Blue Lake
Monitoring Report 2016

What: LID volunteers collected Total Phosphorus (TP), Chlorophyll-a, and transparency information every two weeks from May through September in both Upper and Lower Blue Lake (see map). SWCD Staff collected Dissolved Oxygen and Temperature information throughout the water column, once a month, from May to September in both lakes. SWCD Staff provided training, equipment and coordinated lab testing.

Why: The lake has not been monitored with any regularity in the past. In the last 24 years there have been only scattered transparency readings. More detailed monitoring was done in 2013 and 2014 by the MN Pollution Control Agency (lower Blue only) but they do not plan to return to the lake until 2023. This is the second consecutive year of monitoring done by the Isanti SWCD and the BLID. The data being gathered provides us with an understanding of the lake's health and water quality trends; furthermore, the data helps us diagnose areas of concern and provides evidence for the need to implement lake improvement projects (great for grant applications).

Upper and lower Blue Lake samples are summarized in this report individually.

Lake Data for Upper (Little) Blue Lake	
Township	Spencer Brook
MN Lake ID	30010701
# of Public Boat Access	0
Aquatic Invasive Species	Curly Leaf Pondweed
Surface Area	43 acres
Maximum Depth	10ft
Lake Meets Clean Water Goals	Total Phosphorus: **YES**
(When compared to shallow lake goals)	Chlorophyll-a: **YES**
	Secchi Transparency: **YES**

Lake Data for Lower (Big) Blue Lake	
Township	Spencer Brook/Stanford
MN Lake ID	30010702
# of Public Boat Access	2
Aquatic Invasive Species	Curly Leaf Pondweed
Surface Area	241 acres
Maximum Depth	30ft
Lake Meets Clean Water Goals	Total Phosphorus: **NO**
(When compared to deep lake goals)	Chlorophyll-a: **NO**
	Secchi Transparency: **YES**

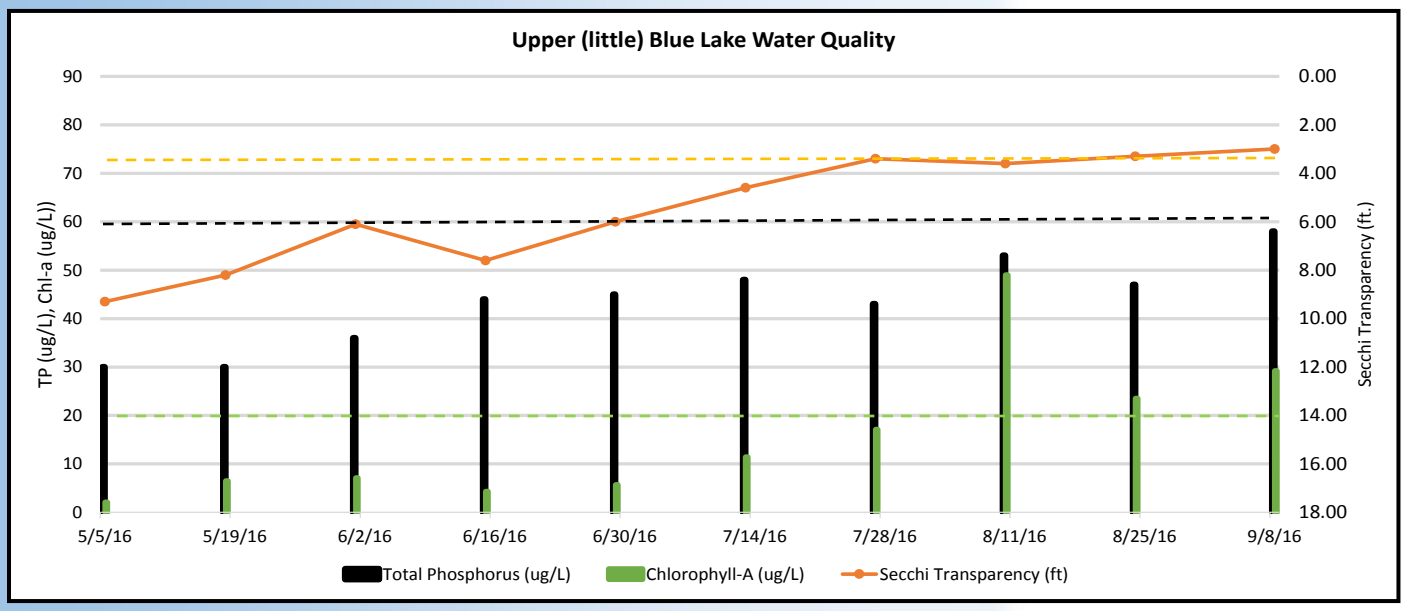
Upper (Little) Blue Lake Monitoring Results 2016

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

MN Clean Water Goals for Shallow Lakes

Total Phosphorus (TP): ≤ 60 ug/L Chlorophyll-a: ≤ 20 mg/m3 Secchi Depth: ≥ 3.28 feet

Growing season average (June-September)	46.75 (TP)	18.41 (Chl-a)	4.70 (Secchi)



Upper/Little Blue Lake has a maximum depth of about 10ft which means this part of the lake may have the characteristics of a shallow lake. Shallow lakes tend to occur in one of two conditions: one is a clear water condition with abundant rooted aquatic vegetation (high fish and wildlife habitat value) and the other is a turbid condition with few aquatic plants (low fish and wildlife habitat value). Shallow lakes are also more concentrated (less volume of water) and the water within them mixes easily. Temperature profile data collected in 2016 verifies the fact that this portion of the lake mixes often (see page 5 for more info). As such, shallow lakes naturally have higher levels of nutrients. The monitoring results for Upper Blue Lake are compared to the state's goals for shallow lakes in this area.

Upper Blue Lake meets all shallow lake water quality goals. TP, Chlorophyll-a and Transparency varied slightly throughout the sample season but generally increased thought the summer. The changes are likely due to wind-mixing, rainfall runoff and/or human activity such as boating.

From August to early September the area received nearly seven inches of rain. Interestingly, the water temperature in Little Blue dropped nearly 10 degrees after these events. The rain, no doubt, carried nutrients from nearby land due to the absence of stormwater treatment practices. The rain events also likely caused the lake water column and nutrients sitting at the bottom of the lake to mix. Low dissolved oxygen at the bottom of the lake indicates that there may be dissolved nutrients sitting at the bottom the lake. Combine the above scenarios with hot temperatures and algae blooms result as indicated by higher concentrations of Chl-a and lower transparency readings.

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.

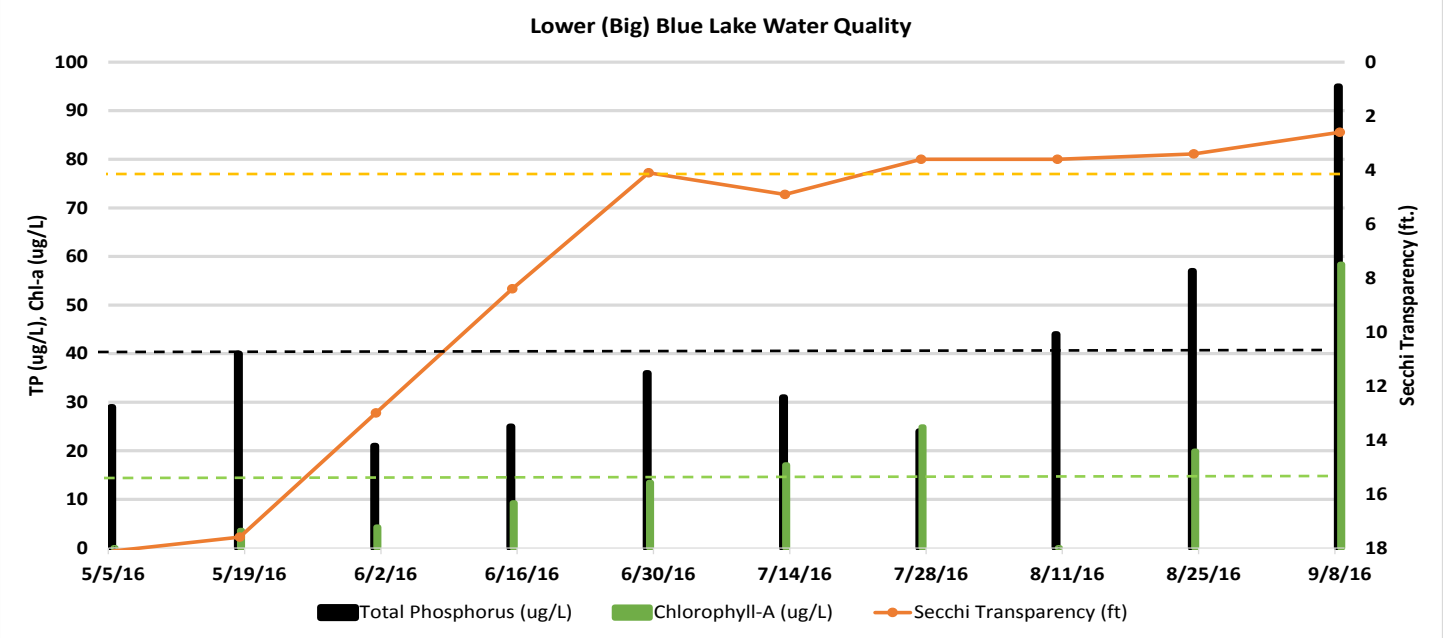
Lower (Big) Blue Lake Monitoring Results 2016

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 (June-September)	41.63 (TP)	18.43 (Chl-a)	5.45 (Secchi)



Lower/Big Blue Lake has a maximum depth around 30ft and the majority of the lake is greater than 15 feet deep which means this part of 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 5. The monitoring results for Lower Blue Lake are compared to the States goals for deep lakes in this area.

When compared to deep lake water quality goals, Big Blue Lake meets the goals for transparency but not for chlorophyll-a and phosphorus. This information means that the lake may be placed on the States "Impaired Waters List"!

Phosphorus was the highest early and late in the season. This result corresponds to the periods of time when the lake water column mixed, meaning higher levels of TP and Chl-a are in part due to internal loading. Nutrients sitting at the lake bottom could be from a combination of sources including the decay of curlyleaf pondweed (there was and extensive infestation in 2016) and an accumulation of nutrients from land runoff. It is important to note that large rains also carried high nutrients from the lake tributaries, verified by monitoring data, and surrounding land. The aforementioned occurrence highlights the importance of implementing storm water practices to treat the runoff before it reaches the lake.

Chl-a concentration was not recorded in the month of July due to incorrect lab data.

General Definitions

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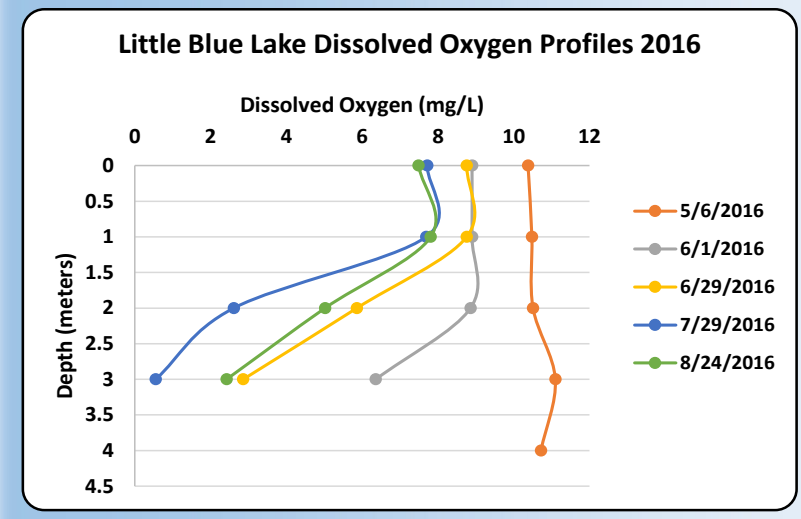
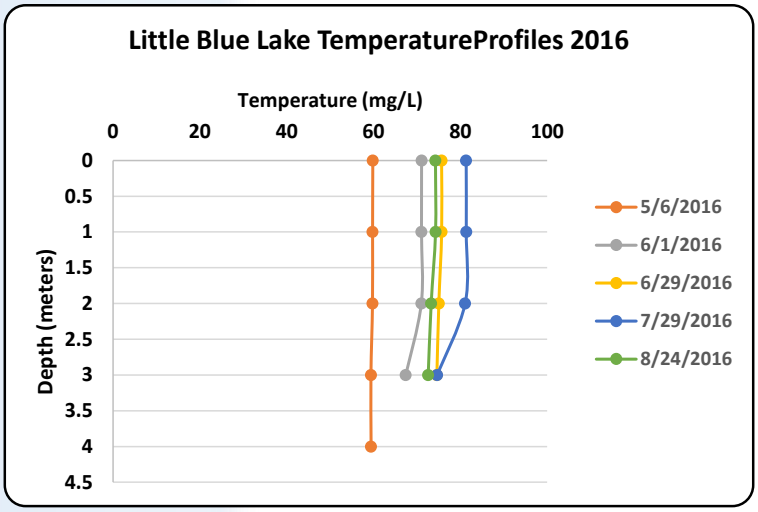
Chlorophyll-a (Chl-a): a pigment found in green plants, used to estimate amounts of algae in a lake.
Secchi Transparency: a measure of light penetration in water, an indication to the amount of algae in the water.

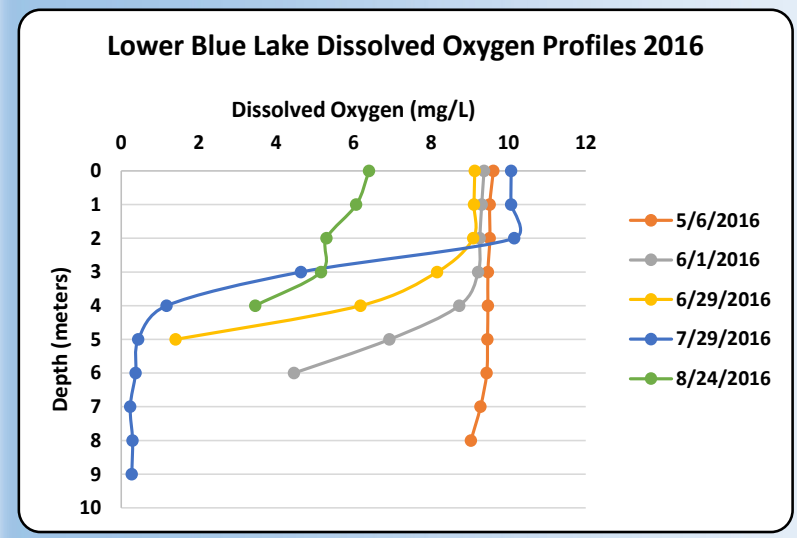
2016 Lake Stratification

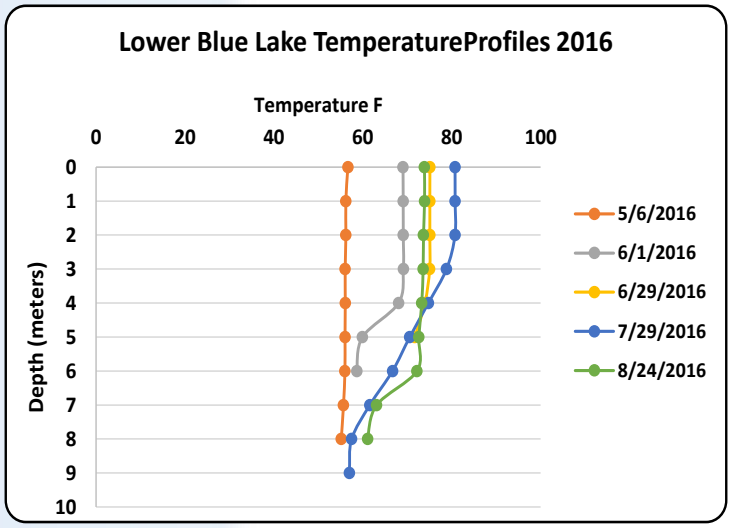
In 2016 we measured temperature and dissolved oxygen profiles starting at the surface of the water and then at one meter increments to the bottom of the lake. This information adds to the story when we analyze lake water quality data. The graphs below are representations of the data collected.

Little Blue Lake: Temperature remains consistent from top to bottom throughout the entire summer season. This indicates that the water column is continually mixing (as expected). As such, nutrients that are sitting in the sediments can continually mix into the lake (internal loading). Adding to this, dissolved oxygen periodically decreases to near zero at the bottom. Phosphorus becomes more soluble and can be released from the bottom sediments when this occurs. See the Little Blue Lake summary for more details on lake health.





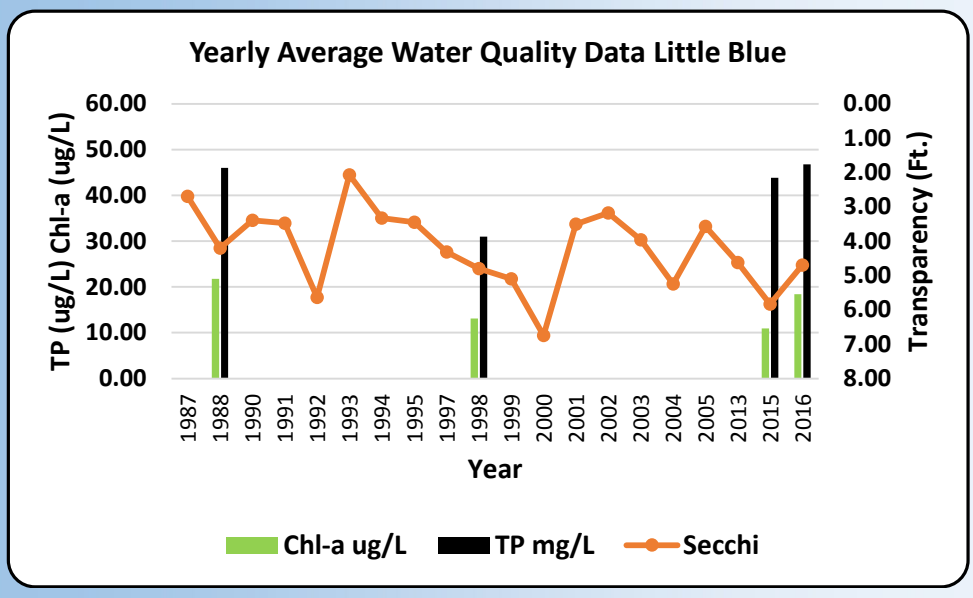




Big Blue Lake: Temperature is consistent throughout the water column early and late in the year and forms layers of water with different temperatures from late May to late August. This process is called thermal stratification and is expected in a deep lake. The cool water acts as a barrier between the 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.

Historic Monitoring Data Comparison

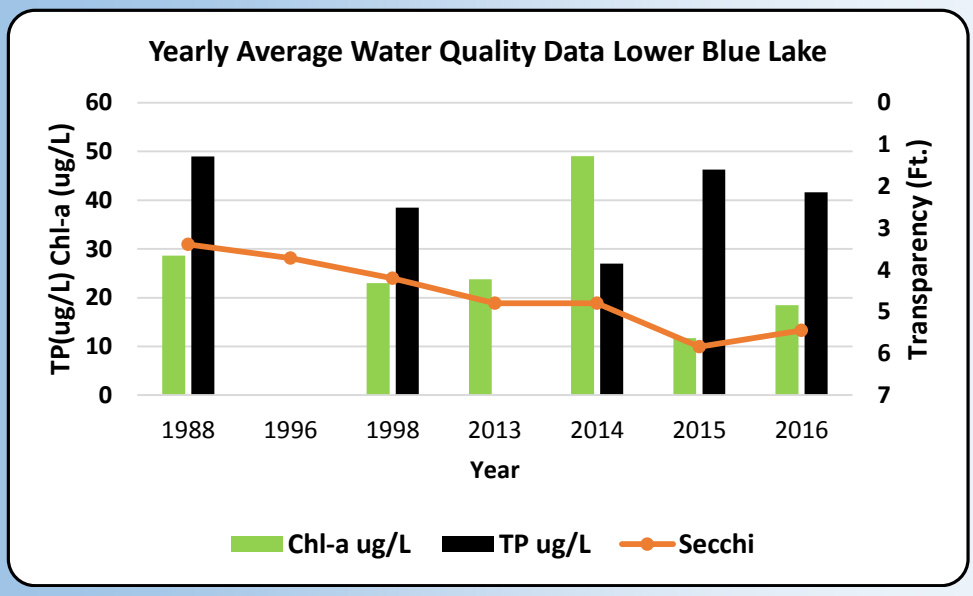
Total Phosphorus (TP), Chlorophyll-a (Chl-a) and Secchi Transparency



Source: MPCA and Isanti SWCD

Little (Upper) Blue Lake has the most historical transparency monitoring data, reporting observations almost every year from 2005 back to 1987. From 2013 to 2015 the average transparency has increased .83 feet. The most recent chlorophyll-a and total phosphorus monitoring was done seventeen years ago, which is not enough information to detect any water quality trends.

The important thing is, this part of the lake is meeting the state goals for lake health.



Source: MPCA and Isanti SWCD

Lower (Big) Blue Lake has three years of recent monitoring data for TP, Chl-a and transparency. More years of data are needed to determine trends; however, it does appear that transparency has improved since 1988.

Unfortunately, 2016 data may put the lake on the States "impaired" waters list.

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 Monitoring Recommendations

It is difficult to draw any conclusions from the limited monitoring data available. The data collected in 2016 did give us valuable insight into water health and how the lake responds over the season. 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 prior to investigating any in-lake activities.

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

- Continue monitoring as planned.
- Continue Collecting temperature and dissolved oxygen profiles during each sample event.
- Make note periods of heavy boat traffic on the lake.
- Make note when CLPW begins to decay.
- Take stratification measurements into early October.

For more information contact: **IsantiSWCD** 763-689-3271
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Thanks to the BLID members who have assisted with lake and stream monitoring, especially Jim LeFebvre and Dave Bebeau!

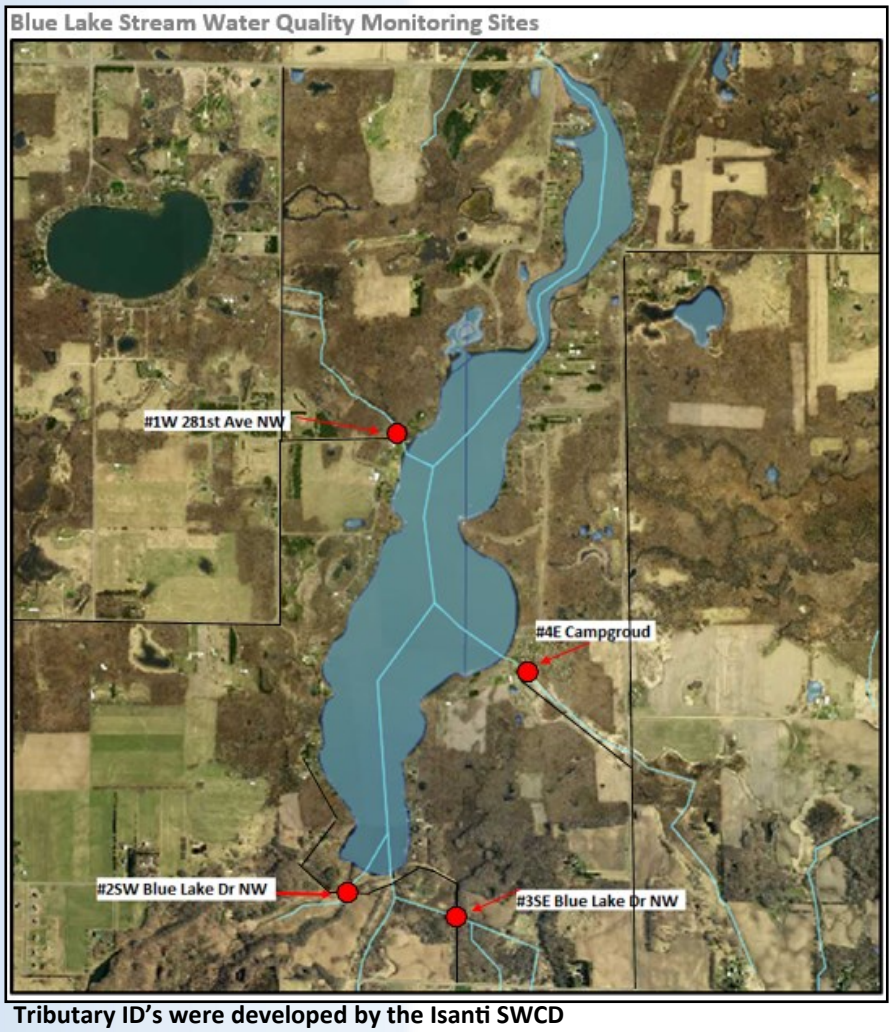
Blue Lake
Tributary Monitoring 2016

Introduction

2016 was the second year that the Blue Lake Improvement District (BLID) partnered with the Isanti Soil and Water Conservation District (SWCD) to monitor the health of the four tributaries that empty into Blue Lake:

- #1 West 281st Ave. NW Dead End Site
- #2 Southwest Blue Lake Dr. NW Site
- #3 Southeast Blue Lake Dr. NW Site
- #4 East Tiger St. NW Site

Site #2



Tributary ID's were developed by the Isanti SWCD

Tributary Monitoring

What: In 2016 eight sampling events were conducted at each of the four tributaries targeting four samples during rain events and four during base flow. The samples were tested for total phosphorus (TP), total suspended solids (TSS) transparency and Ortho Phosphorus (OP). OP was tested at site #4 only. Dissolved oxygen, temperature, conductivity, pH and water flow were measured in the field.

In addition to water quality, water levels were continually tracked using in-stream data loggers. The water levels were recorded every 4 hours from early April through mid October. Water level readings, were paired with flow to help us understand how much water and nutrients are being carried from the tributaries and into the lake.

Why: The information collected helps us focus future lake water quality improvement projects at the best places on the landscape. In other words, near the streams that deliver the most nutrients to the lake. Additionally, this information will be used to track trends and to determine how well water quality improvement projects are working.

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.

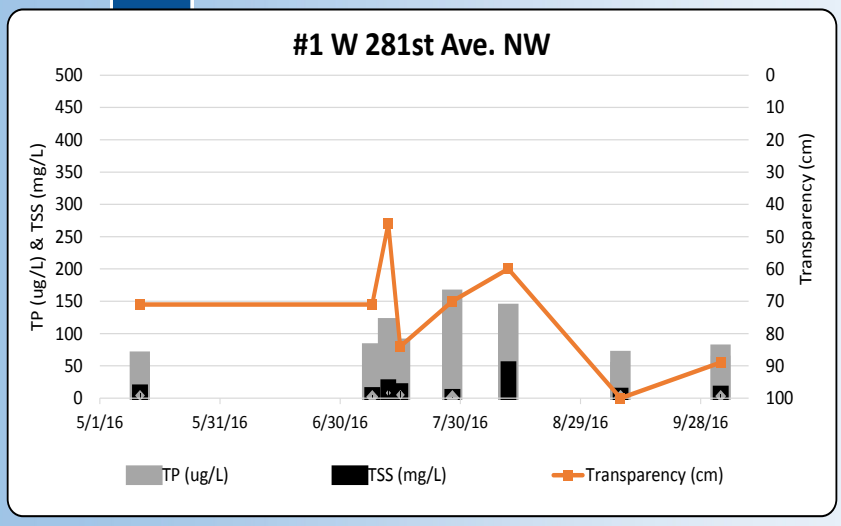
Transparency: an indirect measure of suspended and dissolved materials (soil particles and tea color caused by organic materials) in the water.

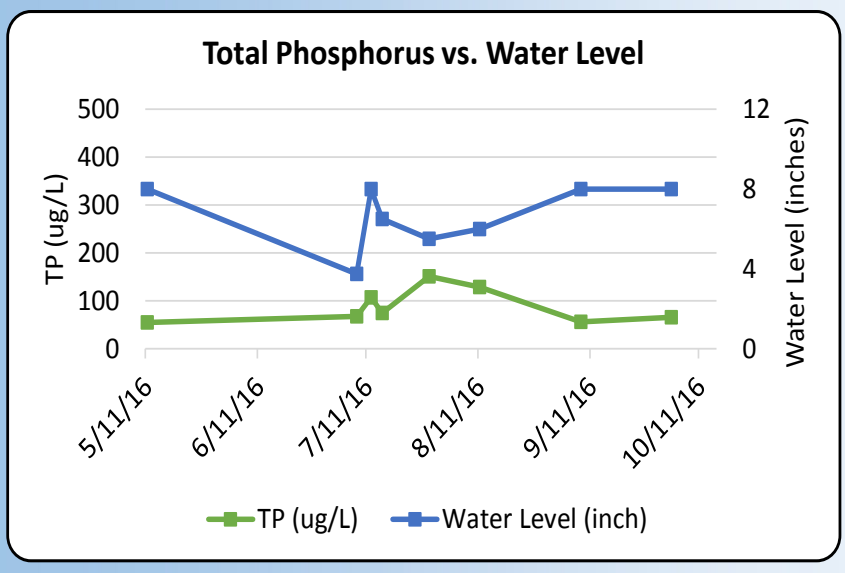
2016 Tributary Monitoring Results

Total Suspended Solids, Total Phosphorus and Transparency Tube

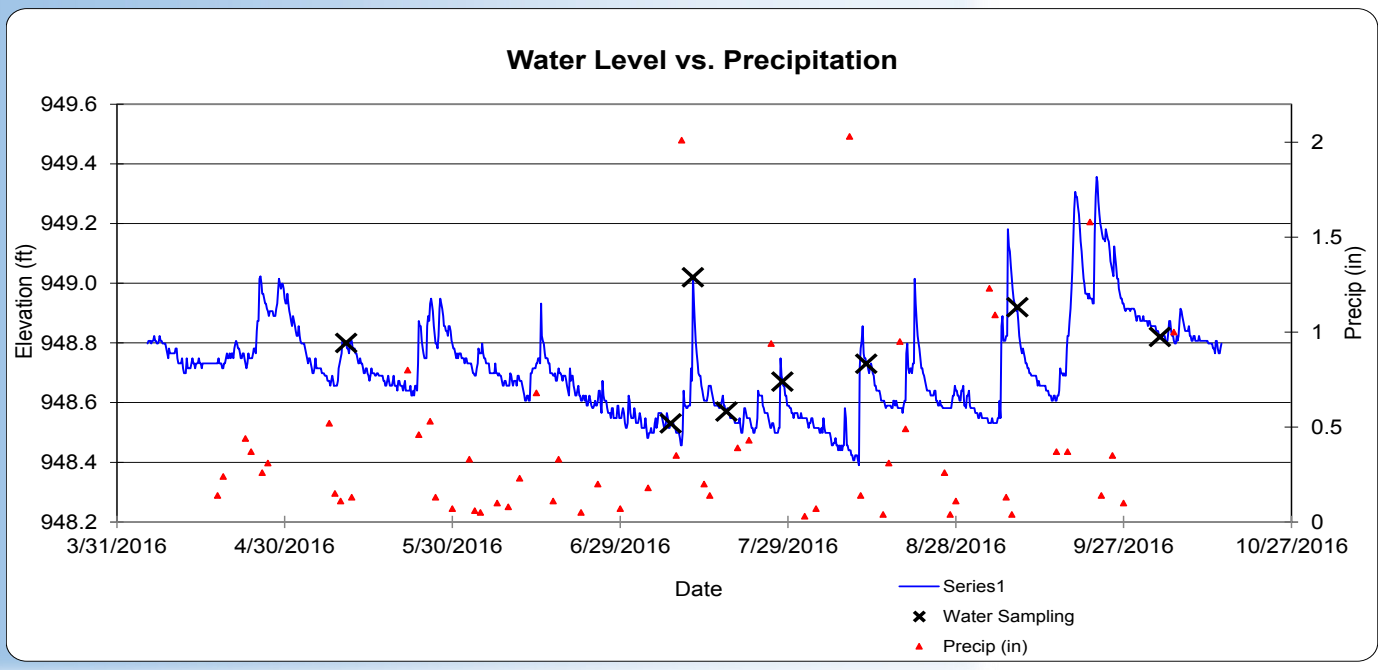
Site:

#1 281st Ave NW



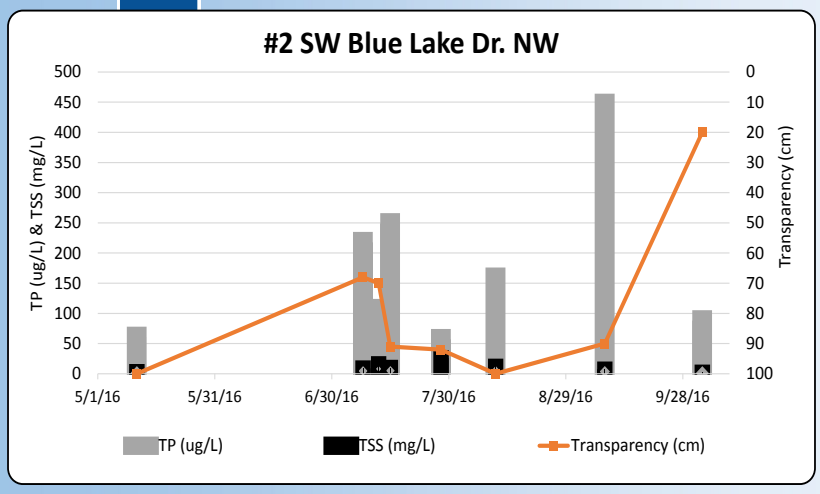


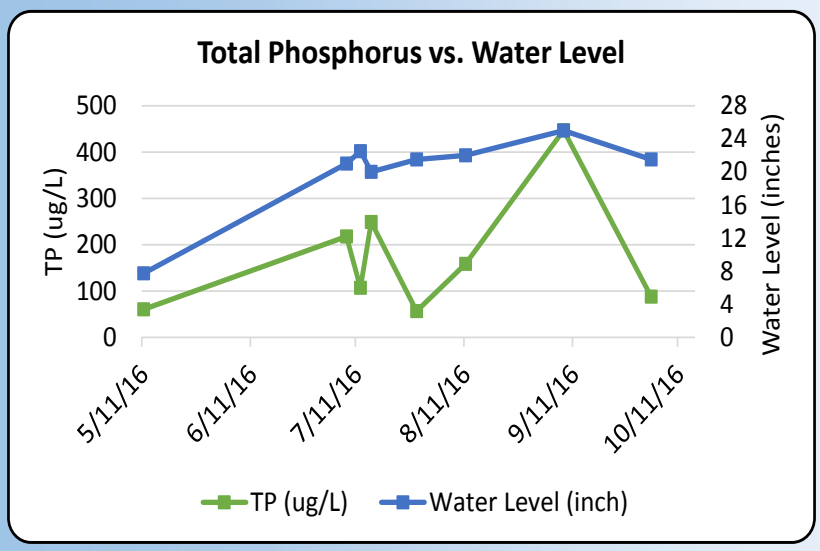
- The average concentration of TP at this location in 2016 was 88.38 µg/L; the lowest concentration measured among all four tributaries. In 2015 the average was 79µg/L, also the lowest measured.
- TP measurements for this area typically range between 60 and 150 µg/L.
- This tributary sends approximately 85 pounds of TP into Blue Lake Each year. This is the second highest contributor behind site 4.
- TSS measurements for this area typically range between 4.8 and 16 mg/L. The average concentration of TSS detected at this location was 11.50 mg/L.
- Transparency readings averaged 73.88 cm (Transparency tubes only measure to 100 cm) this means the water is typically quite clear. The 2015 average was 73.25.
- Water quality does fluctuate in relation to rainfall at this location; reasons for the response likely include: wetland flushing of nutrients after dry spells and rain water runoff from land.



2016 Tributary Monitoring Results

Total Suspended Solids, Total Phosphorus and Transparency Tube

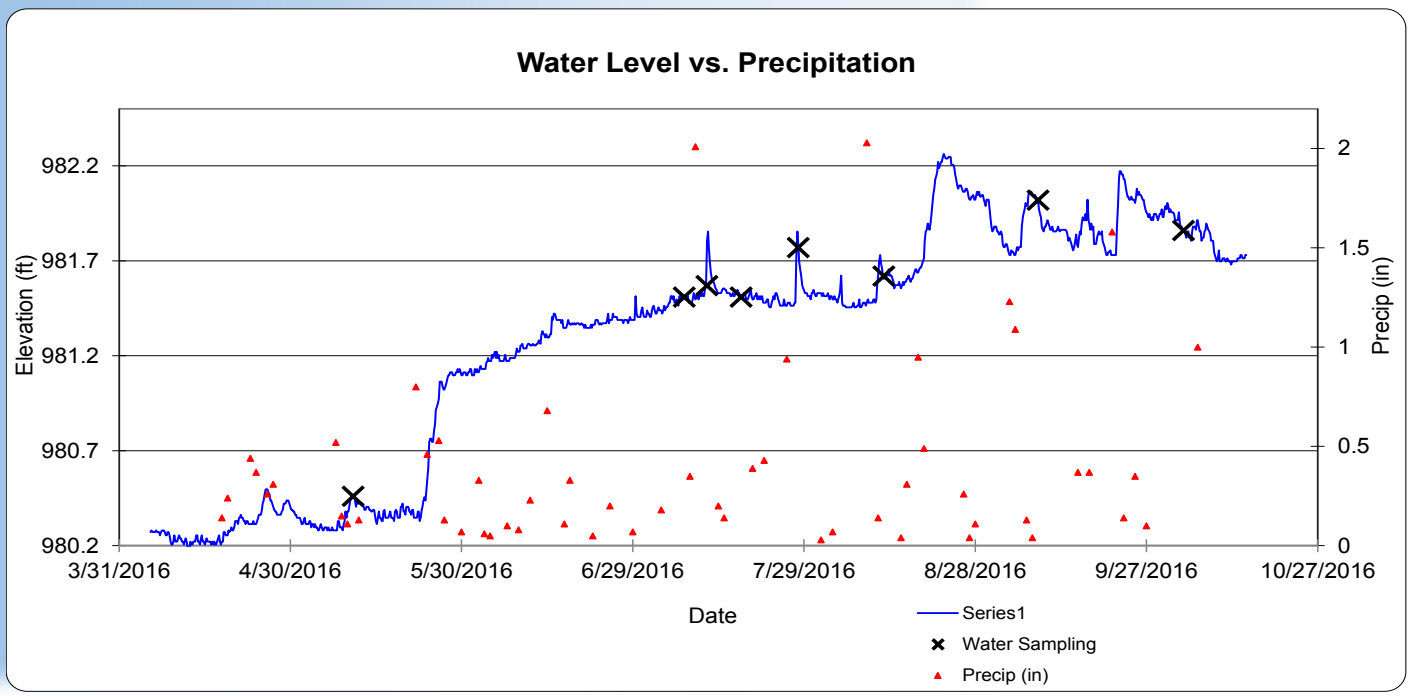




Site:

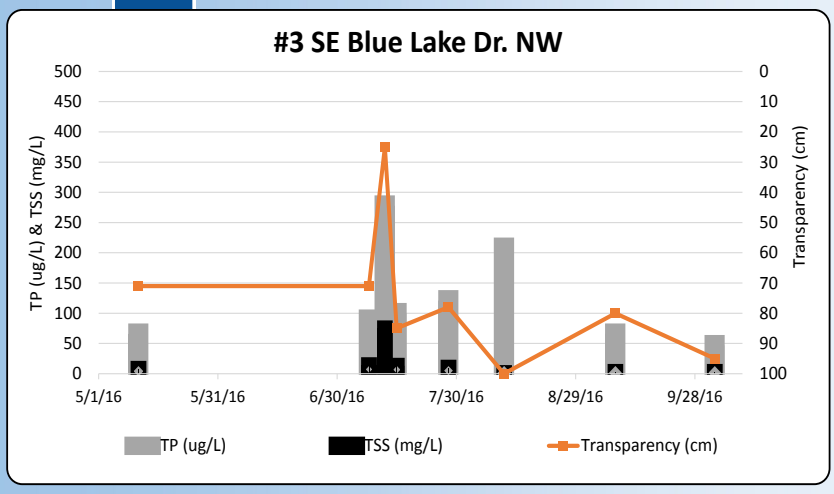
#2SW Blue Lake Dr. NW

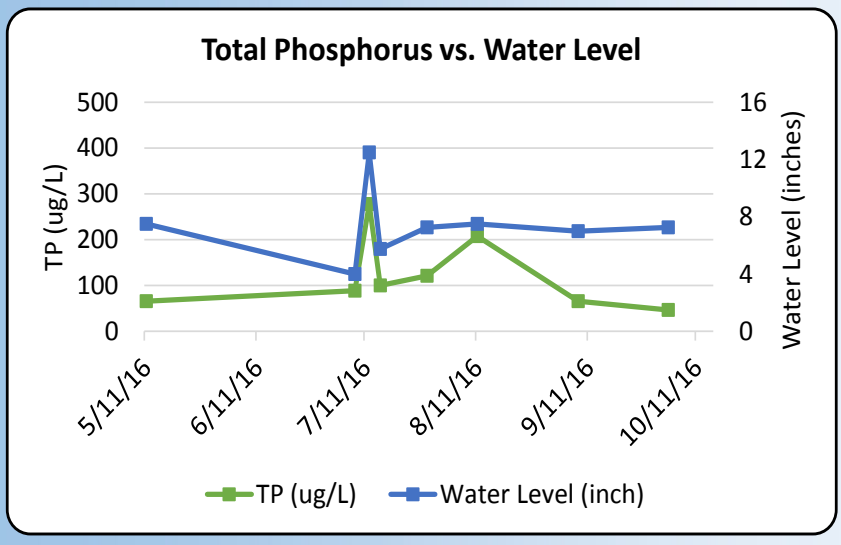
- A beaver dam built down stream between May and August significantly impacted stream flow and water level in 2016. The altered conditions should be taken into consideration when viewing results.
- The average concentration of TP at this location was 173.25 µg/L, the second highest concentration measured among the four tributaries. In 2015 the average was 100µg/L.
- TP measurements for this area typically range between 60 and 150 µg/L.
- Pounds of phosphorus contributed by this tributary were not calculated because of the dam impacts to flow.
- TSS measurements for this area typically range between 4.8 and 16 mg/L. The average concentration of TSS detected at this locations in 2016 was 10.63 mg/L. The 2015 average was 6.88.
- Transparency readings averaged 78.87 cm (Transparency tubes only measure to 100 cm) this means the water is typically quite clear. The 2015 average was 88.62.
- While TP was rather high in 2016 flow was very low due to the dam. More data is needed to determine seasonal trends and lake impacts.



2016 Tributary Monitoring Results

Total Suspended Solids, Total Phosphorus and Transparency Tube

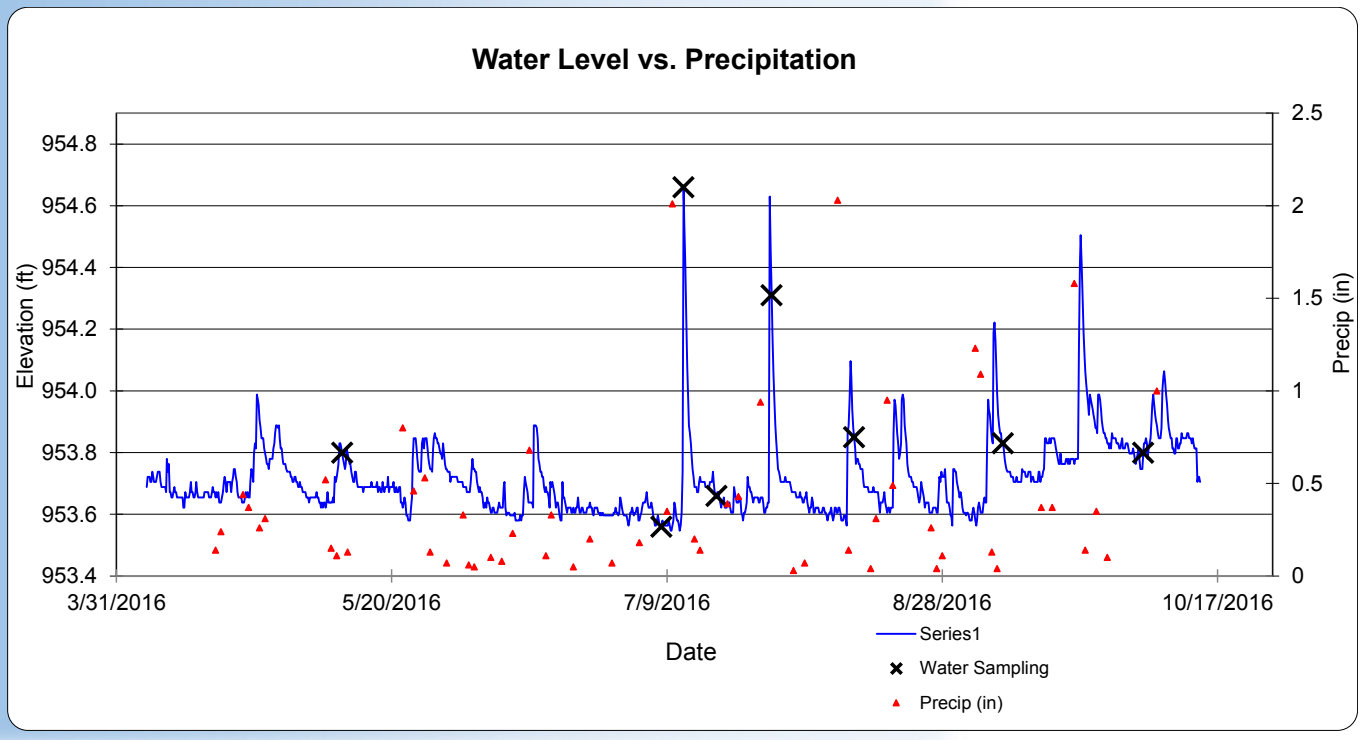




Site:

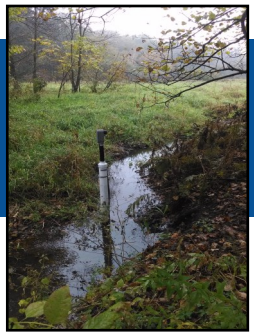
#3SE Blue Lake Dr. NW

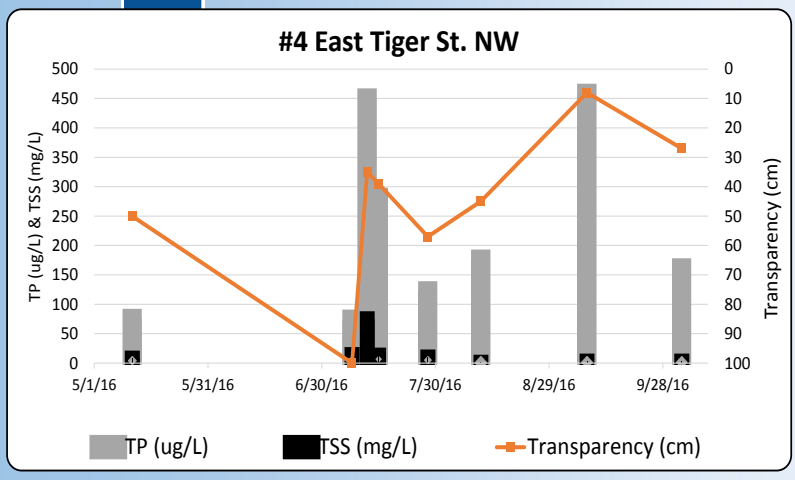
- The average concentration of TP at this location was 121.88 µg/L.; the second lowest of all four sites. In 2015 the average was 119.38 µg/L, slightly less.
- TP measurements for this ecoregion typically range between 60 and 150 µg/L.
- This tributary sends approximately 61 pounds of TP into Blue Lake Each year. This is the lowest of the tributaries. The reason for this is low flow.
- TSS measurements for this ecoregion range between 4.8 and 16 mg/L. The average concentration at this location was 15.88 mg/L. The 2015 average was 19.38.
- Transparency readings averaged 75.63 cm (transparency tubes only measure to 100cm). While it seems that the water is typically quite clear the high water event in early July resulted in a rather drastic reduction in water clarity (25 cm). In 2015 the average was 75.13.
- Water quality fluctuates in response to rain water runoff from land. The highest concentration of TP was measured during the July 12 event (278 µg/L).

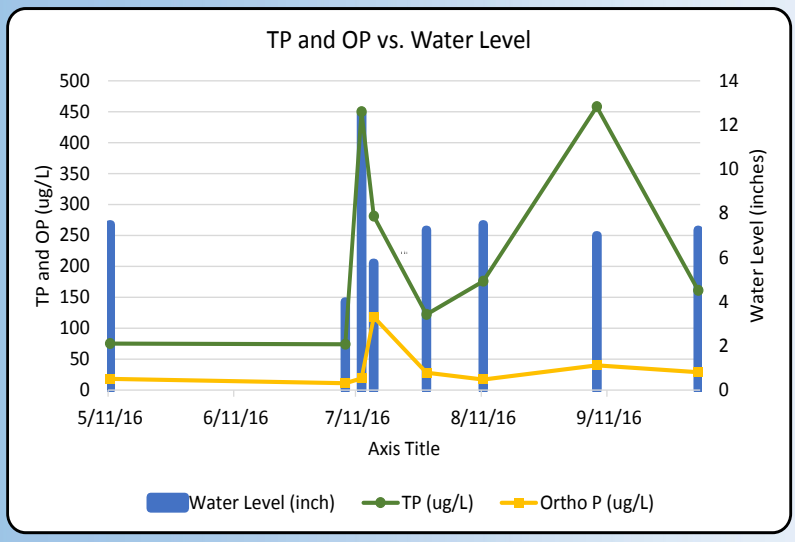


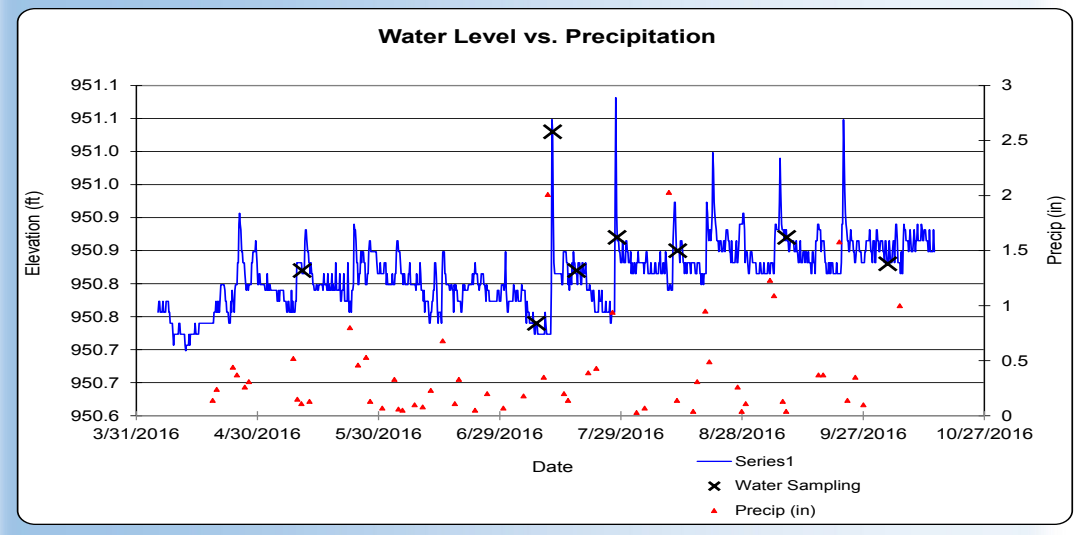
2016 Tributary Monitoring Results

Total Suspended Solids, Total Phosphorus and Transparency Tube









Site:

#4E Campground Site

- The average concentration of TP at this location in 2016 was 224.63 µg/L; the highest concentration measured among all four tributaries (56% higher than site #3). The 2015 average was 169.3 µg/L, the highest then too.
- TP measurements for this area typically range between 60 and 150 µg/L.
- This tributary sends approximately 190 pounds of TP into Blue Lake Each year. This is the highest of all sites!
- TSS measurements for this area range between 4.8 and 16 mg/L. The average concentration of TSS at this location was 26.88 mg/L. Levels increase with high water events which indicate that either material is being washed into the stream or decaying debris is being flushed from the wetland. The 2015 average was 16.13 mg/L.
- Corresponding with high TP and TSS, the transparency at this site was also much lower in 2016 than all other sites. Transparency readings averaged 45.13 cm (transparency tubes only measure to 100 cm). In 2015 the average was 53.63.
- OP was monitored in 2016 to determine the type of best management practice to be placed at the inlet and where the nutrients are coming from. OP part of TP ranged from 9-42%. This means that most TP is attached to particles (soil or other debris).
- Water quality from this inlet is likely influenced by a combination of runoff from the agricultural watershed and wetland flushing.

2016 Results and Recommendations

Tributary 4, similar to in 2015, had the highest concentrations of nutrients and is contributing the most nutrients to the lake. TP was higher than expected during both base flow and storm events. We suspect the elevated levels during high flow are due to a combination of runoff from nearby agricultural land during rain events and flushing of nutrients and organic material from the large wetland-dominated watershed. Interestingly, TP was also high during base-flow events. This characteristic is often observed downstream of wetlands that become anoxic (low –no oxygen) during periods of low flow. Anoxic conditions cause phosphorus to release from sediments. This tributary should be a starting point in which to focus water quality improvement projects. If the wetland is in fact a source of pollution a wetland restoration/treatment may be key to lake protection.

To this point, tributaries 1 and 3 appear to have water quality that is primarily driven by rainfall carrying nutrients off of the land and into the water. Wetland nutrient flushing may play a role in elevated nutrient at site 1 after large rain events. All tested parameters are, for the most part, close to or within typical ranges for this ecoregion; however, they may still contribute to lake pollution over time. While site 3 does receive higher TP after rain events, the flow is low. Thus, the amount of TP moving into the lake is the lowest of all monitored sites. With the information we have now, it appears that site 3 is a low priority.

In 2016 tributary 2 was impacted by a beaver dam. The increase water level and decrease flow in the middle of July indicates the beginning of the dam construction. The data from tributary 2 should be considered non-typical; however, the data can still be used for insight to water quality trends. Contacts have been made in hopes to remove the obstruction and continue monitoring in 2017 and continue to monitor the inlet. More data is needed before determining the priority level.

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.

Below are key points and recommendations for monitoring in 2017 at each of the four tributaries:

Tributaries 1-3:

- Sample as planned (same as 2016): 8 grab samples at highest and lowest water levels (peak flow and low flow); water level measurements; flow; dissolved oxygen; temperature; pH.

Tributary 4:

- Sample as planned (same as 2016): 8 grab samples at highest and lowest water levels (peak flow and low flow); water level measurements; flow; dissolved oxygen; temperature; pH.
- Continue sampling orthophosphorus (OP). By measuring OP, we can gain valuable insight into the sources of nutrients and potential solutions.
- **NEW**: Measure Dissolved oxygen several time prior to 9:00 a.m. to help determine Best Practice type. The SWCD can do this.
- **NEW**: Identify location for a sample point upstream of the wetland complex We may be able to pin-point the area contributing to high nutrient levels.

For more information contact: IsantiSWCD 763-689-3271
Tiffany Determann, District Mgr Tiffany.Determann@mn.nacdnet.net or
Todd Kulaf, Conservation Tech todd.kulaf@mn.nacdnet.net

Thanks to the BLID members who have assisted with lake and stream monitoring, especially Jim LeFebvre and Dave Bebeau!