Green Lake Monitoring Report 2017

What: LID volunteers collected Total Phosphorus (TP), Chlorophyll-a (Chl-a), and Transparency information every two weeks from June through September in the deepest part of the lake (see map). SWCD Staff collected Dissolved Oxygen and Temperature information throughout the water column, once a month, from June through September at the same location. SWCD Staff provided training, equipment and coordinated lab testing.

Why: Green Lake was added to the MN impaired waters list in 2008 for having high nutrients. The listing triggered the completion of a Total Maximum Daily Load (TMDL) study. TMDL's are studies that quantify the TP reduction necessary in order to make the lake healthy again. The study identified that a 39% TP reduction is required for Green Lake.

The monitoring data collected in 2017, the second year of the monitoring partnership between the SWCD and GLID, helps us get a better understanding of the factors driving high nutrient levels. Additionally, we can use the data to track trends over time and track the effectiveness of projects that are meant to improve lake health (i.e. raingardens, lakeshore restorations).

Green Lake samples are summarized in this report.

Lake Data for Green Lake	
Township	Wyanett
MN Lake ID	30013600
# of Public Boat Access	1
Aquatic Invasive Species	CLPW & EWM
Surface Area	822 acres
Maximum Depth	28ft
Lake Meets Clean Water Goals	Total Phosphorus: **No**
	Chlorophyll-a: **No**
	Transparency: **No**

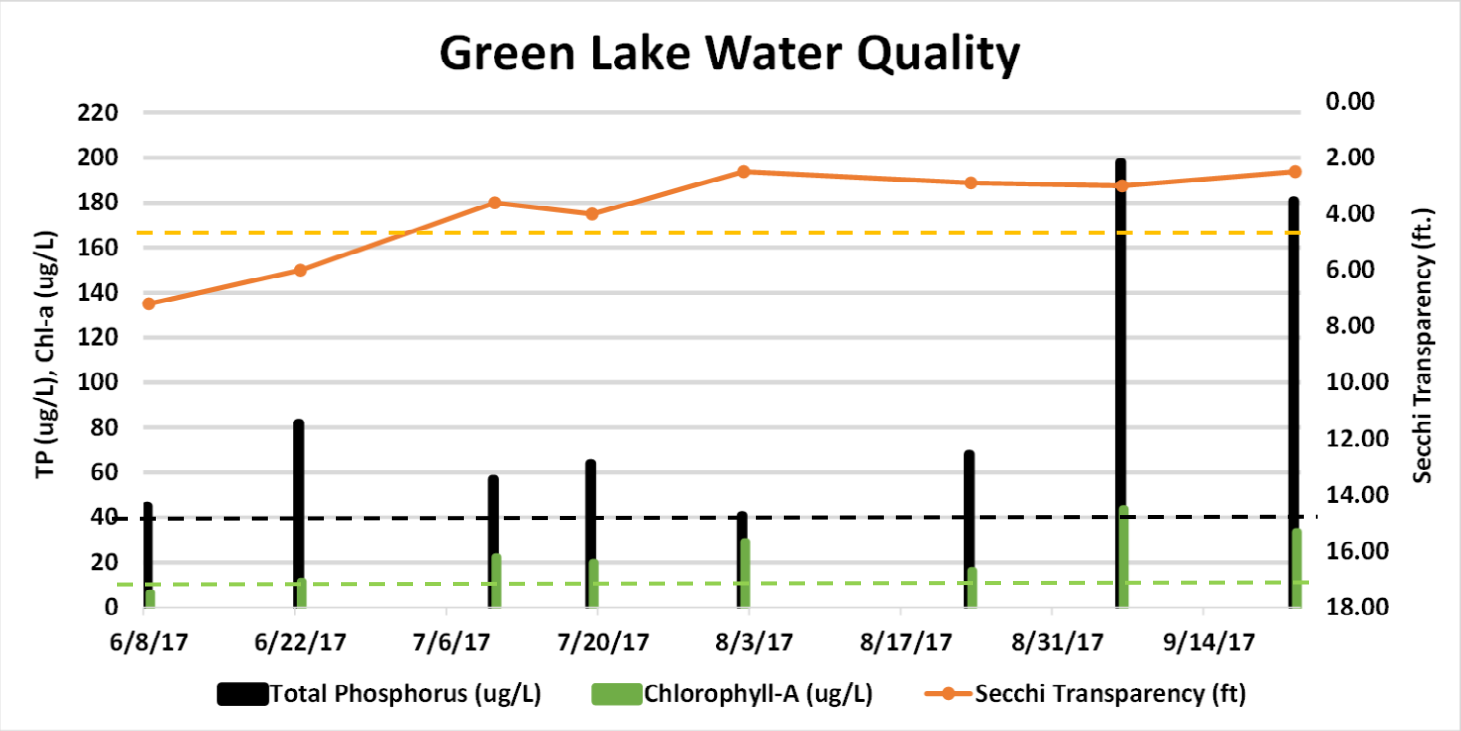
Green Lake Monitoring Results 2017

Total Phosphorus (TP), Chlorophyll-a (Chl-a) and Secchi Transparency

MN Clean Water Goals for Deep Lakes:

Total Phosphorus (TP): ≤ 40 ug/L Chlorophyll-a: ≤ 14mg/m3 Secchi Depth: ≥ 4.59 feet

Growing season average	92.00 (TP)	27.47 (Chl-a)	3.08 (Secchi)



Green Lake has a maximum depth of 28ft and the majority of the lake is greater than 15 feet deep which means this the lake should have characteristics of a deep lake. Deep lakes tend to stratify or form layers, especially during summer, because the density of water changes as its temperature changes. The layers mix in the spring and fall. When the layers mix, nutrients trapped on the bottom of the lake can get released into the water column (termed internal loading). The phenomenon can be seen on the dissolved oxygen and temperature graphs on page 3. The monitoring results for Green Lake are compared to the State goals for deep lakes in this area.

When compared to deep lake water quality goals, Green Lake exceeded thresholds for all three parameters, transparency, TP and Chl-a. This information is what was used to classify the lake as "impaired".

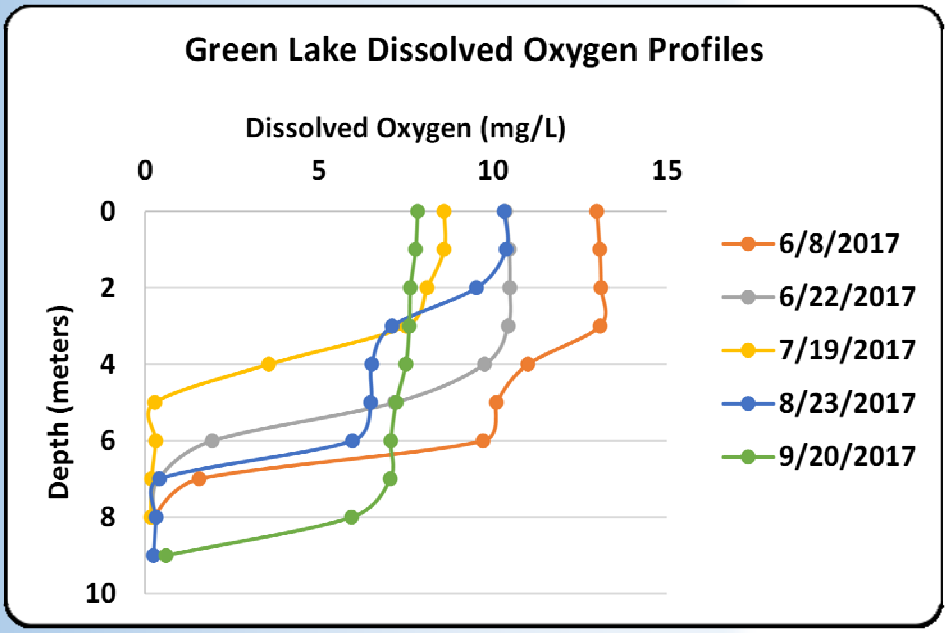
In 2017 the highest TP and Chl-a concentrations were observed late in the growing season. Because the monitoring agreement was not in place before June samples were not collected in May. We suspect that TP and Chl-a would have been higher in May. These results correspond to the periods of time when the lake water column was mixed, meaning nutrients sitting at the bottom of the lake could have been released into the water above. These nutrients could be from a combination of decaying vegetation and/or an accumulation of nutrients built up over time from land runoff. Similar conditions were observed during the 2016 monitoring season. Addressing upland concerns to reduce nutrient runoff to the lake should be the first priority and investigating internal nutrient loading impacts/solutions could be the next step to improving lake water quality.

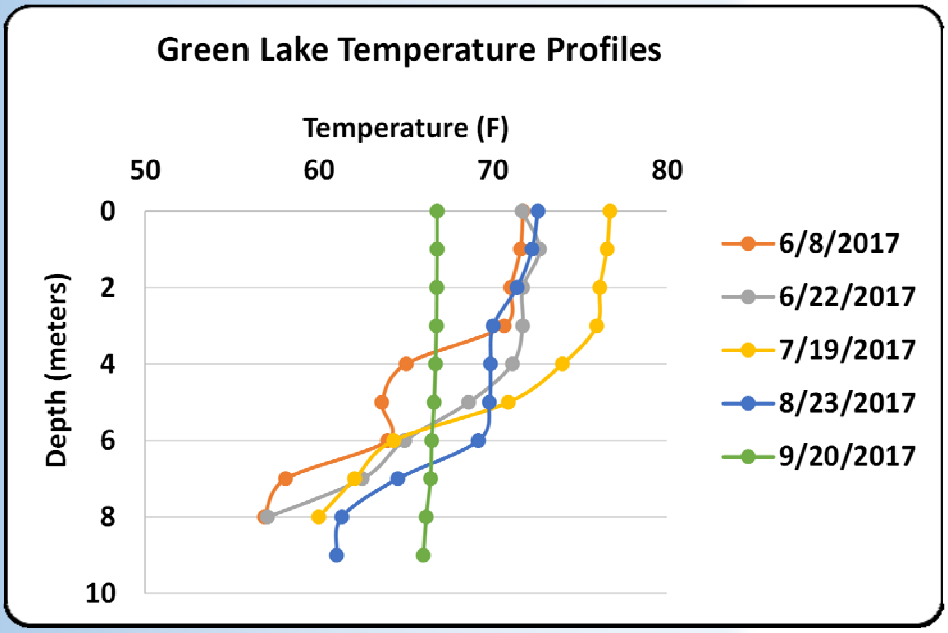
General Definitions

Phosphorus (TP): an essential plant nutrient in which an excess can cause severe algal blooms, measures all usable forms.
Chlorophyll-a (Chl-a): a pigment found in green plants, used to estimate amounts of algae in a lake.
Secchi Transparency: a measure of light penetration in water, an indication to the amount of algae in the water.

2017 Lake Stratification

In 2017 we measured temperature and dissolved oxygen profiles starting at the surface of the water and then at one meter increments to the bottom of the lake. This information adds to the story when we analyze lake water quality data. The graphs below are representations of the data collected.





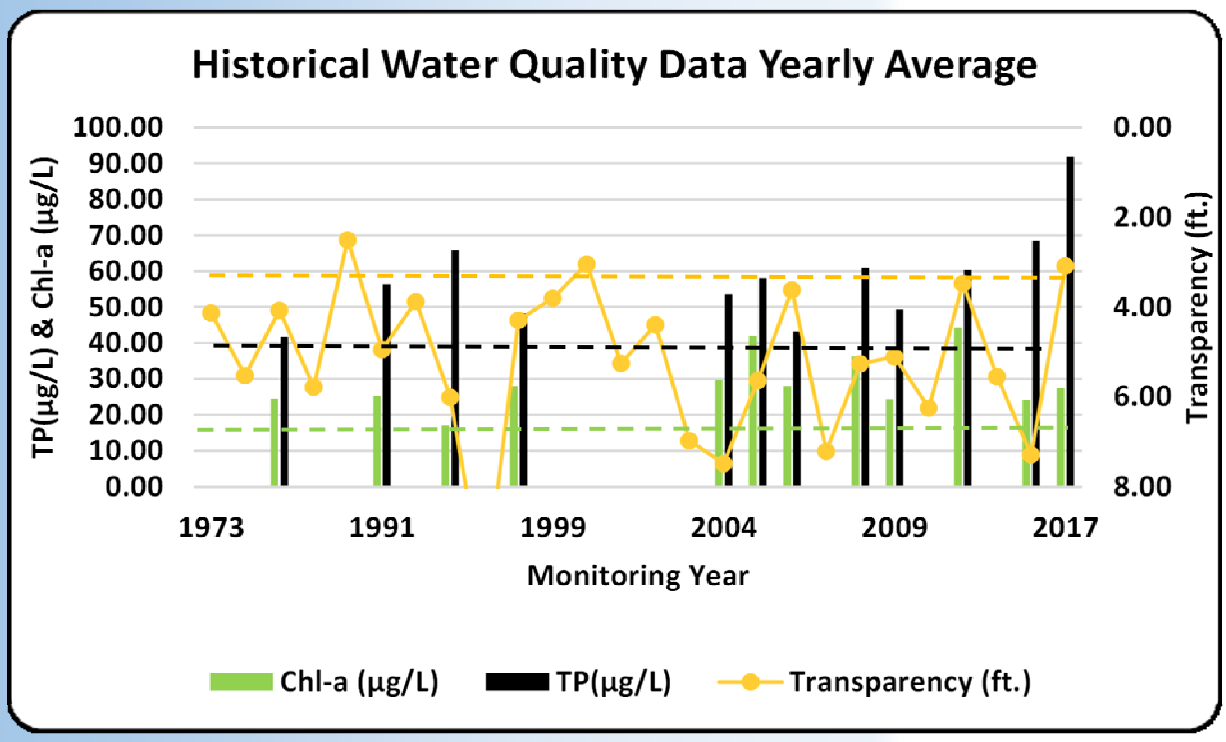
Green Lake: Temperature is consistent throughout the water column late in the year and forms layers of water with different temperatures from June to late August. This process is called thermal stratification and is expected in a deep lake. The cool water acts as a barrier between the lake bottom and the warm waters above. Dissolved oxygen periodically decreases to near zero at the lake bottom. This phenomenon is typical in deep, nutrient rich lakes and occurs as the supply of oxygen is consumed by bacteria and decaying matter over the summer months. When the lake mixes (during fall turnover or because of other events such as heavy rains or winds) the nutrients are allowed to escape into the surface water and can stimulate an algal bloom.

Green Lake Historical Water Quality Data

In order to get an idea of lake health trends over time, we compiled historic TP, Chl-a and Secchi transparency data from the MPCA website. Paired TP, Chl-a and secchi transparency data are periodically available for Green Lake since 1988. Note: this information is beneficial for tracking general trends but there was a minimal amount of data available for each year (i.e. 3 or fewer samples per year). The data set for secchi transparency is much more extensive and dates back to 1973.

The graph below illustrates the that lake averages exceed the TP and Chl-a goals for every year monitored. Over time it appears that water clarity may be getting better. The increase in clarity may reflect aquatic vegetation shifts.

2017 data showed a record high TP concentration which was largely driven by samples taken during lake turnover in September.

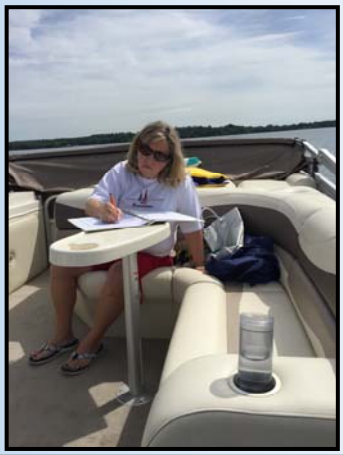


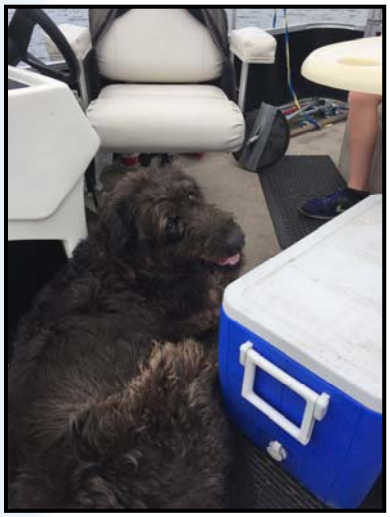
2017 Monitoring Recommendations

It is difficult to draw any hard conclusions from the limited monitoring data available. The data collected in 2017 did give us valuable insight into water health and how the lake responds over the season. 2016 and 2017 data results suggest Internal loading being a large contributor to the excessive nutrient concentrations recorded early and late in the year. We recommend the LID to continue lake and stream monitoring as planned. Additionally, the LID should work with the SWCD to identify ways to minimize runoff from the lake tributaries and lake shore properties and begin the process to investigate internal loading.

Below are key points and recommendations for lake monitoring in 2017:

- Continue monitoring as planned.
- Continue collecting temperature and dissolved oxygen profiles monthly.
- Make note periods of heavy boat traffic or high winds on the lake.





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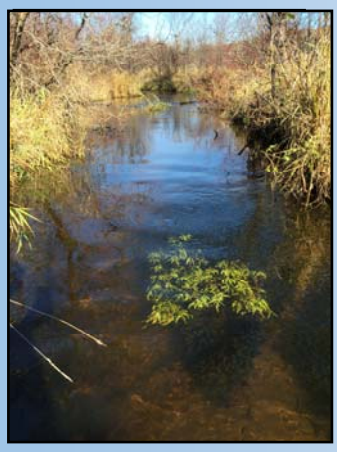
Thanks to the GLID members who have assisted with lake monitoring.

Green Lake Tributary Monitoring 2017

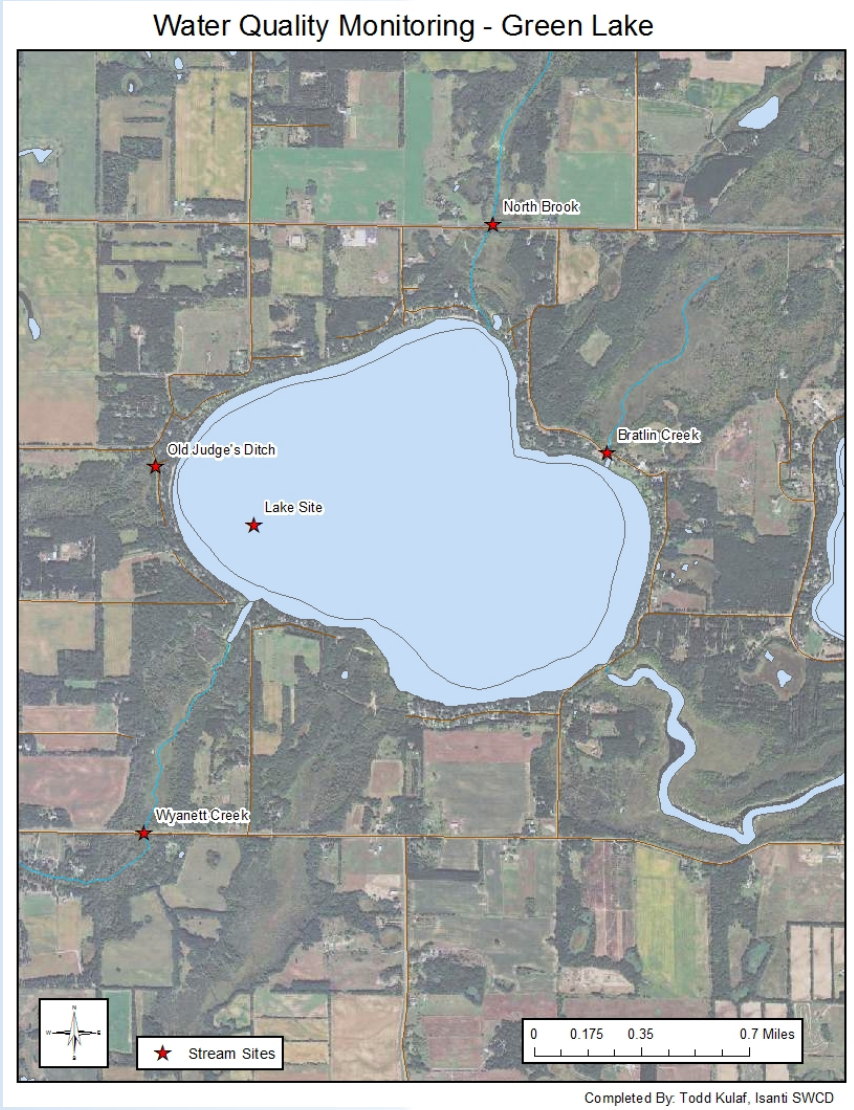
Introduction

The Green Lake Improvement District (GLID) and the Isanti Soil and Water Conservation District (ISWCD) continued monitoring two of the largest tributaries into Green Lake for the second consecutive year. Two additional tributaries were added in 2017.

- North Brook at highway 95
- Wyanett Creek at 325th Ave.
- Bratlin Creek—New in 2017
- Old Judge's Creek—New in 2017



North Brook Site



Tributary Monitoring

What: During 2017 eight sample events were conducted at three major tributaries targeting four samples during rain events and four during base flow. A smaller inlet on the west side of the lake (Old Judge's Creek) was sampled three times randomly from July to Mid-September. The samples were tested for total phosphorus (TP), total suspended solids (TSS) and transparency. Dissolved oxygen, temperature, conductivity, pH and water flow were also measured in the field. TP concentrations were paired with flow to help us get a better understanding of how much water and nutrients are being carried from the tributaries and into the lake (i.e. pounds of phosphorus per day).

Why: The information collected is used in conjunction with the Subwatershed Assessment for North Brook and Wyanett Creek completed in 2017. The data helps us determine which tributary should be a higher priority for water quality projects. In theory, the stream that delivers the most nutrients to the lake would be the highest priority. Additionally, the information collected is used to track trends, determine how well water quality improvement projects are working, and track progress towards the goals set for the steams in the Green Lake Total Maximum Daily Load Study (TMDL).

Total Phosphorus: an essential plant nutrient in which an excess can cause severe algal blooms.

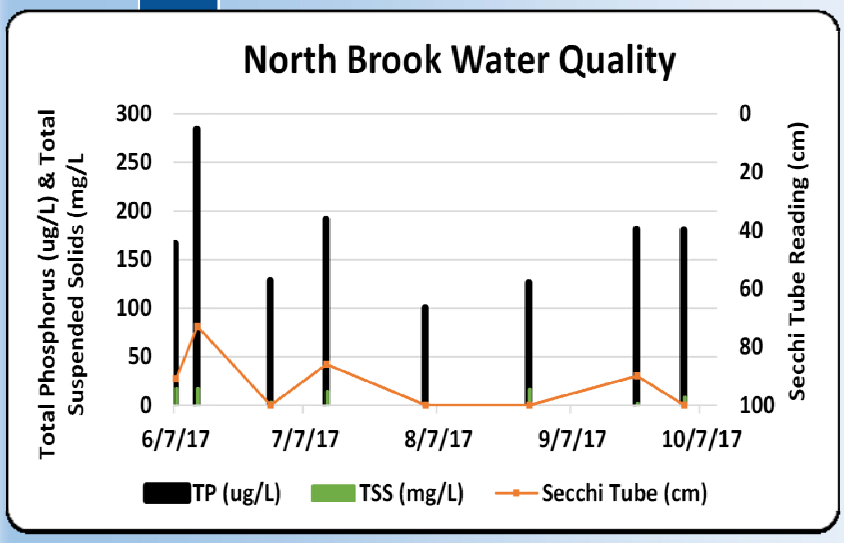
Orthophosphate: the amount of phosphorus that is immediately available for algae and plant growth.

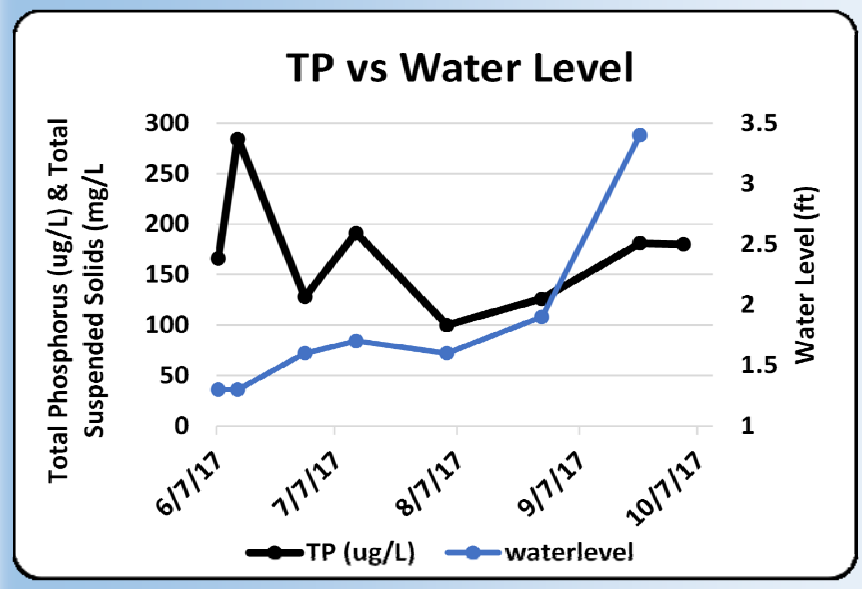
Total Suspended Solids: tiny particles of soil and other matter that remain suspended in water making it cloudy. Particles include sediment and organic matter.

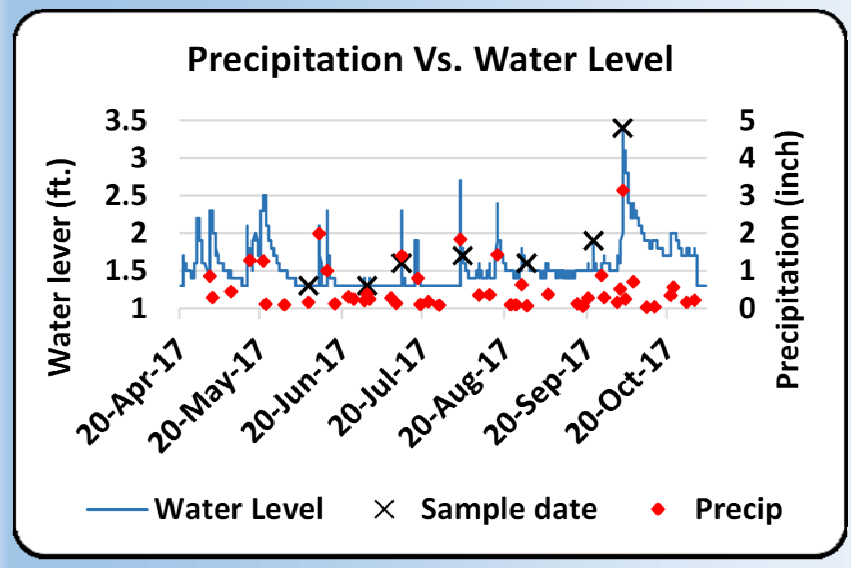
Transparency: an indirect measure of suspended and dissolved materials (soil particles and tea color caused by organic materials) in the water.

2017 Tributary Monitoring Results

Total Suspended Solids (TSS), Total Phosphorus (TP) and Transparency Tube







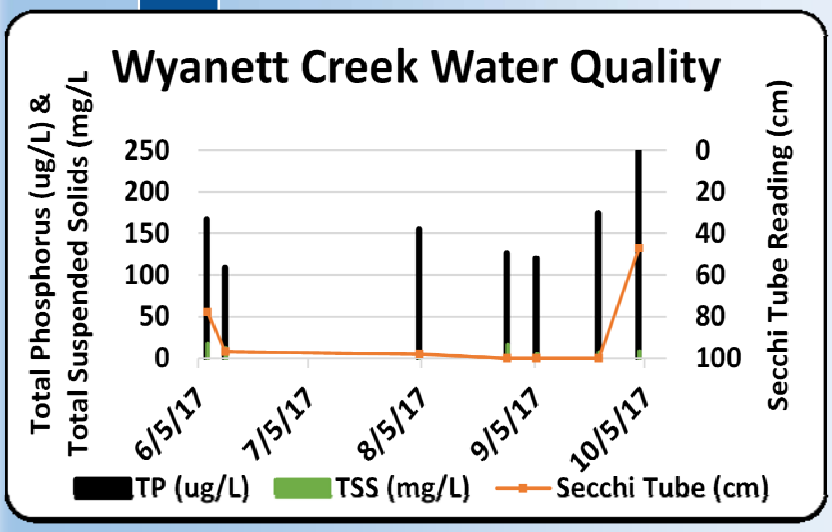
Eco-region Concentrations		
	TP (µg/L)	TSS (mg/L)
Typical Range	60 to 150	4.8 to 16
2017 Average	169	9.8
Goal	100	NA

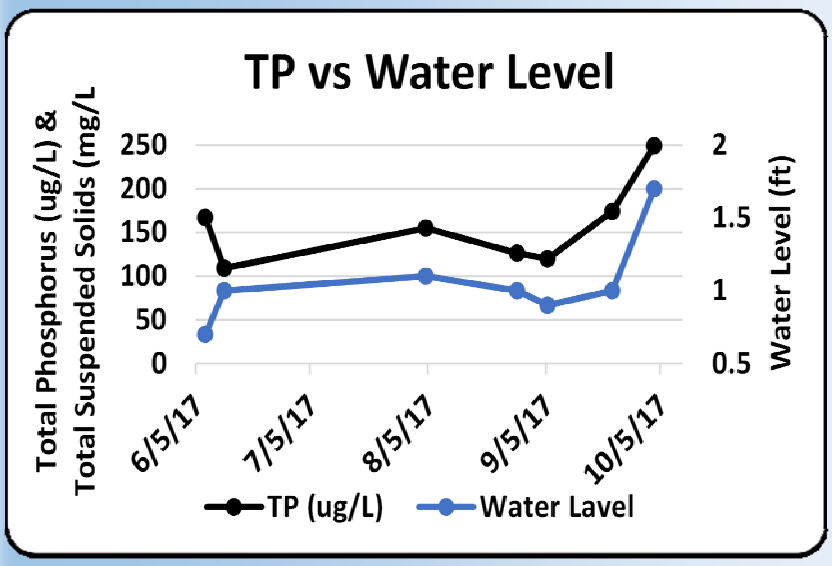
Site: North Brook

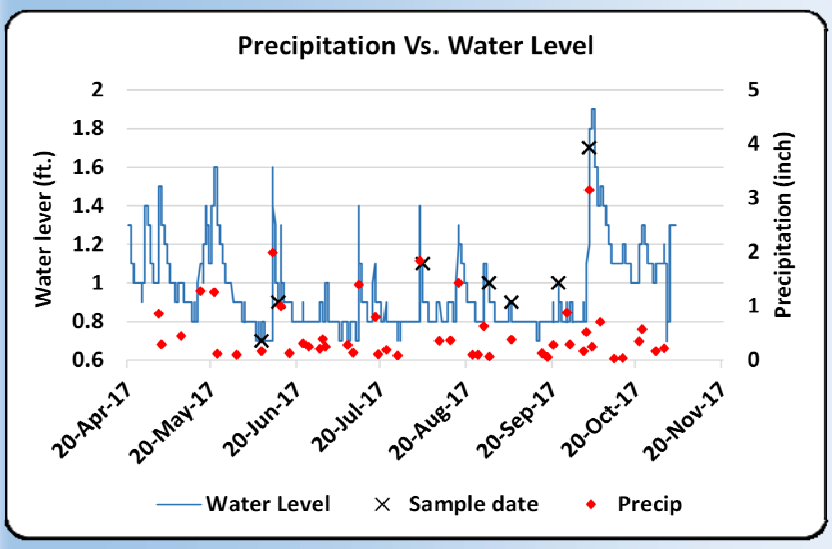
- The average concentration of TP at this location was 169 µg/L . This concentration is above the expected range of concentrations for this region.
- The TMDL Study set a TP goal of 100 µg/L as a concentration for North Brook.
- The average concentration of TSS detected at this location was 9.8 mg/L. This concentration is below the expected range of concentration for this region.
- In 2017, based on paired flow and sample information, North Brook likely contributed slightly less nutrients to the lake than Wyanett Creek. The results are similar to 2016.
- Transparency readings averaged 92.5 cm (Transparency tubes only measure to 100 cm) this means the water is typically quite clear.
- The highest concentrations of TP were observed during storm events.
- Water quality does fluctuate in relation to rain-fall at this location; the most likely causes are a combination of flushing of nutrients from the wetland-dominated watershed following dry spells and rain water runoff from land.

2017 Tributary Monitoring Results

Total Suspended Solids (TSS), Total Phosphorus (TP) and Transparency Tube







Eco-region Concentrations		
	TP (µg/L)	TSS (mg/L)
Typical Range	60 to 150	4.8 to 16
2017 Average	157	10
Goal	100	NA

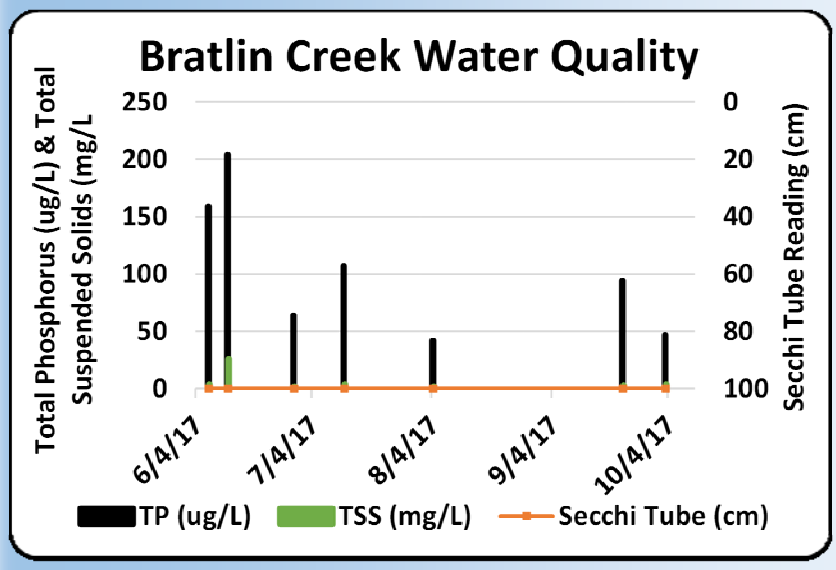
Site:
Wyanett Creek

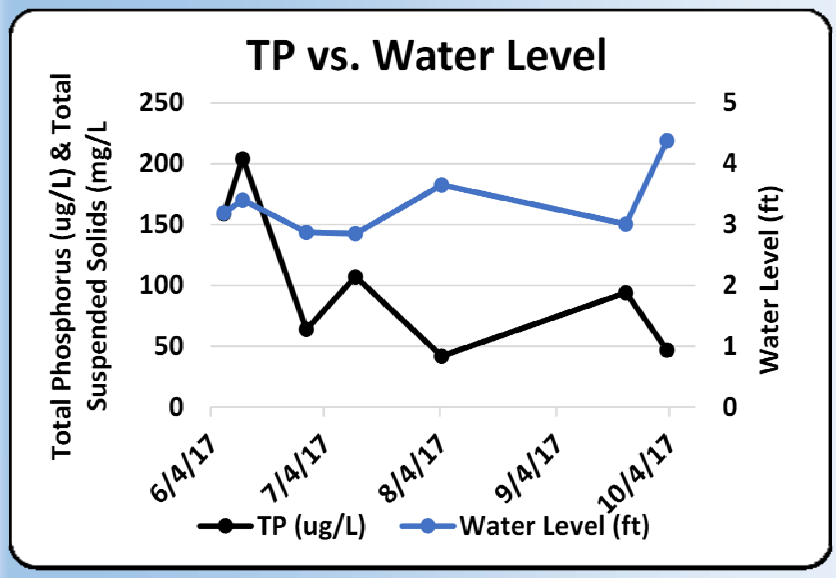
- The average concentration of TP at this location was 157 µg/L; slightly higher than the range of expected concentrations for this ecoregion.
- The TMDL Study set a TP goal of 100 µg/L as a concentration for Wyanett Creek.
- The average concentration of TSS detected at this location was 10 mg/L. This concentration is below the expected range of concentrations for this region.
- In 2017, based on paired flow and sample information, Wyanett Creek likely contributed slightly more nutrients to the lake than North Brook. The results are similar to 2016.
- Transparency readings averaged 88.57 cm (Transparency tubes only measure to 100 cm) this means the water is typically quite clear.
- The highest concentrations of TP were observed during storm events.
- Water quality does fluctuate in relation to rainfall at this location; the most likely causes are a combination of flushing of nutrients from the wetland-dominated watershed following dry spells and rain water runoff from land.

2017 Tributary Monitoring Results

Total Suspended Solids (TSS), Total Phosphorus (TP) and Transparency Tube

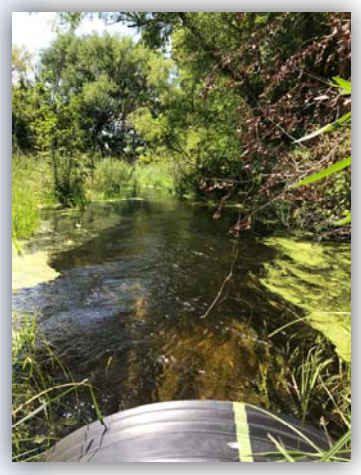
Eco-region Concentrations		
	TP (µg/L)	TSS (mg/L)
Typical Range	60 to 150	4.8 to 16
2017 Average	102	6.4
Goal	100µ/L	NA





Site: Bratlin Creek

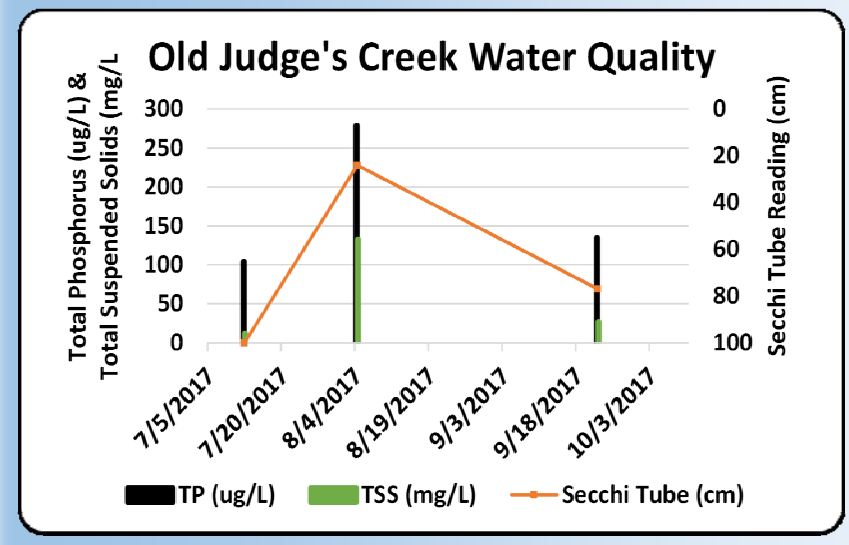
- The average concentration of TP at this location was 102 µg/L; 48lµg/L lower than the range of expected concentrations for this ecoregion.
- The average concentration of TSS detected at this location was 6.4 mg/L. This concentration falls within the expected range of concentrations for this region.
- Based on one year of paired flow and sample information, we believe Bratlin Creek has the least potential to negatively effect water quality in the lake.
- Excellent water clarity. Transparency readings were assumed to exceed 100 cm during each sampling event.
- Early season high TP could indicate some phosphorus is being flushed from the wetland.
- With the exception of the early season, water quality was "good" at this location.
- With only one year of data only speculations can be made to water quality conditions.

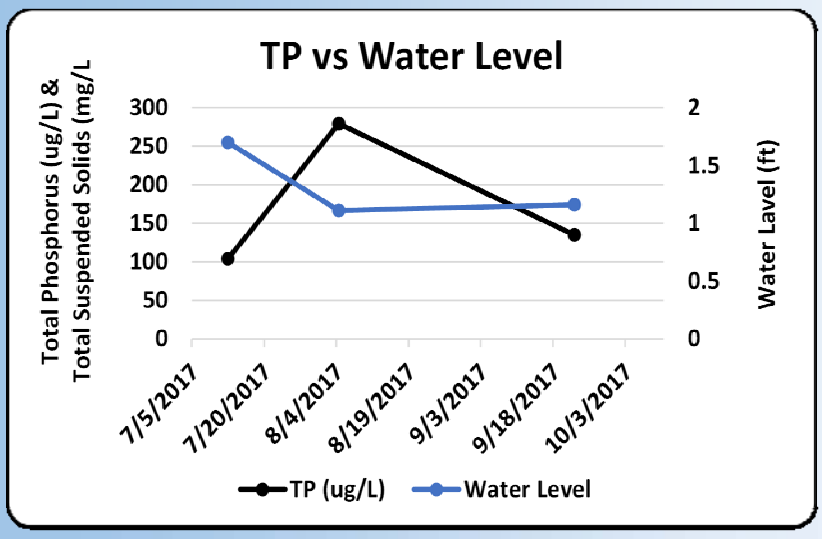


2017 Tributary Monitoring Results

Total Suspended Solids (TSS), Total Phosphorus (TP) and Transparency Tube

Eco-region Concentrations		
	TP (µg/L)	TSS (mg/L)
Typical Range	60 to 150	4.8 to 16
2017 Average	172	19.5
Goal	100	NA





Site:
Old Judges Creek

- The average concentration of TP at this location was 172 µg/L; slightly higher than the range of expected concentrations for this ecoregion.
- The average concentration of TSS detected at this location was 27 mg/L. This concentration is above the expected range of concentrations for this region.
- Based on one year of paired flow we can assume nutrient loading to the lake may have an adverse effect on water quality.
- Transparency readings averaged 67 cm (Transparency tubes only measure to 100 cm) this means the water is typically cloudy.
- TP and TSS were increased significantly following the August storm event that was preceded by a dry period.
- With only three sample it is difficult to form hypothesis to water quality observations. However, the stream has consistent flow and could be contributing significant nutrient concentrations to the lake.

2017 Results and Recommendations

Both North Brook and Wyanett Creek have high concentrations of TP following rain events. TSS also increases following rain (meaning there is organic particles in the water). The response mentioned above may be of one or a combination of the following: 1) flushing of nutrients and organic material from the large wetland-dominated watersheds and/or 2) runoff of nutrients from nearby agricultural land.

Based on the data collected in 2016 and 2017, Wyanett Creek may contribute larger pulses of TP and should be the starting point for targeting upland conservation as prescribed in the subwatershed assessment. However, both watersheds can benefit from best management practices that keep nutrients on the land during rain events.

TP concentrations in Bratlin Creek, for the most part, were low during sampling events. The highest concentrations were observed during the first part of June during a rain event. Transparency was excellent all year, exceeding 100 cm during each sampling event. Keeping the water healthy at this location seems to be important.

Old Judge's Creek, although small, may contribute TP to the lake, particularly early in the season. Increasing sampling at this site will help better understand the potential effect it has on the lake.

Because weather conditions and other environmental factors can vary so drastically from year to year it is recommended to continue monitoring at each of the tributaries as planned. Continued monitoring will give us a better understanding of how the streams and lake respond to environmental conditions and therefore how we might best be able to work together to protect the quality of the lake.

<u>Below are key points and recommendations for monitoring in 2018 at each of the two tributaries:</u>

- Sample as planned (same as 2017): 8 grab samples at highest and lowest water levels (peak flow and low flow); water level measurements; flow; dissolved oxygen; temperature; pH.
- Continue monitoring stream flow: collect stream flow data during 4 peak flow and 4 low flow stream conditions.
- **NEW:** Old Judges Creek, 4 grab samples between July and September at highest water levels (peak flow); water level measurements; flow; dissolved oxygen; temperature; pH.

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