PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

January 20, 2017

Jennifer Satnik
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155-4194

Re: MN0067377 Prior Lake-Spring Lake Ferric Chloride Inflow Treatment System: Annual Progress Report

Dear Jennifer Satnik:

Enclosed is an Annual Progress Report for the Prior Lake-Spring Lake Ferric Chloride Treatment System as required by the permit.

The Discharge Monitoring Reports and Supplemental Report Forms for the National Pollutant Discharge Elimination System permit for the operating year 2016 have been submitted electronically.

If you have any questions about the enclosed materials or the operation of the Prior Lake-Spring Lake Ferric Chloride Inflow Treatment System, please contact me at (952) 440-0068 or jrockney@plslwd.org.

Sincerely,

Jaime Rockney
Water Resources Specialist
Prior Lake-Spring Lake Watershed District
(952) 447-4166

FERRIC CHLORIDE WATER TREATMENT FACILITY
2016 ANNUAL REPORT

NPDES/SDS PERMIT NO: MN0067377

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

January 2017

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.

In 1998, the PLSLWD constructed a 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.

FIGURE 1 FERRIC CHLORIDE SHED AND WEIR

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.

Prior to 2013, the $FeCl_3$ system had not operated since 2011 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. In July 2013, the treatment facility began operating again after it was retrofitted to meet new MPCA permit requirements. 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. 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 (see Figure 5). 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. A new pump was also installed by Vessco in 2013 in order to accommodate the new pumping requirements.

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 3 BYPASS WEIR AT DESILT POND

FIGURE 2 BERM AND INJECTION POINT AT DESILT POND

FIGURE 4 DESILT POND, STANDING AT OUTLET

FIGURE 5 AERIAL MAP OF FERRIC CHLORIDE TREATMENT SYSTEM

OPERATIONS AND MAINTENANCE

According to the Minnesota Department of Natural Resources, 2016 was the 2nd wettest year since 1895 (DNR; Looking Back at 2016). Surprisingly, the ditch remained relatively low as the rainfalls were spread out and no flooding occurred. Between March 11 (when the facility began operating for the season), and November 10 (when treatment ceased and the facility was winterized), high water overtopped the bypass weir for only a total 54 hours during the entire season. That small amount of water that over-topped the bypass weir was some of the only water left untreated. The pump was also stopped from August 8 because flow in the ditch had slowed to a trickle. Rain fell the evening of August 10, which created flow in the ditch again, so the pump was turned back on the next day. A small amount of water remain untreated between the evening of August 10 until the pump was turned back on the next day.

ROUTINE MAINTENANCE

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 6 WEED WHIPPED PATH FROM DESILT POND OUTLET TO INJECTION SITE

The Scott County Highway department cleared brush and trees and mowed the driveway to the Ferric Chloride shed. They also cleaned debris from the rain gutters of the shed this year. 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. In 2015, the Highway Department delivered and spread gravel on the driveway to the shed, as well as part of the driveway to the Geis' household, to sustain the weight of the delivery truck. Scott County Highway Department completed this work at no cost to the District for either labor or material.

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. City staff is also called upon when there are issues with the pump or lines during the operating season. In 2016, a back-pressure regulator was replaced and the hoses and lines were inspected because of air bubbles. The pump operated well and the ditch was treated with Ferric Chloride the entire season, thanks to assistance by City staff. All of this work was done at no charge to the District.

FIGURE 7 FERRIC CHLORIDE PUMP

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 removing old, unneeded items that were accumulating around the shed.

FIGURE 8 FERRIC CHLORIDE DELIVERY

Two 3,000 gallon shipments of Ferric Chloride were delivered in 2016; one on May 12 and one on September 17. The tank contained 2,860 gallons at the beginning of the season and 1,950 gallons were left in the tank at the end of the season. A total of 6,910 gallons of Ferric Chloride treated the ditch water before it reached Spring Lake. When flow of water in the ditch increased, the Ferric Chloride dose increased as well. The system treated between 0.5 and 3.0 gallons per hour of Ferric Chloride the entire season (except Aug 8-11). The maximum rate of treatment is 4 gallons per hour but because flows did not get high enough to warrant that dose.

NEW FOR 2016

It can be very difficult and dangerous to read the level of Ferric Chloride in the tank. If the lighting isn't right in the building, staff would sometimes have to climb the ladder, open the top, and shine a flashlight in the tank to read the level. A Milltronics Sitrans Ultrasonic Level Detector was ordered in 2016 and will be installed in 2017. The equipment will be mounted in the tank and will display the gallons electronically on a wall mount display. The new equipment will increase safety and provide more reliable and useful data.

PLSLWD staff designed, built, and installed a solar shield for the ultrasonic distance sensor, which measures the water level of the stream using sound waves. The speed of sound waves is affect by temperature. However, even when the water level was stable, data showed a diurnal (daily) fluctuation in water level. This was due

FIGURE 9 STAFF INSTALLING SOLAR SHIELD ON ULTRASONIC DISTANCE SENSOR

mostly caused by the heat of the sun beating down on the sensor, followed by cold nights. The sensor shield greatly reduced the fluctuations.

The original manhole cover at the new injection site was a typical, metal manhole cover. It was very heavy and hard to remove for regular maintenance and inspection of the gauges. A new, lighter weight fiberglass manhole was purchased and installed in 2016.

The Desilt pond was mapped for vegetation density, depth, and bottom hardness. More information can be found in the Desilt Pond section below.

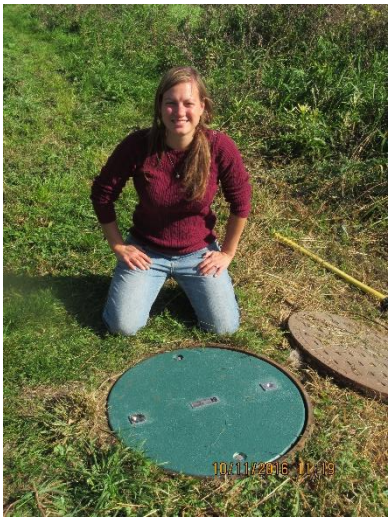


FIGURE 10 STAFF INSTALLING NEW MANHOLE COVER

PLANS FOR 2017

Carp have been observed in the wetland adjacent to the Ferric Chloride shed (Highway 13 Wetland) and the water has become noticeable more turbid in the past few years (visually and shown in sample data). The turbid water could be a sign of carp infestation. It is recommended the fish barrier on the Ferric Chloride weir be fixed or modified as it has not been operational for years. A carp population estimate should also be conducted.

The Ferric Chloride weir is also showing signs of age. Repair should be scheduled to address the cracks, loose boards, and unstable railings.

FIGURE 11 FERRIC CHLORIDE WEIR AND FISH BARRIER

DESILT POND

The desilt pond needs to be cleaned out (dredged) when the pond starts filling up with sediment. In 2016, a company called Platypus mapped the bathymetry of the pond using a remote-control boat and the District's BioBase software. The pond was found to be about 7-8 feet deep in the middle and many years away from needing to be dredged. Vegetation density and bottom hardness are also simultaneously mapped and available upon request. The bathymetry map is shown below.

The last time the pond was dredged was 2012 and it was dredged down to 902 feet in mean sea level. During the time of mapping in 2016, the pond bottom was about 903.5'. 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.

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

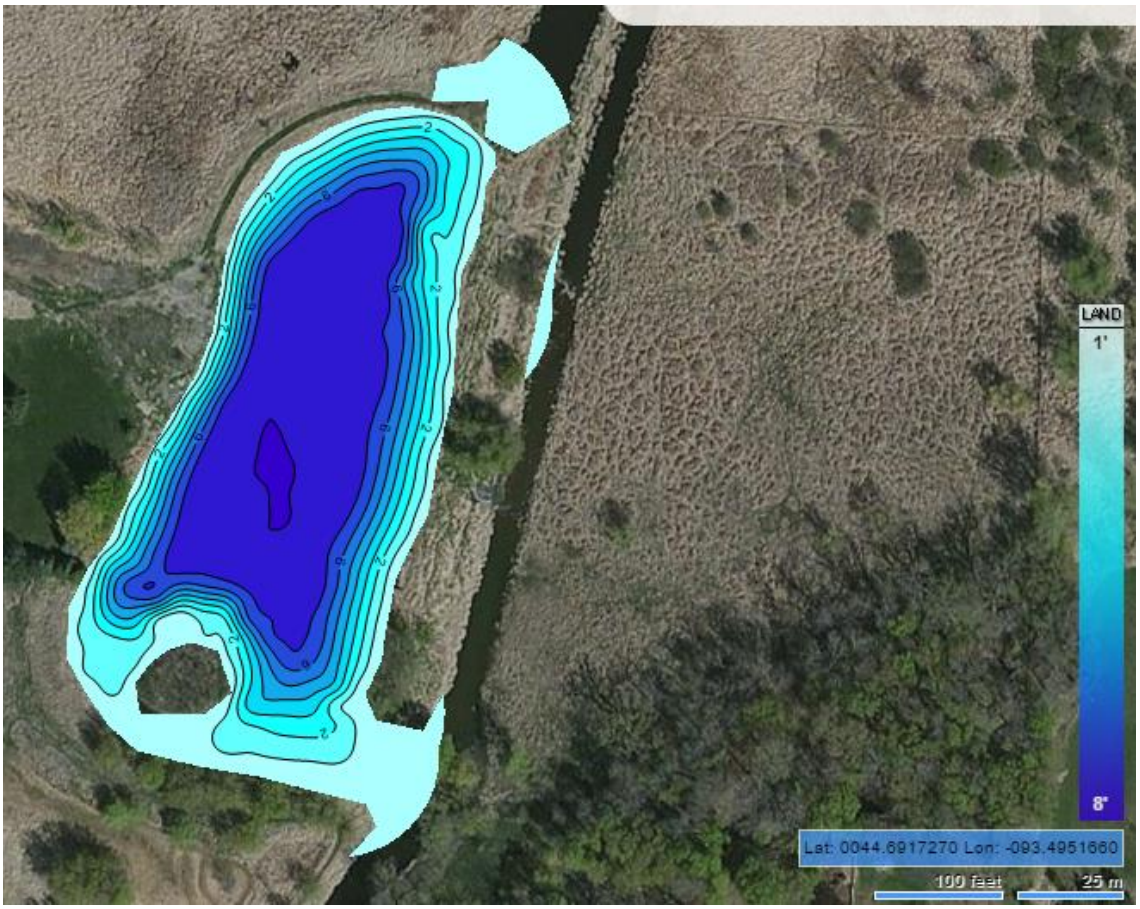


FIGURE 12 BATHYMETRIC MAP CREATED USING BIOBASE SOFTWARE AND PLATYPUS BOAT

RESULTS

During operation in 2016, the system treated approximately 1,327 million gallons (MG) of ditch water. The system reduced the average concentration of Total Phosphorus (TP) by 0.08 mg/L (36%) and removed a calculated 578 pounds of total phosphorus. The concentration of dissolved phosphorus (also referred to as SRP or Soluble Reactive Phosphorus) was reduced by an average of 0.029 mg/L (64%) and approximately 323 pounds of SRP were removed from the system.

TABLE 1 – PHOSPHORUS CONCENTRATIONS AND PERCENT REMOVAL

	SW001 Monthly Mean		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*	0.08	0.028	0.06	0.011	-21%	-61%
April	0.10	0.017	0.08	0.004	-22%	-78%
May	0.15	0.008	0.09	0.003	-41%	-62%
June	0.20	0.024	0.12	0.006	-41%	-76%
July	0.43	0.060	0.16	0.004	-64%	-93%
August	0.32	0.050	0.19	0.018	-40%	-63%
September	0.19	0.107	0.14	0.056	-28%	-47%
October	0.12	0.076	0.07	0.040	-41%	-47%
November	0.09	0.069	0.06	0.034	-31%	-51%
Average 2017	**0.19**	**0.049**	**0.11**	**0.020**	**-36%**	**-64%**

*The $FeCl_3$ system was not operating until March 11, therefore, the first sample taken on March 9 was not treated. A sample taken on August 11 was also not treated. The results of this sample are included in the results because the desilt pond does do some treatment even without the ferric solution.

TABLE 2 SUMMARY OF PHOSPHORUS REMOVALS SINCE 2011

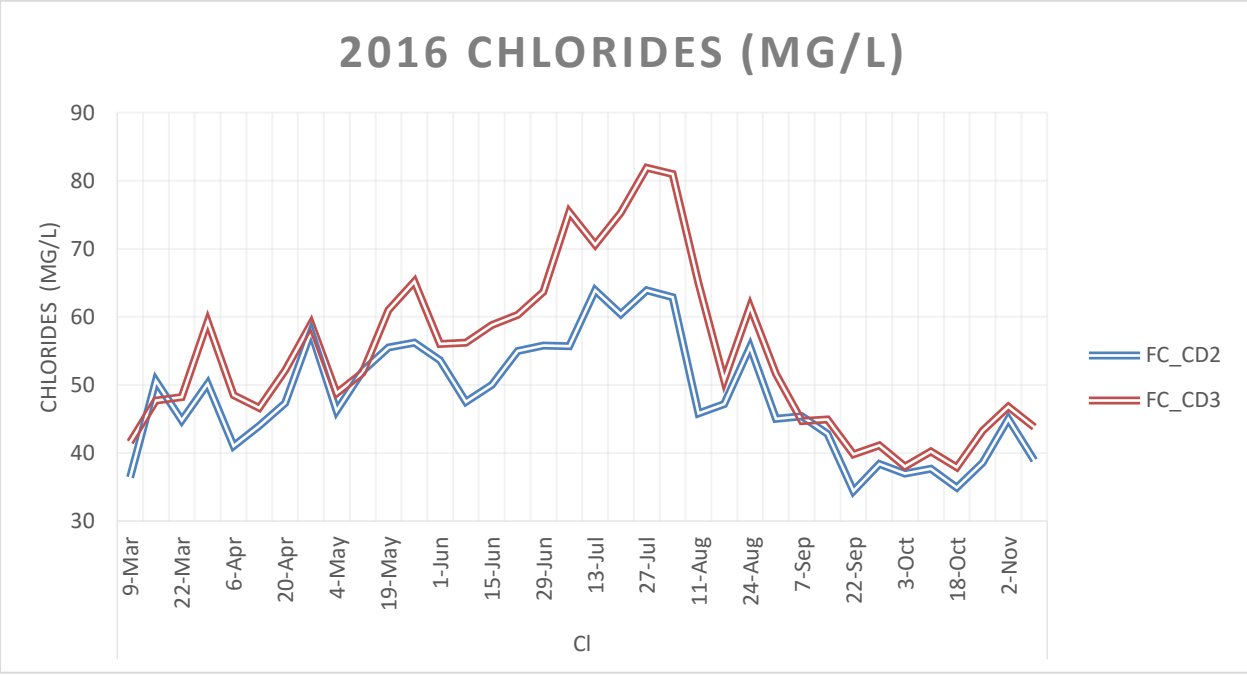
Year	Lbs P Removed	Lbs SRP Removed	% TP Reduction	% SRP Reduction	MG of Water Treated	Notes
2011	N/A	N/A	14% while treating; 1% with no treatment	54% while treating; 5% with no treatment	N/A	Only 30 days total treatment in 2011.
2012	N/A	N/A	12% (no treatment)	7% (no treatment)	N/A	No Treatment this year
2013	449	323	47% (while treating)	56% (while treating)	635	Only 2 months treated
2014	550	752	43%	72%	959	Treatment Apr 1 - Oct 31
2015	402	103	48%	51%	348	Treatment Apr 1 – Oct 31
2016	578	323	36%	64%	1327	Treatment Mar 11 – Nov 10

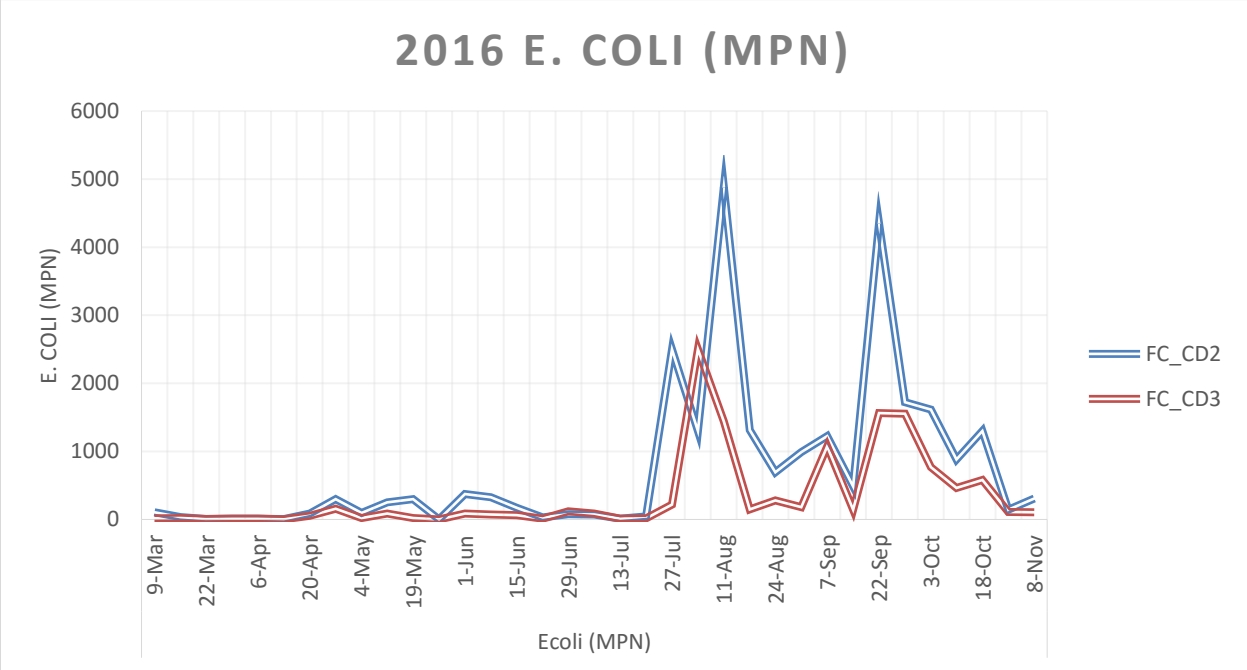
Table 3 Phosphorus Load Reductions

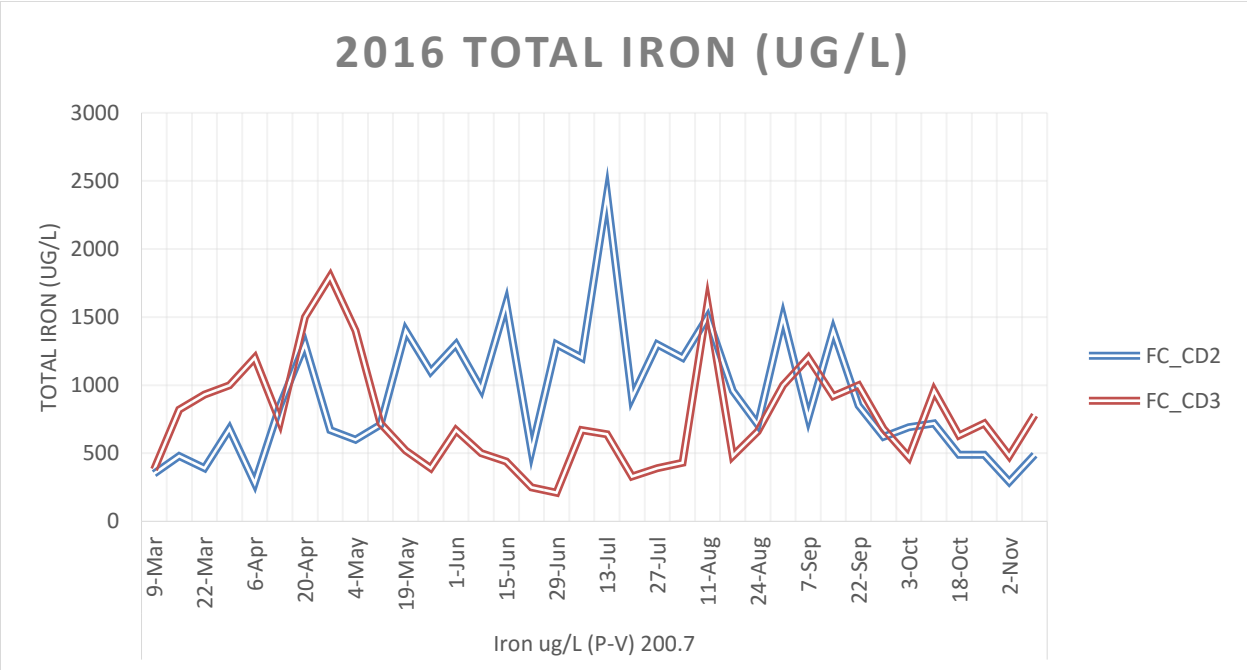
		SW-001	SD-002
March	Average SRP (mg/L)	0.028	0.011
	Average TP (mg/L)	0.08	0.06
	Treated Water (MG)		235
	SRP Load Reduction (pounds)		33.3
	TP Load Reduction (pounds)		39.2
April	Average SRP (mg/L)	0.017	0.004
	Average TP (mg/L)	0.10	0.08
	Treated Water (MG)		169
	SRP Load Reduction (pounds)		18.3
	TP Load Reduction (pounds)		28.2
May	Average SRP (mg/L)	0.008	0.003
	Average TP (mg/L)	0.15	0.09
	Treated Water (MG)		114
	SRP Load Reduction (pounds)		4.8
	TP Load Reduction (pounds)		57.0
June	Average SRP (mg/L)	0.024	0.006
	Average TP (mg/L)	0.20	0.12
	Treated Water (MG)		67
	SRP Load Reduction (pounds)		10.1
	TP Load Reduction (pounds)		44.7
July	Average SRP (mg/L)	0.060	0.004
	Average TP (mg/L)	0.43	0.16
	Treated Water (MG)		23
	SRP Load Reduction (pounds)		10.7
	TP Load Reduction (pounds)		51.8
August	Average SRP (mg/L)	0.050	0.018
	Average TP (mg/L)	0.32	0.19
	Treated Water (MG)		104
	SRP Load Reduction (pounds)		27.8
	TP Load Reduction (pounds)		112.8
September	Average SRP (mg/L)	0.107	0.056
	Average TP (mg/L)	0.19	0.14
	Treated Water (MG)		270
	SRP Load Reduction (pounds)		114.8
	TP Load Reduction (pounds)		112.6
October	Average SRP (mg/L)	0.076	0.040
	Average TP (mg/L)	0.12	0.07
	Treated Water (MG)		269
	SRP Load Reduction (pounds)		80.8
	TP Load Reduction (pounds)		112.2
November	Average SRP (mg/L)	0.069	0.034
	Average TP (mg/L)	0.09	0.06
	Treated Water (MG)		76
	SRP Load Reduction (pounds)		22.2
	TP Load Reduction (pounds)		19
Total	**Total Treated Water (million gallons)**		**1,327**
	Total SRP Load Reduction (pounds)		**323**
	Total TP Load Reduction (pounds)		**578**

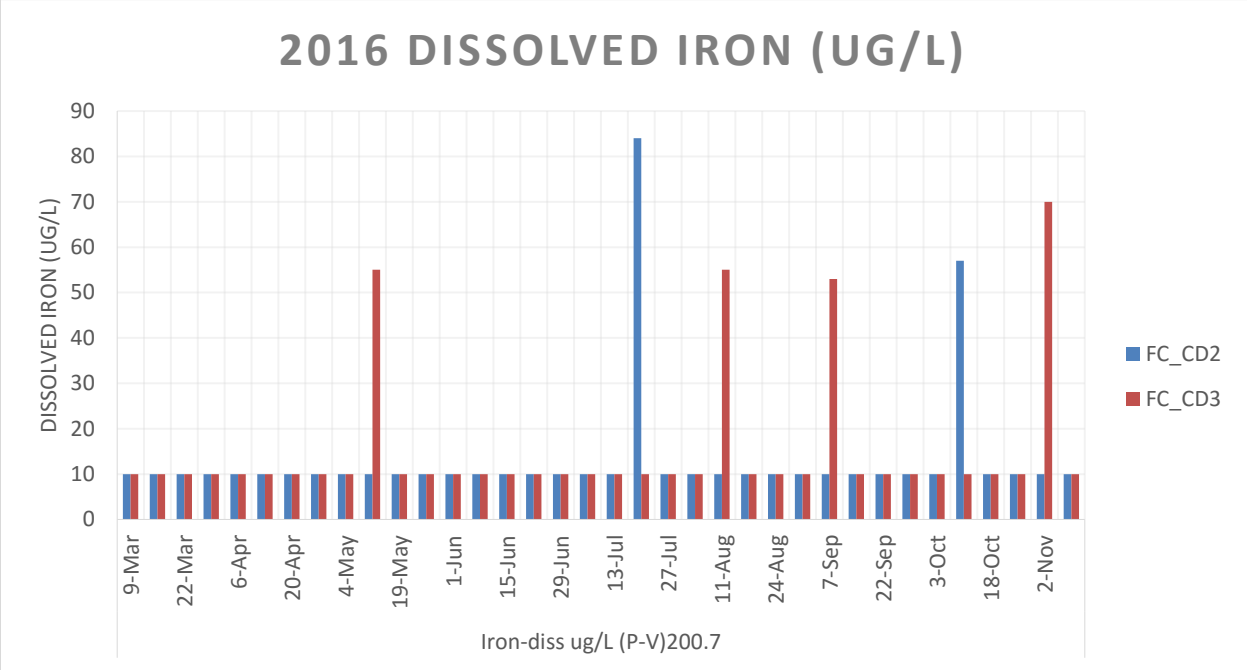
GRAPHS

The following graphs display the monthly mean of samples taken in 2016, before treatment at site SW-001 (FC_CD2) and after treatment, at SD-002 (FC_CD3). Treatment began on March 11 and ceased on November 10. During that time, samples were taken once per week. The samples March 9 and August 11 were not receiving treatment at the time of the sample.

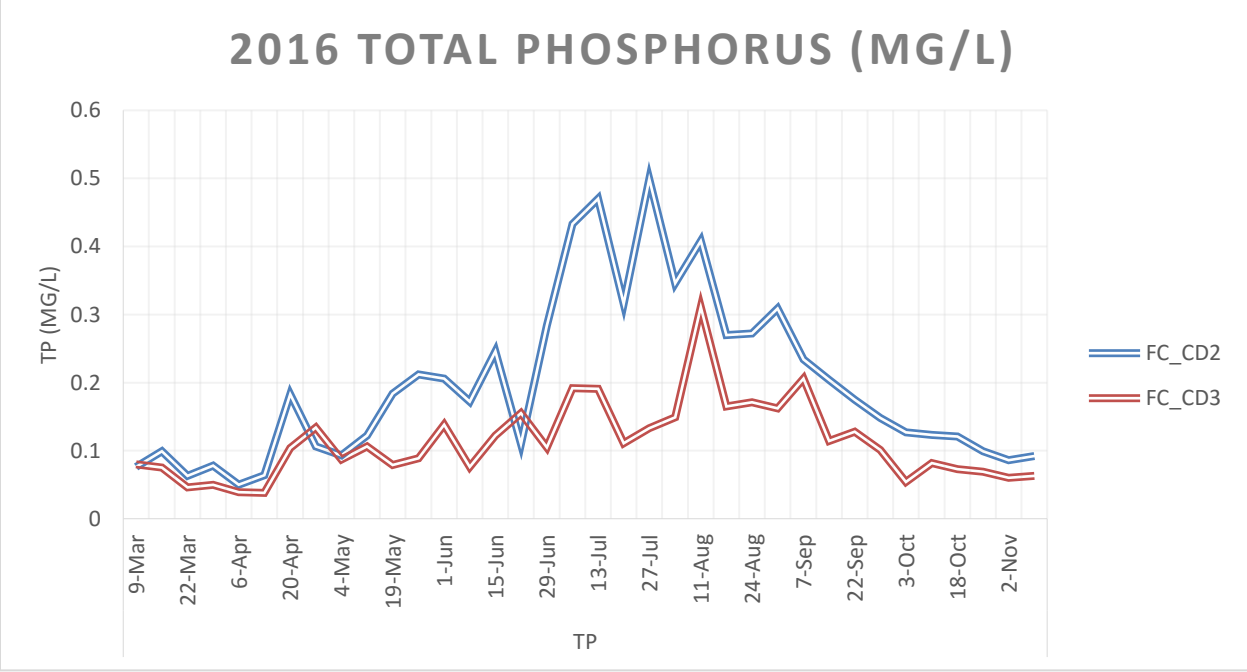


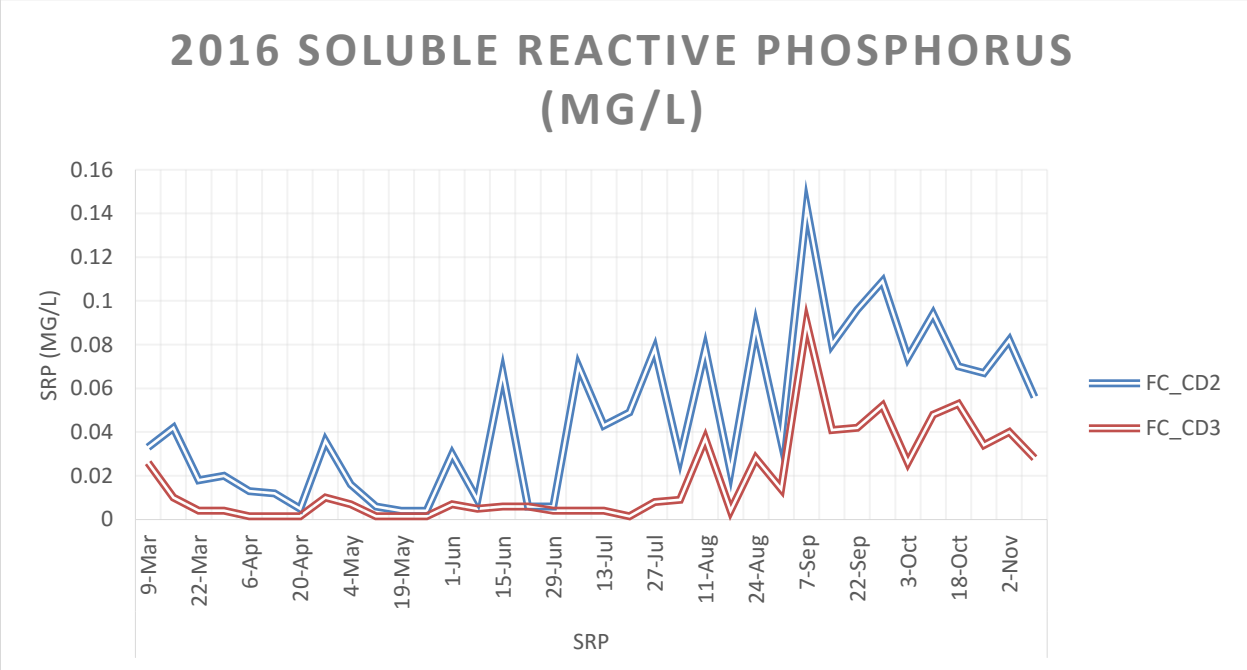

2016 E. COLI (MPN)
E. COLI (MPN)
6000
5000
4000
3000
2000
1000
0
9-Mar
22-Mar
6-Apr
20-Apr
4-May
19-May
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
11-Aug
24-Aug
7-Sep
22-Sep
3-Oct
18-Oct
8-Nov
Ecoli (MPN)
FC_CD2
FC_CD3

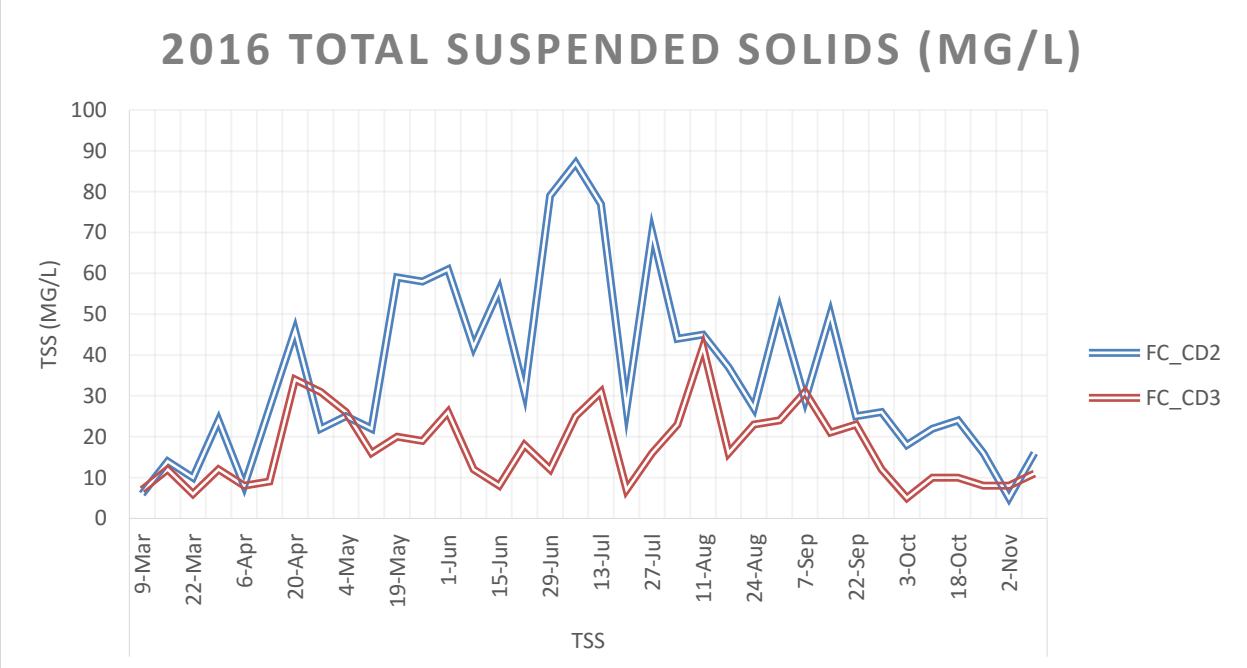

2016 TOTAL IRON (UG/L)
TOTAL IRON (UG/L)
3000
2500
2000
1500
1000
500
0
9-Mar
22-Mar
6-Apr
20-Apr
4-May
19-May
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
11-Aug
24-Aug
7-Sep
22-Sep
3-Oct
18-Oct
2-Nov
Iron ug/L (P-V) 200.7
FC_CD2
FC_CD3

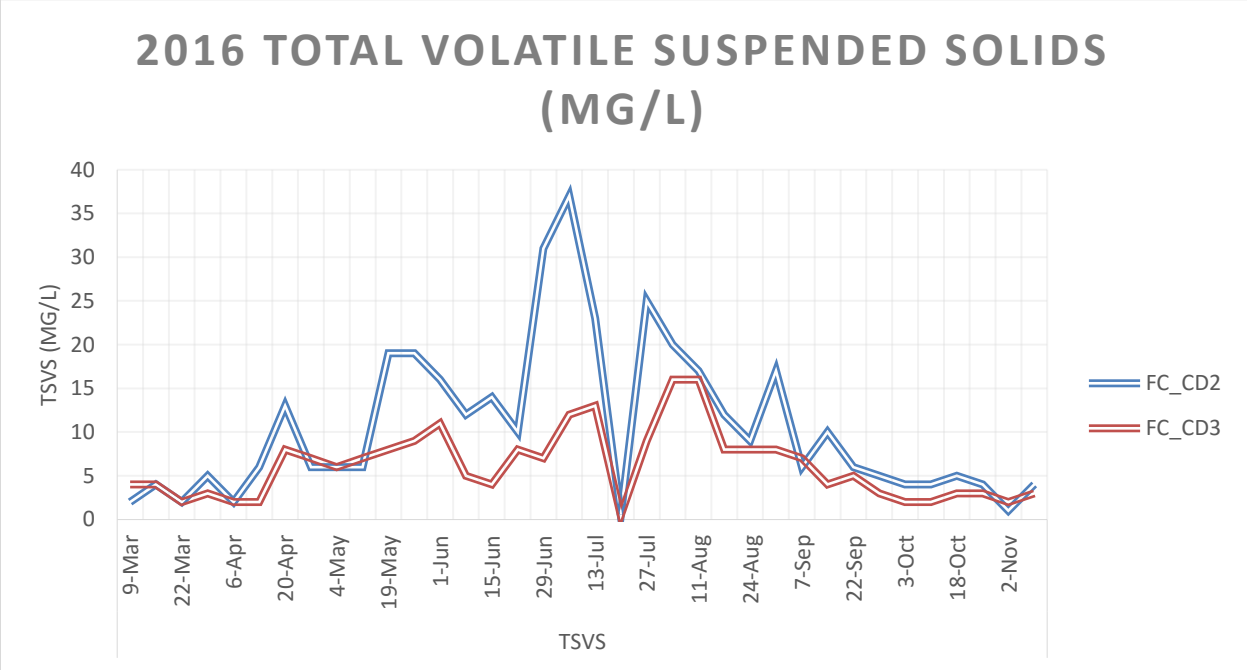


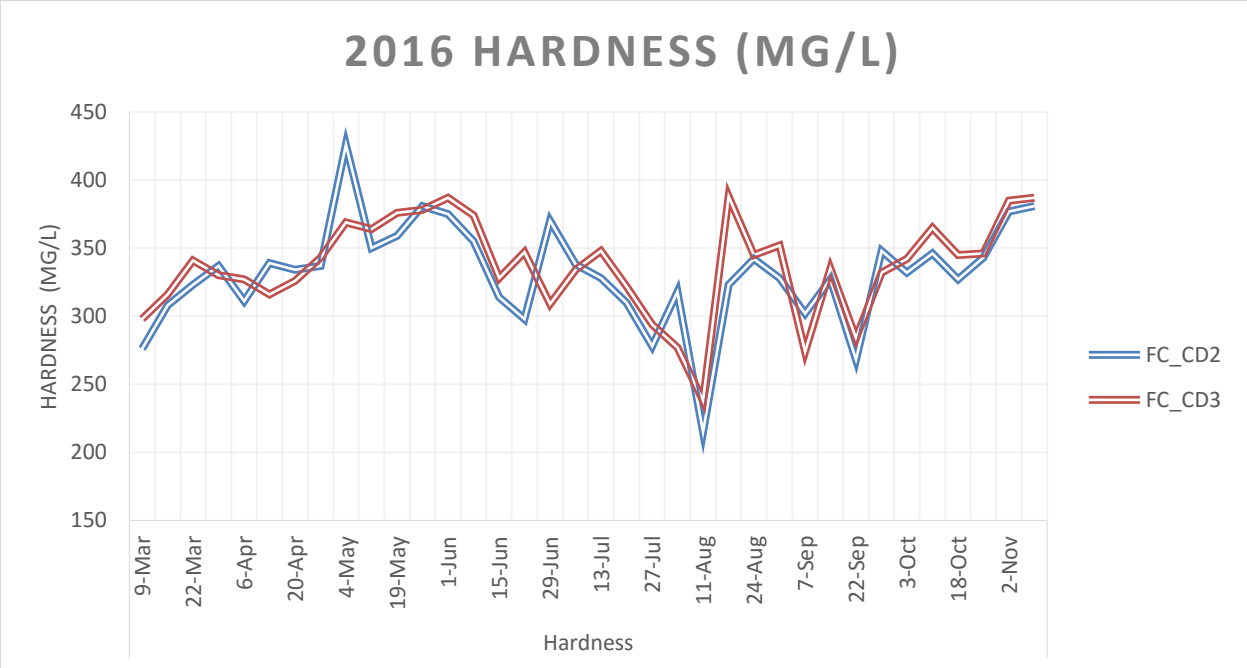
Dissolved Iron results of 10 µg/l were below detection limit and actual results were < 10 µg/l.

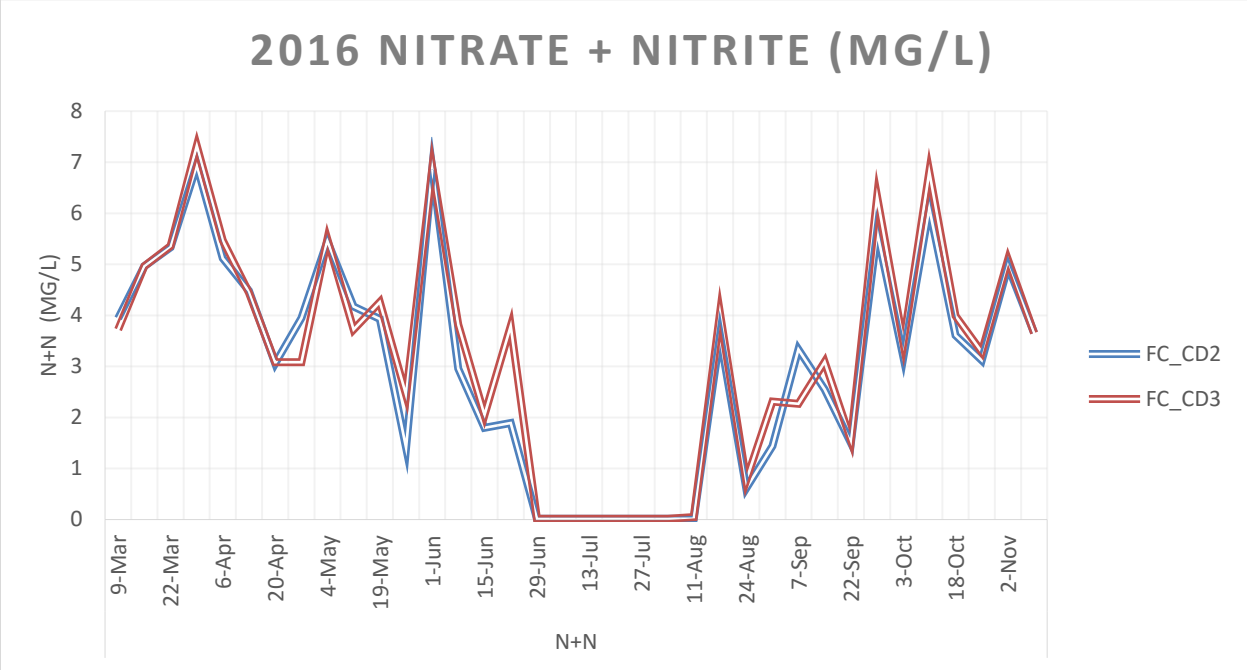


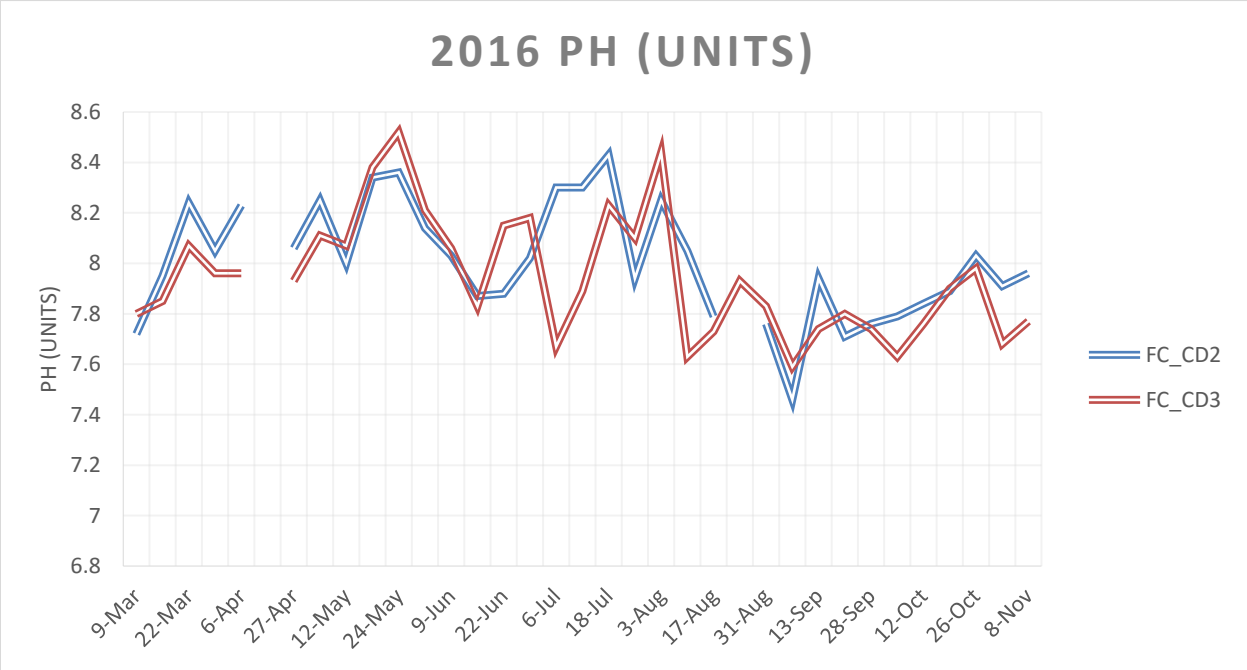

2016 SOLUBLE REACTIVE PHOSPHORUS (MG/L)
SRP (MG/L)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
9-Mar
22-Mar
6-Apr
20-Apr
4-May
19-May
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
11-Aug
24-Aug
7-Sep
22-Sep
3-Oct
18-Oct
2-Nov
SRP
FC_CD2
FC_CD3


2016 TOTAL SUSPENDED SOLIDS (MG/L)
TSS (MG/L)
100
90
80
70
60
50
40
30
20
10
0
9-Mar
22-Mar
6-Apr
20-Apr
4-May
19-May
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
11-Aug
24-Aug
7-Sep
22-Sep
3-Oct
18-Oct
2-Nov
TSS
FC_CD2
FC_CD3


2016 TOTAL VOLATILE SUSPENDED SOLIDS (MG/L)
TSVS (MG/L)
40
35
30
25
20
15
10
5
0
9-Mar
22-Mar
6-Apr
20-Apr
4-May
19-May
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
11-Aug
24-Aug
7-Sep
22-Sep
3-Oct
18-Oct
2-Nov
TSVS
FC_CD2
FC_CD3


2016 HARDNESS (MG/L)
HARDNESS (MG/L)
450
400
350
300
250
200
150
9-Mar
22-Mar
6-Apr
20-Apr
4-May
19-May
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
11-Aug
24-Aug
7-Sep
22-Sep
3-Oct
18-Oct
2-Nov
Hardness
FC_CD2
FC_CD3


2016 NITRATE + NITRITE (MG/L)
N+N (MG/L)
8
7
6
5
4
3
2
1
0
9-Mar
22-Mar
6-Apr
20-Apr
4-May
19-May
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
11-Aug
24-Aug
7-Sep
22-Sep
3-Oct
18-Oct
2-Nov
N+N
FC_CD2
FC_CD3


2016 PH (UNITS)
PH (UNITS)
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
6.8
9-Mar
22-Mar
6-Apr
27-Apr
12-May
24-May
9-Jun
22-Jun
6-Jul
18-Jul
3-Aug
17-Aug
31-Aug
13-Sep
28-Sep
12-Oct
26-Oct
8-Nov
FC_CD2
FC_CD3