FERRIC CHLORIDE WATER TREATMENT FACILITY
2015 ANNUAL REPORT

NPDES/SDS PERMIT NO: MN0067377

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

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PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

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.

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 weir on the south side of Highway 13 where it would mix until reaching the desiltation pond. The new design transfers $FeCl_3$ 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 1). 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.

FIGURE 1 AERIAL MAP OF FERRIC CHLORIDE TREATMENT SYSTEM

SUMMARY OF RESULTS

In 2015, the Prior Lake-Spring Lake Watershed District (PLSLWD) started injecting $FeCl_3$ into the stormwater pond on April 1st and discontinued it on October 31, as part of its winter schedule.

During operation in 2015, the system treated approximately 348 million gallons (MG) of water. The system reduced the average concentration of Total Phosphorus (TP) by 0.11 mg/L (48%) and removed a calculated 402 pounds. The concentration of SRP was reduced by an average of 0.027 mg/L (51%) and approximately 103 pounds were removed from the system.

TABLE 1 – PHOSPHORUS CONCENTRATIONS AND PERCENT REMOVAL

	SW001 Monthly Mean		SD002 Monthly Mean		% Removal 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*	0.20	0.013	0.18*	0.016*	10%*	-24%*
April	0.18	0.003	0.11	0.003	37%	0%
May	0.23	0.021	0.08	0.007	66%	68%
June	0.15	0.029	0.09	0.015	39%	47%
July	0.20	0.074	0.15	0.067	25%	10%
August	0.25	0.079	0.12	0.033	51%	58%
September	0.36	0.083	0.12	0.011	67%	87%
October	0.20	0.040	0.09	0.007	53%	84%
Average Apr-Oct	**0.22**	**0.047**	**0.11**	**0.020**	**48%**	**51%**

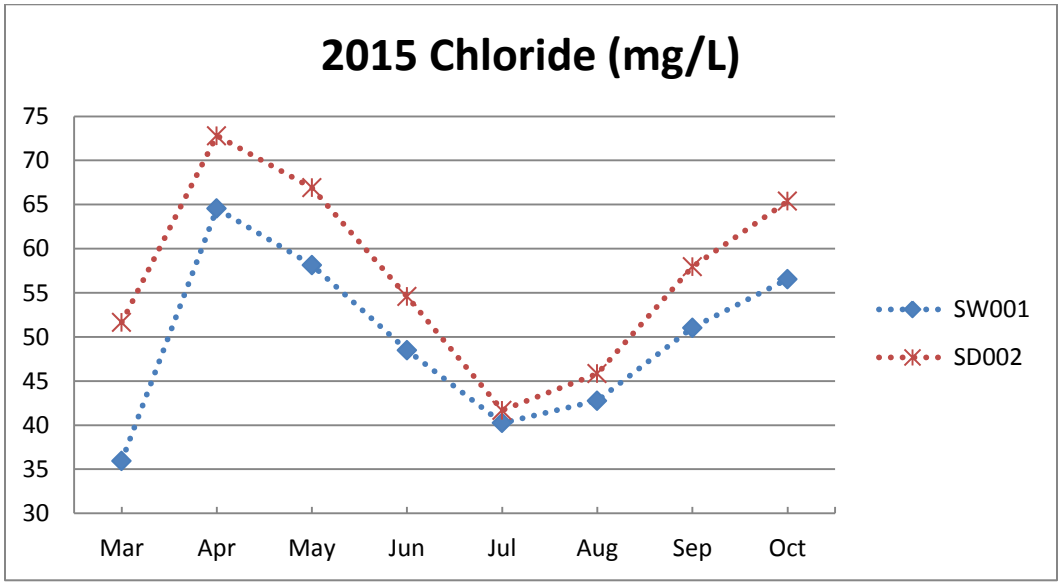
*The $FeCl_3$ system was not operating in March, therefore, these samples were not treated with $FeCl_3$.

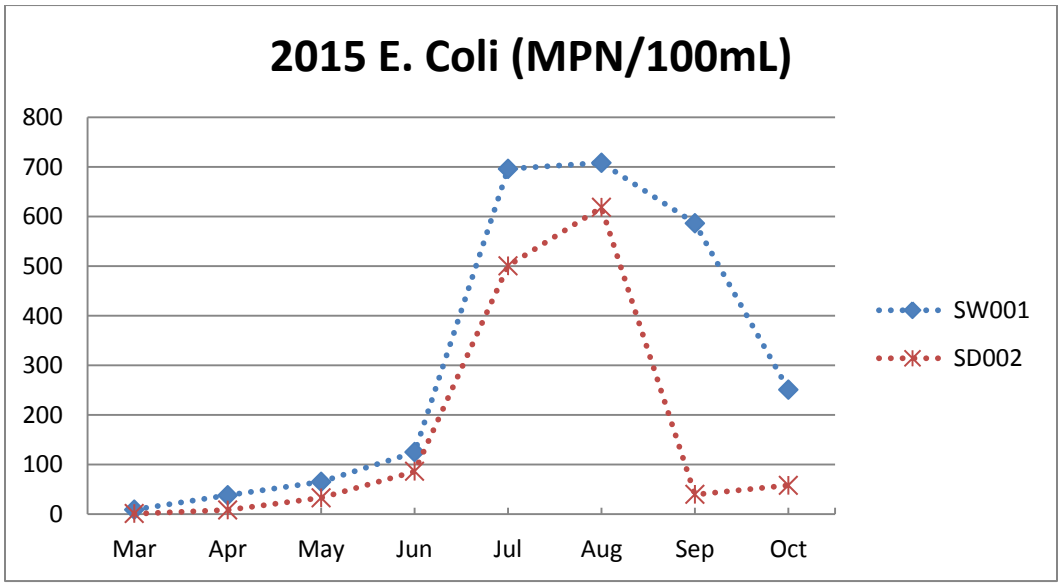
TABLE 2 PHOSPHORUS LOAD REDUCTIONS

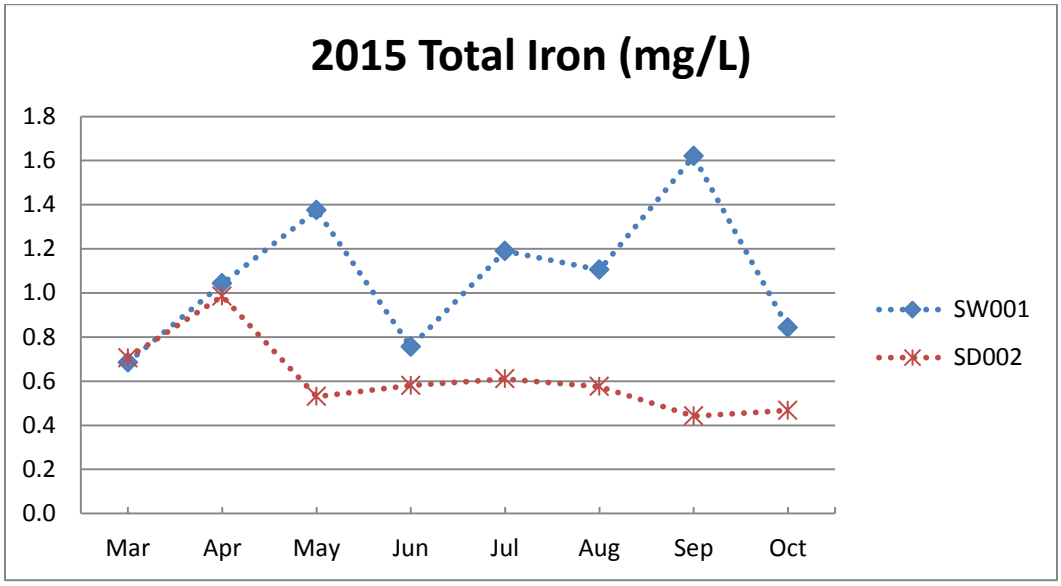
		SW-001	SD-002
April	Average TP (mg/L)	0.18	0.11
	Average SRP (mg/L)	0.003	0.003
	Treated Water (MG)		55.00
	TP Load Reduction (pounds)		29.97
	SRP Load Reduction (pounds)		0.00
May	Average TP (mg/L)	0.23	0.08
	Average SRP (mg/L)	0.021	0.007
	Treated Water (MG)		41.00
	TP Load Reduction (pounds)		50.67
	SRP Load Reduction (pounds)		4.96
June	Average TP (mg/L)	0.15	0.09
	Average SRP (mg/L)	0.029	0.015
	Treated Water (MG)		14.00
	TP Load Reduction (pounds)		7.01
	SRP Load Reduction (pounds)		1.58
July	Average TP (mg/L)	0.20	0.15
	Average SRP (mg/L)	0.074	0.067
	Treated Water (MG)		38.00
	TP Load Reduction (pounds)		16.44
	SRP Load Reduction (pounds)		2.28
August	Average TP (mg/L)	0.25	0.12
	Average SRP (mg/L)	0.079	0.033
	Treated Water (MG)		60.00
	TP Load Reduction (pounds)		62.76
	SRP Load Reduction (pounds)		22.80
September	Average TP (mg/L)	0.36	0.12
	Average SRP (mg/L)	0.083	0.011
	Treated Water (MG)		68.00
	TP Load Reduction (pounds)		137.99
	SRP Load Reduction (pounds)		41.11
October	Average TP (mg/L)	0.20	0.09
	Average SRP (mg/L)	0.040	0.007
	Treated Water (MG)		108.00
	TP Load Reduction (pounds)		96.73
	SRP Load Reduction (pounds)		29.76
Total	Total Treated Water (MG)		348
	Total TP Load Reduction (pounds)		402
	Total SRP Load Reduction (pounds)		103

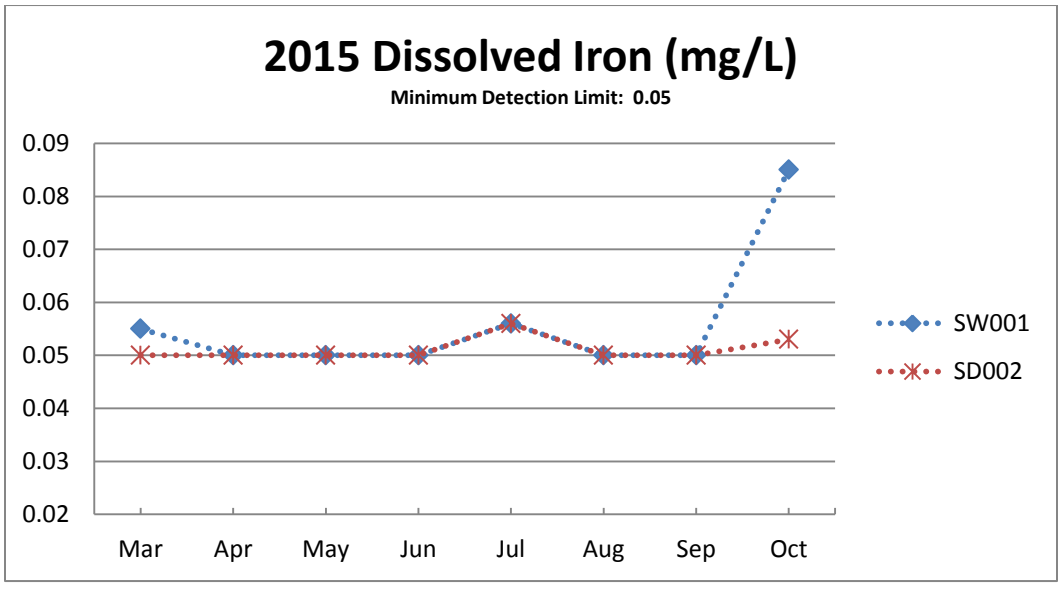
GRAPHS

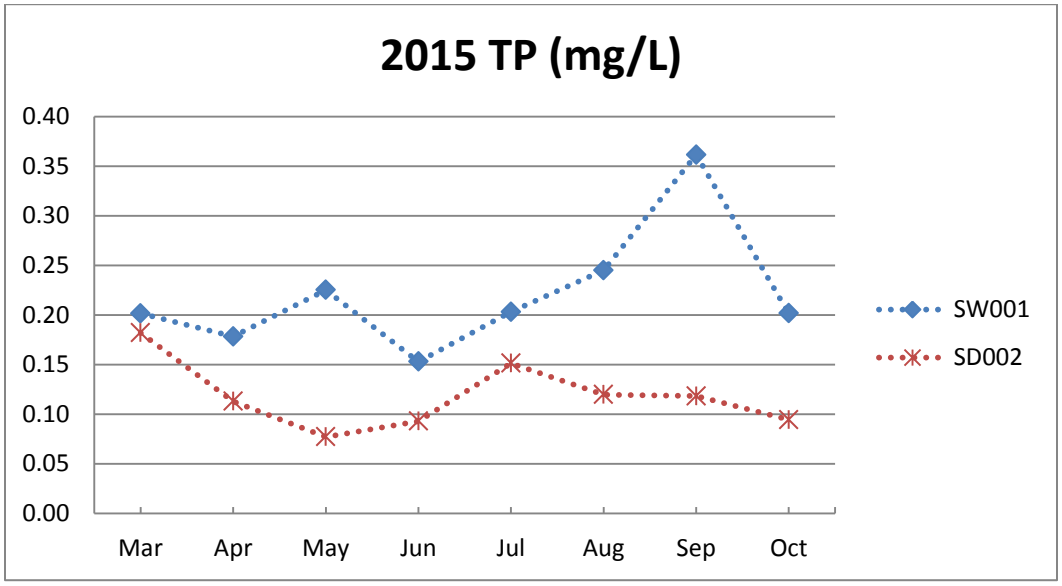
The following graphs display the monthly mean of samples taken in 2015 at site SW-001 (before treatment) and SD-002 (after treatment). Treatment began on April 1 and ceased on October 31. During that time, samples were taken once per week. Two samples were also taken in March *before* treatment began.

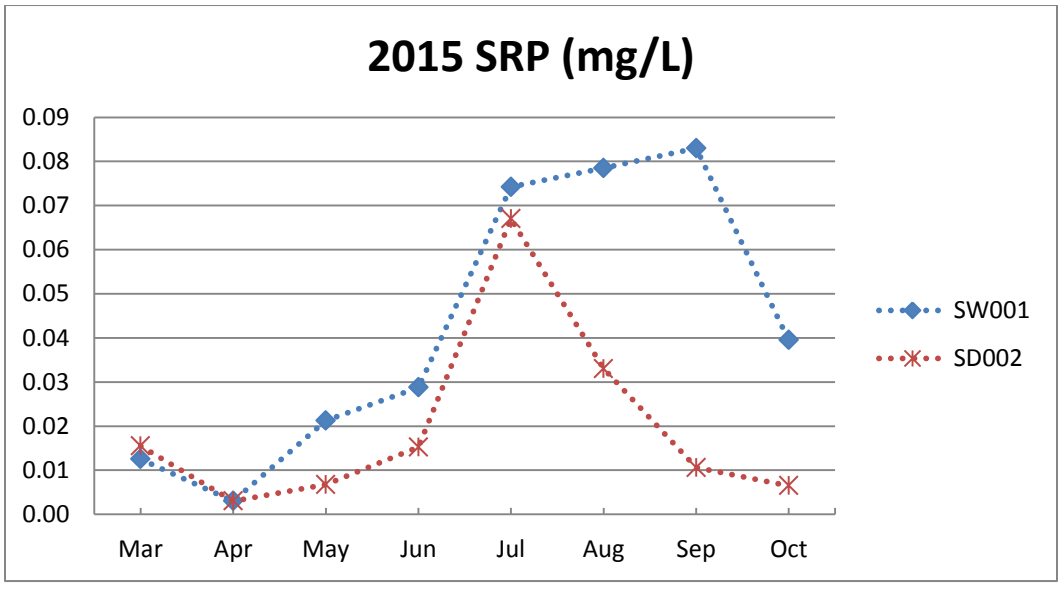


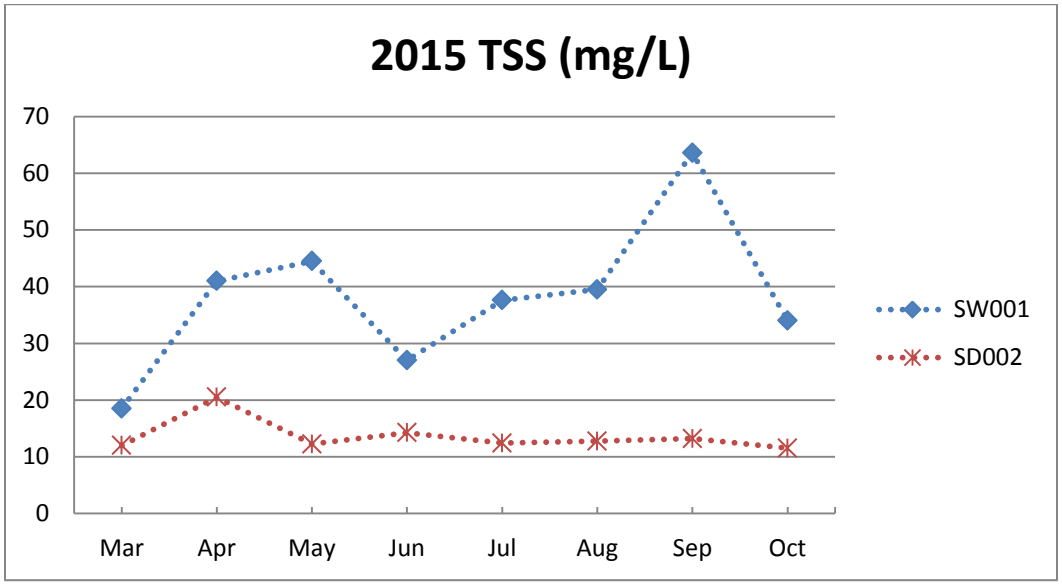


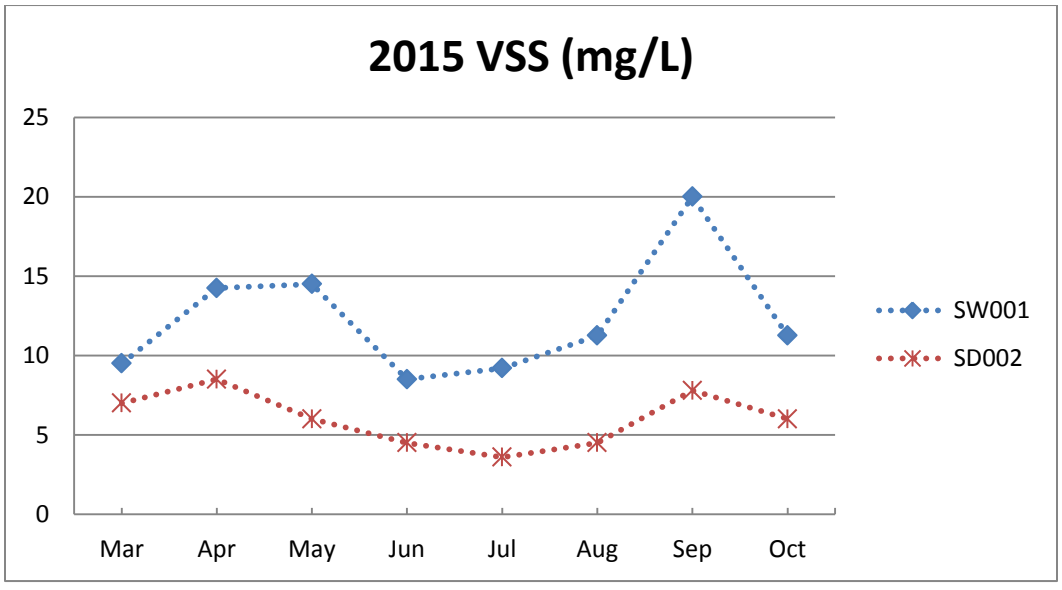

2015 Total Iron (mg/L)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002

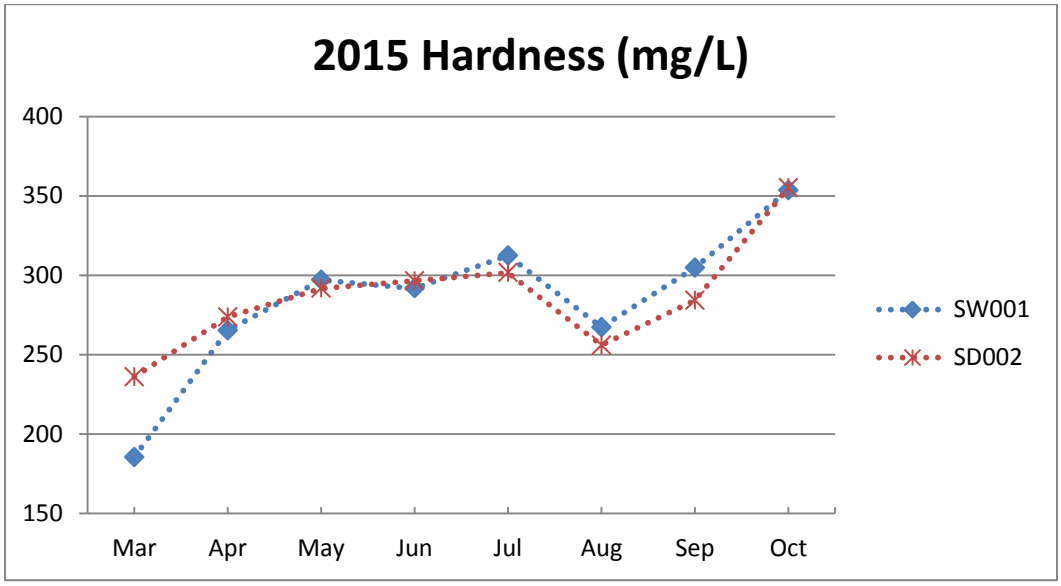

2015 Dissolved Iron (mg/L)
Minimum Detection Limit: 0.05
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002

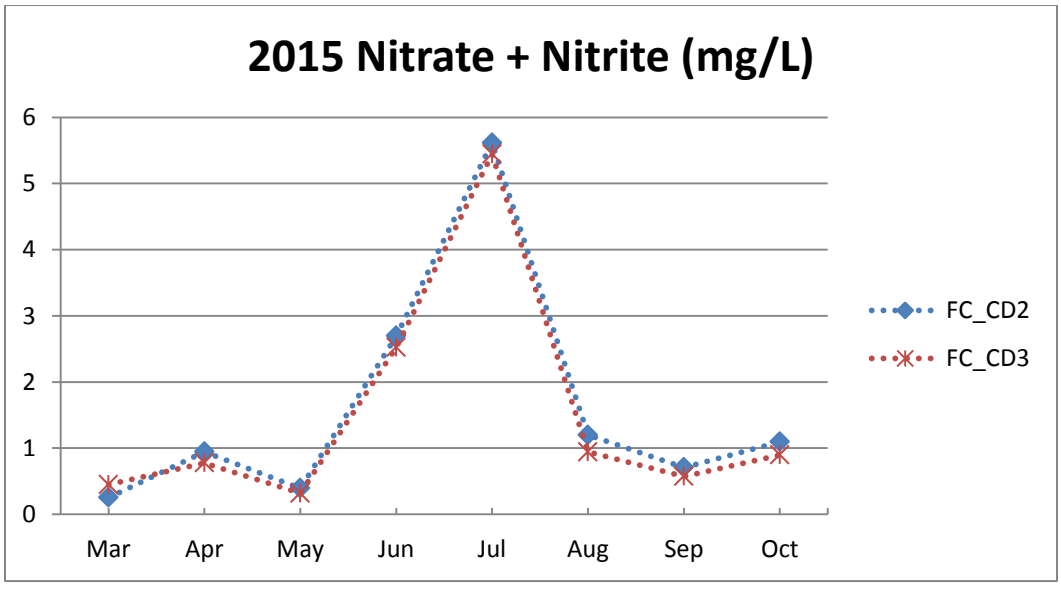

2015 TP (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002

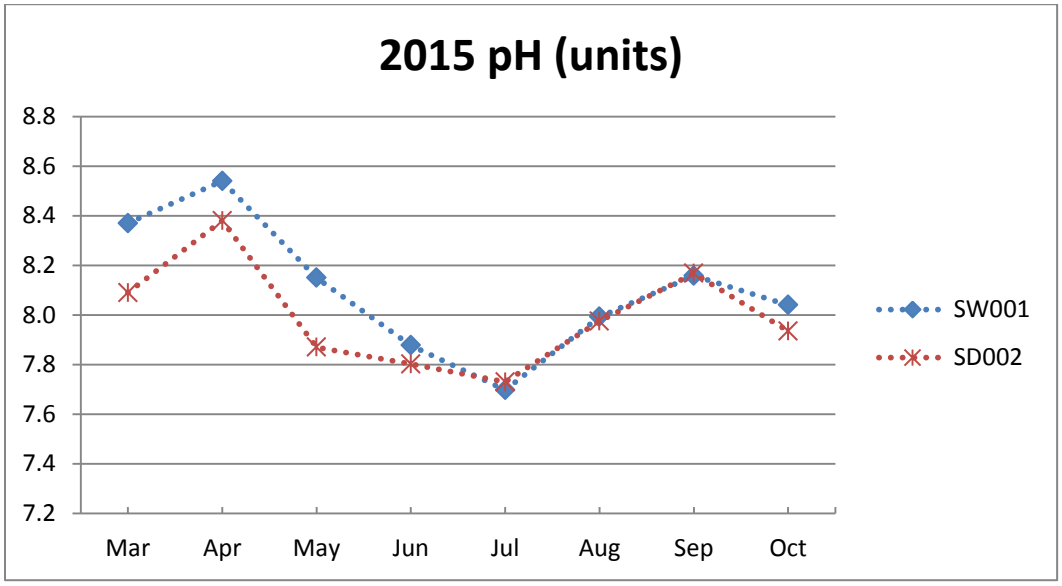

2015 SRP (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002


2015 TSS (mg/L)
70
60
50
40
30
20
10
0
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002


2015 VSS (mg/L)
25
20
15
10
5
0
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002


2015 Hardness (mg/L)
400
350
300
250
200
150
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002


2015 Nitrate + Nitrite (mg/L)
6
5
4
3
2
1
0
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
FC_CD2
FC_CD3


2015 pH (units)
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
SW001
SD002