Attn: Noah Czech, City of St. Cloud
From: Stormwater Research Group, St. Anthony Falls Laboratory (SAFL), University of Minnesota, gulli003@umn.edu
Re: Summary of Collected Data from Pond 52 in St. Cloud, Minnesota during 2021
Date: January 17th, 2022

The following is a summary and brief analysis of the collected data from Pond 52 in St. Cloud, Minnesota that the Stormwater Research Group (PI: John Gulliver) has examined. This summary primarily discusses comparisons between data from 2019, 2020, and 2021 field seasons. Descriptions of the data available preceding the 2019 field season were included in the 2019 field season summary memo dated January 6th, 2020.

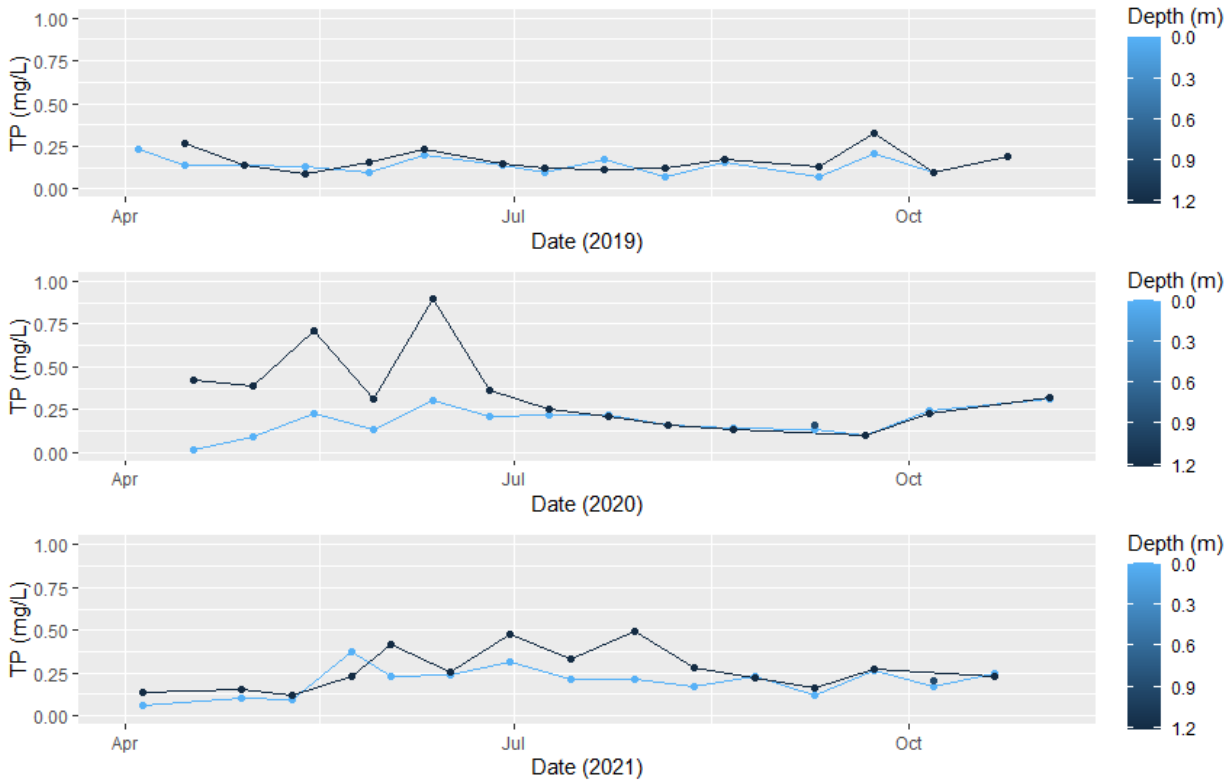

Figure 1. Concentrations of total phosphorus (TP) in the 2021 monitoring season were similar to those from the 2019 and 2020 monitoring seasons. Occasional high hypolimnion (bottom of the water column) TP concentrations could be due to sediment accidentally captured along with the water samples or due to sediment phosphorus release, which would be more likely as observed during the summer of 2021 than during the spring of 2020.

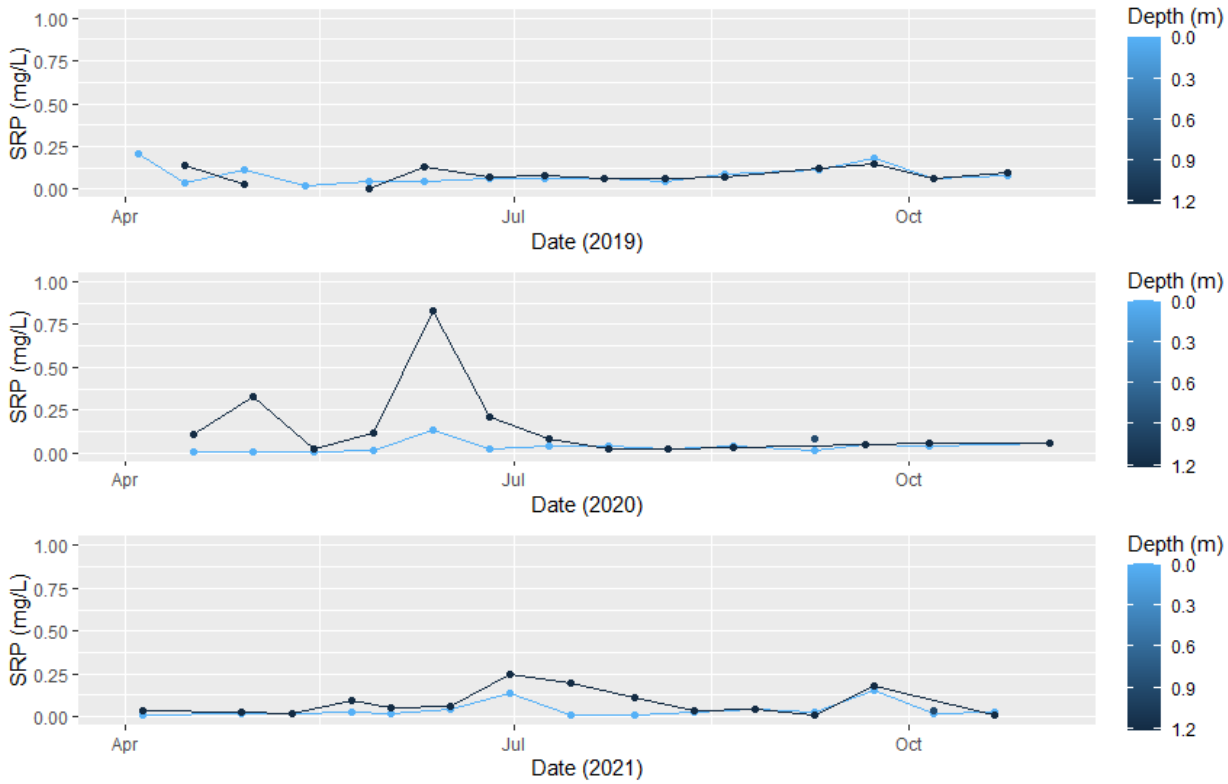

Figure 2. Concentrations of soluble reactive phosphorus (SRP) in the 2021 monitoring season were similar to those from the 2019 and 2020 monitoring seasons.

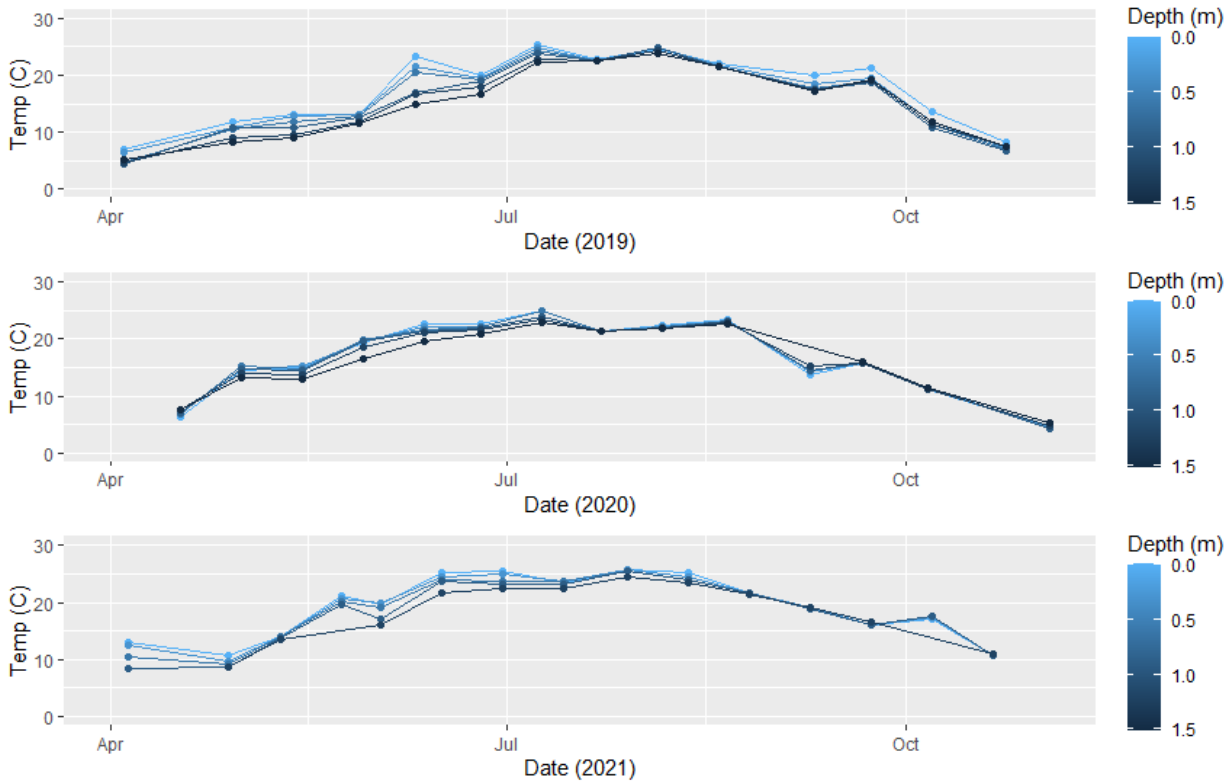

Figure 3. Temperature differences across water depths were minor in all years, and 2021 monitoring season were similar to those from the 2019 and 2020 monitoring seasons.

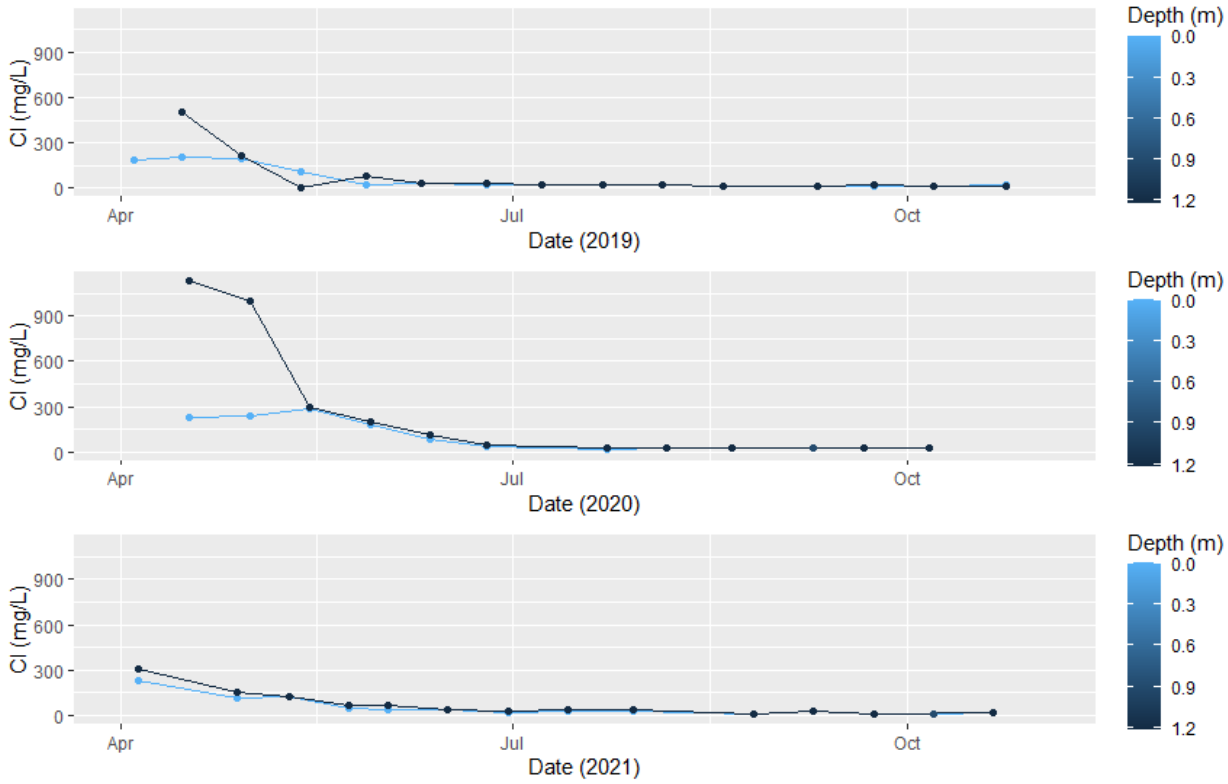

Figure 4. Chloride (Cl) concentrations during April and May of 2021 were lower than those of the 2019 and 2020. The lingering high Cl concentrations attributed to salt-laden snowmelt in 2020 were not present in 2021.

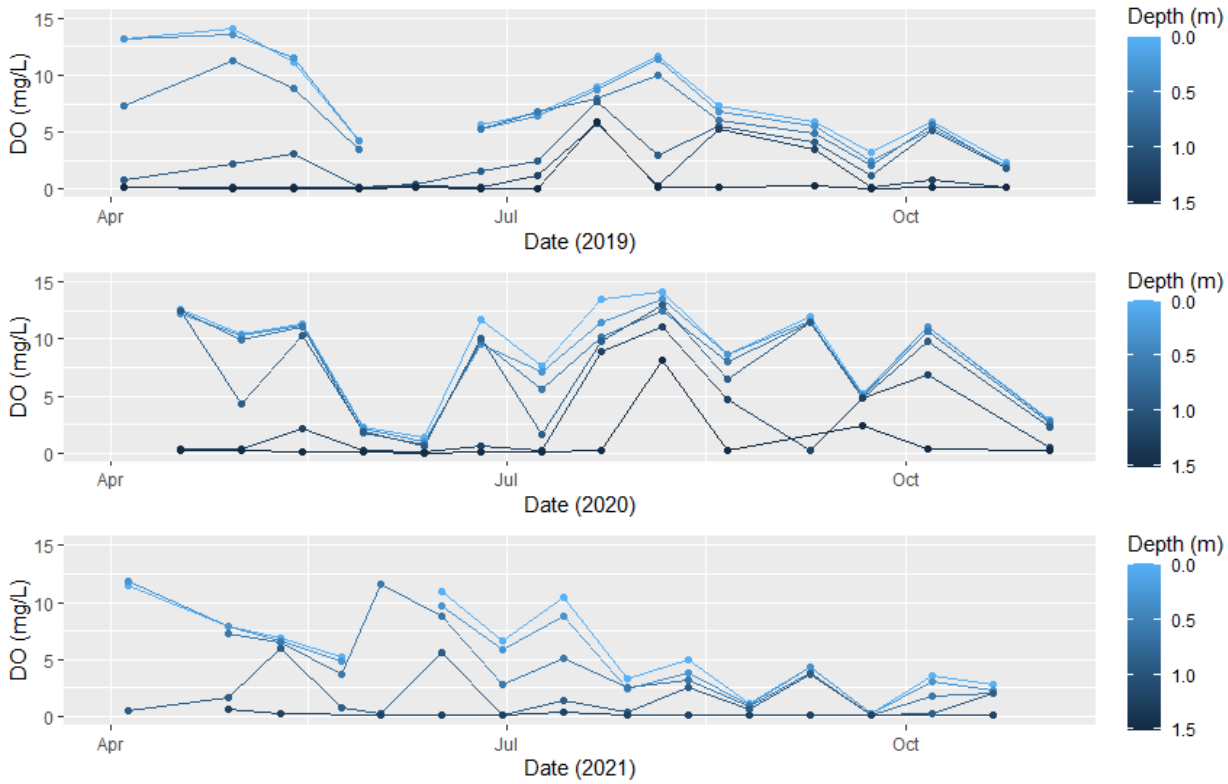

Figure 5. Dissolved oxygen (DO) concentrations at the bottom of the pond were frequently low. The remainder of the water column typically had high DO concentrations, though these decreased throughout the year. Low DO in the upper water column during the late summer and fall may have been influenced by lower than average rainfall during this time in the year (see Figure 6).

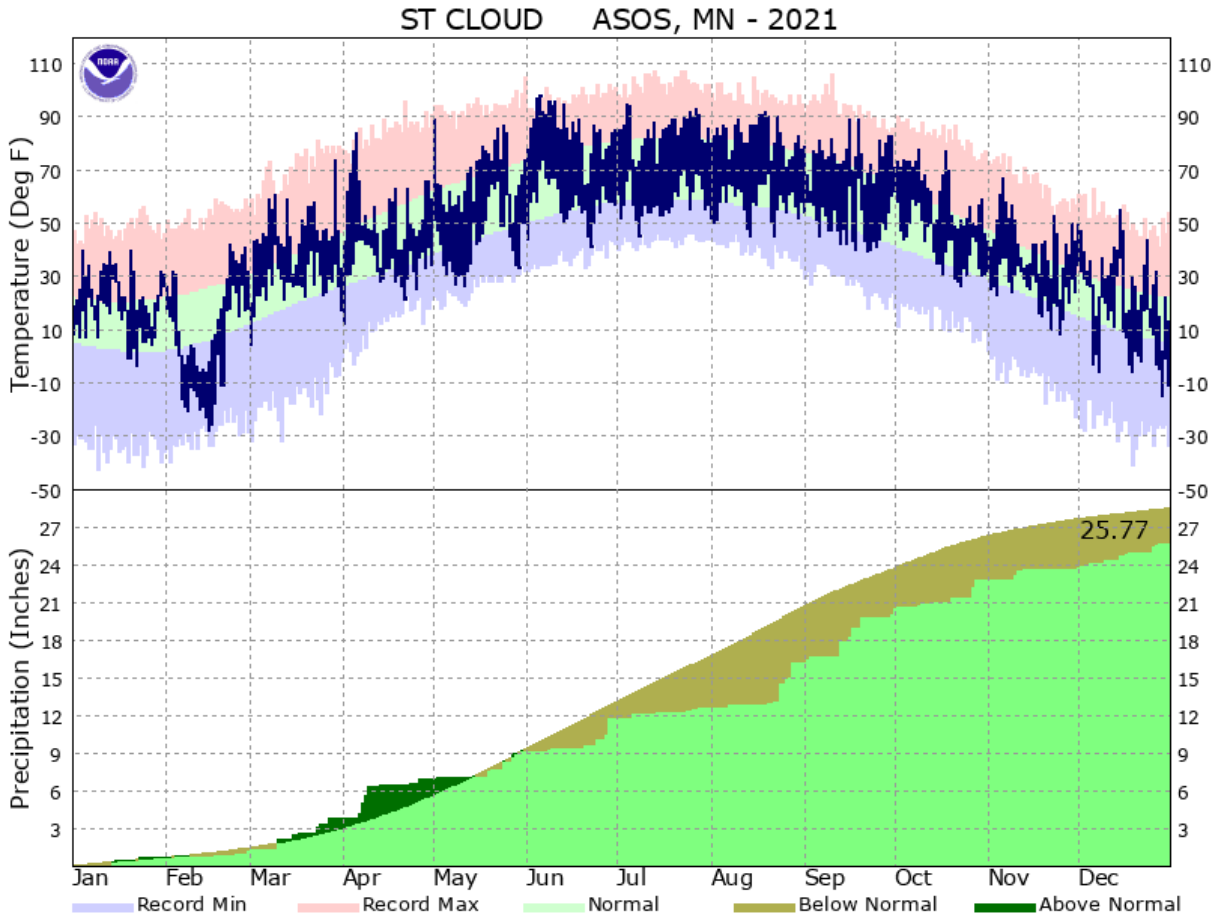

Figure 6. Temperature and precipitation observations for St. Cloud, MN in 2021. Source: NOAA, retrieved from. Below normal precipitation began in early June and reached a maximum difference from normal in late August.

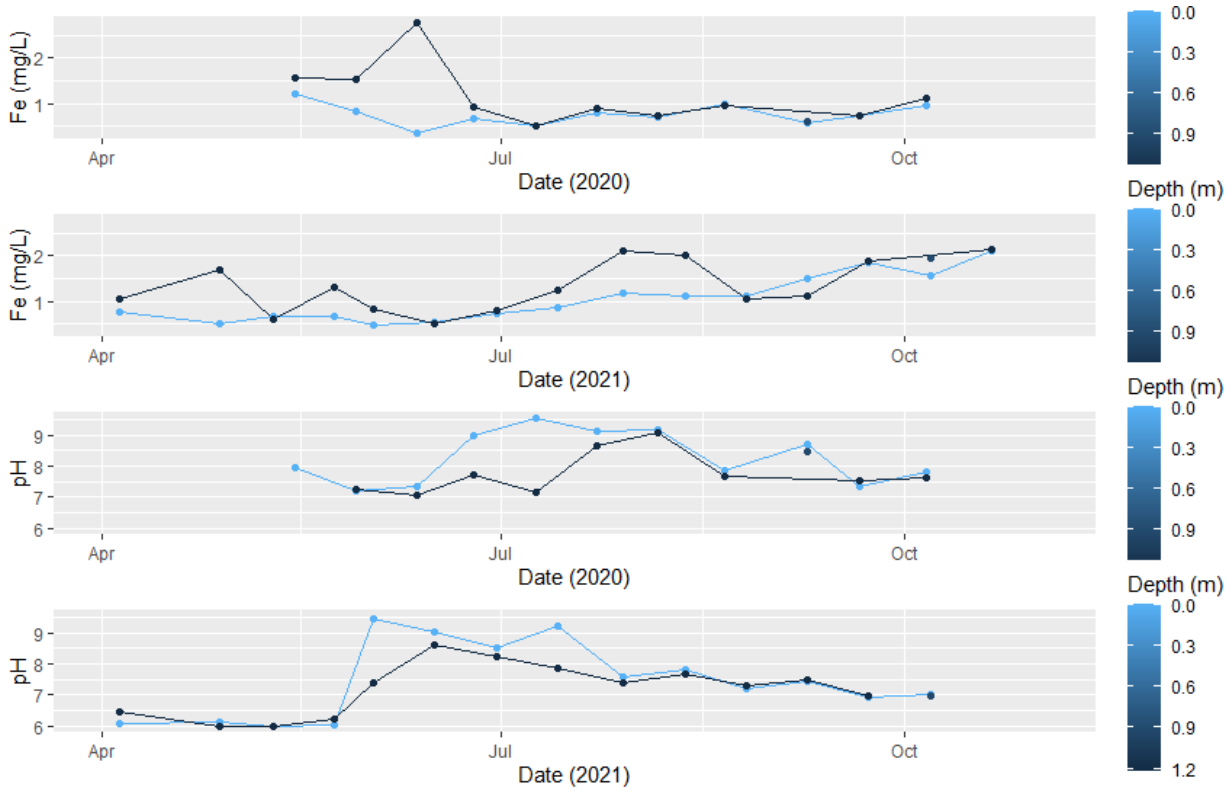

Figure 7. pH has been fluctuating seasonally and may be responsible for changes in dissolved metals such as iron (Fe). Changes in pH can occur due to chemical mechanisms and biological activity including pH increase from photosynthesis during the growing season. Elevated Fe during the anoxic period in the later half of 2021 (see Figure 5) could be evidence of Fe reduction and dissolution, but this did not appear to result in any corresponding TP (Figure 1) or SRP (Figure 2) release.

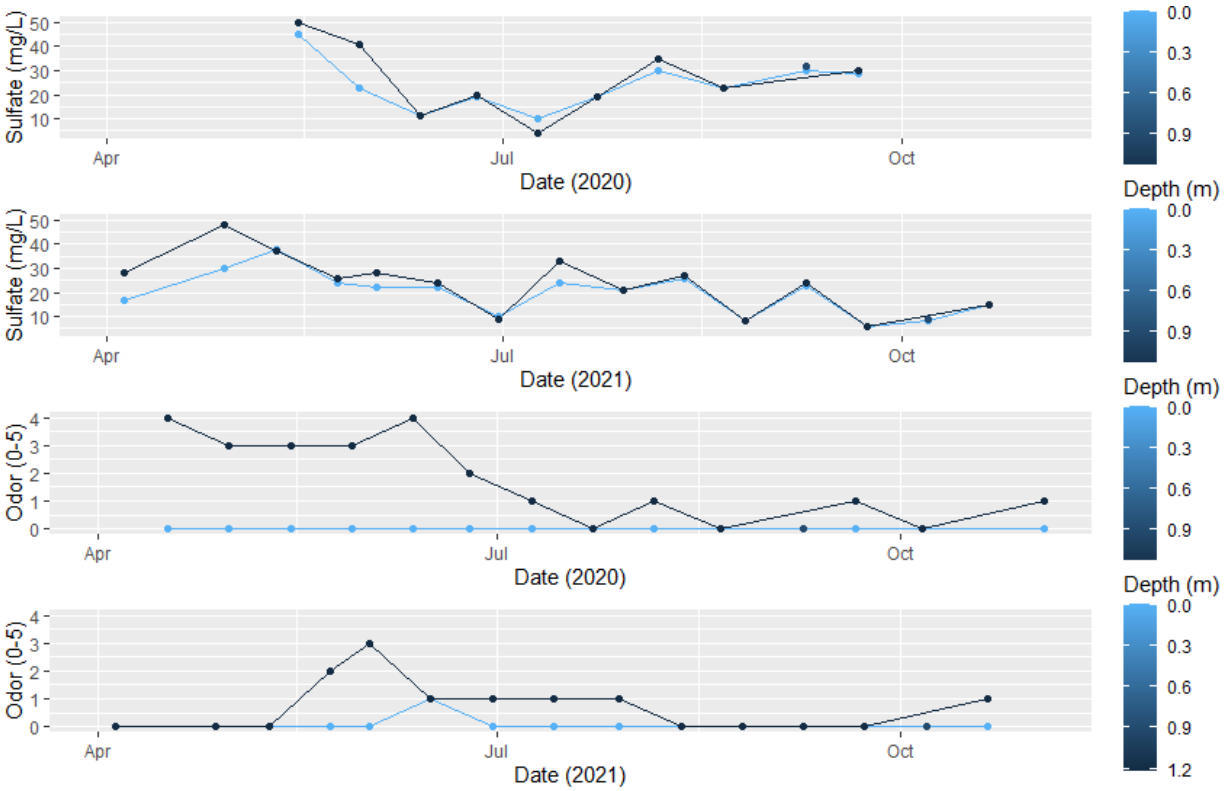

Figure 8. Observations of foul odors were recorded as a potential surrogate for hydrogen sulfide (H2S), but no obvious trends have emerged as of yet. The presence of odors do appear, however, to correlate with various other water quality parameters (see Figure 9).

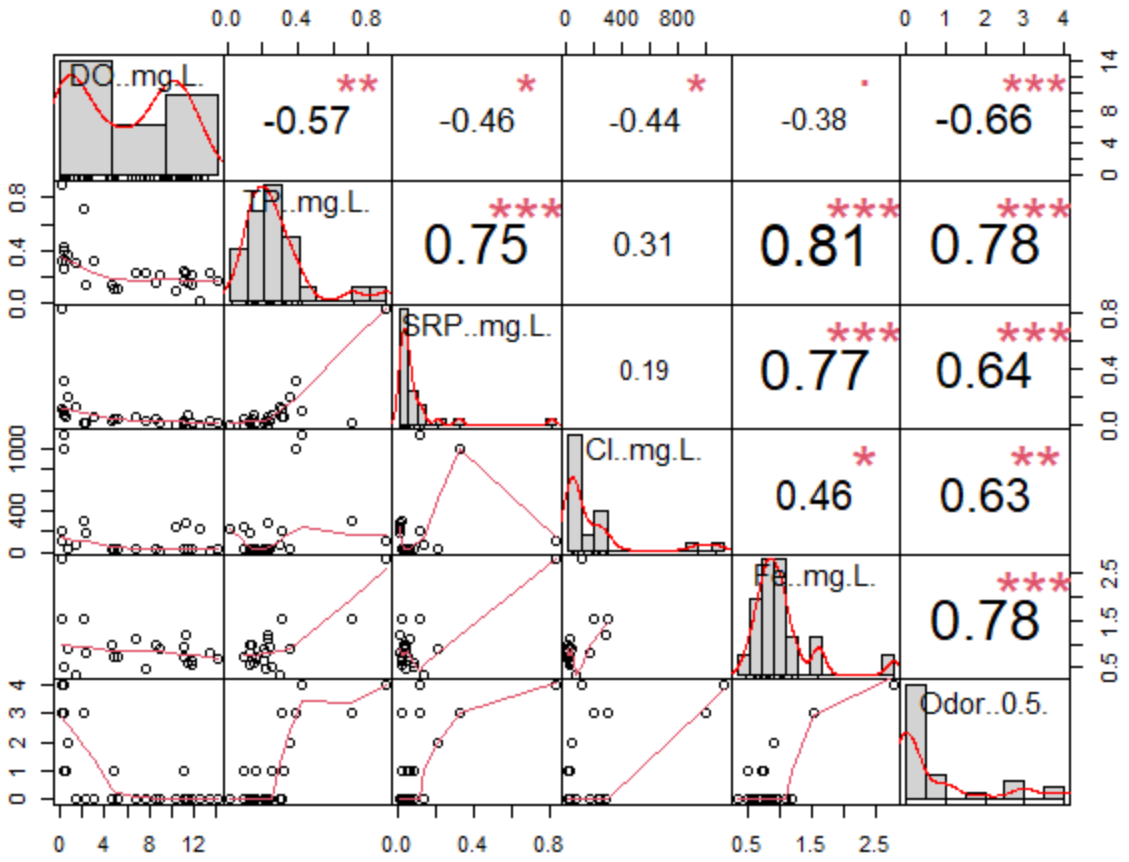

Figure 9. Correlation matrix of selected water quality parameters. The correlation of odor to dissolved oxygen concentration (top right corner), for example, is -0.66, meaning that high odor is correlated with low DO. Black values in each panel represent the correlation 'r' value. The red markers above the r values indicate statistical significance 'p' values (. = <0.1, * = <0.05, ** = <0.01, *** = <0.001).

The negative correlation of odor to DO (-0.66) in Figure 9 means that high odor is related to low DO. The positive correlation of odor and chloride is likely due to odor occurring in the bottom during periods of strong stratification. The correlations of odor to Fe, TP and SRP likely occur because of chemical release from the sediments during periods of strong stratification. Do does not appear to be highly correlated with chemical release in Pond 52A, likely due to the impact of iron filings treatment.

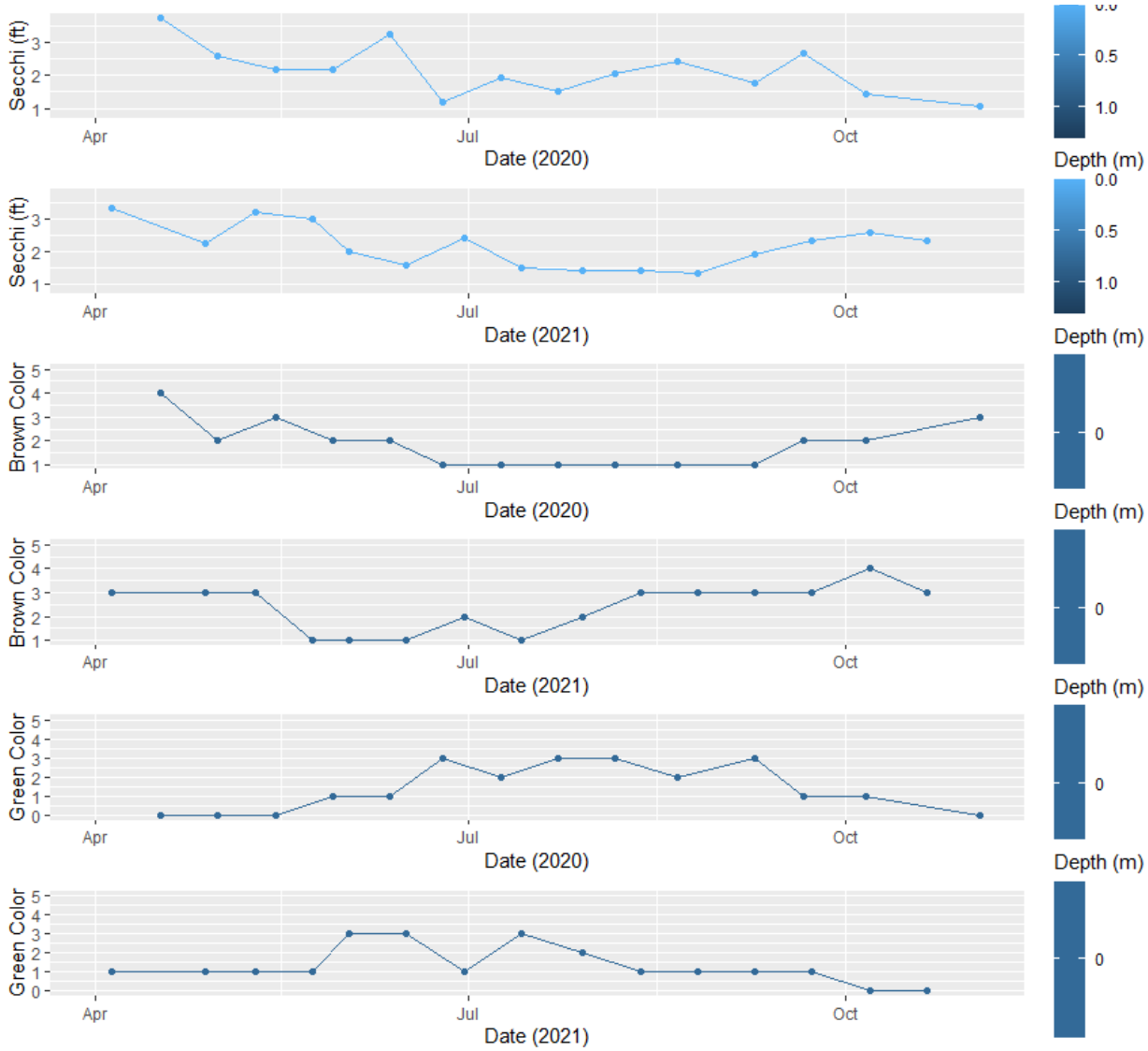

Figure 10. Secchi depths and color observations were recorded to inform data analyses. No obvious trends have emerged as of yet.

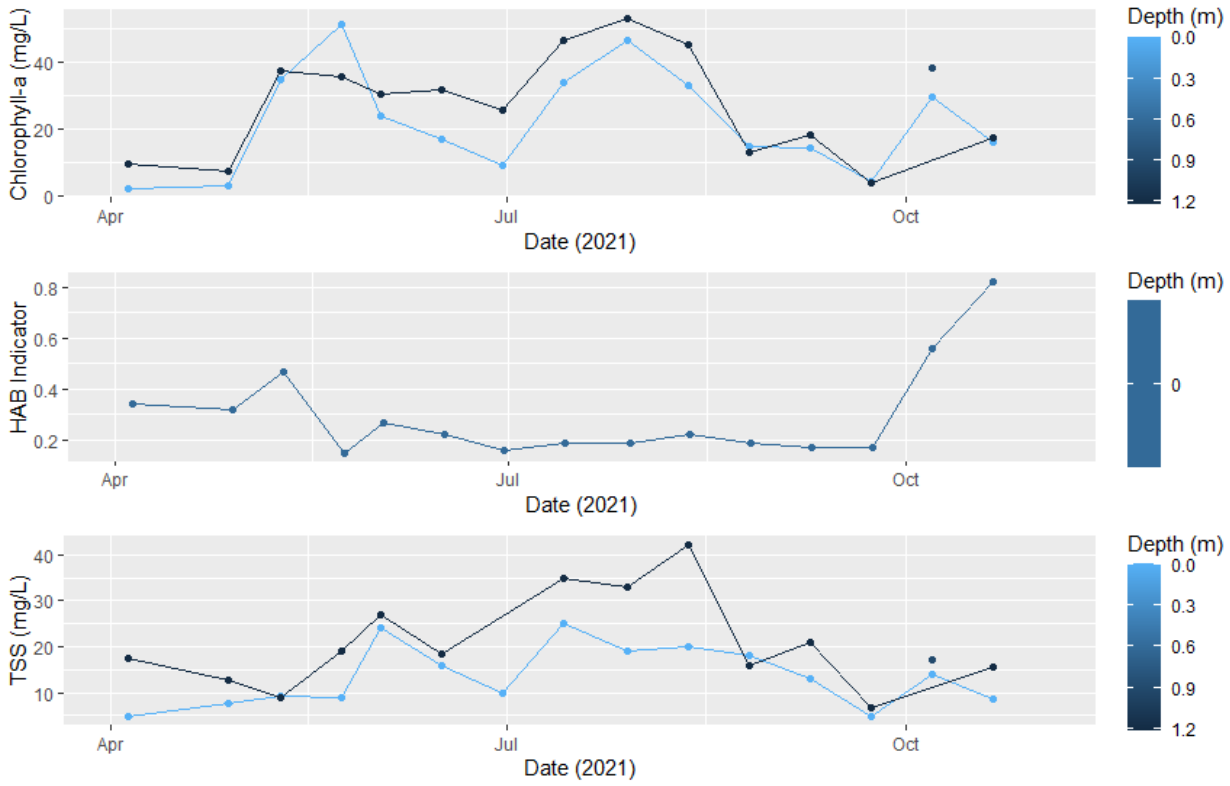

Figure 11. Additional water quality parameters were evaluated in the 2021 field season to assess the potential for harmful algal blooms (HABs) to occur. The elevated concentrations of both chlorophyll-a (corresponding with green color observations in Figure 10) and total suspended solids (TSS) during the warm season suggest the presence of phytoplankton (including algae). The low values of the HAB indicator (calculated as the ratio of phycocyanin concentration to chlorophyll-a concentration representing the approximate ratio of phycocyanin-containing algae such as cyanobacteria to other phytoplankton) suggest that the warm-season algal blooms were not HABs. Elevated HAB indicator values in the fall, however, suggest that cyanobacteria did bloom, and even higher HAB indicator values from the same period in Lake George (not included in this report) suggest the cyanobacteria were widespread.

Recommendations

SRP and TP concentrations in the pond do not appear to have increased substantially since the 2018 dredging and 2019 iron filings application but should continue to be monitored since the required reapplication frequency is not yet known.

Measuring redox potential in the water quality samples or collected in water quality profiles is an inexpensive way to evaluate with more certainty the chemical processes that may be affecting phosphorus dynamics in the pond. Elevated HAB indicator values from both the pond and Lake George are concerning. Phycocyanin and chlorophyll-a concentrations should continue to be measured in order to detect future HABs and issue health advisories as appropriate. The HAB in the pond is likely related to the drought conditions present during the latter half of 2021 which correlated with decreased DO concentrations and elevated Fe concentrations.