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RUSSIAN RIVER WATERSHED ASSOCIATION

NPDES MS4 Permit Monitoring and Reporting Program Watershed Data Evaluation

Prepared for

CITIES OF SANTA ROSA, WINDSOR, COTATI, ROHNERT PARK, SEBASTOPOL, UKIAH, CLOVERDALE, AND HEALDSBURG

SONOMA COUNTY AND SONOMA WATER.

Prepared by

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1 Introduction

The Co-Permittees in the California Regional Water Quality Control Board North Coast Region (Regional Water Board)'s National Pollutant Discharge Elimination System (NPDES) permit Order No. R1-2015-0030 include municipal separate storm sewer system (MS4) agencies located in Mendocino and Sonoma counties within the Russian River watershed. The MS4s located in the Laguna de Santa Rosa watershed include the Cities of Santa Rosa, Windsor, Cotati, Rohnert Park, and Sebastopol, Sonoma County, and Sonoma Water (collectively, Laguna Watershed MS4 agencies). The Laguna Watershed MS4 agencies were required to perform urban runoff and receiving water characterization monitoring during the most recent permit term (2015-2020). The Cities of Healdsburg, Cloverdale, and Ukiah are located in the upper Russian River watershed (collectively, Upper Watershed MS4 agencies) and performed a special study urban runoff evaluation during the most recent permit term.

The Co-Permittees requested that Larry Walker Associates (LWA) conduct this evaluation of monitoring data collected by the Co-Permittees during the most recent permit term through the Russian River Watershed Association (RRWA), but independent of regular RRWA activities and oversight.

1.1 OBJECTIVES

The Co-Permittees requested this external evaluation of historical monitoring data to inform and provide technical support to future monitoring decisions and any recommended changes to the current program and NPDES permit requirements. The assessment can be used as a technical basis for program modifications. The Co-Permittees requested that the evaluation consider or provide the following:

- A high-level data quality review for systematic issues rather than a detailed full assessment that has already been performed by the Co-Permittees.
- A watershed-wide interpretation to provide a more comprehensive interpretation of the integrated dataset (i.e., less evaluations of specific locations or MS4 specific factors and more assessments of land use, storm conditions, first flush vs. later season, etc.).
- The evaluation should address possible coordination with the Russian River Regional Monitoring Program (R3MP).
- Recommendations based on the benefit and purpose of toxicity or bioassessment data collection.
- Identify and focus the effort on the primary constituents of concern including pathogens (*E. coli*), sediment/solids, metals, and phosphorus. Pesticides are not known as an issue, but water quality objective applicability and analytical reporting limits should be evaluated.

1.2 APPROACH

The strategy to present watershed-scale data summaries and identify stormwater monitoring improvements is a stepwise process that should consider several key analyses. The steps include data review, data analysis, and development of recommendations. While some of the key evaluations were identified at the outset of the project, the approach was adaptively managed to better explore identified issues and consider Co-Permittee input throughout the process. The

strategy considers completeness, method representativeness, graphical data review for patterns, assessment of beneficial use protection through water quality objective comparisons, and more detailed statistical assessments.

2 Monitoring Data and Program Specifications Review

LWA performed an assessment of MS4 discharge and receiving water data obtained through water quality, bioassessment, and toxicity programs performed by the Co-Permittees agencies. The data was reviewed for completeness and identification of systematic bias related to documented sample collection or analysis practices.

2.1 DATA AND INFORMATION SOURCES

LWA reviewed the Co-Permittees work plans and reporting documents as shown in **Table 1**. Additionally, LWA compiled precipitation data from the Santa Rosa Airport gage[1] to represent upper and lower watershed conditions and identify storm events. The Santa Rosa Airport gage is located near the geographic center of the study area and is only used to estimate seasonal conditions across the region. If site specific details are evaluated in the future, additional gages should be referenced for higher resolution of spatial differences. LWA also reviewed the constituents of emerging concern (CEC) study performed in the Russian River for conclusions related to downstream conditions and urban runoff (SCCWRP, 2018).[2]

[1] https://cdec.water.ca.gov/webgis/?appid=cdecstation&sta=SNO

[2]Keith A. Maruya, Alvine C. Mehinto, Wenjian Lao, Southern California Coastal Water Research Project, Rebecca Sutton, Thomas Jabusch, Jennifer Sun, Diana Lin, Jay Davis, San Francisco Estuary Institute, and Rich Fadness, North Coast Regional Water Quality Control Board. Southern California Coastal Water Research Project (SCCWRP) *Pilot Monitoring of Constituents of Emerging Concern (CECs) in the Russian River Watershed (Region 1).* SWAMP-MR-RB1-2018-0002.

Table 1. Co-Permittees Reports and Data Sources Reviewed

Document Type	File or Report Name
Work Plan	Laguna de Santa Rosa Watershed Municipal Storm Water NPDES Permit Monitoring and Reporting Program Work Plan (August 2017) [referred to in this document as the Laguna Watershed Work Plan]
Work Plan	Discharge Characterization Special Study Work Order No. R1-2015-0030 MS4 MRP (October 2017) [referred to in this document as the Upper Watershed Work Plan]
Monitoring Results	Master Table B.2.a Cotati
Monitoring Results	Master Table B.2.b Rohnert Park
Monitoring Results	Master Table B.2.c Santa Rosa
Monitoring Results	Master Table B.2.e Sonoma County
Monitoring Results	Master Table B.2.f Windsor
Monitoring Results	Master Table B.2.g Sebastopol
Monitoring Results	Master Table B.5 Toxicity
Monitoring Results	Santa Rosa Sample Tables 03-09-21
Monitoring Results	Sonoma County Historical Outfall Sampling Data
Monitoring Results	MS4 MRP Laguna Watershed October 2018 through March 2019 Semi Annual Monitoring Report (includes toxicity reports)
Monitoring Reports	MS4 MRP Laguna Watershed October 2019 through March 2020 Semi Annual Monitoring Report (includes toxicity reports)
Monitoring Reports	MS4 MRP Laguna Watershed April 2020 through September 2020 Semi Annual Monitoring Report (includes toxicity reports)
Monitoring Reports	MS4 MRP Laguna Watershed October 2021 through March 2021 Semi Annual Monitoring Report (Draft) (includes toxicity reports)
Monitoring Reports	Upper Russian River Discharge Characterization Special Study
Monitoring Reports	Sonoma County Phase I MS4 2018 Bioassessment Monitoring Study
Precipitation Gauge	California Department of Forestry and Fire Protection - Station STA (Santa Rosa CDF)
Precipitation Gauge	National Weather Service - Station SNO (Sonoma County Airport)
Regional Study Reports	Pilot Monitoring of Constituents of Emerging Concern (CECs) in the Russian River Watershed (Region 1). SWAMP-MR-RB1-2018-0002

2.2 SUMMARY OF SITES AND SAMPLING EVENTS EVALUATED

LWA compiled water quality data provided by the Co-Permittees into a flat file format for the site locations detailed in **Table 2** and events summarized in **Appendix A**. Sample collection was completed according to the sampling schedule for wet and dry weather events as summarized in **Table 3**.

Table 2. Monitoring Locations, Site Identification, and Land Use Description

Agency	Site ID	Outfall (Dry/Wet)	Receiving Water	Reported Land Use
Cotati	CO01	Yes/Yes	Yes	Commercial Retail, Residential
Rohnert Park	RP01	Yes/Yes	Yes	Golf Course, Residential
Santa Rosa	SR01	No/Yes	Yes	Downtown
	SR02	No/Yes	Yes	Residential
	SR03	Yes/No	No	Residential, Commercial
	SR04	Yes/No	No	Residential, Commercial
	SR05	No/No	[2]	Residential
Sebastopol	SE01	Yes/Yes	Yes	Mixed Use, Residential, Parks, Commercial
Sonoma County	SC01	Yes/Yes	Yes	Commercial, Industrial, Undeveloped
	SC02	No/Yes	Yes	Agricultural, Rural, Residential, Roadway
	SC03	No/Yes	Yes	Rural Residential, Limited Commercial
	SC04	No/No	[3]	County Park
	SC05	No/No	[3]	Nursery/Landscape Material Retail Center
Windsor	WI01	No/Yes	Yes	Commercial
	WI02	Yes/No	[1]	Residential
Cloverdale	CL01	No/Yes	No	Residential, Open Space
Healdsburg	HE01	No/Yes	No	Residential, Open
Ukiah	UK	No/Yes	No	Commercial, Residential

Notes:
[1] Special study upstream and downstream samples were collected for select constituents.
[2] Receiving water site is monitored only as a chronic toxicity monitoring location.
[3] Monitoring site is used only as a chronic toxicity monitoring location. Both sites are noted as being receiving water locations, but SC04 is a parking lot drain and SC05 is a roadside ditch.

Table 3. Number of Samples Analyzed in Urban Runoff and Receiving Water Monitoring

		Laguna de Santa Rosa Watershed				Upper Watershed
		Outfall		Receiving Water		Outfall
Constituent	**Units**	**Dry**	**Wet**	**Dry**	**Wet**	**Wet**
Ammonia	mg/L	43	80	3	62	3
Antimony	µg/L	0	4	0	0	0
Arsenic	µg/L	0	4	0	0	0
Beryllium	µg/L	0	4	0	0	0
Biochemical Oxygen Demand	mg/L	43	80	3	62	0
Cadmium	µg/L	0	4	0	0	0
Calcium	mg/L	0	17	0	12	3
Chromium	µg/L	0	4	0	0	0
Conductivity	µS/cm	0	3	0	0	3
Copper	µg/L	45	81	3	65	3
Copper, dissolved	µg/L	0	0	0	0	3
Dissolved Oxygen	mg/L	0	4	0	0	0
E. coli	MPN/100mL	13	38	1	22	3
Enterococci	MPN/100mL	17	39	1	24	3
Fecal Coliform	MPN/100mL	0	4	0	0	0
Flow	CFS	29	33	0	6	3
Hardness	mg/L	24	54	21	65	3
Lead	µg/L	45	81	3	65	3
Lead, dissolved	µg/L	0	0	0	0	3
Magnesium	mg/L	0	17	0	12	3
Mercury	µg/L	0	4	0	0	0
Nickel	µg/L	0	5	0	0	0
Nitrate + Nitrite as N	mg/L	0	0	0	0	3
Nitrate-N	mg/L	3	18	0	1	0
Nitrite	mg/L	0	17	0	0	0
ORP	mV	0	0	0	0	3
Orthophosphate	mg/L	0	3	0	0	0
pH	SU	42	67	3	38	3
Selenium	µg/L	0	5	0	0	0
Silver	µg/L	0	5	0	0	0
Temperature	°C	42	60	3	33	3
Thallium	µg/L	0	5	0	0	0
Total Coliform	MPN/100mL	0	1	0	0	3
Total Dissolved Solids	mg/L	0	0	0	0	3
Total Kjeldahl Nitrogen	mg/L	1	17	0	0	3
Total Nitrogen	mg/L	36	74	3	58	3
Total Phosphorus	mg/L	40	80	4	62	3
Total Suspended Solids	mg/L	43	79	3	61	3
Fathead minnow	% Survival	0	0	0	22	0
Fathead minnow	Biomass growth	0	0	0	22	0
Ceriodaphnia dubia	% Survival	0	0	0	40	0
Ceriodaphnia dubia	Reproduction	0	0	0	37	0
Selenastrum capricornutum	Cell Growth	0	0	0	19	0
Turbidity	NTU	0	0	0	0	3
Zinc	µg/L	45	81	3	65	3
Zinc, dissolved	µg/L	0	0	0	0	3

2.3 SUMMARY OF AVAILABLE PROTOCOL DOCUMENTS AND SPECIFICATIONS

LWA reviewed the **Table 1** documentation to evaluate overall consistency with the Laguna Watershed and Upper Watershed MS4 work plans and to identify future modifications to the sample collection or other protocols. **Table 4** summarizes the sampling strategy used as reported by the individual MS4 agencies. Overall sample collection was performed according to the relevant work plans or was not specifically documented. Sample analyses to be performed are evaluated later in this document following data review.

Table 4. Method of Sample Collection and Analysis by Co-Permittee Agency

Agency	Estimated Composite Interval	Composite Duration	Lab or Field Composited	Receiving Water Site Distance Downstream of Outfall (feet)	Primary Analytical Laboratory
Cotati	15-minute	3-hour	Field	984	Brelje and Race
Rohnert Park	Single Grab	NA	NA	50	Alpha Analytical
Santa Rosa	20-minute	3-hour	Lab	1,173-1,385	Santa Rosa
Sebastopol	Not reported	Not reported	Not reported	50	Not reported
Sonoma County	Not reported	Not reported	Not reported	18-42	Alpha Analytical
Windsor	20-minute	3-hour	Field	37	Alpha Analytical
Healdsburg	15-minute	6-hour	Field	NA	Alpha Analytical
Cloverdale	15-minute	3-hour	Field	NA	Alpha Analytical
Ukiah	15-minute	3-hour	Field	NA	Alpha Analytical

Some Co-Permittees initiated sample collection after 0.25 inches of rainfall were observed and some Co-Permittees initially collected samples at set intervals during the first three hours of the storm event. The latter Co-Permittees then switched during more recent events to initiating sample collection after 0.25 inches of rainfall. Without additional information for watershed and hydrograph specifics, there is no evidence to suggest that this variance would significantly bias the sample results for the purpose of this assessment. The intent of a trigger and characterization period (3 hours) would be to characterize the first part of the storm hydrograph. For smaller events, the 0.25 inch rainfall-based trigger would tend to characterize a later period in the hydrograph relative to the peak. Although the different protocols introduce inter-site variability that should be eliminated if feasible, other sources of individual drainage hydrology variability may be more significant. While sample collection based on hydrograph conditions ensures more comparability, it can be logistically infeasible given unpredictable rainfall patterns.

2.4 DATA QUALITY REVIEW

With the exception of a fraction of aquatic toxicity sample endpoints where test interferences were observed, the data reviewed are of high enough quality to use for characterization of urban runoff and receiving waters in this assessment. While a detailed data quality assessment was not performed, data was reviewed for systematic issues such as misreporting, blank contamination, and out-of-range values. There were no significant issues identified with data quality or collection practices. Some minor data transcription errors were corrected in compilation of the

dataset used for this analysis. Aside from the data transcription errors, other more extreme data points are present in the dataset but are within reasonable ranges for urban runoff variability. Without additional information to confirm that the data point is not representative or is in error, the "outlier" should be included in this assessment. If urban runoff management decisions depend on any single extreme data points, the data points should be thoroughly reviewed. Generally, greater variability increases uncertainty in confidence and prediction intervals. Recommendations for future data review and compilation can be developed separately to streamline data review and compilation, but current practices are acceptable and are consistent with the NPDES permit and work plans.

2.4.1 Aquatic Toxicity Data Review

Four of the Co-Permittees performed extensive toxicity testing in the receiving waters downstream from stormwater outfalls (see **Table 2** site list). The Laguna Watershed MS4 Work Plan specifies the toxicity testing objective is to "Determine if storm water and non-storm water flows from the MS4 are causing or contributing to chronic toxicity in receiving water within the Laguna de Santa Rosa Watershed." Toxicity testing measures effect endpoints such as mortality, growth, and reproductive rates.

2.4.1.1 Testing Procedure Failures

Testing procedure failures are abnormalities with sampling or testing procedures resulting in unusable data (i.e., rejected data). Failures of tested samples ("endpoint failures") are negative evaluation outcomes for the test sample endpoint in consideration to control sample endpoints. Because toxicity testing are biological measurement tools, endpoint assessments are subject to variability due to a change of sample conditions (e.g., interfering constituents, presence of pathogens, degradation of toxicants over test period, etc.), laboratory conditions (e.g., test renewal water, cleaning protocols, test species conditions, out-of-range test conditions, etc.), and method protocols (ranges in allowable test conditions, lack of specification of feeding conditions, etc.). In can be difficult to quantify the impact of variability on endpoint assessments without adequate quality control samples (e.g., inter-lab duplicates, contaminant treatments, follow-up microscopy, etc.).

The original toxicity laboratory noted for multiple samples for multiple events that pathogenic material introduced from the water sample, or the test species interfered with the test endpoint (mortality) outcomes. This observed test interference is referred to as pathogen related mortality (PRM) where the introduced pathogen "infects" the test chamber and can readily spread between test animals in the constrained volume. With the mortality PRM failures, the laboratory still reported subsequent endpoint results (i.e., growth), however, the assessment of these later endpoints is directly biased by test animal mortality. The results affected by PRM should not be considered for characterization purposes. **Table 5** summarizes the test procedure failures and a recalculation of the overall endpoint success rates (positive test animal outcomes).

A second laboratory was contracted and observed the same PRM issues with some samples. To mitigate the pathogen interference, the second laboratory treated the sample with antibiotics and PRM was not observed. Alternate testing methods that separate test animals into separate containers has also been used as an effective means of mitigating PRM in other programs.

2.4.1.2 Receiving Water Characterization

The Sonoma County sampling locations SC04 and SC05 are described in the Laguna Watershed MS4 Work Plan and data reports as representative of urban runoff, not receiving waters (page 24, Table 10). SC04 is described as a "storm drain to unnamed drainage ditch". SC05 is described as a "roadside ditch to Mark West Creek". Without associated receiving water sites, the urban runoff site locations appear to be inconsistent with the study objective of characterizing the impact from urban runoff on receiving waters. While toxicity testing characterizing urban runoff can be helpful in identifying causes of downstream impacts in the receiving water, no downstream impacts have been identified in the downstream receiving water. Moreover, toxicity conditions in downstream receiving waters can be mitigated by a number of factors including diluting upstream flows, organic carbon concentrations, toxicant degradation, etc. The downstream receiving water, Mark West Creek, was identified as the least unaltered condition of the creeks that were evaluated for bioassessment conditions. The toxicity testing for SC04 and SC05 is valid but is not representative of receiving water conditions.

Table 5. Toxicity Samples Collected and Trigger Success Rate for Valid Endpoints

Agency	Site ID	Number of Test Endpoints	Number of Valid Endpoints	Percent of Valid Endpoints	Number of Triggering Valid Endpoints	Success Rate of Valid Endpoints
Fathead Minnow						
Santa Rosa	SR01	6	2[1]	33%	0	100%
	SR02	6	5[2]	83%	1	80%
	SR05	6	3[3]	50%	0	100%
Sonoma County	SC01	4	4	100%	0	100%
	SC04	4	4	100%	4	0%
	SC05	4	4	100%	0	100%
Sebastopol	SE01	10	10	100%	0	100%
Rohnert Park	REP01	4	4	100%	0	100%
Ceriodaphnia dubia						
Santa Rosa	SR01	13	12[4]	92%	0	100%
	SR02	13	12[4]	92%	0	100%
	SR05	13	13	100%	2	85%
Sonoma County	SC01	8	8	100%	0	100%
	SC04	8	8	100%	4	50%
	SC05	8	8	100%	0	100%
Sebastopol	SE01	4	4	100%	0	100%
Rohnert Park	REP01	10	10	100%	0	100%
Selenastrum capricornutum						
Santa Rosa	SR01	3	3	100%	0	100%
	SR02	3	3	100%	0	100%
	SR05	3	3	100%	0	100%
Sonoma County	SC01	2	2	100%	0	100%
	SC04	2	2	100%	0	100%
	SC05	2	2	100%	0	100%
Sebastopol	SE01	2	2	100%	0	100%
Rohnert Park	REP01	2	2	100%	0	100%

Notes:

Sites SC04 and SC05 are stormwater conveyance site locations, not receiving water locations.

[1] Both failures of the survival endpoint were due to PRM. Because the mortality endpoints were failures, the growth endpoint is biased and also considered invalid for this assessment.

[2] The failure of the survival endpoint was due to PRM.

[3] Two failures to the survival endpoint were due to PRM. Antibiotics were applied to a third failure of the survival endpoint, which eliminated the toxicity from PRM.

[4] Low hardness was cited as a possible cause of the toxicity.

3 Data Analysis

This watershed data analysis evaluates land use characterization, seasonal effects, comparisons to effect thresholds, and comparisons to other benchmarks to identify key patterns that could inform future monitoring and assessment programs. To perform these assessments, data groupings of the data collected by the Co-Permittees were developed based on criteria discussed in each of the sections below.

The objective of the watershed data analysis is to inform future monitoring program decisions. This is performed by evaluating differences between sites, target seasonal conditions (wet, first flush, dry, etc.), and the justification for constituents. This evaluation of data will also consider issues identified in the methods evaluation (above) that might explain outlier conditions.

3.1 SUMMARY CONDITIONS

LWA summarized samples collected and analyzed for highly detected constituents and not detected or infrequently detected constituents in **Table 6** and **Table 7**, respectively. Based on a review of summary statistics (detection rates), known beneficial use impairments, and reported comparisons to relevant water quality objectives, LWA and the Co-Permittees identified pathogens (characterized by *E. coli*), metals (characterized by copper), sediment and solids (characterized by total suspended solids), and nutrients (characterized by total phosphorus) as the constituents of interest for more detailed assessment. It is assumed that these constituents then are used for assessment of data patterns for water quality issues. **Table 7** summarizes constituents that are generally not detected or infrequently detected at concentrations that are not of concern relative to known effect thresholds. Not detected and low detection rate data are not informative for this analysis and were not considered further.

Table 6. Summary Statistics for Constituents of Interest in Urban Runoff Characterization and Receiving Waters During Wet and Dry Weather Conditions

Constituent	Units	n	% Detected	Mean	Median	Standard Deviation
Urban Runoff						
Dry Weather						
E. coli	MPN/100mL	13	100%	3,409	776	7,023
Copper	µg/L	45	80%	2.4	1.7	2.1
Total Suspended Solids	mg/L	43	70%	4.0	1.8	4.8
Total Phosphorus	mg/L	40	95%	0.3	0.2	0.3
Wet Weather						
E. coli	MPN/100mL	41	100%	15,214	3,654	39,430
Copper	µg/L	84	95%	12.4	10.6	7.4
Total Suspended Solids	mg/L	82	98%	51.4	36.0	54.1
Total Phosphorus	mg/L	83	98%	0.5	0.4	0.4
All Events						
E. coli	MPN/100mL	54	100%	12,372	2,516	34,792
Copper	µg/L	129	90%	8.9	5.6	7.7
Total Suspended Solids	mg/L	125	88%	35.1	14.0	49.2
Total Phosphorus	mg/L	123	97%	0.4	0.3	0.4
Receiving Water						
All Events						
E. coli	MPN/100mL	23	96%	9,063	3,485	11,875
Copper	µg/L	68	94%	9.6	7.5	7.9
Total Suspended Solids	mg/L	64	97%	54.5	36.8	46.4
Total Phosphorus	mg/L	66	98%	0.4	0.4	0.3

Table 7. Pesticide and Organic Constituents with No Detection or Limited Detection in Urban Runoff Characterization

Constituent	n	Percent Detected Samples	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Reporting Limit (µg/L)	Maximum Reporting Limit (µg/L)
Aldrin	20	0%	0.0014	0.02	0.005	0.1
Bifenthrin	10	20% [a]	0.0001	0.79	0.0005	2
Chlordane	20	0%	0.0043	0.1	0.005	0.5
4,4-DDT	20	0%	0.00085	0.03	0.005	0.2
4,4-DDE	20	0%	0.0009	0.04	0.005	0.2
4,4-DDD	20	0%	0.00055	0.05	0.005	0.2
Dieldrin	20	0%	0.0007	0.05	0.005	0.1
Alpha-Endosulfan	19	0%	0.00055	0.1	0.004	0.1
Endosulfan Sulfate	20	0%	0.0016	0.03	0.01	0.5
Endrin	20	0%	0.0009	0.08	0.005	0.1
Endrin Aldehyde	20	0%	0.002	0.04	0.005	0.5
Heptachlor Epoxide	20	0%	0.0012	0.09	0.005	0.2
Heptachlor	20	0%	0.0019	0.05	0.005	0.2
Alpha-Hexachloro-cyclohexane (alpha-BHC)	20	0%	0.0014	0.04	0.005	0.1
Delta-Hexachloro-cyclohexane (delta-BHC)	20	0%	0.0007	0.02	0.005	0.5
Gamma-Hexachloro-cyclohexane (gamma-BHC)	20	0%	0.0018	0.04	0.005	0.1
Toxaphene	20	0%	0.01	2	0.1	5

Notes: [a] Quantified values were reported to be 0.0056 µg/L and 0.0018 µg/L.
•The summary does not include four wet weather samples that were collected by Cotati prior to the start of the 2018 storm season. These four events had high detection and reporting limits and Cotati conducted an additional two events during the 2018 storm season that had limits consistent with the other agencies.
•Reporting limits generally refer to the lowest limit of quantification.

3.2 YEAR-TO-YEAR MEAN VARIATION

The overall datasets for the four constituents of interest are presented in annual groupings with annual mean values and 95% confidence intervals in **Figure 1** through **Figure 4**. When only two data points are available in a grouping, the confidence interval is limited to range between the two values, which is inadequate to evaluate variability.

Considering years where adequate data are available for these four constituents, there is not an apparent year-to-year trend as measured by annual means and the associated confidence intervals that overlap from year to year (i.e., low confidence year-to-year means are different when confidence intervals overlap). Data collected in 2021 are only for a partial monitoring year and do not include a first flush event.

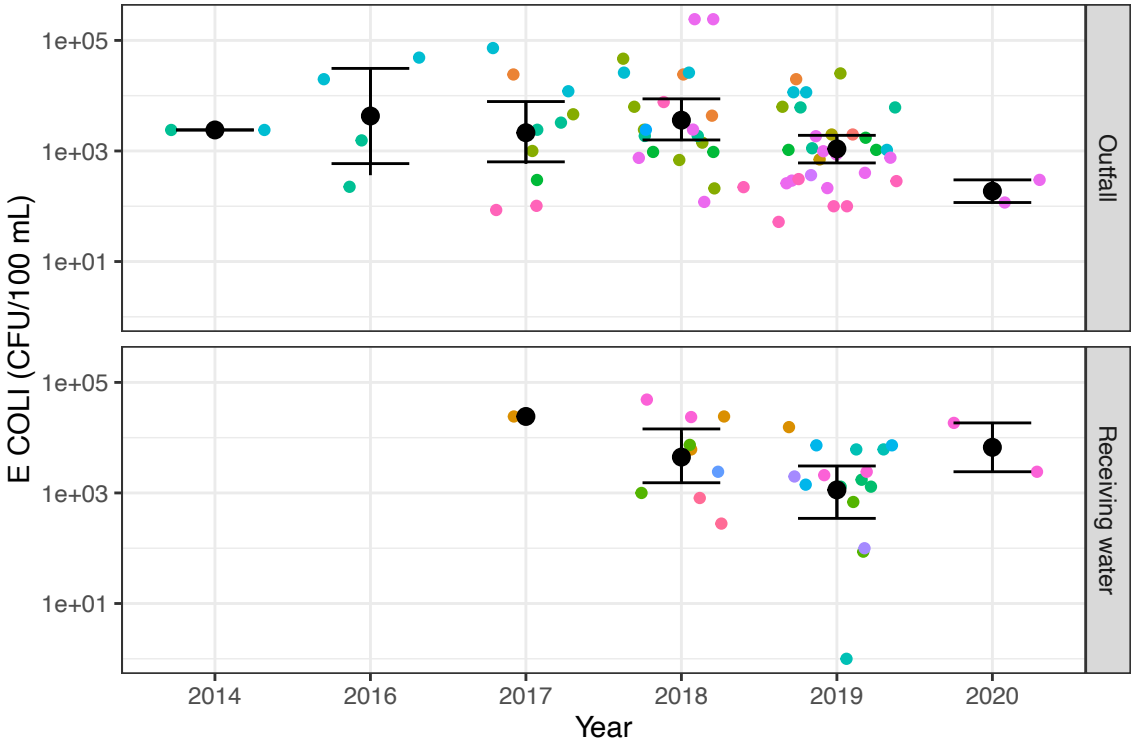


Figure 1. *E. coli* Annual Mean Concentrations in Urban Runoff and Receiving Water

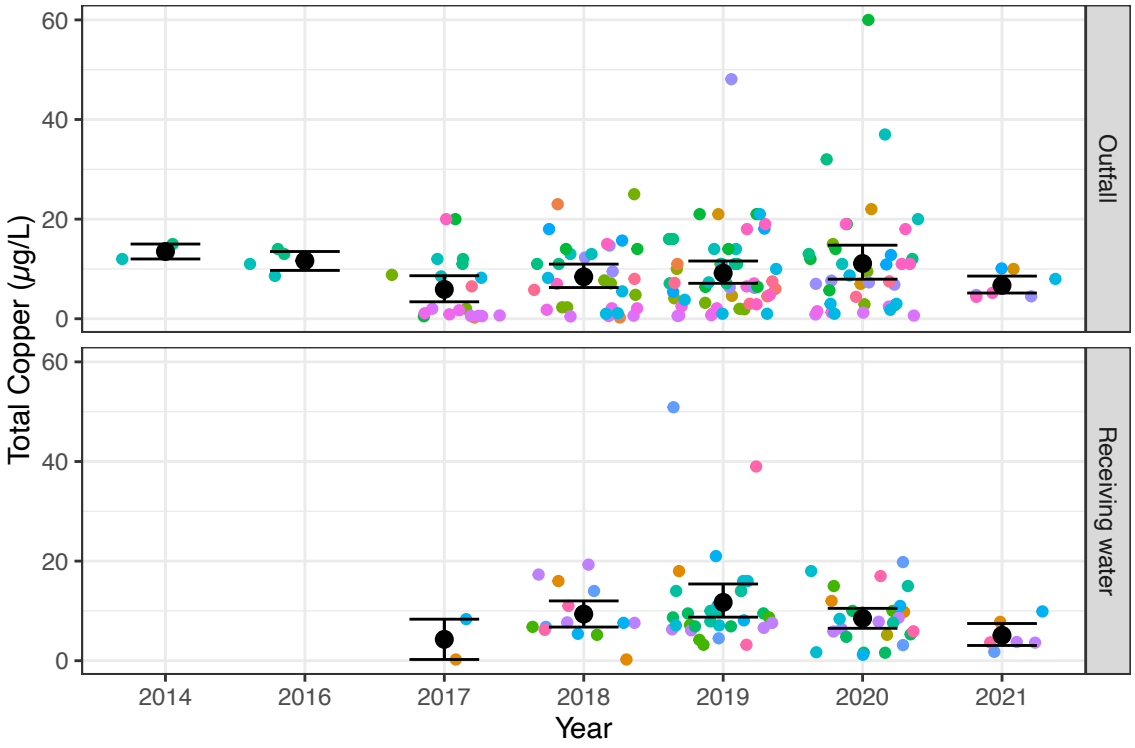


Figure 2. Total Copper Annual Mean Concentrations in Urban Runoff and Receiving Water

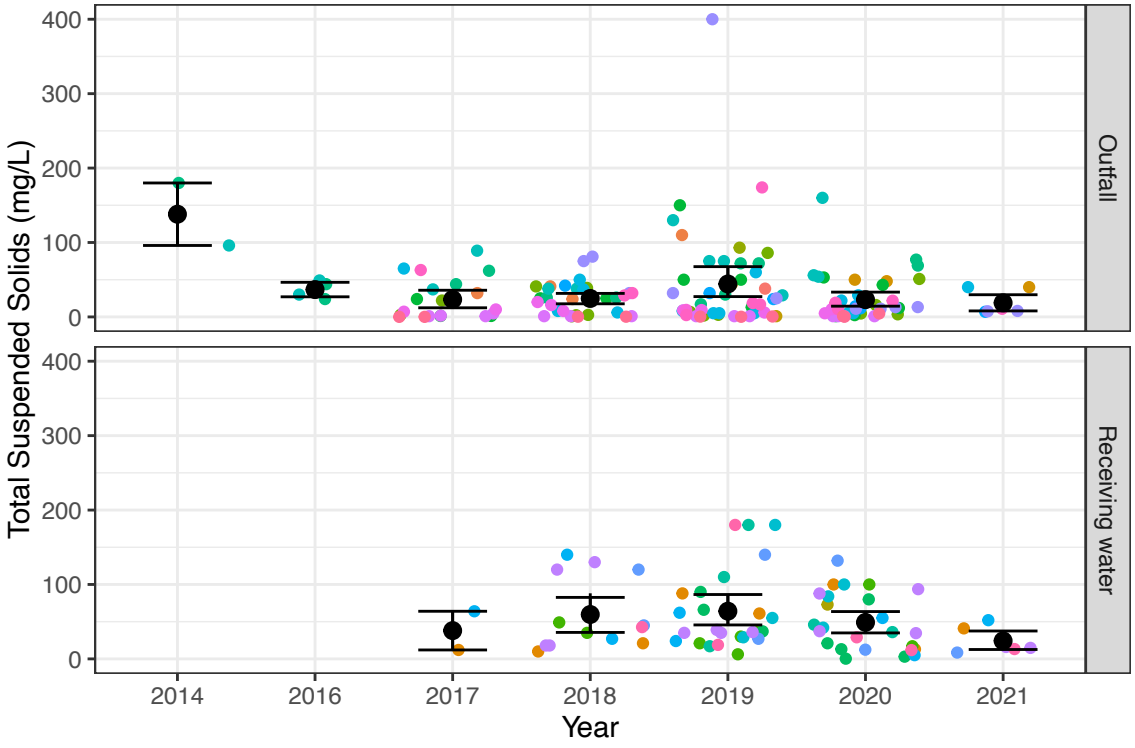


Figure 3. Total Suspended Solids Annual Mean Concentrations in Urban Runoff and Receiving Water

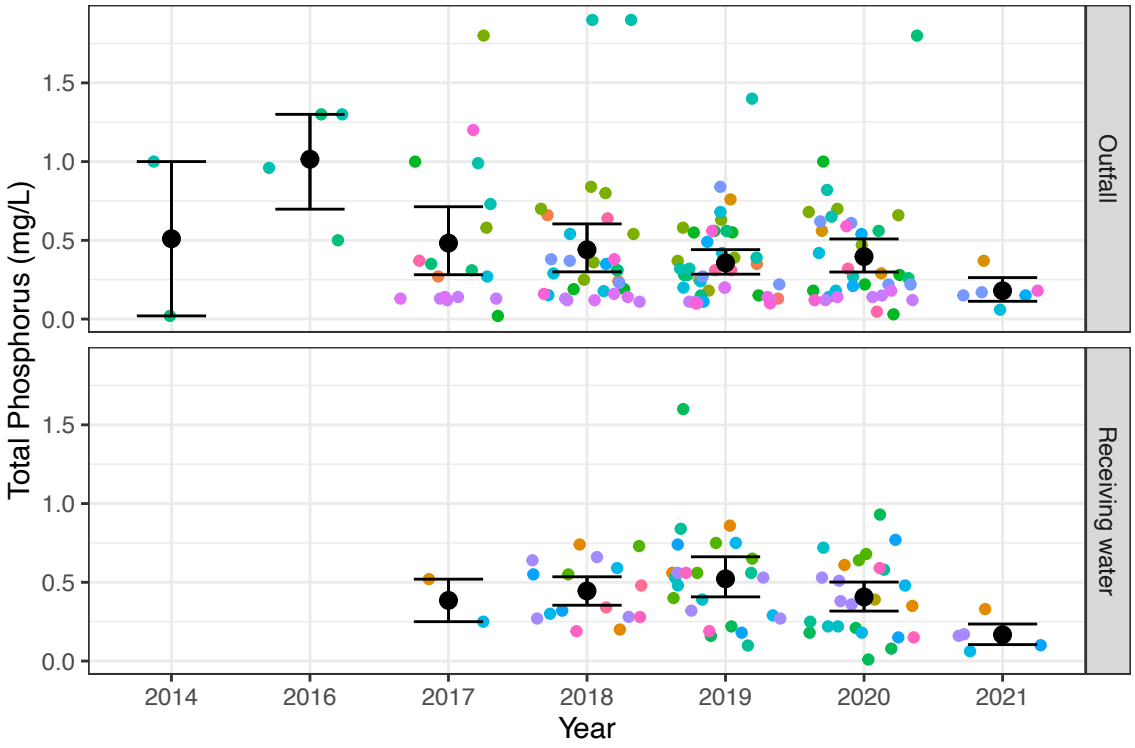


Figure 4. Total Phosphorus Annual Mean Concentrations in Urban Runoff and Receiving Water

3.3 SEASONAL VARIATIONS

It is commonly asserted that urban runoff quality measured as constituent concentration is dependent on seasonal factors. The "seasonal first flush" is the first storm of the water year that follows a significant dry period (i.e., summer dry season). Using Santa Rosa Airport (SNO) daily precipitation data for the study period and Co-Permittee data, LWA categorized sample collection events as "Dry" (collected on a day of no rainfall within 48 hours), "First Flush" (collected before 3" of seasonal rainfall and more than 0.25" in any two day cumulative total), and "Seasonal" (collected after 3" of seasonal rainfall and more than 0.25" in any two day cumulative total). This evaluation verified the categorizations reported by the Co-Permittees.

The indicator constituent assessments shown in **Figure 5** through **Figure 8** confirmed that the dry weather data were lower than for wet weather events in all cases, though dry weather receiving water data was limited. The assessments also suggest that the first flush event observed higher mean concentrations than seasonal events, however, the confidence intervals overlap for *E. coli* and TSS, suggesting that there is more uncertainty in this conclusion for these constituents.

Continued prioritization of first flush sample collection would bias the overall annual means higher if the weighting within the year is not considered statistically (i.e., considering factor analysis to simulate the overall population of storm events). In some cases, targeting first flush events is reasonable to identify worst case conditions and to define this key variable for statistical assessments. First flush event sample collection can provide statistical benefits if appropriately used.

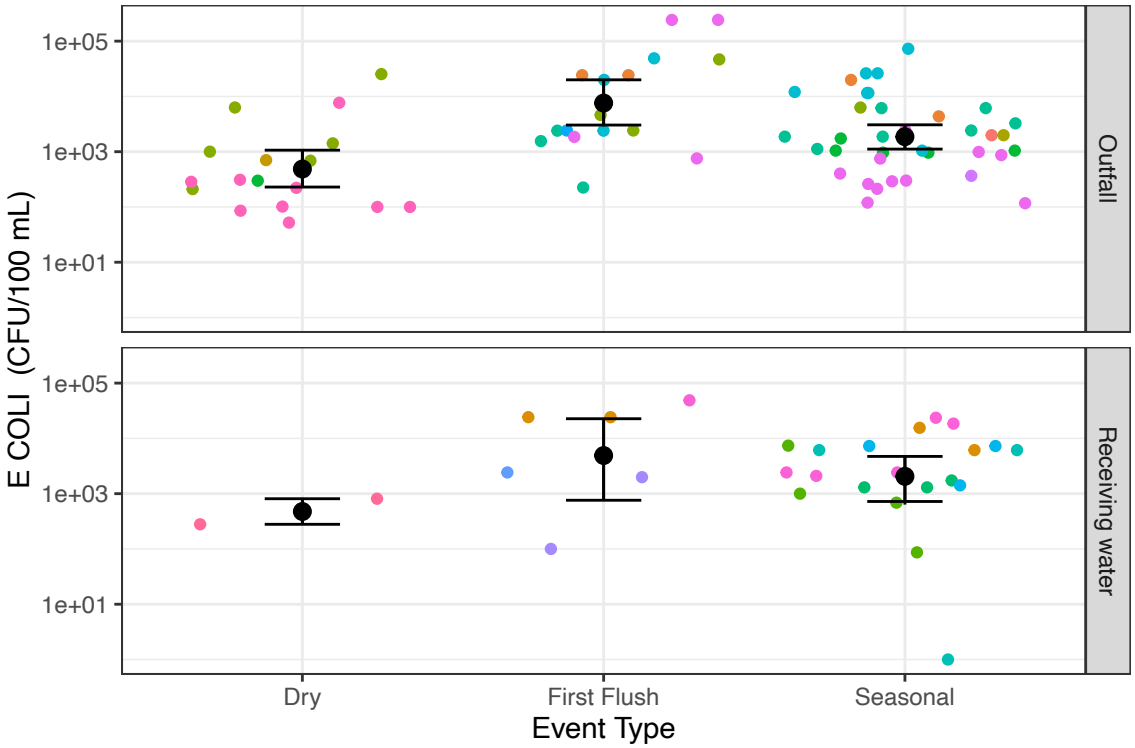


Figure 5. *E. coli* Seasonal Mean Concentration Conditions in Urban Runoff and Receiving Water

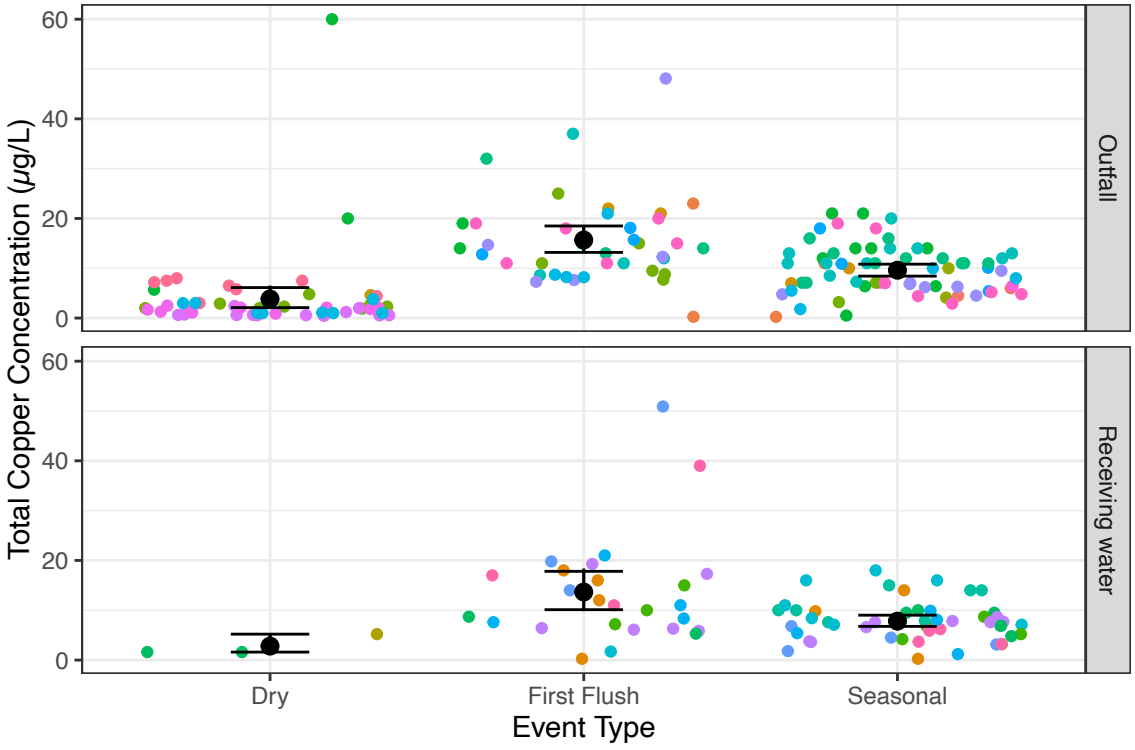


Figure 6. Total Copper Seasonal Conditions Mean Concentrations in Urban Runoff and Receiving Water

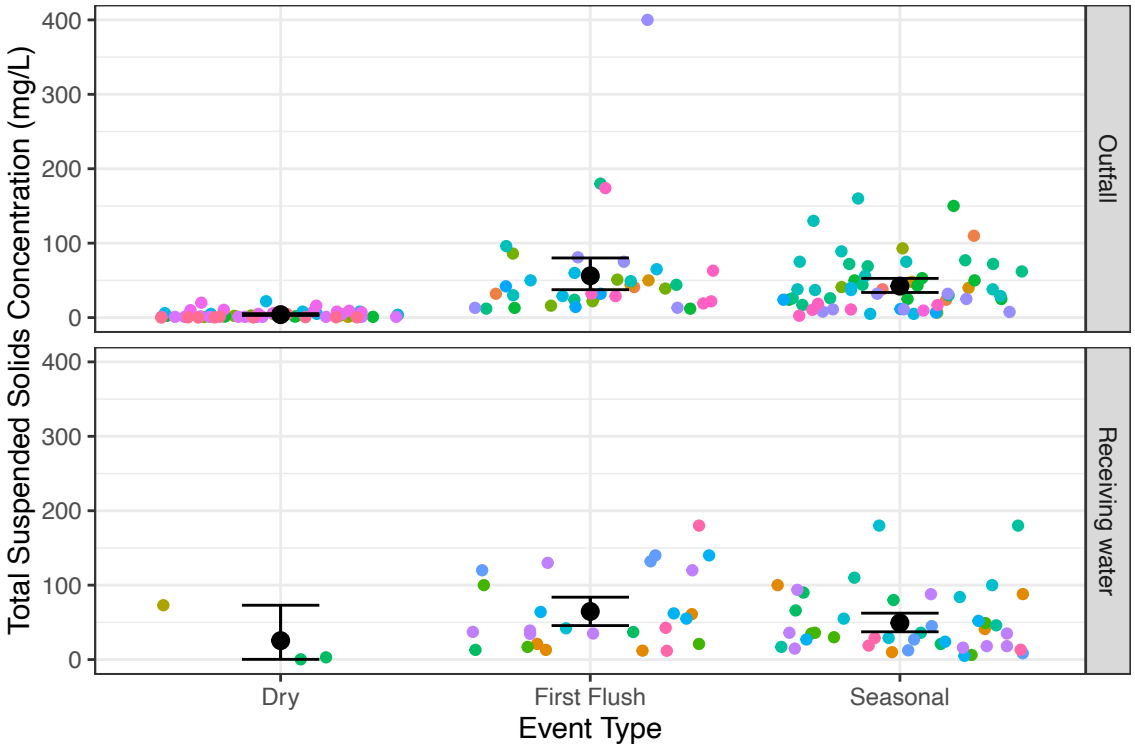


Figure 7. Total Suspended Solids Seasonal Mean Concentration in Urban Runoff and Receiving Water

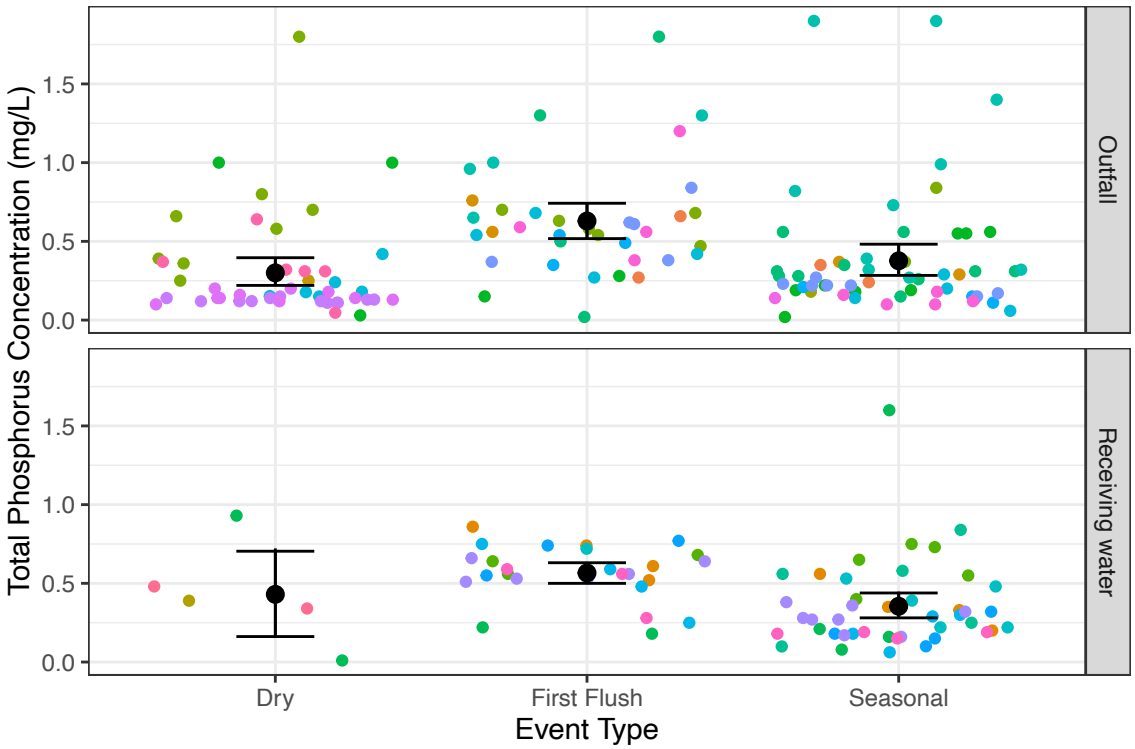


Figure 8. Total Phosphorus Seasonal Mean Concentration in Urban Runoff and Receiving Water

3.4 LAND USE EVALUATION

Land use for tributary drainages is often used in urban runoff monitoring programs to both identify problematic land uses and develop representative monitoring programs so that larger drainage areas can be characterized based on smaller representative sample collection drainages. LWA did not perform a detailed mapping of the Co-Permittee land use drainages, but instead used the reported tributary land uses and identified "primary" and "secondary" land uses that were confirmed against visual inspection of aerial imagery as shown in **Table 8**. All receiving water locations were considered "integrator" sites, however, they generally are more targeted evaluations of outfall impacts, though many include upstream influence and other sources. Therefore, they provide some integration of a wider range of mixed land uses and sources.

A more detailed assessment could provide higher resolution assessments of the fractions of different types of land uses, the age of development, the extent implementation of stormwater quality improvement features, or other landscape considerations.

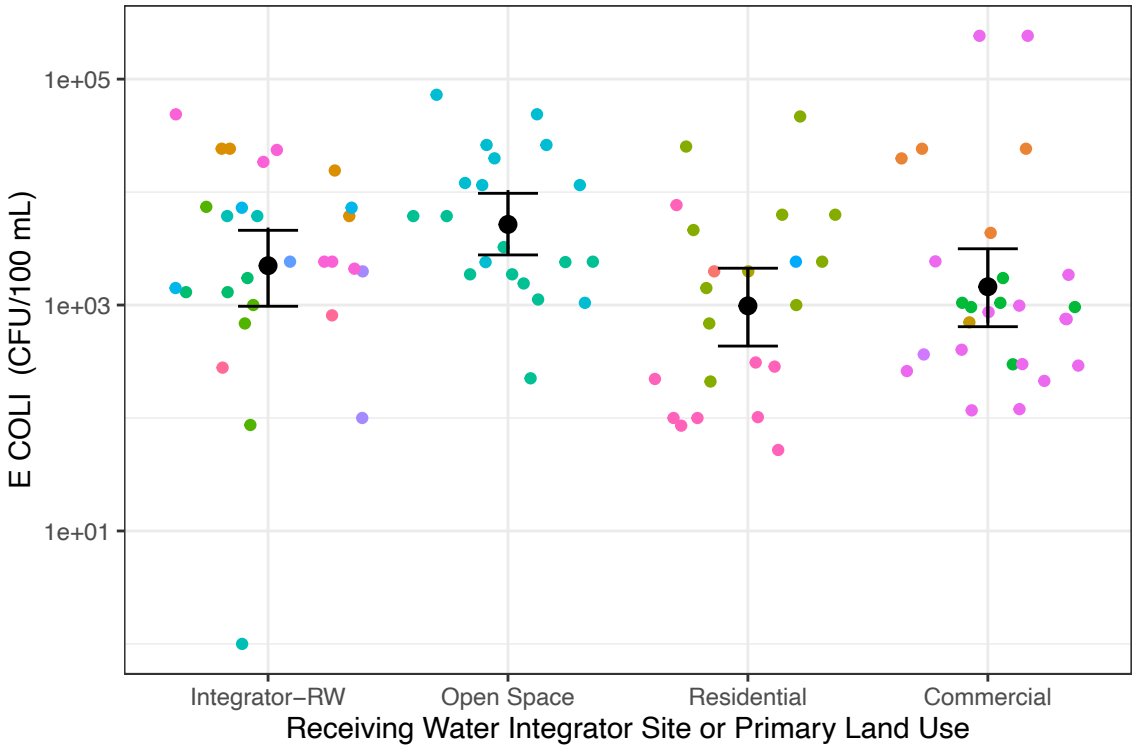


Figure 9 through **Figure 12** characterize Co-Permittee indicator constituent concentrations by land use. This understanding can be used for future monitoring design such that clear objectives and assessment questions are specified.

All indicator constituents showed a similar pattern whereby the open space primary land use observed higher mean concentrations than the residential and commercial primary land uses. This outcome was not anticipated as open space would generally be more pervious surfaces and lower concentrations. Before this observation is further used for monitoring design or other assessments, it should be further verified to rule out site specific conditions or sample collection methods that might bias the results that are not representative of open space.

The residential and commercial primary land uses observed similar mean concentrations except in the case of total phosphorus (see **Figure 12**). It can be difficult to identify reasonably sized areas (> 100 acres) that do not have a mix of urban land uses.

The "Integrator-RW" classification applies to receiving water monitoring locations with tributary drainages that include urban and non-urban land uses and characterize a combination of land uses.

Table 8. Monitoring Sites and Land Use Assumptions

Site ID	Agency	Watershed	Type	Assumed Primary Land Use
CO01	Cotati	Lower	Outfall	Commercial
CO01-RW	Cotati	Lower	Receiving Water	Integrator-RW
CO02	Cotati	Lower	Outfall	Commercial
CO03	Cotati	Lower	Outfall	Commercial
CO03-RW	Cotati	Lower	Receiving Water	Integrator-RW
RP01	Rohnert Park	Lower	Outfall	Residential
RP01-RW	Rohnert Park	Lower	Receiving Water	Integrator-RW
SR01	Santa Rosa	Lower	Outfall	Commercial
SR02	Santa Rosa	Lower	Outfall	Residential
SR03	Santa Rosa	Lower	Outfall	Commercial
SR04	Santa Rosa	Lower	Outfall	Commercial
SR01-RW	Santa Rosa	Lower	Receiving Water	Integrator-RW
SR02-RW	Santa Rosa	Lower	Receiving Water	Integrator-RW
SR03-RW	Santa Rosa	Lower	Receiving Water	Integrator-RW
SR04-RW	Santa Rosa	Lower	Receiving Water	Integrator-RW
SE01	Sebastopol	Lower	Outfall	Residential
SE01-RW	Sebastopol	Lower	Receiving Water	Integrator-RW
SC01	Sonoma County	Lower	Outfall	Commercial
SC02	Sonoma County	Lower	Outfall	Open Space
SC03	Sonoma County	Lower	Outfall	Open Space
SC01-RW	Sonoma County	Lower	Receiving Water	Integrator-RW
SC02-RW	Sonoma County	Lower	Receiving Water	Integrator-RW
SC03-RW	Sonoma County	Lower	Receiving Water	Integrator-RW
WI01	Windsor	Lower	Outfall	Commercial
WI02	Windsor	Lower	Outfall	Residential
WI01-RW	Windsor	Lower	Receiving Water	Integrator-RW
WI02-RW	Windsor	Lower	Receiving Water	Integrator-RW
TS-112619	Windsor	Lower	Receiving Water	Integrator-RW
CL01	Cloverdale	Upper	Outfall	Residential
HE-M-LW	Healdsburg	Upper	Outfall	Residential
UK-M-NOW	Ukiah	Upper	Outfall	Commercial

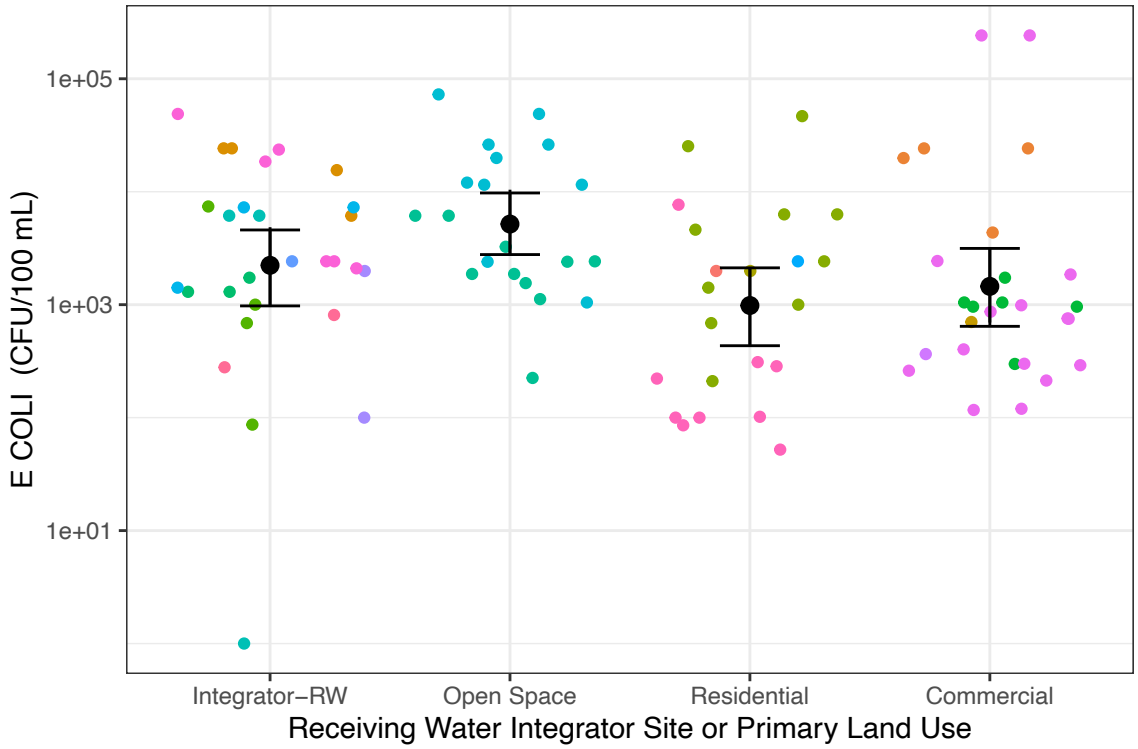


Figure 9. *E. coli* by Primary Land Use in Russian River Watersheds

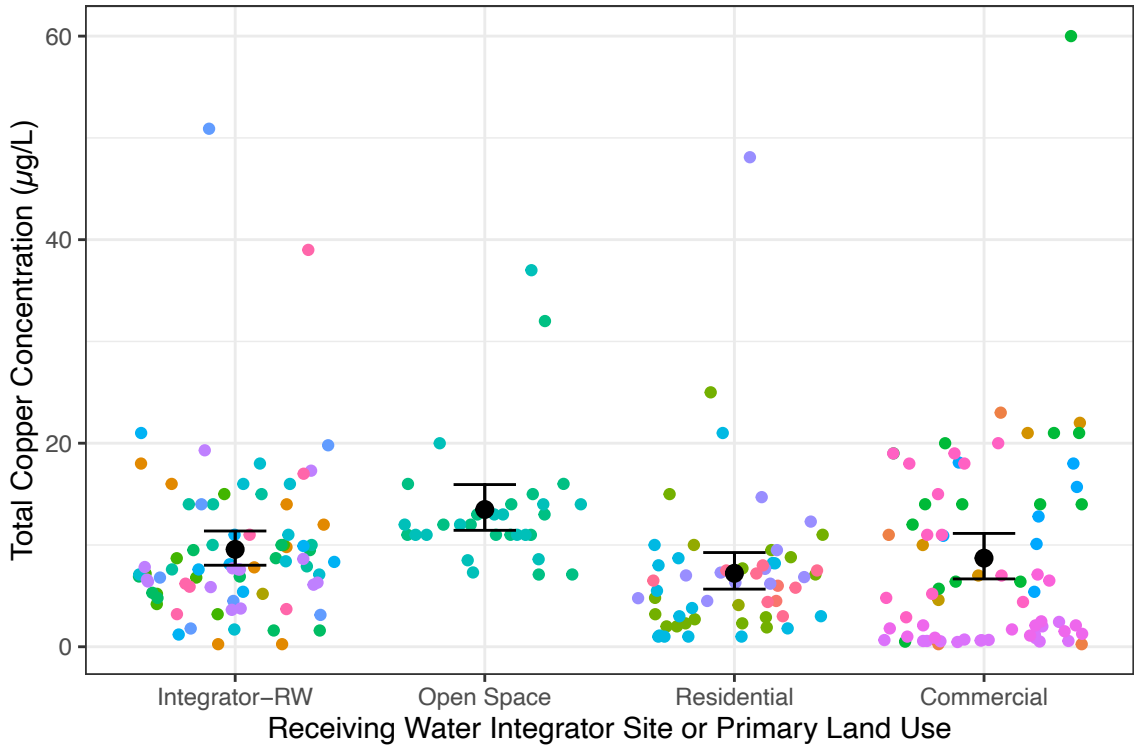


Figure 10. Total Copper by Primary Land Use in Russian River Watersheds

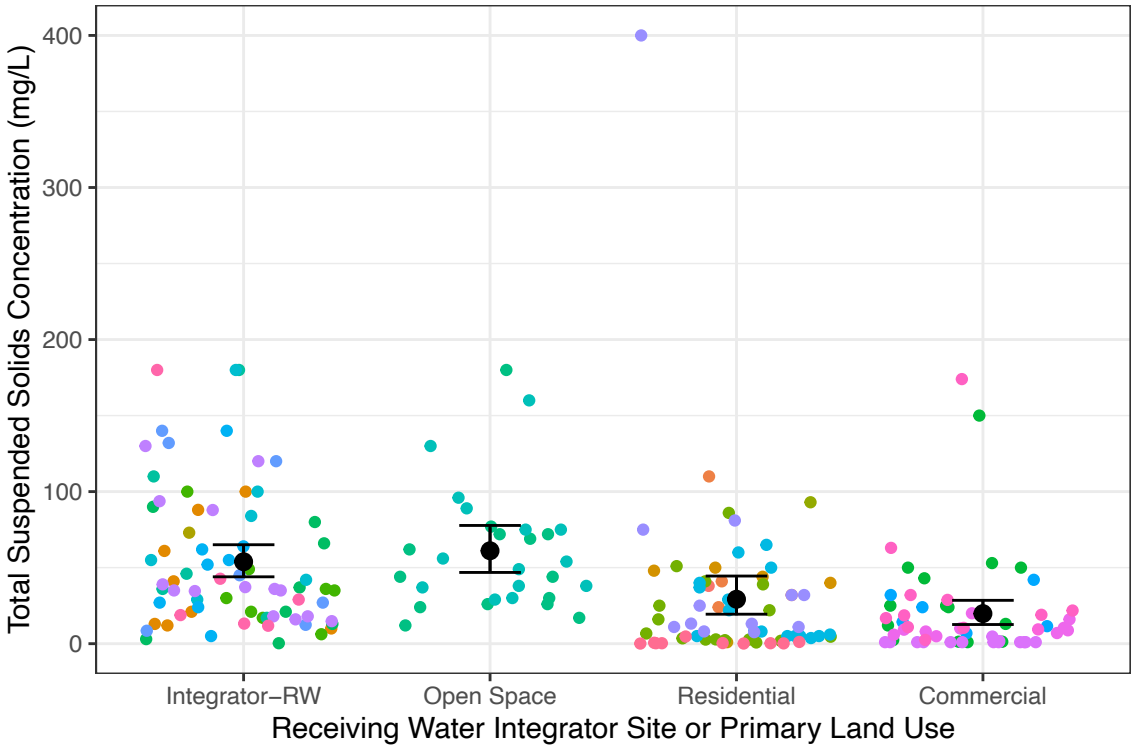


Figure 11. Total Suspended Solids by Primary Land Use in Russian River Watersheds

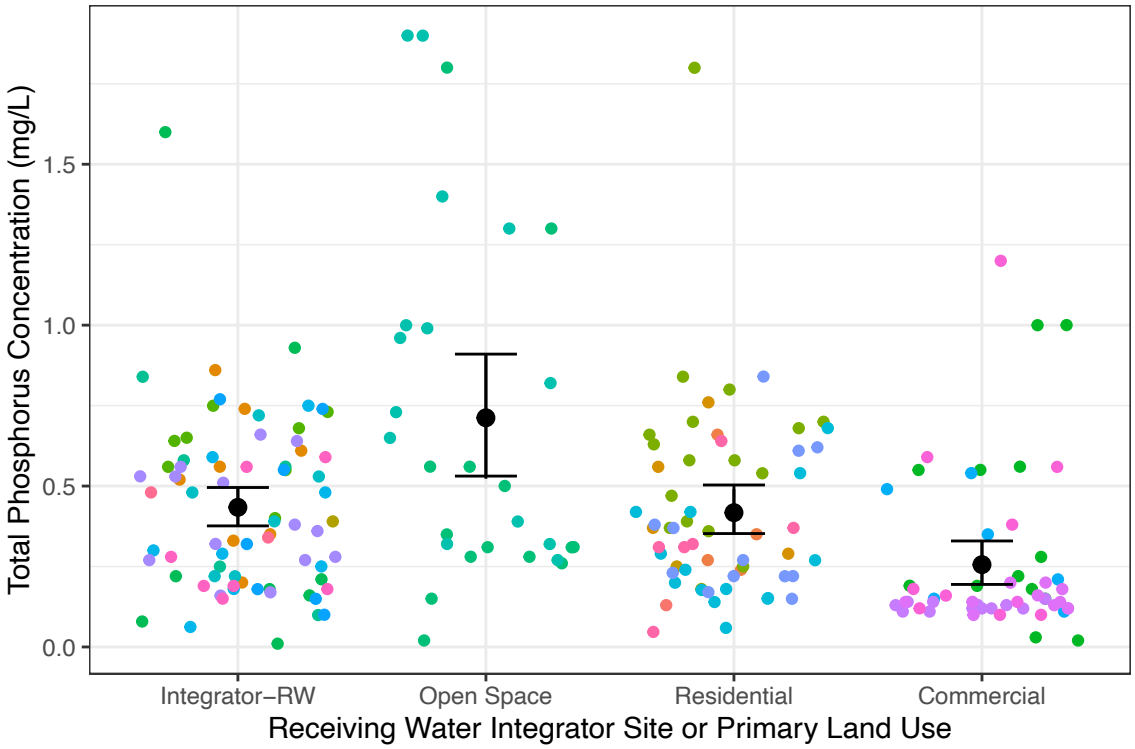


Figure 12. Total Phosphorus by Primary Land Use in Russian River Watersheds

3.5 COMPARISON TO OTHER NORTHERN CALIFORNIA MS4 PHASE I PROGRAMS

LWA compared the Co-Permittee dataset to two Central Valley MS4 Phase I monitoring program datasets. The Central Valley MS4 program includes thirty years of monitoring data compared to the shorter five year Co-Permittee dataset. The Central Valley urban areas are larger in population than the Co-Permittee urban areas but are the best available datasets that have similar monitoring and assessment program data in Northern California. The comparisons are useful to understand the context of the Co-Permittee dataset and verify that the data are in range with other similar programs.

Figure 13 through **Figure 16** are boxplots of dry and wet weather data collected in Northern California for the indicator constituents. The boxes show the 25th percentile value on the bottom, the 75th percentile on the top, and the 50th percentile (median) in the middle. The whiskers show the upper and lower range 1.5 times the interquartile range. Overall, the urban area data appear to be similar. Notably, the Co-Permittee monitoring programs have a significant amount of data relative to the longer dataset duration and larger populations of the other programs.

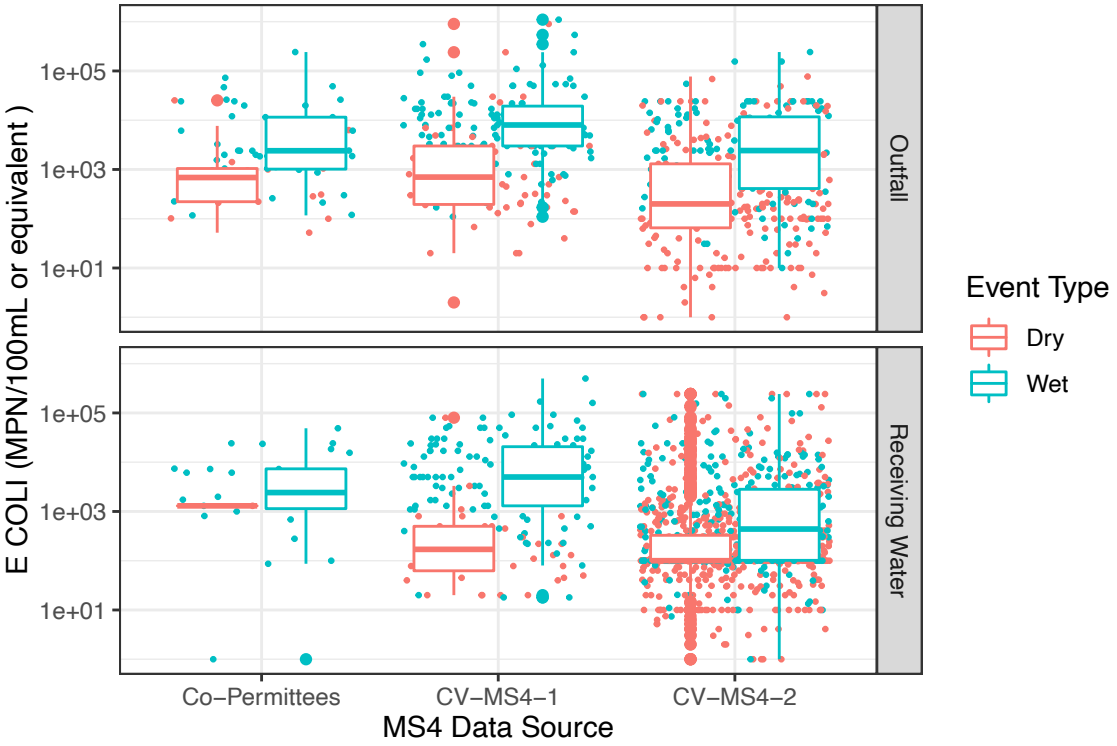


Figure 13. *E. coli* in Northern California Urban Watersheds

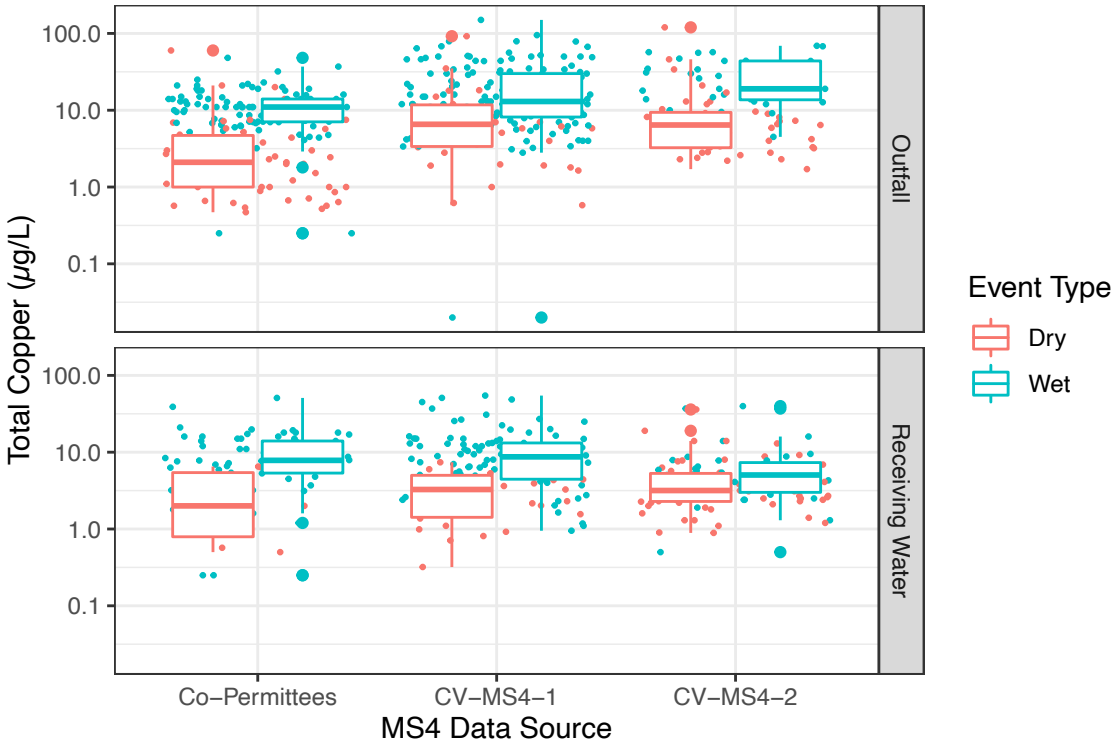


Figure 14. Total Copper in in Northern California Urban Watersheds

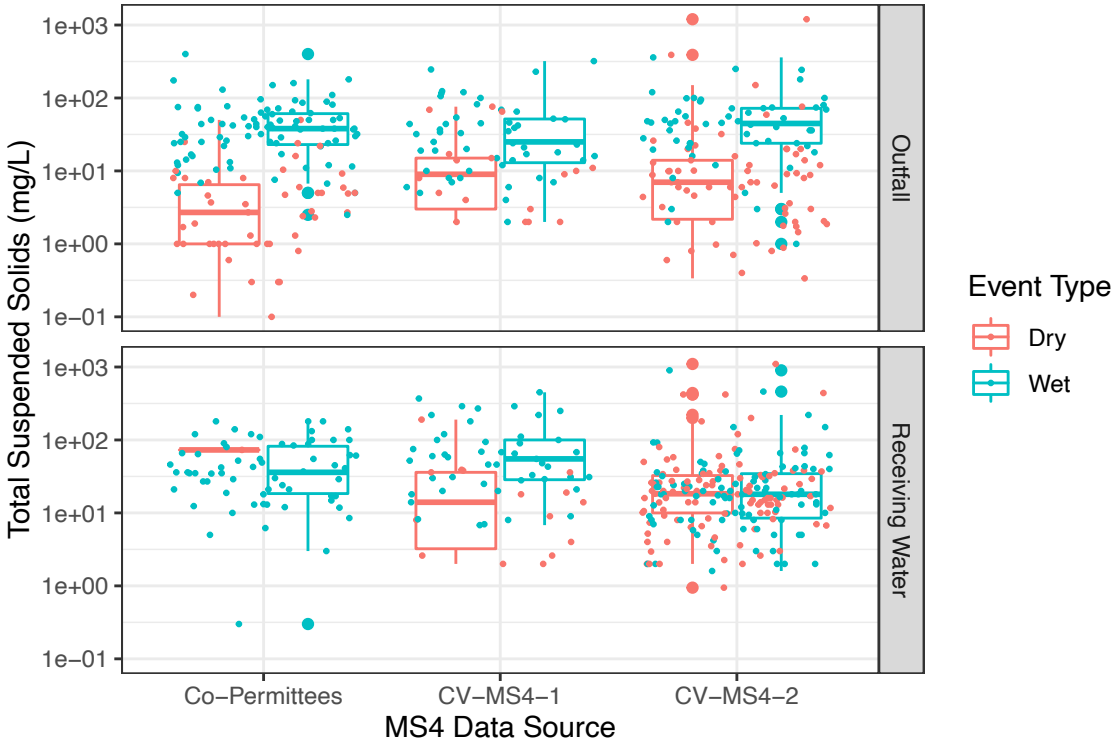


Figure 15. Total Suspended Solids in in Northern California Urban Watersheds

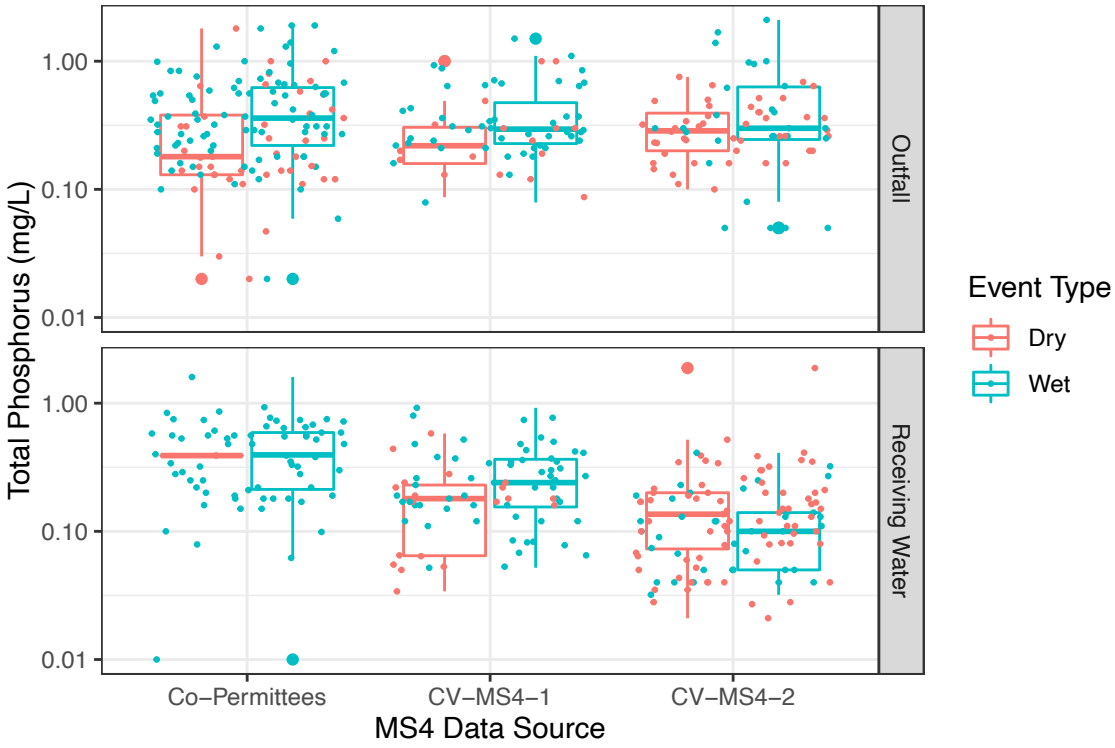


Figure 16. Total Phosphorus in in Northern California Urban Watersheds

3.5.1 Bifenthrin Statewide Concentrations

Co-permittee monitoring of pesticides rarely detected pesticides as shown in **Table 7**, with limited detection of the pyrethroid pesticide bifenthrin (20%). Bifenthrin detections were observed only when lower reporting limits were used. **Figure 17** compares the maximum observed Co-Permittee value against mean values for statewide data collected by the California Department of Pesticide Regulation (DPR) to represent urban runoff conditions. The Co-Permittee maximum value is below average statewide concentrations. The limited Co-Permittee data then suggest that Co-Permittee conditions are not out-of-range (i.e., extremely non-typical) and appear to be lower than statewide averages.

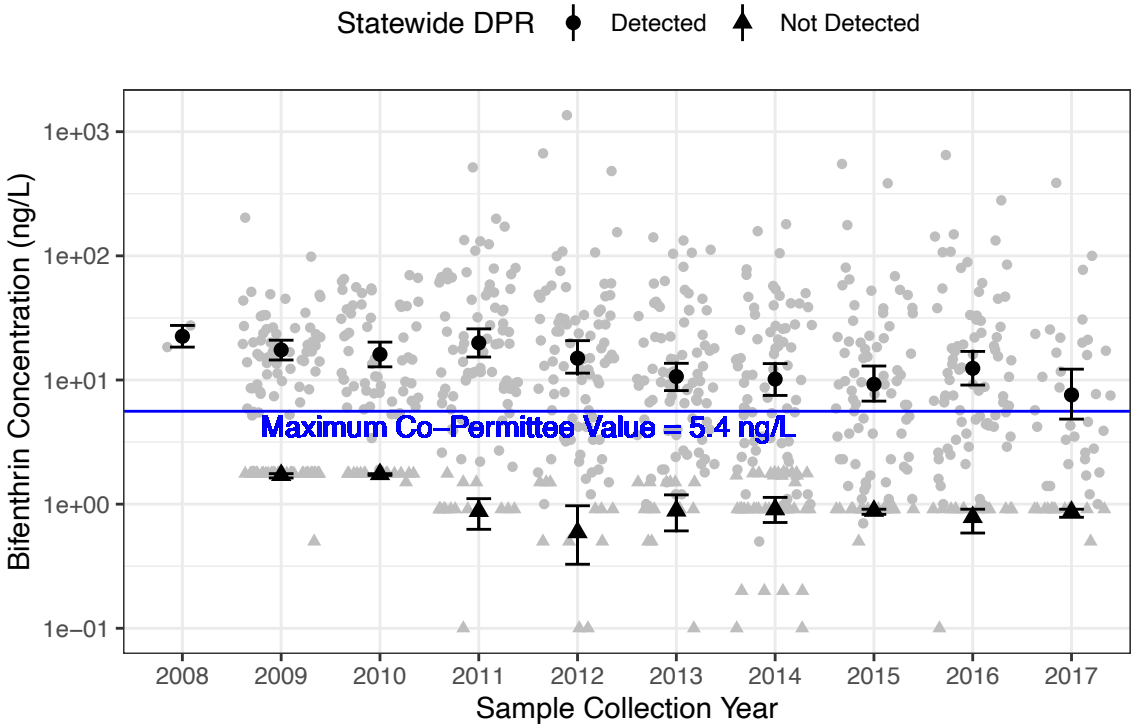


Figure 17. Total Bifenthrin in Department of Pesticide Regulation Urban Monitoring

3.6 WATER QUALITY OBJECTIVE COMPARISON AND CONSIDERATION OF RELEVANT WATER QUALITY THRESHOLDS

Comparisons of monitoring data to water quality objectives (WQOs) or other effect thresholds is one consideration in assessment of water quality standards and the overall protection of beneficial uses. Simple comparisons of urban runoff to water quality objectives do not conclude that an impairment is present. However, WQO comparisons can be useful in screening urban runoff for additional follow-up or prioritization.

The Co-Permittees reported WQO comparisons including relevant California Toxics Rule (CTR), USEPA[3], and Basin Plan objectives. LWA confirmed the calculation of hardness-based CTR objectives and reviewed all assessments. Overall, the calculations and comparisons were performed correctly:

- Total copper, lead, and zinc samples exceeded the CTR WQO in wet weather about half the time and never exceeded in dry weather. The Upper Watershed MS4 agencies compared metals data against the less stringent Water Quality Control Plan for the North Coast (Basin Plan) objectives (incorporates primary and secondary maximum contaminant levels) and did not exceed them. However, the Upper Watershed metals concentrations did exceed the CTR WQO in some cases.
- *E coli* samples frequently exceeded the Basin Plan targets which are based on the Statewide Bacteria Provision WQOs.

[3]United States Environmental Protection Agency (USEPA). Update of Ambient Water Quality Criteria for Ammonia. Publication No. EPA-822-R-99-014. December 1999.

- Pesticides were rarely detected and while there is no applicable WQO for bifenthrin, the detections did exceed the USEPA Office of Pesticide Programs benchmark value of 0.0013 g/L, which is considered a screening value. There are water quality criteria used elsewhere that were developed outside of the USEPA objective development process (e.g., UC Davis for the Central Valley Regional Water Quality Control Board), but those are based on a dissolved concentration that requires organic carbon data to adequately perform any comparisons to those effect levels.
- There is no applicable total phosphorus WQO, and urban land use (outfall) data reported by the Co-Permittees were comparable to other California MS4s.

However, there are mitigating considerations for the applicability of the CTR, *E.* coli, and bifenthrin effect levels. The WQO exposure periods and data averaging periods should be better aligned, and consideration of dissolved constituents is more appropriate for dissolved based WQOs (e.g., metals and bifenthrin).

3.6.1 Dissolved Fractions and Organic Carbon

The Laguna Watershed MS4 total metals comparisons performed with CTR WQOs were based on total metals concentrations. Dissolved (0.45 µm filtered) metal samples are more representative of aquatic life effects as the CTR metal WQOs are based on dissolved concentrations. **Figure 18** compares the Co-Permittee total copper concentrations to two Central Valley Phase 1 MS4s total and dissolved copper (note log transformed scale box-plots). Notably, the Co-Permittee total copper distributions are similar to other Northern California MS4s. The dissolved fraction of copper in urban runoff and receiving waters can be considerably lower than the total concentrations. For example, the "CV-MS4-1" mean total copper concentration was 15.3 µg/L and the mean dissolved copper concentration was 5.68 µg/L. A similar dissolved ratio (0.37) would be expected for Co-Permittee urban runoff and receiving waters. This suggests that Co-Permittee urban runoff and receiving waters comparisons using total concentrations are overly conservative and conditions may actually comply with the CTR WQOs.

EPA has also promulgated copper criteria[4] based on the Biotic Ligand Model[5] which consider dissolved organic carbon complexes that bind with metals to reduce bioavailability. Dissolved organic carbon can be present in urban runoff and receiving waters at higher concentrations during storm events as organic matter is mobilized. The EPA objective has been used by the Los Angeles Regional Water Board and other metals could also be considered using the same Biotic Ligand Model approach.

The UCD bifenthrin effect levels are based on dissolved fractions or consider organic carbon partition calculations as part of the effect level calculation. Because of the lack of dissolved fractions and consideration of organic carbon, LWA considers the assessments of metals and bifenthrin inconclusive and not a confirmation of impairment issues related to these constituents.

[4] United States Environmental Protection Agency, Office of Water. *Aquatic Life Ambient Freshwater Quality Criteria*. EPA-822-R-07-001 4304T February 2007

[5] https://www.epa.gov/wqs-tech/copper-biotic-ligand-model

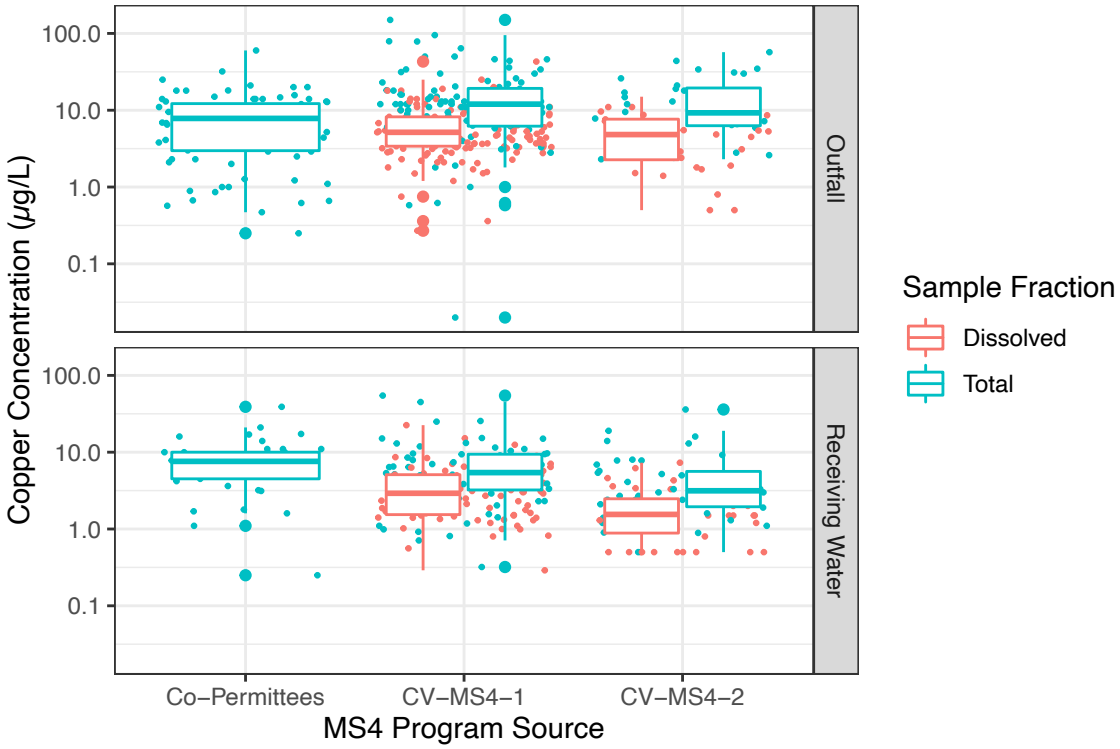


Figure 18. Total and Dissolved Copper in Russian River Urban Watershed Compared to Other Municipal Programs

3.6.2 Exposure Period Assessments

The WQOs are aquatic life or human health based on exposure periods for the specific effect. CTR metals WQOs have an acute (one hour) and chronic (four day) exposure periods. Critical periods during storm events may last on the order of hours and may be significantly diluted if conditions persist for the entire chronic assessment period. Regardless, an assessment of compliance with CTR WQOs should consider the duration of elevated concentrations experienced and acute metals CTR WQOs may be the most relevant. The Statewide Bacteria Provision *E. coli* WQOs are calculated over six weeks (rolling geometric mean) or as the 90th percentile for a month.[6] One time grab sample collection during a storm event is an overly conservative means to assess compliance.

3.7 TOXICITY DATA EVALUATION

Table 5 summarizes the success rates for aquatic toxicity endpoints during the study period for endpoints that are considered valid for this assessment. Endpoint failures were all chronic endpoints and only one endpoint failure result was not related to pathogen related mortality (PRM) or *Ceriodaphnia dubia* reproductive endpoints. The Co-Permittees identified *Ceriodaphnia dubia* as the most sensitive species. Aside from test procedure failures, the toxicants or causes of toxicity in samples were not identified. Endpoint failures were highly limited in receiving water for all species (3 endpoint failures out of 102 total receiving water

[6] State Water Resources Control Board. *Part 3 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California. Bacteria Provisions and a Water Quality Standards Variance Policy*. February 4, 2019. https://www.waterboards.ca.gov/bacterialobjectives/docs/bacteria.pdf

endpoints measured), suggesting the receiving waters are overall in good condition based on these three species (*Ceriodaphnia dubia* or water flea*, Pimephales promelas* or fathead minnow*),* and *Selenastrum capricornutum* or algae).

3.8 BIOASSESSSMENT DATA EVALUATION

The Laguna Watershed MS4 agencies performed bioassessments on five stream reaches. The assessment identified one of the streams as unaltered and the level of alteration was variable across the other four reaches in other urban creeks. While other factors besides urban runoff may cause the alteration, bioassessment monitoring may be a more appropriate as an integrative measurement of the impact of urbanization of watersheds than chronic toxicity testing. The State Water Board is developing a policy related to interpretation of bioassessment data.

Because bioassessment is an integrative assessment, effects can be localized, and alterations may be caused by multiple urban and non-urban factors. Assessments of the broader stream networks could be performed effectively by a coordinated regional monitoring program as part of multiple lines of evidence surveillance program as long as the data collected can be used directly to answer assessment questions.

3.9 RUSSIAN RIVER WATERSHED CONSTITUENTS OF EMERGING CONCERN PILOT STUDY

The contaminants of emerging concern (CEC) study initiated by the Regional Water Board and State Water Board (SCCWRP, 2018) was a pilot evaluation of the Russian River and upstream locations within the Laguna Watershed. The study was intended as a methods evaluation, screening, and prioritization exercise that concluded that the water bodies were at a low to moderate risk and low priority for follow-up studies. The study suggested some pesticide monitoring follow-up may be indicated in urbanized areas but did not consider the data reported by the Co-Permittees. The Co-Permittee bifenthrin data indicates that Co-Permittee concentrations are lower than typical statewide concentrations (**Figure 17**).

4 Recommendations

LWA prepared recommendations based on a review of the overall Co-Permittee monitoring conducted during the past five years (2016-2021). The evaluation considered broader watershed characteristics rather than an evaluation of individual locations or MS4 agencies to inform recommendations on future monitoring design for the Co-Permittee watersheds.

4.1 MONITORING PROGRAM DESIGN CONSIDERATIONS

Co-Permittee monitoring programs conducted during the current permit term effectively and robustly characterized urban runoff and receiving water conditions in the urban watershed evaluation. Additional development of the Russian River Regional Monitoring Program (R3MP) and successful collaborative efforts like the CEC pilot study provide an opportunity to coordinate and leverage resources for an effective receiving water surveillance program to protect beneficial uses in the Laguna de Santa Rosa and Upper Russian River watersheds. Monitoring program design should be focused on known outcome data products or key decision making information needs. The following recommendations are intended to inform possible monitoring program modifications to existing requirements, however, if specific monitoring questions (i.e., Co-Permittee investigative goals) are implemented, more specific design recommendations could be provided:

1. The continued urban runoff discharge monitoring across all Co-Permittee watersheds is not necessary at the same frequency for the purpose of general characterization. A more efficient monitoring design could be developed to answer monitoring questions like "What is the quality of the Russian River watershed urban runoff for key constituents of concern?" A randomized or rotating approach could provide the same spatial characterization data power at a lower cost.
2. Because of overall low concentrations, dry weather monitoring has limited usefulness unless a specific dry weather assessment is identified.
3. Participation in the R3MP could effectively replace the current receiving water monitoring. A status and trends monitoring program at downstream locations and any necessary toxicity evaluations could confirm beneficial use protection and support TMDL implementation. The R3MP could focus on more integrated assessments and novel evaluations to support urban runoff managers and other stakeholders. The downstream locations should be closer to the input to the Russian River with any follow-up moving upstream on a targeted basis as funding allows. In this way overall health of the drainages is assessed efficiently.
4. Toxicity tools in the current permit are the historic three-species using chronic endpoints and a sensitive species selection. While this approach still has widespread use in California, the tools no longer have the precision to quickly understand causes of toxicity which are almost always now more complex with lower signals and higher variability. Downstream (integrated locations) receiving water sample collection by a regional program or research entity with capabilities for novel test evaluations is a recommended approach to better assess stream and river condition than discharge-focused evaluations. To be an effective tool in watershed management, toxicity testing requires significant and sometimes proactive (e.g., multi-day sampling for renewals, broad chemistry analyses, parallel runs of treated samples, alternate species, etc.) efforts to identify the cause of toxicity. Because effect levels of current use pesticides can be low and toxicity testing methods may be sensitive to testing variability

(e.g., pathogen related mortality, test conditions, etc.) or lack of a persistent toxic signal, the cause of toxicity can be difficult to discern. Moreover, the impact from urban runoff is on shorter timescales than chronic testing and results might not be representative of actual exposure periods. Toxicity evaluations should then be performed using an experimental design that ensures useful outcomes at a fixed cost. Budget allocations can then allow prioritization of these investigative activities to constrain the open-ended nature of toxicity identification evaluations.

5. Toxicity testing is more appropriate for receiving waters and the Sonoma County land use characterization sites should be removed from the toxicity testing site list.
6. All monitoring programs should be developed with stated monitoring questions that are answerable or otherwise testable hypotheses so that Co-Permittees and the Regional Water Board have a clear understanding of how outcomes will be assessed. This can be as simple as "What is the average concentration of copper in urban runoff in the study area?" or more complex questions to estimate loads, test differences between sites, etc.

4.1.1 Constituent List for Water Quality Samples

Modest changes to the characterization constituent list should be considered based on the lack of detection or alternate methods to characterize the same conditions. If assessment questions change or the monitoring design is changed substantially, the constituent list should be reevaluated. The following adjustments to the current monitoring design are recommended for outfall monitoring:

- Total nitrogen and ammonia could be replaced by nitrate plus nitrate and total Kjeldahl nitrogen (TKN) or total organic nitrogen if this is preferred to better understand the available inorganic and organic carbon fractions. Although TMDL efforts have focused on ammonia, ammonia concentrations are generally not of concern in urban runoff unless non-stormwater untreated wastewater sources are comingled.
- *Enterococci* should be removed from the sample collection list. *Enterococci* has Statewide Bacteria Provision water quality objectives that are applicable to saltwater. If *E. coli* sample collection is continued, collection of *Enterococci* does not provide additional highly useful information related to impairments or sources of pathogens.
- Addition of total and dissolved organic carbon. These provide good indicators of toxicant availability to aquatic life for metals (e.g., using Biotic Ligand Model) and some pesticides. Organic carbon can also be variable in urban runoff with higher peaks in early season storm events.
- Addition of filtered metals to be paired with total metals. Filtration is best performed within 15 minutes of the completion of the composite or grab sample using vacuum type filter "cones". Filtered samples are a better representation of aquatic life exposure for comparison to CTR objectives. The use of dissolved metals would likely demonstrate that CTR WQOs are not exceeded. Metals filtration within 15 minutes of sample collection or composite completion for storm samples can be logistically infeasible, and some results may need to be qualified for the unavoidable holding time exceedance. If dissolved samples are collected, continued collection of total metals would be less critical, but still useful to understand the sediment-bound metals and partitioning between total and dissolved which can be transformed in the receiving water.

The following adjustments are recommended to the once per permit term outfall monitoring:

- Antimony, arsenic, beryllium, cadmium, chromium (total), selenium, silver, thallium, and cyanide should be removed as they are not commonly detected in urban runoff at concentrations of concern and do not provide useful information for urban runoff management.
- Organochlorine pesticides should be removed from the once per permit term screening and any other monitoring that is not directly connected to a known impairment. Organochlorine pesticides were not detected in the once per permit monitoring and are primarily legacy compounds.
- Pyrethroid pesticides should be added to the once per permit term screening based on the CEC study recommendation. Measurement or calculation of the dissolved (bioavailable) fraction should be considered such that either filtered samples or organic carbon (filtered and unfiltered) are analyzed. In may also be reasonable to leverage data collected elsewhere in California, though this may overestimate Co-Permittee concentrations.

Appendix A. Water Quality Sampling Events for all Sites

Table A-1. Sampling Event Dates for Each Monitoring Location During Wet and Dry Weather Conditions

Agency	Monitoring Type	Site ID	Sample Date
Cloverdale	Outfall	CL01	2/25/2019
Cotati	Outfall	CO01	11/8/2017
Cotati	Outfall	CO01	3/1/2018
Cotati	Outfall	CO01	11/21/2018
Cotati	Outfall	CO01	1/16/2019
Cotati	Outfall	CO02	11/26/2019
Cotati	Outfall	CO02	1/16/2020
Cotati	Outfall	CO02	11/17/2020
Cotati	Outfall	CO02	1/27/2021
Cotati	Outfall	CO03	9/24/2019
Cotati	Outfall	CO03	8/28/2020
Cotati	Receiving water	CO01-RW	11/8/2017
Cotati	Receiving water	CO01-RW	3/1/2018
Cotati	Receiving water	CO01-RW	11/21/2018
Cotati	Receiving water	CO01-RW	1/16/2019
Cotati	Receiving water	CO01-RW	11/26/2019
Cotati	Receiving water	CO01-RW	1/16/2020
Cotati	Receiving water	CO01-RW	11/17/2020
Cotati	Receiving water	CO01-RW	1/4/2021
Cotati	Receiving water	CO03-RW	8/28/2020
Healdsburg	Outfall	HE-M-LW	2/13/2019
Rohnert Park	Outfall	RP01	9/28/2017
Rohnert Park	Outfall	RP01	11/8/2017
Rohnert Park	Outfall	RP01	1/8/2018
Rohnert Park	Outfall	RP01	4/3/2018
Rohnert Park	Outfall	RP01	9/18/2018
Rohnert Park	Outfall	RP01	9/25/2018
Rohnert Park	Outfall	RP01	10/2/2018
Rohnert Park	Outfall	RP01	11/21/2018
Rohnert Park	Outfall	RP01	9/18/2019
Rohnert Park	Outfall	RP01	9/24/2019
Rohnert Park	Outfall	RP01	11/26/2019
Rohnert Park	Outfall	RP01	12/18/2019
Rohnert Park	Outfall	RP01	9/15/2020
Rohnert Park	Outfall	RP01	9/29/2020
Rohnert Park	Outfall	RP01	11/17/2020
Rohnert Park	Outfall	RP01	12/16/2020
Rohnert Park	Receiving water	RP01-RW	1/8/2018
Rohnert Park	Receiving water	RP01-RW	3/1/2018
Rohnert Park	Receiving water	RP01-RW	3/13/2018
Rohnert Park	Receiving water	RP01-RW	1/9/2019
Rohnert Park	Receiving water	RP01-RW	1/16/2019

Agency	Monitoring Type	Site ID	Sample Date
Rohnert Park	Receiving water	RP01-RW	11/26/2019
Rohnert Park	Receiving water	RP01-RW	12/18/2019
Rohnert Park	Receiving water	RP01-RW	1/16/2020
Rohnert Park	Receiving water	RP01-RW	11/17/2020
Rohnert Park	Receiving water	RP01-RW	12/16/2020
Santa Rosa	Outfall	SR01	3/20/2018
Santa Rosa	Outfall	SR01	10/2/2018
Santa Rosa	Outfall	SR01	1/16/2019
Santa Rosa	Outfall	SR01	11/26/2019
Santa Rosa	Outfall	SR01	4/4/2020
Santa Rosa	Outfall	SR01	11/17/2020
Santa Rosa	Outfall	SR01	2/1/2021
Santa Rosa	Outfall	SR02	3/13/2018
Santa Rosa	Outfall	SR02	10/2/2018
Santa Rosa	Outfall	SR02	1/16/2019
Santa Rosa	Outfall	SR02	11/26/2019
Santa Rosa	Outfall	SR02	4/4/2020
Santa Rosa	Outfall	SR02	11/17/2020
Santa Rosa	Outfall	SR02	2/1/2021
Santa Rosa	Outfall	SR03	9/5/2017
Santa Rosa	Outfall	SR03	9/20/2017
Santa Rosa	Outfall	SR03	10/5/2017
Santa Rosa	Outfall	SR03	9/5/2018
Santa Rosa	Outfall	SR03	9/26/2018
Santa Rosa	Outfall	SR03	8/28/2019
Santa Rosa	Outfall	SR03	9/10/2019
Santa Rosa	Outfall	SR03	7/23/2020
Santa Rosa	Outfall	SR03	8/25/2020
Santa Rosa	Outfall	SR04	9/5/2017
Santa Rosa	Outfall	SR04	9/20/2017
Santa Rosa	Outfall	SR04	10/5/2017
Santa Rosa	Outfall	SR04	9/5/2018
Santa Rosa	Outfall	SR04	9/26/2018
Santa Rosa	Outfall	SR04	8/28/2019
Santa Rosa	Outfall	SR04	9/10/2019
Santa Rosa	Outfall	SR04	7/23/2020
Santa Rosa	Outfall	SR04	8/25/2020
Santa Rosa	Receiving water	SR01-RW	3/13/2018
Santa Rosa	Receiving water	SR01-RW	3/21/2018
Santa Rosa	Receiving water	SR01-RW	10/2/2018
Santa Rosa	Receiving water	SR01-RW	1/16/2019
Santa Rosa	Receiving water	SR01-RW	2/13/2019
Santa Rosa	Receiving water	SR01-RW	11/26/2019
Santa Rosa	Receiving water	SR01-RW	1/16/2020
Santa Rosa	Receiving water	SR01-RW	4/4/2020
Santa Rosa	Receiving water	SR01-RW	5/11/2020
Santa Rosa	Receiving water	SR01-RW	11/17/2020
Santa Rosa	Receiving water	SR01-RW	12/17/2020

Agency	Monitoring Type	Site ID	Sample Date
Santa Rosa	Receiving water	SR01-RW	2/1/2021
Santa Rosa	Receiving water	SR01-RW	2/11/2021
Santa Rosa	Receiving water	SR02-RW	3/13/2018
Santa Rosa	Receiving water	SR02-RW	3/21/2018
Santa Rosa	Receiving water	SR02-RW	10/2/2018
Santa Rosa	Receiving water	SR02-RW	1/16/2019
Santa Rosa	Receiving water	SR02-RW	2/13/2019
Santa Rosa	Receiving water	SR02-RW	11/26/2019
Santa Rosa	Receiving water	SR02-RW	1/16/2020
Santa Rosa	Receiving water	SR02-RW	4/4/2020
Santa Rosa	Receiving water	SR02-RW	5/11/2020
Santa Rosa	Receiving water	SR02-RW	11/17/2020
Santa Rosa	Receiving water	SR02-RW	12/17/2020
Santa Rosa	Receiving water	SR02-RW	2/1/2021
Santa Rosa	Receiving water	SR02-RW	2/11/2021
Santa Rosa	Receiving water	SR03-RW	9/5/2017
Santa Rosa	Receiving water	SR03-RW	10/5/2017
Santa Rosa	Receiving water	SR03-RW	9/5/2018
Santa Rosa	Receiving water	SR03-RW	9/26/2018
Santa Rosa	Receiving water	SR03-RW	8/28/2019
Santa Rosa	Receiving water	SR03-RW	9/10/2019
Santa Rosa	Receiving water	SR03-RW	7/23/2020
Santa Rosa	Receiving water	SR03-RW	8/25/2020
Santa Rosa	Receiving water	SR04-RW	9/5/2017
Santa Rosa	Receiving water	SR04-RW	9/20/2017
Santa Rosa	Receiving water	SR04-RW	10/5/2017
Santa Rosa	Receiving water	SR04-RW	9/5/2018
Santa Rosa	Receiving water	SR04-RW	9/26/2018
Santa Rosa	Receiving water	SR04-RW	8/28/2019
Santa Rosa	Receiving water	SR04-RW	9/10/2019
Santa Rosa	Receiving water	SR04-RW	7/23/2020
Santa Rosa	Receiving water	SR04-RW	8/25/2020
Santa Rosa	Receiving water	SR05-RW	3/21/2018
Santa Rosa	Receiving water	SR05-RW	1/16/2019
Santa Rosa	Receiving water	SR05-RW	2/13/2019
Santa Rosa	Receiving water	SR05-RW	1/16/2020
Santa Rosa	Receiving water	SR05-RW	5/11/2020
Santa Rosa	Receiving water	SR05-RW	12/17/2020
Santa Rosa	Receiving water	SR05-RW	2/11/2021
Sebastopol	Outfall	SE01	11/8/2017
Sebastopol	Outfall	SE01	3/1/2018
Sebastopol	Outfall	SE01	4/20/2018
Sebastopol	Outfall	SE01	4/30/2018
Sebastopol	Outfall	SE01	10/2/2018
Sebastopol	Outfall	SE01	1/30/2019
Sebastopol	Outfall	SE01	2/1/2019
Sebastopol	Outfall	SE01	4/30/2019
Sebastopol	Outfall	SE01	9/17/2019

Agency	Monitoring Type	Site ID	Sample Date
Sebastopol	Outfall	SE01	11/26/2019
Sebastopol	Outfall	SE01	3/6/2020
Sebastopol	Outfall	SE01	3/29/2020
Sebastopol	Outfall	SE01	9/23/2020
Sebastopol	Outfall	SE01	10/18/2020
Sebastopol	Outfall	SE01	11/17/2020
Sebastopol	Outfall	SE01	1/26/2021
Sebastopol	Receiving water	SE01-RW	11/8/2017
Sebastopol	Receiving water	SE01-RW	11/17/2017
Sebastopol	Receiving water	SE01-RW	3/1/2018
Sebastopol	Receiving water	SE01-RW	10/2/2018
Sebastopol	Receiving water	SE01-RW	2/1/2019
Sebastopol	Receiving water	SE01-RW	11/26/2019
Sebastopol	Receiving water	SE01-RW	3/29/2020
Sebastopol	Receiving water	SE01-RW	11/17/2020
Sebastopol	Receiving water	SE01-RW	1/26/2021
Sonoma County	Outfall	SC01	5/11/2017
Sonoma County	Outfall	SC01	9/11/2017
Sonoma County	Outfall	SC01	9/19/2017
Sonoma County	Outfall	SC01	3/1/2018
Sonoma County	Outfall	SC01	1/16/2019
Sonoma County	Outfall	SC01	2/12/2019
Sonoma County	Outfall	SC01	2/13/2019
Sonoma County	Outfall	SC01	11/26/2019
Sonoma County	Outfall	SC01	1/16/2020
Sonoma County	Outfall	SC01	4/24/2020
Sonoma County	Outfall	SC01	8/27/2020
Sonoma County	Outfall	SC01	11/17/2020
Sonoma County	Outfall	SC01	12/17/2020
Sonoma County	Outfall	SC02	12/11/2014
Sonoma County	Outfall	SC02	1/5/2016
Sonoma County	Outfall	SC02	3/11/2016
Sonoma County	Outfall	SC02	2/2/2017
Sonoma County	Outfall	SC02	3/24/2017
Sonoma County	Outfall	SC02	3/1/2018
Sonoma County	Outfall	SC02	1/16/2019
Sonoma County	Outfall	SC02	2/12/2019
Sonoma County	Outfall	SC02	2/13/2019
Sonoma County	Outfall	SC02	12/1/2019
Sonoma County	Outfall	SC02	1/16/2020
Sonoma County	Outfall	SC02	11/17/2020
Sonoma County	Outfall	SC02	12/17/2020
Sonoma County	Outfall	SC03	12/11/2014
Sonoma County	Outfall	SC03	1/5/2016
Sonoma County	Outfall	SC03	3/11/2016
Sonoma County	Outfall	SC03	2/2/2017
Sonoma County	Outfall	SC03	3/24/2017
Sonoma County	Outfall	SC03	3/1/2018

Agency	Monitoring Type	Site ID	Sample Date
Sonoma County	Outfall	SC03	1/16/2019
Sonoma County	Outfall	SC03	2/12/2019
Sonoma County	Outfall	SC03	2/13/2019
Sonoma County	Outfall	SC03	12/1/2019
Sonoma County	Outfall	SC03	1/16/2020
Sonoma County	Outfall	SC03	11/17/2020
Sonoma County	Outfall	SC03	12/17/2020
Sonoma County	Receiving water	SC01-RW	5/11/2017
Sonoma County	Receiving water	SC01-RW	3/1/2018
Sonoma County	Receiving water	SC01-RW	1/6/2019
Sonoma County	Receiving water	SC01-RW	1/16/2019
Sonoma County	Receiving water	SC01-RW	2/1/2019
Sonoma County	Receiving water	SC01-RW	2/12/2019
Sonoma County	Receiving water	SC01-RW	2/13/2019
Sonoma County	Receiving water	SC01-RW	11/26/2019
Sonoma County	Receiving water	SC01-RW	1/16/2020
Sonoma County	Receiving water	SC01-RW	4/5/2020
Sonoma County	Receiving water	SC01-RW	4/24/2020
Sonoma County	Receiving water	SC01-RW	8/27/2020
Sonoma County	Receiving water	SC01-RW	11/17/2020
Sonoma County	Receiving water	SC01-RW	12/17/2020
Sonoma County	Receiving water	SC02-RW	1/5/2016
Sonoma County	Receiving water	SC02-RW	3/11/2016
Sonoma County	Receiving water	SC02-RW	2/2/2017
Sonoma County	Receiving water	SC02-RW	3/24/2017
Sonoma County	Receiving water	SC02-RW	3/1/2018
Sonoma County	Receiving water	SC02-RW	1/16/2019
Sonoma County	Receiving water	SC02-RW	2/12/2019
Sonoma County	Receiving water	SC02-RW	2/13/2019
Sonoma County	Receiving water	SC02-RW	12/1/2019
Sonoma County	Receiving water	SC02-RW	1/16/2020
Sonoma County	Receiving water	SC02-RW	12/17/2020
Sonoma County	Receiving water	SC03-RW	1/5/2016
Sonoma County	Receiving water	SC03-RW	3/11/2016
Sonoma County	Receiving water	SC03-RW	2/2/2017
Sonoma County	Receiving water	SC03-RW	3/24/2017
Sonoma County	Receiving water	SC03-RW	3/1/2018
Sonoma County	Receiving water	SC03-RW	1/16/2019
Sonoma County	Receiving water	SC03-RW	2/12/2019
Sonoma County	Receiving water	SC03-RW	2/13/2019
Sonoma County	Receiving water	SC03-RW	12/1/2019
Sonoma County	Receiving water	SC03-RW	1/16/2020
Sonoma County	Receiving water	SC03-RW	11/17/2020
Sonoma County	Receiving water	SC03-RW	12/17/2020
Sonoma County	Receiving water	SC04-RW	1/6/2019
Sonoma County	Receiving water	SC04-RW	2/1/2019
Sonoma County	Receiving water	SC04-RW	1/16/2020
Sonoma County	Receiving water	SC04-RW	4/5/2020

Agency	Monitoring Type	Site ID	Sample Date
Sonoma County	Receiving water	SC05-RW	1/6/2019
Sonoma County	Receiving water	SC05-RW	2/1/2019
Sonoma County	Receiving water	SC05-RW	1/16/2020
Sonoma County	Receiving water	SC05-RW	4/5/2020
Ukiah	Outfall	UK-M-NOW	2/1/2019
Windsor	Outfall	WI01	10/20/2017
Windsor	Outfall	WI01	2/28/2018
Windsor	Outfall	WI01	3/20/2018
Windsor	Outfall	WI01	3/21/2018
Windsor	Outfall	WI01	10/2/2018
Windsor	Outfall	WI01	2/12/2019
Windsor	Outfall	WI01	11/26/2019
Windsor	Outfall	WI01	1/16/2020
Windsor	Outfall	WI01	11/17/2020
Windsor	Outfall	WI01	1/26/2021
Windsor	Outfall	WI02	9/6/2017
Windsor	Outfall	WI02	6/5/2018
Windsor	Outfall	WI02	9/5/2018
Windsor	Outfall	WI02	5/7/2019
Windsor	Outfall	WI02	8/28/2019
Windsor	Outfall	WI02	6/16/2020
Windsor	Outfall	WI02	9/10/2020
Windsor	Receiving water	WI01-RW	2/28/2018
Windsor	Receiving water	WI01-RW	10/2/2018
Windsor	Receiving water	WI01-RW	2/12/2019
Windsor	Receiving water	WI01-RW	11/26/2019
Windsor	Receiving water	WI01-RW	1/16/2020
Windsor	Receiving water	WI01-RW	11/17/2020
Windsor	Receiving water	WI01-RW	1/26/2021
Windsor	Receiving water	WI02-RW	6/5/2018
Windsor	Receiving water	WI02-RW	9/5/2018