Ferric Chloride Water Treatment Facility
2020 Annual Report

NPDES/SDS Permit No: MN0067377

Mailed to:
Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Road North
Saint Paul, MN 55155

January 2021

PRIOR LAKE
SPRING LAKE
WATERSHED DISTRICT

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Background

Spring Lake is a recreational lake located in central Scott County, Minnesota. The lake is listed on the State Impaired Waters List as impaired for aquatic recreation due to excess nutrients. Monitoring completed by the Prior Lake-Spring Lake Watershed District (PLSLWD) in the 1990's identified phosphorus as the nutrient most contributing to water quality impairment and algae blooms. That study also noted that a significant portion of the phosphorus entering Spring Lake was in the form of dissolved phosphorus (soluble reactive phosphorus, or SRP) thus making it readily available for algal uptake. Spring Lake flows directly into Upper Prior Lake, which is also listed as impaired due to excess nutrients.

The treatment system involves the injection of 32.5% liquid $FeCl_3$ solution into a stormwater pond, or desiltation basin. The iron within the $FeCl_3$ binds with the dissolved phosphorus in the water and creates colloidal particles (floc) which settle at the bottom of the basin. The treated water then flows downstream into Spring Lake.

In 1998, the PLSLWD constructed the ferric chloride ($FeCl_3$) treatment system to precipitate SRP out of stormwater from County Ditch 13, the main inflow to Spring Lake. The system was constructed as part of a Minnesota Pollution Control Agency (MPCA) Clean Water Partnership Implementation Project. The treatment system began operating under a permit from the Department of Natural Resources. In 2004, the treatment system permit was renewed as a National Pollutant Discharge Elimination System permit administered by the MPCA. The District applied to the MPCA for a renewed permit in 2009. That permit was approved in 2012. However, the system did not operate in 2011 or 2012 because it no longer met the requirements of the permit. During this time, the District was working toward a design that would meet requirements of the new MPCA permit. The old system injected $FeCl_3$ directly into the channel immediately downstream of the Ferric Chloride weir on the south side of Highway 13 where it would mix until reaching the desiltation pond.

In July 2013, the treatment facility began operating again after it was retrofitted to meet new MPCA permit requirements. The new design transfers $FeCl_3$ underground for 900 feet from the treatment building through a double walled pipe to a culvert north of Highway 13 that flows directly into the desiltation basin. The new design addresses the previous concerns of the MPCA by avoiding direct discharge into a water of the state, and instead, goes directly into a stormwater pond.

Figure 1. Bypass Weir

The retrofit project was designed by consultants Bolton and Menk, Inc. and installed by S.M. Hentges & Sons, Inc. The new design allowed for more water to be treated as compared to the old system. With the old system, high flows could resuspend phosphorus-iron flocculants within the basin and flush the flocculent downstream and into Spring Lake. The new system was designed to overtop a bypass weir (and flow

around the desiltation basin) before the flows reached a point of resuspension in the pond. This allows for the maximum amount of phosphorus to be treated without resuspending the material in the desiltation basin. Staff reviewed the project design and confirmed it was operating as designed.

Figure 2. Aerial Map of Ferric Chloride Treatment System

Operations and Maintenance

For a video tutorial on how the system works, visit https://www.youtube.com/watch?v=Nr7kr-CE8vQ&feature=youtu.be.

Access is needed to the Desilt pond outlet and injection site. A grass path to the outlet of the Desilt pond was regularly mowed by the homeowner, Gary Stevens. When the water level of the outlet was low enough, he voluntarily drove his lawnmower across the outlet and mowed a path from the outlet of the Desilt pond to the injection site at the berm. When water conditions were too high, staff weed whipped a path to the injection site.

Figure 3. Weed Whipped Path from Desilt Pond Outlet to Injection Site

The Scott County Highway Department cleared brush and mowed the edges of the driveway to the Ferric Chloride shed. Mowing and clearing is necessary for the Ferric Chloride delivery truck to have a clear path to the shed and to reduce encroachment on the driveway.

City of Prior Lake staff (Public Works Water Department) helps PLSLWD staff maintain the pump, hoses, and injection site every year. Each spring, City staff inspects the pump and hoses, replaces old and worn parts, re-installs the injector, starts the pump, and ensures proper pumping. In fall, the City staff winterizes the facility by purging the ferric line to prevent freezing and removes, cleans, and stores the injector in a City facility over-winter.

Other routine maintenance by PLSLWD staff included cleaning the staff gauge, removing debris from the Ferric Chloride and bypass weir, installing snowmobile signs, downloading and calibrating the ultrasonic distance sensor, inspecting the facility 3 times per week, taking flow measurements and weekly samples, and cleaning in and around the shed.

Operations and Maintenance items that were done in 2020, in addition to the above-mentioned routine items:

- A temporary fish barrier was installed in April
- Lowered water level in wetland for permanent fish barrier installation
- Permanent fish barrier was installed at the ferric chloride weir in August. The wooden deck over the weir and tines to block fish was replaced with a metal deck which has ability to raise and lower tines to block carp
- Carp were removed from the Geis Wetland
- A “pit tag station” was operated above and below weir to monitor if the carp are getting into the Geis wetland
- A carp trap was operated at the outlet of the desilt pond. Cameras were installed
- Had to operate pump in manual mode due to temporary barrier affecting water levels and therefore discharge
- Pump turned off from August 24-September 30 for fish barrier installation and no flow in ditch
- Eye wash station maintained
- A new driveway design was analyzed to be less intrusive on the Geis’s lawn which may be constructed in 2021
- Repaired damaged grass after ferric delivery truck got stuck

Figure 4 New walking deck over weir and fish barrier

Ferric Usage

The tank stored 1,541 gallons over winter and began dosing on March 10. When the pump was shut off at the end of the season, 2,237 gallons were left in the tank. Two shipments of Ferric Chloride occurred in 2020; 3,200 gallons on April 7 and 3000 gallons on July 1. A total of 5,833 gallons of Ferric Chloride treated the stream before it reached Spring Lake as shown in Table 1.

Table 1. Ferric Usage (usage wasn't tracked prior to 2014)

Year	Starting Ferric (gal)	Delivered Ferric (gal)	Ending Ferric (gal)	Total Ferric Used (gal)
2020	1541	6,200	2237	5533
2019	1385	6450	1955	5880
2018	3700	3500	1350	5850
2017	1970	8800	3500	7270
2016	2680	6000	1950	6730
2015	2925	3000	1445	4480
2014	N/A	10200	2925	>7275

During the April 7 ferric chloride delivery, the tanker truck got stuck in the ditch when trying to deliver. This further enhances the need to modify the driveway to make is safer and easier to deliver ferric chloride. A tow-truck was called to pull the tanker truck out of the ditch and the ditch and grass was destroyed in that area.

Figure 5 Tanker truck got stuck in ditch when trying to deliver

Future Maintenance

Carp have been observed in the wetland adjacent to the Ferric Chloride shed (Highway 13 Wetland) and the water has become noticeably more turbid in the past few years (visually and in the data). In 2018, WSB Consulting estimated 1,452±615 carp are living in the pond, equating to a biomass of 198±61 pounds per acre. Because the old fish barrier was missing tines and inoperable, a new fish barrier was installed in 2020. That barrier also included a new, safer and sturdier walking deck. Staff and consultants will continue to track and remove carp in the wetland until levels are at a manageable level that does not affect water quality.

The ferric chloride tank is now 23 years old and needs to be replaced. Staff has researched options for removing and replacing the tank. A considerable complication regarding the facility is that the shed was not designed for the tank to be removed, so the shed will need to be at least partially dismantled. The tank will be replaced as soon as board of managers approve funds for a new tank.

The driveway to the shed continues to be an issue when ferric is delivered. Staff has discussed design options that could reduce the damage done to the Geis's lawn and provide easier access for the delivery driver. Modifications can take place when board of managers approve funds for this project.

A study (Upper Watershed Blueprint) by Wenck is being conducted to analyze the efficiency of the ferric chloride treatment facility. The study will determine if there are modifications to make the system even more effective by removing more phosphorus from County Ditch 13 before reaching Spring Lake.

Desilt Pond

The desilt pond needs to be cleaned out (dredged) when the pond starts filling up with sediment. The last time the pond was dredged was 2012 and that was dredged down to 902 feet in mean sea level. As storage volume is reduced, the detention time for settling and pollutant removal efficiency is reduced. Once the pond bottom nears 908', the pond should be dredged again.

In 2019, staff mapped the bathymetry of the pond using a kayak that has the BioBase unit attached to it. The pond was found to be about 7-8 feet deep (bottom elevation of 903.5") in the middle and as a result, is likely several years away from needing to be dredged. The bathymetry map is shown below.

Some historic pond dredging and survey information is summarized here:

1978: Desilt pond constructed with a bottom elevation of 902.5', and an outlet elevation of 910.3'
1998: Desilt pond bottom surveyed at 907.8'
1999: Pond was dredged to an elevation of 902.5'
2005: Pond bottom surveyed at 904.5'
2010: Pond bottom surveyed at 906.5'
2012: Pond was dredged to 902.0' (as-built survey available)
2016: Pond mapped by Platypus and estimated to be 903.5' using BioBase software
2019: Pond mapped twice with BioBase kayak setup. It was mapped in July and October (before and after Highway 13 culvert replacement) to see if the desilt pond would fill in with sediment after construction. BioBase shows it is still about the same as 2016 – 903.5'.

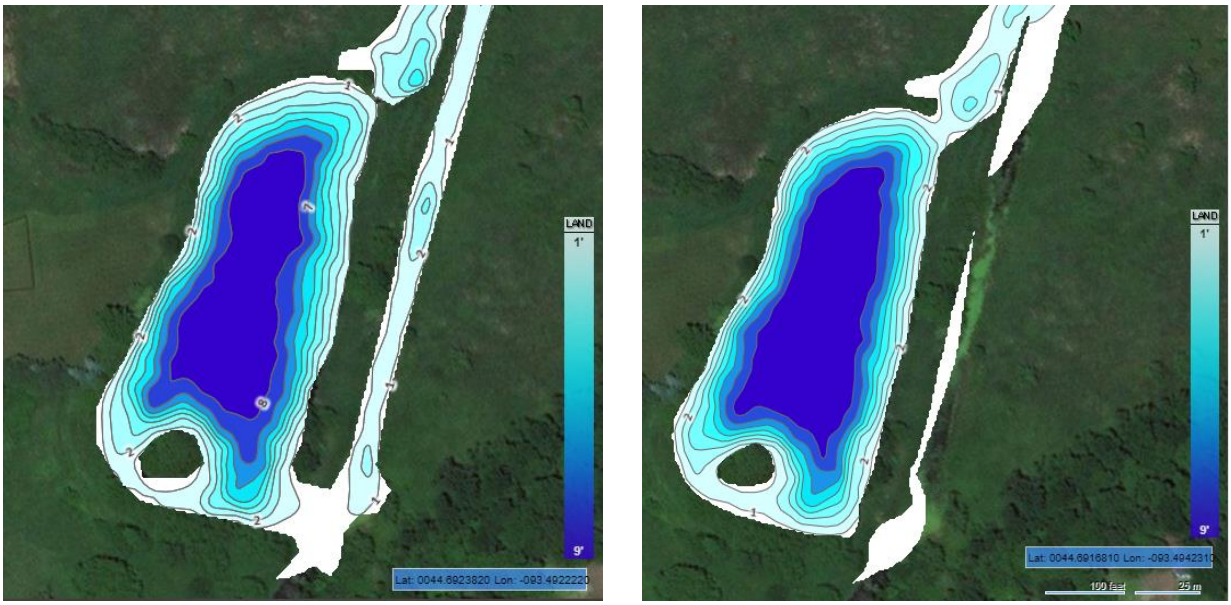

Figure7. - Bathymetry map of Desilt Pond on 7/26/19 (left) before Highway 13 culvert construction started. Bottom of pond was 903.5'. Bathymetry map of Desilt Pond on 10/24/19 (right) after Highway 13 culvert was replaced and the bottom still mapped out at about 903.5'.

Phosphorus Reduction

Table 2 shows that during 2020 operations the system reduced the average concentration of total phosphorus (TP) by 25% and the concentration of dissolved phosphorus (also referred to as SRP or Soluble Reactive Phosphorus) was reduced by an average of 58%. The breakdown of monthly average nutrient concentrations are listed in Table 4.

Table 22. Summary of Phosphorus removals since 2011

Year	Lbs P Removed	Lbs SRP Removed	% TP Reduction	% SRP Reduction	MG of Water Treated	Notes
2011	N/A	N/A	14% treated; 1% no treatment	54% treated, 5% no treatment	N/A	30 days total treatment
2012	N/A	N/A	12% (no treatment)	7% (no treatment)	N/A	No Treatment this year
2013	449	323	47% (while treating)	56% (while treating)	635	Treated 2 months
2014	550	752	43%	72%	959	Treated 4/1-10/31
2015	402	103	48%	51%	348	Treated 4/1-10/31
2016	578	323	36%	64%	1327	Treated 3/11-11/10
2017	534	240	35%	58%	938	Treated 3/5-11/30
2018	465	616	31%	58%	1614	Treated 4/1-11/20
2019	466	594	19%	43%	1981	Treated 4/1-11/12
2020	N/A	N/A	25%	58%	N/A	Treated 3/10-8/24, 9/30-11/4

Table 3. – Phosphorus Concentrations and Percent Removal (Negative values indicate a reduction)

	Before Treatment (SW001) Monthly Mean		After Treatment (SD002) Monthly Mean		% Change after Treatment	
Month	Total Phosphorous (mg/l)	SRP (mg/l)	Total Phosphorous (mg/l)	SRP (mg/l)	Total Phosphorous (mg/l)	SRP (mg/l)
March	0.12	0.052	0.11	0.035	-8%	-33%
April	0.07	0.022	0.06	0.012	-14%	-45%
May	0.17	0.06	0.15	0.028	-12%	-53%
June	0.3	0.083	0.21	0.036	-30%	-57%
July	0.35	0.097	0.21	0.068	-40%	-30%
August	0.38	0.036	0.16	0.008	-58%	-78%
October	0.2	0.079	0.18	0.01	-10%	-87%
November	0.16	0.065	0.11	0.01	-31%	-85%
AVERAGE	**0.22**	**0.062**	**0.15**	**0.026**	**-25%**	**-58%**

Water Quality Results

The following graphs display the monthly mean of samples analyzed in 2020, before treatment at site SW-001 (FC_CD2) and after treatment, at SD-002 (FC_CD3). Samples began on March 11 and the last sample was taken November 4. During that time, water quality sampling and monitoring was conducted once per week except there were no samples taken between August 24 and September 30 due to the fish barrier installment and/or no flow.

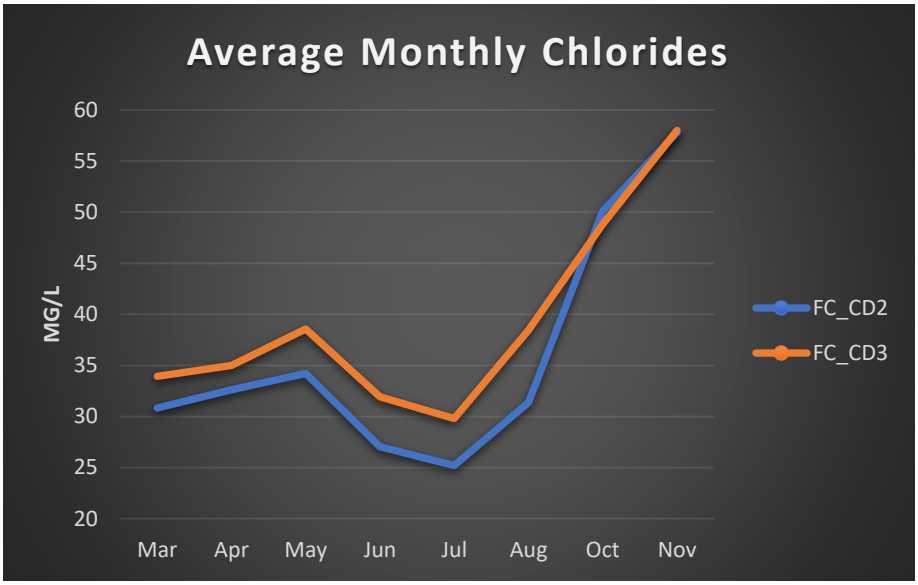

Figure 6 Chloride from de-icing salt, water softening, dust suppressant, fertilizer, and manure gets into lakes and streams. The state water quality standard for chlorides is 230 mg/l, which these sites are well below.

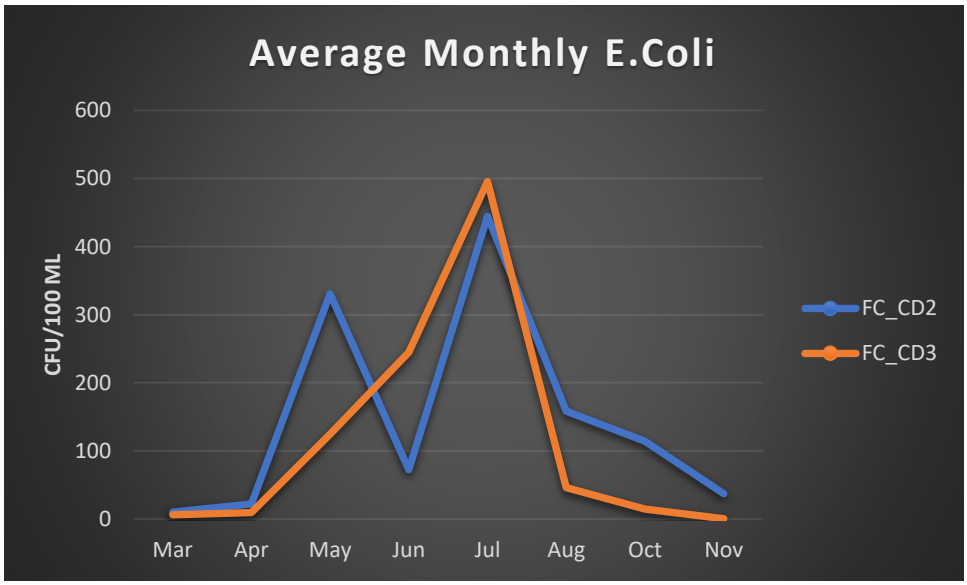

Figure 7 Bacteria in Minnesota lakes and streams mainly come from sources such as failing septic systems, wastewater treatment plant releases, livestock, and urban stormwater. A monthly geometric mean greater than 126 colony-forming units per 100 milliliters of water, between April and October, suggests that the stream is not meeting the standard.

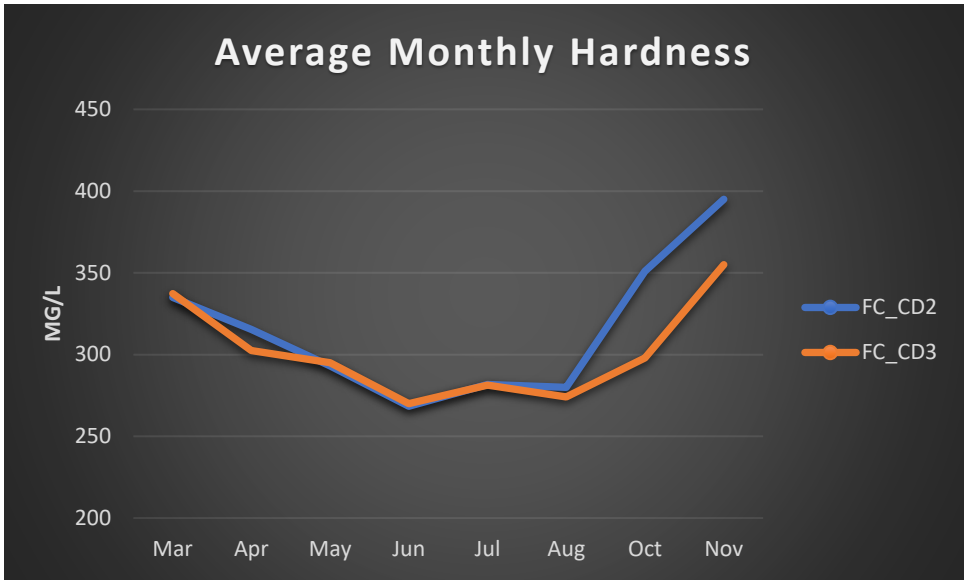

Figure 8 Hardness does not have a standard itself but is used in calculations to analyze the water quality of other standards. Waters with a total hardness in the range of 0 to 60 mg/L are termed soft; from 60 to 120 mg/L moderately hard; from 120 to 180 mg/L hard; and above 180 mg/L very hard.

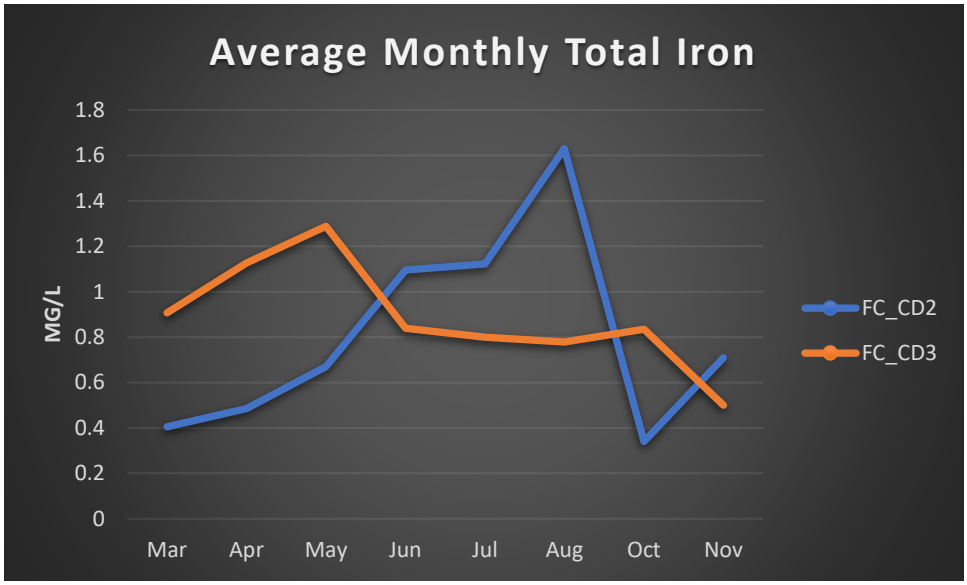

Figure 9 Average Monthly Total Iron

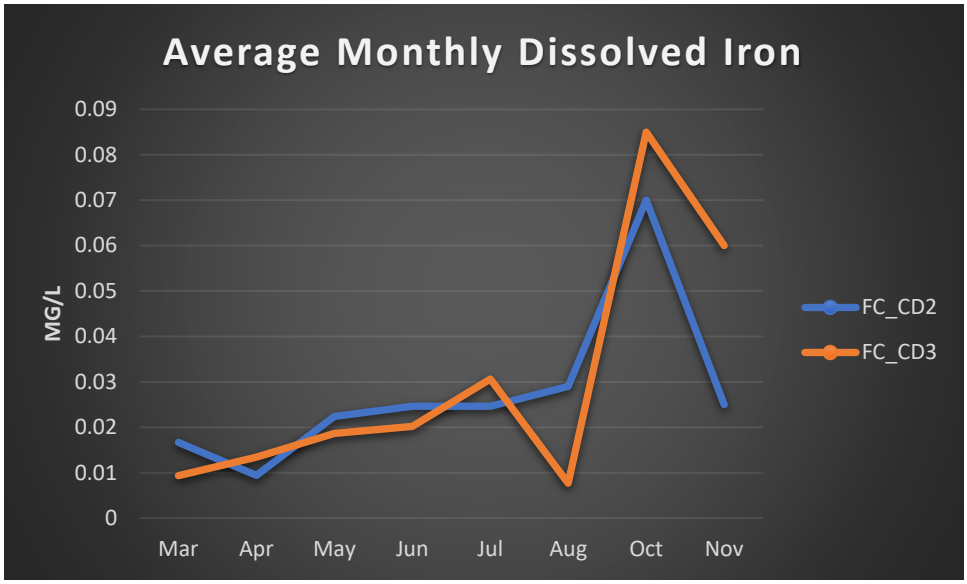

Figure 10 Average Monthly Dissolved Iron.

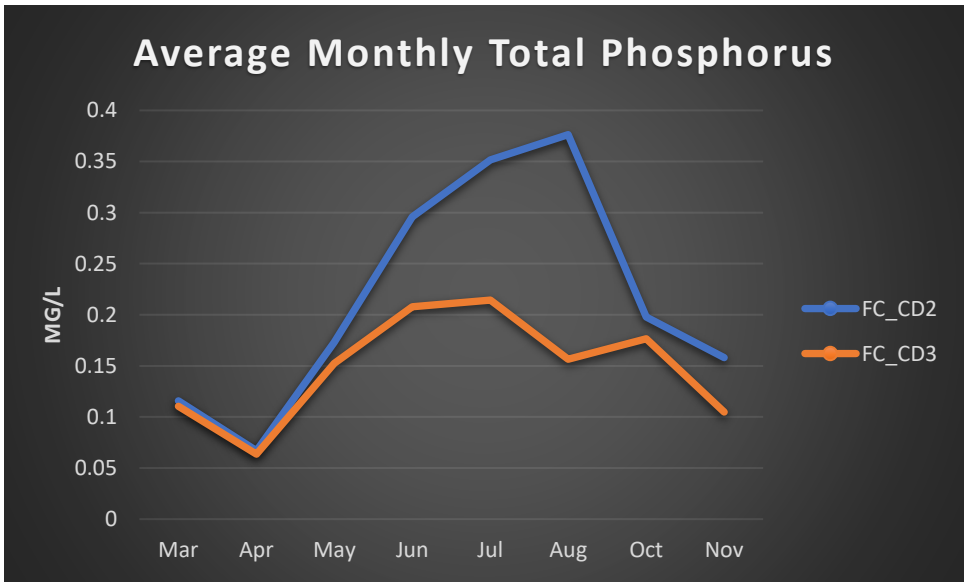

Figure 11 EPA recommends less than 0.1 mg/l.

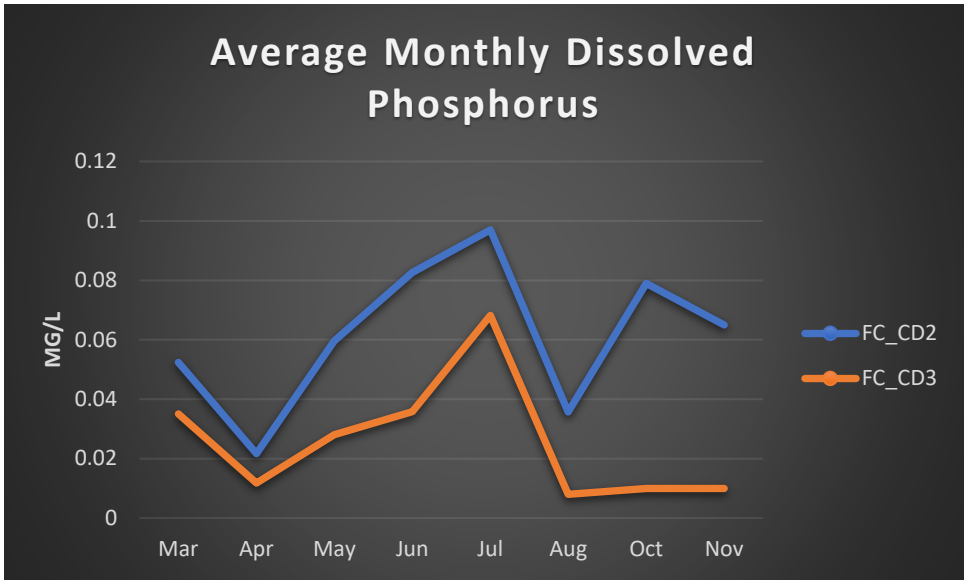

Figure 12 Average Monthly Dissolved Phosphorus.

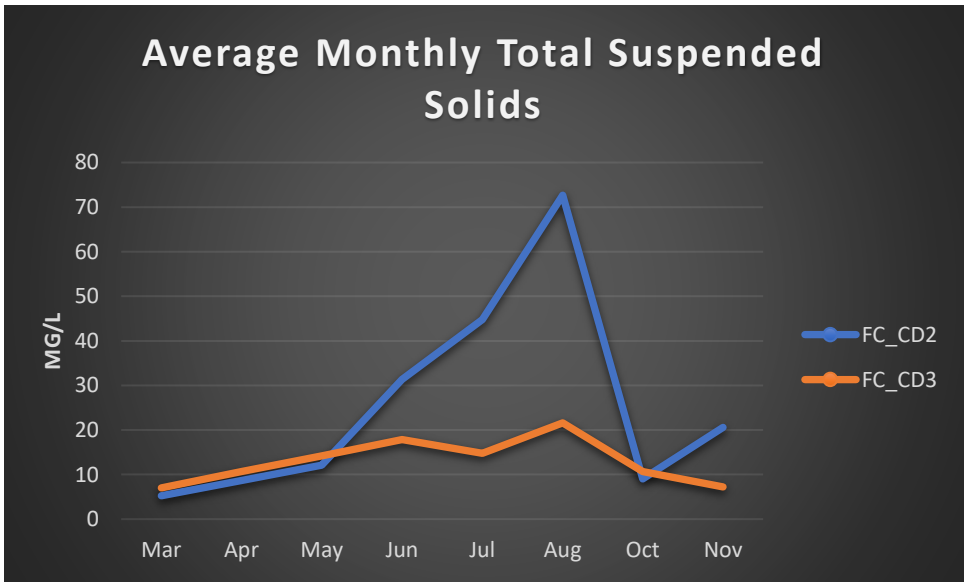

Figure 13 TSS standard for Southern River Nutrient Region is 65 mg/l.

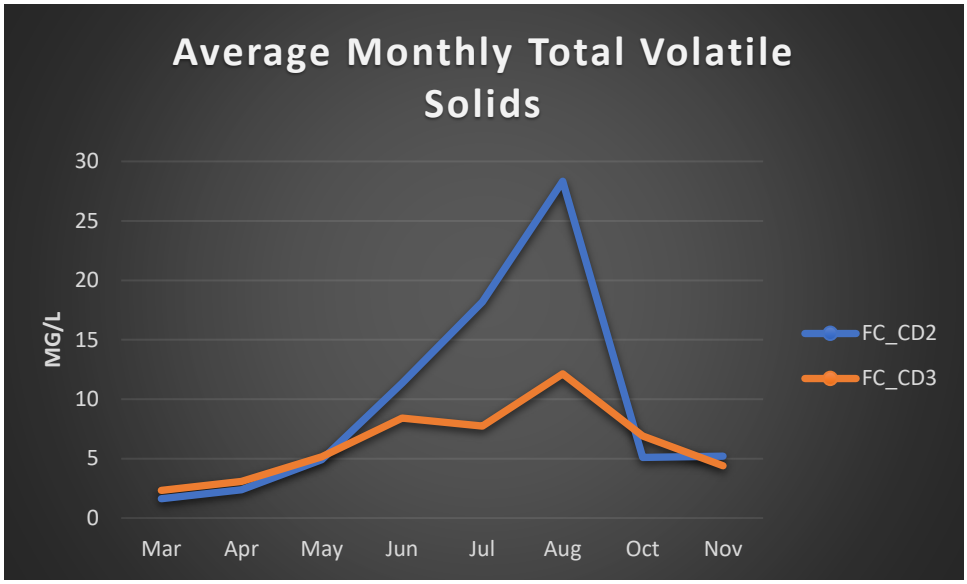

Figure 14 Average Monthly Volatile Suspended Solids

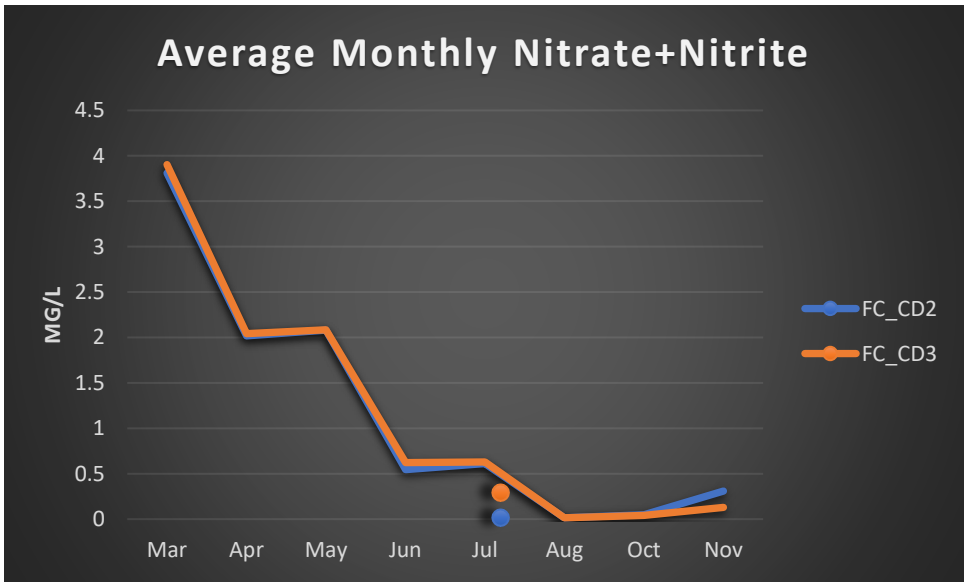

Figure 15 Average Monthly Nitrate + Nitrite

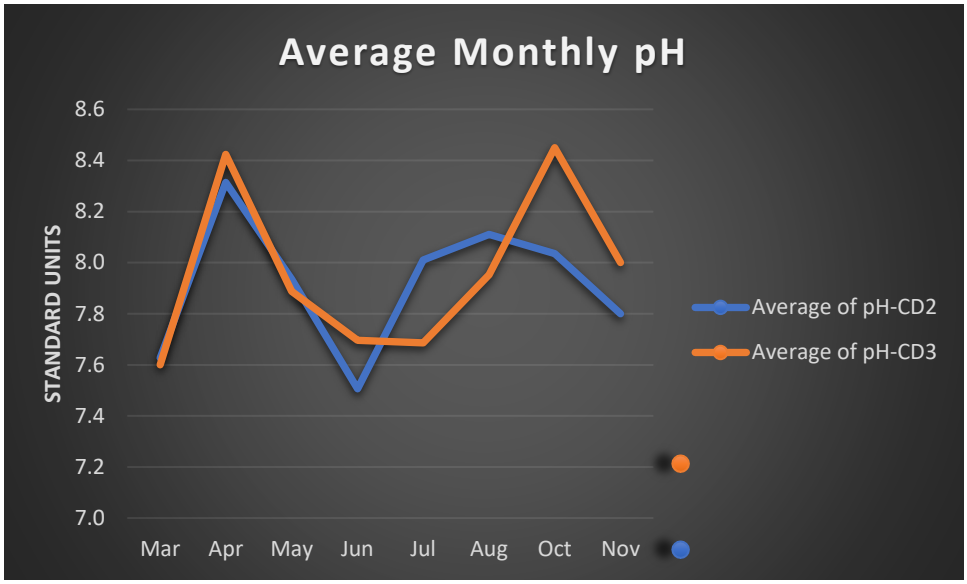

Figure 16 The pH water quality standard is a minimum of 6.5 and max of 8.5.