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MS4 2009 Permit Monitoring Results (2010-2015)

Summary of Sonoma County Water Agency's Data for two Sites in Santa Rosa Creek

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Introduction

Under the 2009 North Coast Regional Water Quality Control Board's NPDES Permit No. R1-2009-0050[1] for storm water and non-storm water discharges from municipal separate storm sewer systems (2009 MS4 Permit), the Sonoma County Water Agency (SCWA) conducted monthly water quality monitoring at two receiving water sites on Santa Rosa Creek located below and above the City of Santa Rosa (2010-2015). Results were submitted to the North Coast Regional Water Quality Control Board (Regional Water Board) in annual reports. The San Francisco Estuary Institute (SFEI) provided data management support to Regional Water Board staff to format and upload those data to SFEI's Regional Data Center (RDC) to demonstrate online data management and reporting service available to environmental water quality monitoring programs and projects.

SFEI's RDC is one of three state-sponsored, online environmental monitoring data management services in California. Data submitted to SFEI's RDC is passed to the California Environmental Data Exchange Network (CEDEN) on a weekly basis. Water quality monitoring data uploaded to the RDC can be accessed via an interactive Data Display and Download website (CD3) or from CEDEN. Additionally, conventional water quality data loaded to CEDEN are transfered to the EPA's Water Quality Exchange (WQX), a requirement of many State, Tribal, and Federal agencies.

The CD3 tool provides online access to environmental monitoring data from one or more projects selected from an interactive map. Results are selected and summarized (on-screen) in several kinds of charts, and can be downloaded in spatial and tabular formats for futher analyses. These online services were developed under funding from the San Francisco Bay Regional Monitoring Program for Water Quality (Bay RMP) and the State Water Board, which funded the expansion of the tools to support environmental water quality monitoring data across California. Many analytical laboratories that work with environmental samples from California are familiar with the data upload templates of the RDC and CEDEN[2], and submit results directly without requiring the client to reformat them.

This memo summarizes the 2009 MS4 Permit's receiving water monitoring data from the SCWA's two monitoring sites that were uploaded to SFEI's RDC and CEDEN. The memo describes monitoring frequency, analytical methods, data completeness, and compares the results from the downstream site (C1-SRC-D) to the upstream 'background' site (C2-SRC-U) and to regional water quality standards. In a separate appendix, receiving water results were further compared to other monitoring project results from sites in Santa Rosa Creek including the Surface Water Ambient Monitoring Program (SWAMP, 2004 - 2011) and Nutrient and Pathogen TMDL Development Monitoring Surveys conducted by the Regional Water Board (TMDL, 2008 & 2010-2011). Real-time precipitation and hydrology data from two local monitoring stations were included in this summary to identify when the SCWA's 2009 MS4 Permit receiving water sampling events occurred during periods of unusually high stream flow.

[1] https://www.casqa.org/sites/default/files/effectiveness_assessment/pages_from_01_r1-2009-0050.pdf

[2] The RDC and CEDEN data upload templates are the same making data submission easier.

Figure1. Map of real-time precipitation and stream-flow monitoring stations, and the SCWA's two receiving water quality monitoring sites in Santa Rosa Creek and surrounding area.

Methods

The SCWA's 2009 MS4 Permit receiving water monthly monitoring in Santa Rosa Creek was conducted between July 20, 2010 and June 19, 2015 at two sites: C1-SRC-D and C2-SRC-U (located downstream and upstream of the City of Santa Rosa's urban area respectively). Water samples were analyzed for the following parameters:

- **Field Collected Measures** (N = 3): Temperature, pH, Dissolved Oxygen (DO)
- **Chemistry & Pathogens** (N = 12): Biological Oxygen Demand (BOD[3]), Total Suspended Solids (TSS), Ammonia as NH3, Total Nitrogen - Kjeldahl (TKN), Total Phosphorus, Total Orthophosphate as P, Nitrate as N, Nitrite as N, Total Nitrogen as N, and Bacteria (Enterococci, Fecal Coliform, and E. coli in MPN units)
- **Toxicity**: organism-based chronic toxicity tests with pass/fail results (not reported in this memo)

Table 1 lists the analytical methods, sampling period, and number of sites sampled (including the number of sample results reported) for each parameter.

[3] The MS4 Permit describes BOD as *Biochemical* Oxygen Demand, however CEDEN reports this parameter as *Biological* Oxygen Demand. These terms are synonyms and we will employ the CEDEN nomenclature in this memo.

Table 1. List of laboratory analytical methods, period of sampling, number of sites (including the number of results reported), and the method Reporting Limits (RL) submitted by the SCWA for the 2009 MS4 Permit monthly receiving water monitoring effort at C1-SRC-D and C2-SRC-U.

Parameter, Water Fraction (Reporting Unit)	Method	Sample Date Range	Number of Sites & (N Sample Results Reported Per Site)	Reporting Limit (RL)	Reporting Completeness
pH	Field Measure	07-2010 to 06-2015	2 (60)	.	100%
Temperature (Deg. C)	Field Measure	07-2010 to 06-2015	2 (60)	.	100%
Dissolved Oxygen (mg/L)	Field Measure	07-2010 to 10-2014	2 (52-52)	.	87%
Ammonia as NH3, Total (mg/L)	SM 4500-NH3 C v18	07-2010 to 06-2015	2 (59-60)	0.2	99%
Biological Oxygen Demand (mg/L)	SM 5210 B	07-2010 to 06-2015	2 (59-60)	5	99%
Nitrate as N, Total (mg/L)	EPA 300.0	07-2010 to 06-2015	2 (59-60)	0.2	99%
Nitrite as N, Total (mg/L)	EPA 300.0	07-2010 to 05-2011	2 (11)	0.2	18%
Orthophosphate as P, Total (mg/L)	SM 4500-P E	07-2010 to 06-2015	2 (59-60)	0.02-0.3	99%
Phosphorus as P (mg/L)	SM 4500-P E	07-2010 to 06-2015	2 (59-60)	1	99%
Total Nitrogen, Kjeldahl (mg/L)	SM 4500-N org B	07-2010 to 06-2015	2 (59)	0.2	98%
Total Suspended Solids (mg/L)	SM 2540 D	07-2010 to 06-2015	2 (59)	1 - 1	98%
E. coli (MPN/100 mL)	SM 9223	07-2010 to 06-2015	2 (58-59)	1	99%
Enterococcus (MPN/100 mL)	SM 9230 C	07-2010 to 06-2015	2 (58-59)	2	99%
Fecal Coliform (MPN/100 mL)	SM 9221 E	07-2010 to 06-2015	2 (58-59)	1.8 - 2	99%

Reporting Completeness

60 monthly sampling events were successfully completed for the 2009 MS4 Permit period at both receiving water monitoring sites (C1-SRC-D and C2-SRC-U). All parameters except for Total Nitrogen as N were analyzed and reported. However, some parameters were not reported for every sample resulting in an overall data reporting completeness rate of 93% (not including Total Nitrogen as N). Examples of incomplete reporting for specific parameters include the following: Nitrite as N was only reported through May, 2011 (11 events out of 60 for both monitoring sites), and Dissolved Oxygen was reported through October, 2014 (52 events out of 60 for both monitoring sites).

Water Quality Data Accessed from CEDEN

The SCWA's 2009 MS4 Permit monthly receiving water monitoring data and other publically available water quality monitoring data from Santa Rosa Creek (within and near the City of Santa Rosa) were

downloaded from CEDEN in May-2017. The download included monitoring results for the 2009 MS4 Permit receiving water parameters and included data for the following programs who reported those parameters:

- SCWA's 2009 MS4 Permit monthly receiving water monitoring (2010-2015);
- Surface Water Ambient Monitoring Program (SWAMP, 2004 - 2011); and
- Regional Water Board's Nutrient and Pathogen TMDL development surveys (TMDL, 2008 & 2011/2012 respectively).

The SWAMP and the Nutrient and Pathogen TMDL survey results are further described and summarized in Appendix A. The purpose of evaluating those results was to determine if other monitoring programs and regional surveys are reporting the same matrix, fraction, and parameters as the MS4 Permit receiving water monitoring requires, and to generally compare the results across programs. Table 2 describes the SCWA's 2009 MS4 Permit monthly receiving water monitoring sites.

Toxicity results are not included in this memo because those data were not availble online at the time of the report.

Table 2. SCWA's 2009 MS4 Permit's receiving water monitoring sites in Santa Rosa Creek. Datum = NAD83.

Station Code	Description	Latitude	Longitude
C1-SRC-D	SCWA monthly receiving water site located at the confluence of Piner and Santa Rosa Creeks. This site is just downstream of the urban footprint of the City of Santa Rosa. Sampled 7-2010 through 6-2015. This location is also a City of Santa Rosa 2009 MS4 Permit bioassay monitoring site.	38.4452	-122.7760
C2-SRC-U	SCWA monthly receiving water site located upstream of the urban footprint of the City of Santa Rosa near Hwy 12 overpass. Sampled 7-2010 through 6-2015. This site is considered the 'background' monitoring station for the SCWA's downstream site (C1-SRC-D).	38.4565	-122.6365

Rainfall and Stream Flow Data

Real-time precipitation and stream flow data from monitoring stations in or near Santa Rosa Creek were included in this memo to put the SCWA's 2009 MS4 Permit receiving water quality monitoring sampling events into context with regard to weather and stream flow conditions. This is important because pollutant load conditions can fluctuate drastically as a result of high stormwater and runoff events and high stream flow conditions. However, it should be noted that the MS4 Permit goals were not focused on monitoring changes in pollutant loads due to storm events.

The California Irrigation Management Information System Program (CIMIS) monitors over 145 automated weather stations across California[4] and rainfall data were downloaded from the CIMIS website for the continuous precipitation monitoring station nearest Santa Rosa – station number 83, which is located southwest of Santa Rosa Creek in the Mark West Creek HUC-10 watershed.

[4] http://www.cimis.water.ca.gov/Default.aspx

Stream flow data were downloaded from the U.S. Geological Survey's (USGS) real-time streamflow website[5] for the active USGS continuous stream flow monitoring station (number 11466200) that is located in Santa Rosa Creek in the City of Santa Rosa. The station is between the SCWA's 2009 MS4 Permit sites and very close to a SWAMP monitoring site (114SR2971).

Table 3. Location of the precipitation and stream-flow continuous monitoring stations located in or near the City of Santa Rosa (station location datum = NAD83).

Program	Site Name	Description	Latitude	Longitude
CIMIS	CIMIS Rainfall	Santa Rosa continuous precipitation monitoring station 83	38.40355	-122.79993
USGS	USGS Flow	USGS continuous stream flow gauge Santa Rosa Creek station 11466200	38.43667	-122.72360

General Data Analyses

The SCWA's receiving water monitoring results were evaluated for each target parameter by plotting the results for the downstream and upstream sites (C1-SRC-D and C2-SRC-U respectively) over time for the 2009 MS3 Permit period: 60 monthly sampling events sampled from July 2010 though June 2015. Non-detects are represented in the plots as ½ the reported method detection limit (MDL) or ½ the reporting limit (RL) if the MDL was not provided.

Boxplots that display key summary statistics for each site (for the whole monitoring period) were included to broadly compare the downstream concentrations to the upstream 'background' concentrations. The "Anatomy of a Box and Whisker Plot" information box (below) describes the statistical components of a boxplot.

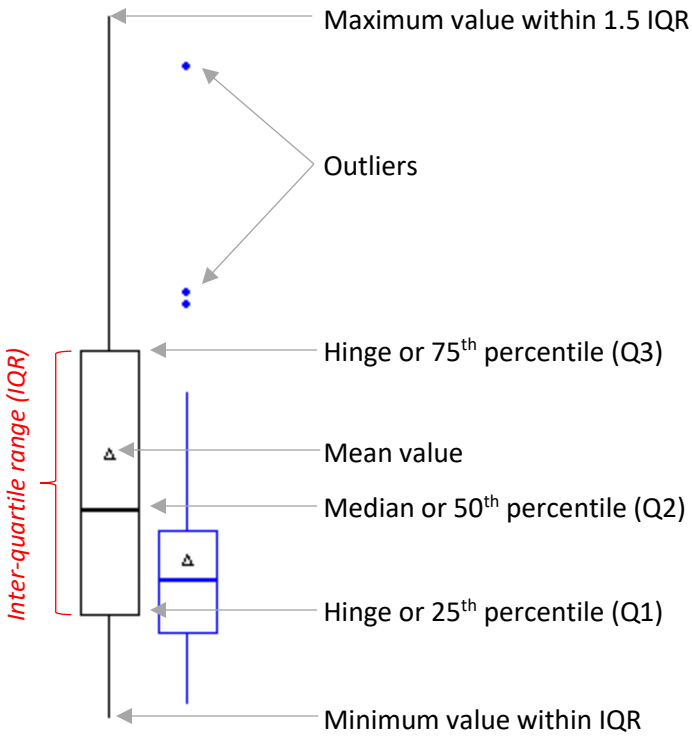
A short descriptive summary compares the downstream receiving water site to the upstream 'background' monitoring site for each target parameter, highlighting general differences between sites and the water quality objectives. Sampling events with unusually high results are listed along with the average daily stream flow and rainfall for that day.

[5] https://waterdata.usgs.gov/ca/nwis/rt

Anatomy of a Box and Whisker Plot (Boxplot)

The boxplot figures presented in this memo are based on the Tukey method (McGill, Tukey, and Larsen, 1978[6]). They compactly display several summary statistics about the monitoring results at each MS4 station over the 2009 Permit period including the median, two hinges, two whiskers, and all "outlying" points individually.

The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the largest value no further than 1.5 * IQR from the hinge (where IQR is the inter-quartile range, or distance between the first and third quartiles). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Data beyond the end of the whiskers are called "outlying" points and are plotted individually. The mean is overlaid on top the the boxplot (as a triangle).



Comparison to Water Quality Objectives

Numeric and narrative water quality objectives that apply to Santa Rosa Creek were provided by the North Coast Regional Water Board's MS4 Program Manager and are described in the North Coast's Basin Plan (May, 2011) or other regulatory documents (Table 4). The monitoring sites reported in this memo are located in Santa Rosa Creek upstream of the Laguna de Santa Rosa, which is listed for the following Benefiicial Uses and specific water quality objectives for the parameters reported in this memo: contact water recreation (REC-1); domestic water supply (MUN); spawning, reproductive and/or early development of fish (SPWN); cold freshwater habititat (COLD); and shellfish harvesting (SHELL).

Lines representing *numeric* water quality objectives from the North Coast's Basin Plan were overlaid on the time-series and boxplot summaries whenever they were available and they fell within the scale of the y-axis. The *narrative* Basin Plan Objectives require a comparison of receiving water quality results to 'background' conditions. The Sonoma County Water Agencgy's upstream site (C2-SRC-U) was considered the 'background' condition for those comparisons in this memo and exceedances were highlighted in the time-series plots in grey.

[6] McGill, R., Tukey, J. W. and Larsen, W. A. (1978) Variations of box plots. The American Statistician 32, 12-16 http://ggplot2.tidyverse.org/reference/geom_boxplot.html

Table 4. North Coast Regional Water Board's Water Quality Objectives for the SCWA's 2009 MS4 Permit's receiving water monitoring parameters.

Parameter	Narrative Objective	Numeric Objective	Source
Ammonia as NH3	Waters shall not contain toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal or aquatic life.	Sample specific – based on sample pH and Temperature	1999 Update of Ambient Water Quality Criteria for Ammonia
BOD	None		
DO		Minimum: 7.0 90% Lower Limit: 7.5 50% Lower Limit: 10.0	Basin Plan 2011
E. Coli	The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels.		Basin Plan 2011
Enterococci	The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels.		Basin Plan 2011
Fecal Coliform	The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels.	REC-1: 400 MPN/100ml SHELL: 49 MPN/100ml	Basin Plan 2011
Nitrate as N	In no case shall waters designated for use as MUN contain concentrations of chemical constituents in excess of MCLs and SMCL.	MCL*: 10 mg/L	Title 22 of the California Code of Regulations
Nitrite as N	In no case shall waters designated for use as MUN contain concentrations of chemical constituents in excess of MCLs and SMCL.	MCL*: 1 mg/L	Title 22 of the California Code of Regulations
pH		not <6.5 or >8.5	Basin Plan Table 3-1
Phosphorus	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.	0.02 mg/L	California Nutrient Numeric Endpoint (Tetra Tech 2006)
Temperature	The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.	(COLD) Not more than 5 Deg. F above background (or not ≥ 2.8 Deg. C).	Basin Plan 2011
Total Nitrogen, Kjeldahl	None		
Total Ortho-phosphate	None		
TSS	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.		Basin Plan 2011

* MCL = Maximum Contaminant Level

Bacteria

The Basin Plan (May, 2011) states that for waters designated for contact recreation (REC-1), the median fecal coliform concentration (based on a minimum five samples for any 30-day period) shall not exceed 50/100 ml, nor shall more than ten percent of samples exceed 400 MPN/100 ml over a 30-day period. Additional Basin Plan guidance states that all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43 MPN/100 ml for a 5-tube decimal dilution test or, 49 MPN/100 ml when a three-tube decimal dilution test is used. The Russian River Pathogen TMDL Draft Staff Report[7] recommends using 49 MPN/100 ml for waters designated for shellfish harvesting. For this memo we will compare SCWA's fecal coliform results to the REC-1 400 MPN/100 ml and 49 MPN/100 ml.

Ammonia

The intent of the ammonia water quality objective is to protect against the chronic toxic effects of ammonia in the receiving waters. The U.S.EPA 1999 Updated Water Quality Criterion for ammonia (EPA-822-R-99-014, December 1999) is temperature and pH dependent and variable for streams where mussels and salmonids (*Oncoryncus*) are present. Santa Rosa Creek is listed for SHELL, COLD, and SPWN beneficial uses and is considered salmonid habitat. Therefore the North Coast Water Board recommends using '*Table N.3 Criterion – Unionid Mussels Absent and Oncoryncus Present'* to compare ammonia to the sample-specific acute criteria maximum concentration (CMC).

Field-measured pH and temperatures for the SCWA's receiving water quality monitoring (2010-2015) ranged from 6.15-8.99 and 5-23 Deg. C respectively. Therefore, the lowest possible sample specific criterion for Ammonia as mg TAN/L for any combination of measured pH and temperature would be 0.88 (at pH = 9.0 and temperature ≤ 27 Deg. C).

The water quality criterion for ammonia is reported as Total Ammonia Nitrogen (TAN) with units of mg TAN/L while the SCWA reported Ammonia as NH3 (unionized ammonia) in mg/L. When asked about a conversion factor in order to compare reported results to the criterion, the analytical laboratory said that "total ammonia as NH3 and total ammonia as N use the same lab method (SM4500-NH3C). The only difference between the two is that ammonia as NH3 reports the entire weight of the ammonia ion (including the 3 hydrogens), while ammonia as N only reports the weight of the N atom." To compare the monitoring results to the Ammonia water quality criterion, it was necessary to convert the Ammonia as mg TAN/L criterion to Ammonia as NH3 units using the following formula[8]:

NH3-N*1.21589 = NH3 (0.88 mg TAN/L *1.21589 = 1.07 mg/L of Ammonia as NH3)

In 2013 the USEPA updated the Ammonia water quality criterion for freshwater to account for more sensitive species. The North Coast Water Board is in the process of reviewing and updating the ammonia objective for the North Coast. This memo uses the 1999 criterion for waters where salmonids are present (as described above) by request of the Regional Water Board because that was the applicable criterion when the 2009 MS4 Permit was issued.

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[7] http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/russian_river/pdf/150821/russian_river_tmdl_chapter_2_standards_and_targets_public_review_draft.pdf

[8] based on communication with the laboratory and the following link: http://hachcompany.custhelp.com/app/answers/answer_view/a_id/1000078/~/what-do-the-units-nh3-n-mean%3F

Results

The SCWA's 2009 MS4 Permit monthly receiving water monitoring results for each water quality parameter (2010-2015) are summarized below. As a reminder, site C1-SRC-D is located downstream of the City of Santa Rosa and C2-SRC-U is located upstream of the urban footprint and is considered a 'background' receiving water site.

Pollutant load concentrations can fluctuate dramatically as a result of storm events that result in high runoff and stream flow. To put the SCWA's receiving water quality monitoring results into context with regard to weather and hydrologic conditions, total daily rainfall and average daily stream flow estimates, from nearby monitoring stations were charted and the monthly water quality sampling events were overlaid on the time series plots to indicate when the sampling occurred (Figure 2).

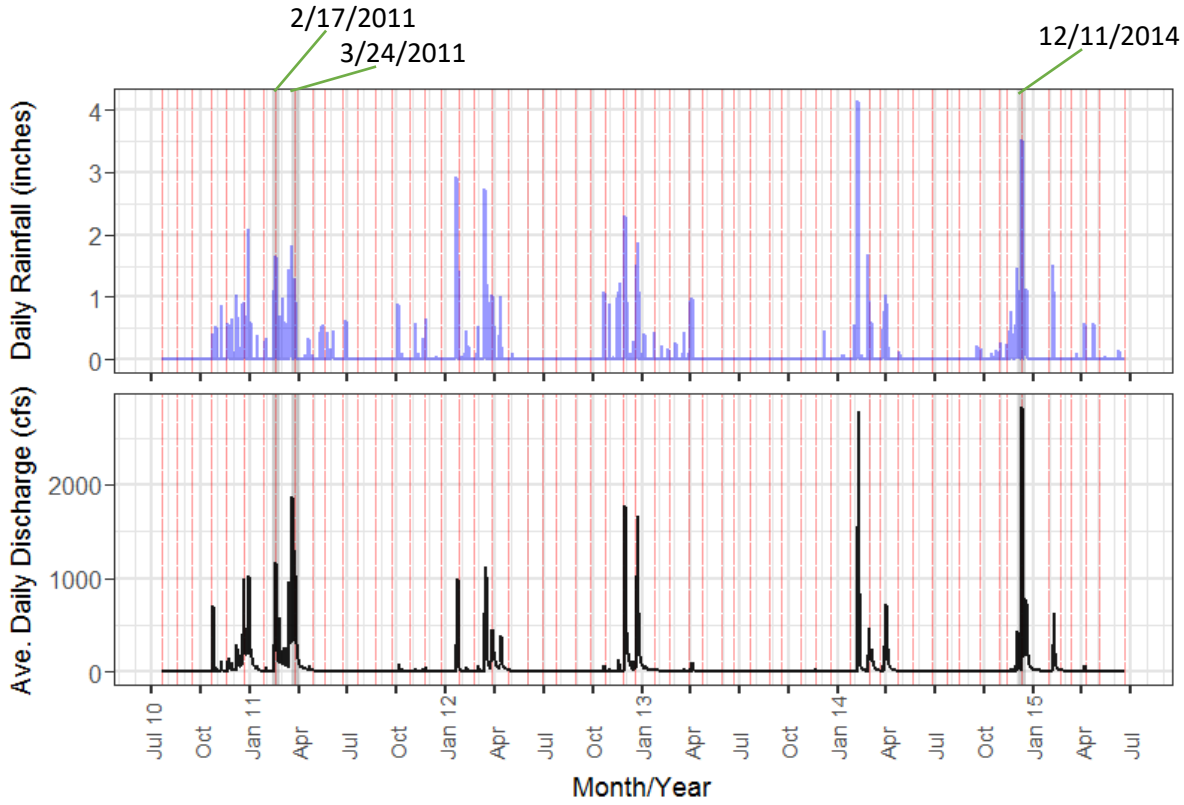


Figure 2. Daily rainfall (inches) and average daily stream stream flow (or discharge in cfs) in Santa Rosa Creek - July 20, 2010 through June 19, 2015. Red dashed lines indicate The SCWA's 2009 MS4 Permit monthly receiving water sampling dates (n= 60). There were three times when water quality sampling events coincided with average daily stream flows >1,000 cfs. Sampling dates are listed above the chart and inidcated as semi-transparent vertical grey bars.

Over the five-year monitoring period ((July 20, 2010 through June 19, 2015) there were 16 days when the average daily stream flow in Santa Rosa Creek exceeded 1,000 cfs. There were three times when water quality sampling events coincided with average daily stream flows >1,000 cfs.:

- 2/17/2011 – 1,170 cfs,
- 3/24/2011 – 1,300 cfs, and
- 12/11/2014 – 2,830 cfs (the highest average daily flow recorded during the monitoring period).

The timing of those high flow events is represented by three semi-transparent vertical grey bars in Figure 2, as well as in each the following time-series plots for each parameter.

FIELD MEASURES

pH

Monthly field measures of receiving water for pH (2010-2015) ranged from 6.15 to 8.59 and 6.96 to 8.99 at the downstream and upstream sites respectively. The average detected concentrations at the downstream and upstream sites was 7.47 and 7.77 respectively, a difference of 0.3 units. The Basin Plan objective range for pH is not to be <6.5 or >8.5. The downstream site (C1-SRC-D) reported two measures that were outside the acceptable range: one fell below the lower limit (on 11/27/2012, pH=6.15) and one fell above the upper limit (on 2/20/2015, pH=8.59). The upstream site reported three sampling events when pH was above the upper limit (4/28/2011, pH=8.73; 5/21/2014, pH=8.61; and 3/11/2015, pH=8.99). The average daily stream flow on any of those dates was not unusually high.

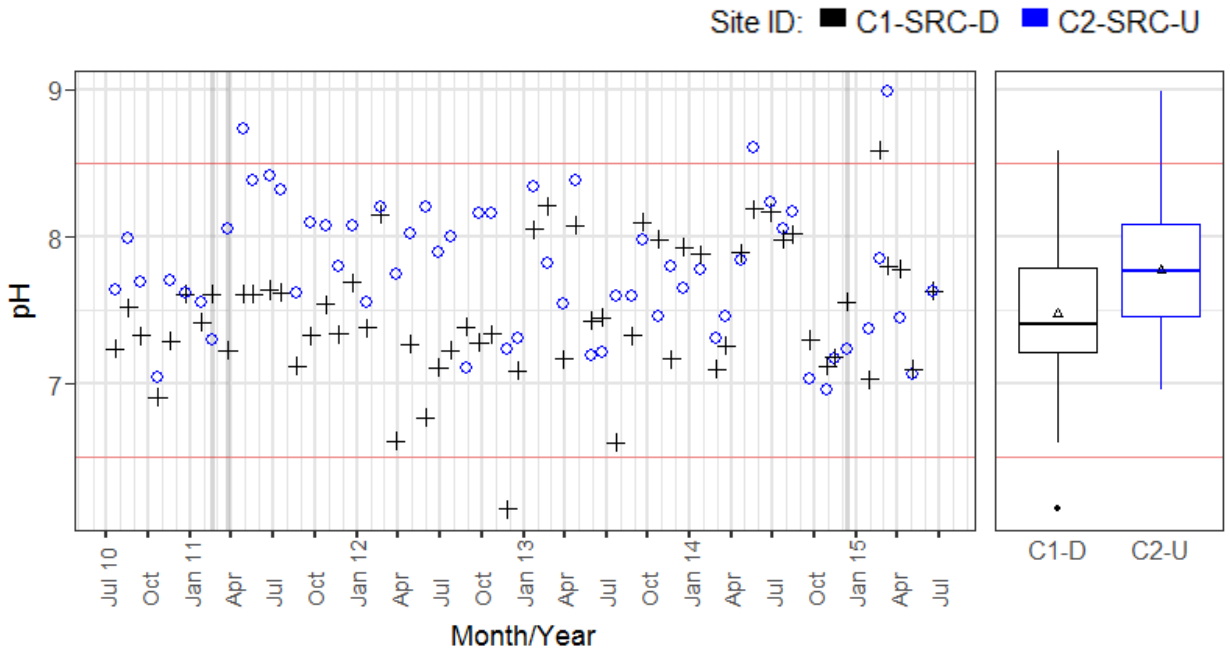


Figure 3. Monthly field-measured pH levels ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The Basin Plan upper and lower limit objective is represented by red lines.

TEMPERATURE

Monthly field measures of receiving water temperature (2010-2015) ranged from 5 to 23 and 5 to 19 Deg. C at the downstream and upstream sites respectively. The average temperature at the downstream and upstream sites was 14 and 12 Deg. C respectively, a difference of 2 degrees.

The Basin plan objective of Temperature in streams designated for COLD beneficial uses is that waters should not be > 5 Deg. F above background (or ≥ 2.8 Deg. C). Considering the upstream site as the background condition, 1/3 of the sampling events (20 out of 60 events) had downstream temperatures that were between 2.9 and 5.9 Deg. C higher than the upstream temperature on the same day.

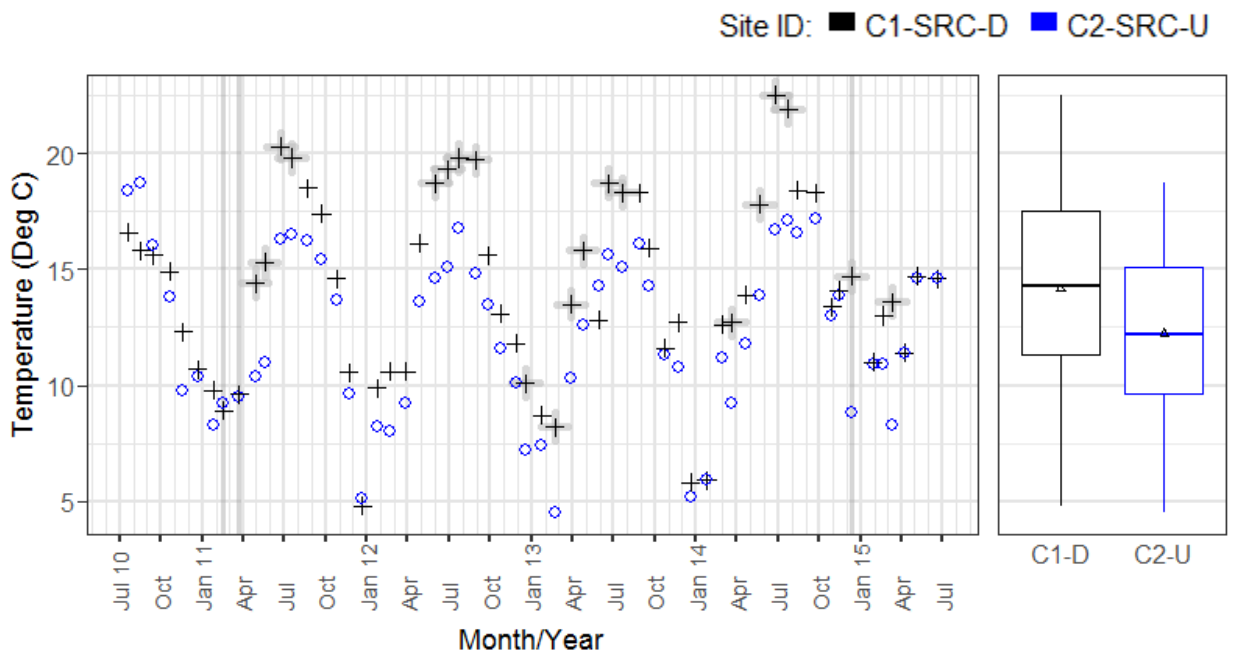


Figure 4. Monthly field-measured Temperature levels ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The Basin Plan water quality objective for COLD beneficial use streams in not more than 5 Deg. F (or 2.8 Deg. C) above background. 20 sampling events reported downstream temperatures that were 2.8 to 5.9 Deg. C higher than upstream (background) temperatures – those results are highlighted in grey.

DISSOLVED OXYGEN

Monthly receiving water field-measured results for Dissolved Oxygen (July 2010-October 2014) ranged from 3.8 to 15.9 and 4.0 to 15.6 mg/L at the downstream and upstream sites respectively. The average concentrations at the downstream and upstream 'background' monitoring sites were 7.9 and 9.0 mg/L respectively, with a difference of 1.1 mg/L. Monthly Dissolved Oxygen monitoring results were not reported after October, 2014 resulting in 87% complete reporting (or 52 out of 60 sampling events).

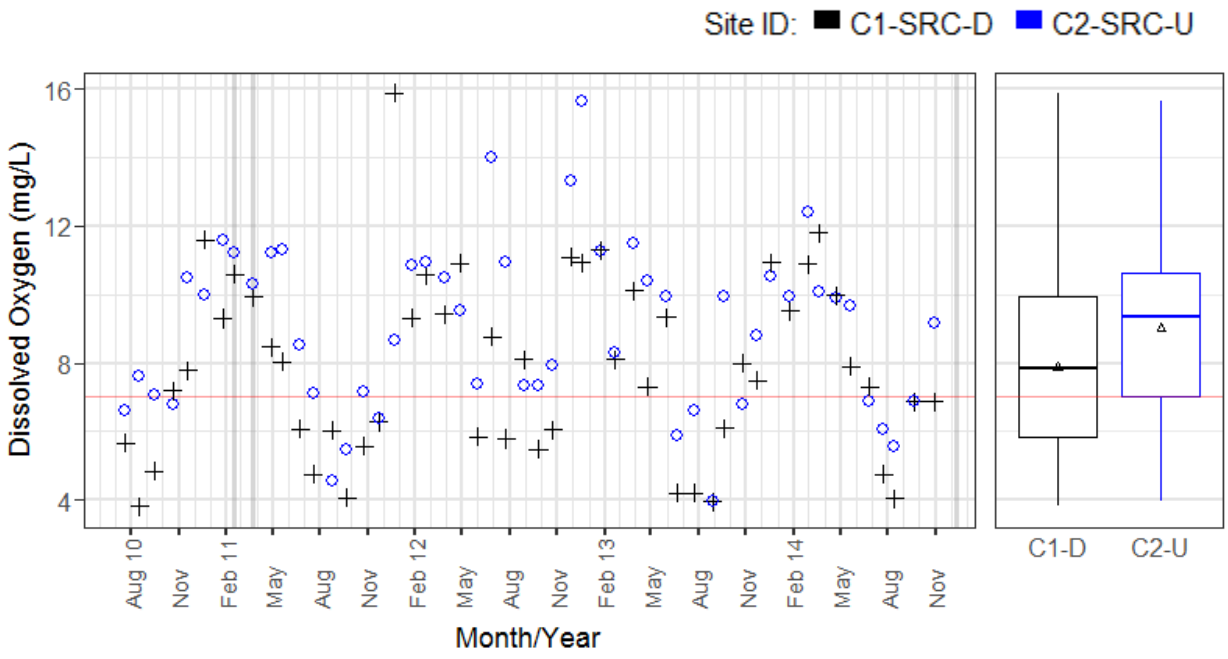


Figure 5. Monthly Dissolved Oxygen results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The Basin Plan minimum limit of 7.0 mg/L is represented by a red lines The method reporting limit (RL) is 5 mg/L.

The minimum water quality objective for Dissolved Oxygen is 7.0 mg/L. 40% of all the monitoring results from the downstream (C1-SRC_D) site fell below 7.0 mg/L compared to 25% of the upstream (C2-SRC_U) results.

Two additional water quality objectives for Dissolved Oxygen were applied to the monitoring results based on percentages of reported results over time:

- The 90th percentile Lower Limit water quality objective is 7.5 mg/L, which means that 90% of the Dissolved Oxygen results *in a calendar year* must be equal to or above that lower limit.
- The 50th percentile Lower Limit water quality objective for Dissolved Oxygen is 10.0 mg/L, which means that 50% of the *monthly means for a calendar year* must be equal to or above that lower limit.

Table 5 lists the number of samples reported each year at the downstream and upstream receiving water monitoring sites, the percent of monthly sample results that were 1) less than the minimum

objective (7.0 mg/L); 2) above the 90th percentile Lower Limit objective (≥7.5 mg/L) for the calendar year; and 3) above the 50th percentile Lower Limit objective (≥10 mg/L) in a calendar year. With the exception of the upstream site (C2-SRC-U) in 2012, none of the SCWA's MS4 receiving water results met the Basin Plan percentile objectives for Dissolved Oxygen.

Table 5. Percent of monthly sampling results that were below the 7.0 mg/L minimum WQO, and above the 90% and 50% Lower Limit objectives for Dissolved Oxygen by calendar year (July 2010 - October 2014).

Site Code	Year	Number of Samples	Percent of Results <7 mg/L	Percent of Results ≥7.5 mg/L	Percent of Results ≥10 mg/L
C1-SRC-D	2010	6	50%	33%	17%
C2-SRC-U	2010	6	33%	50%	33%
C1-SRC-D	2011	12	50%	50%	17%
C2-SRC-U	2011	12	25%	58%	42%
C1-SRC-D	2012	12	33%	67%	33%
C2-SRC-U	2012	12	0%	75%	58%*
C1-SRC-D	2013	12	33%	50%	25%
C2-SRC-U	2013	12	33%	67%	33%
C1-SRC-D	2014	10	40%	50%	20%
C2-SRC-U	2014	10	40%	60%	20%
C1-SRC-D	**All Years**	**52**	**40%**	**52%**	**23%**
C2-SRC-U	**All Years**	**52**	**25%**	**63%**	**38%**

* Met the 50% lower limit objective

CHEMISTRY

AMMONIA

Monthly receiving water Ammonia as NH3 results for 2010-2015 ranged from non-detect (MDL= <0.1) to 0.34 and non-detect (MDL= <0.1) to 0.51 mg/L at the downstream and upstream sites respectively. More than half the Ammonia results were non-detects (<0.1 mg/L): 52% and 71% non-detected results at the downstream and upstream sites respectively. The average Ammonia concentrations at the downstream and upstream 'background' monitoring sites were 0.12 and 0.11 mg/L respectively, with a difference of 0.01 mg/L. There was one unusually high result (0.51 mg/L) at the upstream (C2-SRC-U) site on 2/17/2011. The average daily stream flow on that day was unusually high (1,170 cfs).

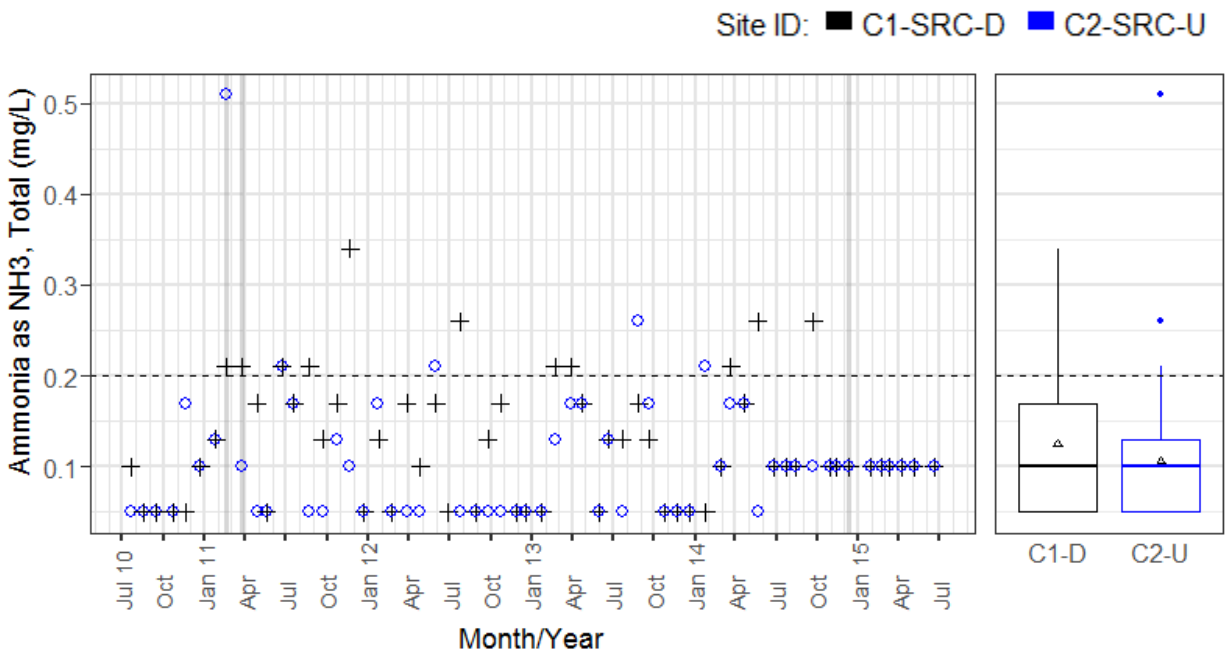


Figure 6. Monthly Ammonia (as NH3) results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The method reporting limit (RL) is 0.2 mg/L and is represented by the dashed black line.

None of the receiving water results were above the sample specific water quality criteria for Ammonia. The criterion is dependent on temperature and pH of a water sample. All the water quality samples collected by the SCWA's receiving water quality monitoring effort had field measured pH and temperatures that ranged from 6.15-8.99 and 5-23 Deg. C respectively. The lowest possible sample specific criterion for Ammonia as mg TAN/L is 0.88 (at pH = 9.0, temperature ≤ 27 Deg. C). When converted to Ammonia as NH3 the criterion is 1.07 mg/L, more than twice as high as the highest reported monthly receiving water Ammonia results sampled 2010-2015.

BIOLOGICAL OXYGEN DEMAND (BOD)

Monthly receiving water results for biological oxygen demand (BOD, 2010-2015) ranged from non-detect (MDL= <1) to 8.8 and non-detect (MDL= <1) to 16.0 mg/L at the downstream and upstream sites respectively. Most of the results were non-detects (<1 mg/L): 78% and 81% of the samples were non-detected results at the downstream and upstream sites respectively. The average detected concentrations at the downstream and upstream 'background' monitoring sites was 1.51 and 1.52 mg/L respectively, with a difference of 0.01 mg/L. There is no water quality monitoring objective for BOD. There was one sampling event (12/11/2014) that had unusually high results at both the downstream and upstream sites (BOD concentrations were 8.8 and 16 mg/L respectively). Average daily flow on 12/11/2014 was the highest recorded during the monitoring period at 2,830 cfs.

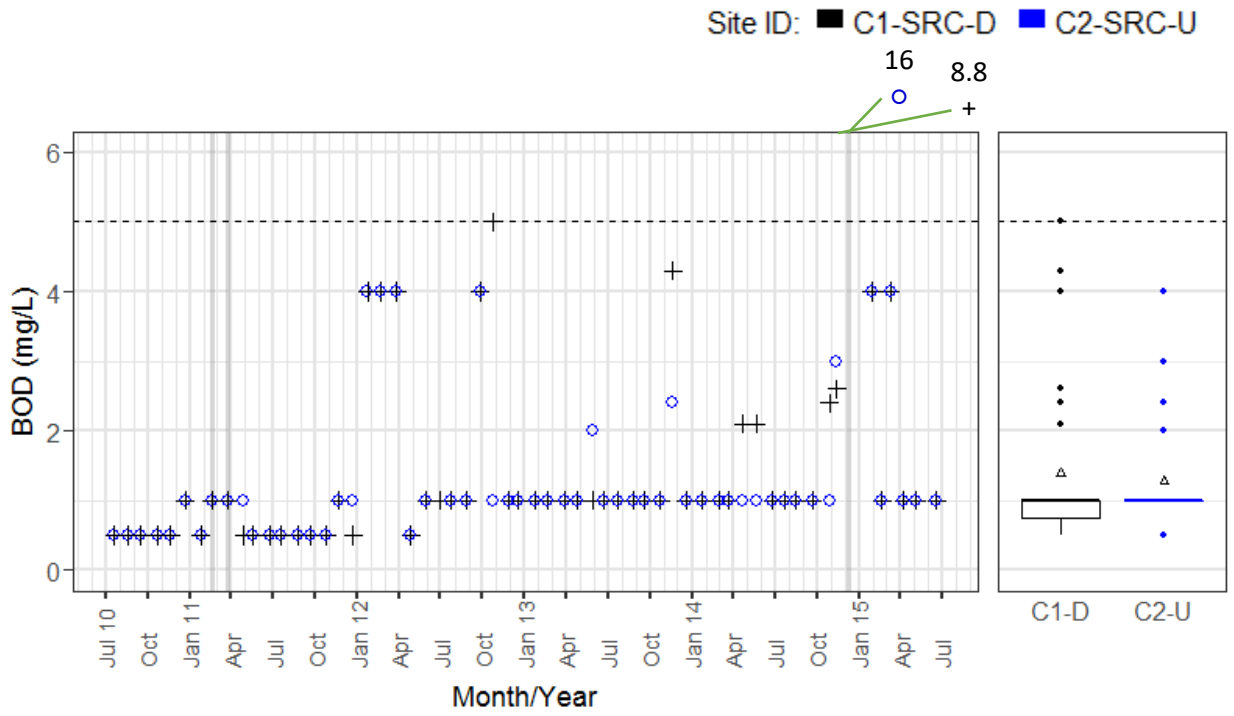


Figure 7. Monthly BOD results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The method reporting limit (RL) is 5 mg/L and is represented by the dashed black line.

NITRATE

Monthly receiving water results for Nitrate as N (2010-2015) ranged from non-detect (MDL= <0.05) to 2.50 and non-detect (MDL= <0.05) to 0.91 mg/L at the downstream and upstream sites respectively. 17% of the downstream (C1-SRC-D) and 8% of the upstream (C2-SRC-U) sample results were non-detects (MDL= <0.05). The average detected concentrations at the downstream and upstream sites was 0.28 and 0.16 mg/L respectively, a difference of 0.12 mg/L. The maximum concentration limit (MCL) for Nitrate is 10 mg/L as specified in Title 22 of the California Code of Regulations. None of the receiving water samples exceeded that limit. There was one unusually high result reported at the downstream site on 3/11/2015 (2.5 mg/L), which was almost three times higher than the next highest result - reported at C2-SRC-U on 12/11/2014 (result = 0.91 mg/L). The average daily stream flow on 3/11/2015 was not unusually high.

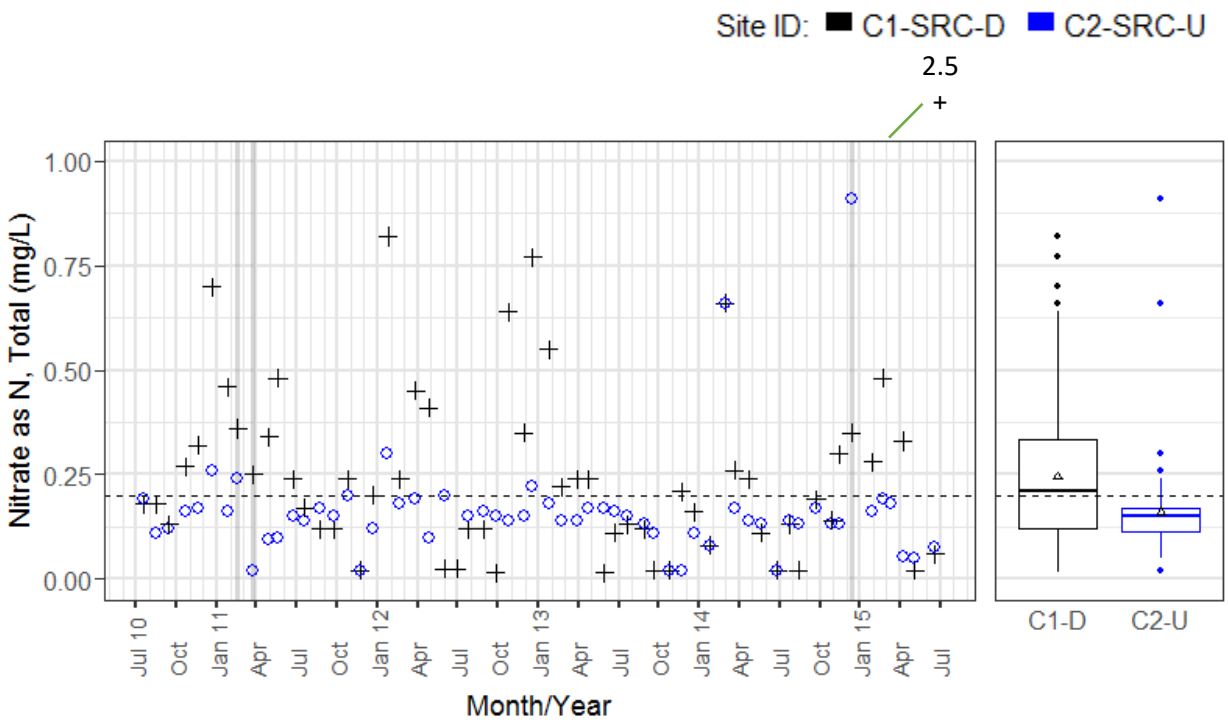


Figure 8. Monthly Nitrate results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The method reporting limit (RL) is 0.2 mg/L and is represented by the dashed black line. One unusually high value is not shown for C1-SRC-D sampled on 3/11/2015, value = 2.5 mg/L - almost three times higher than the next highest result reported.

NITRITE

Monthly receiving water results for Nitrite as N were reported for the first 11 months of monitoring (July, 2010 through May, 2011). Over 80% of the results were non-detects (MDL= <0.02). The detected results were reported in the first three months of sampling (July through September, 2010) when the laboratory reported an MDL that was 10x lower than later reports (MDL= <0.002) and ranged from non-detect to 0.005 mg/L – well below the MDL of later reports. The maximum concentration limit (MCL) for Nitrite is 1 mg/L as specified in title 22 of the California Code of Regulations. None of the receiving water samples exceeded that limit. Because all the reported results were essentially non-detect values (<0.02 mg/L), a scatter plot of the results is not presented for Nitrite.

ORTHOPHOSPHATE

Monthly receiving water results for Orthophosphate as P (2010-2015) ranged from non-detect (MDL= <0.02) to 0.57 and non-detect (MDL= <0.02) to 0.53 mg/L at the downstream and upstream sites respectively. 2% of the downstream (C1-SRC-D) and 2% of the upstream (C2-SRC-U) sample results were non-detects (MDL= <0.02). The average detected concentrations at the downstream and upstream sites was 0.22 and 0.14 mg/L respectively, a difference of 0.08 mg/L. There is no water quality objective for orthophosphate.

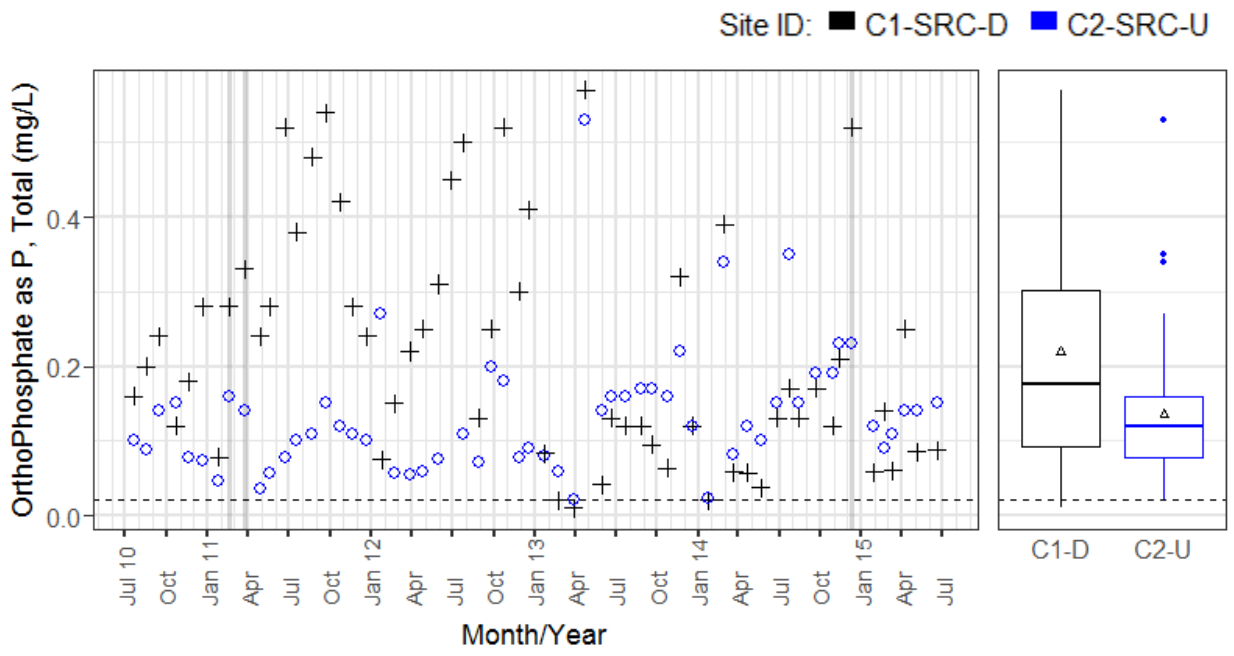


Figure 9. Monthly Ortho-phosphate results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The method reporting limit (RL) is 0.02 mg/L and is represented by the dashed black line.

PHOSPHORUS

Monthly receiving water results for Phosphorus as P (2010-2015) ranged from non-detect (MDL= <0.02) to 0.27 and non-detect (MDL= <0.02) to 4.20 mg/L at the downstream and upstream sites respectively. The average detected Phosphorus concentrations at the downstream and upstream sites was 0.09 and 0.06 respectively (not including the highest outlier result at the upstream site), a difference of 0.03 mg/L. There was one unusually high Phosphorus concentration at 4.2 mg/L at the upstream site (sampled on 12/11/2014), which was ten times higher than the next highest reported concentration of 0.35 mg/L. Average daily flow on 12/11/2014 was the highest recorded during the monitoring period at 2,830 cfs.

The California Nutrient Numeric Endpoint for Phosphorus is 0.02 mg/L (Tetra Tech 2006) and almost 90% of the reported receiving water results were above the guideline: 50 out of 60 downstream results (83%) and 54 of 59 upstream results (92%), respectively.

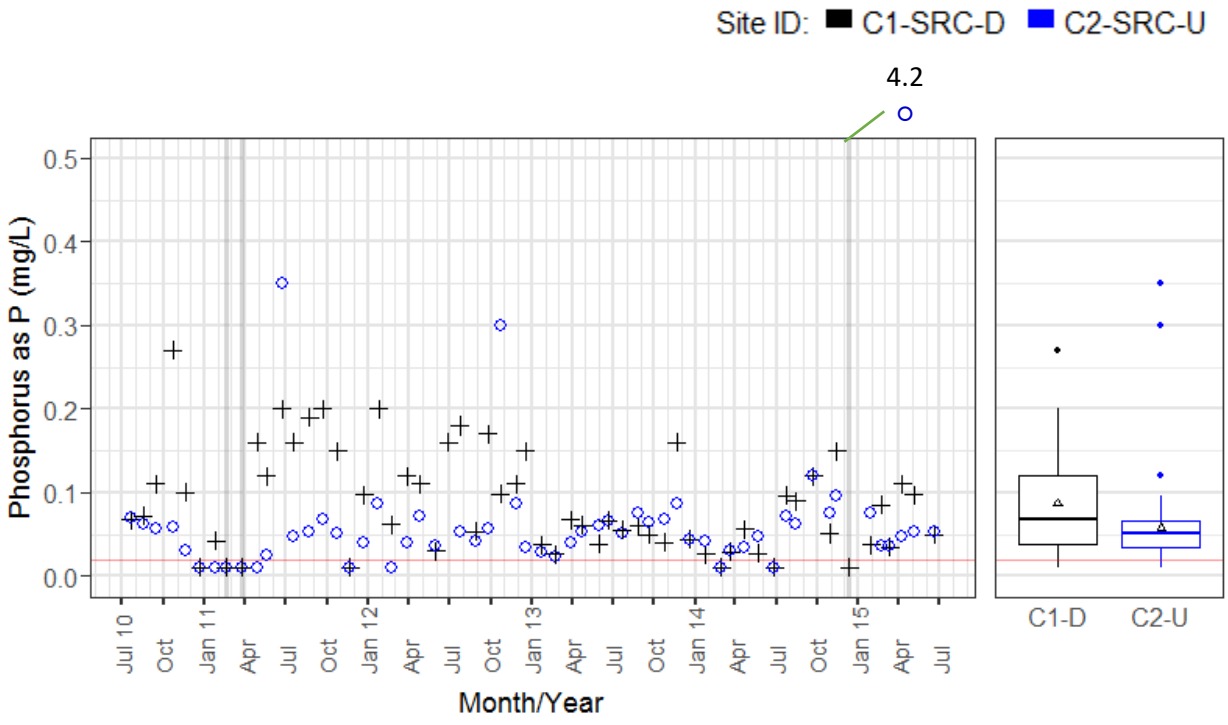


Figure 10. Monthly Phophorus as P results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The method detection limit (MDL) is 0.02 mg/L (the same as the California Nutrieent Numeric Endpoint). The reporting limit (RL) is 1 mg/L and is not shown. One unusually high result sampled on 12/11/2014 at C2-SRC-U had a reported value of 4.2 mg/L and is not shown as it was more than ten times higher than the next highest reported value.

TOTAL NITROGEN, KJELDAHL

Monthly receiving water results for Total Nitrogen, Kjeldahl (2010-2015) ranged from non-detect (MDL= <0.2) to 3.3 and non-detect (MDL= <0.2) to 34 mg/L at the downstream and upstream sites respectively. The average detected Total Nitrogen, Kjeldahl concentrations at the downstream and upstream sites was 0.5 and 0.3 mg/L respectively (not including the two highest outlier results at the upstream site), a difference of 0.2 mg/L. There is no water quality monitoring objective for Total Nitrogen, Kjeldahl. The upstream site reported two unusually high Total Nitrogen, Kjeldahl concentrations of 18 and 34 mg/L on 8/28/2012 and 12/11/2014 respectively, more than eight times higher than the next highest reported concentration of 2.2 mg/L at the upstream site. Average daily flow on 12/11/2014 2014 was the highest recorded during the monitoring period at 2,830 cfs.

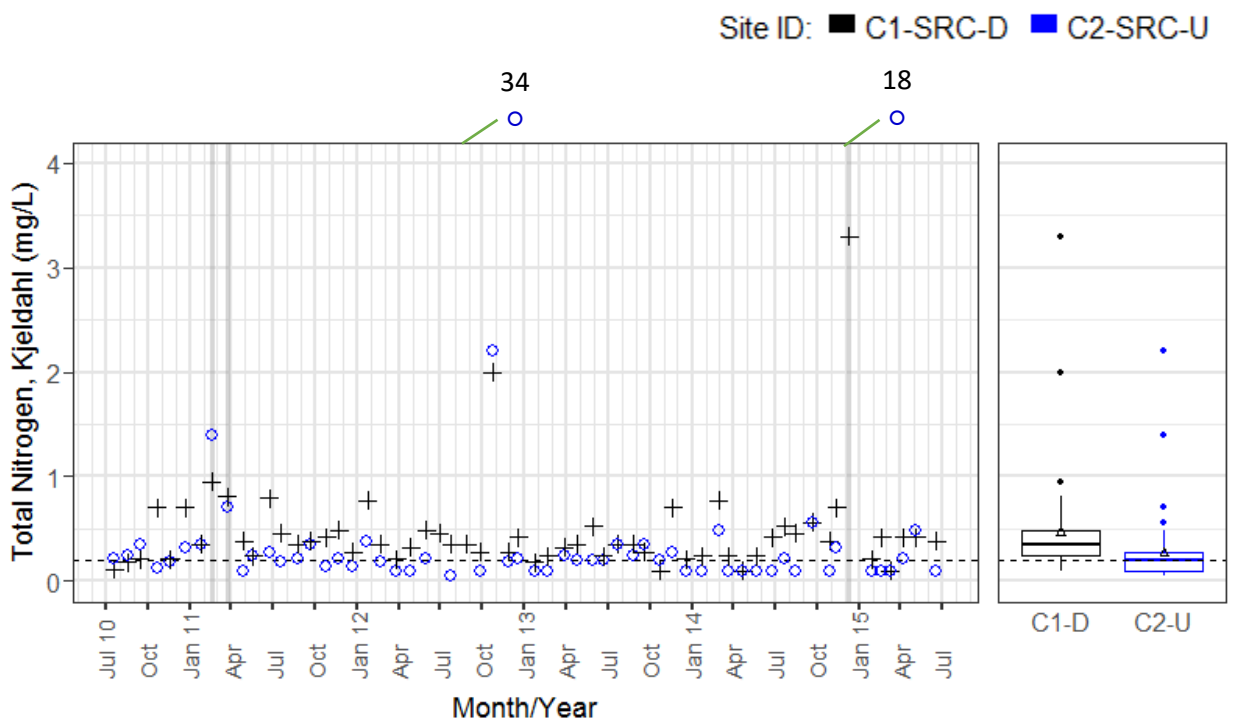


Figure 11. Monthly Total Nitrogen, Kjeldahl results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The method reporting limit (RL) is 0.2 mg/L and is represented by the dashed black line. Two unusually high concentrations, at C2-SRC-U, of 18 and 34 mg/L on 8/28/2012 and 12/11/2014 respectively, were more than eight times higher than the next highest reported concentration of 2.2 mg/L at the upstream site.

TOTAL SUSPENDED SOLIDS (TSS)

Monthly receiving water results for total suspended solids (TSS, 2010-2015) ranged from non-detect (MDL= <0.3) to 820 and non-detect (MDL= <0.3) to 8200 mg/L at the downstream and upstream sites respectively. The highest TSS concentrations were reported on 12/11/2014, which was the highest recorded average daily flow of all the SCWA's sampling events at 2,830 cfs. TSS concentrations on that day were 820 mg/L downstream and 8200 mg/L upstream. TSS concentrations were also unusually high on 2/17/2011, another day when average daily flow was unusually high (1,170 cfs). Average TSS concentrations at the downstream and upstream sites was 8 and 3 mg/L respectively (not including the three highest outlier results), a difference of 5 mg/L.

The narrative Basin Plan objective for TSS states that "waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses". This objective was not able to be evaluated. However, downstream concentrations were compared to upstream "background" conditions whenever the downstream concentrations were above the method reporting limit (RL of 1 mg/L). 63% of the sampling events (or 37 out of 59 events) reported downstream TSS concentrations that were more than 20% higher than upstream, background concentrations on the same day.

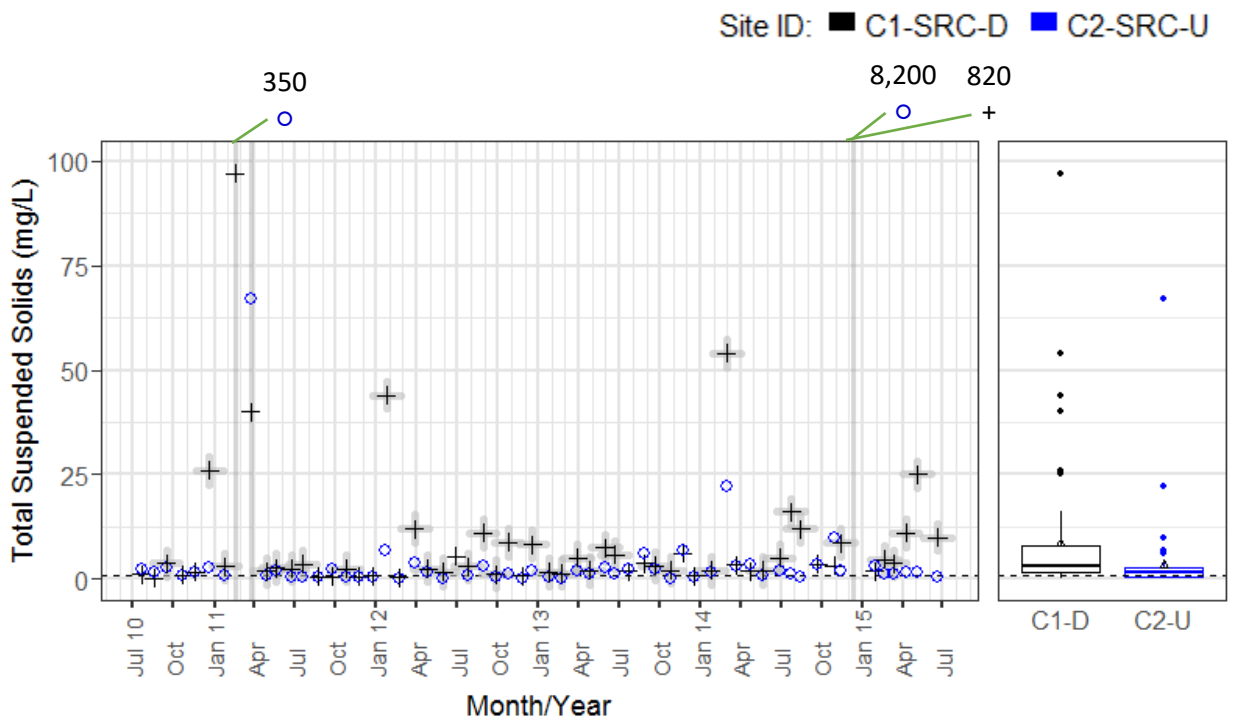


Figure 12. Monthly TSS results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites. The method reporting limit (RL) is 1 mg/L and is represented by the dashed black line. Three unusually high concentrations (two at the C2-SRC-U site and one at C1-SRC-D) were not plotted but their concentrations are shown at the appropriate date above the chart. Downstream concentrations that were more than 20% higher than upstream concentrations are highlighted in grey.

BACTERIA

Monthly receiving water results for bacteria (E. coli, Enterococcus, and Fecal Coliform, 2010-2015) ranged widely at both sites (from single digits to greater than the method maximum: >2400 for E. coli and Enterococcus[9], and >1600 for Fecal Coliform (Figures 13-15).

The narrative North Coast Basin Plan objectives state that bacteria in receiving waters shall not be degraded beyond natural background levels, and that fecal coliform concentrations for waters designated for contact recreation (REC-1) shall not exceed 400/100 ml in 10% of samples over a 30-day period. For waters designated for shellfish harvesting (SHELL), fecal coliform concentrations in waters shall not exceed 49/100 ml.

Bacteria concentrations were highly variable at both monitoring sites, and downstream concentrations were generally higher than upstream concentrations. In general, the highest concentrations were observed between October and April of most years.

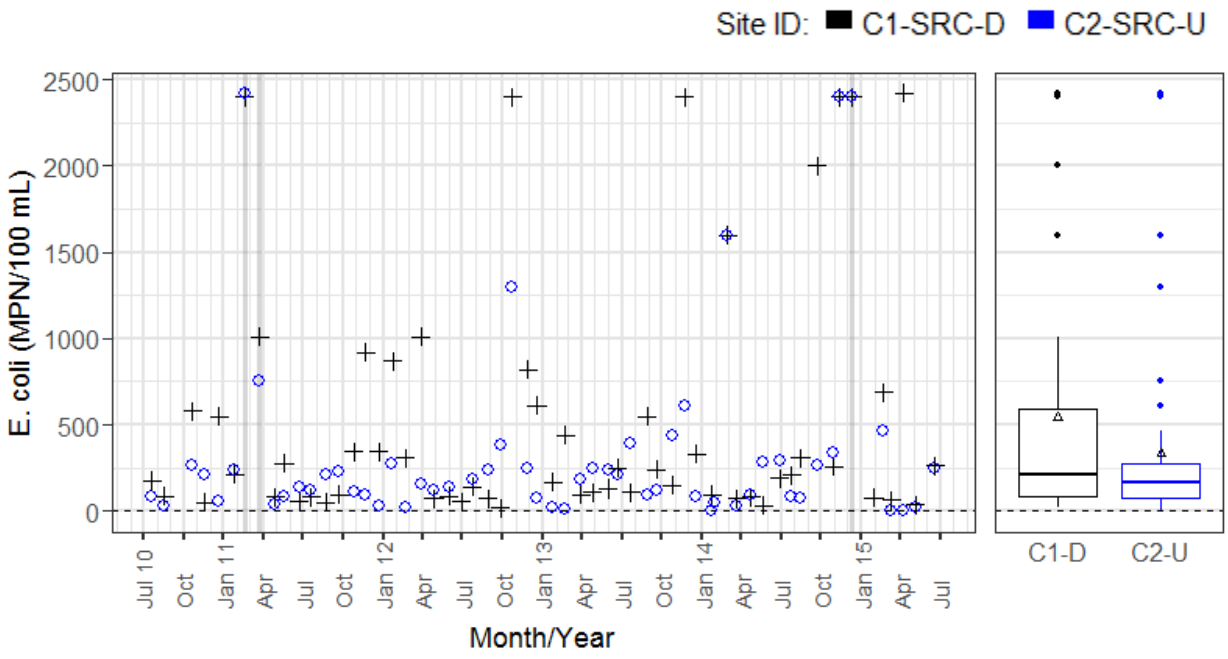


Figure 13. Monthly E. coli results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites.

[9] The maximum reported values for Enterococcus changed during the monitoring period: from > 1600 in 2/2014 to >2400 in 11/2014.

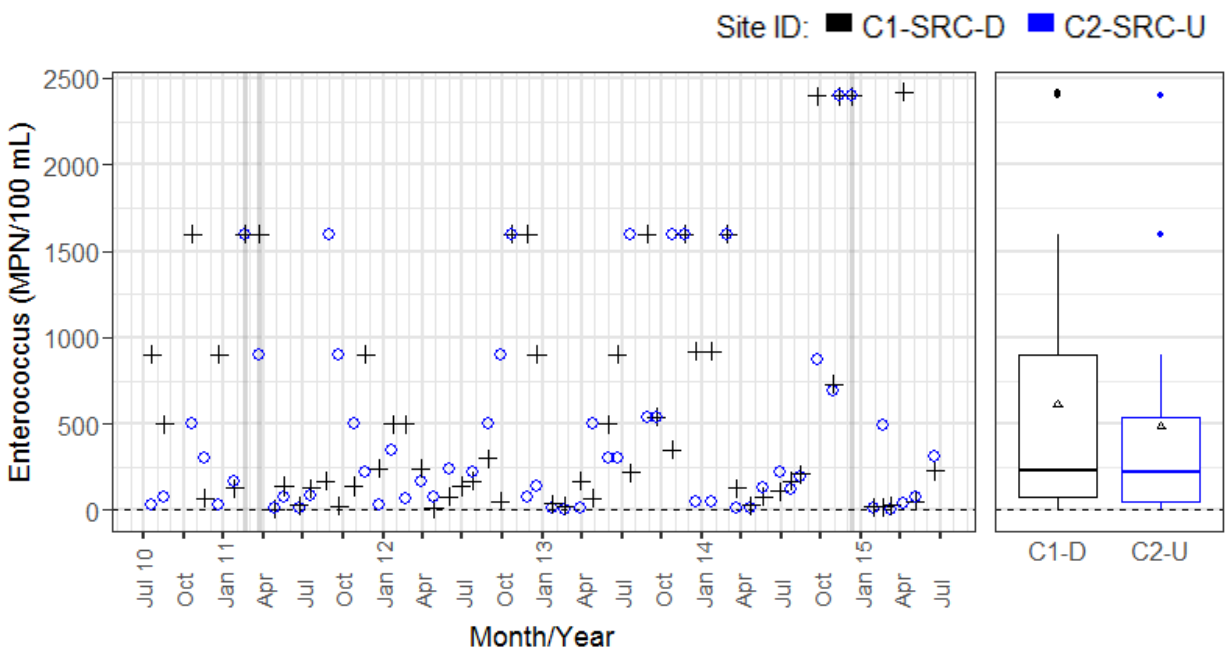


Figure 14. Monthly Enterococcus results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites.

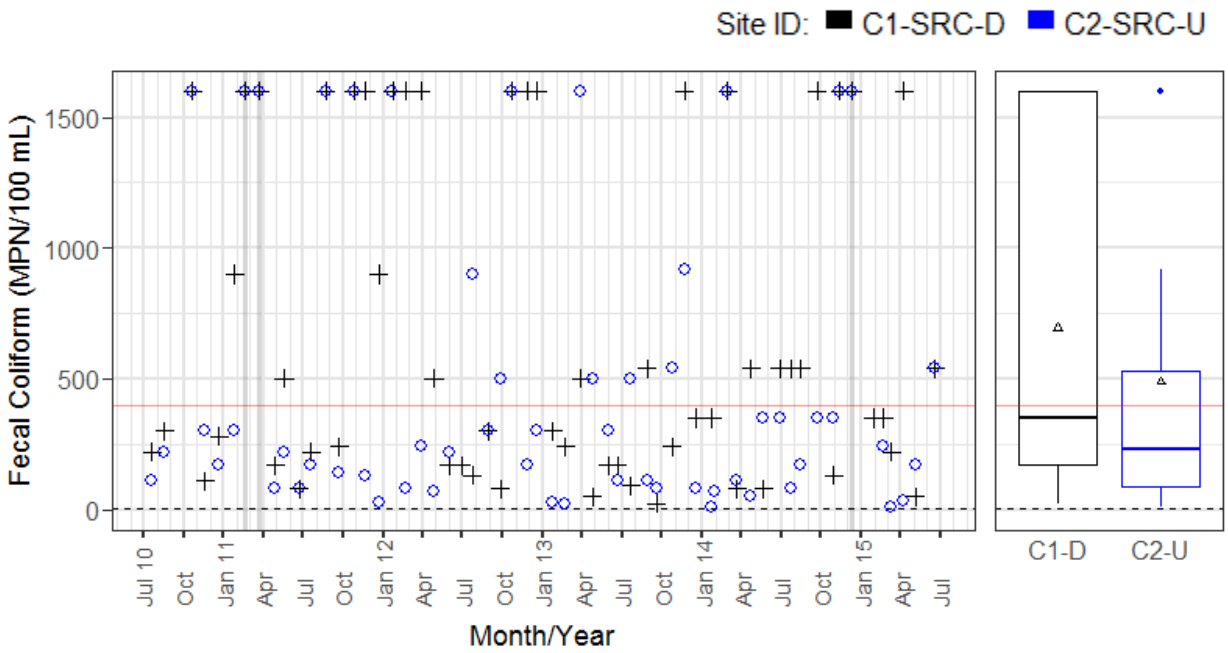


Figure 15. Monthly Fecal Coliform results ploted over time for the downstream (C1-SRC-D, plus-sign) and upstream (C2-SRC-U, open circles) MS4 2009 Permit receiving water sites.

Downstream Fecal Coliform concentrations exceeded the WQO of 400 MPN/L in about half the samples while upstream concentrations exceeded the WQO in less than a quarter of the samples. When upstream concentrations exceeded the WQO so did downstream concentrations. Most results at both sites were well above 49 MPN/100 ml guideline for waters designated for shellfish harvesting.

Summary

Results of the SCWA's 2009 MS4 Permit's receiving water monitoring were plotted and summarized in this memo. Whole water samples were collected monthly at two stormwater sites in Santa Rosa Creek (downstream and upstream of the City of Santa Rosa) between July 2010 and June 2015 (60 sampling events in total). Samples were analyzed for fourteen environmental parameters and toxicity. However, toxicity results were not reported in this memo because those data were not electronically available. Results from the upstream monitoring site were considered the 'background' condition for comparing downstream results to narrative water quality objectives (WQOs) provided by the North Coast Regional Water Quality Control Board. Table 6 compares monitoring results at the two sites.

Temperature and Dissolved Oxygen (measured in the field) generally did not meet the WQOs. 33% of the downstream temperature results exceeded the narrative objective. 40% of the downstream Dissolved Oxygen results and 25% of the upstream results were below the numeric WQO minimum of 7.0 mg/L. None of the results at either site met the Basin Plan's percentile objectives for Dissolved Oxygen. Only 5% of pH field-measures did not meet the WQO.

Average downstream chemical concentrations were generally higher than average upstream concentrations for most parameters (Table 6). Ammonia as NH3 and Nitrate as N concentrations were below WQOs. Average BOD concentrations at both sites were similar to each other and most results were below detection. Nitrite as N was only measured for the first year and most of those results were non-detects.

Phosphorus as P concentrations at both sites were above the numeric endpoint of 0.02 mg/L most of the time (>80%). Total Suspended Solids concentrations were generally fairly low (below 25 mg/L) but, more than half (63%) of the downstream concentrations were >20% higher than upstream concentrations. There are no WQOs for BOD, Orthophosphate, or Total Nitrogen, Kjeldahl.

Bacteria concentrations were highly variable at both monitoring sites, but downstream concentrations were generally higher than upstream concentrations. In general, the highest concentrations were observed between October and April of most years. Downstream Fecal Coliform concentrations exceeded the WQO of 400 MPN/L in about half the samples, while upstream concentrations exceeded the WQO in less than a quarter of the samples.

Table 6. Summary of receiving water monitoring results from SCWA's 2009 MS4 Permit (2010-2015).

Parameter (Unit)	Field Result Range*	Method Detection Limit (MDL)	Average of all Downstream Results C1-SRC-D	Average of all Upstream Results C2-SRC-U	Difference Between Average of all Down & Upstream Results
pH (none)	6.2 - 8.99	.	7.5	7.8	-0.3
Temperature (Deg. C)	4.5 - 22.5	.	14	12	2
Dissolved Oxygen (mg/L)	3.8 - 15.9	.	7.9	9.0	-1.1
Ammonia as NH3, Total (mg/L)	ND - 0.51	0.1 - 0.2	0.12	0.11	0.01
BOD (mg/L)	ND - 16	1 - 2	1.51	1.52	-0.01
Nitrate as N, Total (mg/L)	ND - 2.5	0.03 - 0.2	0.28	0.16	0.12
Nitrite as N, Total (mg/L)	ND - 0.01	0.002 - 0.02	0.01	0.01	0.00
Orthophosphate as P, Total (mg/L)	ND - 0.57	0.02	0.22	0.14	0.08
Phosphorus as P (mg/L)	ND - 4.2	0.02	0.09	0.06**	0.03
Total Nitrogen, Kjeldahl (mg/L)	ND - 34	0.1 - 0.2	0.5	0.3**	0.2
Total Suspended Solids (mg/L)	ND - 8200	0.3 - 1	8**	3**	5
E. coli (MPN/100 mL)	3 - 2420	1	542	342	200
Enterococcus (MPN/100 mL)	2 - 2419.6	1	611	484	127
Fecal Coliform (MPN/100 mL)	7.8 - 1600	1.8 - 2	696	497	199

* Non-detect results (ND) were analyzed using 1/2 the MDL or (if the MDL was not reported) 1/2 the RL.
** not including the highest outliers

As a general comparison, and to evaluate if the North Coast's Surface Water Ambient Monitoring Program (SWAMP) or other publically available water quality monitoring data could be used to compare MS4 Permitte results to ambient 'background' water quality sites in Santa Rosa Creek, data were downloaded from the California Environemental Data Exchange Network (CEDEN) and summarized. Monitoring locations were mapped, and conventional water quality monitoring results were summarized annually along with the SCWA's 2009 MS4 Permit results in Appendix A. Data included SWAMP and the North Coast Regional Board's TMDL survey sampled between 2004 and 2012 (not all the MS4 Permit parameters were analysed or they were analysed for the dissolved water fraction). Results from these other monitoring efforts were generally within the same range as the SCWA's 2009 MS4 Permit results with the exception of bacteria. The TMDL survey reported unusually high bacteria concentrations in 2012 with Fecal Coliform concentrations as high as 24,000 MPN/100 ml while the SCWA's analytical methods precluded quantifying concentrations beyond 1,600 MPN/100 ml. Comparison of publically available SWAMP and TMDL water quality monitoring data in Santa Rosa Creek showed that there is inadequate public reporting of ambient water quality monitoring data in Santa Rosa Creek to support comparison of MS4 Permittee data to 'background' concentrations.

Appendix A. Annual Comparisons of Water Quality Sites in Santa Rosa Creek

North Coast Regional Water Board's SWAMP and Nutrient and Pathogen TMDL Water Quality Monitoring efforts, in Santa Rosa Creek, are compared to the SCWA's Russian River 2009 MS4 Permit Receiving Water Monitoring effort.

Description of Other Monitoring Programs and Sites

The following plots visually summarize water quality monitoring data from Santa Rosa Creek for the same parameters as reported by the SCWA's 2009 MS4 Permit. The purpose of compiling and plotting this information was to:

1) evaluate if other monitoring programs (and surveys) that uploaded data to CEDEN are reporting the same matrix, fraction, and parameters as the 2009 MS4 Permit's receiving water monitoring requirements,
2) evaluate if SWAMP or other monitoring programs are monitoring regularly enough to provide data that could be used to further characterize 'background' water quality conditions in Santa Rosa Creek, and
3) generally compare water quality results across programs for sites within Santa Rosa Creek.

Data were downloaded from the California Environmental Data Exchange Network (CEDEN, accessed in May 2017) from the following programs:

- SCWA's 2009 MS4 Permit monthly receiving water monitoring (2010-2015).
- North Coast Water Board's Surface Water Ambient Monitoring Program (SWAMP, 2004 - 2011), and
- North Coast Water Board's Nutrient and Pathogen TMDL development surveys (TMDL, 2008 & 2011/2012 respectively).

Figure A1 is a map of the monitoring sites that are located in Santa Rosa Creek for each program and Table A1 briefly describes each site and its coordinates. The list is arranged based on the relative location of each site along the creek, from downstream to upstream (west to east), to match the map.

Some SWAMP and TMDL conventional water quality parameters were only reported for the dissolved water fraction and therefore could not be compared to the SCWA's 2009 MS4 Permit monitoring results, which reported whole water sample concentrations (total fraction). Other target parameters were not measured.

There were nine SWAMP monitoring sites in Santa Rosa Creek (sampled between 2004 and 2011) near or between the SCWA's two receiving water sites. Sampling frequencies varied by site because SWAMP has deployed several different survey designs for different project goals across 12 watersheds in the North Coast. For example, SWAMP sites in Santa Rosa Creek include one fixed long-term status and trends monitoring site and several rotating intensification of monitoring sites. Sampling frequencies have varied over time. SWAMP's monitoring efforts in Santa Rosa Creek only overlapped with the 2009 MS4 Permit between July, 2010 and October, 2011.

The TMDL Nutrient survey sampled weekly at three sites in Santa Rosa Creek in 2008, one of which was at SWAMP's long-term Status and Trends monitoring site. The TMDL Pathogen survey sampled weekly at two sites in Santa Rosa Creek between May, 2011 and February, 2012 (both sites were also sampled by SWAMP in 2011).

Figure A1. Map of the water quality monitoring sites in Santa Rosa Creek located in and around the City of Santa Rosa. Table A1 provides short descriptions of the sites and location coordinates for each station.

Site Code	Program
114SR0761	SWAMP & TMDL
C1-SRC-D	2009 MS4 Permit
114SR1770	TMDL
114SR2971	SWAMP
114CE0695	SWAMP
114SR3121	SWAMP
114SR3184	SWAMP
114SR3260	SWAMP & TMDL
114SR3320	SWAMP
114SR3438	SWAMP
114SR4686	TMDL
C2-SRC-U	2009 MS4 Permit
114SR6158	SWAMP & TMDL

Table A1. Water quality monitoring sites in Santa Rosa Creek located in and around the City of Santa Rosa. The sites are ordered to reflect the relative position of each site downstream to upstream (from west to east). Datum = NAD83.

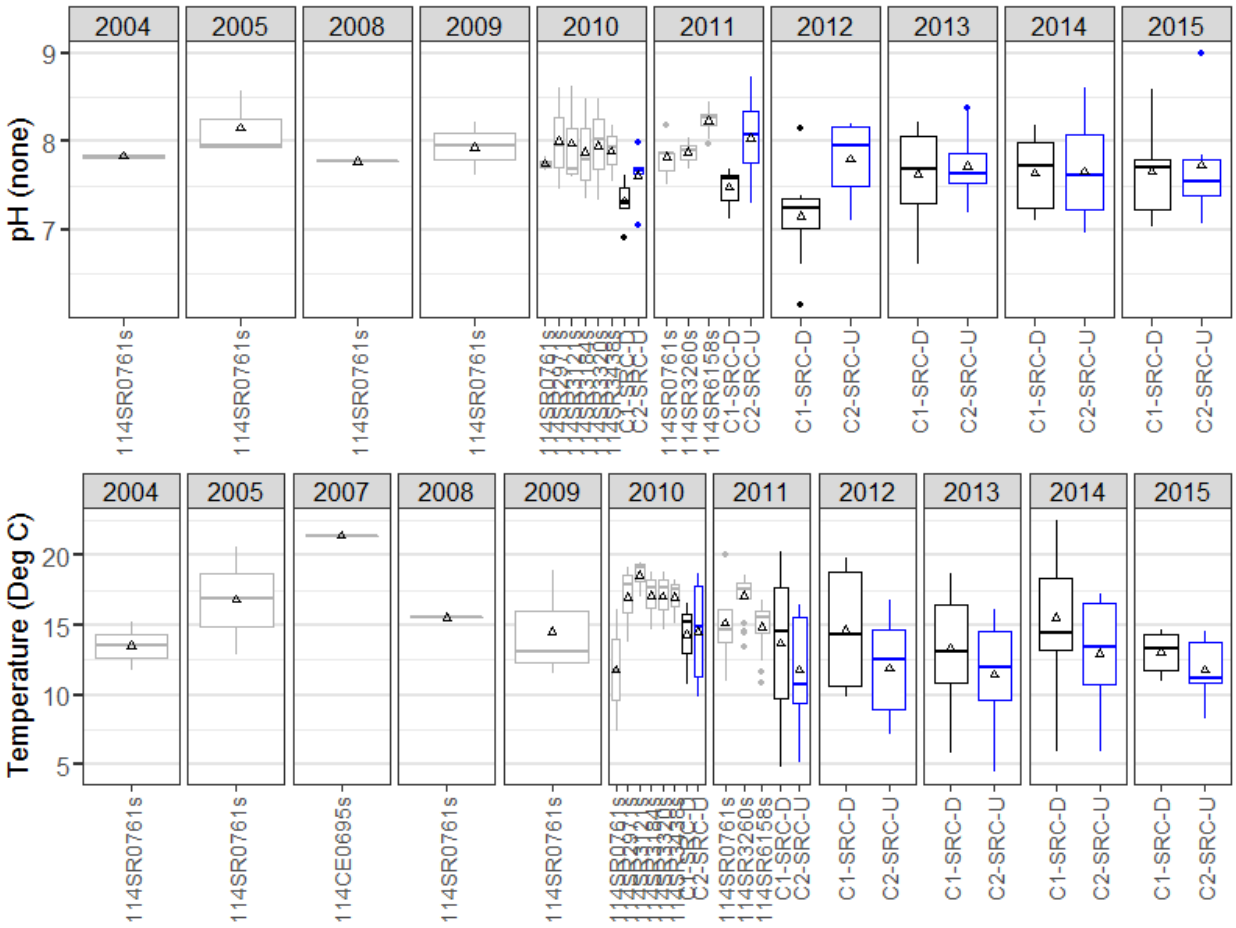
Program	Site Code	Description	Latitude	Longitude
SWAMP & TMDL	114SR0761	SWAMP and Nutrient TMDL site located low in the watershed, downstream of the City of Santa Rosa and near the Laguna de Santa Rosa. This is one of SWAMP's Long-term Status and Trend monitoring sites - sampled in 2004-2005, 2008-2011. Nutrient TMDL site - sampled weekly June-September 2008.	38.4452	-122.8068
2009 MS4 Permit	C1-SRC-D	SCWA monthly receiving water site located at the confluence of Piner and Santa Rosa Creeks. This site is just downstream of the urban footprint of the City of Santa Rosa. Sampled 7-2010 through 6-2015. This location is also a City of Santa Rosa 2009 MS4 Permit bioassay monitoring site.	38.4452	-122.7760
TMDL	114SR1770	Nutrient TMDL site located in the City of Santa Rosa at the Fulton Road overpass - sampled weekly June-September 2008.	38.4418	-122.7696
SWAMP	114SR2971	SWAMP rotating intensification monitoring site in the City of Santa Rosa's urban footprint. Sampled 3 times in 2010. This location is also a dry weather receiving water monitoring site for the City of Santa Rosa's 2009 MS4 Permit.	38.4364	-122.7288
SWAMP	114CE0695	SWAMP monitoring site across the creek from 114SR2971 and sampled once in July 2007.	38.4361	-122.7289
SWAMP	114SR3121	SWAMP rotating intensification monitoring site in the City of Santa Rosa's urban footprint. Sampled 3 times in 2010.	38.4363	-122.7233
SWAMP	114SR3184	SWAMP rotating intensification monitoring site in the City of Santa Rosa's urban footprint. Sampled 3 times in 2010.	38.4350	-122.7217
SWAMP & TMDL	114SR3260	SWAMP & Pathogen TMDL site in the City of Santa Rosa just downstream of Hwy 101 overpass. SWAMP sampled in 2011. Pathogen TMDL sampled weekly (May 2011 - February 2012)	38.4350	-122.7187
SWAMP	114SR3320	SWAMP rotating intensification monitoring site in the City of Santa Rosa's urban footprint. Sampled 3 times in 2010.	38.4361	-122.7172
SWAMP	114SR3438	SWAMP rotating intensification monitoring site in the City of Santa Rosa's urban footprint. Sampled 3 times in 2010.	38.4371	-122.7129
TMDL	114SR4686	Nutrient TMDL site located in Santa Rosa Creek upstream of Rincon Creek tributary in a suburban neighborhood within the City of Santa Rosa - sampled weekly June-September 2008.	38.4531	-122.6771
2009 MS4 Permit	C2-SRC-U	SCWA monthly receiving water site located upstream of the urban footprint of the City of Santa Rosa near Hwy 12 overpass. Sampled 7-2010 through 6-2015. This site is considered the 'background' monitoring station for the SCWA's downstream site (C1-SRC-D).	38.4565	-122.6365
SWAMP & TMDL	114SR6158	SWAMP & Pathogen TMDL upstream site above the City of Santa Rosa near Highway 12 overpass. This site is also a City of Santa Rosa 2009 MS4 Permit bioassay monitoring site. SWAMP sampled in 2011. Pathogen TMDL sampled weekly (May 2011 - February 2012).	38.4570	-122.6309

Annual Summary Plots Comparing Results from SWAMP, TMDL, and MS4

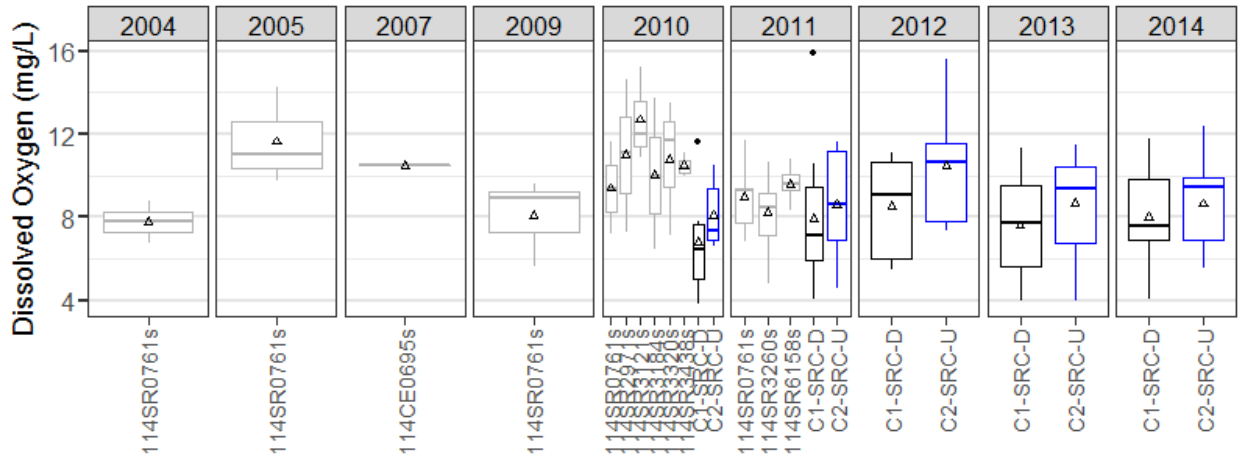
Summary boxplots of whole water monitoring results for the SCWA's 2009 MS4 Permit's receiving water targeted parameters are presented below. The boxplots represent annual summary statisitcs[10] for SCWA's 2009 MS4 Permit monthly receiving monitoring sites (C1-SRC-D (in black) and C2-SRC-U (in blue)), SWAMP monitoring sites, and TMDL survey sites (in grey). An 's' or a 't' after a site code indicates that the results are from the SWAMP or TMDL program, respectively.

Each plot includes different numbers of sites, time periods, and sampling frequencies based on the data that was publically available from CEDEN in May-2017.

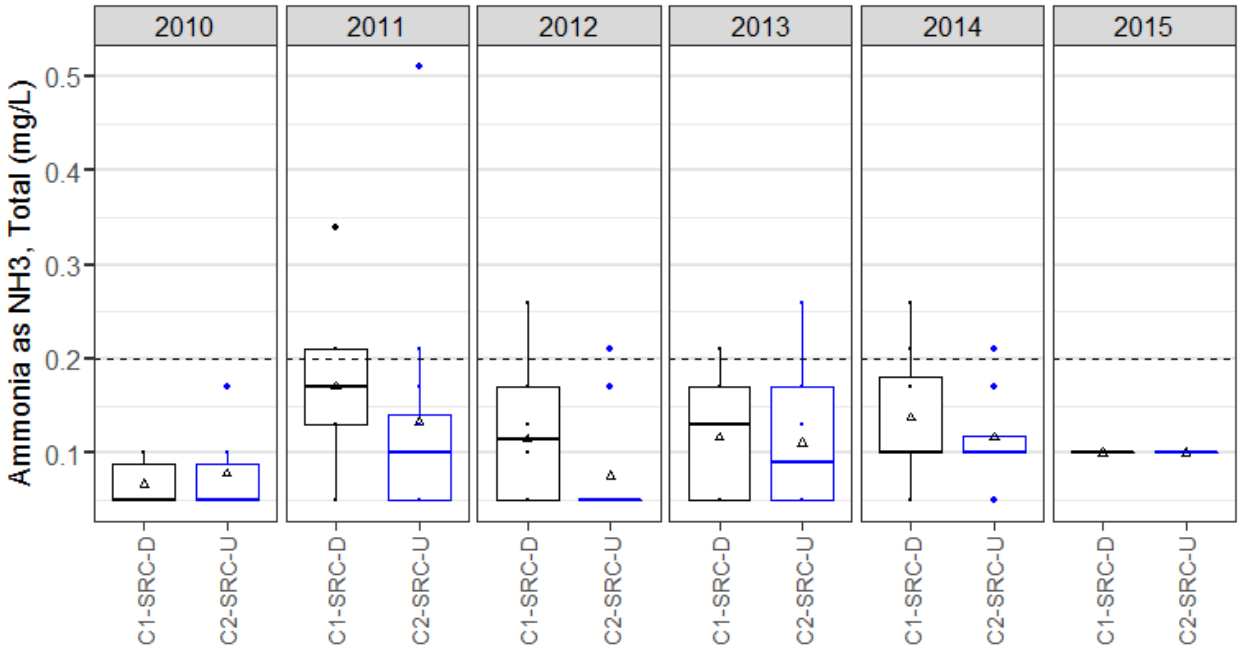
FIELD MEASURES

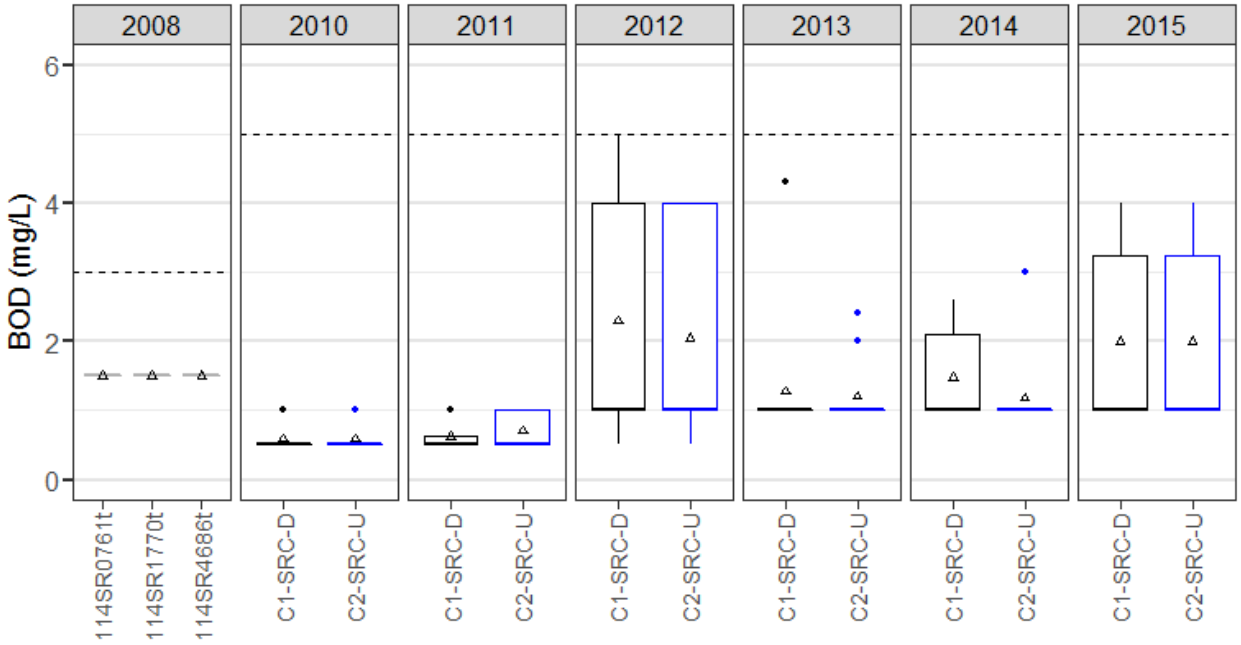


[10] See the Methods section for a description of the summary statistics displayed (page 6).

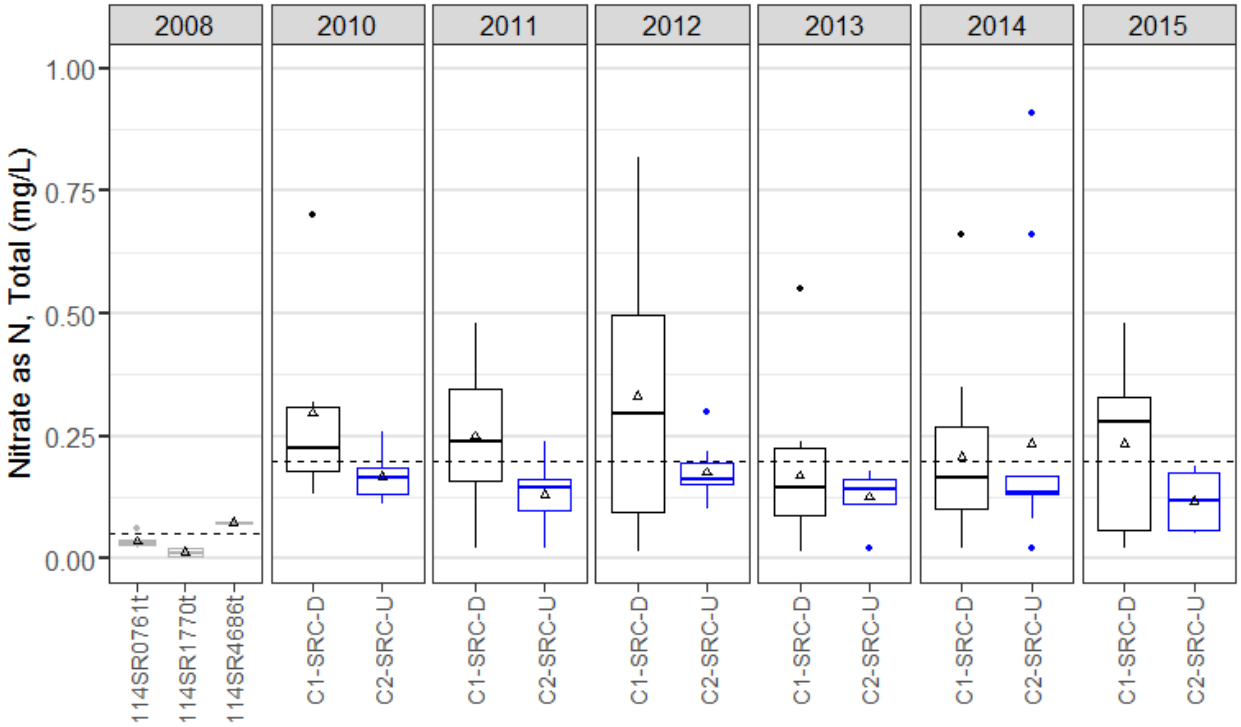

2004
2005
2007
2009
2010
2011
2012
2013
2014
Dissolved Oxygen (mg/L)
16
12
8
4
114SR0761s
114SR0761s
114CE0695s
114SR0761s
C2-SRC-U
114SR0761s
114SR3260s
114SR6158s
C1-SRC-D
C2-SRC-U
C1-SRC-D
C2-SRC-U
C1-SRC-D
C2-SRC-U
C1-SRC-D
C2-SRC-U

CHEMISTRY

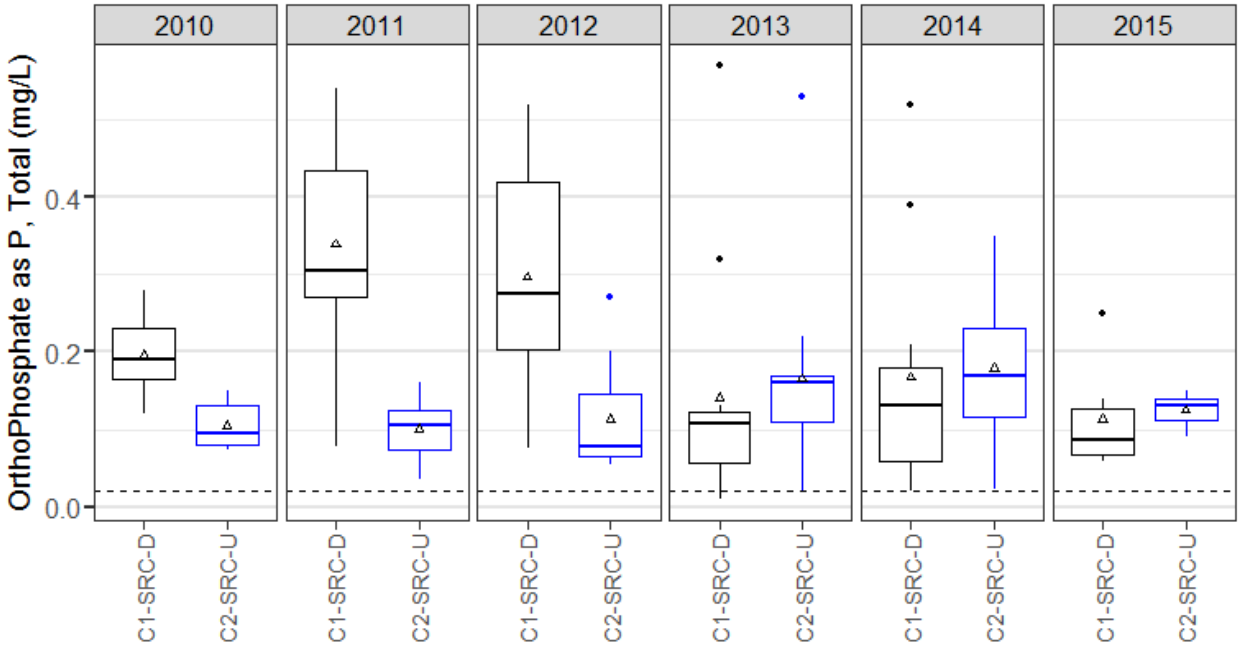

2010
2011
2012
2013
2014
2015
Ammonia as NH3, Total (mg/L)
0.5
0.4
0.3
0.2
0.1
C1-SRC-D
C2-SRC-U

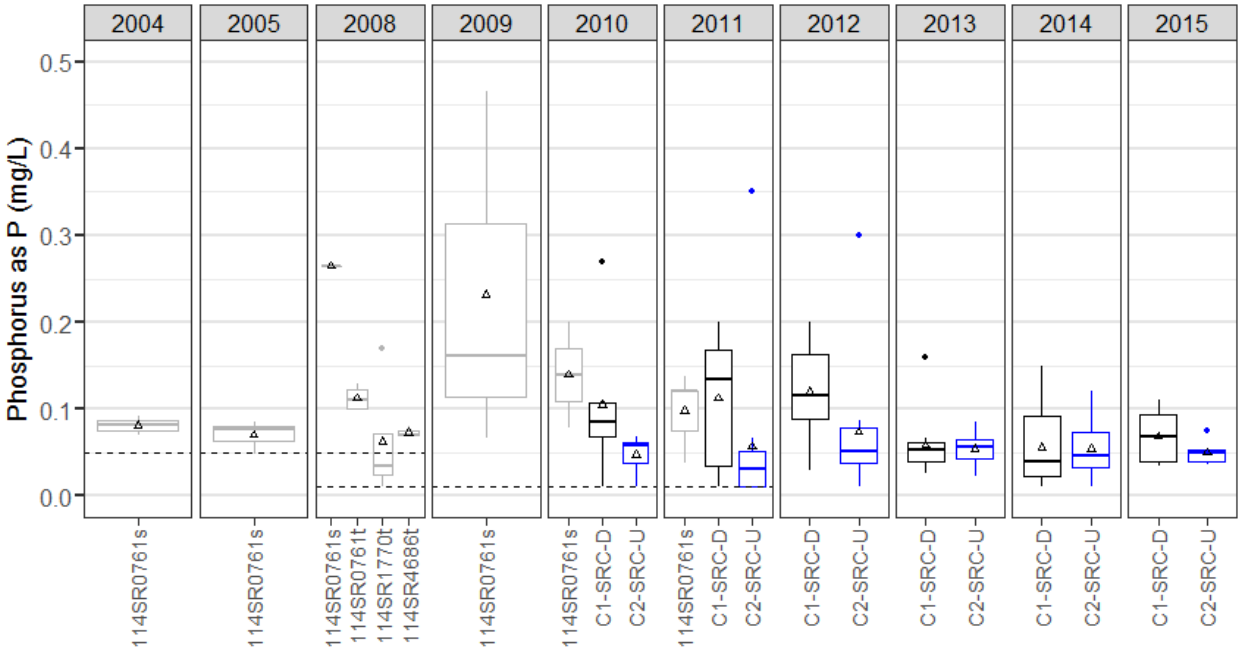


BOD: Two unusually high outliers in 2014 not shown (C1-SRC-D = 8.8mg/L and C2-SRC-U = 16 mg/L)

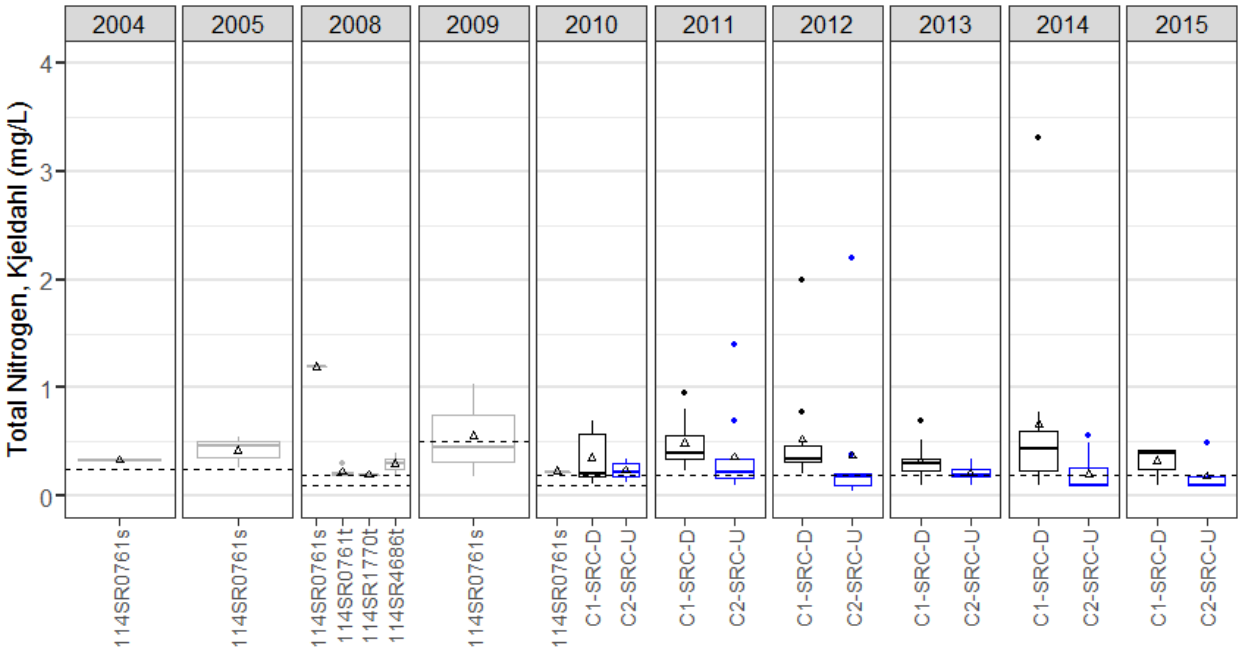


Nitrate: One unusually high outlier in 2015 not shown (C1-SRC-D = 2.5 mg/L)

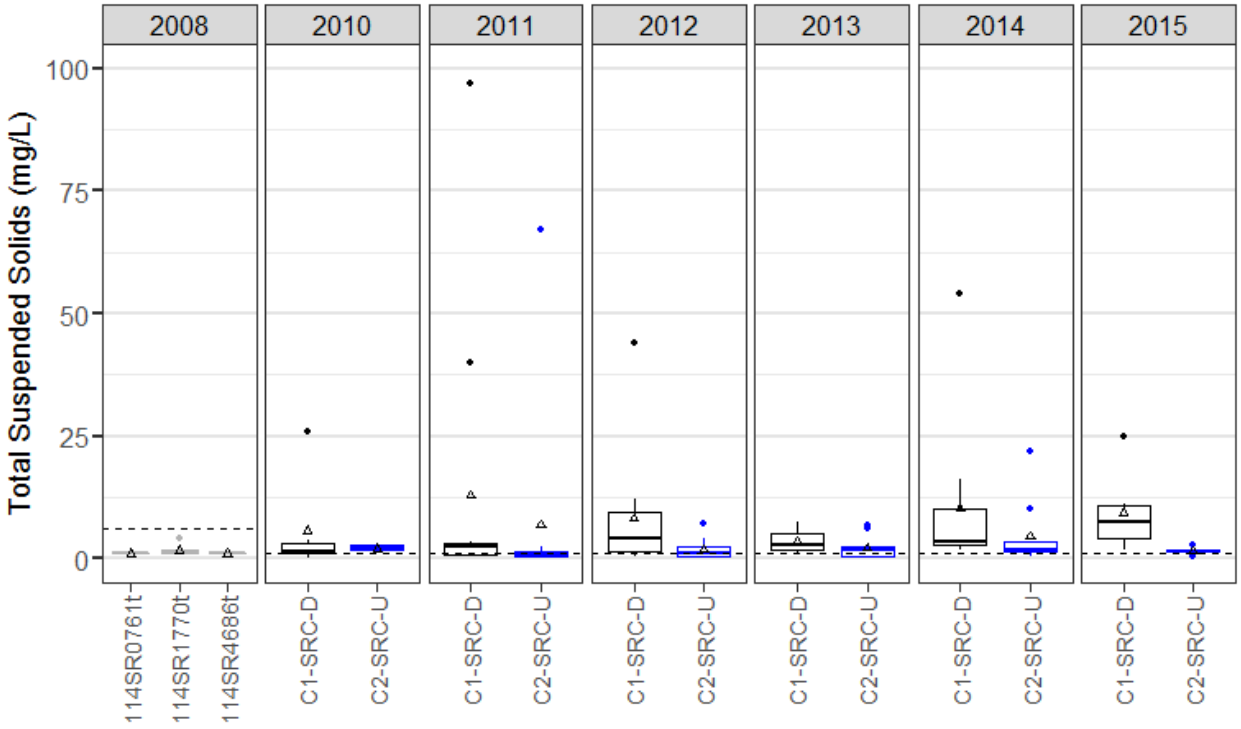




Phosphorus: One unusually high outlier in 2014 not shown (C2-SRC-U = 4.2 mg/L)

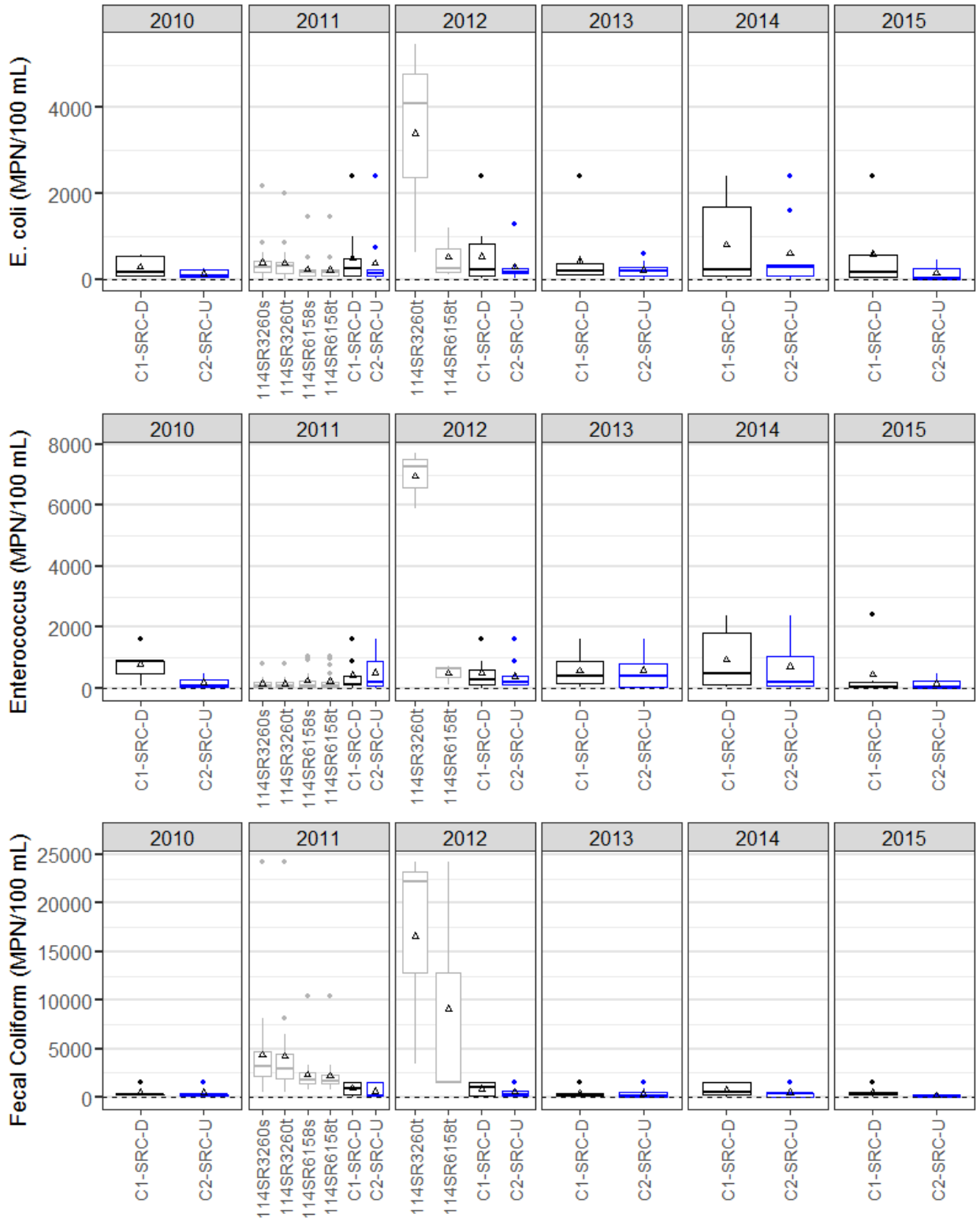


TKN: Two unusually high outliers not shown (C2-SRC-U = 34 and 18 mg/L in 2012 and 2014 respectively)



TSS: Three unusually high outliers not shown (C2-SRC-U = 350 and 8,200 mg/L in 2011 and 2014 respectively, and C1-SRC-D = 820 mg/L in 2014)

BACTERIA


2010
2011
2012
2013
2014
2015
E. coli (MPN/100 mL)
Enterococcus (MPN/100 mL)
Fecal Coliform (MPN/100 mL)
C1-SRC-D
C2-SRC-U
114SR3260s
114SR3260t
114SR6158s
114SR6158t