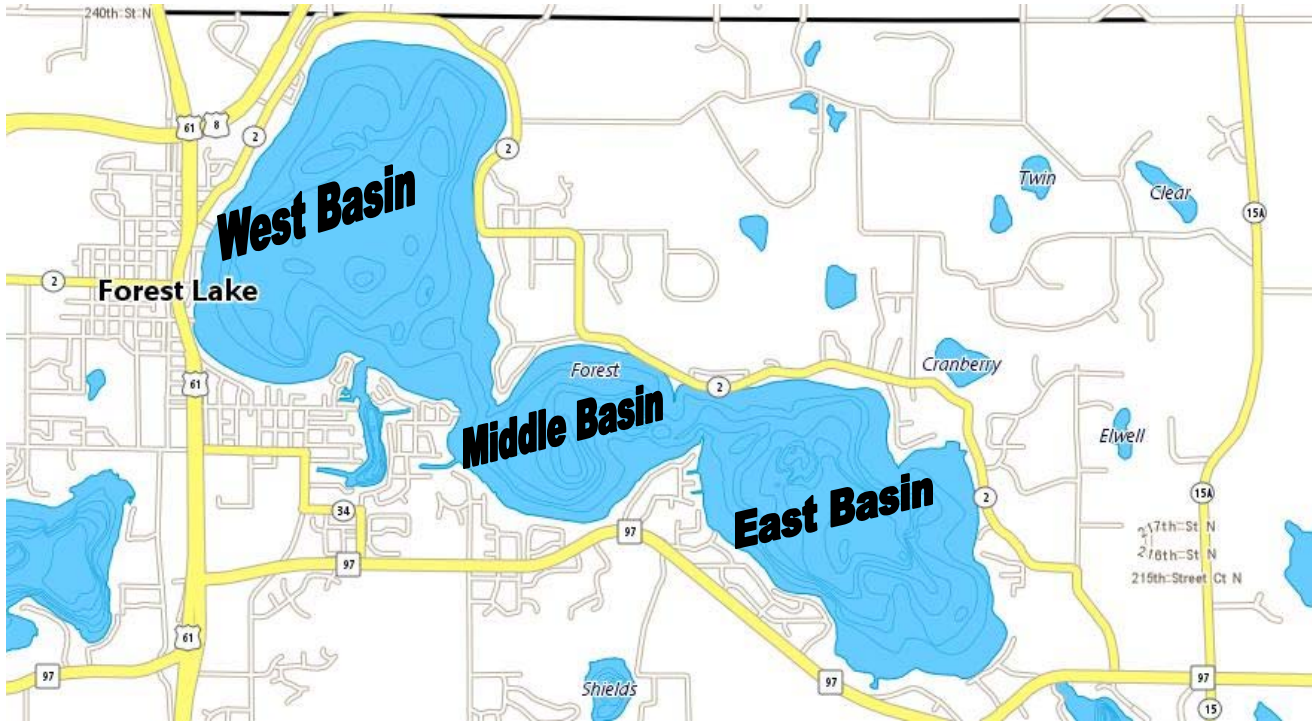


Forest Lake 2018 Water Quality Summaries

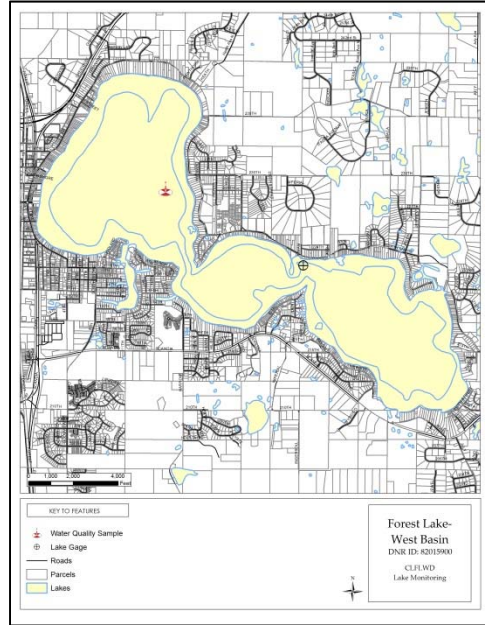


Water quality sampling for Forest Lake is conducted on each of the three basins shown above. The following pages include a summary for each of the three basins and one page on lake level statistics

Forest Lake (West Basin)

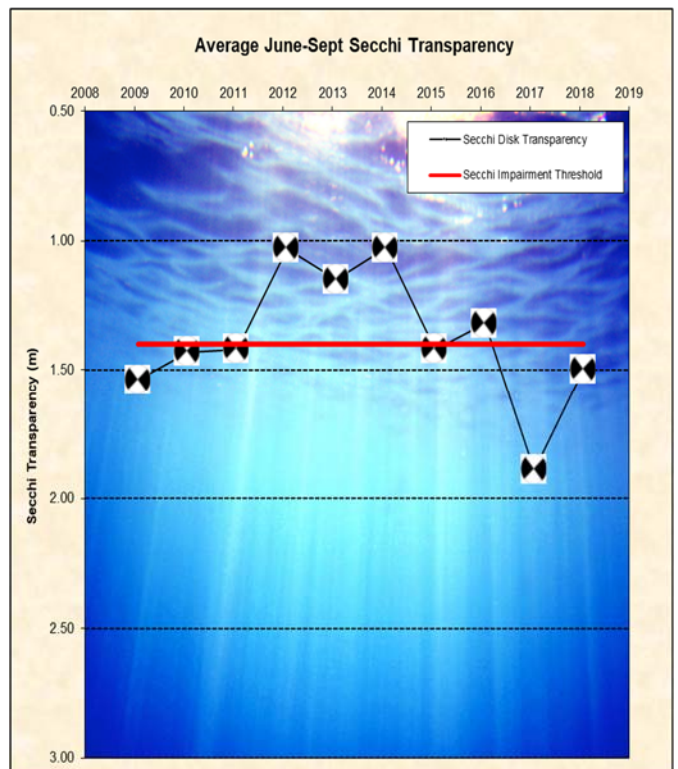
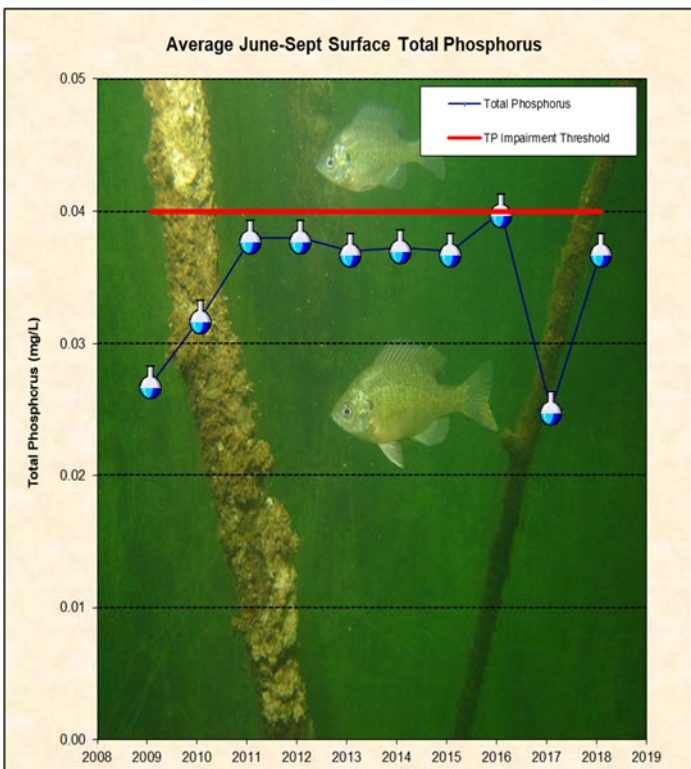
2018 Lake Grade: C+

- DNR ID #: 82015900
- Municipality: City of Forest Lake
- Location: Section 9 T32N-R21W
- Lake Size: 1,086.08 acres
- Maximum Depth (2018): 21 ft.
- Ordinary High Water Mark: 901.8 ft.
- 67% Littoral
Note: Littoral area is the portion of the lake <15 ft. and dominated by aquatic vegetation.

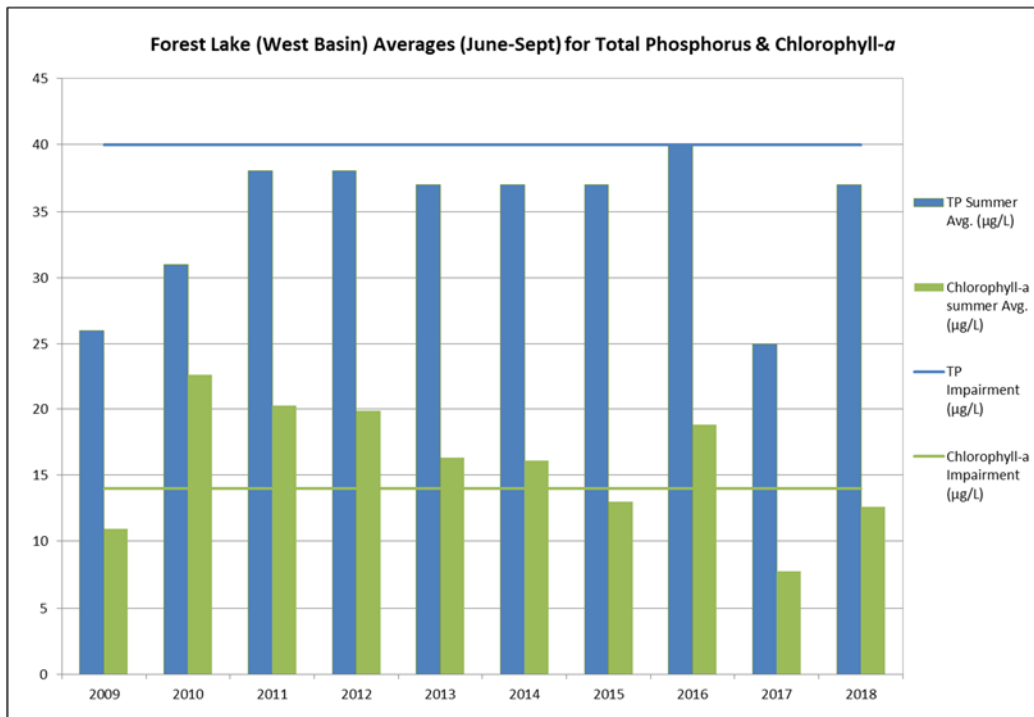


Summary Points

- Based on the chlorophyll-*a* results Forest Lake (West Basin) was considered eutrophic in 2018, according to the Carlson Trophic State Index.
- Using the 2-tailed Kendall Tau correlation test ($p < 0.05$) there is no trend for the average total phosphorus or average Secchi transparency and there is an insufficient number of years of data to determine trends for chlorophyll-*a* at this time.
- The major land use is urban.
- The lake did not stratify in 2018.
- Eurasian watermilfoil, Flowering rush, Curly-leaf pondweed (invasive aquatic plants), and Zebra mussels are present in this lake.



| Date/Time | Total Phosphorus (mg/L) | Uncorrected Trichromatic Chlorophyll-a (µg/L) | Pheophytin-Corrected Chlorophyll-a (µg/L) | Total Kjeldahl Nitrogen (mg/L) | Secchi Disk Depth (m) | Surface Temperature (Celsius) | Surface Dissolved Oxygen (mg/L) |
|---|-------------------------|---|---|--------------------------------|-----------------------|-------------------------------|---------------------------------|
| 5/15/2018 12:47 | 0.020 | 3.3 | 3.0 | 0.74 | 3.51 | 16.4 | 10.35 |
| 5/29/2018 12:59 | 0.032 | 4.1 | 3.4 | 0.79 | 3.35 | 24.2 | 8.87 |
| 6/14/2018 12:17 | 0.046 | 11.0 | 13.0 | 0.85 | 1.52 | 21.9 | 9.02 |
| 6/28/2018 9:24 | 0.044 | 9.3 | 8.7 | 0.86 | 1.52 | 24.1 | 7.99 |
| 7/10/2018 13:24 | 0.035 | 13.0 | 15.0 | 0.73 | 1.37 | 26.4 | 9.02 |
| 7/24/2018 10:33 | 0.045 | 16.0 | 15.0 | 1.00 | 1.37 | 25.5 | 9.24 |
| 8/7/2018 12:25 | 0.039 | 16.0 | 15.0 | 0.95 | 1.37 | 24.2 | 9.33 |
| 8/21/2018 8:28 | 0.031 | 11.0 | 11.0 | 0.81 | 1.52 | 24.2 | 7.13 |
| 9/6/2018 13:18 | 0.030 | 13.0 | 12.0 | 0.96 | 1.68 | 23.1 | 7.71 |
| 9/18/2018 15:16 | 0.029 | 12.0 | 11.0 | 0.75 | 1.68 | 21.9 | 7.64 |
| 10/4/2018 12:56 | 0.031 | 13.0 | 11.0 | 0.83 | 1.22 | 12.6 | 10.34 |
| 10/23/2018 15:31 | 0.019 | 4.6 | 3.4 | 0.77 | 2.44 | 7.4 | 11.20 |
| 2018 Average | 0.033 | 10.5 | 10.1 | 0.84 | 1.88 | 21.0 | 8.99 |
| 2018 Summer Average | 0.037 | 12.7 | 12.6 | 0.86 | 1.50 | 23.9 | 8.39 |
| Volunteer Data | | | | | | | |
| 5/17/2018 14:33 | 0.012 | 2.7 | 2.3 | 0.68 | 3.30 | 19.2 | NA |
| 6/14/2018 14:00 | 0.027 | 9.0 | 7.4 | 0.76 | 1.25 | 22.1 | NA |
| 7/12/2018 10:00 | 0.030 | 14.0 | 13.0 | 0.69 | 1.40 | 25.9 | NA |
| 7/25/2018 11:22 | 0.041 | 15.0 | 15.0 | 0.78 | 1.15 | 25.8 | NA |
| 8/9/2018 10:00 | 0.024 | 12.0 | 12.0 | 0.74 | 1.15 | 26.2 | NA |
| 9/6/2018 13:00 | 0.027 | 10.0 | 9.6 | 0.82 | 1.55 | 25.3 | NA |
| 10/7/2018 13:00 | 0.019 | 8.3 | 7.4 | 0.79 | 1.55 | 22.6 | NA |
| 2018 Average | 0.026 | 10.1 | 9.5 | 0.75 | 1.62 | 23.9 | NA |
| 2018 Summer Average | 0.030 | 12.0 | 11.4 | 0.76 | 1.30 | 25.1 | NA |
| Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth* | | | | | | | |
| Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth* | | | | | | | |
| 2018 Elevation (ft) | High | High Date | Low | Low Date | Average | | |
| | 901.77 | 5/8/2018 | 901.41 | 9/18/2018 | 901.62 | | |
| *Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made." | | | | | | | |

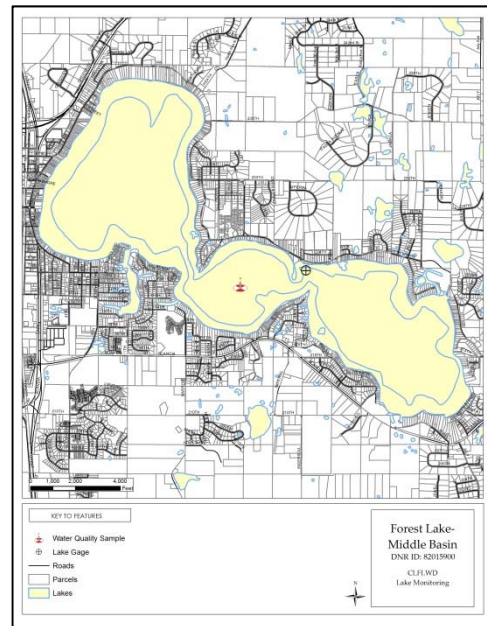


| Lake Water Quality Summary | | | | | | | | | | |
|----------------------------|------------------------|----------|-----------|-----------|----------|----------|-----------|----------|-----------|----------|
| | Lake Grades (May-Sept) | | | | | | | | | |
| | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 |
| Total Phosphorus (mg/L) | C | B | C | C | C | C | C | C | B- | B |
| Chlorophyll-a (µg/L) | B | B | B | B | B | B | C | C | C+ | B+ |
| Secchi depth (ft) | C | B | C | C | D | D | D | B | C | C |
| Overall | C+ | B | C+ | C+ | C | C | C- | C | C+ | B |

Forest Lake (Middle Basin) 2018 Lake Grade: B-

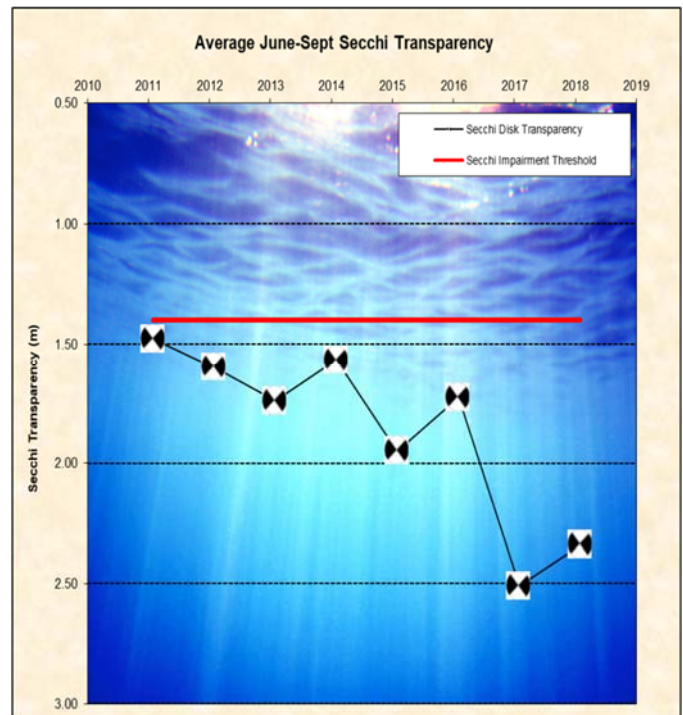
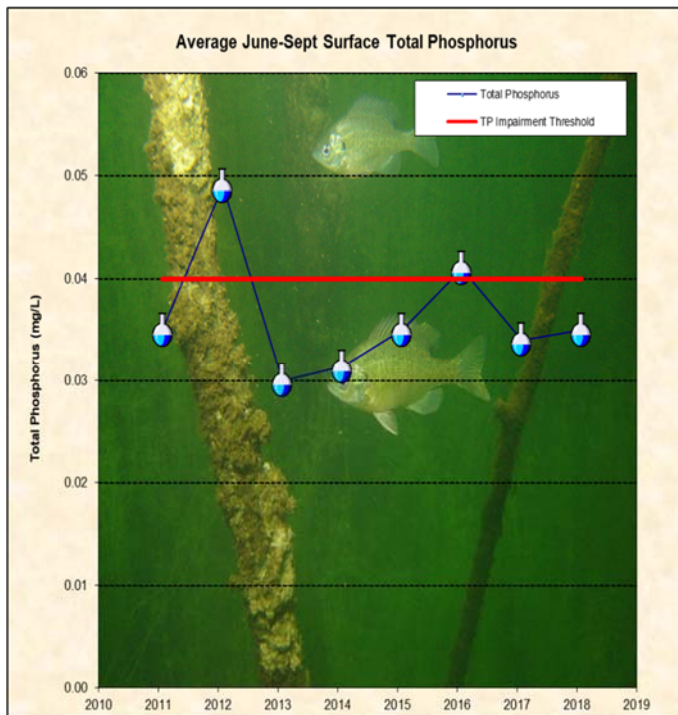
- DNR ID #: 82015900
- Municipality: City of Forest Lake
- Location: Section 9 T32N-R21W
- Lake Size: 363.80 acres
- Maximum Depth (2018): 33.5 ft.
- Ordinary High Water Mark: 901.8 ft.
- 67% Littoral

Note: Littoral area is the portion of the lake <15 ft. and dominated by aquatic vegetation.

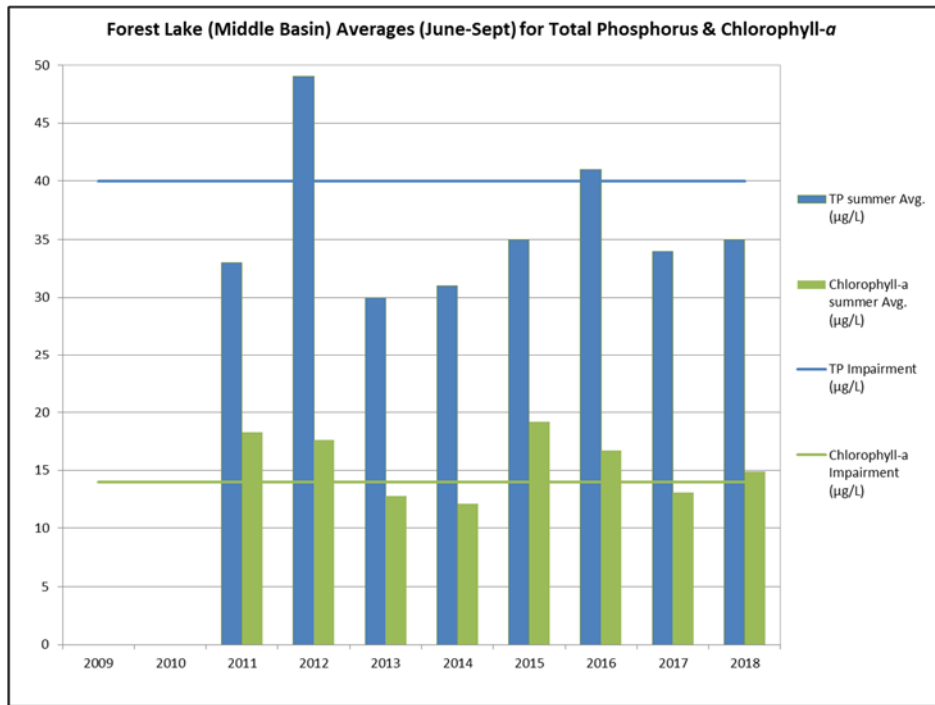


Summary Points

- Based on the chlorophyll-*a* results Forest Lake (Middle Basin) was considered eutrophic in 2018, according to the Carlson Trophic State Index.
- Using the 2-tailed Kendall Tau correlation test ($p < 0.05$) there is no trend for the average total phosphorus or average Secchi transparency and there is an insufficient number of years of data to determine trends for chlorophyll-*a* at this time.
- The major land use is urban and rural/agricultural.
- The lake stratified in 2018 with the thermocline varying between 5 and 6 meters.
- Eurasian watermilfoil, Flowering rush, Curly-leaf pondweed (invasive aquatic plants), and Zebra mussels are present in this lake.



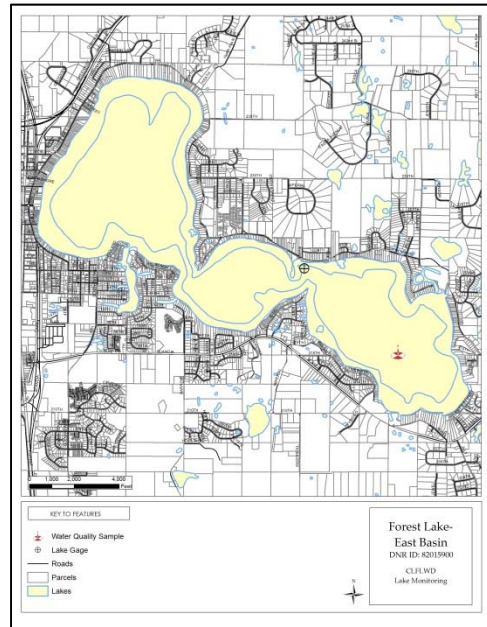
| Date/Time | Total Phosphorus (mg/L) | Uncorrected Trichromatic Chlorophyll-a (µg/L) | Pheophytin-Corrected Chlorophyll-a (µg/L) | Total Kjeldahl Nitrogen (mg/L) | Secchi Disk Depth (m) | Surface Temperature (Celsius) | Surface Dissolved Oxygen (mg/L) |
|---|-------------------------|---|---|--------------------------------|-----------------------|-------------------------------|---------------------------------|
| 5/15/2018 13:02 | 0.021 | 4.5 | 4.0 | 0.71 | 3.05 | 17.2 | 10.49 |
| 5/29/2018 13:21 | 0.026 | 3.0 | 3.5 | 0.76 | 3.35 | 25.0 | 8.18 |
| 6/14/2018 12:34 | 0.021 | 3.0 | 3.0 | 0.62 | 3.35 | 22.1 | 8.90 |
| 6/28/2018 9:42 | 0.035 | 10.0 | 9.9 | 0.82 | 3.05 | 24.3 | 8.72 |
| 7/10/2018 13:10 | 0.025 | 10.0 | 10.0 | 0.72 | 2.29 | 26.5 | 8.97 |
| 7/24/2018 10:15 | 0.051 | 13.0 | 12.0 | 1.00 | 3.05 | 25.3 | 9.54 |
| 8/7/2018 12:39 | 0.063 | 34.0 | 33.0 | 1.20 | 1.52 | 24.3 | 9.99 |
| 8/21/2018 8:46 | 0.028 | 19.0 | 18.0 | 0.92 | 1.98 | 24.6 | 6.57 |
| 9/6/2018 13:31 | 0.029 | 23.0 | 21.0 | 1.00 | 1.68 | 23.1 | 7.18 |
| 9/18/2018 15:00 | 0.026 | 13.0 | 12.0 | 0.87 | 1.83 | 22.2 | 6.39 |
| 10/4/2018 12:41 | 0.045 | 4.7 | 3.2 | 0.99 | 3.05 | 12.9 | 8.58 |
| 10/23/2018 15:17 | 0.020 | 3.5 | 3.0 | 0.68 | 4.27 | 7.6 | 11.02 |
| 2018 Average | 0.033 | 11.7 | 11.1 | 0.86 | 2.71 | 21.3 | 8.71 |
| 2018 Summer Average | 0.035 | 15.6 | 14.9 | 0.89 | 2.34 | 24.1 | 8.28 |
| Volunteer Data | | | | | | | |
| 5/20/2018 15:25 | 0.021 | 3.4 | 3.0 | 0.60 | 3.60 | 18.5 | NA |
| 6/15/2018 17:30 | 0.022 | 3.6 | 3.2 | 0.48 | 3.30 | 23.6 | NA |
| 7/14/2018 18:30 | 0.029 | 6.8 | 6.0 | 0.70 | 2.20 | 29.3 | NA |
| 7/28/2018 16:00 | 0.031 | 9.2 | 8.8 | 0.64 | 1.90 | 25.7 | NA |
| 8/11/2018 15:30 | 0.023 | 9.9 | 9.6 | 0.77 | 2.00 | 28.3 | NA |
| 9/9/2018 10:30 | 0.024 | 16.0 | 15.0 | 0.92 | 1.80 | 21.0 | NA |
| 10/6/2018 7:30 | 0.026 | 3.0 | 2.3 | 0.83 | 3.90 | 11.8 | NA |
| 2018 Average | 0.025 | 7.4 | 6.8 | 0.71 | 2.67 | 22.6 | NA |
| 2018 Summer Average | 0.026 | 9.1 | 8.5 | 0.70 | 2.24 | 25.6 | NA |
| Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth* | | | | | | | |
| Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth* | | | | | | | |
| | High | High Date | Low | Low Date | Average | | |
| 2018 Elevation (ft) | 901.77 | 5/8/2018 | 901.41 | 9/18/2018 | 901.62 | | |
| *Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made." | | | | | | | |



| Lake Water Quality Summary | | | | | | | | | | |
|-----------------------------------|-------------------------------|----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | Lake Grades (May-Sept) | | | | | | | | | |
| | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 |
| Total Phosphorus (mg/L) | C | B | C | C | B | B | C | C | NA | NA |
| Chlorophyll-a (µg/L) | B | B | B | C | B | B | B | B | NA | NA |
| Secchi depth (ft) | B | B | C | C | C | C | C | C | NA | NA |
| Overall | B- | B | C+ | C | B- | B- | C+ | C+ | NA | NA |

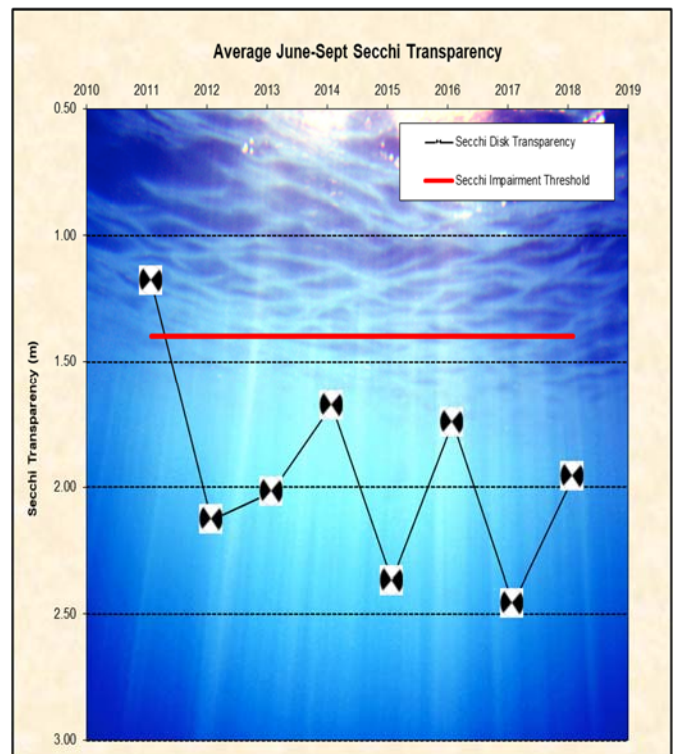
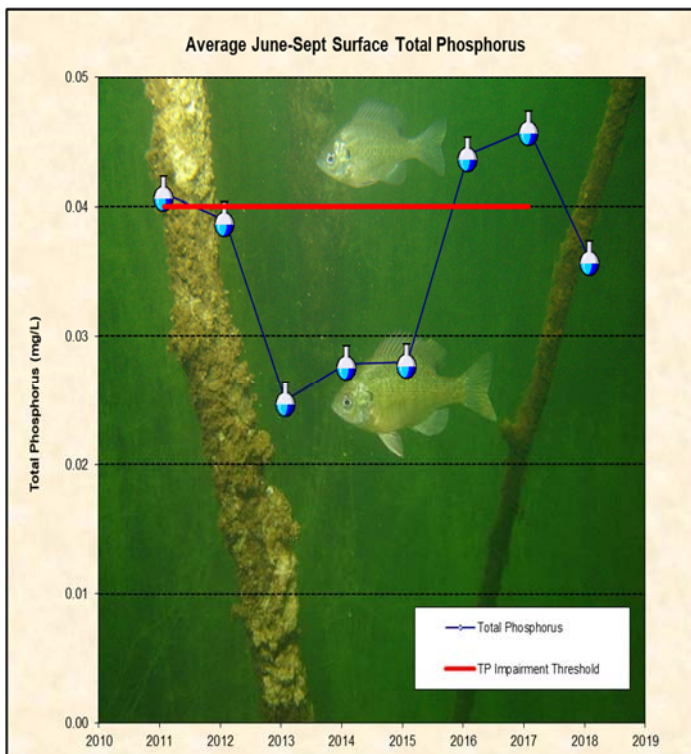
Forest Lake (East Basin) 2018 Lake Grade: C+

- DNR ID #: 82015900
 - Municipality: City of Forest Lake
 - Location: Section 9 T32N-R21W
 - Lake Size: 789.58 acres
 - Maximum Depth (2018): 35 ft.
 - Ordinary High Water Mark: 901.8 ft.
 - 67% Littoral
- Note: Littoral area is the portion of the lake <15 ft. and dominated by aquatic vegetation.

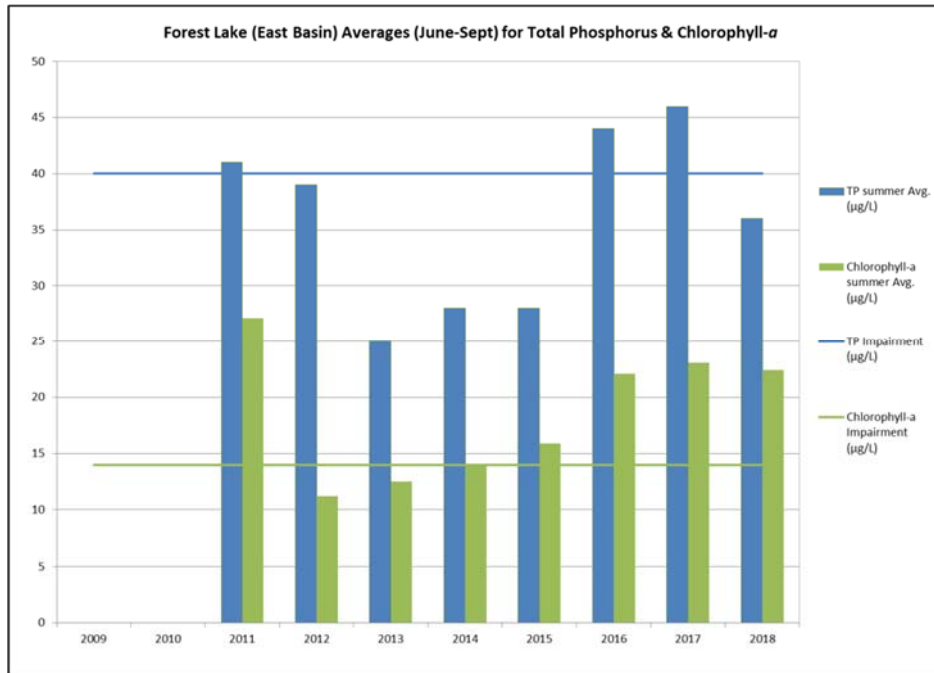


Summary Points

- Based on the chlorophyll-*a* results Forest Lake (East Basin) was considered eutrophic in 2018, according to the Carlson Trophic State Index.
- Using the 2-tailed Kendall Tau correlation test ($p < 0.05$) there is no trend for the average total phosphorus, chlorophyll-*a*, or average Secchi transparency at this time.
- The major land use is semi-urban and rural/agricultural.
- The lake stratified in 2018 with the thermocline varying between 5 and 7 meters.
- Eurasian watermilfoil, Flowering rush, Curly-leaf pondweed (invasive aquatic plants), and Zebra mussels are present in this lake.



| Date/Time | Total Phosphorus (mg/L) | Uncorrected Trichromatic Chlorophyll-a (µg/L) | Pheophytin-Corrected Chlorophyll-a (µg/L) | Total Kjeldahl Nitrogen (mg/L) | Secchi Disk Depth (m) | Surface Temperature (Celsius) | Surface Dissolved Oxygen (mg/L) |
|---|-------------------------|---|---|--------------------------------|-----------------------|-------------------------------|---------------------------------|
| 5/15/2018 13:26 | 0.023 | 6.1 | 5.4 | 0.68 | 2.74 | 17.7 | 11.12 |
| 5/29/2018 13:45 | 0.026 | 5.5 | 7.5 | 0.72 | 2.74 | 24.6 | 8.55 |
| 6/14/2018 12:53 | 0.024 | 5.6 | 5.0 | 0.68 | 2.74 | 21.5 | 8.82 |
| 6/28/2018 10:08 | 0.025 | 9.3 | 8.8 | 0.67 | 2.90 | 24.7 | 8.60 |
| 7/10/2018 12:54 | 0.030 | 10.0 | 11.0 | 0.74 | 2.29 | 26.4 | 8.26 |
| 7/24/2018 9:55 | 0.039 | 21.0 | 20.0 | 0.86 | 2.29 | 25.0 | 8.74 |
| 8/7/2018 12:56 | 0.057 | 46.0 | 45.0 | 1.10 | 1.37 | 24.4 | 10.97 |
| 8/21/2018 9:02 | 0.028 | 32.0 | 31.0 | 0.96 | 1.37 | 24.5 | 6.48 |
| 9/6/2018 13:45 | 0.047 | 35.0 | 33.0 | 1.10 | 1.37 | 23.2 | 8.36 |
| 9/18/2018 14:46 | 0.037 | 27.0 | 25.0 | 0.91 | 1.37 | 22.2 | 7.16 |
| 10/4/2018 12:26 | 0.060 | 19.0 | 18.0 | 0.94 | 1.98 | 13.3 | 9.04 |
| 10/23/2018 15:01 | 0.023 | 4.6 | 4.3 | 0.72 | 2.74 | 7.6 | 10.48 |
| 2018 Average | 0.035 | 18.4 | 17.8 | 0.84 | 2.16 | 21.3 | 8.88 |
| 2018 Summer Average | 0.036 | 23.2 | 22.4 | 0.88 | 1.96 | 24.0 | 8.42 |
| Volunteer Data | | | | | | | |
| 5/24/2018 11:21 | 0.022 | 4.4 | 4.2 | 0.56 | 2.60 | 21.1 | NA |
| 6/17/2018 10:34 | 0.027 | 7.2 | 5.4 | 0.49 | 3.00 | 23.3 | NA |
| 7/15/2018 10:15 | 0.018 | 4.9 | 4.5 | 0.59 | 2.40 | 28.1 | NA |
| 7/23/2018 13:50 | 0.036 | 20.0 | 19.0 | 0.77 | 1.90 | 27 | NA |
| 8/11/2018 9:37 | 0.027 | 31.0 | 30.0 | 0.81 | 1.30 | 26.8 | NA |
| 9/14/2018 10:27 | 0.049 | 30.0 | 30.0 | 1.10 | 1.20 | 21.9 | NA |
| 2018 Average | 0.030 | 16.3 | 15.5 | 0.72 | 2.07 | 24.7 | NA |
| 2018 Summer Average | 0.031 | 18.6 | 17.8 | 0.75 | 1.96 | 25.4 | NA |
| Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth* | | | | | | | |
| Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth* | | | | | | | |
| | High | High Date | Low | Low Date | Average | | |
| 2018 Elevation (ft) | 901.77 | 5/8/2018 | 901.41 | 9/18/2018 | 901.62 | | |
| *Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made." | | | | | | | |



| Lake Water Quality Summary | | | | | | | | | | |
|-----------------------------------|-------------------------------|-----------|----------|----------|-----------|-----------|-----------|----------|-----------|-----------|
| | Lake Grades (May-Sept) | | | | | | | | | |
| | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 |
| Total Phosphorus (mg/L) | C | C | C | B | B | B | C | C | NA | NA |
| Chlorophyll-a (µg/L) | B | C | C | B | B | B | B | C | NA | NA |
| Secchi depth (ft) | C | B | C | B | C | C | C | C | NA | NA |
| Overall | C+ | C+ | C | B | B- | B- | C+ | C | NA | NA |

Forest Lake Water Surface Elevation Statistics

Outlet Elevation (dam): 901.4 ft.

Ordinary High Water Level (OHW) Elevation: 901.8 ft.

100 Year Flood Elevation (CLFLWD): 902.4 ft.

Highest Recorded Elevation: 902.23 ft. (06/24/1993)

Lowest Recorded Elevation: 899.45 ft. (10/07/1969)

Datum: NGVD 29 (ft.)

