resourceful. naturally.
engineering and environmental consultants

BARR

Technical Memorandum

To: Nine Mile Creek Watershed District Board of Managers
From: Keith Pilgrim and Janna Kieffer
Subject: Lake Cornelia: 2020 Alum Treatment and Mid-Summer Phytoplankton Blooms
Date: September 9, 2020
c: Randy Anhorn

The purpose of this memorandum is to evaluate the recent phytoplankton (algae) blooms in Lake Cornelia within the context of historical phosphorus and phytoplankton (measured as chlorophyll *a*) concentrations in the lake and the alum treatment which was conducted in the spring of 2020.

Lake Cornelia Management Approach

The Use Attainability Analysis, which was completed in July 2019, identified four causes of persistent phytoplankton blooms in Lake Cornelia: (1) stormwater inputs, (2) the growth and die-off of the invasive aquatic plant curly-leaf pondweed, (3) release of phosphorus from lake bottom sediments (internal loading), and (4) invasive bottom-feeding fish, common carp and goldfish. In order to attain phosphorus and chlorophyll *a* (chl *a*) concentrations that approach water quality standards for shallow lakes, all four of these sources/causes have to be addressed. Implicit to this approach is also the need to promote aquatic plant growth by improving lake clarity.

Planning and implementation of management activities to address the four sources/causes of persistent phytoplankton blooms are underway. Management activities are in progress to address two of the four sources/causes of persistent phytoplankton blooms: herbicide treatments are currently being conducted in the spring of each year by the City of Edina to control curly-leaf pondweed, and one-half of the proposed alum treatment was completed in the spring of 2020 to reduce internal loading from lake sediments. Design of a stormwater filtration Best Management Practice (BMP) in Rosland Park to remove phosphorus from stormwater before it reaches Lake Cornelia is underway. A study of the dynamics of the carp and goldfish population and options for carp and goldfish removal is also underway, but management of the population has not yet begun.

Reducing Internal Loading

Internal loading control in Lake Cornelia involves two parts: (1) alum treatment, and (2) reduction of the common carp and the goldfish population. The alum treatment conducted in the spring was designed to be half (alum gallons: 11,667 and sodium aluminate gallons: 5,834) of the total (alum gallons: 23,337 and sodium aluminate gallons: 11,558) alum dose required to bind up the phosphorus that typically releases from lake bottom sediments when oxygen is low in the water column. The half dose was designed to bind up phosphorus called mobile-phosphorus. The other half of the dose is planned to be conducted approximately five years after the initial treatment, with the timing and dose required to be determined

based on sediment coring. For internal phosphorus loading control to be complete, the carp and goldfish population need to be significantly reduced and the full alum treatment applied. Another important aspect of this approach is the installation of aeration under the ice during the winter to support a native fish population that can compete with the carp and goldfish and help maintain low carp and goldfish populations.

The alum treatment, when completed (both treatments), is expected to reduce total phosphorus loading in North Cornelia by approximately 12 to 33 percent and for South Cornelia from 19 to 32 percent. After reviewing the historical monitoring data that is presented below, it can be seen that it is difficult to separate the effect of the partial alum treatment from natural variability in lake water quality from year to year.

Phosphorus and Phytoplankton in 2020 Compared to Previous Years

Provided below are plots of total phosphorus and phytoplankton (measured as chl *a*) measurements collected during June through September in North and South Cornelia from 2004 through 2017. Upon review of these plots, a first observation is that there is a considerable degree of variability with a given year and between years. The boxes identify where most of the monitoring results lie, the red "+" is the mean of that year, and the blue dots identify the high and low measurements. It can be seen in Figure 1 that for North Cornelia, total phosphorus during a "good" year" (monitoring year 2016) averaged 0.11 mg/L and ranged from approximately 0.05 mg/L to 0.15 mg/L. Also for North Cornelia in 2016 (Figure 1), chlorophyll *a* concentrations averaged 36 ug/L and ranged from approximately 5 ug/L to around 90 ug/L. For South Lake Cornelia (Figure 2), phosphorus during a "good year" (monitoring year 2013) averaged 0.11 mg/L and ranged from approximately 0.07 mg/L to 0.17 mg/L. For South Cornelia (Figure 2) in 2013, chlorophyll *a* averaged 35 ug/L and ranged from approximately 10 ug/L to around 60 ug/L. It can be seen in Figure 1 (North Lake Cornelia) that during most years, total phosphorus exceeded 0.2 mg/L and chlorophyll *a* readily exceeded 50 ug/L. In Figure 2 (South Cornelia), total phosphorus readily exceeded 0.15 mg/L and chlorophyll *a* was often above 50 ug/L.

Comparing the historical data in Figure 1 and 2 to monitoring data collected in North and South Cornelia in 2020 (through the August 17th sampling event), it appears that total phosphorus and chlorophyll *a* concentrations in 2020 were actually at the lower end of the range of historical data. Total phosphorus in North Cornelia hovered around 0.11 mg/L with a spike observed on August 3 of 0.21 mg/L. Chlorophyll *a* concentrations in North Cornelia averaged 64 ug/L (June through September) and ranged from 9 to 101 ug/L (full year). Total phosphorus in South Cornelia ranged from 0.053 to 0.11 mg/L (full year) with higher concentrations of 0.11 mg/L observed during the August 3, 2020 sampling event. Chlorophyll *a* concentrations in South Cornelia averaged 45 ug/L (summer only) and ranged from 8 to 69 ug/L (full year). Results from the September 8, 2020 sampling event were not included in the analysis, as lab results were not available yet.

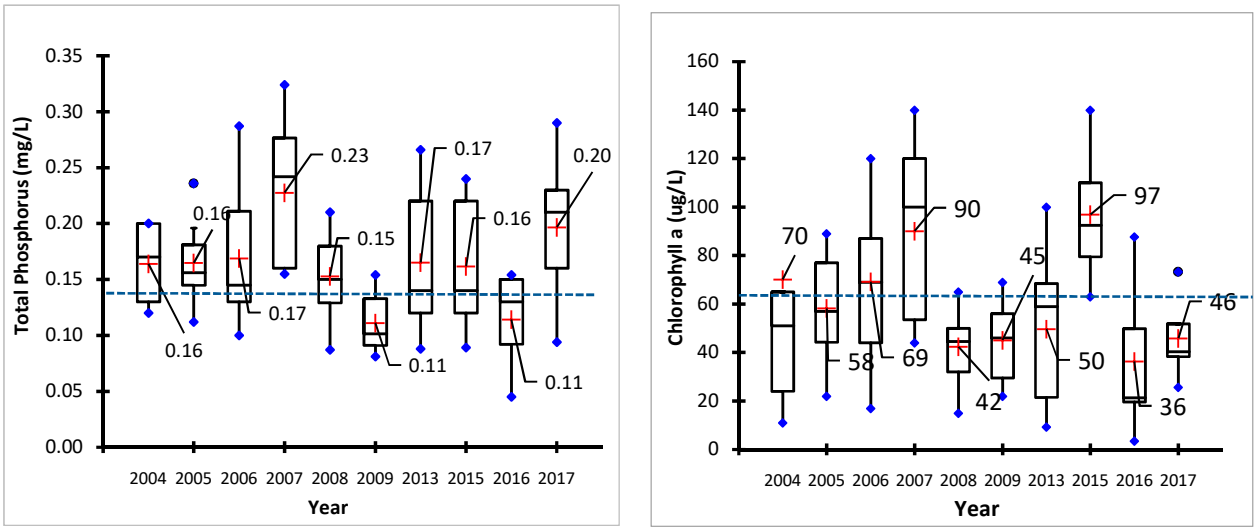


Figure 1. North Cornelia-Historical phosphorus and chlorophyll *a* concentrations. Dashed blue line is the 2020 average summer value, excluding the September 8, 2020 monitoring event

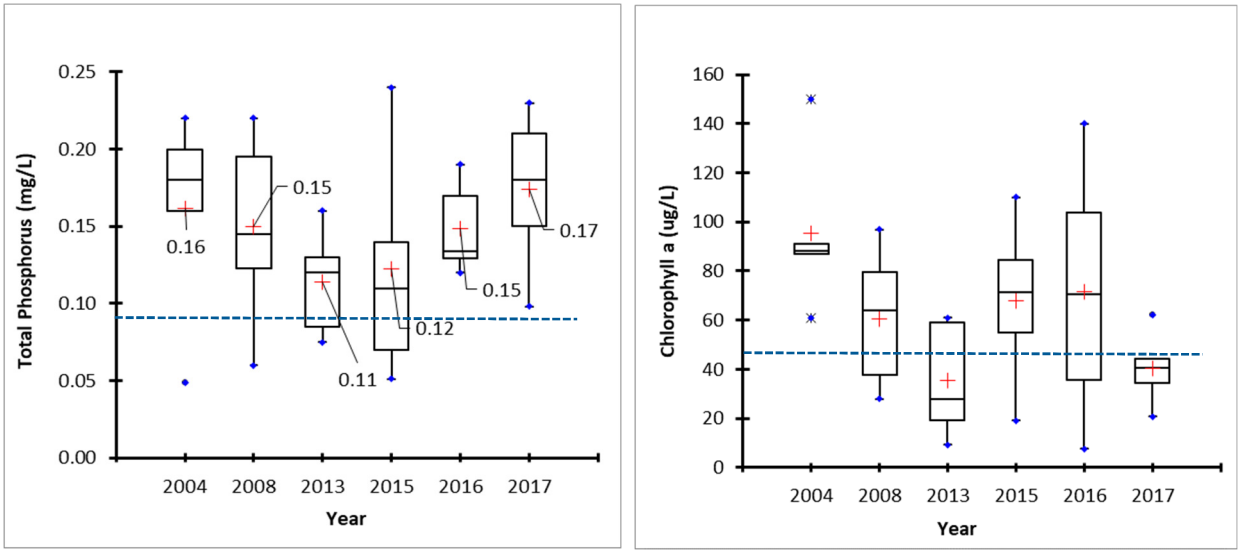
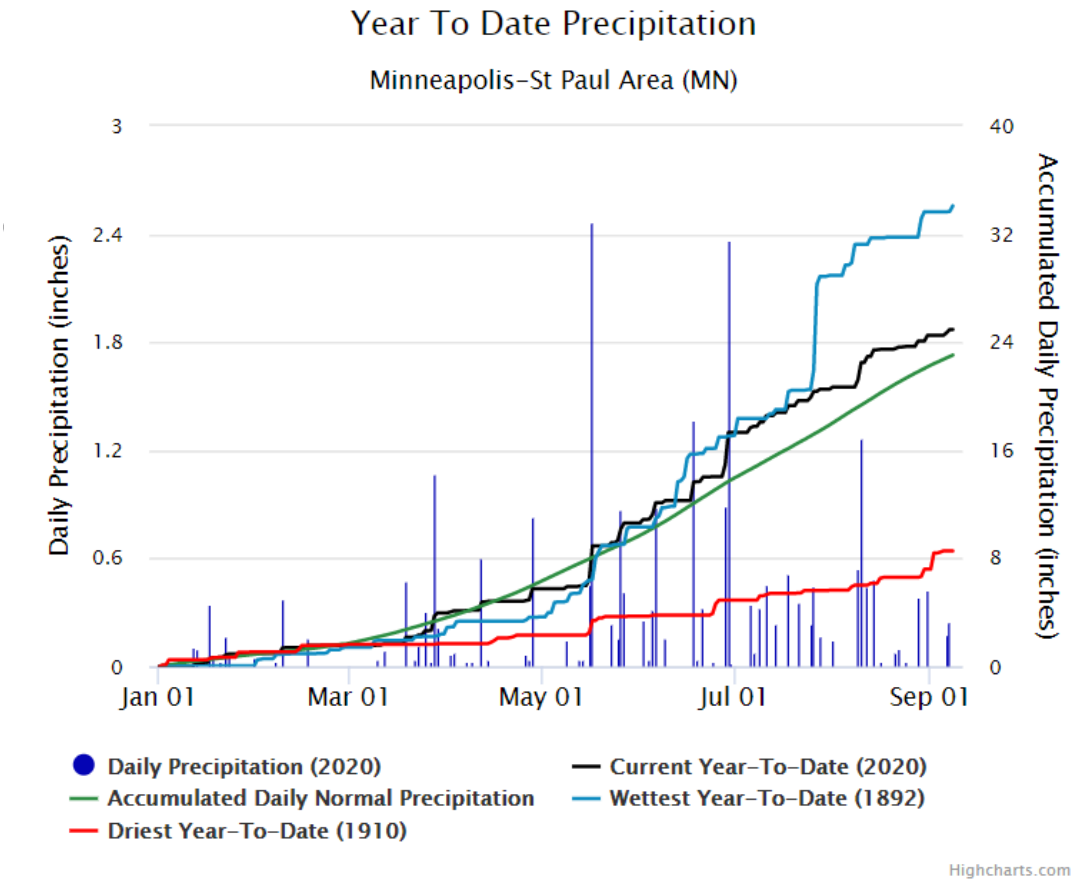


Figure 2. South Cornelia-Historical phosphorus and chlorophyll *a* concentrations. Dashed blue line is the 2020 average summer value, excluding the September 8, 2020 monitoring event (lab results not available).

Table 1. Monitoring data for North and South Cornelia for 2020. Dashed blue line is the 2020 average summer value, excluding the September 8, 2020 monitoring event (lab results not available).

	North Cornelia		South Cornelia	
Date	TP (mg/L)	Chl *a* (ug/L)	TP (mg/L)	Chl *a* (ug/L)
4/21/2020	0.100	8.6	0.053	8.3
6/15/2020	0.110	24.1	0.095	15.7
7/13/2020	0.110	78.1	0.093	55.8
8/3/2020	0.210	101	0.110	69.4
8/17/2020	0.120	51.8	0.068	38.9
Average (summer)	0.140	64	0.092	45

Overall, it appears that total phosphorus was generally lower in North and South Cornelia in 2020 compared to historical conditions. Chlorophyll *a* in North Cornelia was similar to historical conditions and generally lower than historical conditions in South Cornelia. One additional note is that it appears that the big increase in total phosphorus measured on August 3 was due to a series of medium sized storm events during July that likely led to significant stormwater inputs with phosphorus loads. This can be seen in the graph below (source https://www.dnr.state.mn.us/climate/climate_monitor/precipcharts.html). This observation reinforces the need for the planned external load control efforts to reduce the phosphorus from stormwater runoff (i.e., the Rosland Park stormwater filtration BMP).



Conclusions

The alum treatment, upon completion of both treatments, is expected to reduce total phosphorus loading in North Cornelia by approximately 12 to 33 percent and for South Cornelia from 19 to 32 percent. The remainder of the phosphorus load is largely from external (watershed) sources (e.g., 48 to 76 percent for North Cornelia). Overall, it appears that total phosphorus concentrations were generally lower in North and South Cornelia in 2020 compared to historical conditions. Other observations from a comparison of 2020 and historic phytoplankton data include:

- Although chlorophyll *a* concentrations in mid-July and early August were high in South Cornelia, maximum and average chlorophyll *a* were lower in 2020 compared to most monitored years since 2004 (see Figure 2).
- For North Cornelia, the average chlorophyll *a* in 2020 was typical of past years.

After reviewing the historical monitoring data that is presented in this memo, it can be seen that it is difficult to separate the effect of the partial alum treatment from natural variability. It is also difficult to

determine the degree that phosphorus reduction observed so far in 2020 may have been a result of the alum treatment without further analysis which would include modeling.

It is important to note that significant reductions in total phosphorus are needed in order to begin to reduce chlorophyll *a* growth. A significant switch in the ecological condition of Lake Cornelia will not occur until all of the management activities are executed to the degree that the current excess of phosphorus is reduced to concentrations that begin to impede phytoplankton growth and improve lake clarity, which will also stimulate plant growth. This process is also referred to as a "lake switch" which is characterized by a significant increase in aquatic plants and significant reductions in phytoplankton blooms. It can be expected that progress at Lake Cornelia will be difficult to observe until all of the management activities are executed.