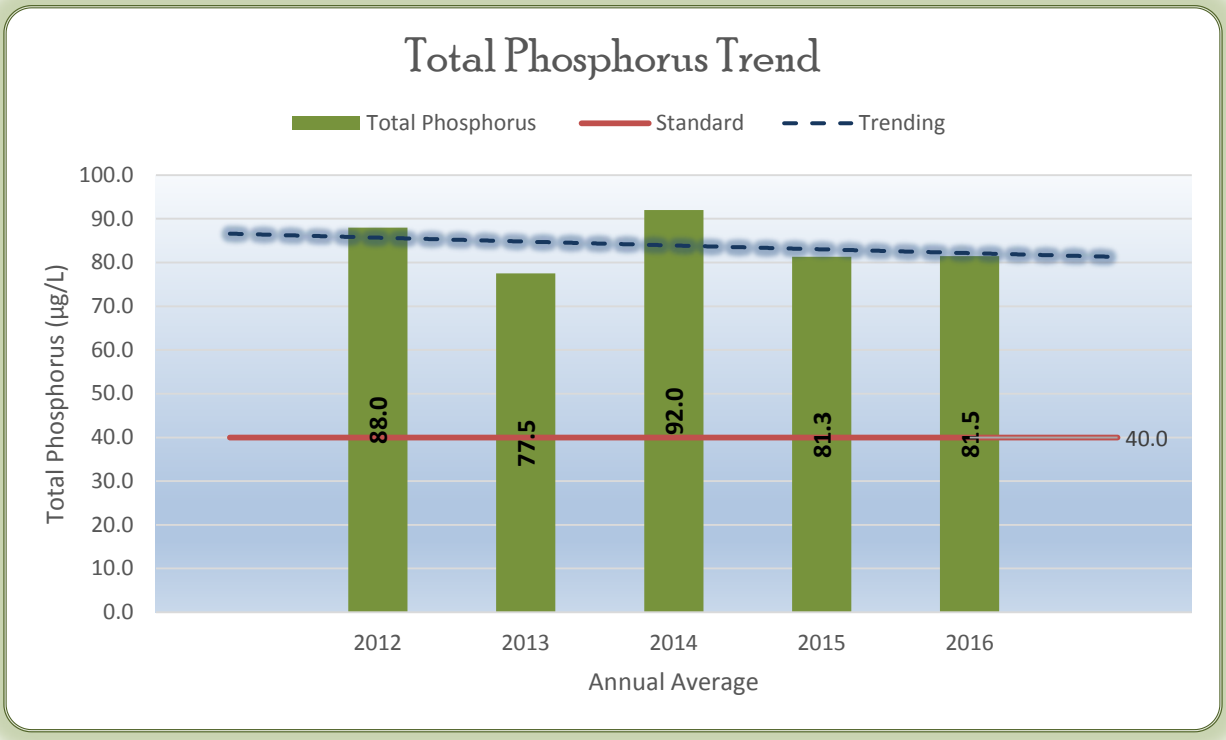

# Total Phosphorus

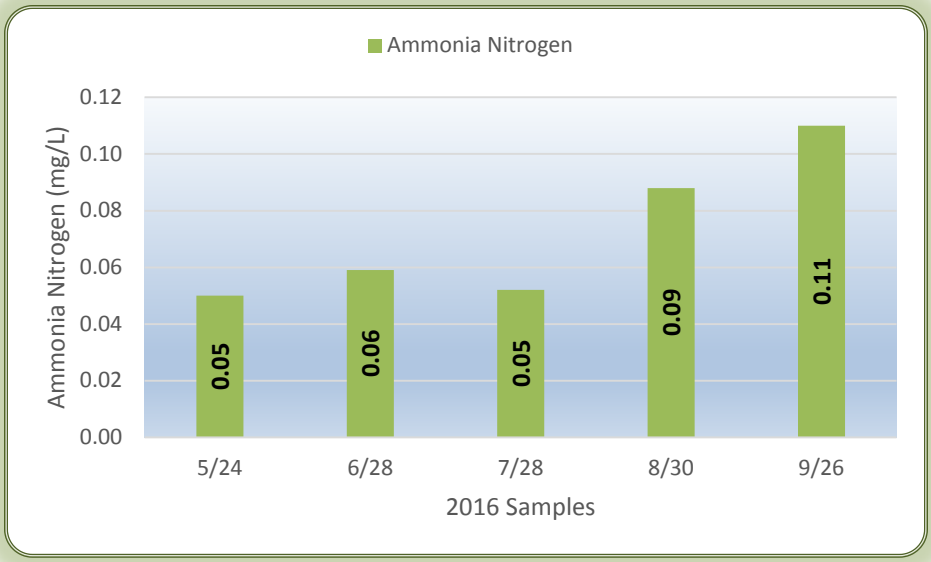
## West Rush Lake

Expected Range:
23.0-50.0 µg/L

Deep Lake Standard:
40.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | No Data | 80.0 | 70.8 | 82.2 | 69.6 | 65.4 |
| Grade | - | - | - | D | D | D | D | D |
| June-Sept Average (µg/L) | No Data | No Data | No Data | 88.0 | 77.5 | 92.0 | 81.3 | 81.5 |
| Meets Standard (40.0 µg/L) | - | - | - | No | No | No | No | No |





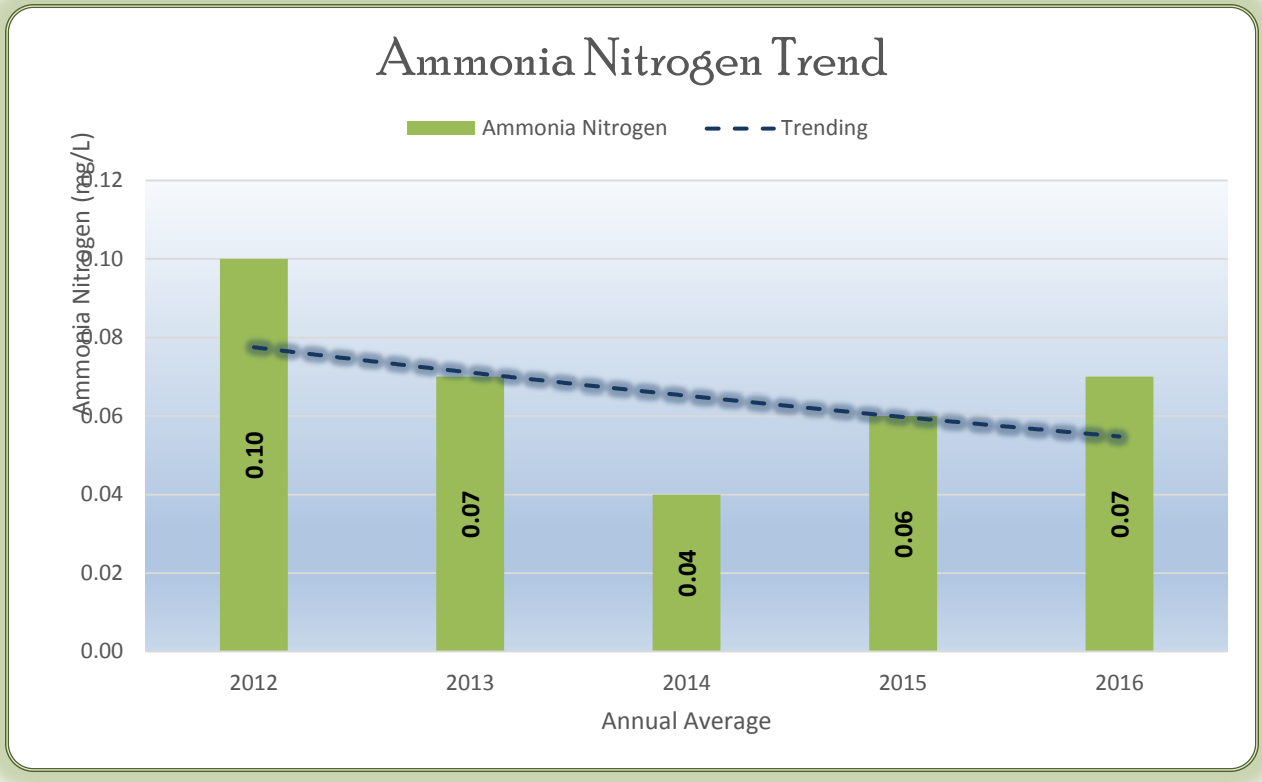

# Ammonia Nitrogen

## West Rush Lake

Expected Range:
None

Deep Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | No Data | 0.10 | 0.07 | 0.04 | 0.06 | 0.07 |

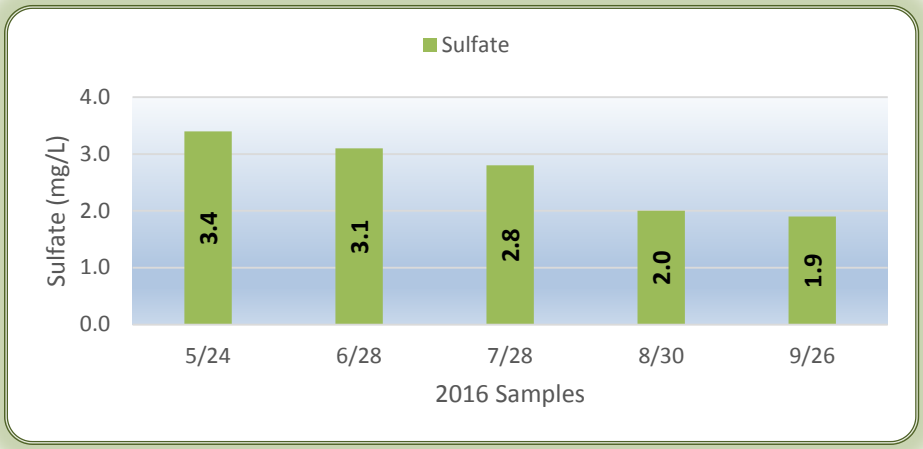


# General Observations
## West Rush Lake

*See page 14 for explanation of color classification

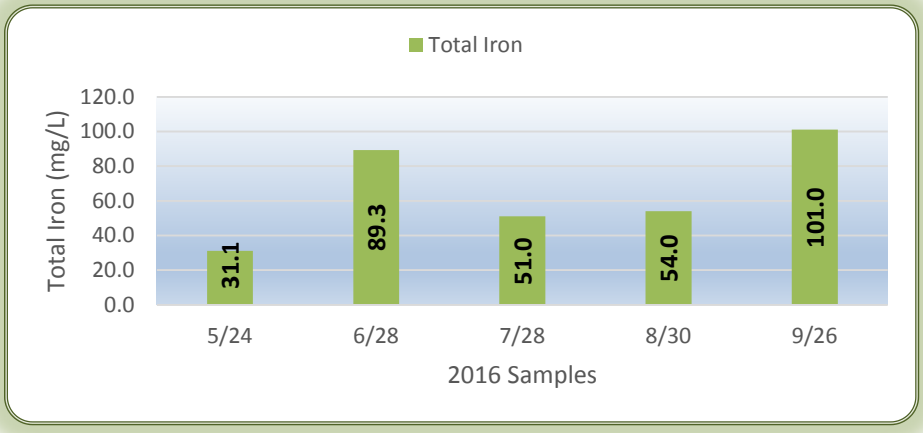
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper* | Color* |
|---|---|---|---|---|
| May | 2<br>Low Algae | 2<br>Good | Macadamia | |
| June | 3<br>Medium Algae | 3<br>Fair | Beach Grass | |
| July | 4<br>High Algae | 4<br>Poor | Cornichon | |
| August | 5<br>Severe Algae | 5<br>Very Poor | Mossy Rock | |
| September | 4<br>High Algae | 4<br>Poor | Dried Chamomile | |

West Rush Lake | Sulfate | Expected Range: None | Deep Lake Standard: None




| Average mg/L | |
|---|---|
| 2015 | 3.2 |
| 2016 | 2.5 |

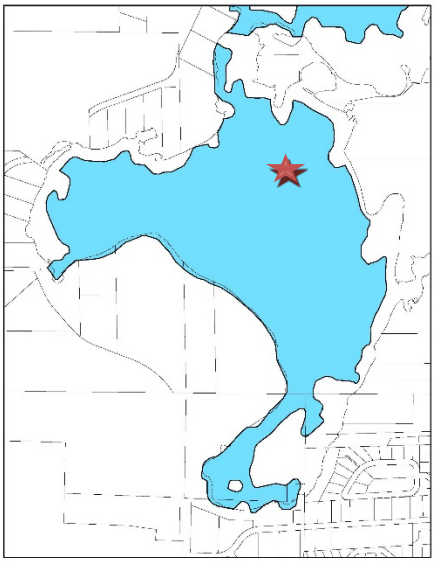
West Rush Lake | Total Iron | Expected Range: None | Deep Lake Standard: None




| Average mg/L | |
|---|---|
| 2015 | 0.05 |
| 2016 | 65.3 |

# School Lake

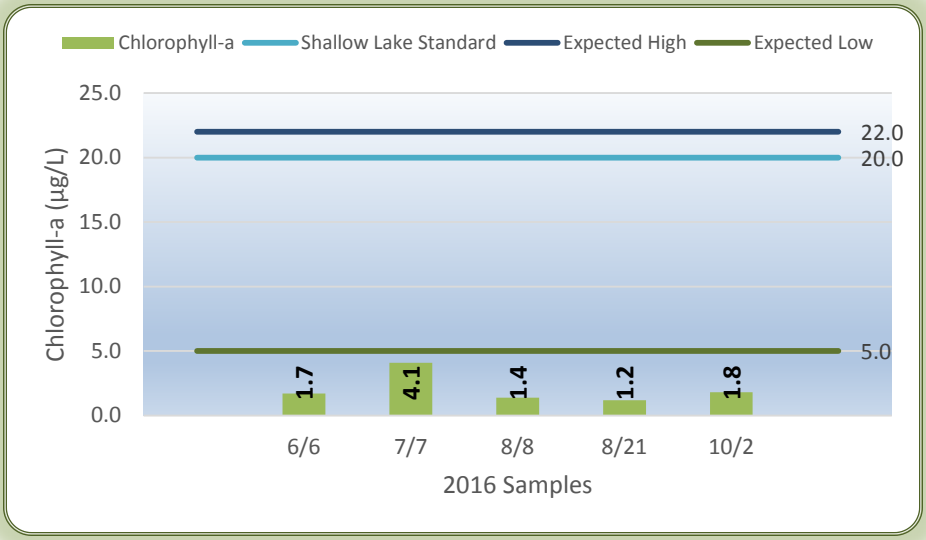
Lake 13-0044-00 Site 201



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Mesotrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 3 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 37.6 | 53.1 | 49.4 | 46.7 |
| Classification | Mesotrophic | Eutrophic | Mesotrophic | Mesotrophic |
| 2016 Average (May-Sept) | 2.0 µg/L | 1.6 meters | 23.0 µg/L | - |
| Grade | A | C* | B | B |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 2.1 µg/L | 1.6 meters | 20.8 µg/L | - |
| Meets Standard | No | No | No | No |

*Grade may be artificially low due to shallow total depth or aquatic vegetation




## Chlorophyll-a

School Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 20.0 µg/L |
|---|---|---|---|---|
| 2008 | 84.5 | D | 84.6 | No |
| 2009 | 72.3 | D | 76.8 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 2.0 | A | 2.1 | Yes |

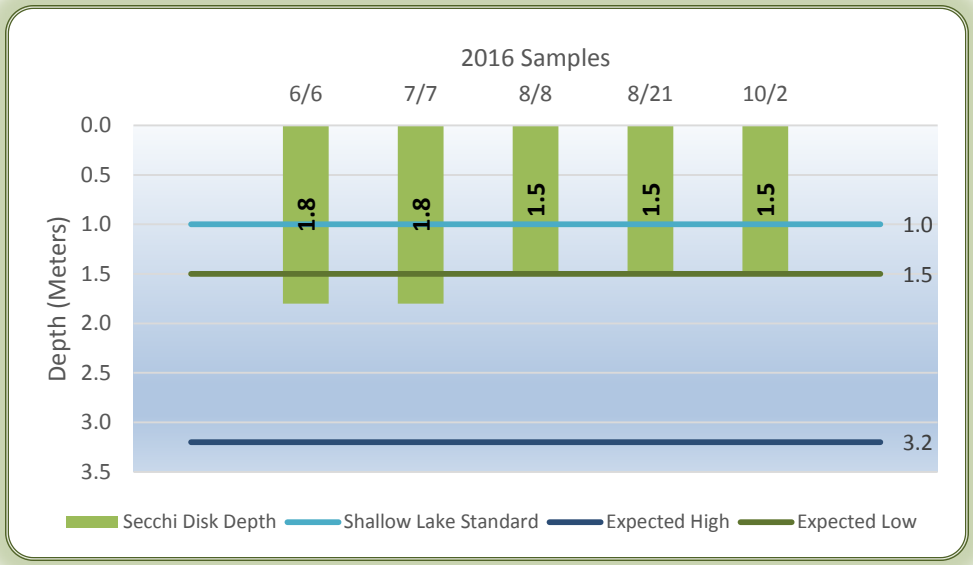
## Secchi Disk Depth

School Lake

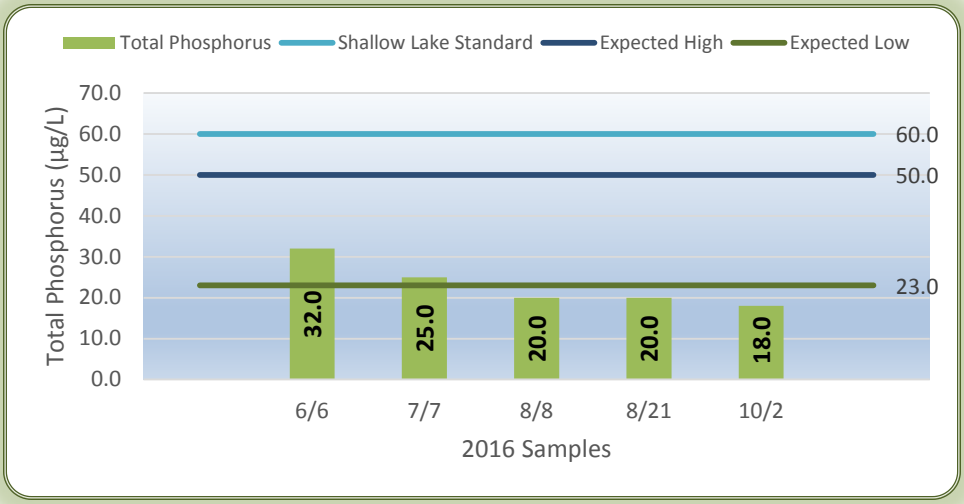
Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

*Grades may be artificially low due to shallow total depth or aquatic vegetation




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1 meter |
|---|---|---|---|---|
| 2008 | 0.4 | F | 0.4 | No |
| 2009 | 0.4 | F | 0.4 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 1.6 | C* | 1.6 | Yes |




# Total Phosphorus

School Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

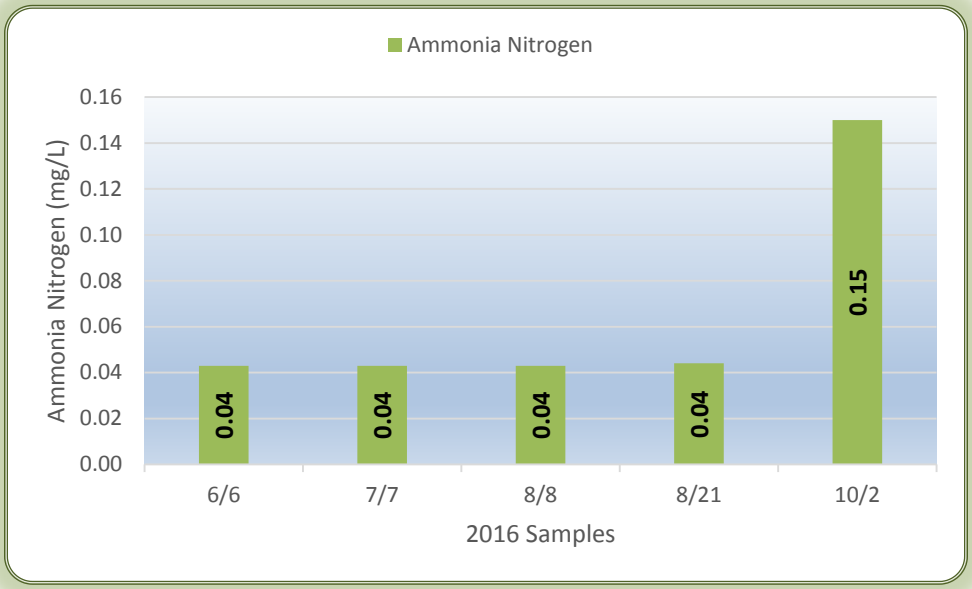
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 60.0 µg/L |
|---|---|---|---|---|
| 2008 | 191.0 | F | 190.8 | No |
| 2009 | 217.0 | F | 221.8 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 23.0 | B | 20.8 | Yes |

# Ammonia Nitrogen

School Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average mg/L | |
|---|---|
| 2008-2015 | No Data |
| 2016 | 0.06 |

General Observations
School Lake

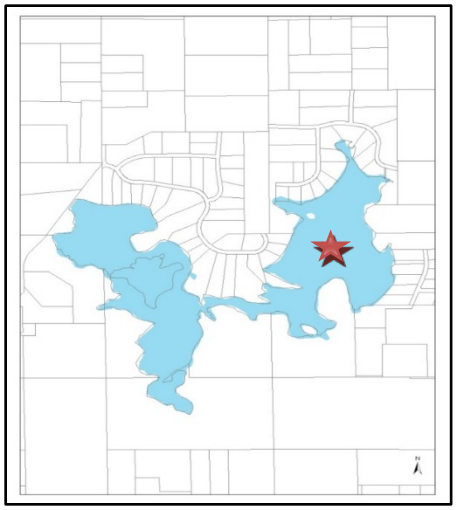
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 3<br>Medium Algae | 2<br>Good | Shortbread | |
| June | 3<br>Medium Algae | 3<br>Fair | Dried Chamomile | |
| July | 2<br>Low Algae | 3<br>Fair | Toasted Marshmallow | |
| August | 2<br>Low Algae | 3<br>Fair | Shortbread | |
| September | 2<br>Low Algae | 3<br>Fair | Lemon Ice | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

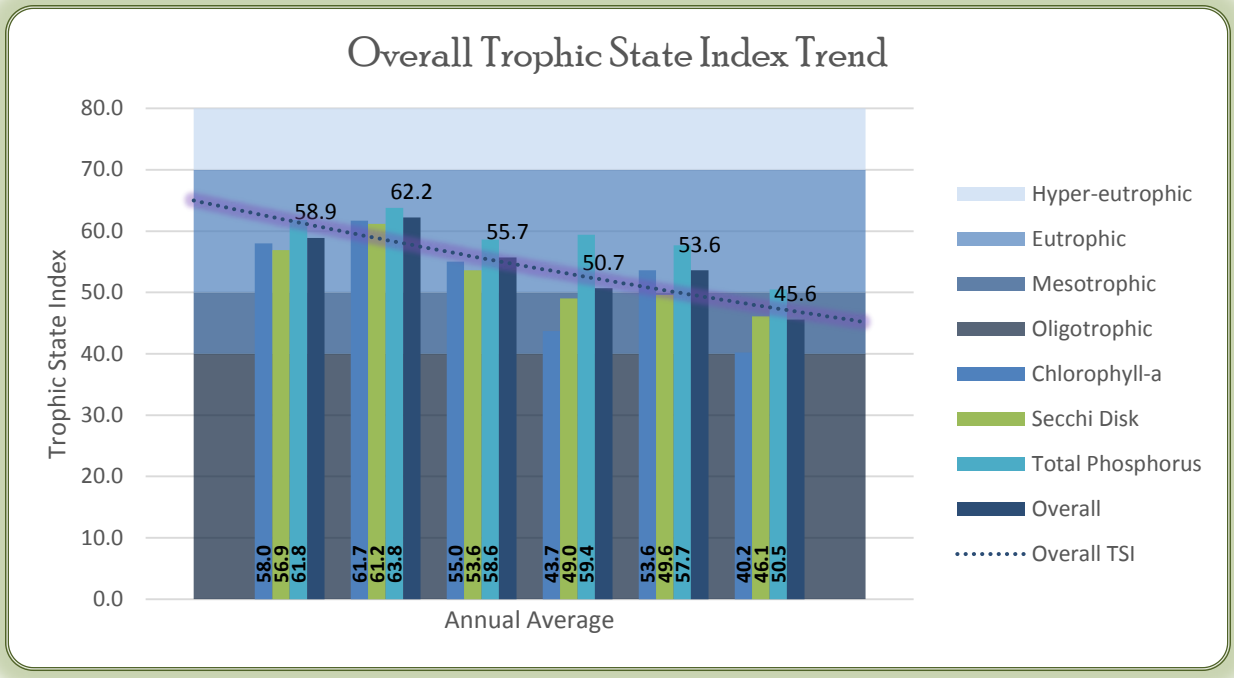
# Spider Lake-East

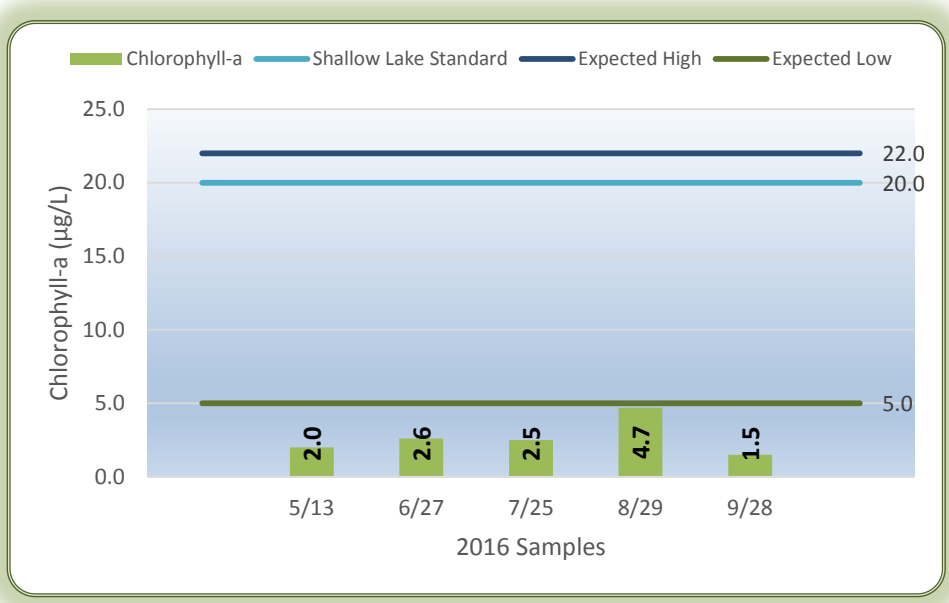
Lake 13-0019-00 Site 202



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Mesotrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 2 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 40.2 | 46.1 | 50.5 | 45.6 |
| Classification | Mesotrophic | Mesotrophic | Eutrophic | Mesotrophic |
| 2016 Average (May-Sept) | 2.7 µg/L | 2.6 meters | 24.8 µg/L | - |
| Grade | A | B | B | B |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 2.8 µg/L | 2.7 meters | 25.5 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





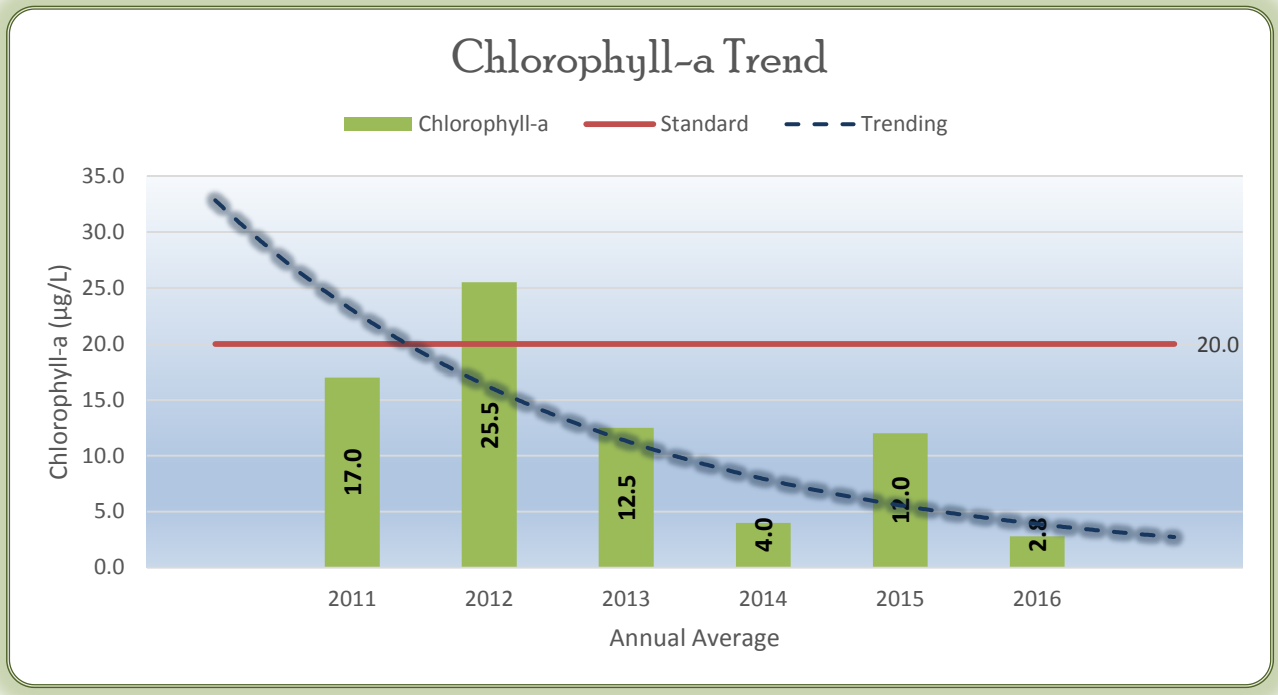

# Chlorophyll-a

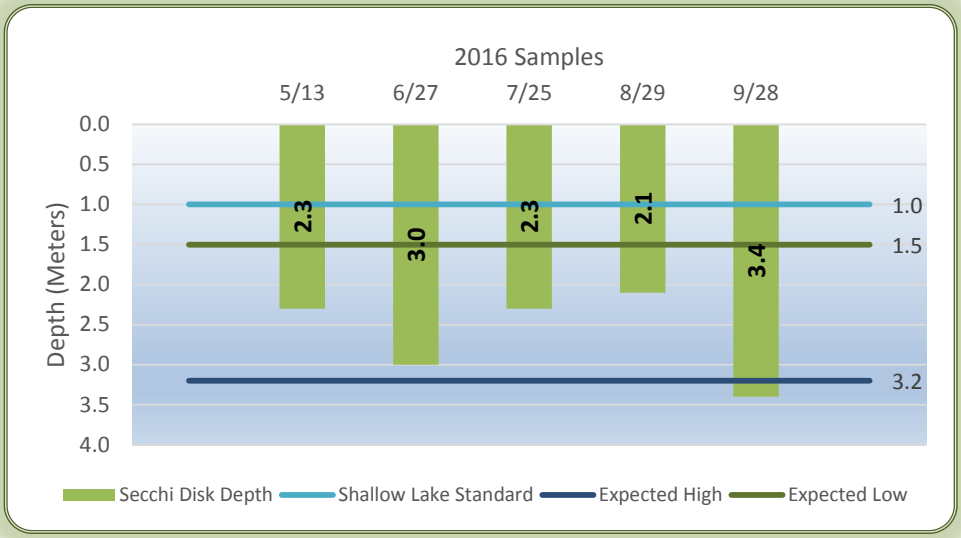
## Spider Lake-East

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | 16.4 | 23.8 | 12.0 | 3.8 | 10.4 | 2.7 |
| Grade | - | - | B | C | B | A | B | A |
| June-Sept Average (µg/L) | No Data | No Data | 17.0 | 25.5 | 12.5 | 4.0 | 12.0 | 2.8 |
| Meets Standard (20.0 µg/L) | - | - | Yes | No | Yes | Yes | Yes | Yes |





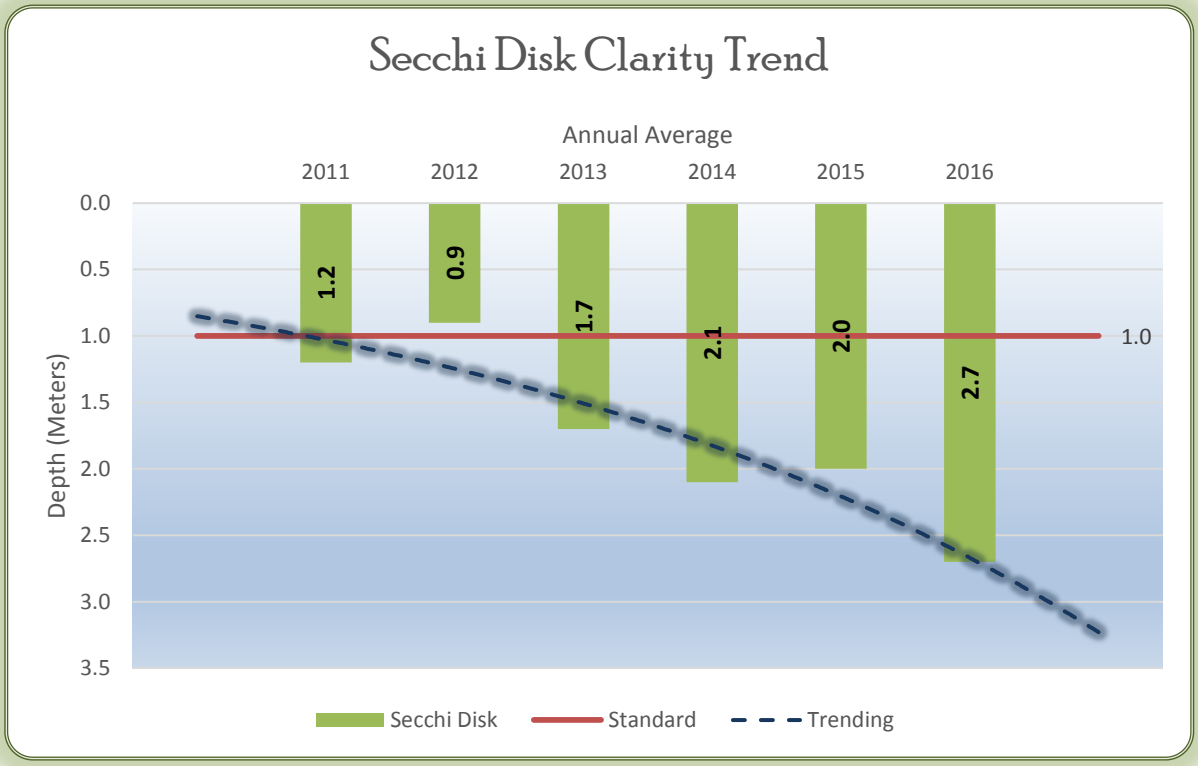

# Secchi Disk Depth

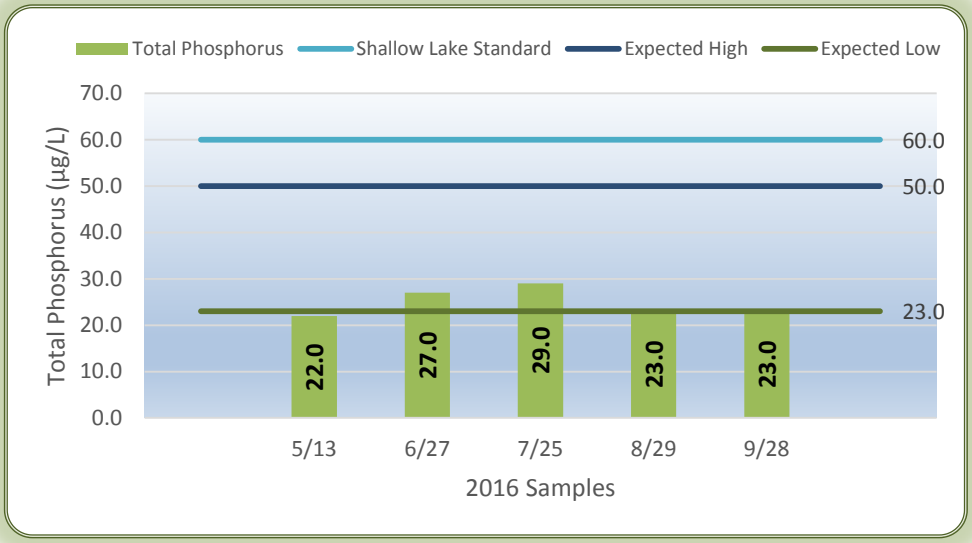
## Spider Lake-East

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | No Data | No Data | 1.2 | 0.9 | 1.6 | 2.1 | 2.1 | 2.6 |
| Grade | - | - | C | D | C | C | C | B |
| June-Sept Average (Meters) | No Data | No Data | 1.2 | 0.9 | 1.7 | 2.1 | 2.0 | 2.7 |
| Meets Standard (>1.0 meter) | - | - | Yes | No | Yes | Yes | Yes | Yes |





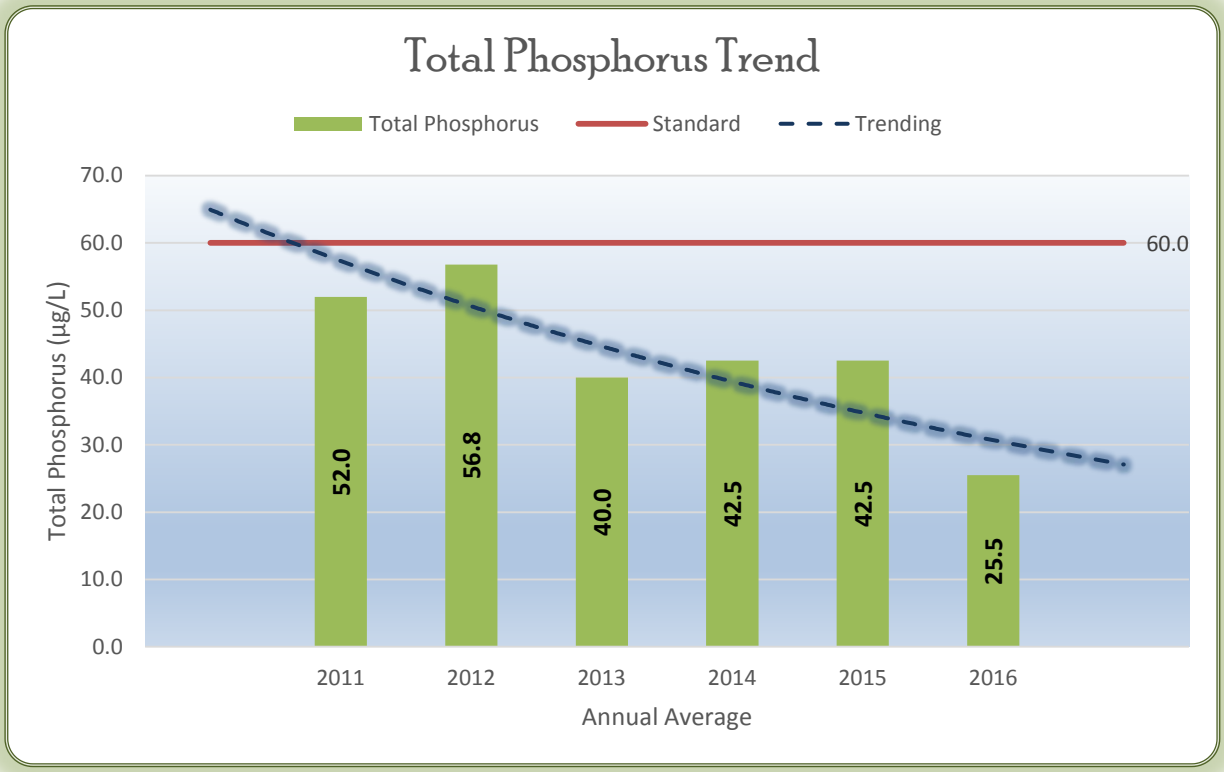

# Total Phosphorus

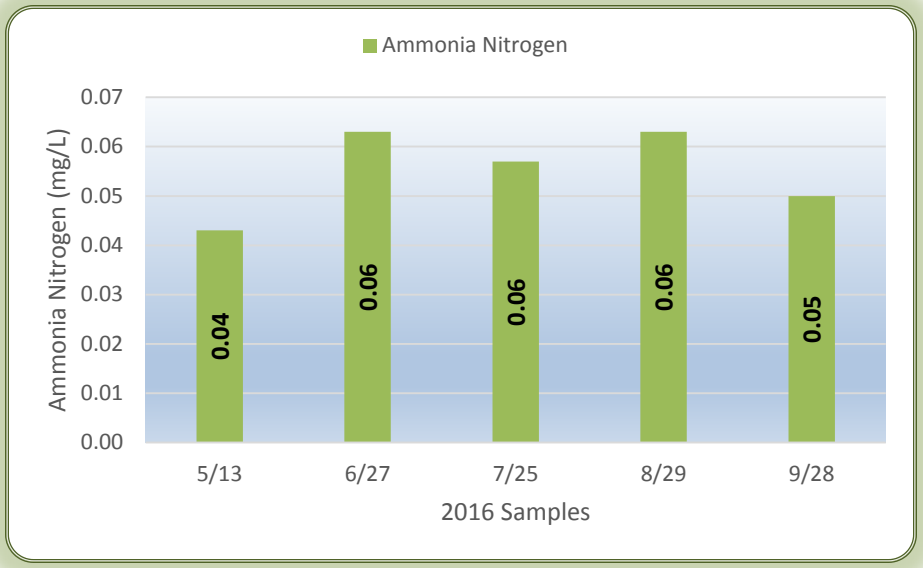
## Spider Lake-East

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | No Data | No Data | 55.0 | 62.4 | 43.6 | 46.0 | 41.0 | 24.8 |
| Grade | - | - | C | C | C | C | C | B |
| June-Sept Average (µg/L) | No Data | No Data | 52.0 | 56.8 | 40.0 | 42.5 | 42.5 | 25.5 |
| Meets Standard (60.0 µg/L) | - | - | Yes | Yes | Yes | Yes | Yes | Yes |





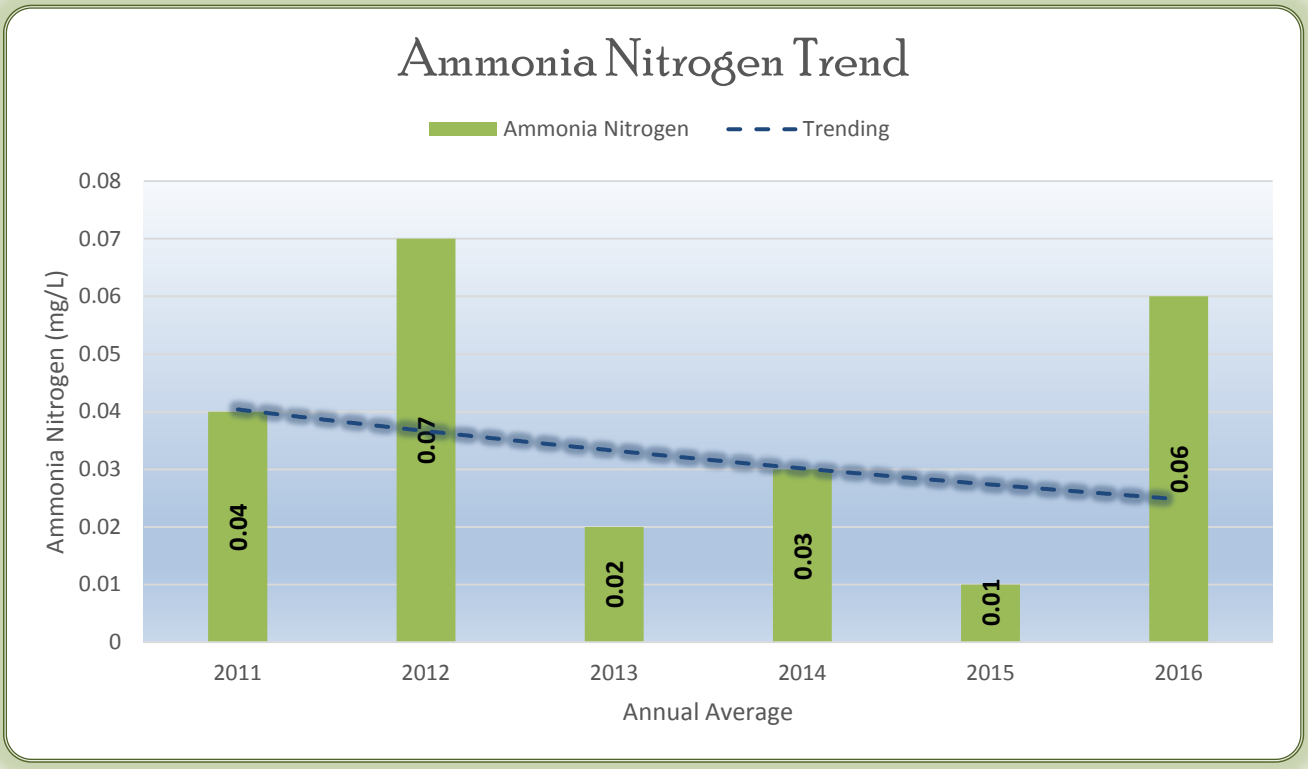

# Ammonia Nitrogen

## Spider Lake-East

Expected Range:
None

Shallow Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | 0.04 | 0.07 | 0.02 | 0.03 | 0.01 | 0.06 |



General Observations
Spider Lake~East

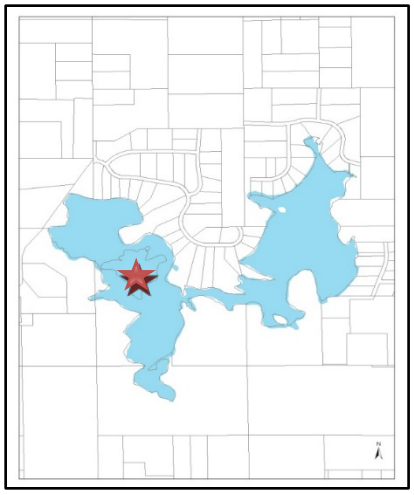
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Malted | |
| June | 1<br>Clear | 1<br>Very Good | Rice Paper | |
| July | 2<br>Low Algae | 2<br>Good | Chopstick | |
| August | 2<br>Low Algae | 2<br>Good | Chopstick | |
| September | 1<br>Clear | 1<br>Very Good | Macadamia | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll~a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll~a, Secchi transparency, and Phosphorus.

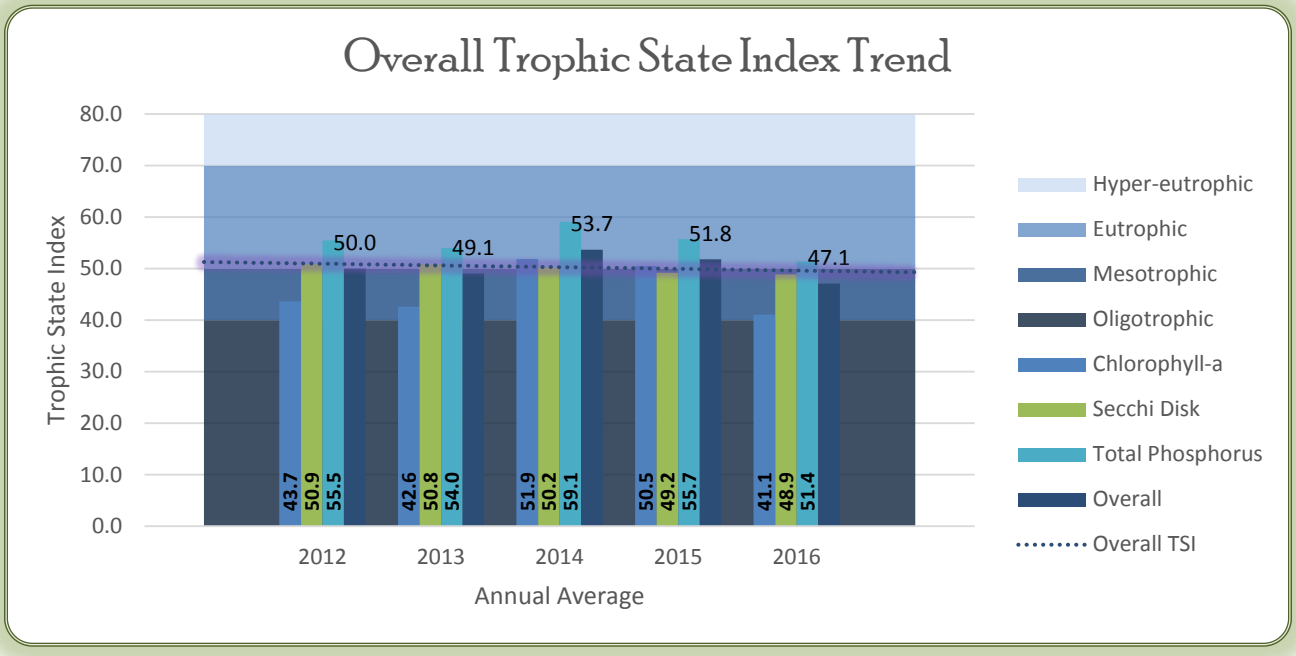
# Spider Lake-West

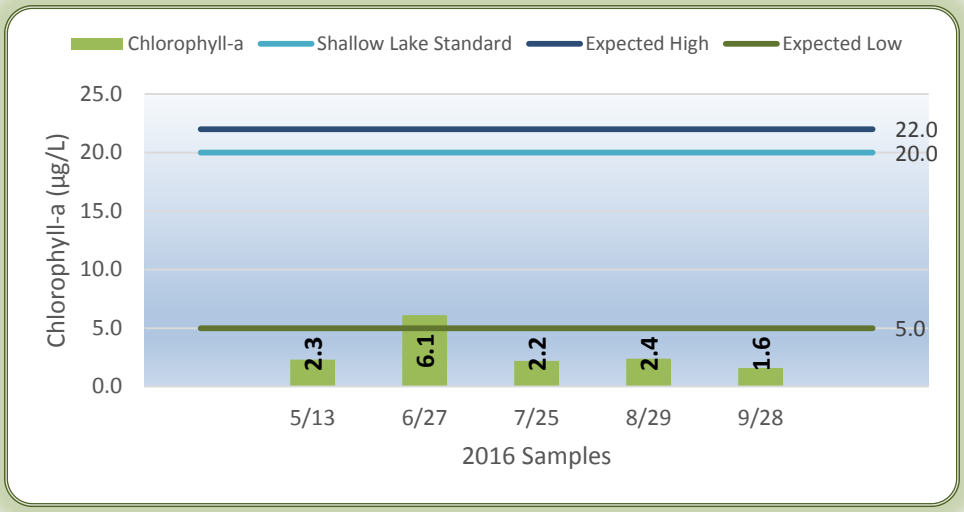
Lake 13-0019-00 Site 201



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Mesotrophic |
| Overall Lake Quality Grade | B |
| Meets MPCA Standards | Yes |
| 2016 Ranking | 5 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 41.1 | 48.9 | 51.4 | 47.1 |
| Classification | Mesotrophic | Mesotrophic | Eutrophic | Mesotrophic |
| 2016 Average (May-Sept) | 2.9 µg/L | 2.2 meters | 26.4 µg/L | - |
| Grade | A | B-C | B | B |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 3.1 µg/L | 2.0 meters | 26.5 µg/L | - |
| Meets Standard | Yes | Yes | Yes | Yes |





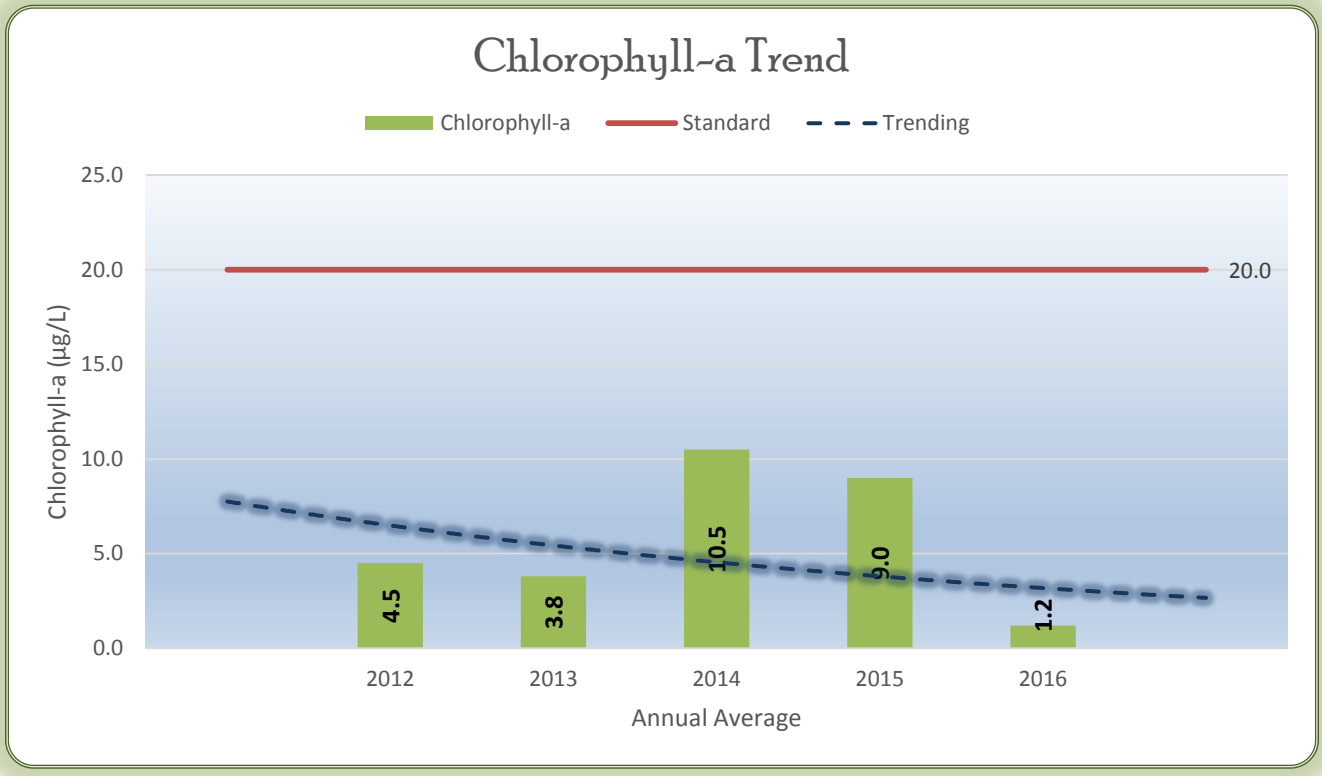

# Chlorophyll-a

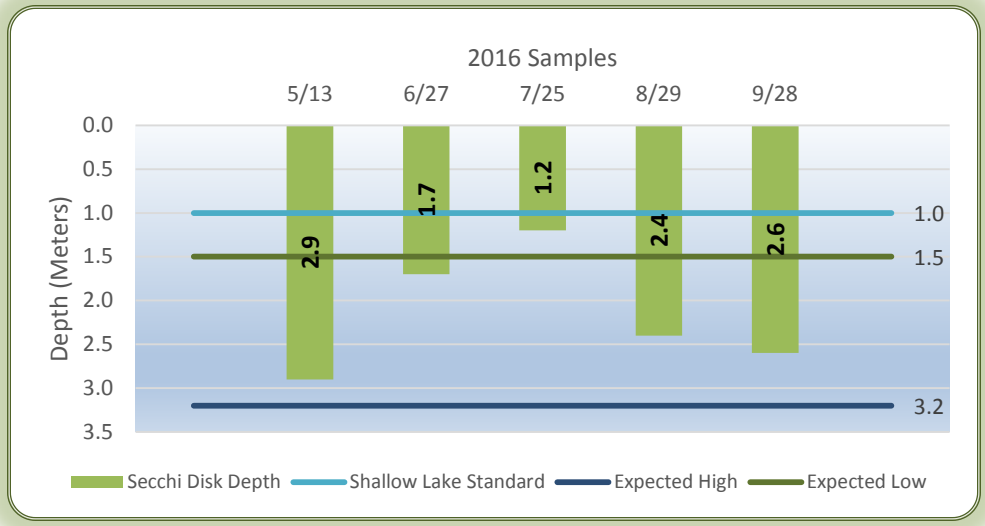
## Spider Lake-West

**Expected Range:**
**5.0-22.0 µg/L**

**Shallow Lake Standard:**
**20.0 µg/L**

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 16.2 | 6.7 | No Data | No Data | 3.8 | 3.4 | 8.8 | 7.6 | 2.9 |
| Grade | C | A | - | - | A | A | A | A | A |
| June-Sept Average (µg/L) | 17.3 | 7.2 | No Data | No Data | 4.5 | 3.8 | 10.5 | 9.0 | 1.2 |
| Meets Standard (20.0 µg/L) | Yes | Yes | - | - | Yes | Yes | Yes | Yes | Yes |





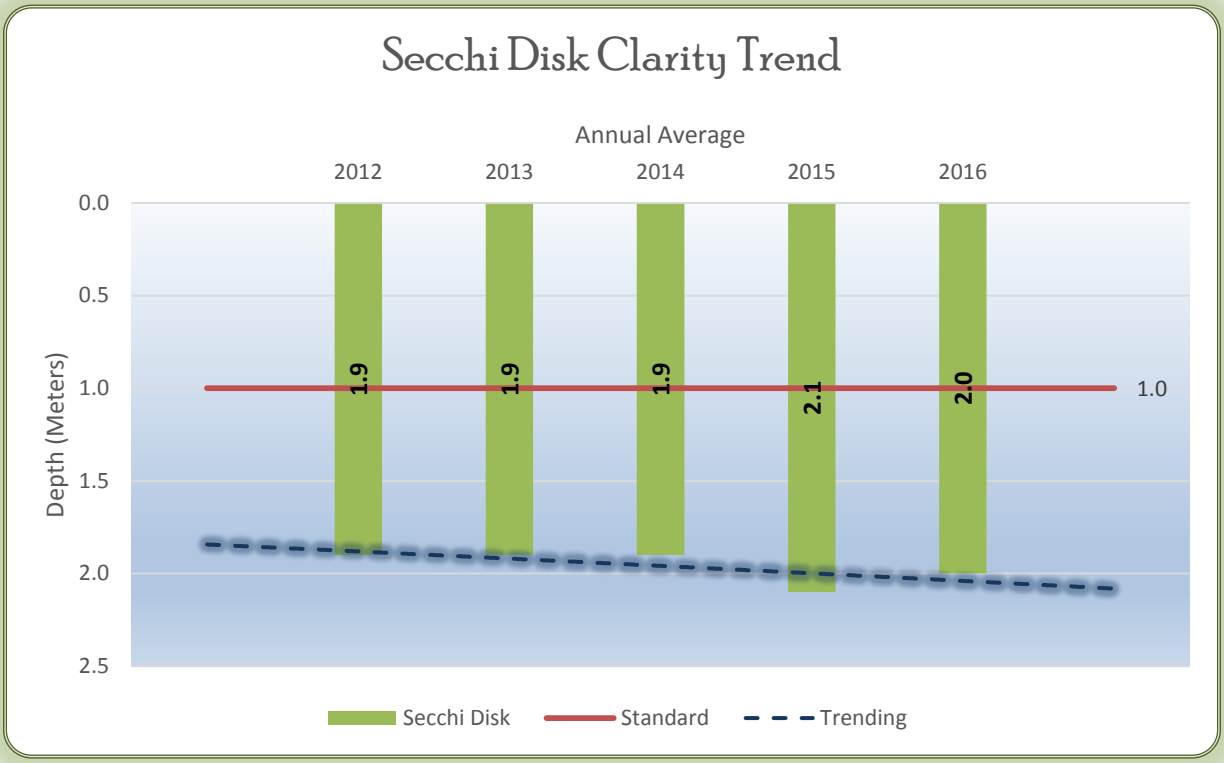

# Secchi Disk Depth

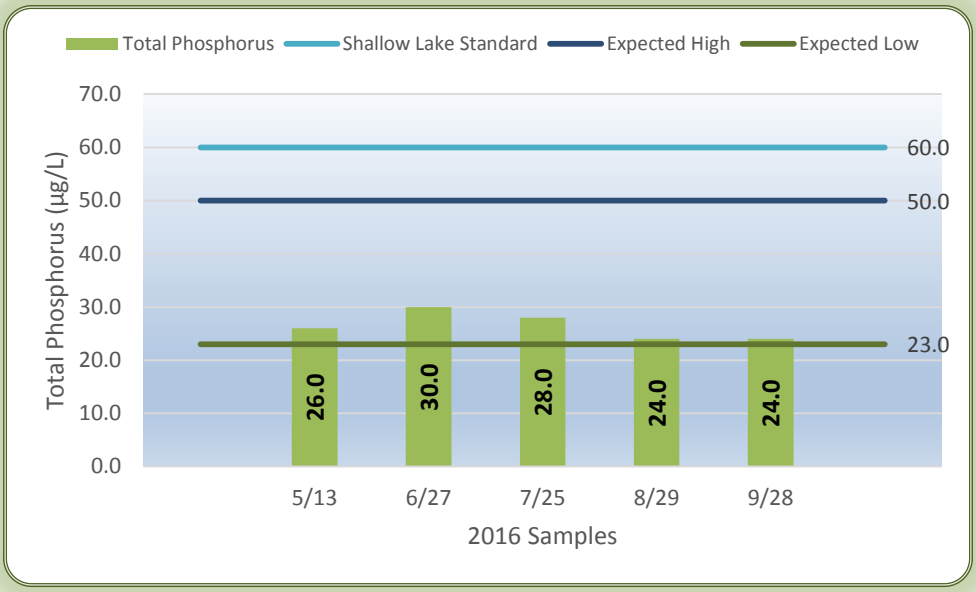
## Spider Lake-West

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| May-Sept Average (Meters) | 1.2 | No Data | No Data | No Data | 1.9 | 1.9 | 2.0 | 2.3 | 2.2 |
| Grade | C | - | - | - | C | C | C | C | B-C |
| June-Sept Average (Meters) | 1.3 | No Data | No Data | No Data | 1.9 | 1.9 | 1.9 | 2.1 | 2.0 |
| Meets Standard (>1.0 meter) | Yes | - | - | - | Yes | Yes | Yes | Yes | Yes |





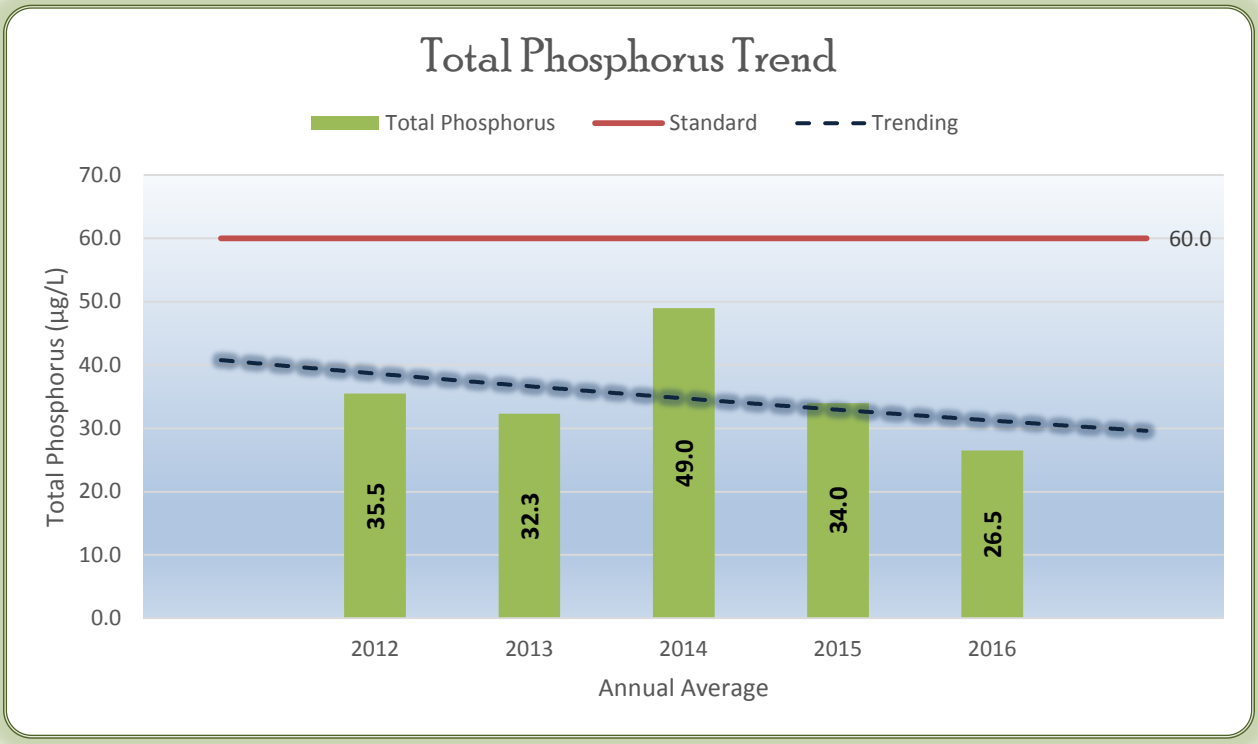

# Total Phosphorus

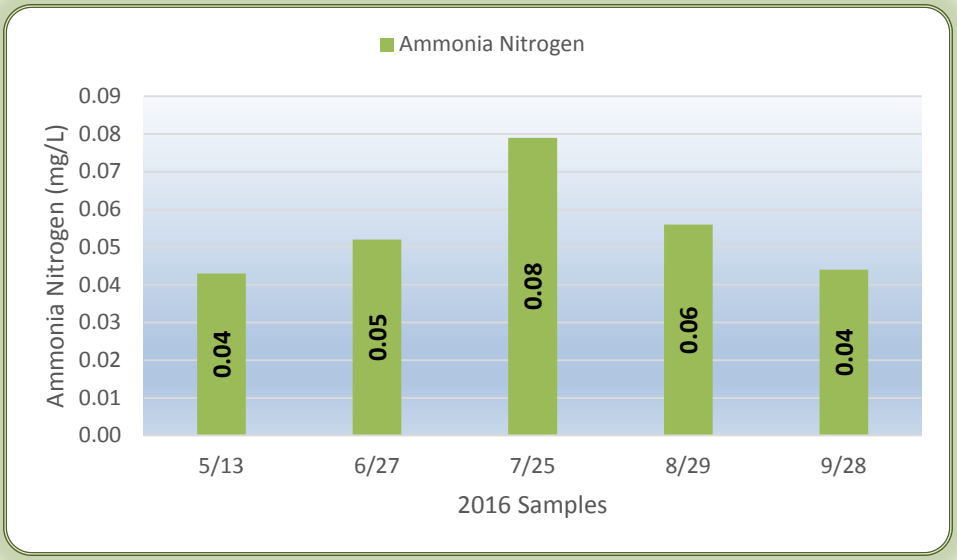
## Spider Lake-West

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| May-Sept Average (µg/L) | 50.0 | 58.0 | No Data | No Data | 35.2 | 31.8 | 45.2 | 35.6 | 26.4 |
| Grade | C | C | - | - | C | B | C | C | B |
| June-Sept Average (µg/L) | 50.1 | 57.3 | No Data | No Data | 35.5 | 32.3 | 49.0 | 34.0 | 26.5 |
| Meets Standard (60.0 µg/L) | Yes | Yes | - | - | Yes | Yes | Yes | Yes | Yes |





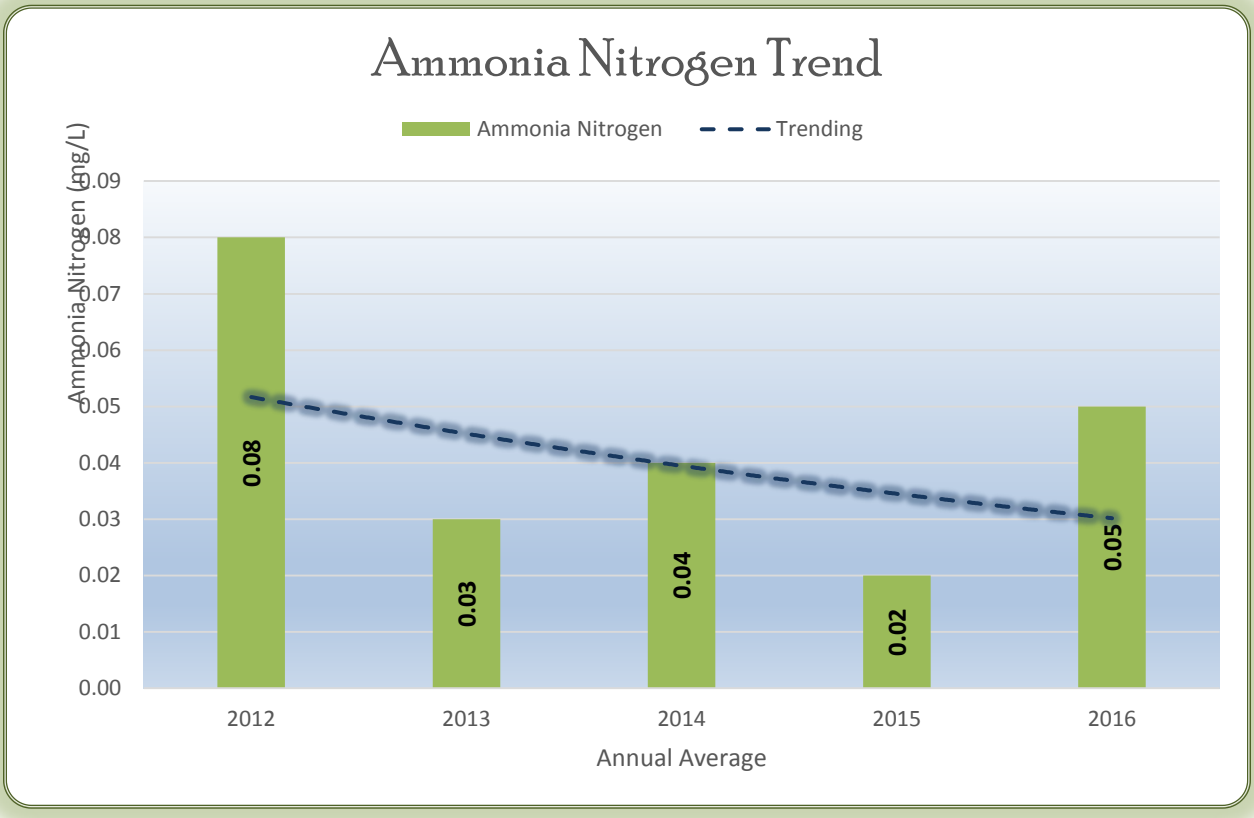

# Ammonia Nitrogen

## Spider Lake-West

Expected Range:
None

Shallow Lake Standard:
None

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Average (mg/L) | No Data | No Data | No Data | 0.08 | 0.03 | 0.04 | 0.02 | 0.05 |



General Observations
Spider Lake–West

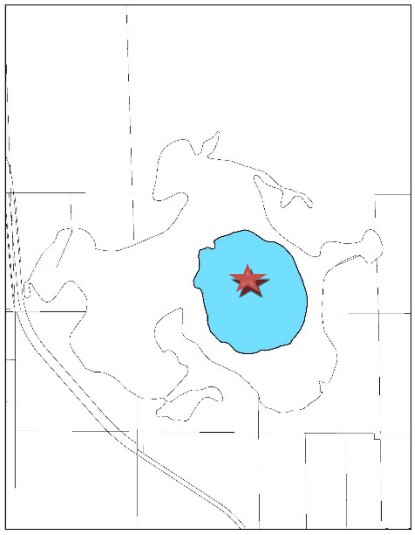
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Chopstick |  |
| June | 2<br>Low Algae | 2<br>Good | Bamboo |  |
| July | 2<br>Low Algae | 2<br>Good | Macadamia |  |
| August | 1<br>Clear | 1<br>Very Good | Chopstick |  |
| September | 1<br>Clear | 1<br>Very Good | Rice Paper |  |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

# Swamp Lake

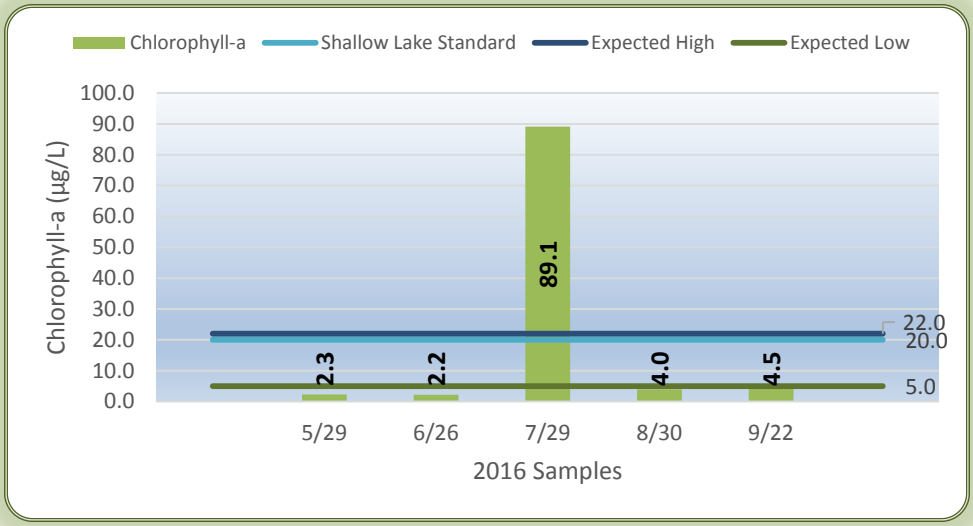
Lake 13-0016-00



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | C- |
| Meets MPCA Standards | No |
| 2016 Ranking | 19 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 60.2 | 60.6 | 54.5 | 58.5 |
| Classification | Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 20.4 µg/L | 1.0 meter | 33.2 µg/L | - |
| Grade | C | D* | C | C- |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 25.0 µg/L | 0.9 meters | 32.8 µg/L | - |
| Meets Standard | No | No | Yes | No |

*Grade may be artificially low due to shallow total depth or aquatic vegetation




## Chlorophyll-a

Swamp Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

| Year | Average (May-Sept) µg/L | Grade | Average(June-Sept) µg/L | Meets Standard 20.0 µg/L |
|---|---|---|---|---|
| 2008-2015 | No Data | - | No Data | - |
| 2016 | 20.4 | C | 25.0 | No |

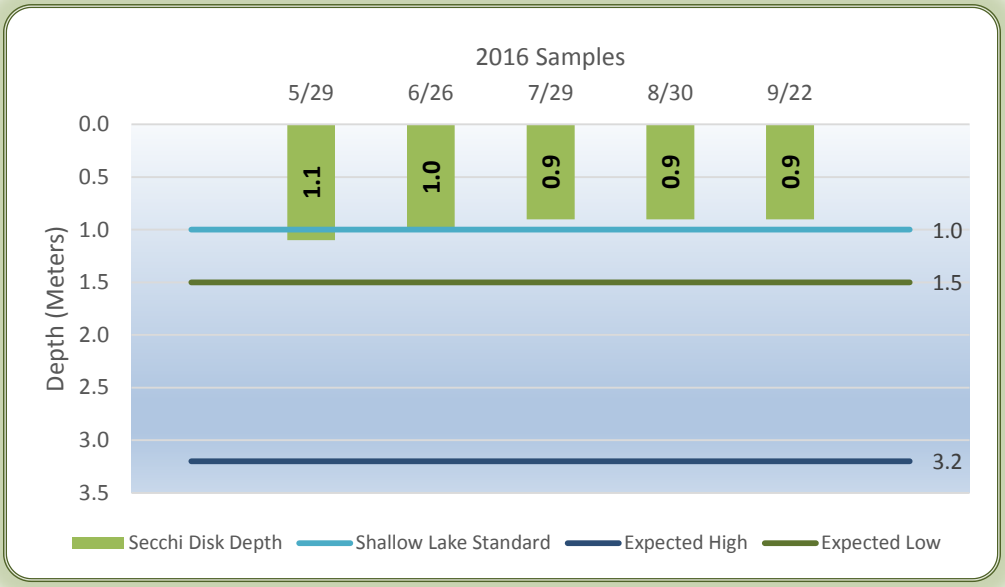
## Secchi Disk Depth

Swamp Lake

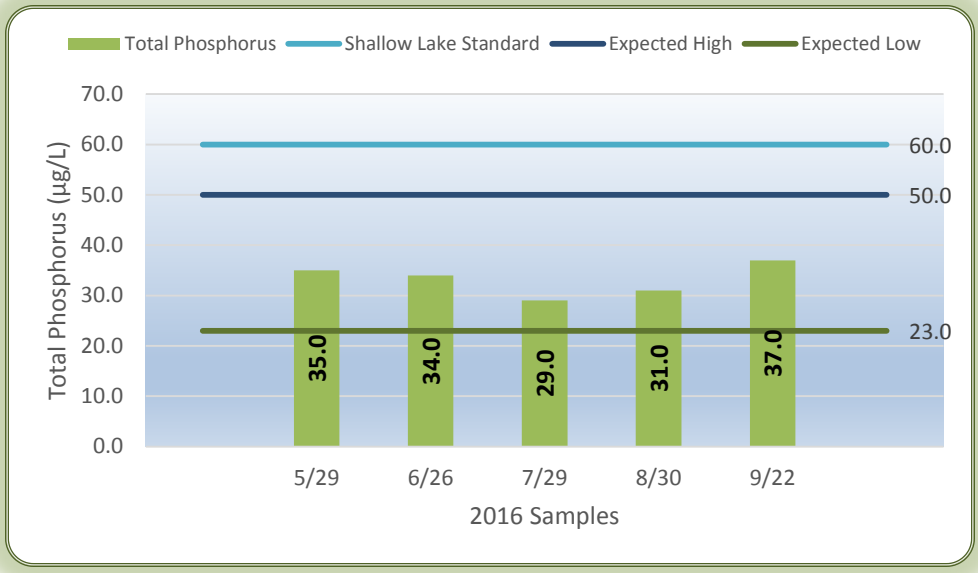
Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter

*Grade may be artificially low due to shallow total depth or aquatic vegetation




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1.0 meter |
|---|---|---|---|---|
| 2008-2015 | No Data | - | No Data | - |
| 2016 | 1.0 | D* | 0.9 | No |




## Total Phosphorus

Swamp Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

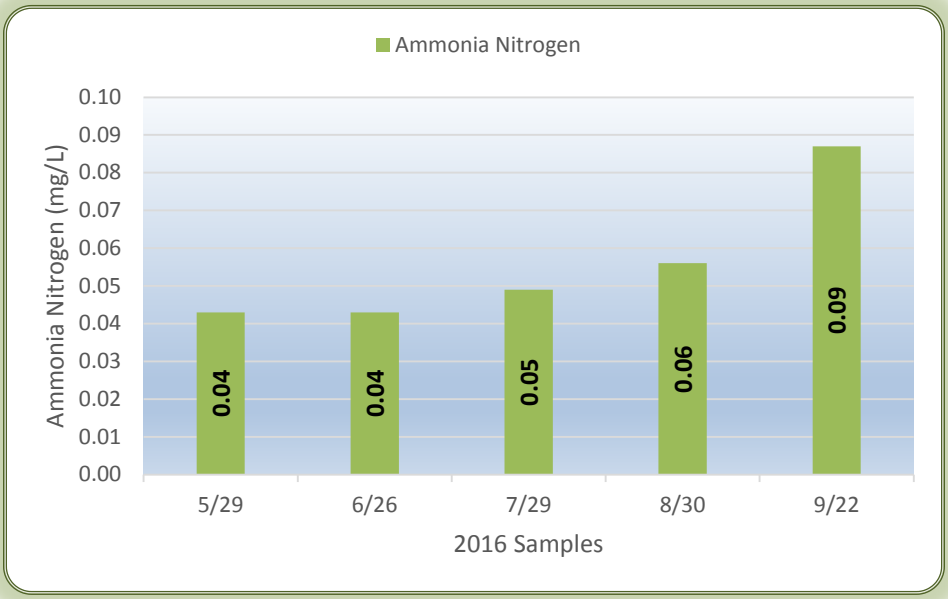
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 60.0 µg/L |
|---|---|---|---|---|
| 2008-2015 | No Data | - | No Data | - |
| 2016 | 33.2 | C | 32.8 | Yes |

## Ammonia Nitrogen

Swamp Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average mg/L | |
|---|---|
| 2008-2015 | No Data |
| 2016 | 0.06 |

General Observations
Swamp Lake

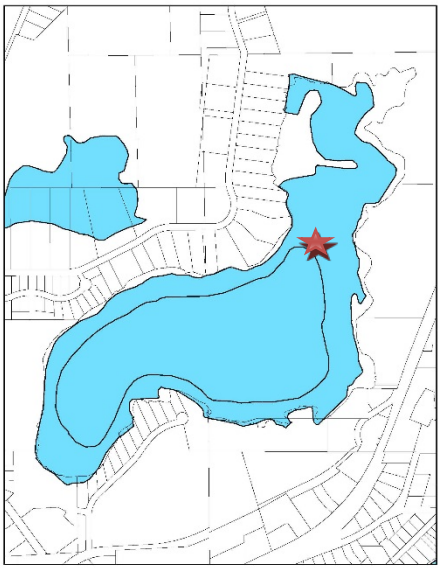
| Month | Physical Condition | Recreational Suitability | Color of Filter Paper* | Color* |
|---|---|---|---|---|
| May | 1<br>Clear | 1<br>Very Good | Chopstick | |
| June | 1<br>Clear | 5<br>Very Poor | Chopstick | |
| July | 1<br>Clear | 5<br>Very Poor | Dune | |
| August | 1<br>Clear | 5<br>Very Poor | Dune | |
| September | 1<br>Clear | 5<br>Very Poor | Parchment Paper | |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.

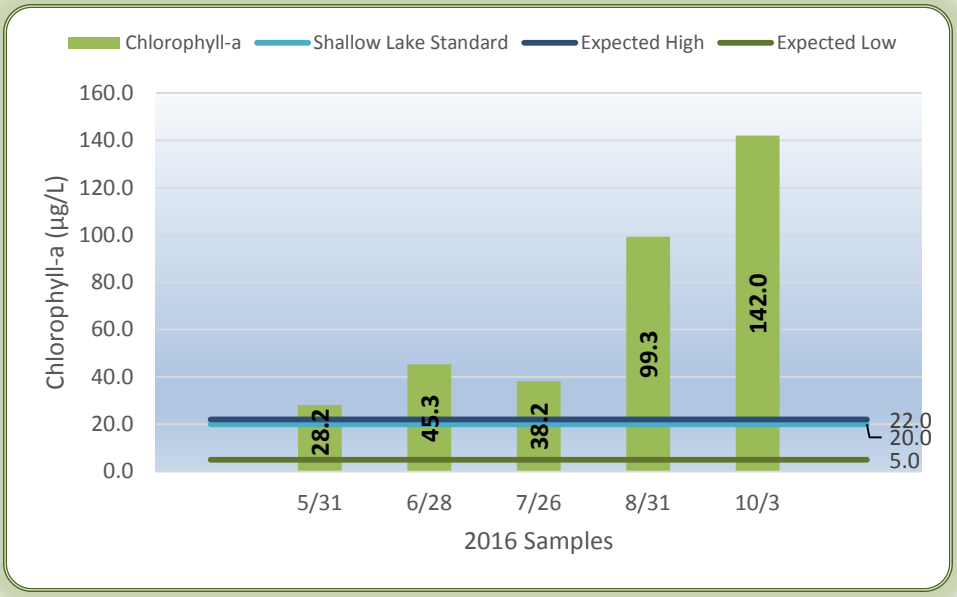
# Walmark Lake

Lake 13-0029-00 Site 202



| 2016 Report Card: Shallow Lake | |
|---|---|
| Lake Classification | Eutrophic |
| Overall Lake Quality Grade | D |
| Meets MPCA Standards | No |
| 2016 Ranking | 27 of 29 |

| | Chlorophyll-a | Secchi Disk Depth | Total Phosphorus | Overall |
|---|---|---|---|---|
| Trophic State Index | 72.4 | 68.4 | 68.8 | 69.8 |
| Classification | Hyper-Eutrophic | Eutrophic | Eutrophic | Eutrophic |
| 2016 Average (May-Sept) | 70.6 µg/L | 0.6 meters | 88.6 µg/L | - |
| Grade | D | F | D | D |
| MPCA Standard (Shallow) | 20.0 µg/L | >1.0 meter | 60.0 µg/L | - |
| 2016 Average (June-Sept) | 81.2 µg/L | 0.5 meters | 92.0 µg/L | - |
| Meets Standard | No | No | No | No |




## Chlorophyll-a

Walmark Lake

Expected Range:
5.0-22.0 µg/L

Shallow Lake Standard:
20.0 µg/L

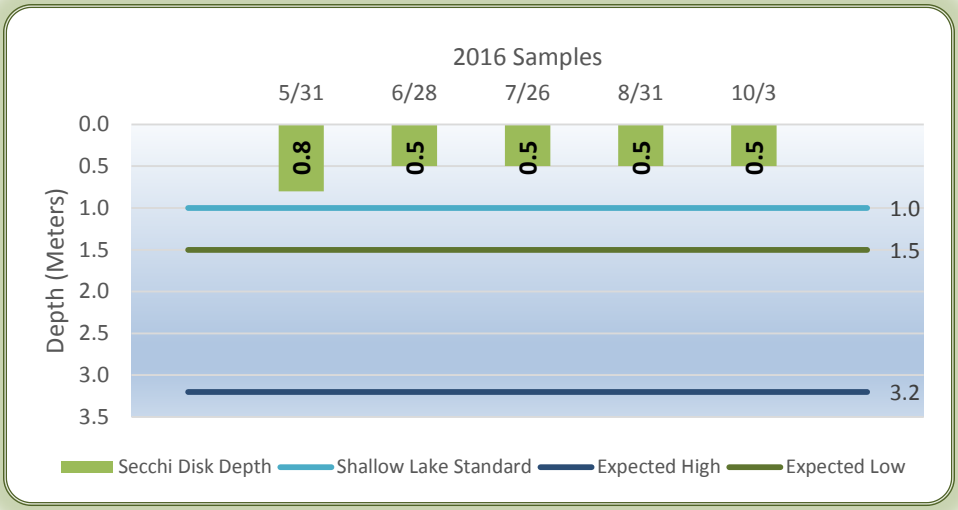
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 20.0 µg/L |
|---|---|---|---|---|
| 2009 | 262.0 | F | 269.4 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 88.6 | D | 92.0 | No |

## Secchi Disk Depth

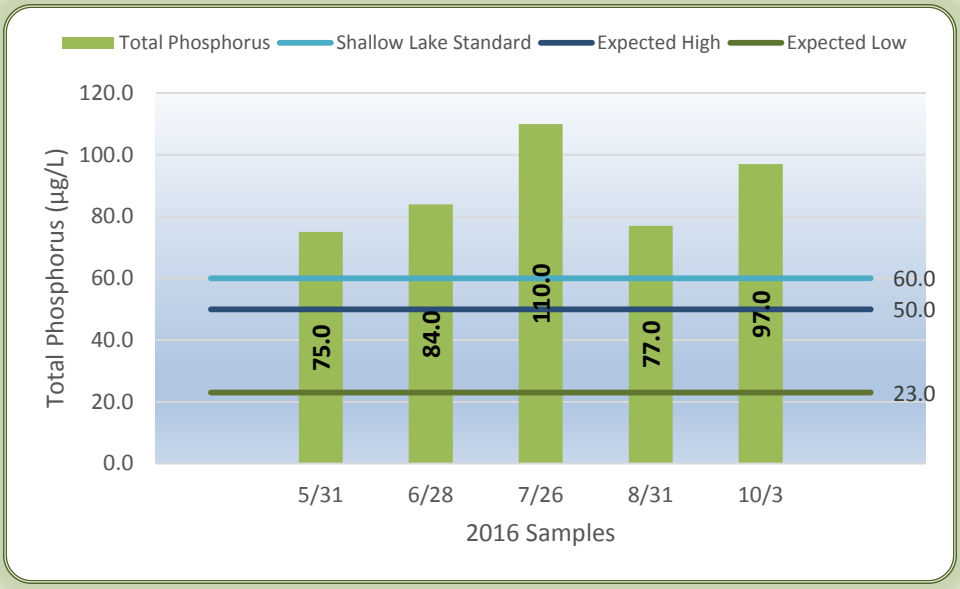
Walmark Lake

Expected Range:
1.5-3.2 meters

Shallow Lake Standard:
>1.0 meter




| Year | Average (May-Sept) Meters | Grade | Average (June-Sept) Meters | Meets Standard >1.0 meter |
|---|---|---|---|---|
| 2009 | 0.3 | F | 0.2 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 06 | F | 0.5 | No |




## Total Phosphorus

Walmark Lake

Expected Range:
23.0-50.0 µg/L

Shallow Lake Standard:
60.0 µg/L

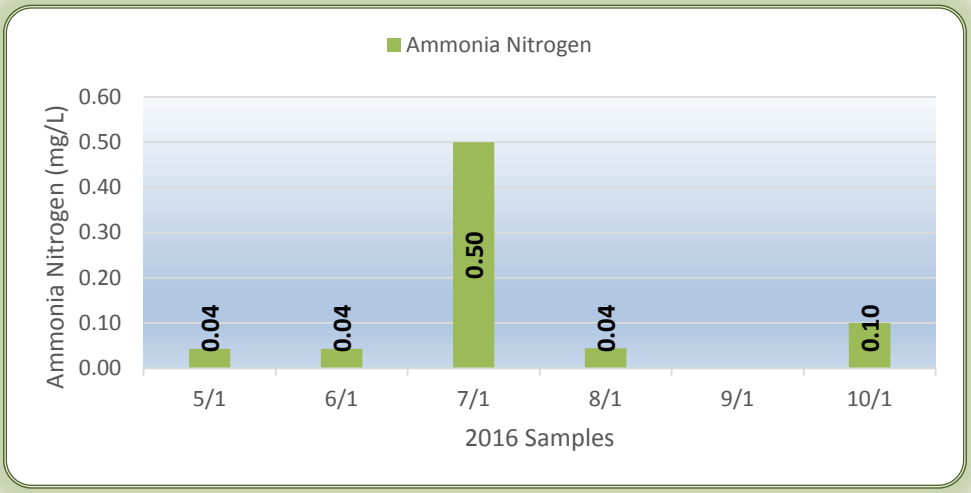
| Year | Average (May-Sept) µg/L | Grade | Average (June-Sept) µg/L | Meets Standard 60.0 µg/L |
|---|---|---|---|---|
| 2009 | 281.0 | F | 271.0 | No |
| 2010-2015 | No Data | - | No Data | - |
| 2016 | 88.6 | D | 92.0 | No |

## Ammonia Nitrogen

Walmark Lake

Expected Range:
None

Shallow Lake Standard:
None




| Average mg/L | |
|---|---|
| 2009 | 0.09 |
| 2010-2015 | No Data |
| 2016 | 0.15 |

General Observations
Walmark Lake

| Month | Physical Condition | Recreational Suitability | Color of Filter Paper | Color |
|---|---|---|---|---|
| May | 3<br>Medium Algae | 3<br>Fair | Dried Chamomile |  |
| June | 3<br>Medium Algae | 3<br>Fair | Cornucopia |  |
| July | 3<br>Medium Algae | 3<br>Fair | Cornucopia |  |
| August | 3<br>Medium Algae | 3<br>Fair | Cornichon |  |
| September | 3<br>Medium Algae | 3<br>Fair | Cornichon |  |

# Explanation of Color Classification

During each sample, water was run through filter paper. Algae remain on filter paper. The color of the filter paper was compared to paint samples and matched as closely as possible. The averages for Chlorophyll-a, Secchi transparency, and Phosphorus concentration for each color were determined from the average values of the samples within that color. The chart shown on page 13 is sorted according to phosphorus concentrations from lowest to highest. Only colors with 10 or more samples collected were included in the chart. A total of 521 samples were collected. There is a correlation between the algae color on the filter paper and the concentrations of Chlorophyll-a, Secchi transparency, and Phosphorus.


Chisago
COUNTY