Monterey Bay Sanctuary Citizen Watershed Monitoring Network
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MONTEREY REGIONAL STORM WATER MANAGEMENT PROGRAM

SUMMARY DATA ANALYSIS AND GRAPHIC DISPLAY

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Monterey Bay National Marine Sanctuary

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OVERVIEW

The purpose of this review and report is to portray concentration and load data for storm water and dry weather runoff in a way that allows storm water program managers to evaluate the effectiveness of efforts to reduce pollutants entering the Pacific Ocean from storm drains located within the Monterey Regional Storm Water Management Program (MRSWMP) area of responsibility. We base our analysis on monitoring data collected by the volunteer citizen monitoring effort, which is led and organized by staff at the Monterey Bay National Marine Sanctuary. Monitoring of storm water runoff by the MBNMS citizen science program includes both a pre-permit time period from 2000 – 2006, prior to NPDES MS4 Phase II permits ("pre-permit"), the post-permit time period from 2007-2014 ("post-permit Phase I"), and the time period after the first MRSWMP multi-year report, 2015-2021 ("post-permit Phase II"). Please refer to annual MRSWMP monitoring reports for further explanation of protocols and methods for data collection and analysis.

Our results indicate that runoff water quality has generally improved over the last 21 years of MRSWMP monitoring, particularly during storm water runoff ("wet") events. In particular, concentrations of nitrate, copper, lead, and zinc in storm water runoff have decreased significantly since both prior to the NPDES MS4 Phase II permits in 2006 and the last multi-year MRSWMP report in 2015. Additionally, no analyte concentrations in runoff during wet events have significantly increased at any site from 2000-2021. Among the cities that were monitored (Monterey, Pacific Grove, Seaside, Salinas, Carmel, Carmel Valley, and Pajaro), water quality trends were generally similar. Management efforts that likely contributed to the observed water quality improvements include public education and outreach directed towards specific sectors, public involvement in clean-up and sampling, eliminating illicit discharges, developing guidelines and standards for construction runoff, implementing street sweeping, periodically cleaning out storm drains, and assessing sewer line integrity.

Analyte concentrations during wet events were generally higher than those measured during dry weather runoff events. This is likely due to the majority of pollutants entering outfalls during storm water runoff events, and these pollutant concentrations are particularly high since samples were collected during the first major rain event of the season (the "First Flush"). The only major pollutant measured over the MRSWMP monitoring timeframe that was consistently higher during dry weather runoff events was nitrate, likely due to nutrients added to lawns, golf courses, urban public spaces and agricultural lands, primarily during the dry season.

Despite water quality improvements over time, there were still some analytes that consistently exceeded Water Quality Objectives (WQOs). The analytes for which the 85th percentile concentration exceeded the WQO were: *E. Coli*, Enterococci, MBAS, orthophosphate-P, and turbidity for both wet and dry events; copper and zinc for wet events; and nitrate for dry events. Management practices to reduce concentrations of these analytes are recommended to ensure that water quality in the Monterey Bay continues to improve.

The report is broken into five separate analyses described below.

Section I: Comparison of Pre-Permit, Post-Permit Phase I, and Post-Permit Phase II Pollutant Concentrations for MRSWMP Jurisdictions

Our review starts with a comparison of pre-permit, post-permit Phase I, and post-permit Phase II results to discover whether there has been an improvement (or worsening) in pollutant concentrations at storm water outfalls collectively for the MRSWMP region for the years 2000 – 2021. MRSWMP cities with storm drain outfalls that discharge to the ocean or 303d listed waterbody and were sampled over this time period include Monterey and Pacific Grove (2000-2021), Seaside (2004-2021), Carmel (2007-2021), Pajaro (2008-2018), Carmel Valley (2009-2018), and Salinas (2019-2021). For each pollutant (analyte) measured consistently over the MRSWMP monitoring period, box and whisker plots of concentrations during the pre-permit, post-permit Phase I, and post-permit Phase II timeframes in order to visualize how concentrations have changed over time. Additionally, a Wilcoxon Rank-Sum test was performed to determine if there was a statistically significant difference between pre-permit, post-permit Phase I, and post-permit Phase II analyte concentrations. All sites sampled as part of MRSWMP monitoring from 2000-2021 were included in this analysis.

Section II: 85th Percentiles for Pollutants Measured

Based on data collected between 2006-2021 (post-permit Phase I and post-permit Phase II), we developed the 85th percentiles representing the highest 15% of concentrations observed in this time frame. This approach uses the 85th percentile to provide a benchmark for relative comparison between sites and is a practice used in the ASBS program as suggested by the State Water Resources Control Board (SWRCB). Water Quality Objectives for pollutants are also shown so that the 85th percentiles can be compared with concentrations established for aquatic health.

Section III: Trend Analysis of Pollutant Concentrations at Outfalls

A statistical analysis (Mann Kendall test) was performed to assess the existence of trends in concentrations at each outfall that was consistently monitored during wet conditions over all the years of monitoring data (2000-2021). The sites included in this analysis were only in Monterey and Pacific Grove.

Section IV: Instantaneous Load at Outfalls Clustered by City

Instantaneous load for pollutants was plotted at outfalls where both flow and concentration data were available for 2009-2021 for the cities of Carmel, Pacific Grove, and Monterey.

Section V: Plots of Pollutant Concentrations at Outfalls

Pollutant concentration plots were developed for monitoring data collected at each storm water outfall monitored, including pre-permit, post-permit Phase I, and post-permit Phase II monitoring. The plots included the city's 85th percentile, as well as all MRSWMP data 85th percentile for both dry and wet weather and their combined results.

SUMMARY OF MONITORING ACTIVITY

MRSWMP adopted Monterey Bay National Marine Sanctuary (Sanctuary) volunteer water quality monitoring programs in Fall 2007 (Permit Year 2).

- 2007-2008, Permit Year (PY) 2-3 MRSWMP monitoring included a Dry Run, First Flush and two dry weather events using Urban Watch protocols. Twenty-three outfalls >18"
- 2009-2010, PY 4-5 monitoring was adjusted to follow First Flush protocols for both wet and dry weather events (1 wet, 3 dry). Twenty-three outfalls >18"
- 2011, PY 6 monitoring followed First Flush protocols for both wet and dry weather events (2 wet, 2 dry). Twenty-three outfalls >18"
- 2012-2013, PY 7 of 1st Phase II MS4 Permit and PY1 of 2nd Phase II MS4 Permit monitoring followed First Flush protocols for both wet and dry weather events (2 wet, 2 dry). However, the number of outfalls changed to complement the ASBS Special Protection monitoring requirements.
- 2014-2021, PY2 - PY9 of 2nd Phase II MS4 Permit followed First Flush protocols for one wet and one dry weather events at the reduced number of outfalls to complement the ASBS Special Protection monitoring requirements.

DEFINITIONS:

Dry Run – Water samples are collected prior to the first major rainstorm of the year. It usually takes place on the Saturday after volunteer training in September. This gives volunteers an opportunity to visit their site in the daylight and collect a dry weather sample for comparison.

First Flush – Water samples are collected during the first major rainstorm of the winter season. We strive for conductivity below 1000 µS and sheeting rain on the roadway.

Second Flush – Water samples are collected during a late season rainstorm.

Spring/Summer Run – Samples are collected during the dry weather season.

METHODS:

Grab samples were collected at up to 34 storm drain outfalls greater than 18" in diameter that discharge to the ocean or a river. During the First Flush, volunteers collect two or three time series samples. Second Flush and dry weather samples include just one grab sample. Protocols include field measurements for temperature, conductivity, pH and transparency (if sufficient light) and collection of samples to be analyzed in a lab for bacteria (*E. coli* and *Enterococcus*), nutrients (nitrate as N, urea, and orthophosphate as P), total metals (copper, zinc, lead), total suspended solids, and MBAS (surfactants).

WET WEATHER SAMPLE DATES AND PRECIPITATION AMOUNT:

Table 1: Precipitation is shown for wet weather monitoring dates in 2009-2021. The Lover's Point station (KCAPACIF27) was used for reporting precipitation in Pacific Grove. The Monterey Airport (KMRY) was used for reporting precipitation in Carmel, Monterey and Seaside. The Salinas North station (CIMIS #116) was used for reporting precipitation in Salinas.

	Precipitation (in)		
Wet Sample Date	**Carmel, Monterey, Seaside**	**Salinas**	**Pacific Grove**
10/13/2009	2.92	2.02	2.92
10/17/2010	0.25	0.11	0.17
11/20/2010	1.45	0.72	0.94
10/5/2011	0.84	0.00	0.57
10/22/2012	0.24	0.00	0.30
3/6/2013	0.33	0.29	0.22
10/28/2013	0.39	0.04	0.16
11/20/2013	0.36	0.25	0.19
3/31/2014	0.38	0.19	0.31
10/25/2014	0.18	0.19	0.09
10/31/2014	1.35	0.90	1.10
11/2/2015	1.42	0.00	1.19
10/15/16	0.59	0.00	0.17
11/16/17	0.45	0.06	0.23
11/23/18	0.29	0.48	0.34
11/26/19	0.94	0.40	0.74
12/13/20	0.28	0.26	0.25
10/24/21	1.75	0.76	0.66

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Figure 1: Map of MRSWMP Monitoring Locations.

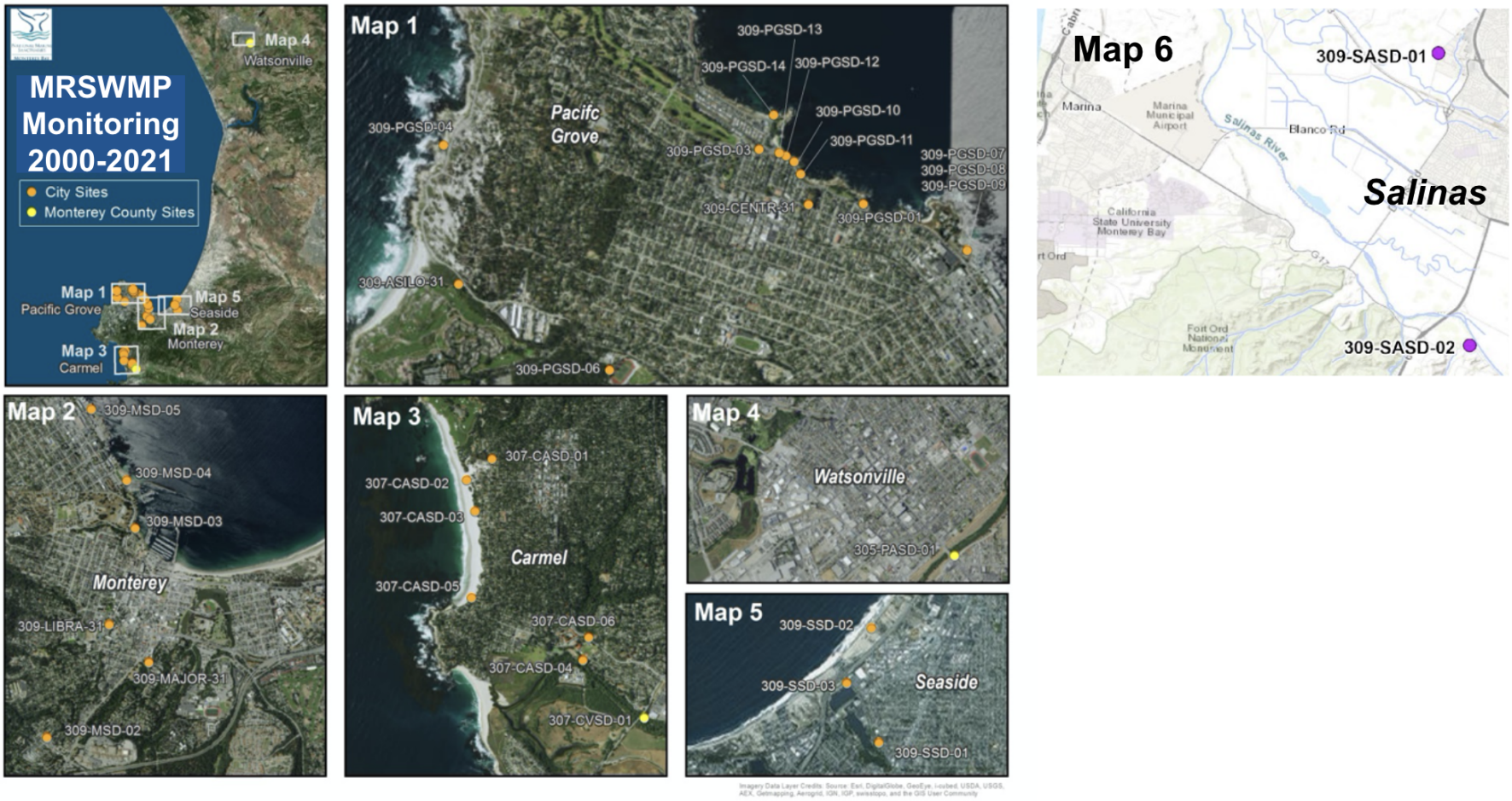

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Table 2: Monitoring Site Information

City	Site ID	Site Name
Carmel	307-CASD-01	4th Avenue
Carmel	307-CASD-02	Ocean
Carmel	307-CASD-03	8th Avenue
Carmel	307-CASD-04	Mission
Carmel	307-CASD-05	Santa Lucia
Carmel	307-CASD-06	Rio Road
Monterey	309-LIBRA-31	Hartnell Gulch
Monterey	309-MAJOR-31	Majors Creek
Monterey	309-MSD-02	Soledad (St. Timothy's)
Monterey	309-MSD-03	Twin 51's
Monterey	309-MSD-04	San Carlos
Monterey	309-MSD-05	Steinbeck
Pacific Grove	309-ASILO-31	Asilomar
Pacific Grove	309-CENTR-31	Greenwood
Pacific Grove	309-PGSD-01	8th Street
Pacific Grove	309-PGSD-03	Lover's Point
Pacific Grove	309-PGSD-04	Pico
Pacific Grove	309-PGSD-06	Congress
Pacific Grove	309-PGSD-07	Hopkins (old)
Pacific Grove	309-PGSD-08	HopkinsPG
Pacific Grove	309-PGSD-09	HopkinsMon
Pacific Grove	309-PGSD-10	Fountain
Pacific Grove	309-PGSD-11	Fountain and 15th
Pacific Grove	309-PGSD-12	Grand
Pacific Grove	309-PGSD-13	Forest
Pacific Grove	309-PGSD-14	17th Avenue
Pacific Grove	309-PGSD-15	Sea Palm
Seaside	309-SSD-01	Hilby
Seaside	309-SSD-02	Bay Street
Seaside	309-SSD-03	Hotel
Salinas	309-SASD-01	Boronda Street
Salinas	309-SASD-02	Las Palmas
Carmel Valley	307-CVSD-01	Carmel Valley
Pajaro	305-PASD-01	Pajaro

I. COMPARING PRE-PERMIT AND POST-PERMIT CONCENTRATIONS

Comparisons of the concentrations of pollutants between the pre-permit (2000 to 2006), post-permit Phase I (2007 to 2014), and post-permit Phase II (2015 to 2021) timeframes were made for pollutants consistently monitored by the MBNMS citizen science program for all sites. The term "Post-permit Phase I" refers to the time period after which the first NPDES Phase II MS4 permit was approved for Monterey County, and before the first multi-year MRSWMP report in 2015. The term "Post-permit Phase II" refers to the time period since the first multi-year MRSWMP report in 2015 through the present. Thus, both the "Post-permit Phase I" and "Post-permit Phase II" time periods had active permitting requirements for storm water quality. The pollutants that were consistently monitored during all time periods and included in statistical analyses were total copper, total zinc, total lead, nitrate-N, orthophosphate-P, *E.coli*, and total suspended solids (TSS). Additionally, MBAS was consistently monitored during the post-permit Phase I and post-permit Phase II time periods, so it was included in the statistical analyses for those timeframes. Pollutants that were not consistently monitored could not be included in the statistical comparison due to lack of data.

This comparison allows for an overall review of program effectiveness of two Monterey Peninsula cities in improving storm water pollution following intensified efforts to reduce pollution through best management practices as a result of the NPDES Phase II MS4 permit requirements and changes in management practices following the first multi-year MRSWMP report published in 2015. City efforts to reduce pollution included: public education and outreach directed towards specific sectors, public involvement in clean-up and sampling, eliminating illicit discharges, developing guidelines and standards for construction runoff, implementing street sweeping, periodically cleaning out storm drains, assessing sewer line integrity, and other measures as spelled out in the "Monterey Regional Storm Water Management Program, October 31, 2005". As more monitoring data is collected through time at other Monterey Peninsula cities, we will be able to track overall program effectiveness in the region.

The statistical comparisons to determine whether a difference existed between pre-permit, post-permit Phase I, and post-permit Phase II concentrations were made using the Wilcoxon Rank-Sum test, which is a nonparametric alternative to the sample t-test. A p-value ≤ 0.05 was selected to represent a significant difference between the two time frames. In this case, we were 95% confident that a difference existed in pollution concentrations prior to implementation of MRSWMP compared with after implementation of MRSWMP, thus concluding that a change had taken place. For this analysis, wet and dry weather results were analyzed separately because of the differences found under these two conditions.

To supplement the statistical test, box and whisker plots of the three timeframes for all sites were developed for wet and dry concentrations. Box and whisker plots show a distribution of the dataset in a convenient format for making comparisons. The box represents the range of 50% of the data with a line drawn in the middle that represents the median value. The upper and lower whiskers represent the remaining upper and lower 25% of the data, excluding outliers. Outliers (much higher or lower values) are represented by the circles drawn above or below the whiskers. Viewing these plots allows for the comparison of statistical findings with the data range differences between the three timeframes. Box and whisker plots were also developed for the cities

of Pacific Grove, Monterey, Carmel, and Seaside, so that comparisons between cities could be visualized and assessed.

Under wet conditions, concentrations of nitrate, copper, lead, and zinc decreased significantly over time. For these analytes, post-permit concentrations were significantly lower than pre-permit Phase I concentrations and post-permit Phase II concentrations were significantly lower than post-permit concentrations. *E. coli,* orthophosphate-P, TSS, and MBAS concentrations did not change significantly over time. No analytes saw increases in concentrations over time. A summary of Wilcoxon Rank Sum results with p-values for all concentration changes during wet conditions can be found in Table 3.

Under dry conditions, differences in concentrations over time were more variable. During dry conditions, the source of the flows is largely from irrigation of lawns, golf courses, urban public spaces, small springs and agricultural lands, as well as some illicit discharges or spills. Lead and TSS decreased significantly over time (post-permit Phase I concentrations were significantly lower than pre-permit concentrations, and post-permit Phase II concentrations were significantly lower than post-permit Phase I concentrations). For copper, post-permit Phase I and post-permit Phase II concentrations were significantly lower than pre-permit concentrations, but post-permit Phase I and II concentrations were not significantly different from each other. *E. coli* was significantly lower during post-permit Phase I than pre-permit, but was significantly higher during post-permit Phase II. Nitrate was significantly higher during post-permit Phase I than pre-permit, but was not significantly different during post-permit Phase II. MBAS also increased, and was significantly higher during post-permit Phase II than Phase I. A summary of Wilcoxon Rank Sum results with p-values for all concentration changes during dry conditions can be found in Table 4.

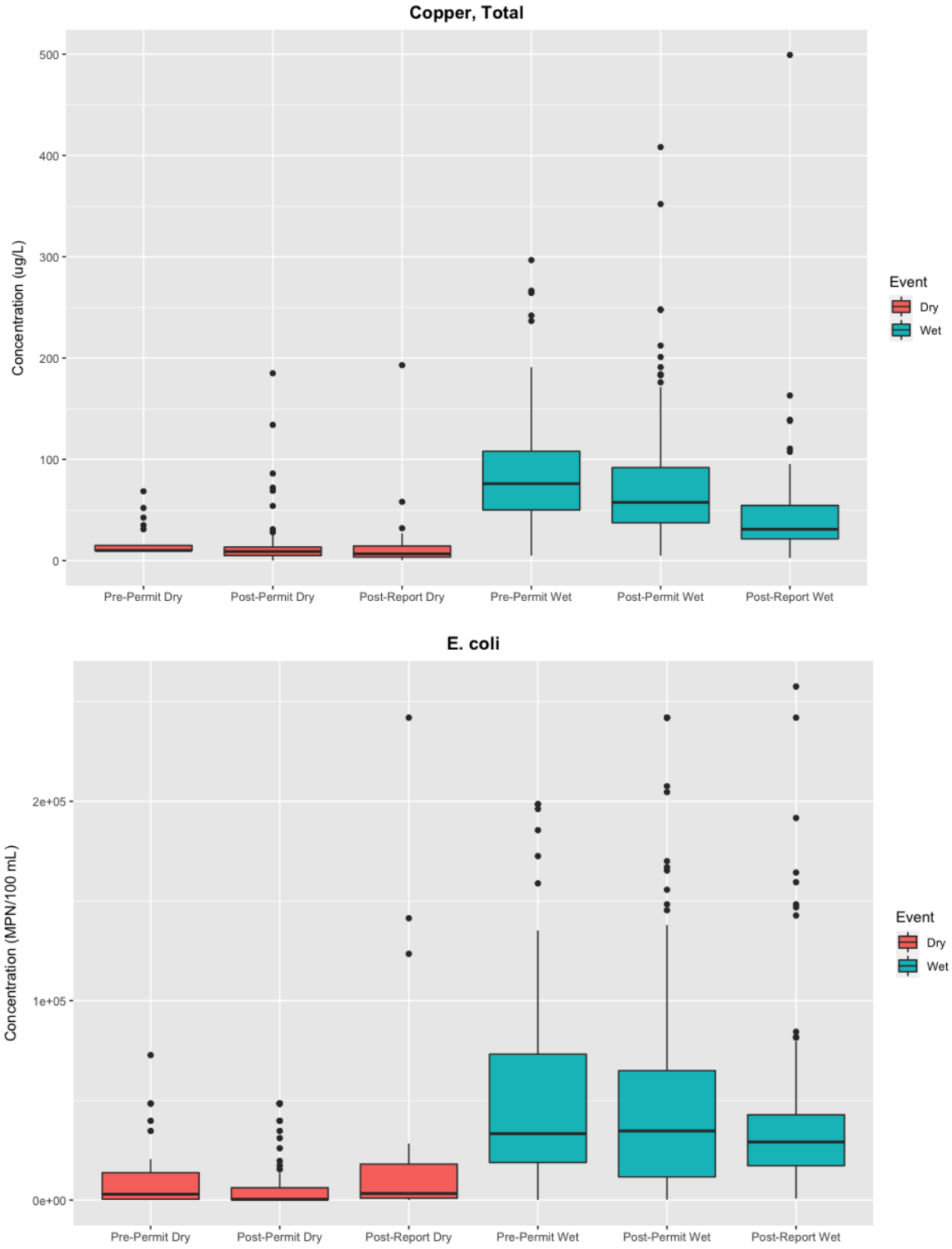
Table 3. Results of the Wilcoxon Rank-Sum test comparing pre-MRSWMP permit (2000-2006), post-MRSWMP permit (2007-2014), and post-permit Phase II (2015-2021) concentrations for sites consistently monitored by both programs during wet conditions. A p-value ≤ 0.05 is considered significant, indicating a change between the two time periods most likely occurred. Bolded values were significant, with green representing a decrease in concentrations over time and red representing an increase in concentrations over time. Dashed lines indicate that there was not sufficient data for statistical analysis.

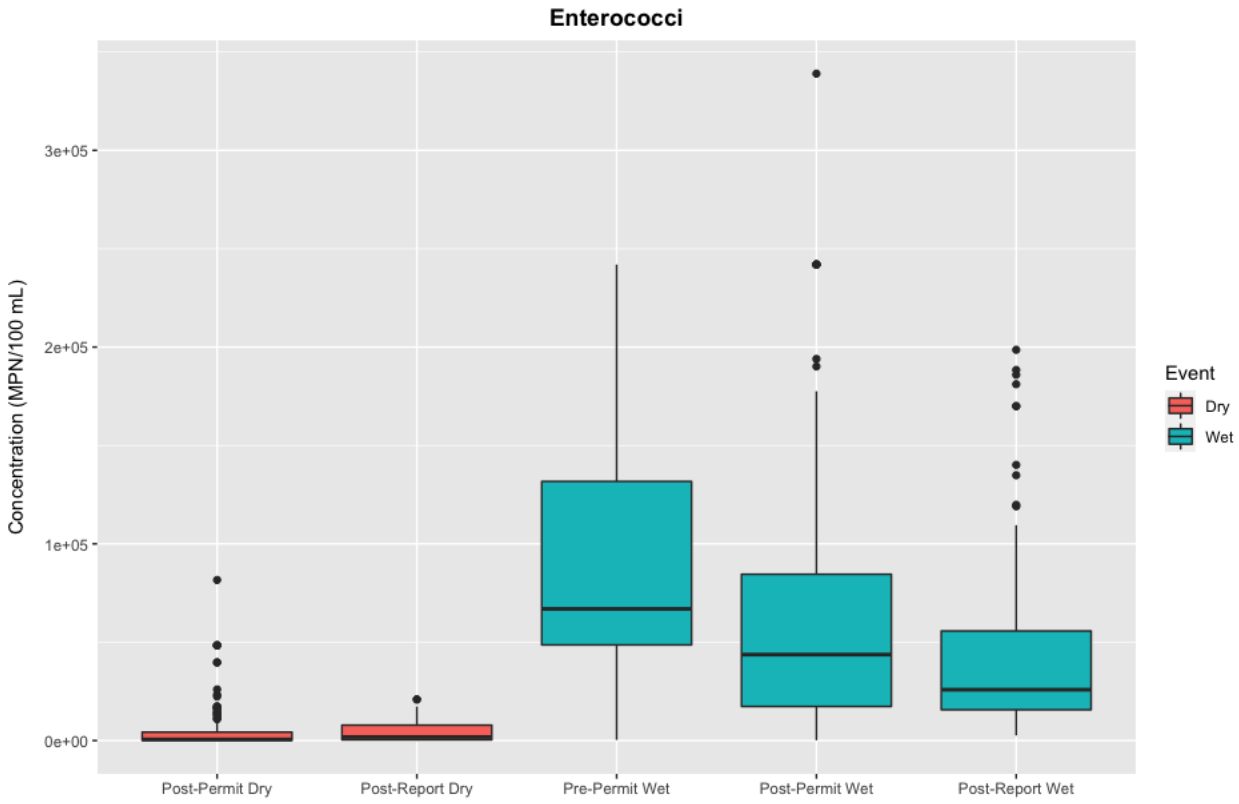
Comparison, Wet	Nitrate as N p-value	Copper p-value	E. coli p-value	MBAS p-value	Lead p-value	o-Phosphate-P p-value	Zinc p-value	TSS p-value
Pre-permit > Post-permit Phase I	**1.7e-05**	**0.01**	0.17	-	**3.3e-04**	0.18	**2.9e-04**	0.28
Pre-permit > Post-permit Phase II	**< 2.2e-16**	**7.3e-12**	0.11	-	**4.4e-09**	0.33	**2.4e-13**	0.45
Post-permit Phase I > Post-permit Phase II	**2.7e-09**	**1.54e-08**	0.42	0.15	**0.003**	0.77	**2.4e-07**	0.68

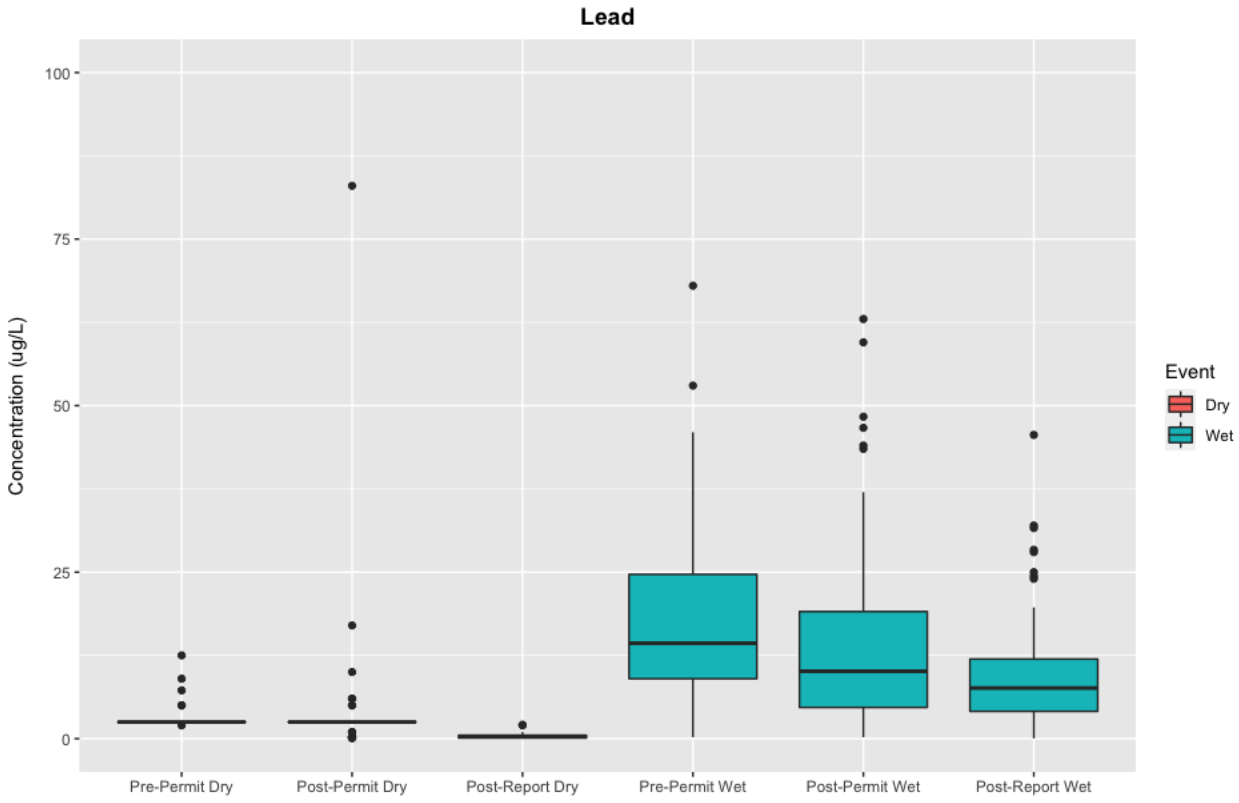
Table 4. Results of the Wilcoxon Rank-Sum test comparing pre-MRSWMP permit (2000-2006), post-MRSWMP permit (2007-2014), and post-permit Phase II (2015-2021) concentrations for sites consistently monitored by both programs during dry conditions. A p-value ≤ 0.05 is considered significant, indicating a change between the two time periods most likely occurred. Bolded values were significant, with green representing a decrease in concentrations over time and red representing an increase in concentrations over time. Dashed lines indicate that there was not sufficient data for statistical analysis.

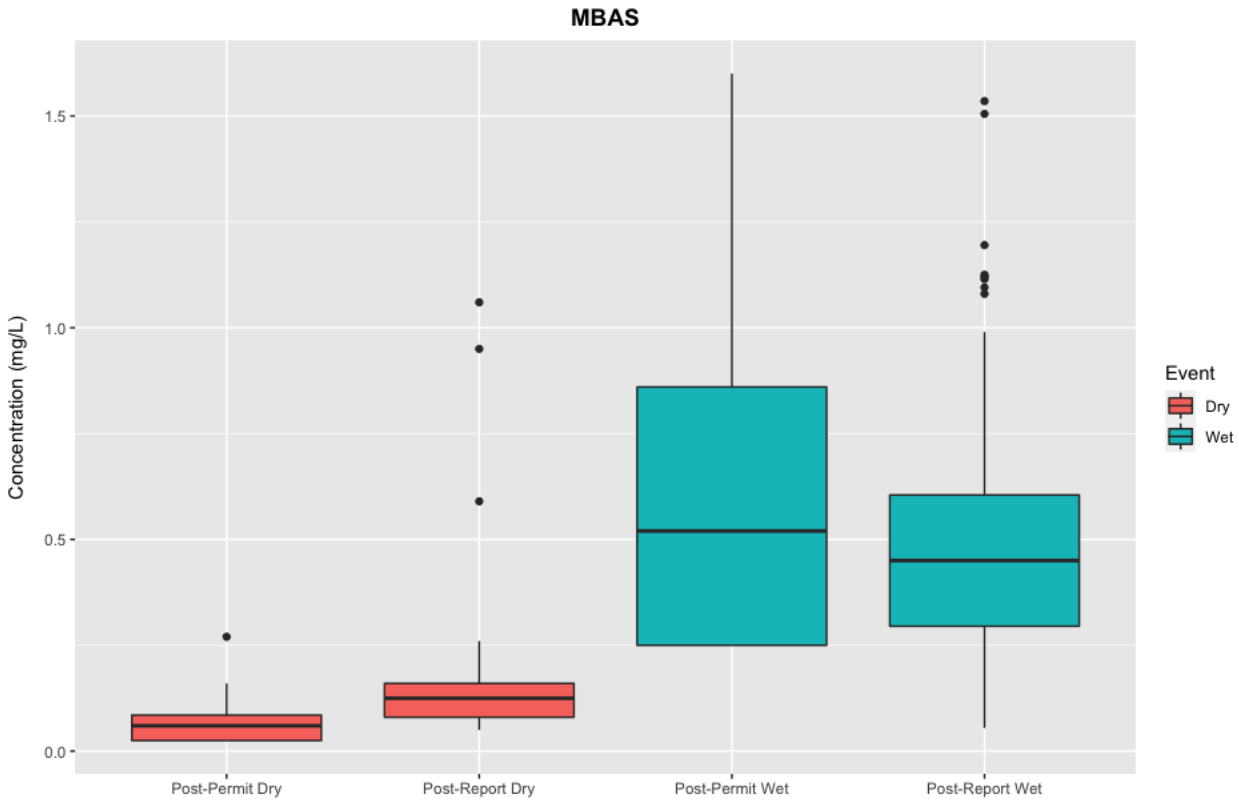
Comparison, Dry	Nitrate as N p-value	Copper p-value	E. coli p-value	MBAS p-value	Lead p-value	o-Phosphate-P p-value	Zinc p-value	TSS p-value
Pre-permit > Post-permit Phase I	-	**4.0e-04**	**0.02**	-	**0.02**	0.21	0.77	**0.001**
Post-permit Phase I > Pre-permit	**0.05**	-	-	-	-	-	-	-
Pre-permit Phase I > Post-permit Phase II	0.79	**0.001**	0.68	-	**3.2e-12**	0.27	0.49	**4.8e-04**
Post-permit Phase I > Post-permit Phase II	0.27	0.86	-	-	**< 2.2e-16**	-	-	**0.02**
Post-permit Phase II > Post-permit Phase I	-	-	**0.005**	**0.002**	-	0.32	0.68	-

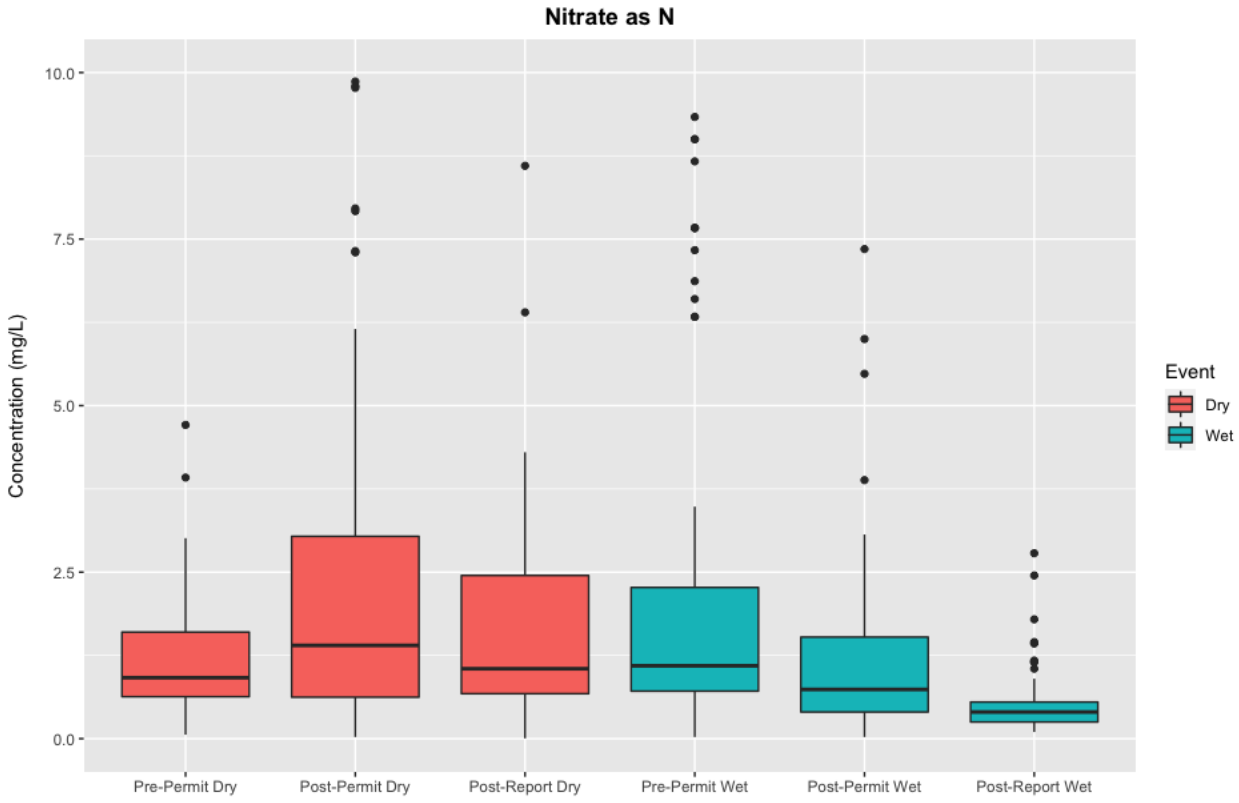
Figure 2. Boxplot and whisker plots comparing pre-permit, post-permit Phase I ("post-permit"), and post-permit Phase II ("post-report") pollutant concentrations for all sites during both dry and wet events.

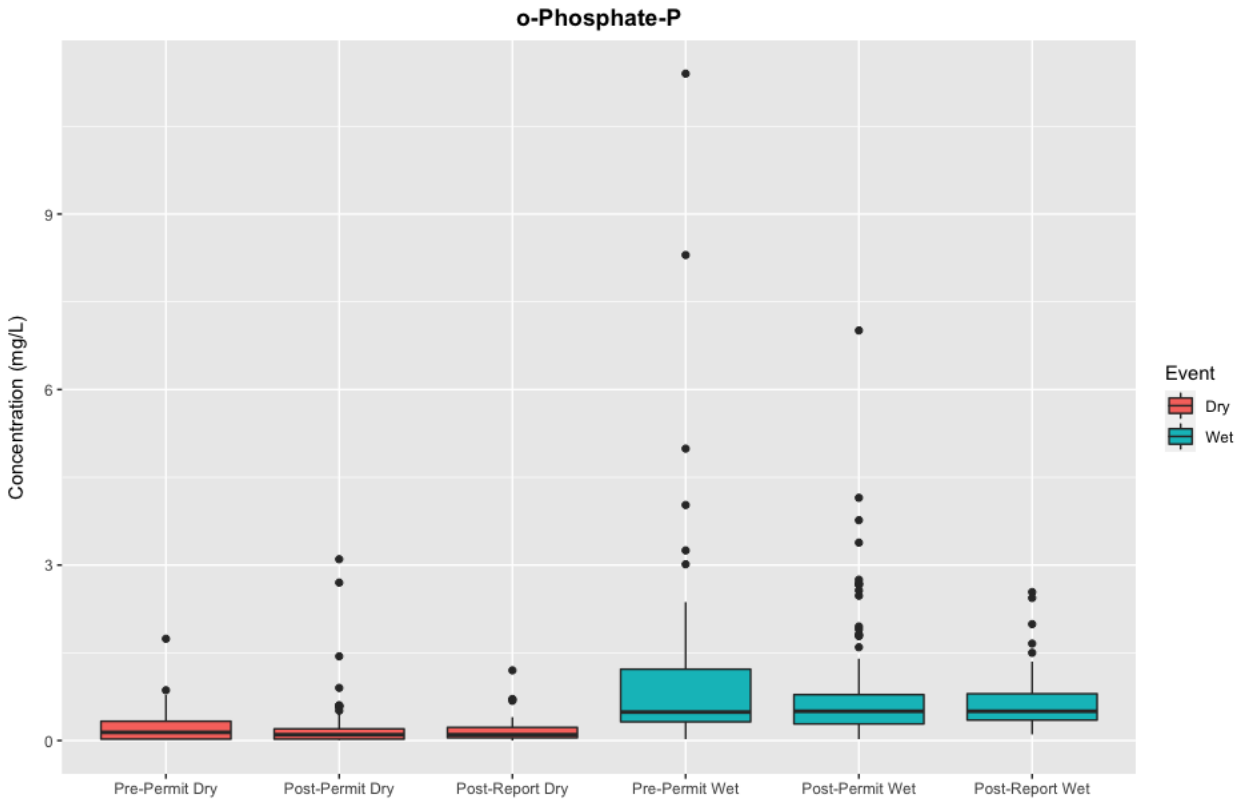


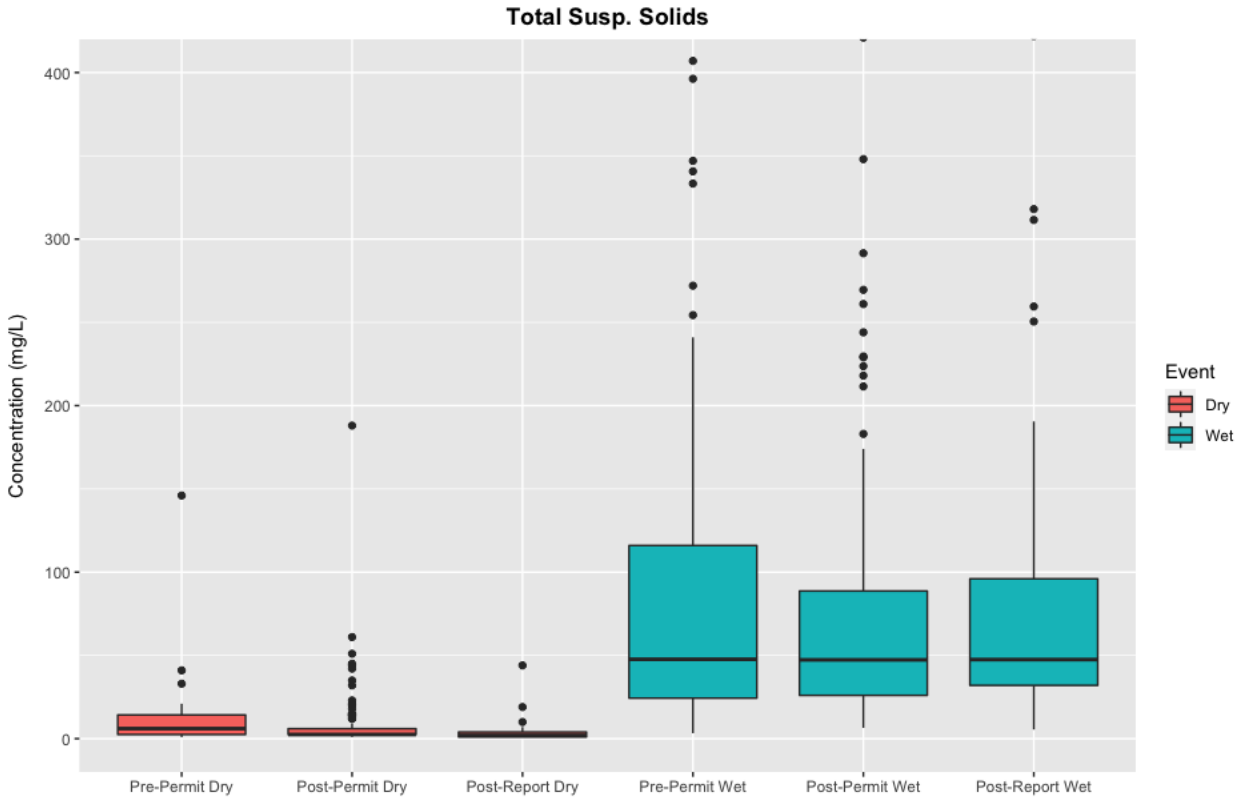

Enterococci
Concentration (MPN/100 mL)
3e+05
2e+05
1e+05
0e+00
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


Lead
Concentration (ug/L)
100
75
50
25
0
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


MBAS
Concentration (mg/L)
1.5
1.0
0.5
0.0
Post-Permit Dry
Post-Report Dry
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


Nitrate as N
Concentration (mg/L)
10.0
7.5
5.0
2.5
0.0
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


o-Phosphate-P
Concentration (mg/L)
0
3
6
9
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


Total Susp. Solids
Concentration (mg/L)
0
100
200
300
400
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet

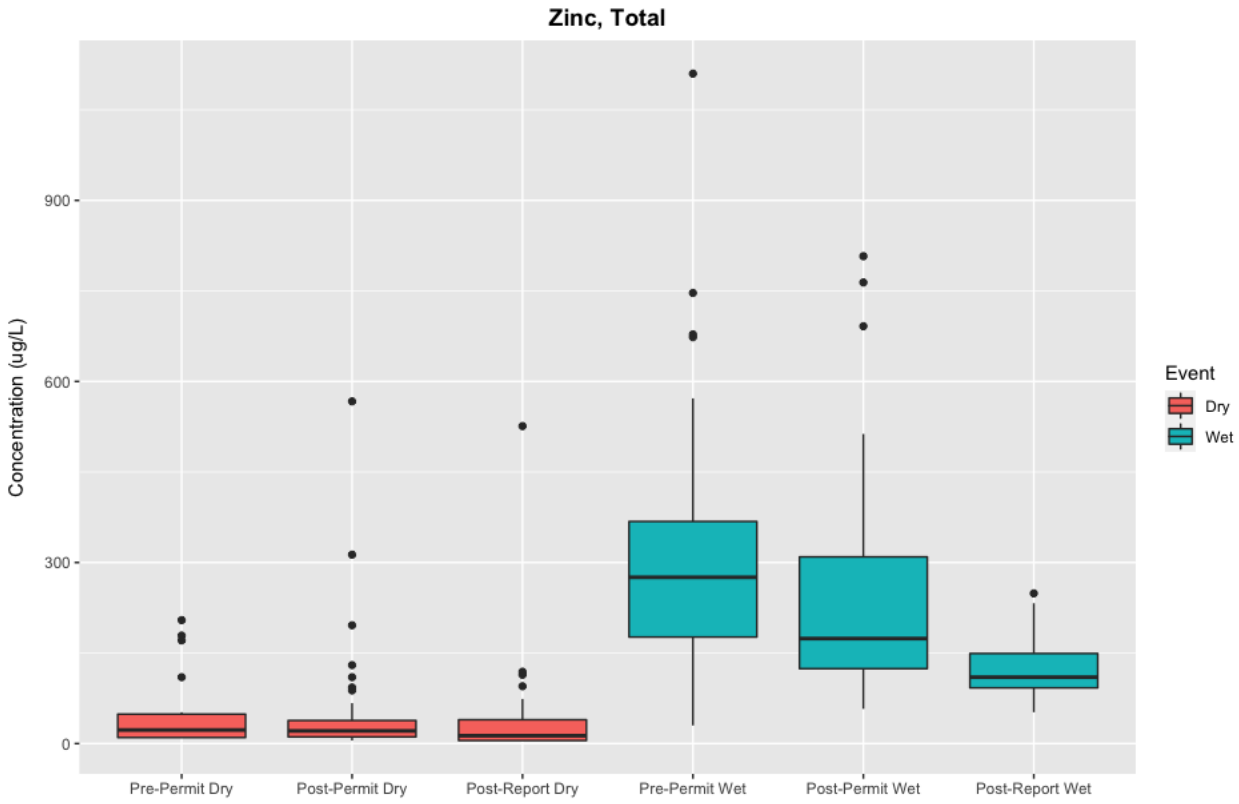
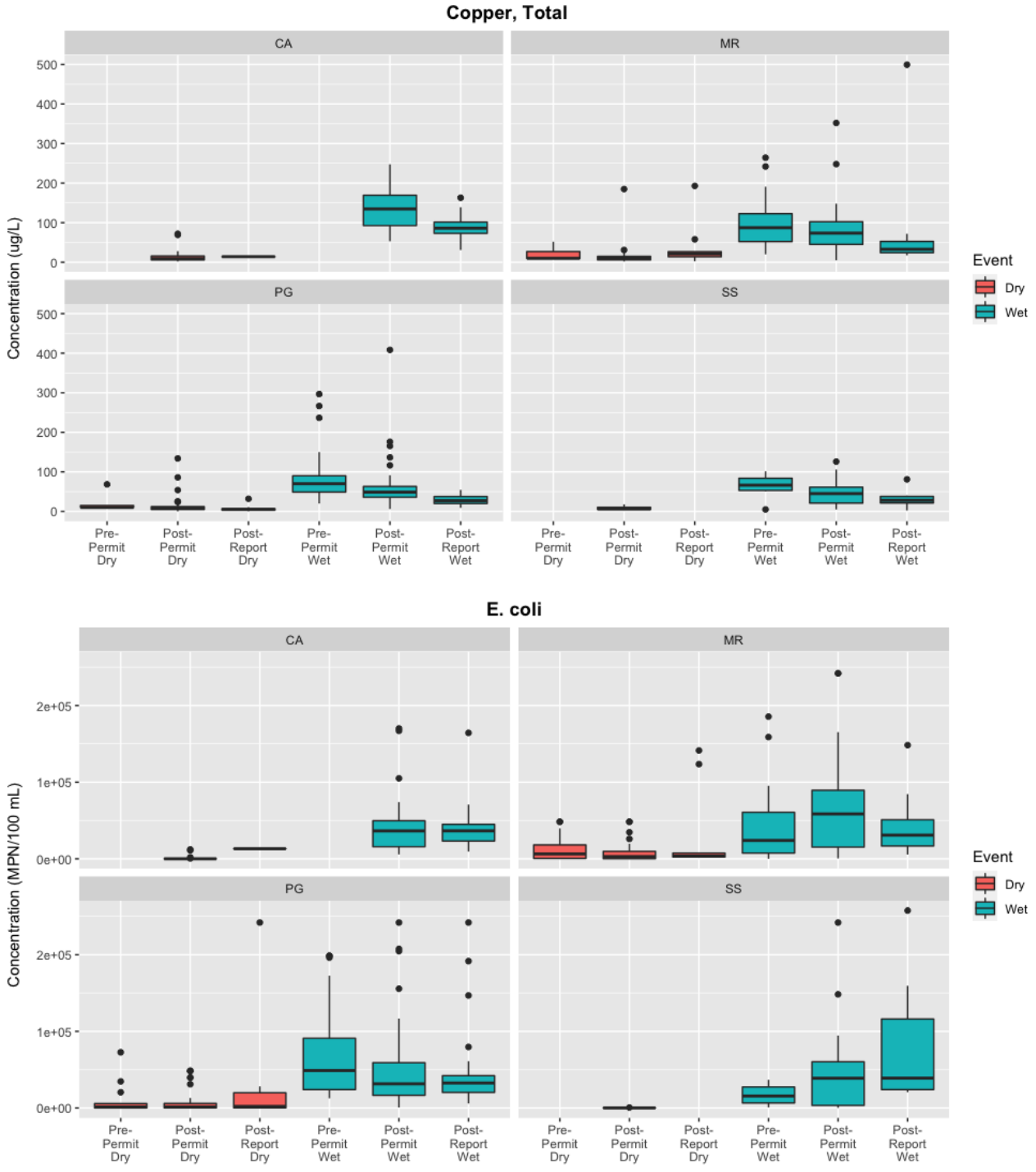
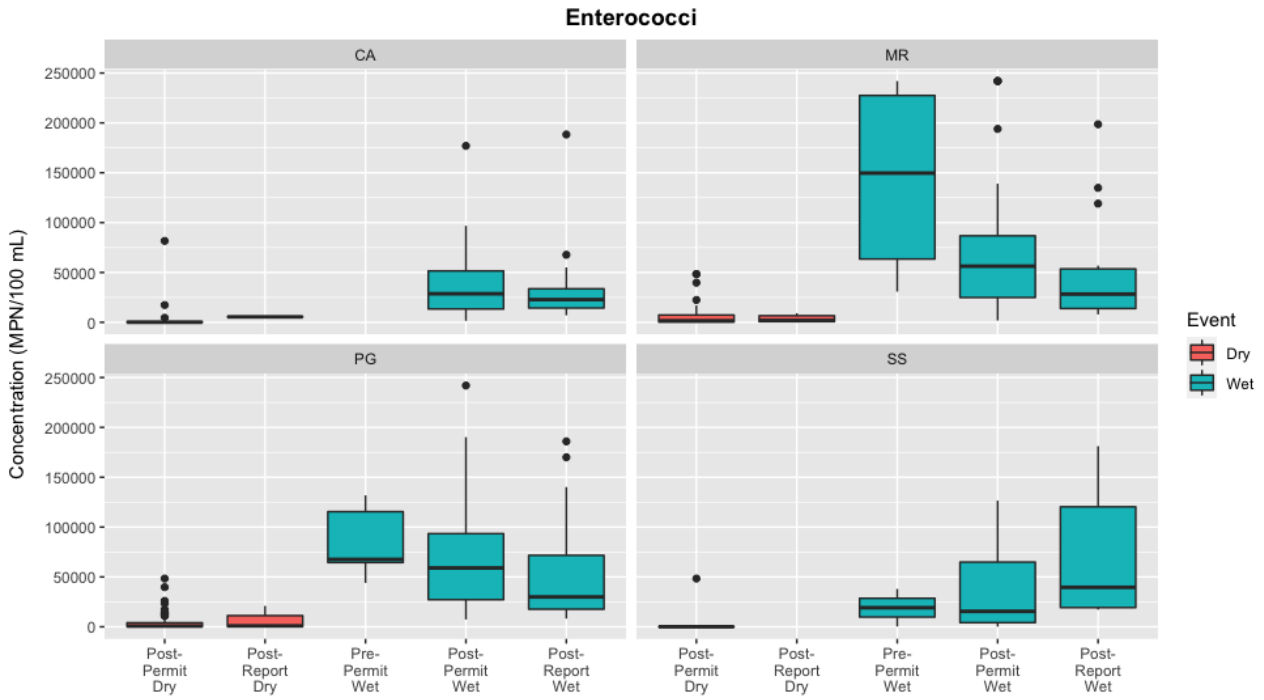
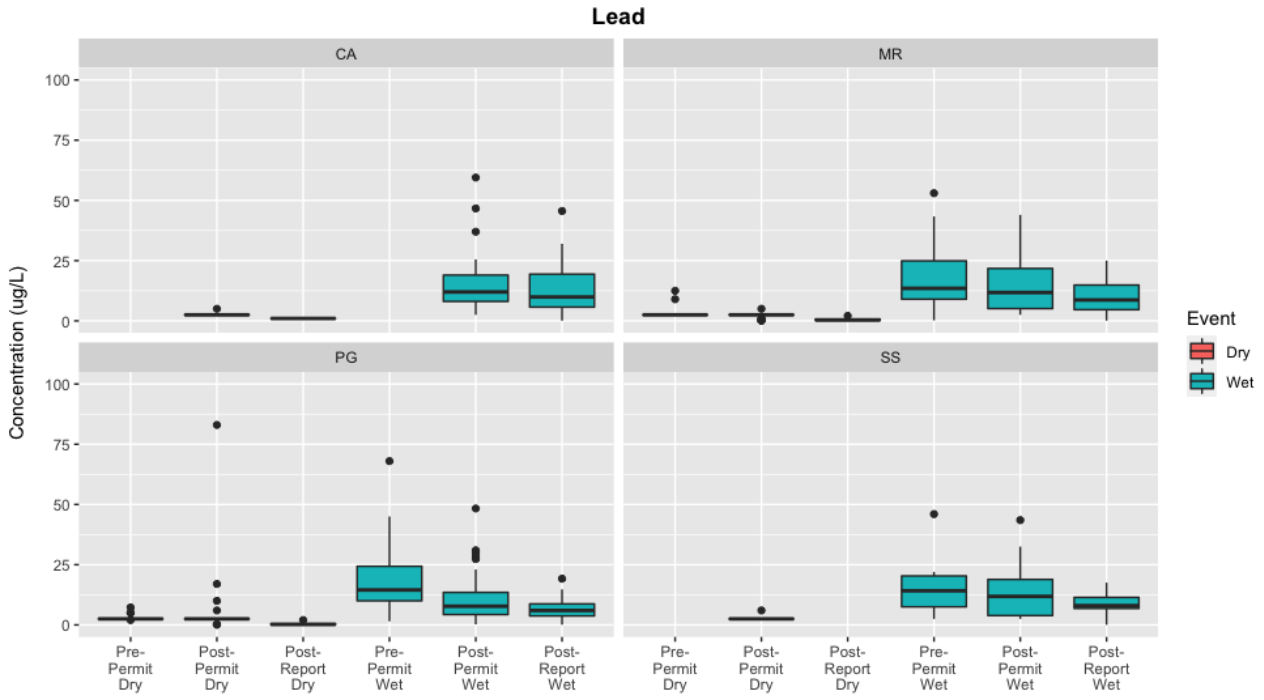
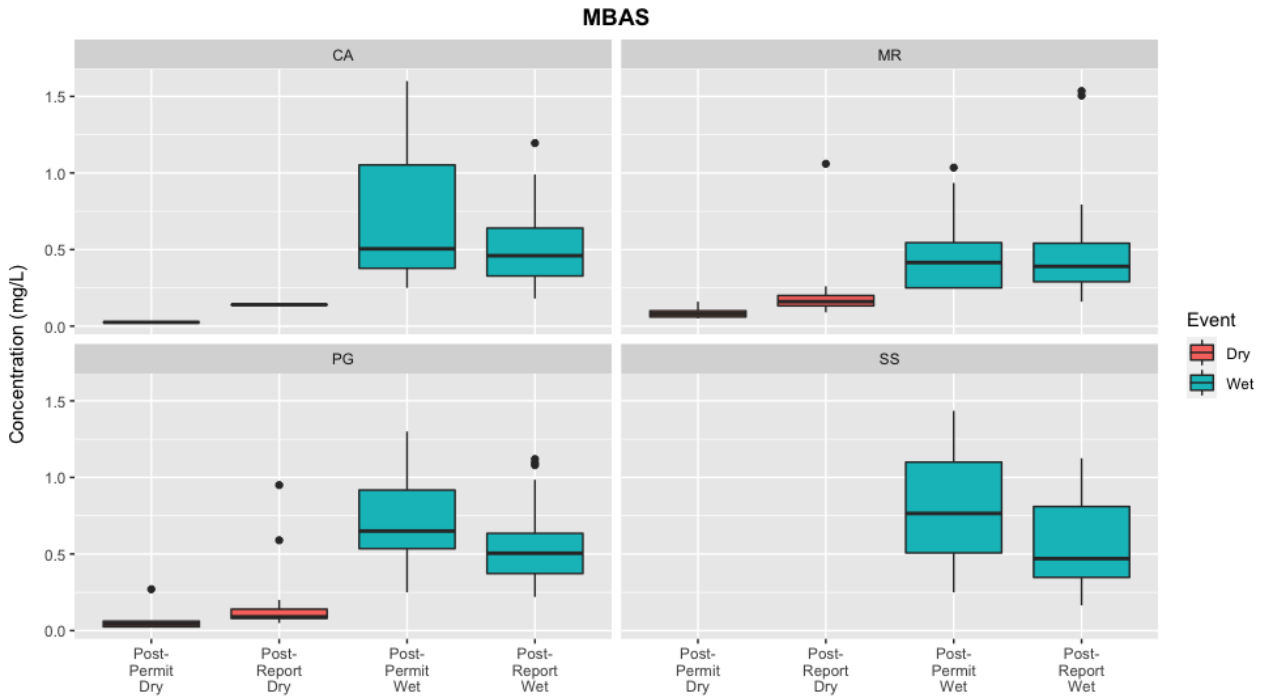

Zinc, Total
Concentration (ug/L)
900
600
300
0
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet

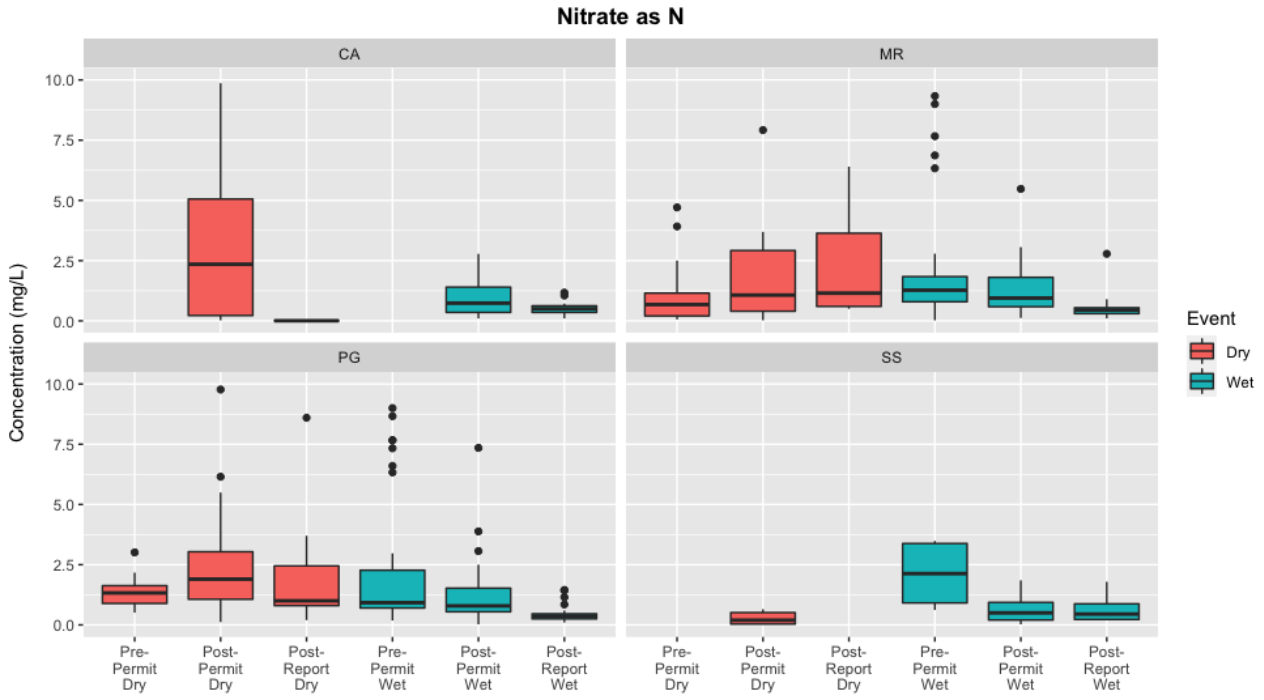
Figure 3: Box and whisker plots of analyte concentrations by city, where "CA" = Carmel, "MR" = Monterey, "PG" = Pacific Grove, and "SS" = Seaside. On these plots, Post-Permit Phase I is labelled as "Post-Permit" and Post-Permit Phase II is labelled as "Post-Report."

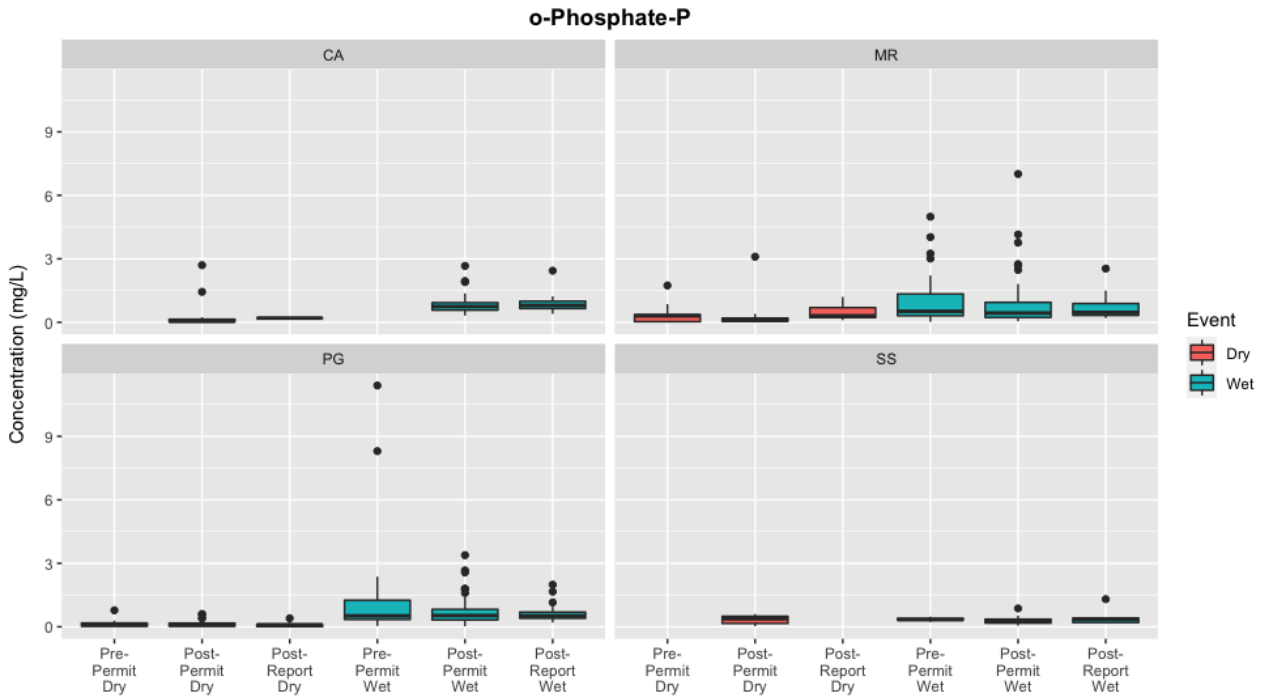


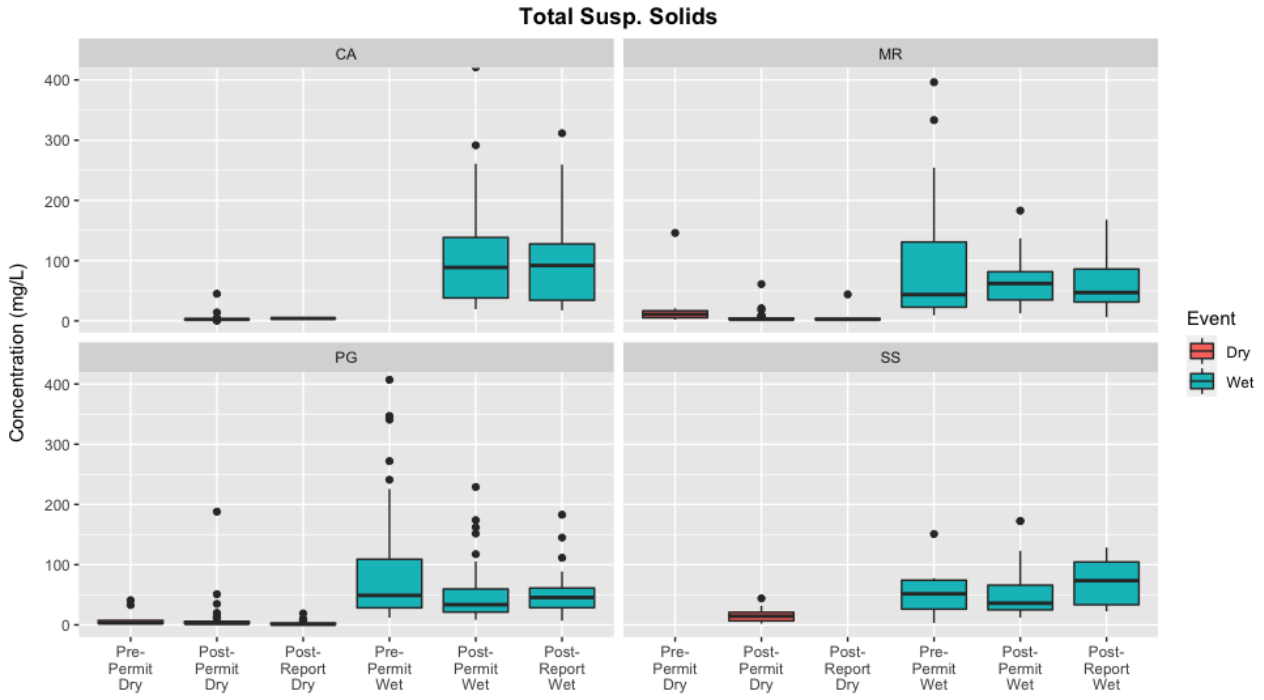

Enterococci
CA
MR
PG
SS
Concentration (MPN/100 mL)
250000
200000
150000
100000
50000
0
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


Lead
CA
MR
PG
SS
Concentration (ug/L)
100
75
50
25
0
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


MBAS
CA
MR
PG
SS
Concentration (mg/L)
1.5
1.0
0.5
0.0
Post-
Permit
Dry
Post-
Report
Dry
Post-
Permit
Wet
Post-
Report
Wet
Event
Dry
Wet


Nitrate as N
CA
MR
PG
SS
Concentration (mg/L)
10.0
7.5
5.0
2.5
0.0
Pre-
Permit
Dry
Post-
Permit
Dry
Post-
Report
Dry
Pre-
Permit
Wet
Post-
Permit
Wet
Post-
Report
Wet
Event
Dry
Wet


o-Phosphate-P
CA
MR
PG
SS
Concentration (mg/L)
0
3
6
9
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet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CA
MR
PG
SS
Concentration (mg/L)
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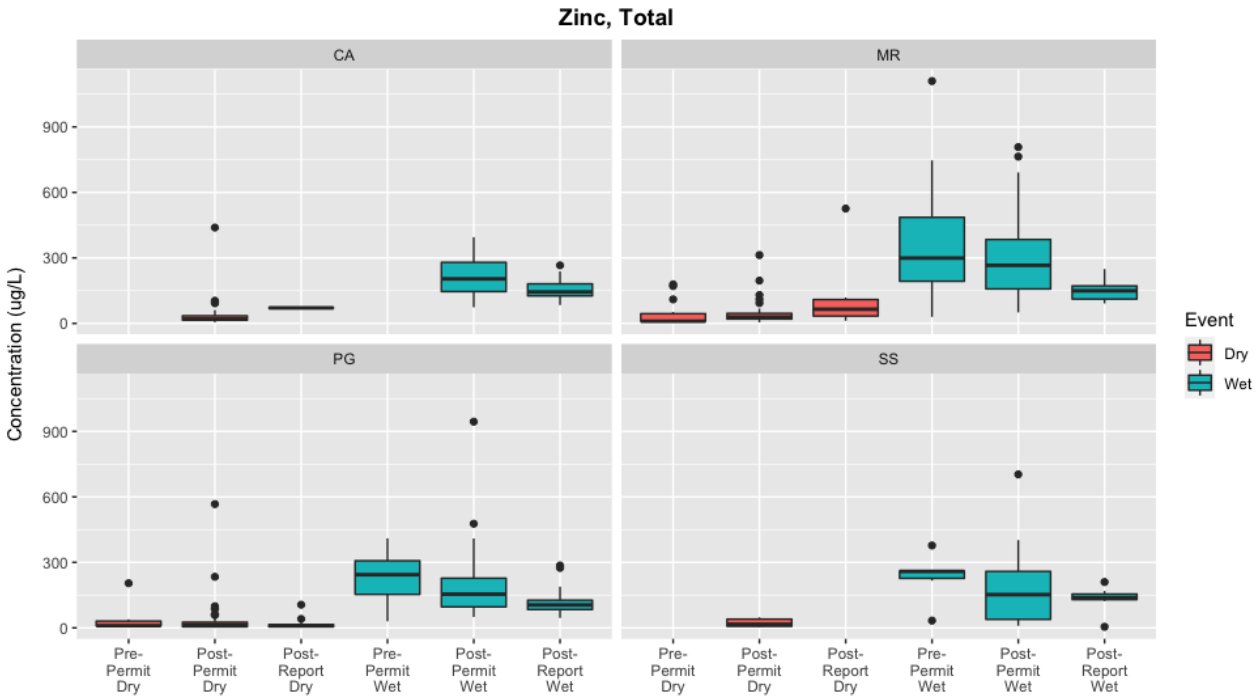
100
200
300
400
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet


Zinc, Total
CA
MR
PG
SS
Concentration (ug/L)
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300
600
900
Pre-Permit Dry
Post-Permit Dry
Post-Report Dry
Pre-Permit Wet
Post-Permit Wet
Post-Report Wet
Event
Dry
Wet

II. CONCENTRATION 85TH PERCENTILES

Monitoring data for all MRSWMP sites from 2006-2021 was analyzed to provide the 85th percentile of concentration for each pollutant or water quality measure. Percentile information can be helpful in identifying locations with the highest concentration of pollutants, indicating where a problem may exist. The 85th percentile provides a benchmark for relative comparison between sites and is a practice used in the ASBS program as requested by the SWRCB. Water Quality Objectives for pollutants are also shown so that the 85th percentiles can be compared with concentrations established for aquatic health. However, the Water Quality Objectives are limits for the receiving water body, not storm water outfalls. The concentrations of pollutants in the receiving water bodies are expected to be lower than those of the storm water outfalls, but were not sampled as part of the MRSWMP monitoring.

Pollutants assessed were total copper, total zinc, total lead, nitrate-N, orthophosphate-P, urea, *E.coli*, *Enterococcus*, total coliform, total suspended solids, MBAS, fluoride, ammonia, hardness, potassium and calcium. Water quality measures assessed were color and turbidity. Percentiles were calculated for the following scenarios:

- Combined wet and dry weather MRSWMP data by analyte for all sites
- Wet weather MRSWMP data by analyte for all sites
- Dry weather MRSWMP data by analyte for all sites
- Combined wet and dry weather MRSWMP data by analyte for each City with more than five sites
- Wet weather MRSWMP data by analyte for each City with more than five sites
- Dry weather MRSWMP data by analyte for each City with more than five sites

The terms “wet” and “dry” denote whether precipitation was occurring at the time of monitoring and do not indicate whether there was flow or not at the monitoring site. However, during dry weather monitoring, sometimes flow was absent, and a sample could not be obtained.

Our results indicate that there were some analytes that consistently exceeded Water Quality Objectives (WQOs). The analytes for which the 85th percentile concentration exceeded the WQO were: *E. Coli*, Enterococci, MBAS, orthophosphate-P, and turbidity for both wet and dry events; copper and zinc for wet events; and nitrate for dry events. Management practices to reduce concentrations of these analytes are recommended to ensure that water quality in the Monterey Bay continues to improve.

In addition to providing 85th percentiles, histograms for the combined wet and dry weather are shown in order to inform the distribution of concentrations found. For each histogram, the x-axis represents the measured concentration of an analyte and the y-axis represents the number of samples, or frequency. Typically, concentration results are skewed toward the left axis, with a predominance of lower values found and fewer high values.

For each day of wet weather monitoring, a time series of two or three samples were taken. For computation of the percentiles of concentration, the average of each day’s samples at a monitoring

site was used. When sites did not have flow, no sample was collected and therefore no concentration was determined for that day.

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CONCENTRATION 85TH PERCENTILES

Table 4: Wet and Dry Combined Percentiles: 85th concentration percentiles for wet and dry weather conditions for MRSWMP monitoring (2006-2021) shown by analyte or water quality measure for all MRSWMP sites. Highlighted values indicate where the 85th percentile of analyte concentrations exceed the WQO.

Monterey Bay		Combined Wet and Dry		Wet Weather		Dry Weather		WQO
Analyte	Units	# Samples	85th Percentile	# Samples	85th Percentile	# Samples	85th Percentile	Receiving Water
Ammonia-N	mg/L	158	0.895	105	0.93	53	0.727	< 50 mg/L
Calcium	mg/L	379	89	222	26.3	157	109	NA
Coliform, Total	MPN/100 mL	315	2.42E+05	162	2.42E+05	153	4.84E+04	NA
Color	Color Units	152	250	103	293	49	150	< 500
Color, True	Color Units	21	159	13	183	8	29.8	< 500
Copper, Total	ug/L	463	83.6	262	112	201	21.5	< 30 ug/L
E. coli	MPN/100 mL	460	5.99E+04	259	8.35E+04	201	1.73E+04	< 235 MPN/100 mL
Enterococci	MPN/100 mL	451	8.16E+04	259	1.12E+05	192	1.48E+04	< 104 MPN/100 mL
Flow	L/sec	223	533	114	1.20E+03	109	10	NA
Fluoride	mg/L	112	0.4	85	0.32	27	0.5	NA
Hardness as CaCO3	mg/L	435	371	253	107	182	447	> 10 and < 2000 mg/L
Lead, Total	ug/L	463	15.5	262	21.5	201	2.5	< 30 ug/L
Magnesium	mg/L	364	38.6	207	11.4	157	46	NA
MBAS (Surfactants)	mg/L	173	0.772	116	0.91	57	0.466	< 0.2 mg/L
Nitrate as N	mg/L	463	2.5	262	1.61	201	3.65	< 2.25 mg/L
o-Phosphate-P	mg/L	463	0.804	262	1.00	201	0.39	< 0.12 mg/L
Potassium	mg/L	173	10	116	9.83	57	10.1	< 20 mg/L
Total Susp. Solids	mg/L	456	90	255	126	201	15	< 500 mg/L
Turbidity	NTU	173	51.9	116	57.8	57	26.2	< 25 NTU
Urea	ug/L	457	408	256	539	201	172	NA
Zinc, Total	ug/L	463	238	262	303	201	88	< 200 ug/L

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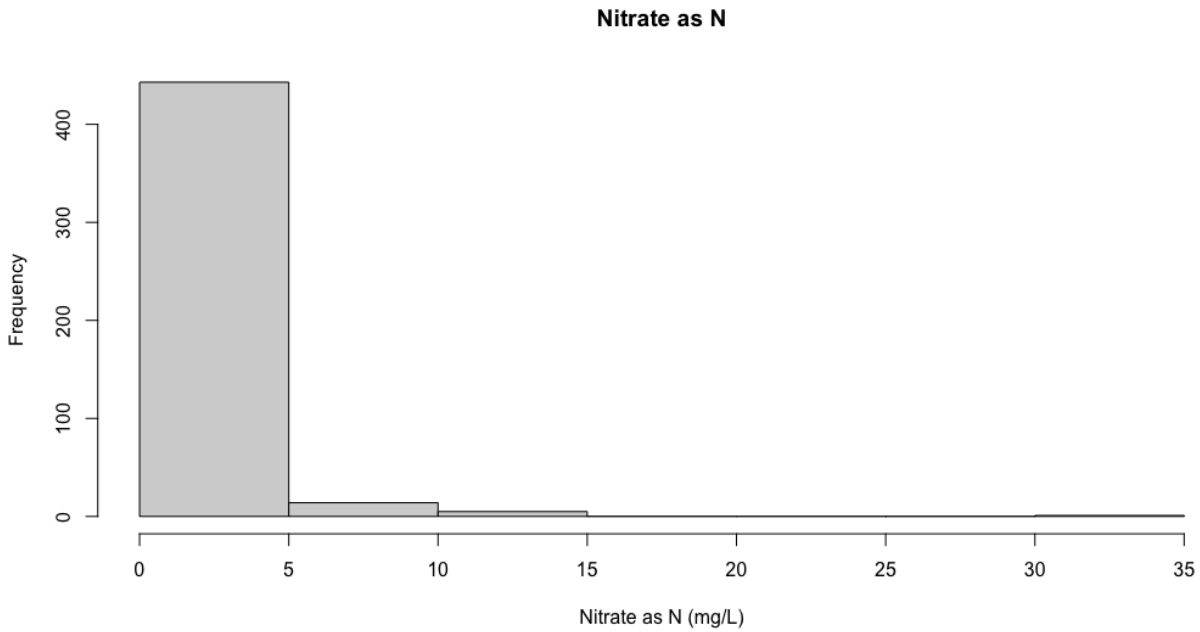
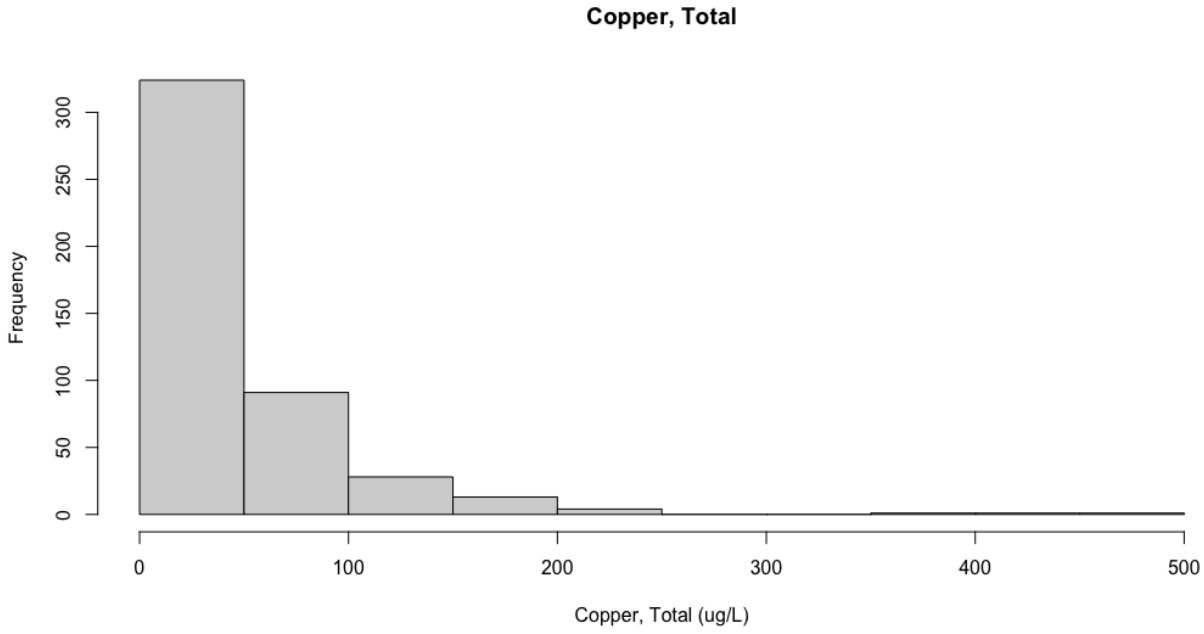
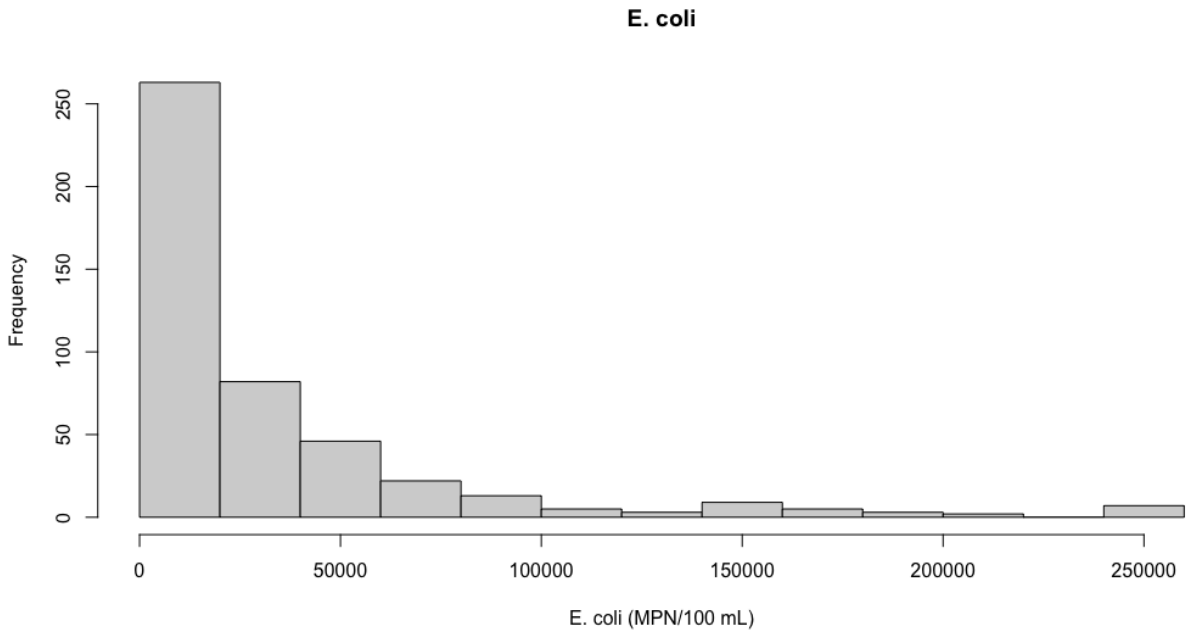
Figure 4: Histograms for Pollutant Concentrations for Combined Wet and Dry Weather Data at All Sites.






E. coli
Frequency
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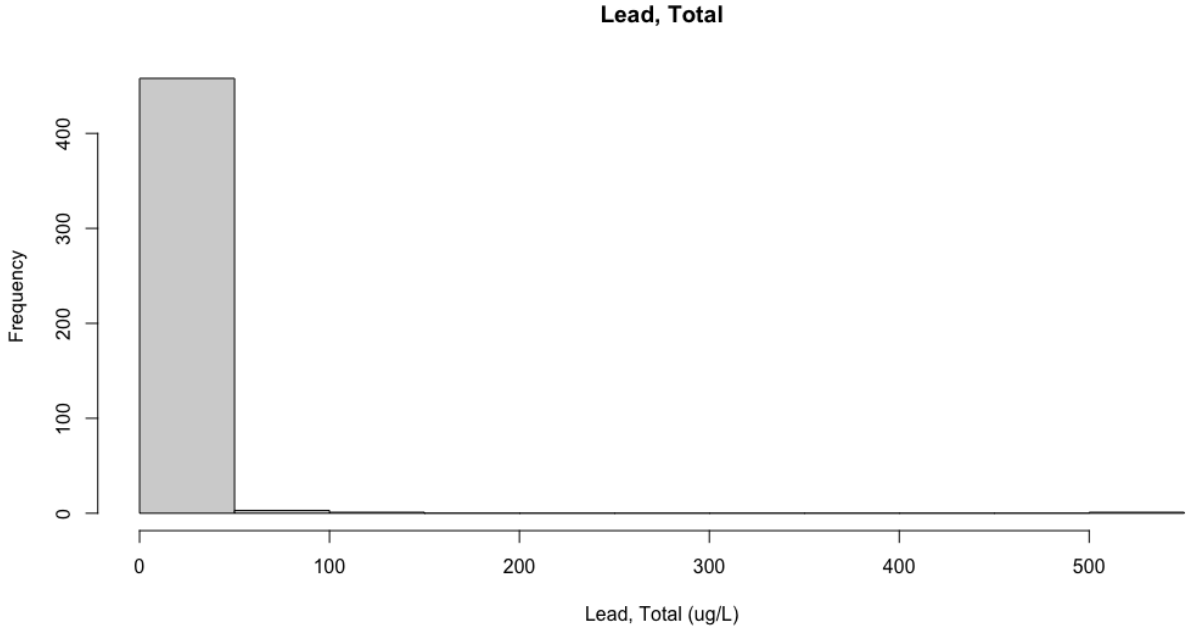
50
100
150
200
250
0
50000
100000
150000
200000
250000
E. coli (MPN/100 mL)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Frequency
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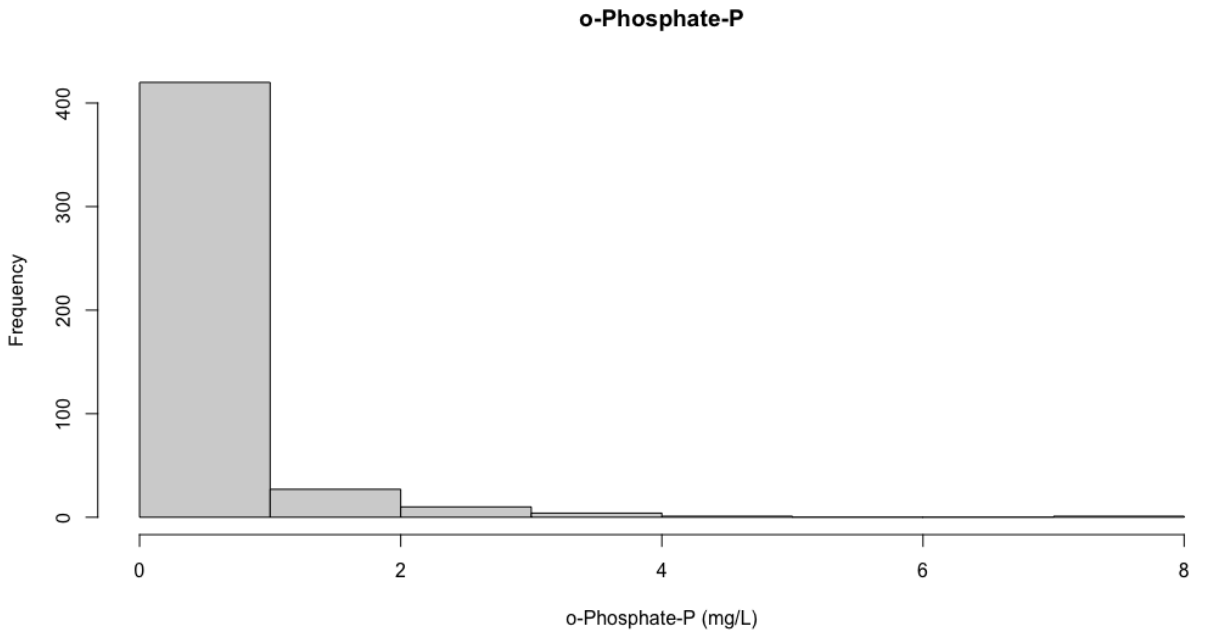
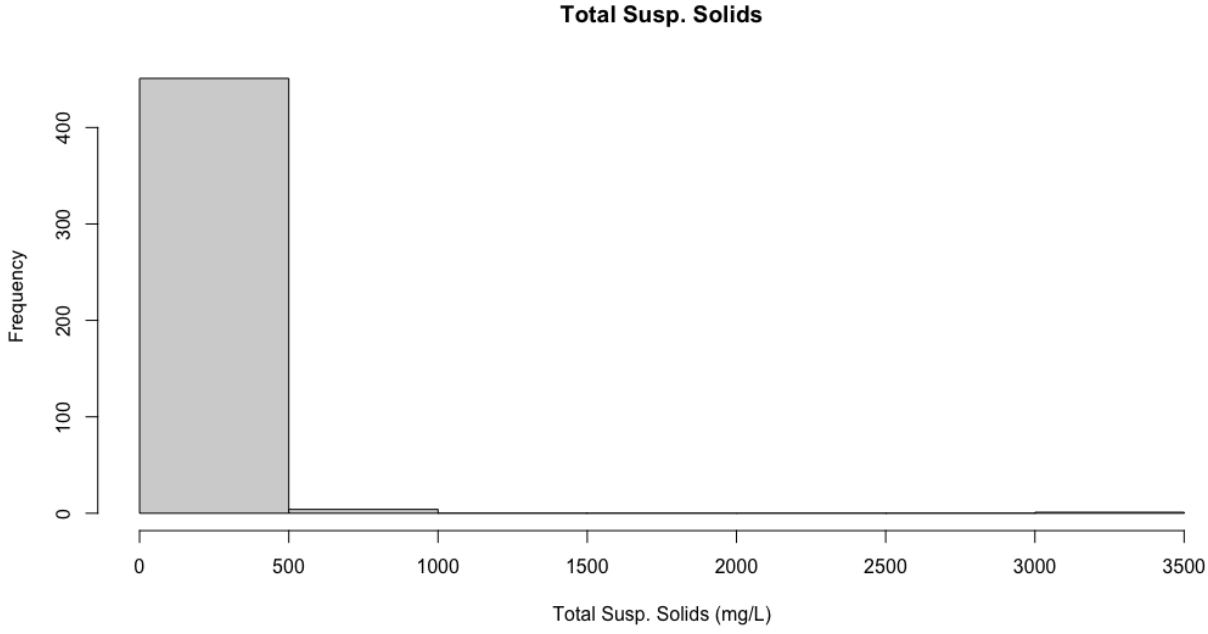
100
200
300
400
0
100
200
300
400
500
Lead, Total (ug/L)


o-Phosphate-P
Frequency
0
100
200
300
400
0
2
4
6
8
o-Phosphate-P (mg/L)


Total Susp. Solids
Frequency
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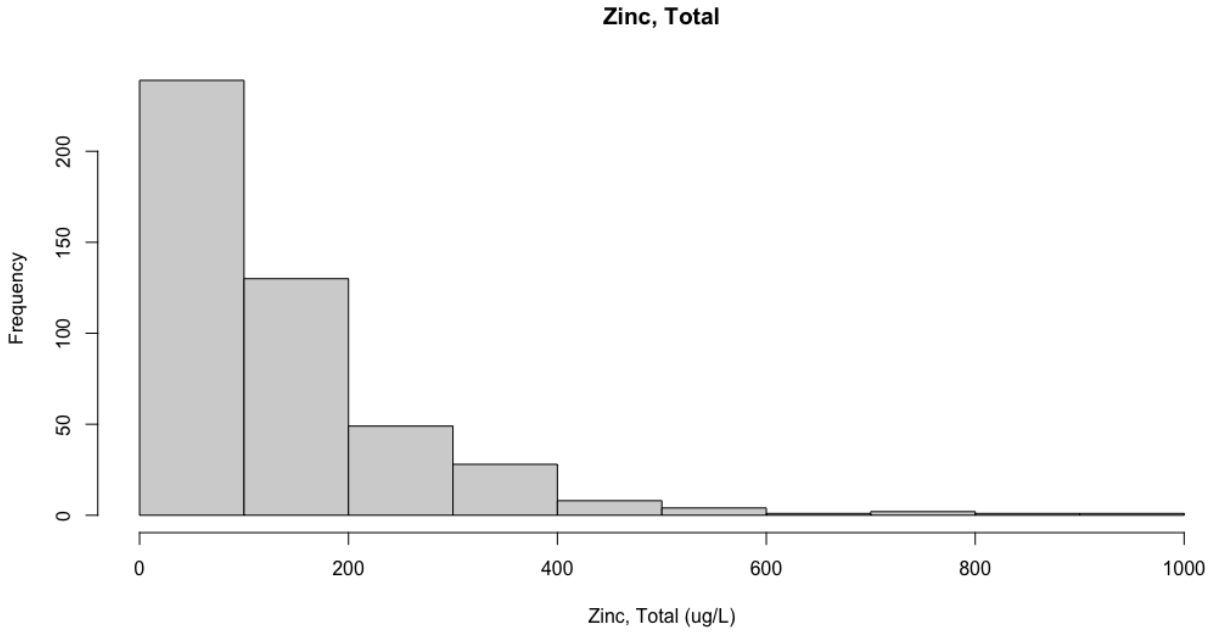
100
200
300
400
0
500
1000
1500
2000
2500
3000
3500
Total Susp. Solids (mg/L)


Zinc, Total
Frequency
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50
100
150
200
0
200
400
600
800
1000
Zinc, Total (ug/L)

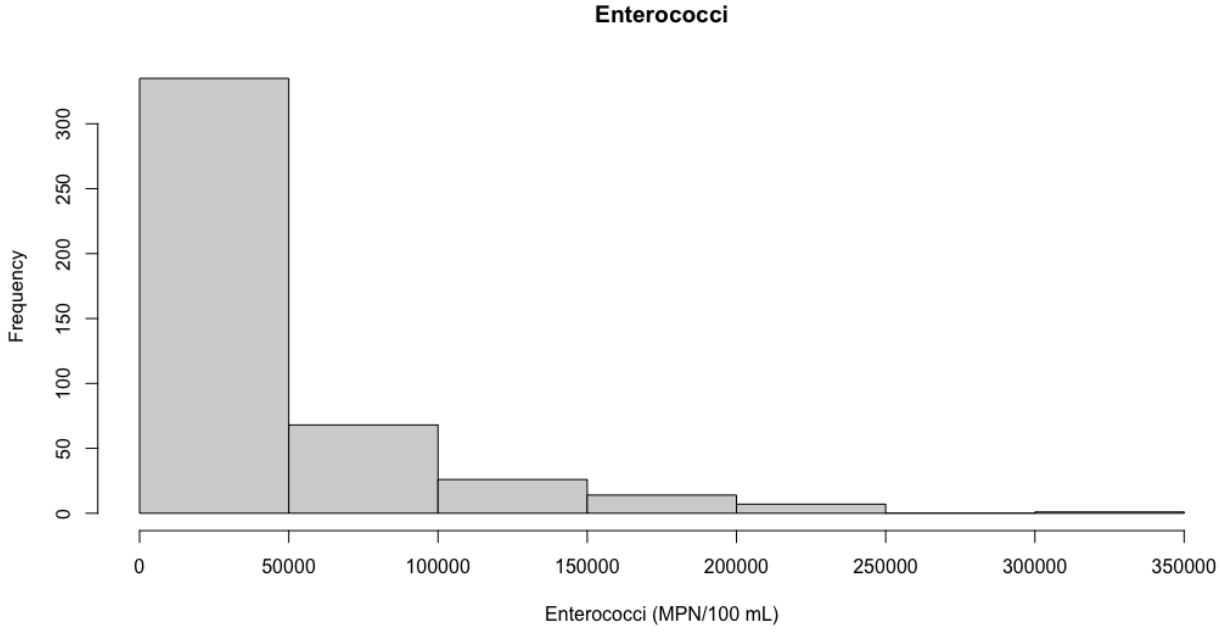

Enterococci
Frequency
0
50
100
150
200
250
300
0
50000
100000
150000
200000
250000
300000
350000
Enterococci (MPN/100 mL)

Table 5: City of Carmel 85th Percentile: Concentration percentiles for MRSWMP data (2006-2021) for Carmel by analyte or water quality measure. Highlighted values indicate where the 85th percentile of analyte concentrations exceed the WQO.

Carmel		Combined Wet and Dry			Wet Weather			Dry Weather			WQO
Analyte	Units	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	Receiving Water
Ammonia-N	mg/L	21	0.835	0.895	18	0.835	0.931	3	0.904	0.727	< 50 mg/L
Calcium	mg/L	60	68	89	40	22.7	26.3	20	75.3	109	NA
Coliform, Total	MPN/100 mL	46	2.42E+05	2.42E+05	27	2.42E+05	2.42E+05	19	1.92E+04	4.84E+04	NA
Color	Color Units	22	371	250	18	361	293	4	381	150	< 500
Color, True	Color Units	2	211	159	2	211	183	NA	NA	29.8	< 500
Copper, Total	ug/L	70	159	83.6	47	170	112	23	56.7	21.5	< 30 ug/L
E. coli	MPN/100 mL	68	4.91E+04	5.99E+04	45	6.29E+04	8.35E+04	23	1.19E+04	1.73E+04	< 235 MPN/100 mL
Enterococci	MPN/100 mL	68	5.48E+04	8.16E+04	45	6.63E+04	1.12E+05	23	1.28E+04	1.48E+04	< 104 MPN/100 mL
Flow	L/sec	53	1000	533	31	1350	1200	22	1	10	NA
Fluoride	mg/L	17	0.4	0.4	15	0.4	0.316	2	0.1	0.5	NA
Hardness as CaCO3	mg/L	67	305	371	45	105	107	22	325	447	> 10 and < 2000 mg/L
Lead, Total	ug/L	70	22.2	15.5	47	24.6	21.5	23	2.5	2.5	< 30 ug/L
Magnesium	mg/L	57	34.6	38.6	37	12	11.4	20	37	46	NA
MBAS (Surfactants)	mg/L	24	0.863	0.772	20	0.926	0.91	4	0.526	0.466	< 0.2 mg/L
Nitrate as N	mg/L	70	2.65	2.5	47	1.42	1.61	23	7.31	3.65	< 2.25 mg/L
o-Phosphate-P	mg/L	70	1.08	0.804	47	1.16	0.998	23	0.681	0.39	< 0.12 mg/L
Potassium	mg/L	24	13	10	20	13.7	9.83	4	8.73	10.1	< 20 mg/L
Total Susp. Solids	mg/L	69	157	90	46	219	126	23	11.3	15	< 500 mg/L
Turbidity	NTU	24	96.6	51.9	20	93.6	57.8	4	62.5	26.2	< 25 NTU
Urea	ug/L	69	326	408	46	349	539	23	31.7	172	NA
Zinc, Total	ug/L	70	250	238	47	289	303	23	102	88	< 200 ug/L

Table 6: City of Pacific Grove 85th Percentile: Concentration percentiles for MRSWMP data (2006-2021) for Pacific Grove by analyte or water quality measure. Highlighted values indicate where the 85th percentile of analyte concentrations exceed the WQO.

Pacific Grove		Combined Wet and Dry			Wet Weather			Dry Weather			WQO
Analyte	Units	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	Receiving Water
Ammonia-N	mg/L	68	0.69	0.89	37	0.88	0.93	31	0.50	0.73	< 50 mg/L
Calcium	mg/L	160	86.2	89	85	23.9	26.3	75	94.9	109	NA
Coliform, Total	MPN/100 mL	132	2.42E+05	2.42E+05	61	2.42E+05	2.42E+05	71	4.84E+04	4.84E+04	NA
Color	Color Units	63	200	250	35	248	293	28	100	150	< 500
Color, True	Color Units	10	158	159	5	167	183	5	51.6	29.8	< 500
Copper, Total	ug/L	201	54.5	83.6	103	66.2	112	98	17	21.5	< 30 ug/L
E. coli	MPN/100 mL	201	4.84E+04	5.99E+04	103	7.91E+04	8.35E+04	98	2.18E+04	1.73E+04	< 235 MPN/100 mL
Enterococci	MPN/100 mL	197	8.74E+04	8.16E+04	103	1.16E+05	1.12E+05	94	1.38E+04	1.48E+04	< 104 MPN/100 mL
Flow	L/sec	93	450	533	45	1.08E+03	1.20E+03	48	12.9	10	NA
Fluoride	mg/L	44	0.28	0.4	28	0.22	0.32	16	0.3	0.5	NA
Hardness as CaCO3	mg/L	186	369	371	97	96.4	107	89	404	447	> 10 and < 2000 mg/L
Lead, Total	ug/L	201	11.3	15.5	103	15.4	21.5	98	2.5	2.5	< 30 ug/L
Magnesium	mg/L	154	38.1	38.6	79	9.15	11.4	75	42.9	46	NA
MBAS (Surfactants)	mg/L	73	0.71	0.772	40	0.91	0.91	33	0.50	0.47	< 0.2 mg/L
Nitrate as N	mg/L	201	2.46	2.50	103	1.53	1.61	98	3.64	3.65	< 2.25 mg/L
o-Phosphate-P	mg/L	201	0.74	0.80	103	1.06	1.00	98	0.25	0.39	< 0.12 mg/L
Potassium	mg/L	73	9.42	10.0	40	9.4	9.83	33	9.6	10.1	< 20 mg/L
Total Susp. Solids	mg/L	200	57.2	90.0	102	71.4	126.3	98	10.9	15	< 500 mg/L
Turbidity	NTU	73	31.6	51.9	40	40.2	57.8	33	21.1	26.2	< 25 NTU
Urea	ug/L	199	363	408	101	450	539	98	179	172	NA
Zinc, Total	ug/L	201	175	238	103	242	303	98	53.0	88	< 200 ug/L

Table 7: City of Monterey 85th Percentile: Concentration percentiles for MRSWMP data (2006-2021) for Monterey by analyte or water quality measure. Highlighted values indicate where the 85th percentile of analyte concentrations exceed the WQO.

Monterey		Combined Wet and Dry			Wet Weather			Dry Weather			WQO
Analyte	Units	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	# Samples	City 85th Percentile	Monterey Bay 85th Percentile	Receiving Water
Ammonia-N	mg/L	42	1.34	0.89	25	2.97	0.93	17	0.90	0.73	< 50 mg/L
Calcium	mg/L	105	121	89	53	35.3	26.3	52	169	109	NA
Coliform, Total	MPN/100 mL	94	2.42E+05	2.42E+05	41	2.42E+05	2.42E+05	53	4.84E+04	4.84E+04	NA
Color	Color Units	40	225	250	25	235	293	15	148	150	< 500
Color, True	Color Units	6	93.4	159	3	95.0	183	3	23.4	29.8	< 500
Copper, Total	ug/L	127	80.3	83.6	60	121	112	67	23.2	21.5	< 30 ug/L
E. coli	MPN/100 mL	127	8.20E+04	5.99E+04	60	1.15E+05	8.35E+04	67	1.56E+04	1.73E+04	< 235 MPN/100 mL
Enterococci	MPN/100 mL	122	7.24E+04	8.16E+04	60	1.35E+05	1.12E+05	62	1.55E+04	1.48E+04	< 104 MPN/100 mL
Flow	L/sec	75	572	533	37	1440	1203	38	13.7	10	NA
Fluoride	mg/L	30	0.50	0.4	21	0.23	0.32	9	0.6	0.5	NA
Hardness as CaCO3	mg/L	119	449	371	60	135	107	59	673	447	> 10 and < 2000 mg/L
Lead, Total	ug/L	127	14.6	15.5	60	22.0	21.5	67	2.5	2.5	< 30 ug/L
Magnesium	mg/L	102	44.9	38.6	50	12.9	11.4	52	57.7	46	NA
MBAS (Surfactants)	mg/L	46	0.57	0.77	28	0.79	0.91	18	0.27	0.466	< 0.2 mg/L
Nitrate as N	mg/L	127	2.98	2.50	60	1.83	1.61	67	3.61	3.65	< 2.25 mg/L
o-Phosphate-P	mg/L	127	0.90	0.80	60	1.55	1.00	67	0.35	0.39	< 0.12 mg/L
Potassium	mg/L	46	8.81	10.0	28	6.77	9.83	18	10.5	10.1	< 20 mg/L
Total Susp. Solids	mg/L	125	70.6	90.0	58	93.0	126	67	9.26	15	< 500 mg/L
Turbidity	NTU	46	41.8	51.9	28	49.6	57.8	18	20.2	26.2	< 25 NTU
Urea	ug/L	125	596	408	58	917	539	67	199	172	NA
Zinc, Total	ug/L	127	293	237.8	60	386	303	67	96.5	88	< 200 ug/L

III. TREND ANALYSIS

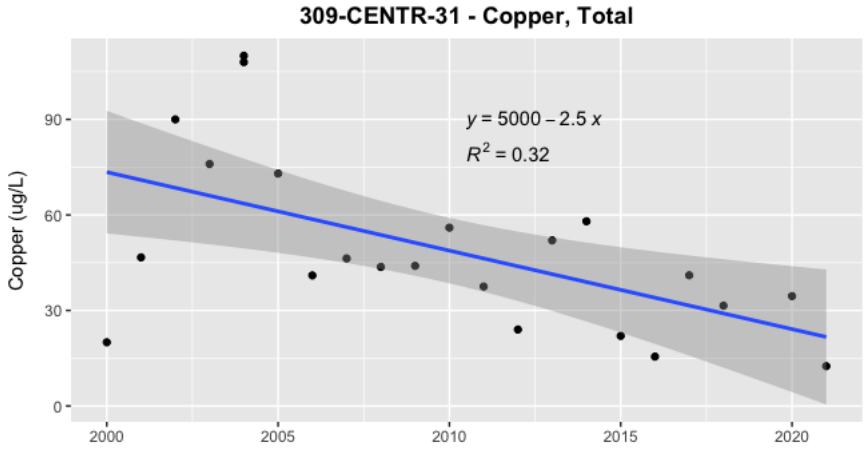
Trends were evaluated for each site using the monotonic, non-parametric Mann-Kendall test (Kendall 1938, Mann 1945, Kendall 1948) using combined pre-permit, post-permit, and post-permit Phase II data. This test was chosen because it does not require that the data conform to any particular distribution. This is important for maintaining comparability of data in a data set such as MRSWMP since water quality data were positively skewed and often to varying degrees, so conducting transformations in order to perform parametric statistics is less accurate. Due to the variation found between data under wet and dry weather conditions, the trend analysis was performed only for wet conditions. Trends were evaluated for sites and pollutants consistently monitored by the MBNMS citizen science program from 2000-2021. These sites were only in Monterey and Pacific Grove and include: "309-MSD-03", "309-MSD-04", "309-MSD-05", "309-PGSD-01", "309-CENTR-31", "309-PGSD-03", and "309-PGSD-04".

As statistics is based on probability, there is always the chance of making an error and either falsely identifying a trend when in actuality there is none (Type 1 error) or not identifying a trend when one does actually exist (Type 2 error). The chance of making an error is diminished with increasing data. To be cautious about making a Type 1 error, we set our significance level at a p-value of 0.05. This p-value implies that we have a 5% chance of incorrectly asserting there is a trend when there is not one. Due to the few number of samples for analyzing site trends, there is a high likelihood of making a Type 2 error. In other words, a trend may exist, but we have an insufficient number of data points necessary to detect it. With increasing years of sampling, this trend may become apparent in the future.

A total of 20 trends were found, all of which represented improvement in water quality shown by their declining slope. Trends were found at 7 different sites located within 2 cities: Monterey and Pacific Grove. Trends were found for 7 pollutants (*Enterococci*, zinc, lead, nitrate, copper, ammonia, and o-phosphate) and no trends were found for 2 pollutants (E. Coli and total suspended solids). Decreasing trends (improving water quality) for nitrate were found at 7 sites, for copper and zinc at 5 sites, for lead and o-phosphate at 3 sites, and for Enterococci and ammonia at 1 site. Analyte trends for each site evaluated are shown in Table 8.

Table 8. Trend Test results for analyte concentrations over the time period of monitoring (2000 – 2021) for sites and pollutants consistently monitored by the MBNMS citizen science program. Significant relationships (p-value < 0.05) between concentration and time are indicated in bold. All significant relationships indicate decreasing trends (improving water quality).

	Pacific Grove				Monterey		
Analyte	309-CENTR-31 p-value	309-PGSD-01 p-value	309-PGSD-03 p-value	309-PGSD-04 p-value	309-MSD-03 p-value	309-MSD-04 p-value	309-MSD-05 p-value
Nitrate as N	**0.00042**	**0.09**	**0.0012**	**0.000697**	**0.0081**	**0.00096**	**0.014**
Copper	**0.0048**	**0.013**	**0.0014**	0.09	**0.00434**	**0.0026**	0.11
Ammonia-N	0.23	1	**0.0094**	0.2	0.173	0.25	0.173
E.coli	1	0.14	0.114	0.197	0.867	0.48	0.27
Lead	0.14	0.065	**0.019**	**0.0012**	0.69	0.69	**0.0027**
o-Phosphate-P	0.165	1	**0.0036**	0.08	0.28	**0.024**	**0.03**
Total Susp. Solids	0.93	0.89	0.615	0.94	0.73	0.21	1
Zinc	**0.011**	0.16	**0.00183**	**0.000458**	0.19	**0.005**	**0.00047**
Enterococci	1	0.89	0.34	0.54	0.13	0.55	**0.0093**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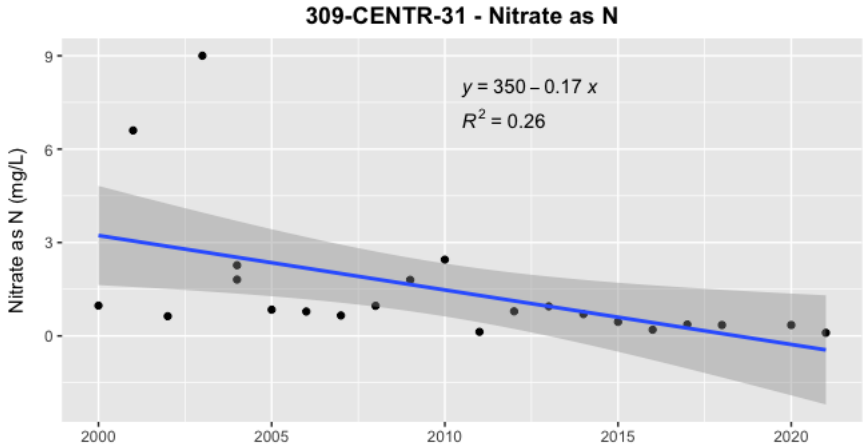
R2 = 0.32
Copper (ug/L)
90
60
30
0
2000
2005
2010
2015
2020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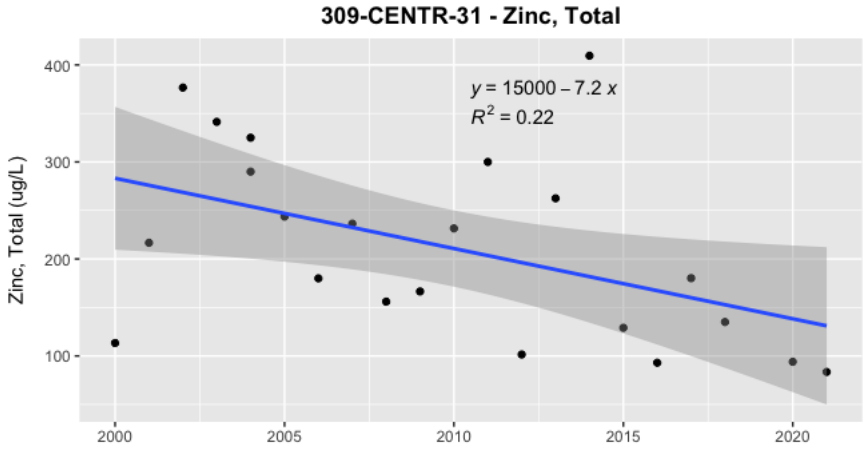
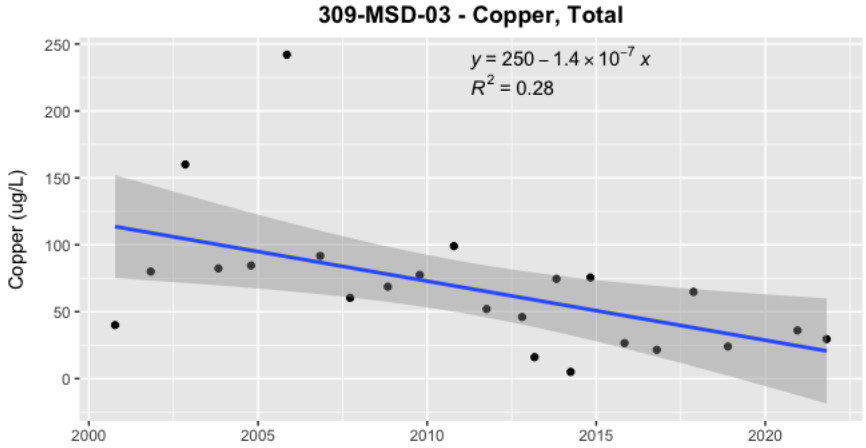
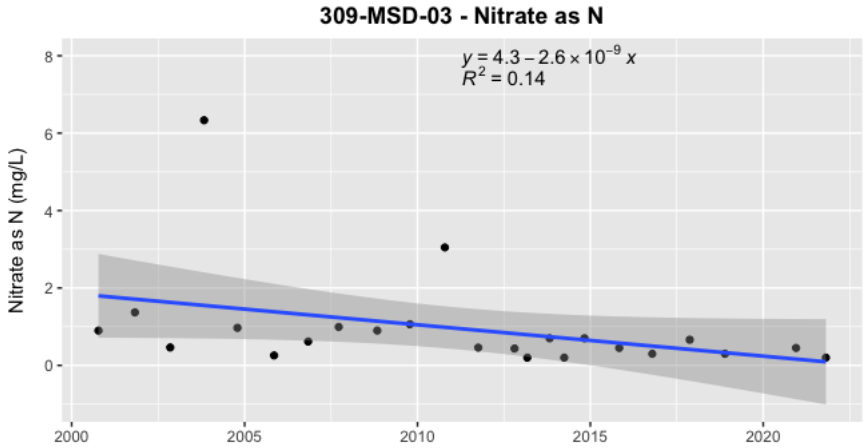
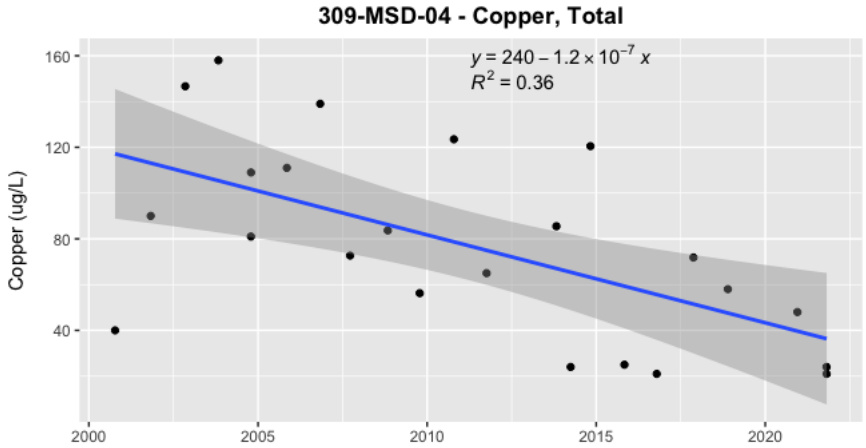
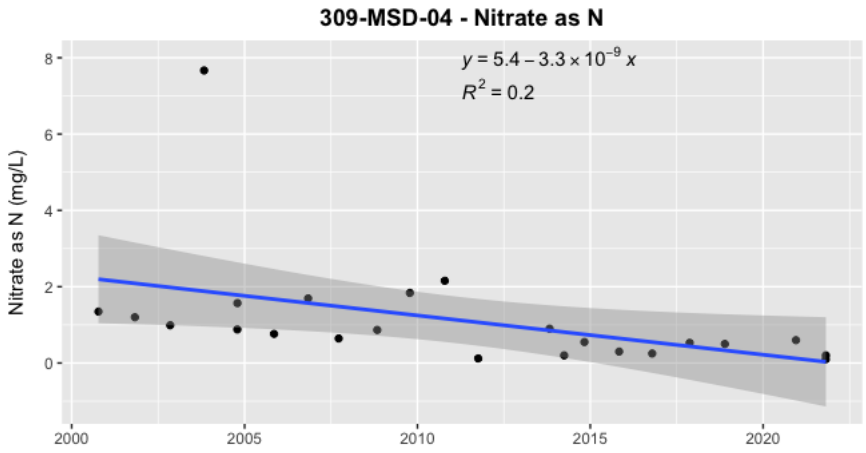
y = 350 – 0.17 x
R2 = 0.26
Nitrate as N (mg/L)
9
6
3
0
2000
2005
2010
2015
2020

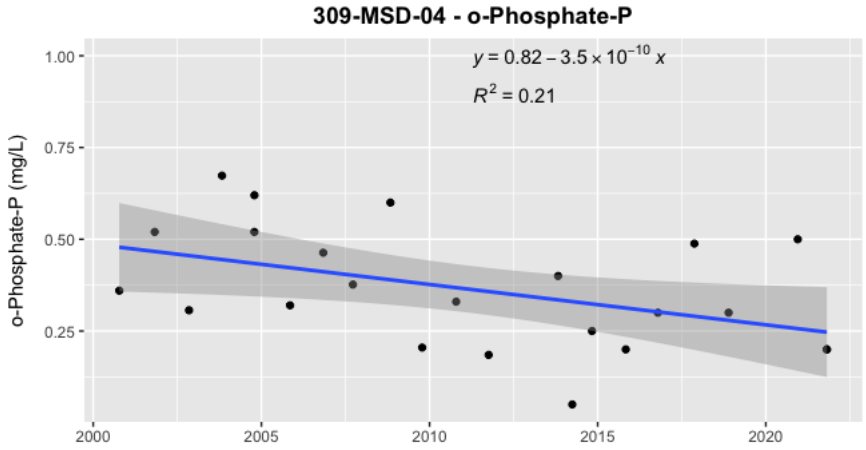

309-CENTR-31 - Zinc, Total
y = 15000 – 7.2 x
R2 = 0.22
Zinc, Total (ug/L)
400
300
200
100
2000
2005
2010
2015
2020

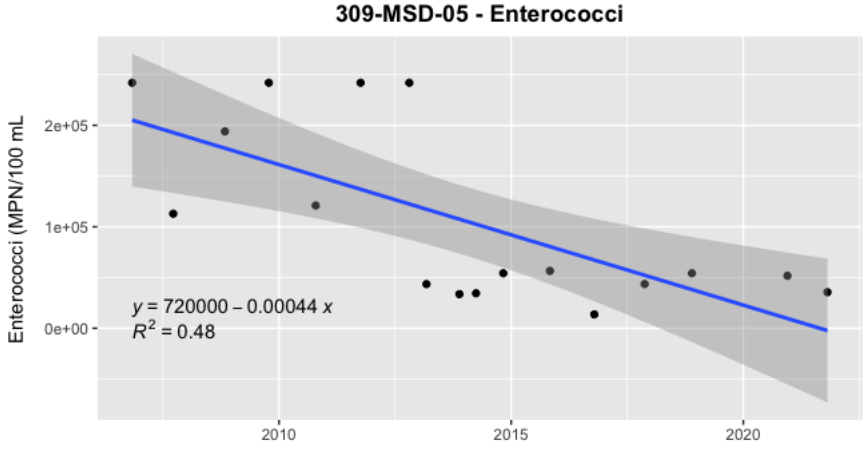

309-MSD-03 - Copper, Total
$y = 250 - 1.4 \times 10^{-7}\, x$
$R^2 = 0.28$
Copper (ug/L)
250
200
150
100
50
0
2000
2005
2010
2015
2020

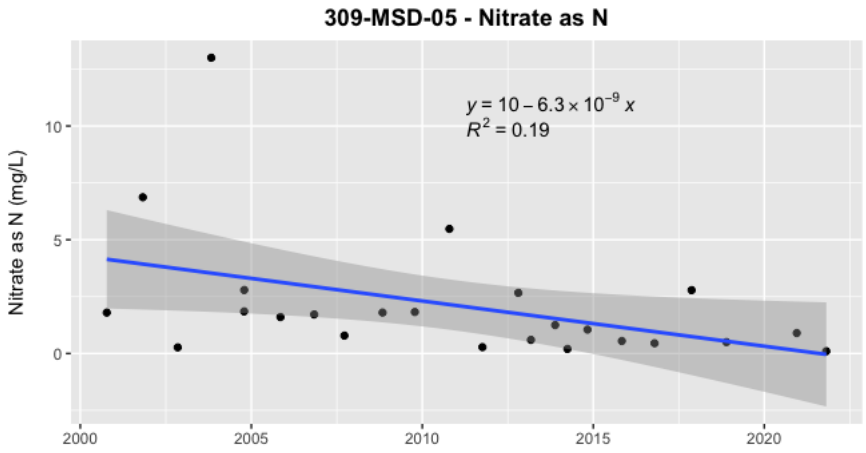

309-MSD-03 - Nitrate as N
$y = 4.3 - 2.6 \times 10^{-9}\, x$
$R^2 = 0.14$
Nitrate as N (mg/L)
8
6
4
2
0
2000
2005
2010
2015
2020

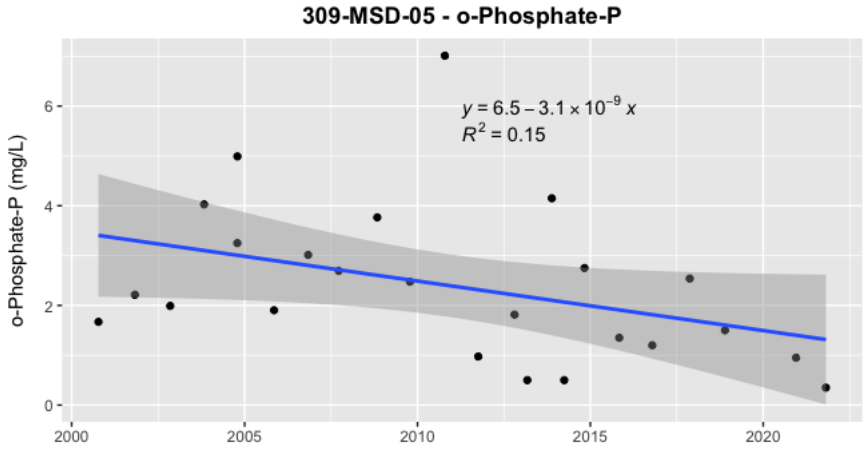

309-MSD-04 - Copper, Total
$y = 240 - 1.2 \times 10^{-7}\, x$
$R^2 = 0.36$
Copper (ug/L)
160
120
80
40
2000
2005
2010
2015
2020

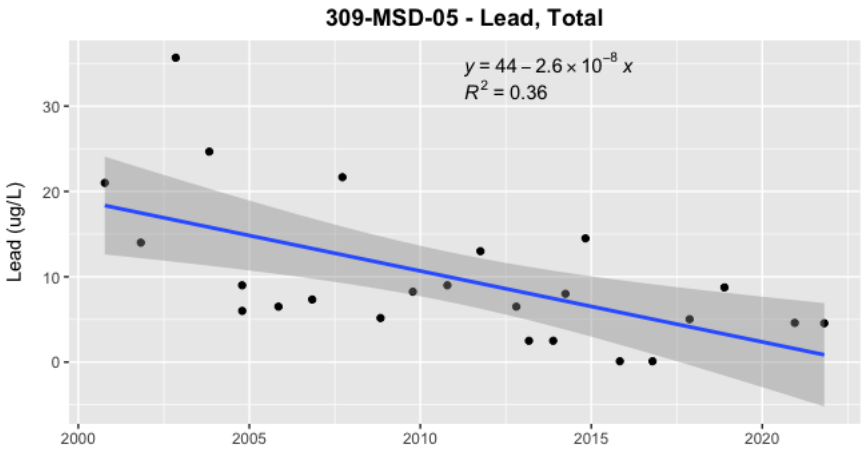

309-MSD-04 - Nitrate as N
$y = 5.4 - 3.3 \times 10^{-9}\ x$
$R^2 = 0.2$
Nitrate as N (mg/L)
8
6
4
2
0
2000
2005
2010
2015
2020

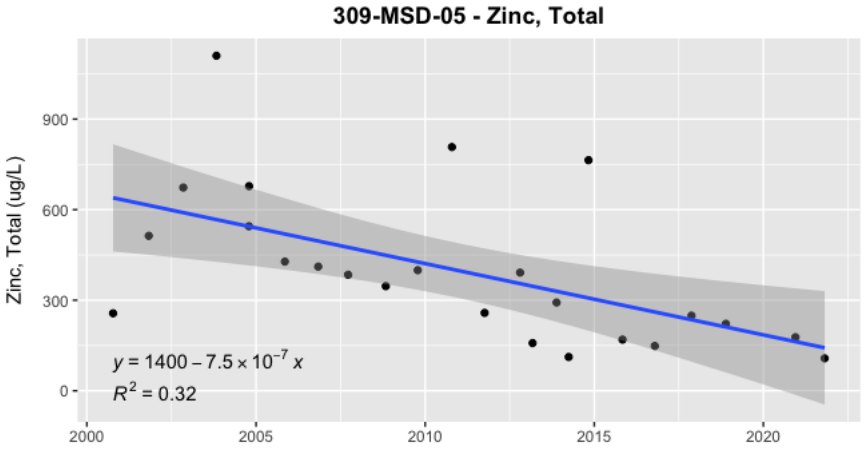

309-MSD-04 - o-Phosphate-P
$y = 0.82 - 3.5 \times 10^{-10}\ x$
$R^2 = 0.21$
o-Phosphate-P (mg/L)
1.00
0.75
0.50
0.25
2000
2005
2010
2015
2020


309-MSD-05 - Enterococci
Enterococci (MPN/100 mL
2e+05
1e+05
0e+00
$y = 720000 - 0.00044\ x$
$R^2 = 0.48$
2010
2015
2020


309-MSD-05 - Nitrate as N
$y = 10 - 6.3 \times 10^{-9}\, x$
$R^2 = 0.19$
Nitrate as N (mg/L)
10
5
0
2000
2005
2010
2015
2020


309-MSD-05 - o-Phosphate-P
$y = 6.5 - 3.1 \times 10^{-9}\, x$
$R^2 = 0.15$
o-Phosphate-P (mg/L)
6
4
2
0
2000
2005
2010
2015
2020


309-MSD-05 - Lead, Total
$y = 44 - 2.6 \times 10^{-8}\, x$
$R^2 = 0.36$
Lead (ug/L)
30
20
10
0
2000
2005
2010
2015
2020

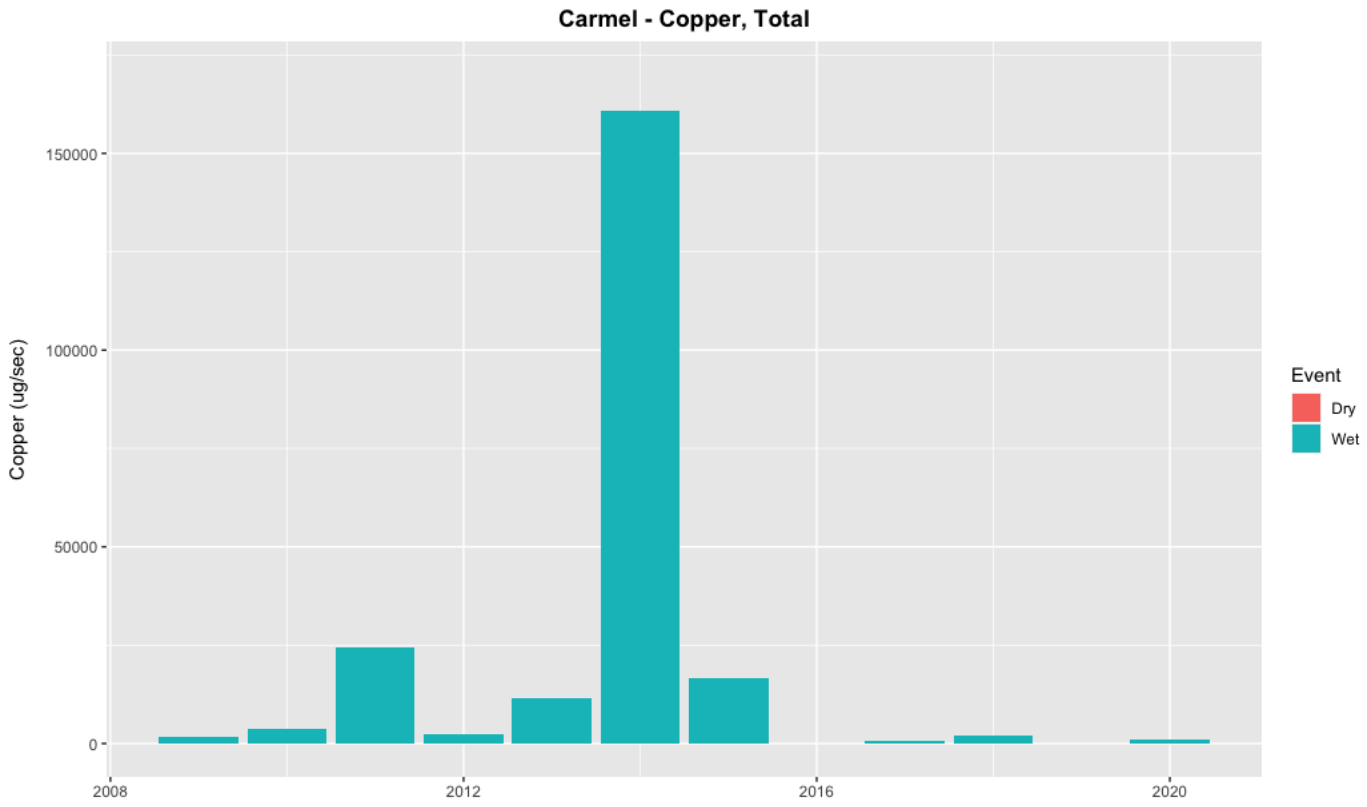

309-MSD-05 - Zinc, Total
$y = 1400 - 7.5 \times 10^{-7}\, x$
$R^2 = 0.32$
Zinc, Total (ug/L)
900
600
300
0
2000
2005
2010
2015
2020

IV. INSTANTANEOUS LOAD

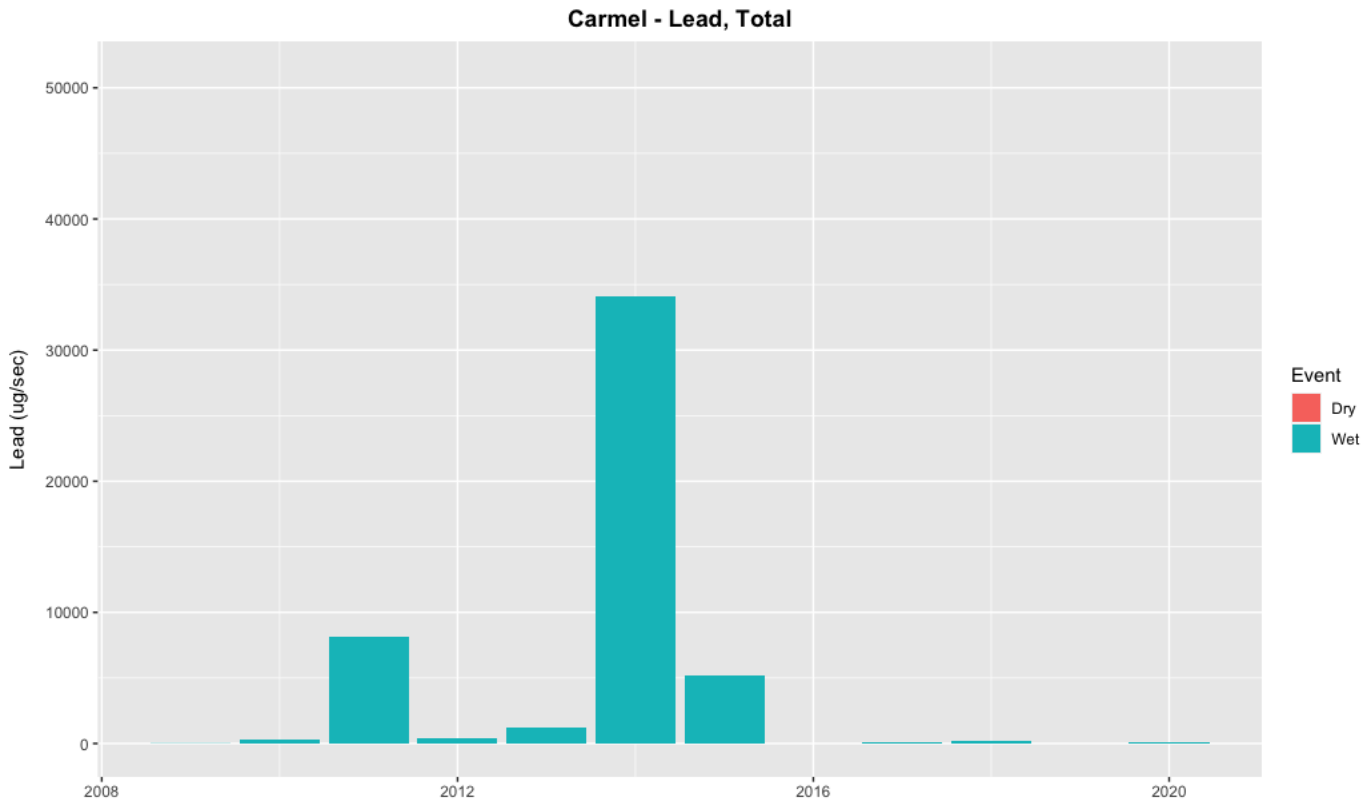
Load was determined for sites where there was both a measure of flow and concentration at the time of sampling. For each day of sampling, the load measures from the time series were averaged to compute the instantaneous load on that day. Annual load cannot be extrapolated from these instantaneous loads as both concentration and flow are highly variable and MRSWMP sampling occurred only between 2 and 4 times per year. Events are classified as wet or dry, where wet events represent samples and measures taken during the first rainfall of the water year and dry events occur prior to rainfall. On some occasions, sites were dry and could not be monitored during the dry season. In these cases, there was no sample taken.

For the instantaneous load bar charts, when sites were monitored multiple times during either wet or dry events in a single year, the average load for this wet or dry event was calculated for the year for the graphic.

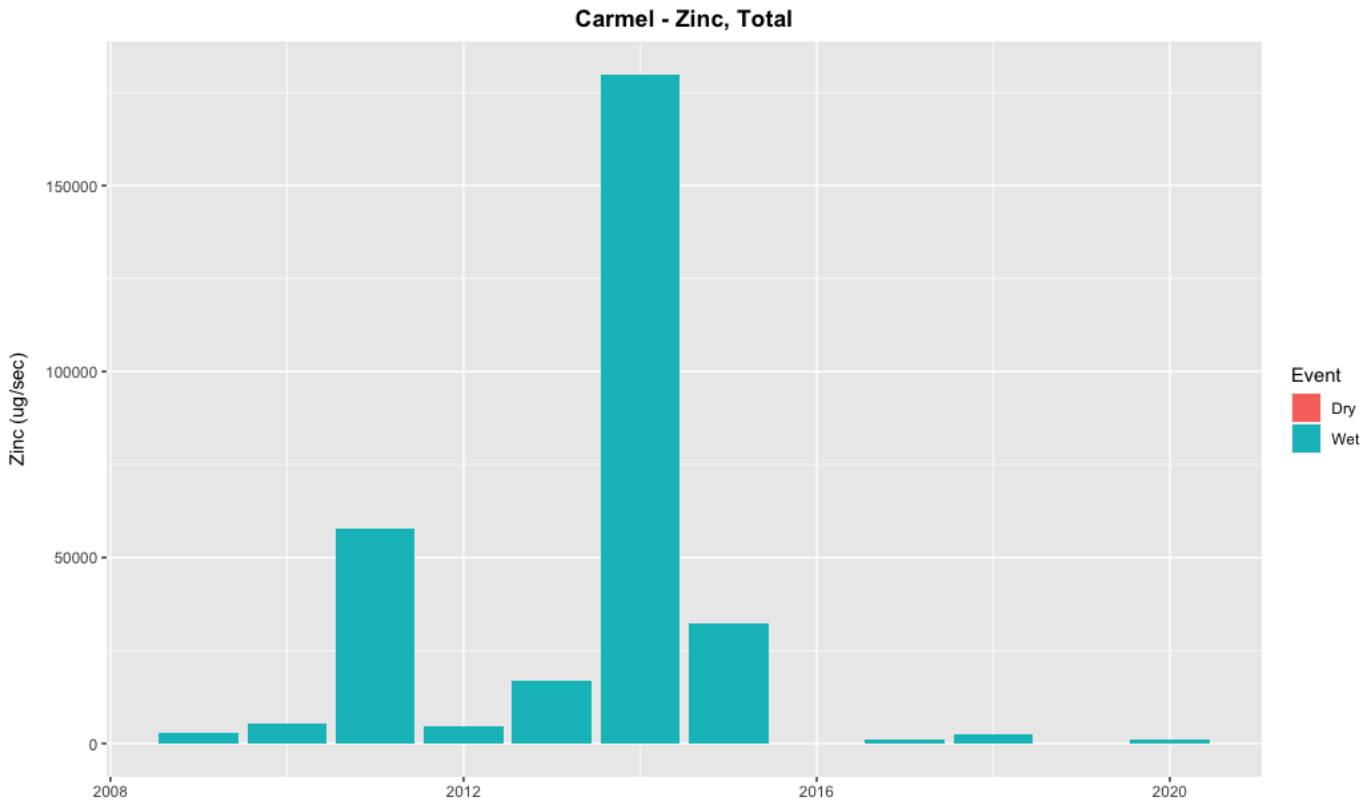
INSTANTANEOUS COPPER LOAD (UG/SEC)



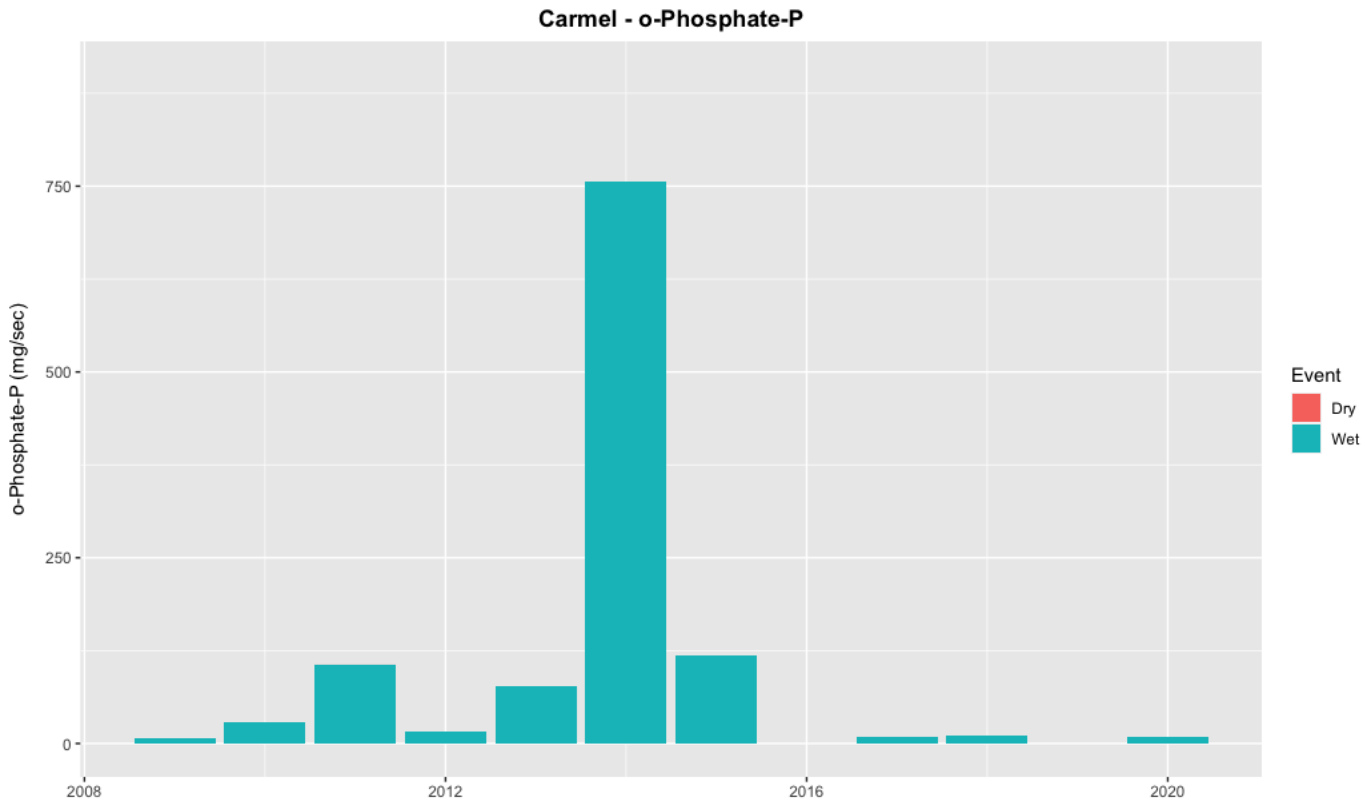
INSTANTANEOUS LEAD LOAD (UG/SEC)



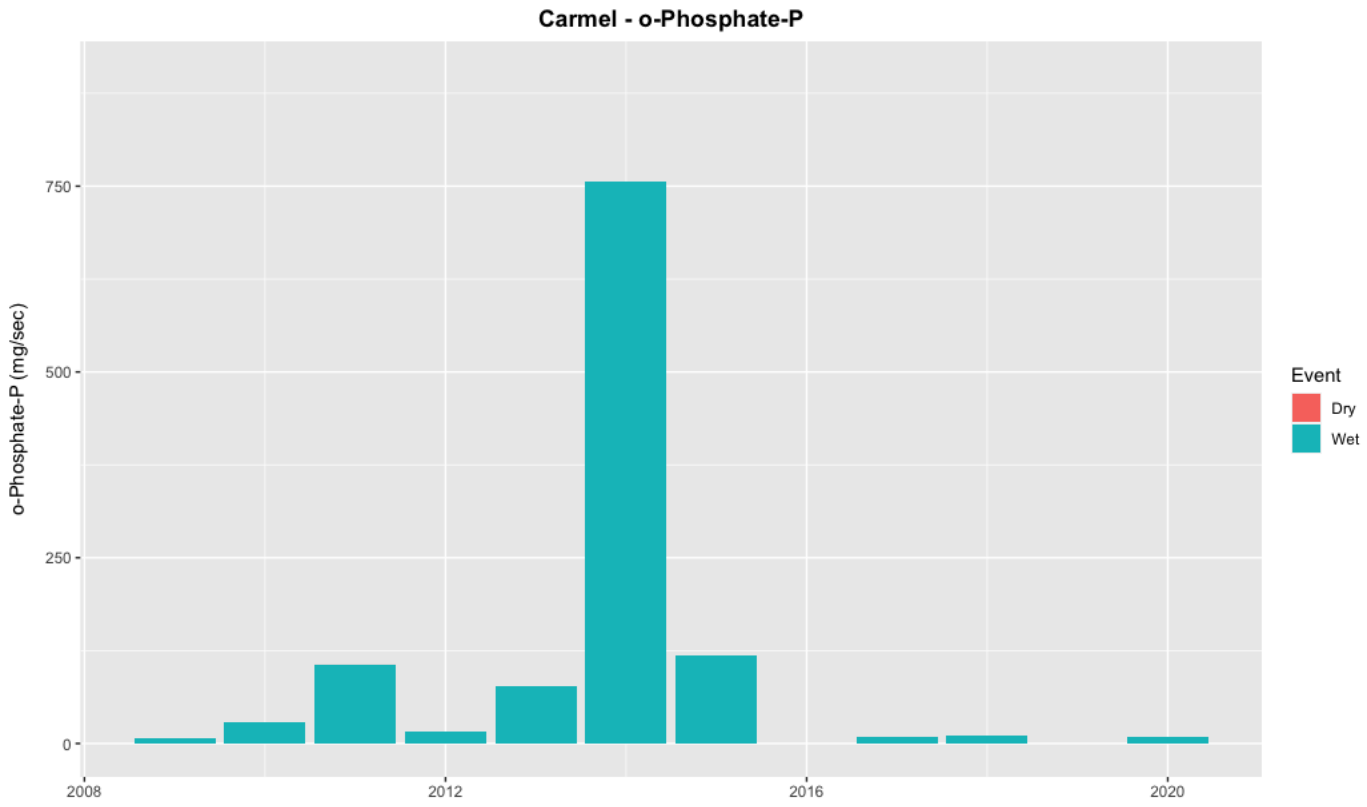
INSTANTANEOUS ZINC LOAD (UG/SEC)



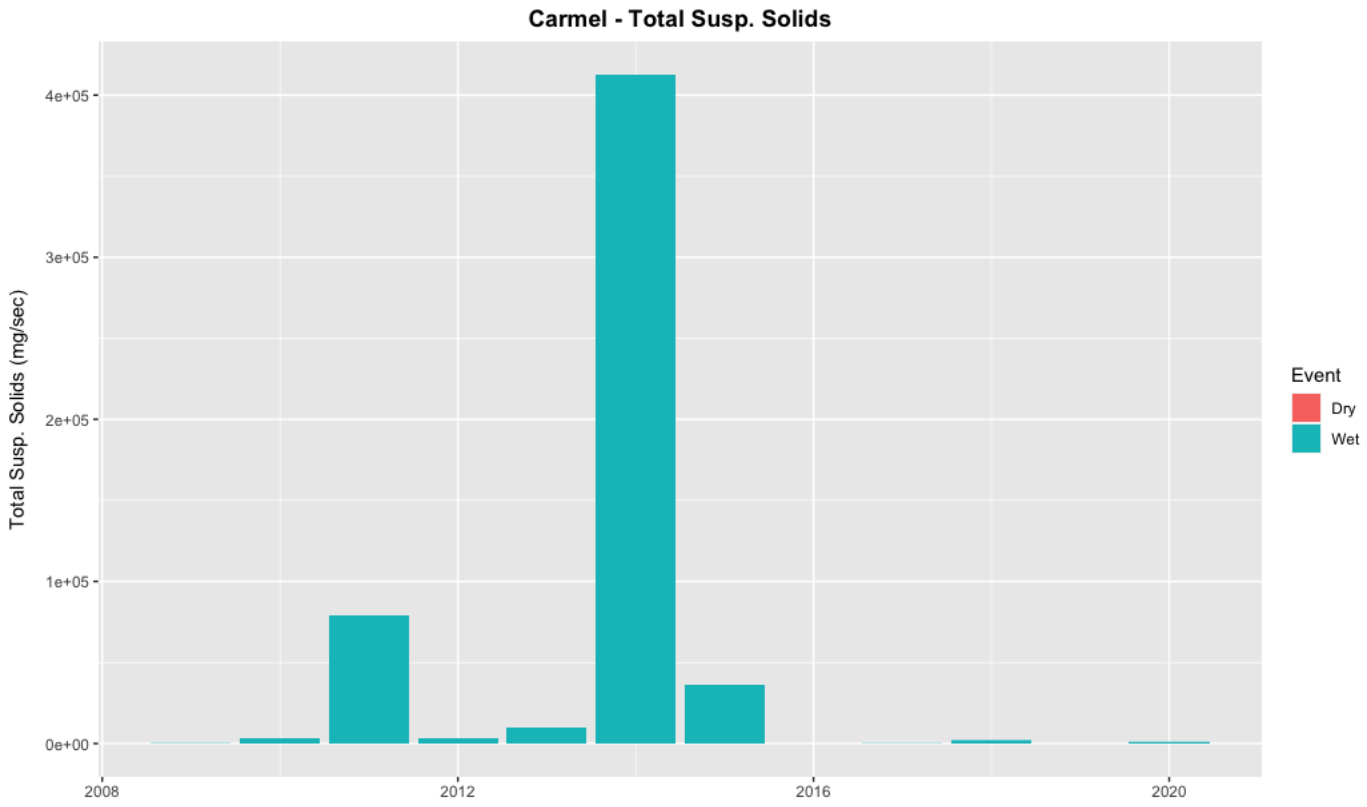
INSTANTANEOUS ORTHOPHOSPHATE LOAD (MG/SEC)



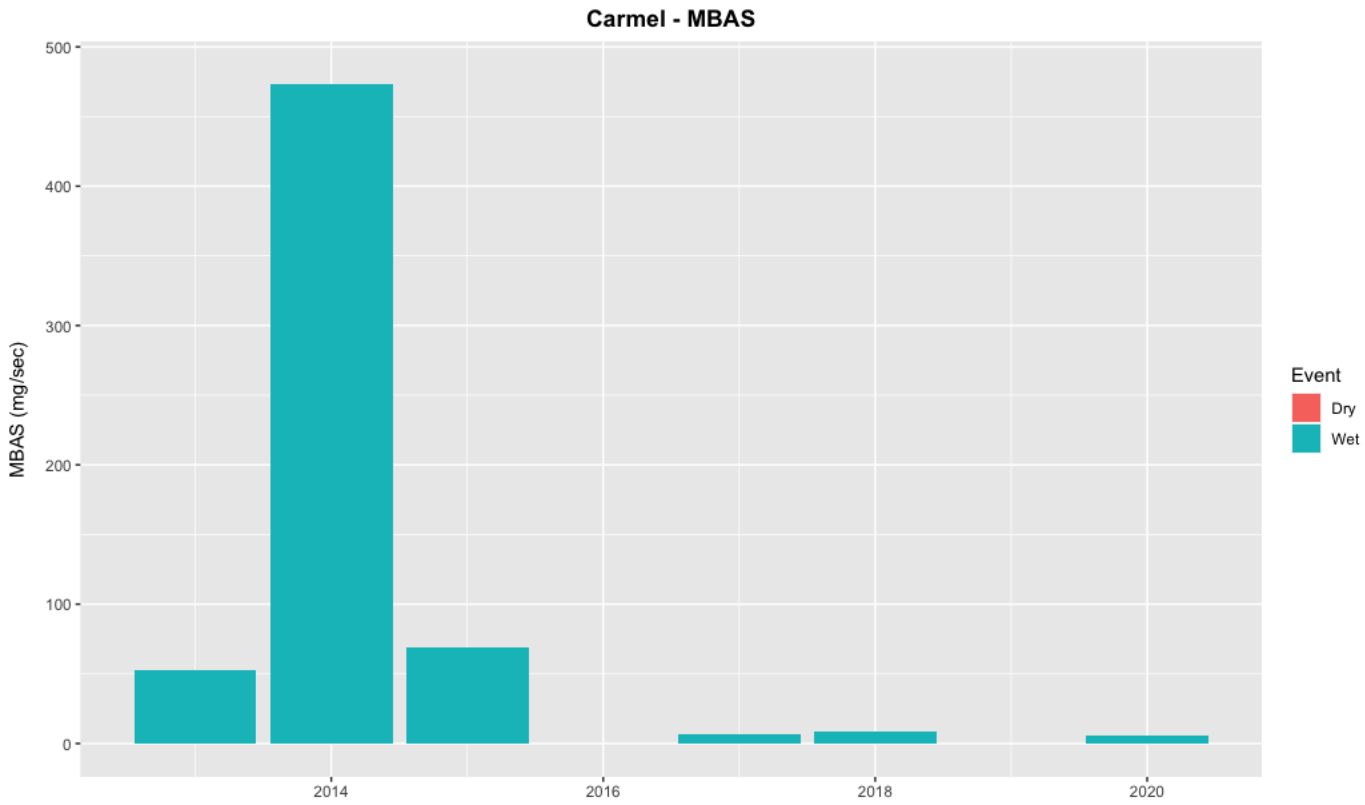
INSTANTANEOUS NITRATE LOAD (MG/SEC)



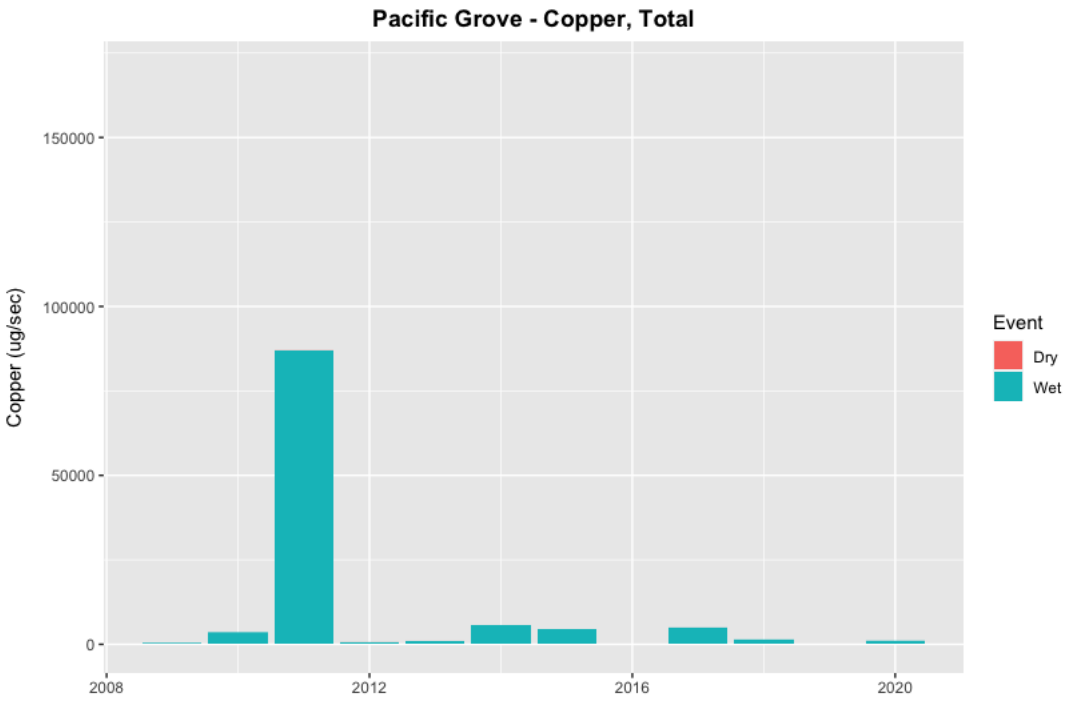
INSTANTANEOUS TOTAL SUSPENDED SOLIDS LOAD (MG/SEC)



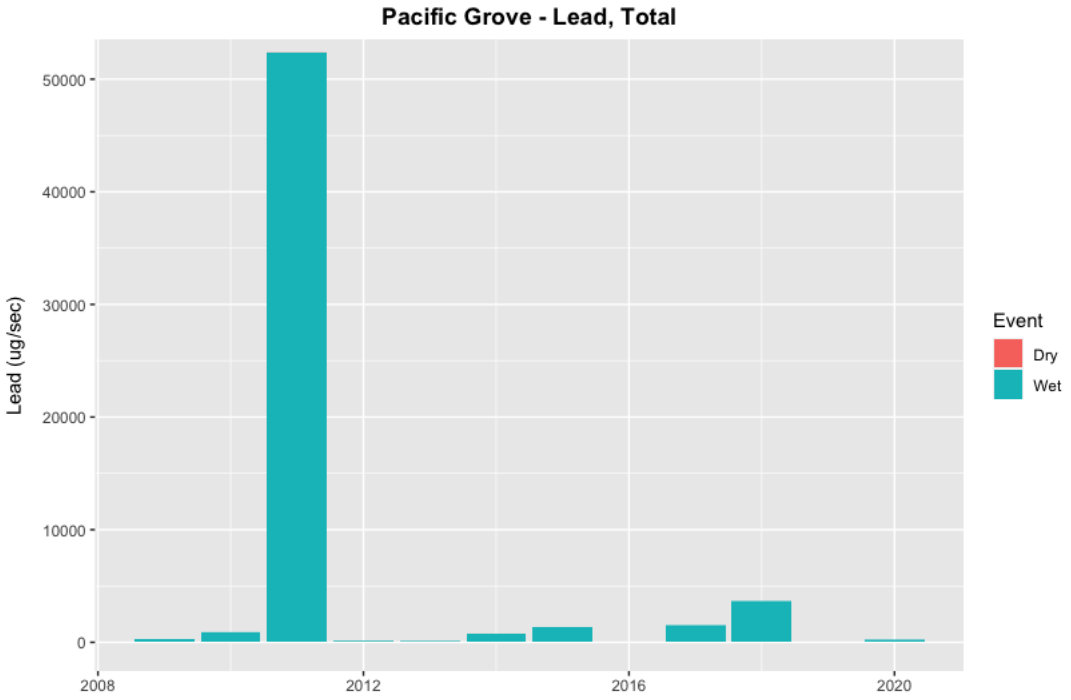
INSTANTANEOUS MBAS SURFACTANTS LOAD (MG/SEC)



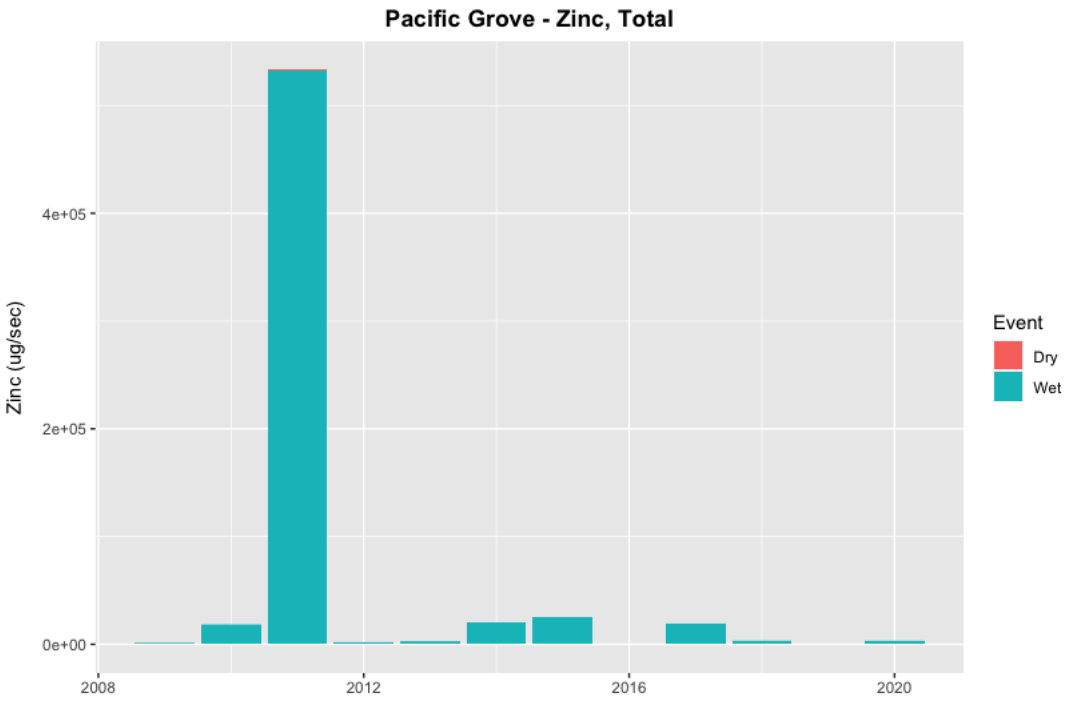
INSTANTANEOUS COPPER LOAD (UG/SEC)



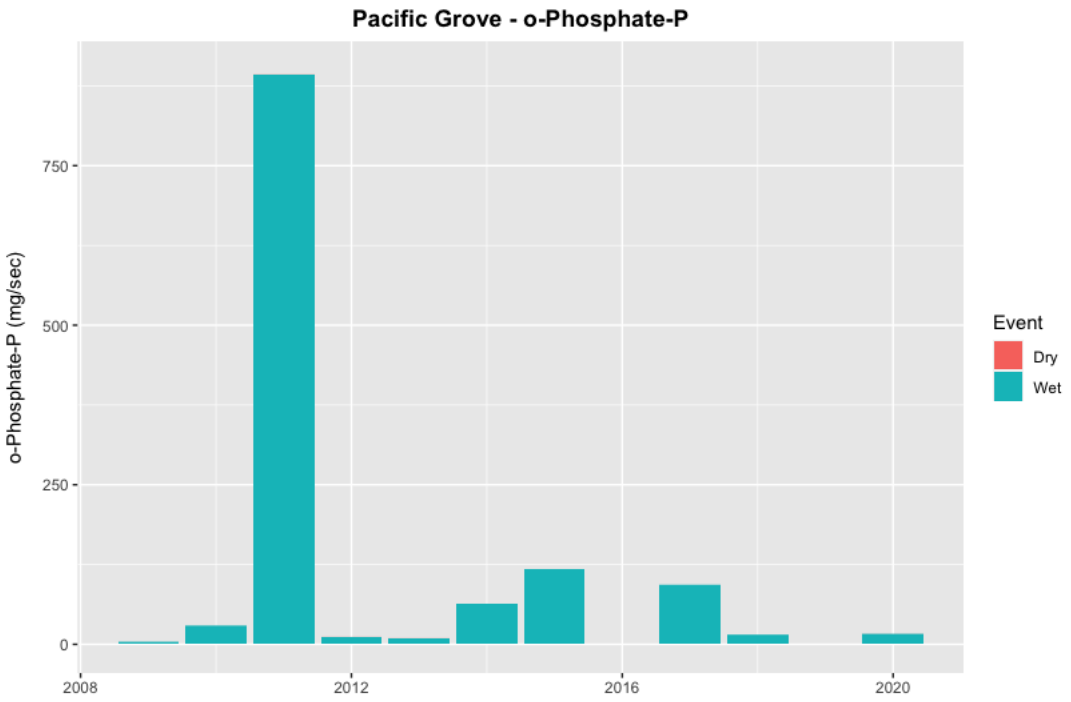
INSTANTANEOUS LEAD LOAD (UG/SEC)



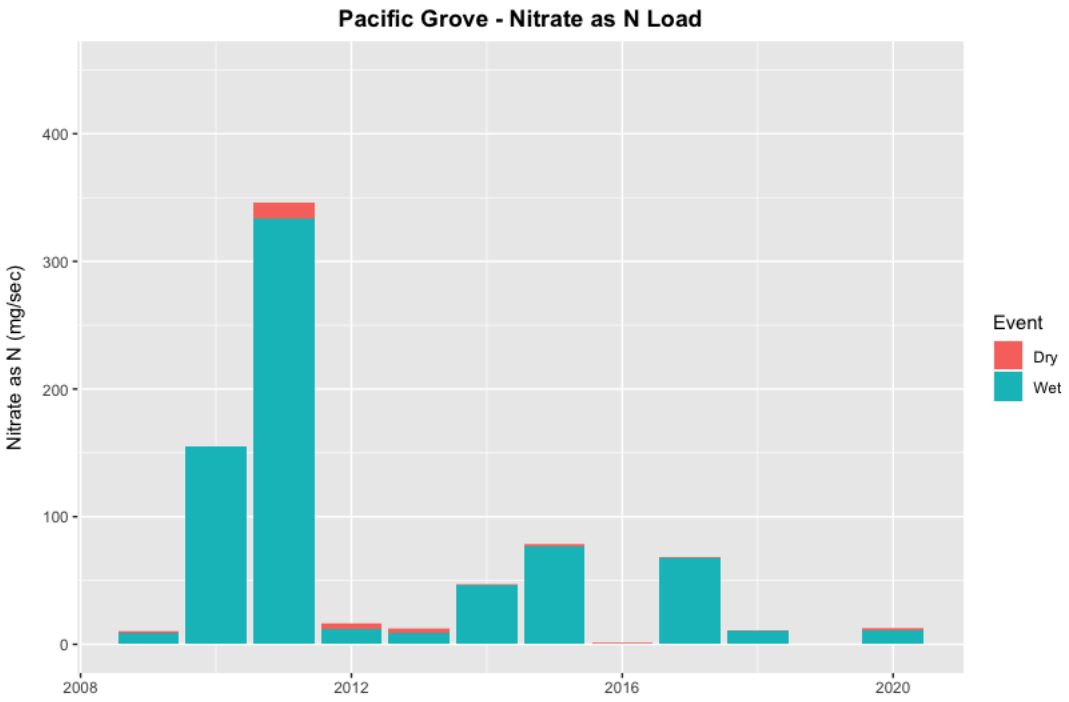
INSTANTANEOUS ZINC LOAD (UG/SEC)



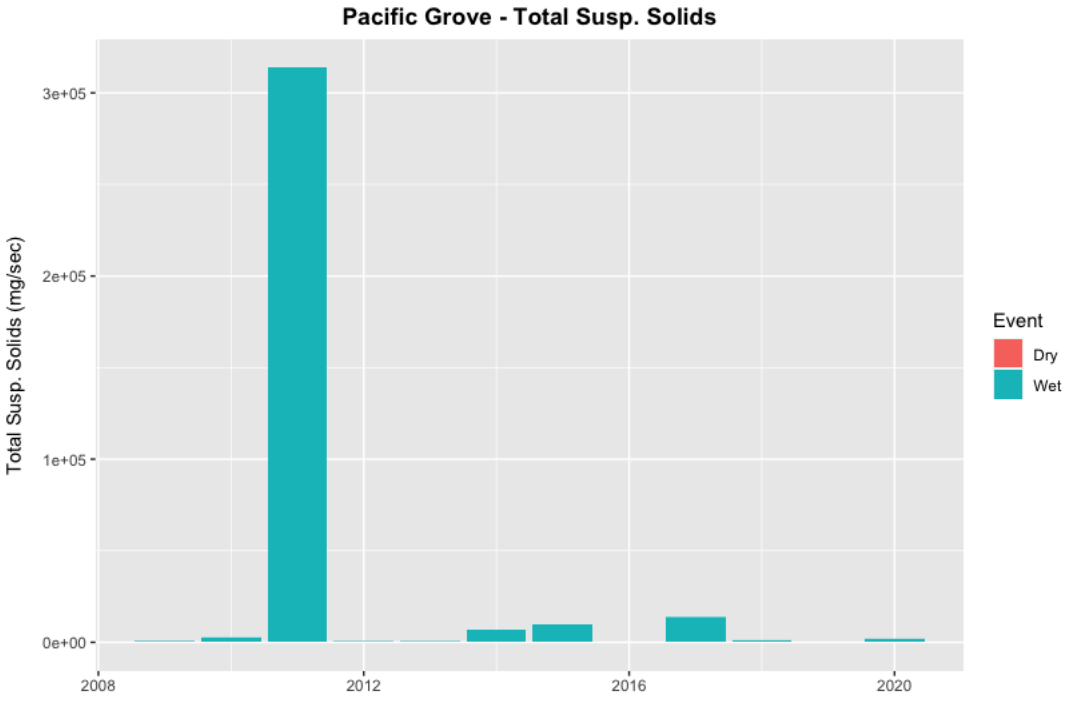
INSTANTANEOUS ORTHOPHOSPHATE LOAD (MG/SEC)



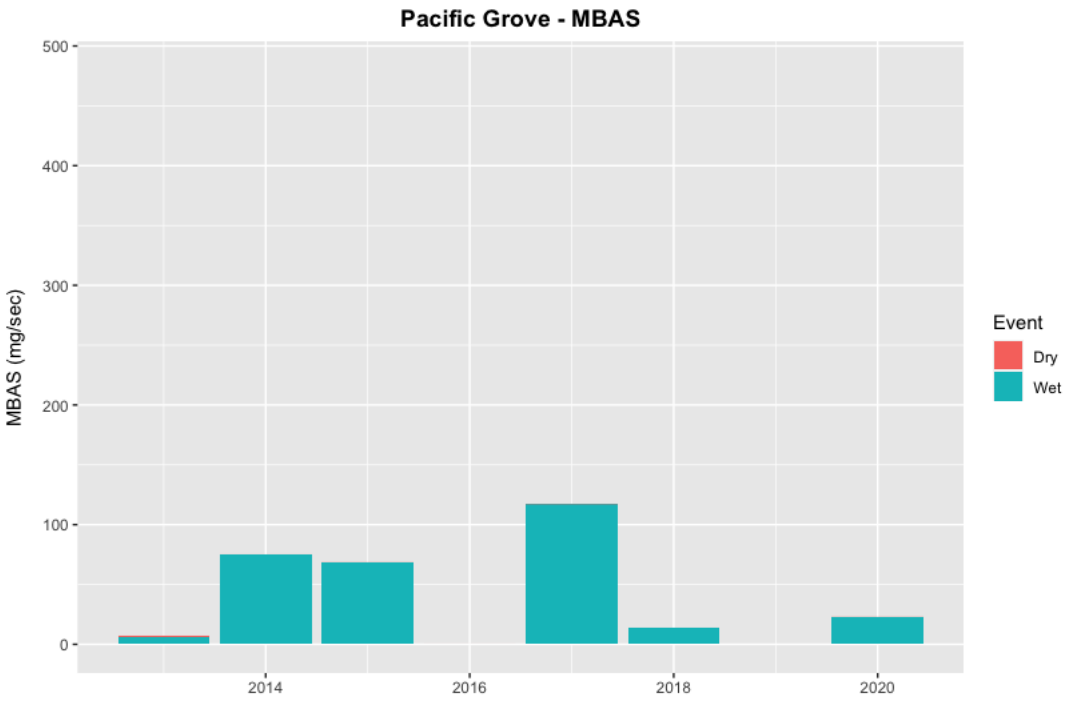
INSTANTANEOUS NITRATE LOAD (MG/SEC)



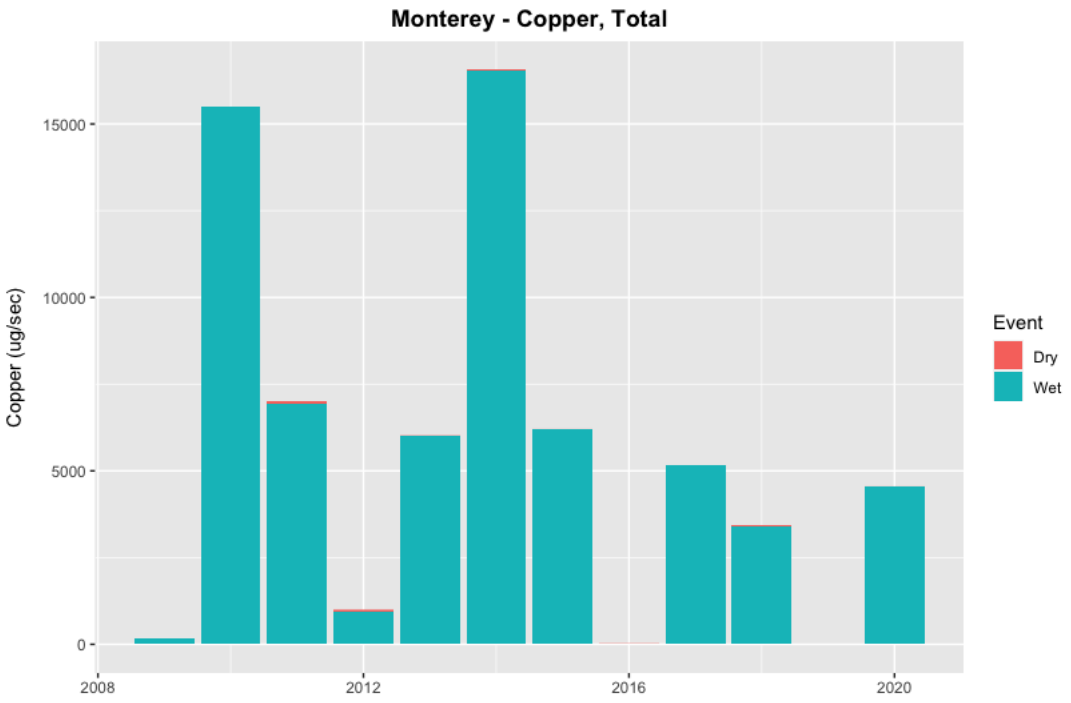
INSTANTANEOUS TOTAL SUSPENDED SOLIDS LOAD (MG/SEC)



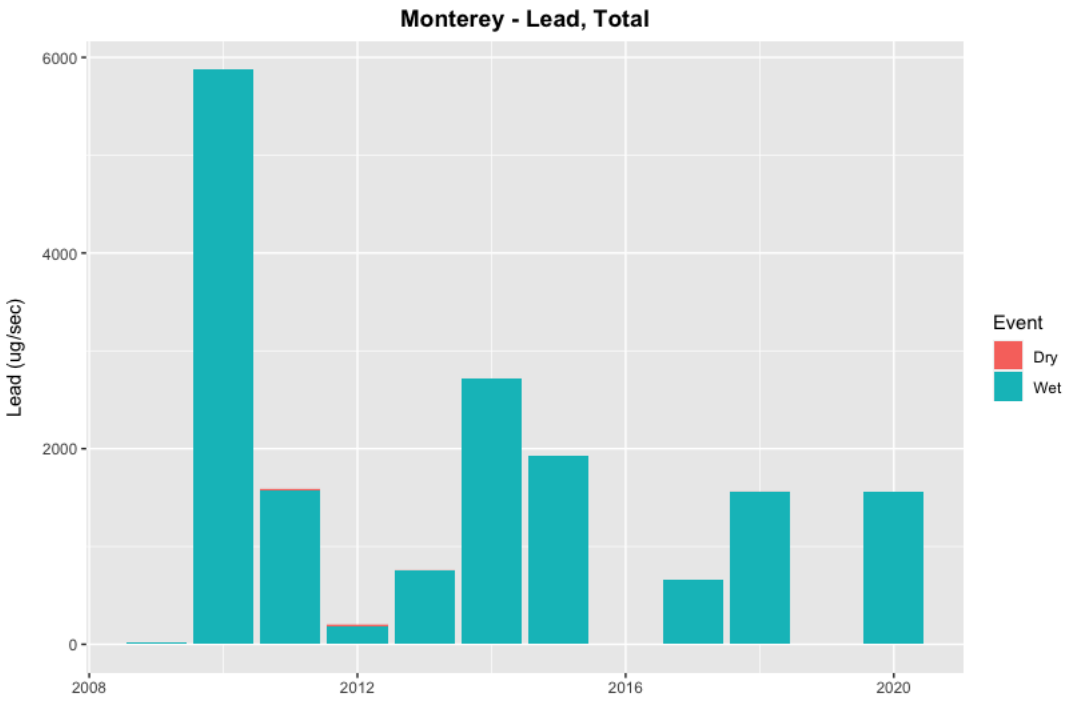
INSTANTANEOUS MBAS (SURFACTANTS) LOAD (MG/SEC)



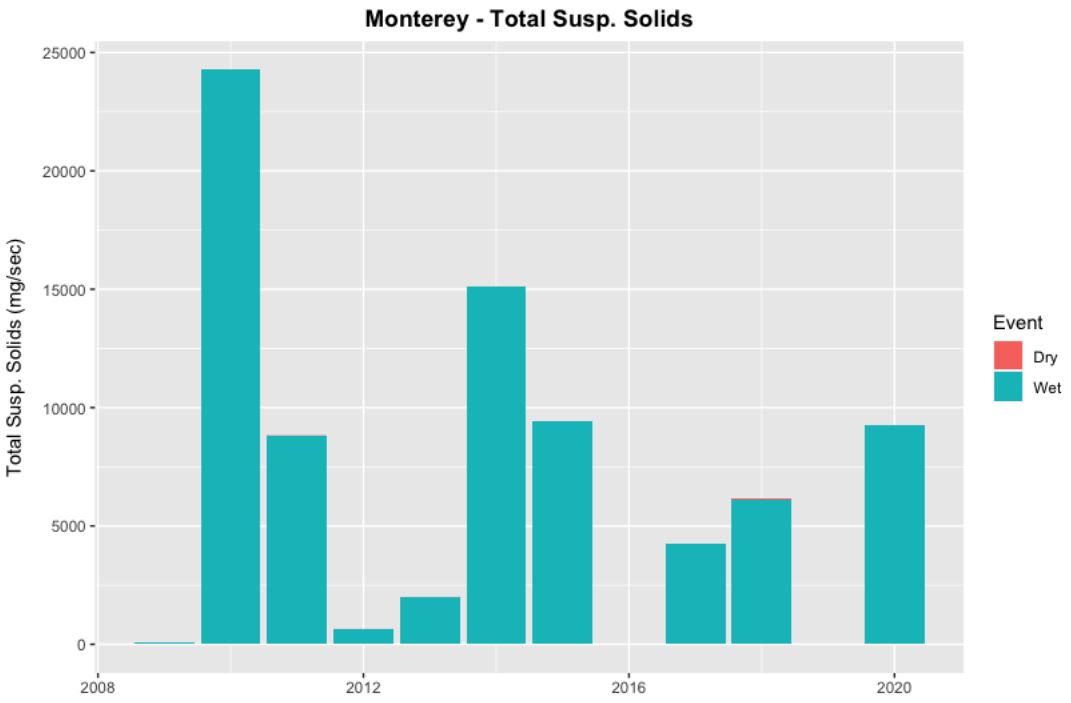
INSTANTANEOUS COPPER LOAD (UG/SEC)



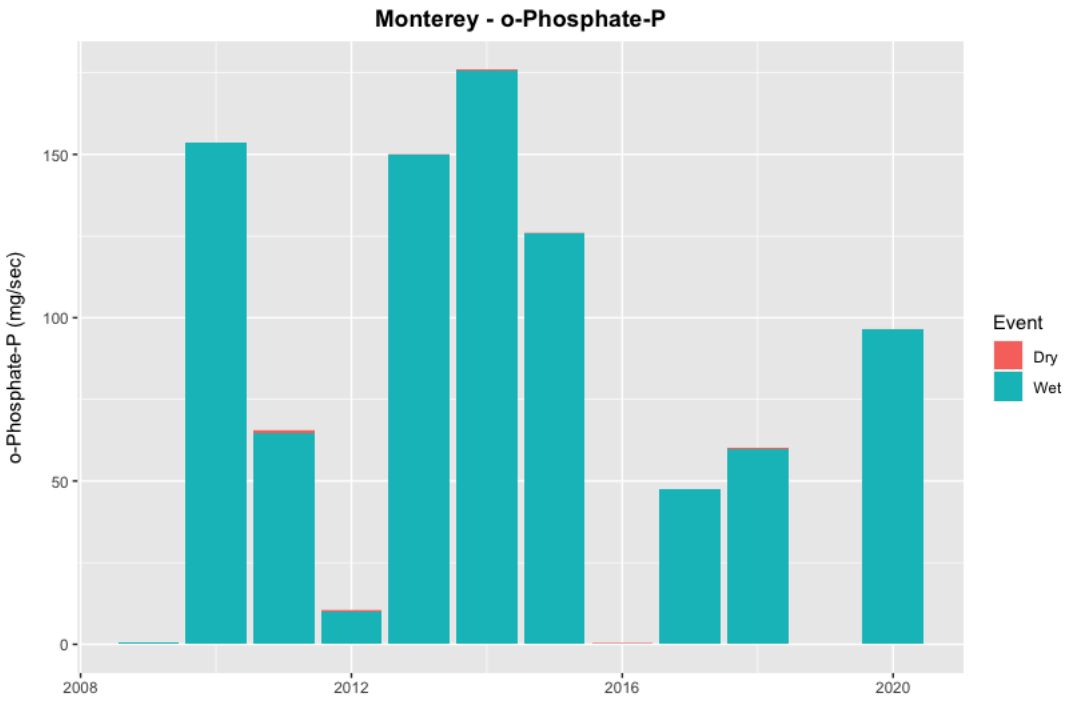
INSTANTANEOUS LEAD LOAD (UG/SEC)



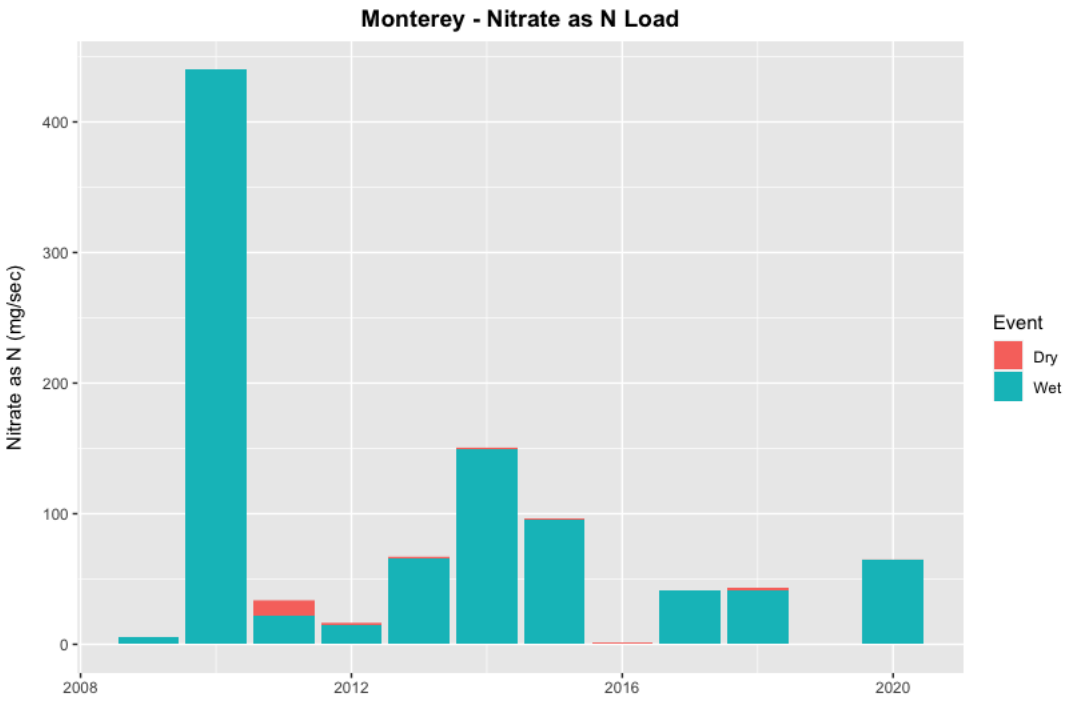
INSTANTANEOUS TOTAL SUSPENDED SOLIDS LOAD (MG/SEC)



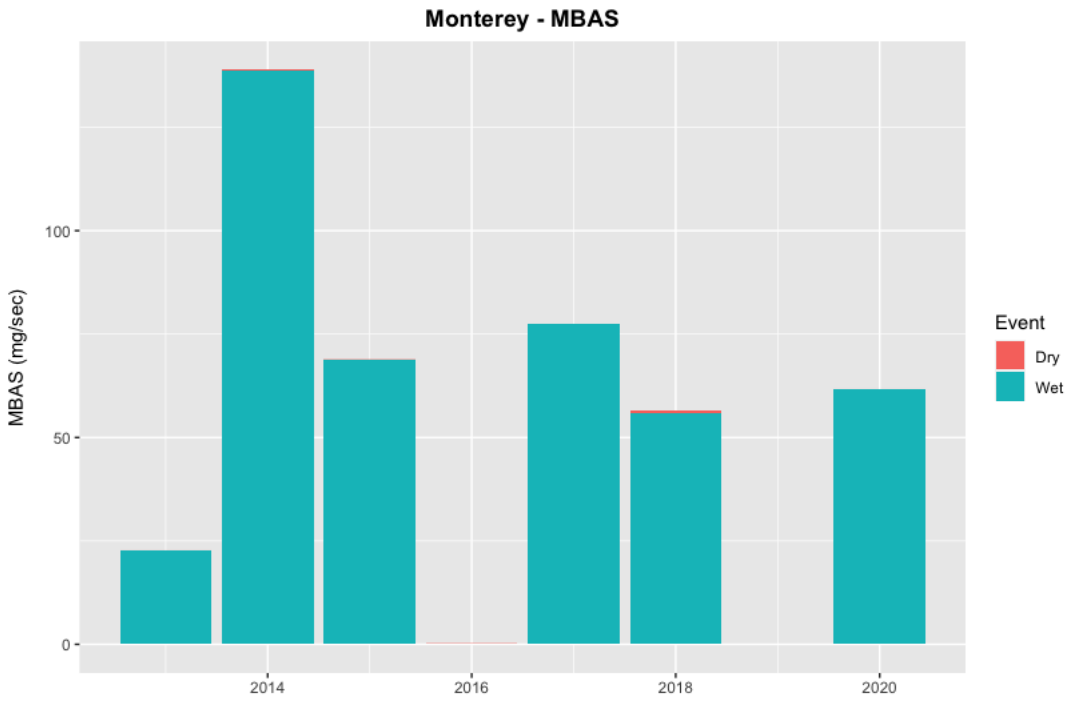
INSTANTANEOUS ORTHOPHOSPHATE LOAD (MG/SEC)



INSTANTANEOUS NITRATE LOAD (MG/SEC)



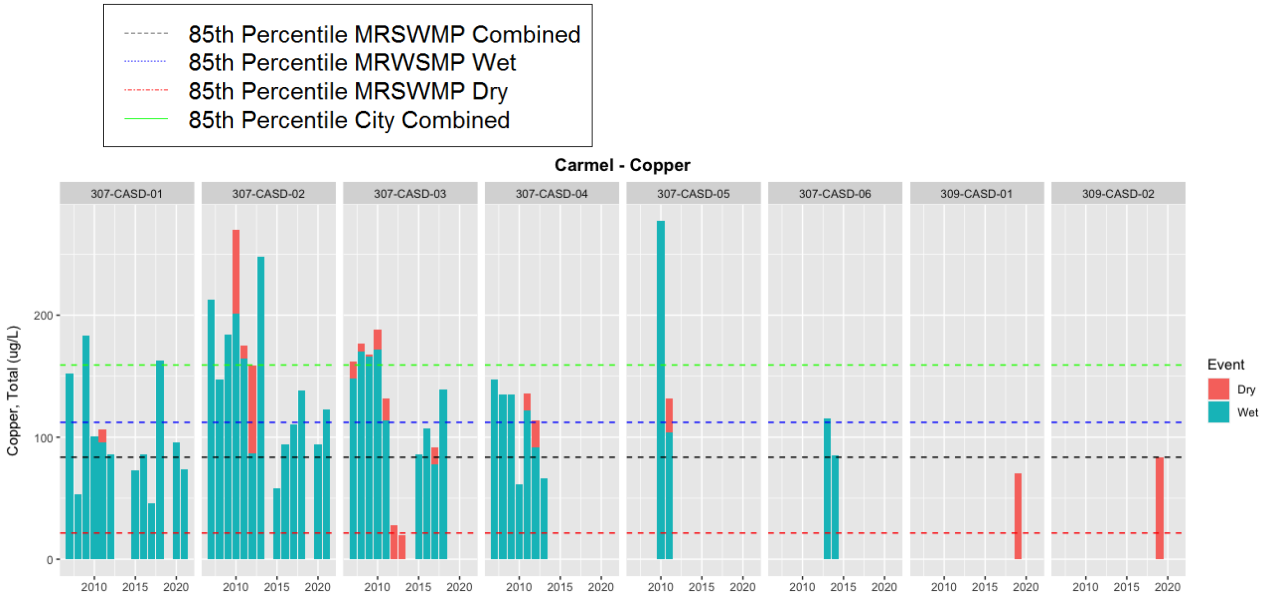
INSTANTANEOUS MBAS (SURFACTANTS) LOAD (MG/SEC)

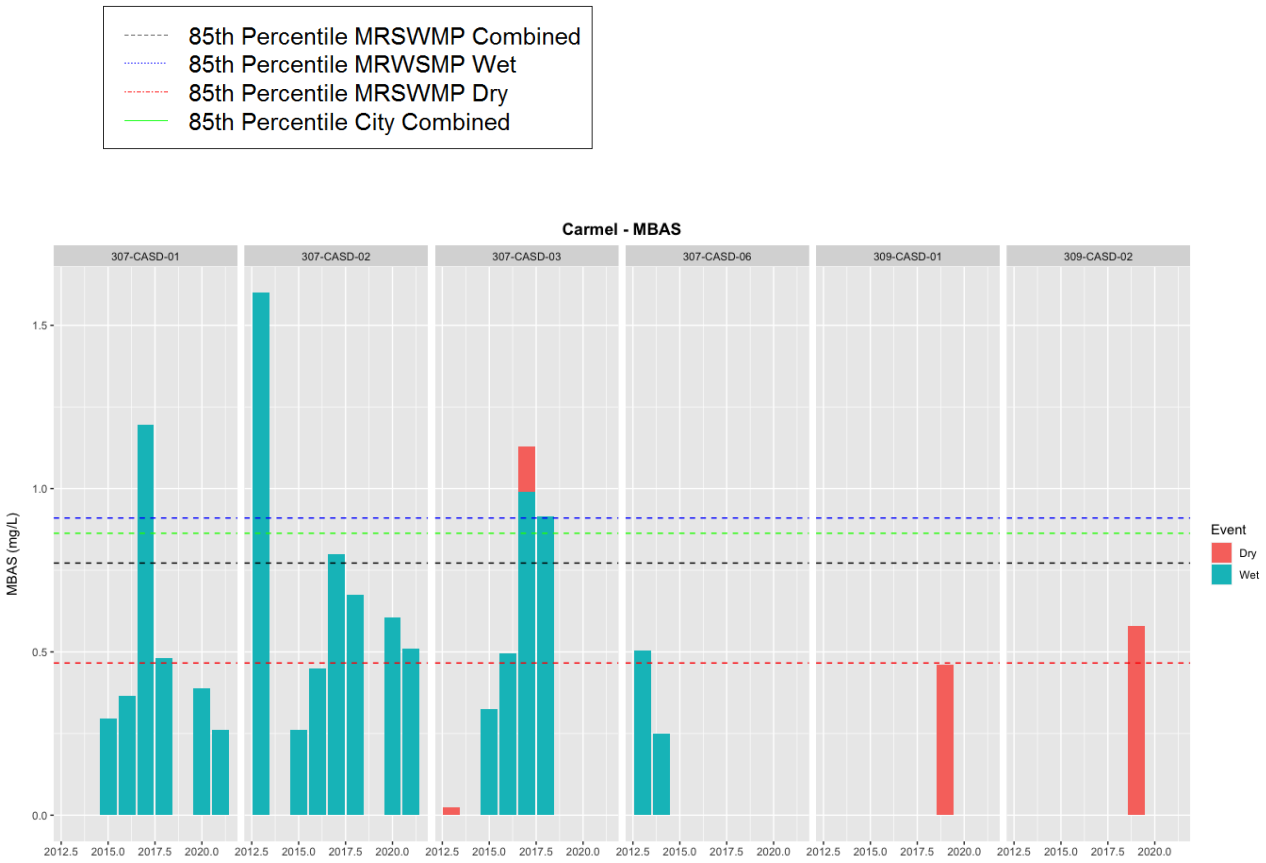


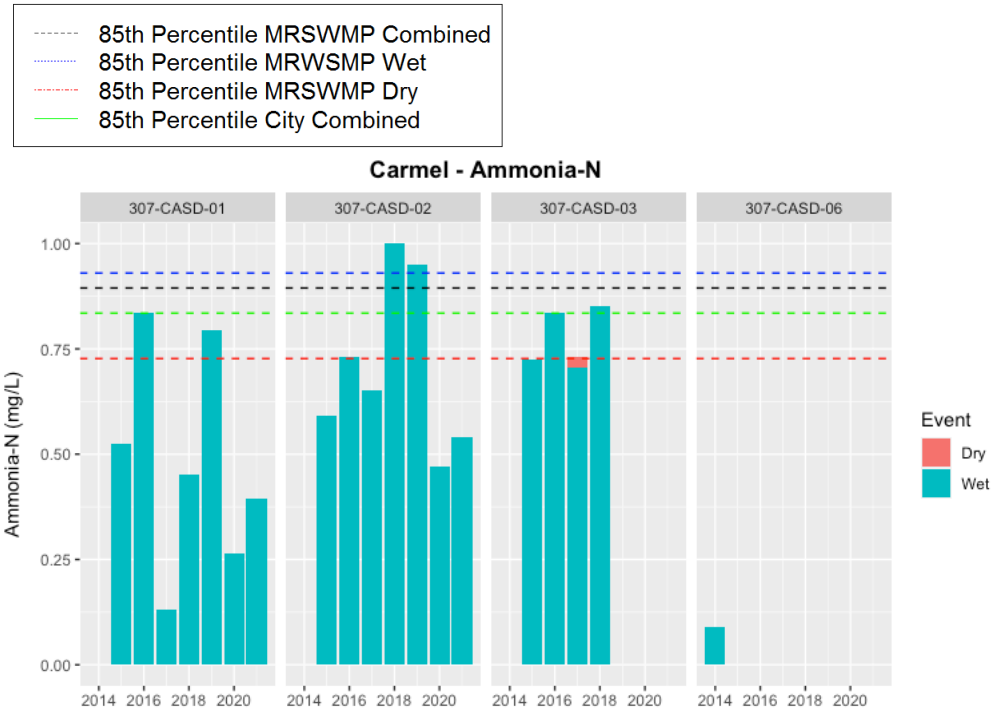
V. CONCENTRATION PLOTS

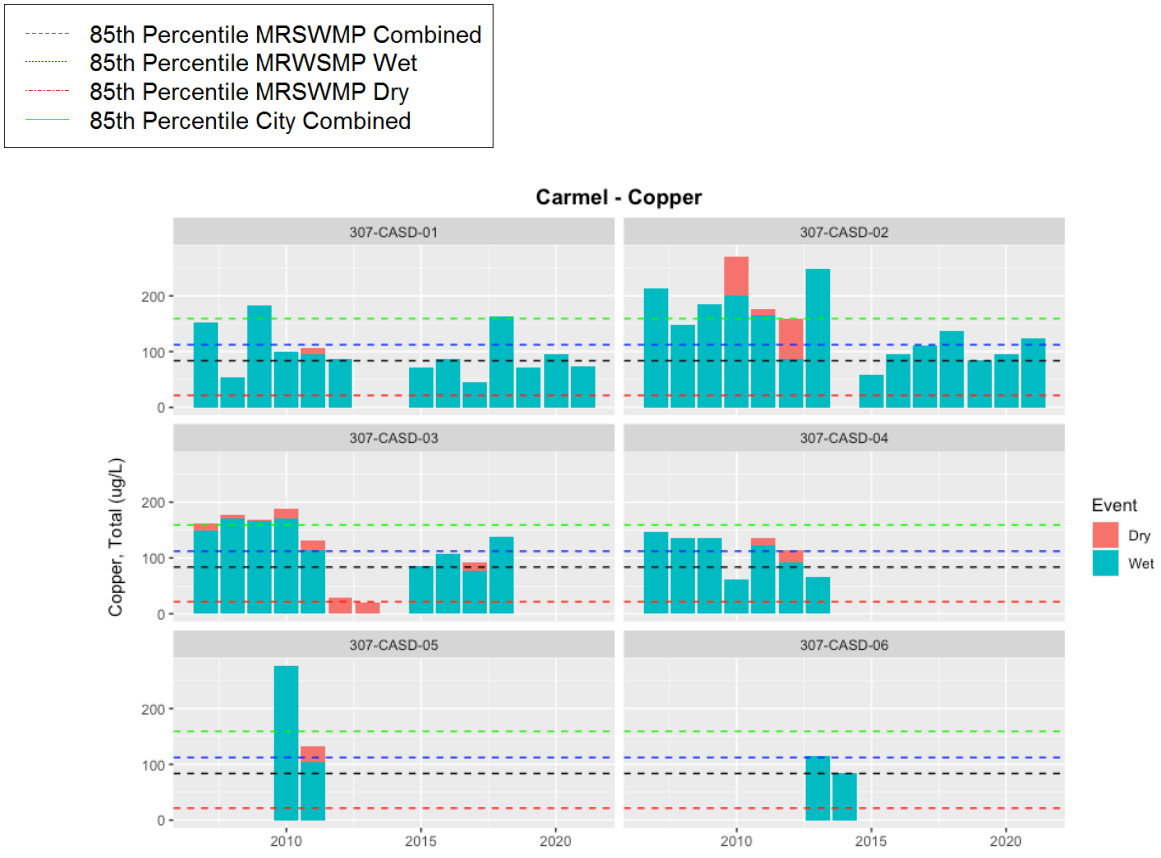
Plots showing concentration at the time of monitoring were developed for the following pollutants: total copper, total zinc, total lead, nitrate-N, orthophosphate-P, *E.coli*, *Enterococcus*, total suspended solids, MBAS, and ammonia. Plots include monitoring results from 2000-2021. Data points represent the average daily concentration from the time series of samples taken that day.

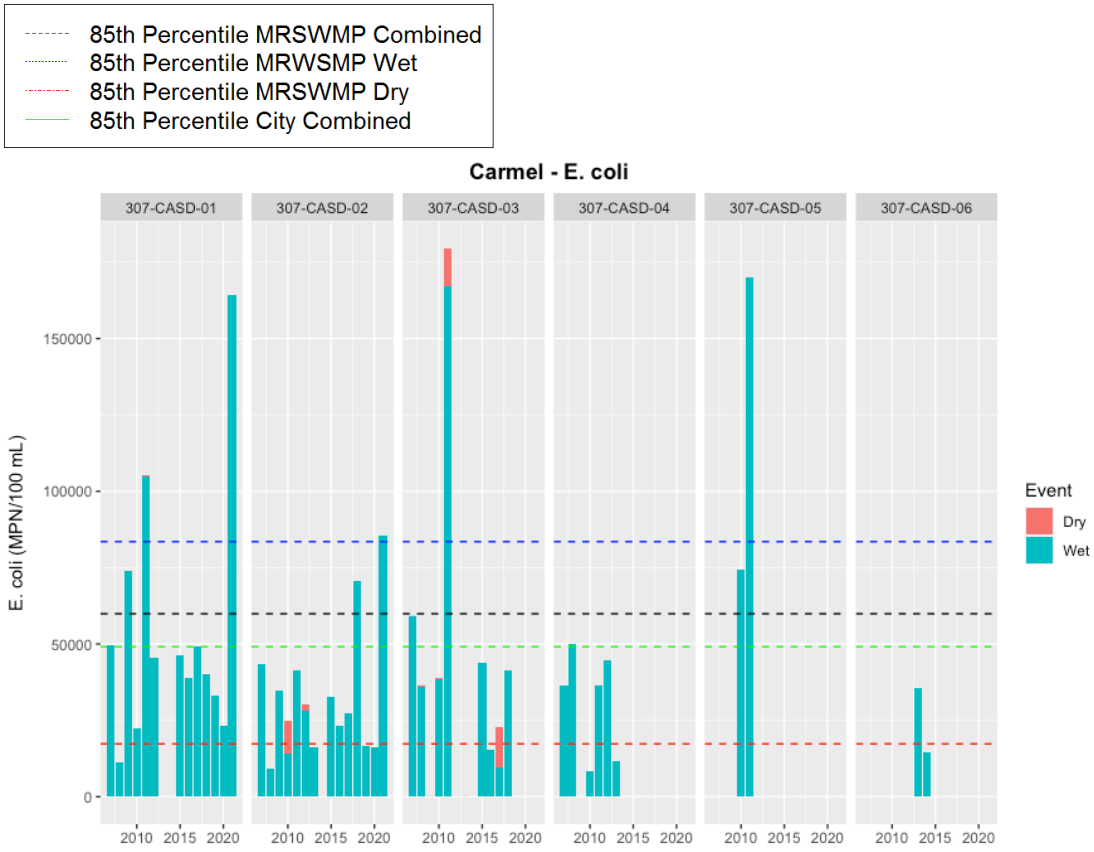
The plots also display the 85th percentiles as horizontal lines. These lines provide information about how wet and dry weather 85th percentiles compare with one another. In most cases, but not all, higher concentrations of pollutants are found in wet weather. There is also an 85th percentile line for the combined wet and dry weather for Cities with more than 5 monitoring sites (Carmel, Monterey and Pacific Grove).

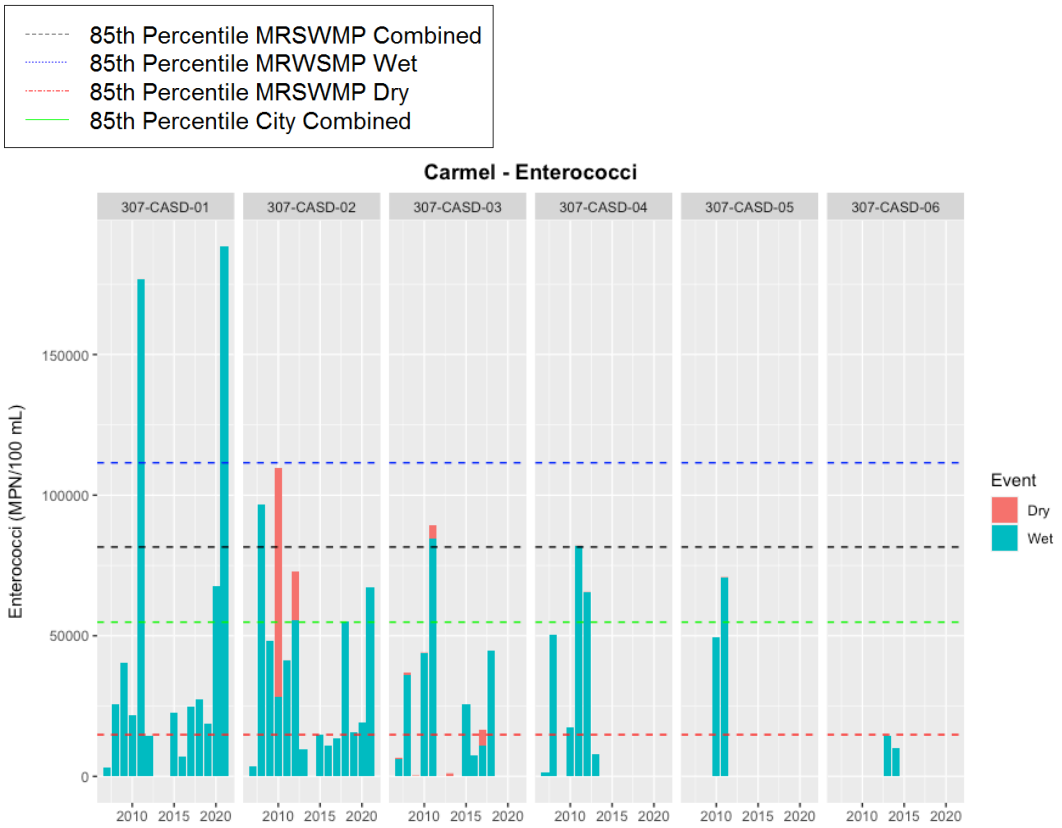

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Copper
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
309-CASD-01
309-CASD-02
Copper, Total (ug/L)
0
100
200
2010
2015
2020
Event
Dry
Wet

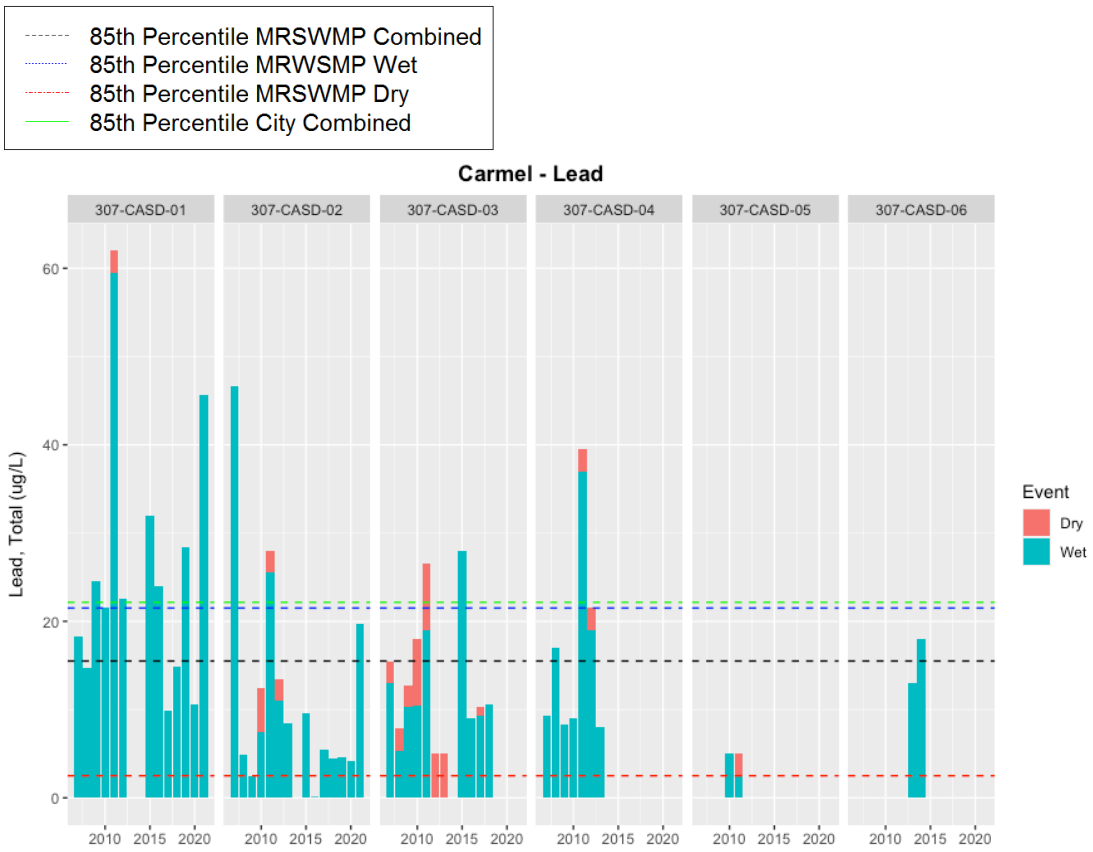

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - MBAS
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-06
309-CASD-01
309-CASD-02
MBAS (mg/L)
0.0
0.5
1.0
1.5
2012.5
2015.0
2017.5
2020.0
Event
Dry
Wet

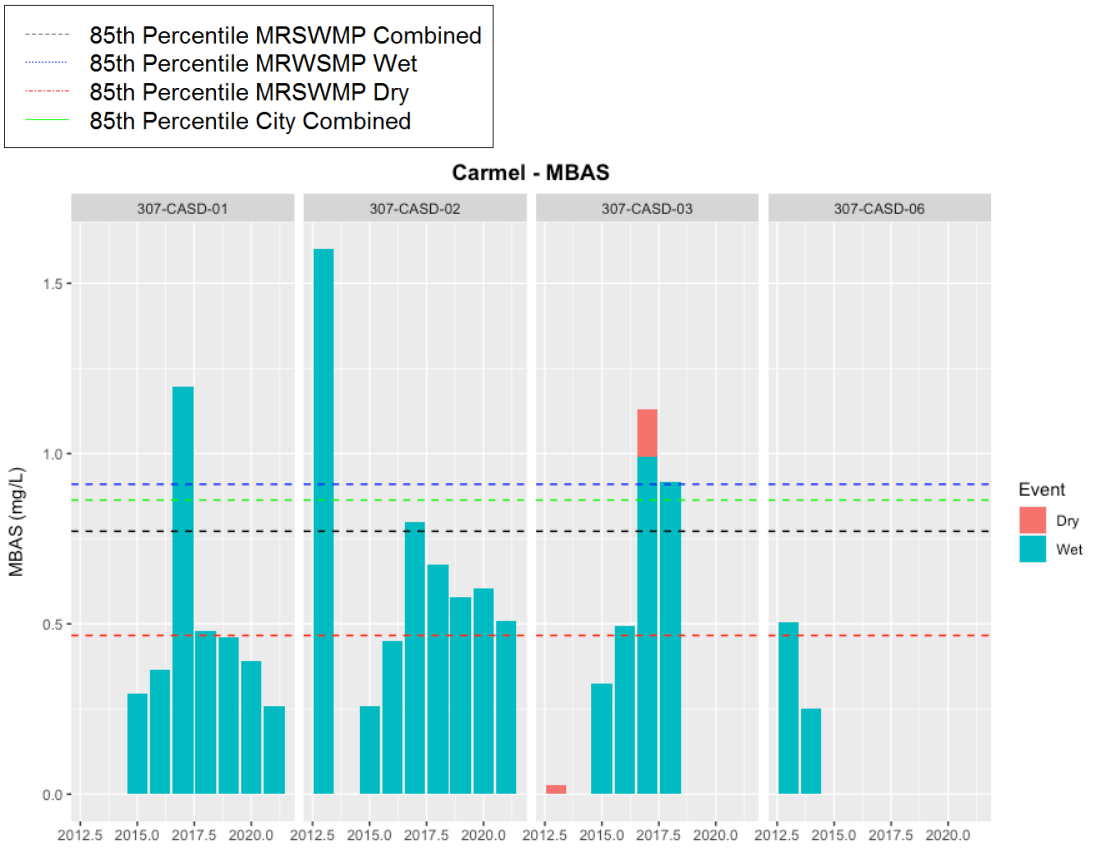

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Ammonia-N
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-06
Ammonia-N (mg/L)
1.00
0.75
0.50
0.25
0.00
2014
2016
2018
2020
Event
Dry
Wet

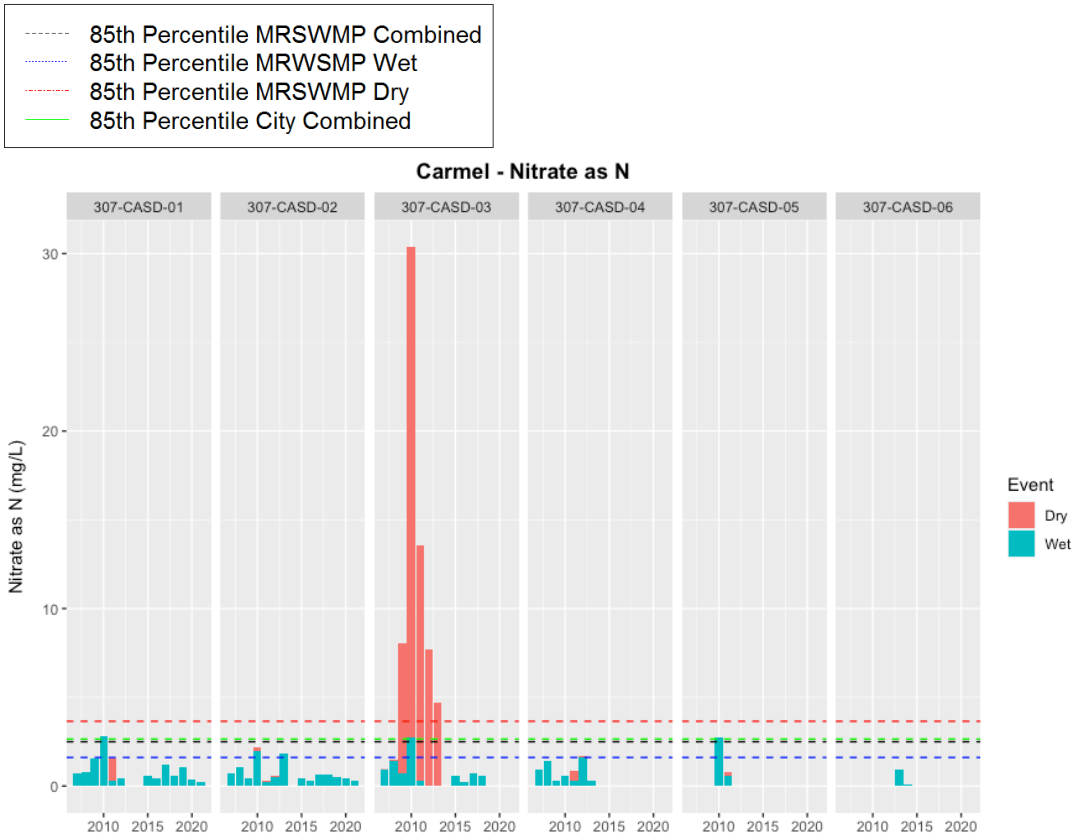

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Copper
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
Copper, Total (ug/L)
200
100
0
2010
2015
2020
Event
Dry
Wet

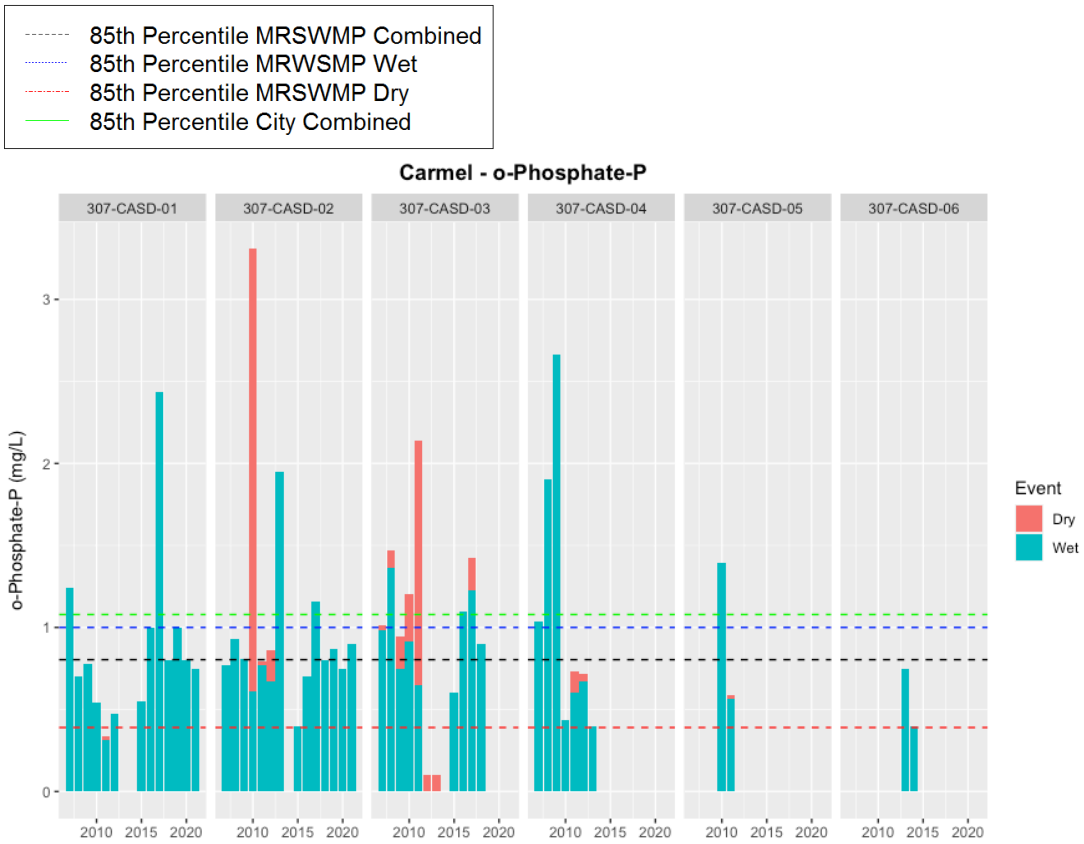

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - E. coli
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
E. coli (MPN/100 mL)
150000
100000
50000
0
2010
2015
2020
Event
Dry
Wet

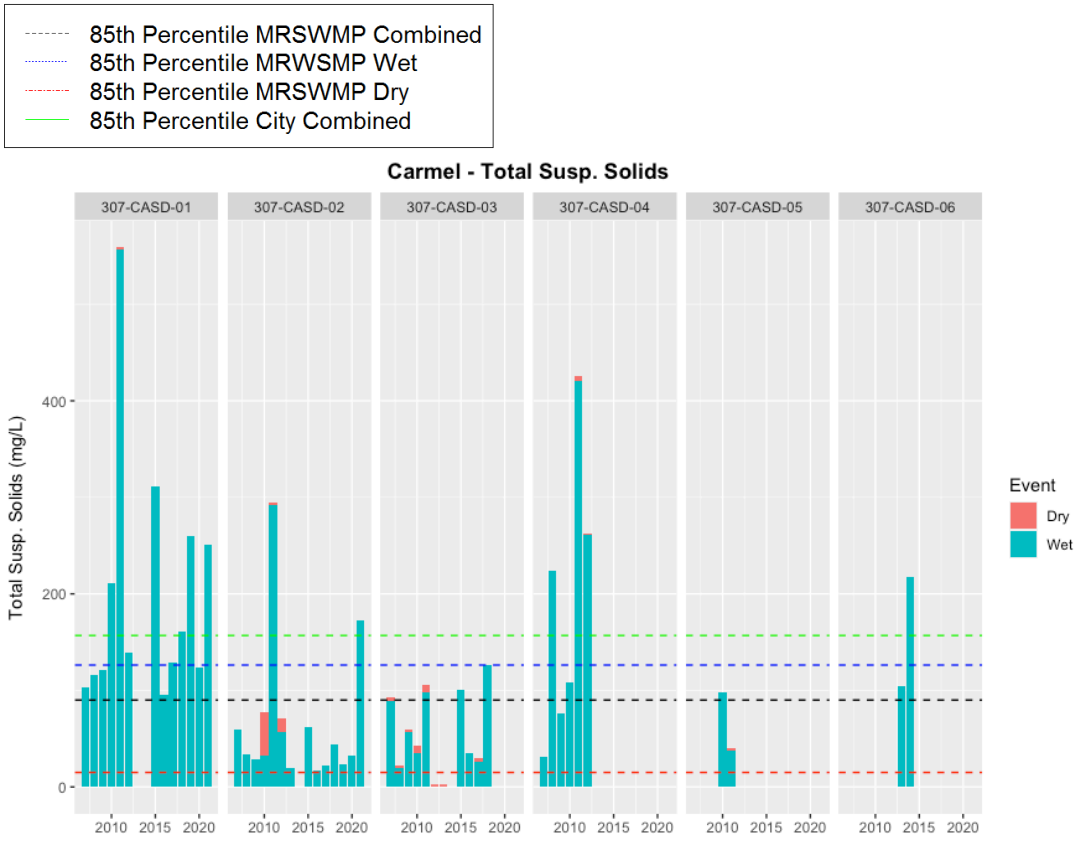

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Enterococci
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
Enterococci (MPN/100 mL)
150000
100000
50000
0
2010
2015
2020
Event
Dry
Wet

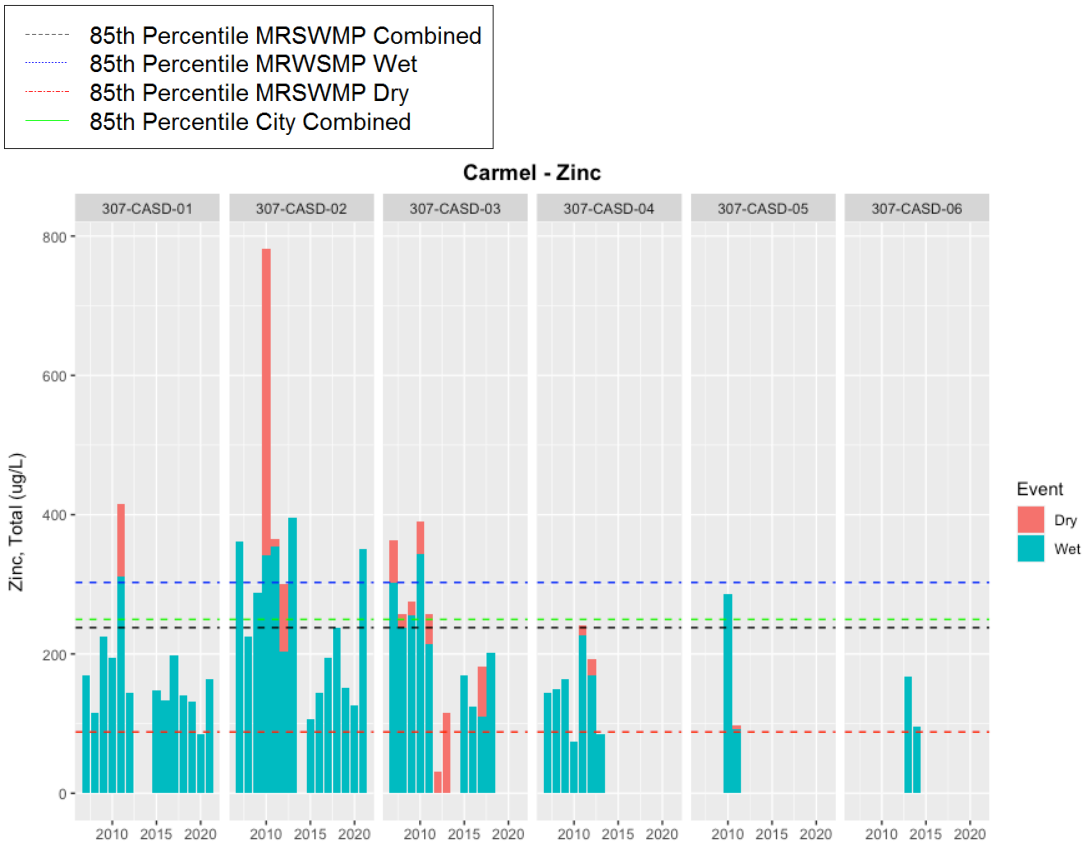

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Lead
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
Lead, Total (ug/L)
0
20
40
60
2010
2015
2020
Event
Dry
Wet

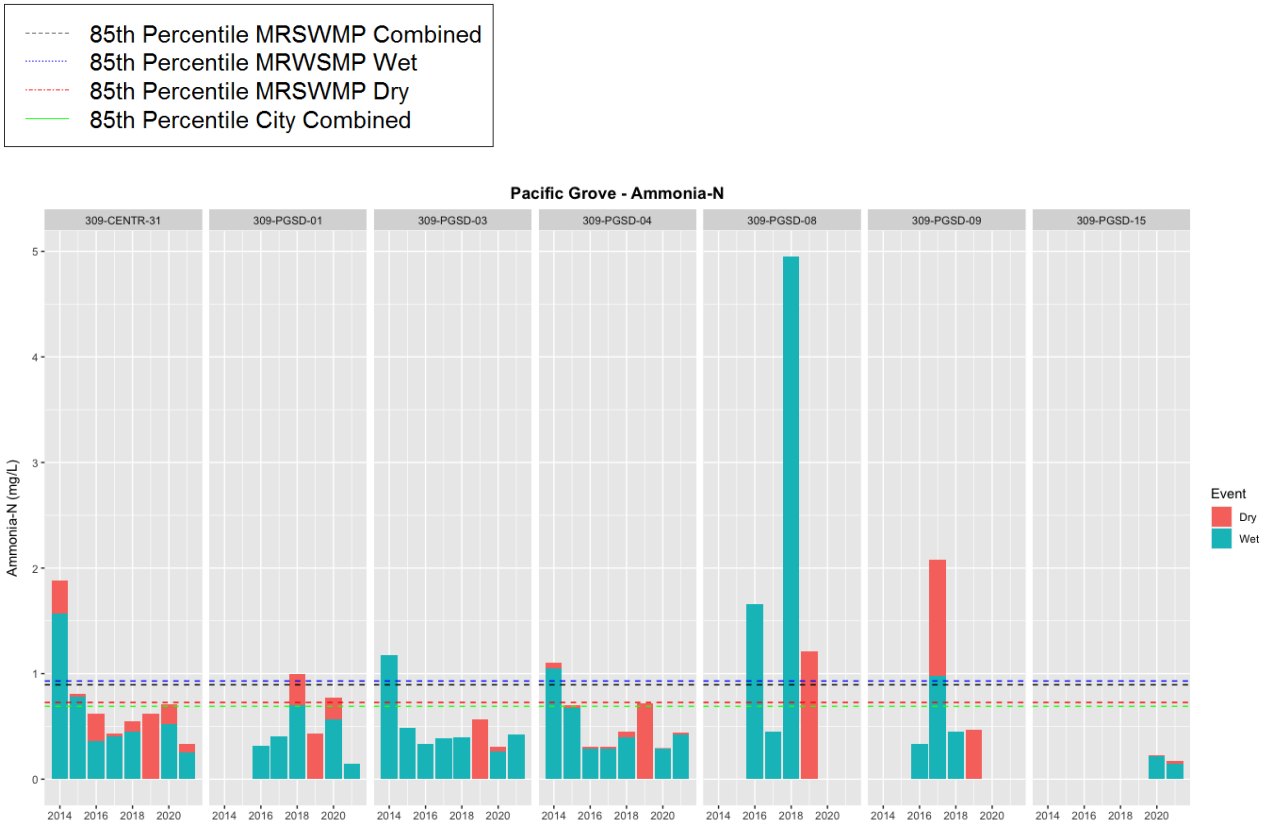

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - MBAS
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-06
MBAS (mg/L)
0.0
0.5
1.0
1.5
2012.5
2015.0
2017.5
2020.0
Event
Dry
Wet

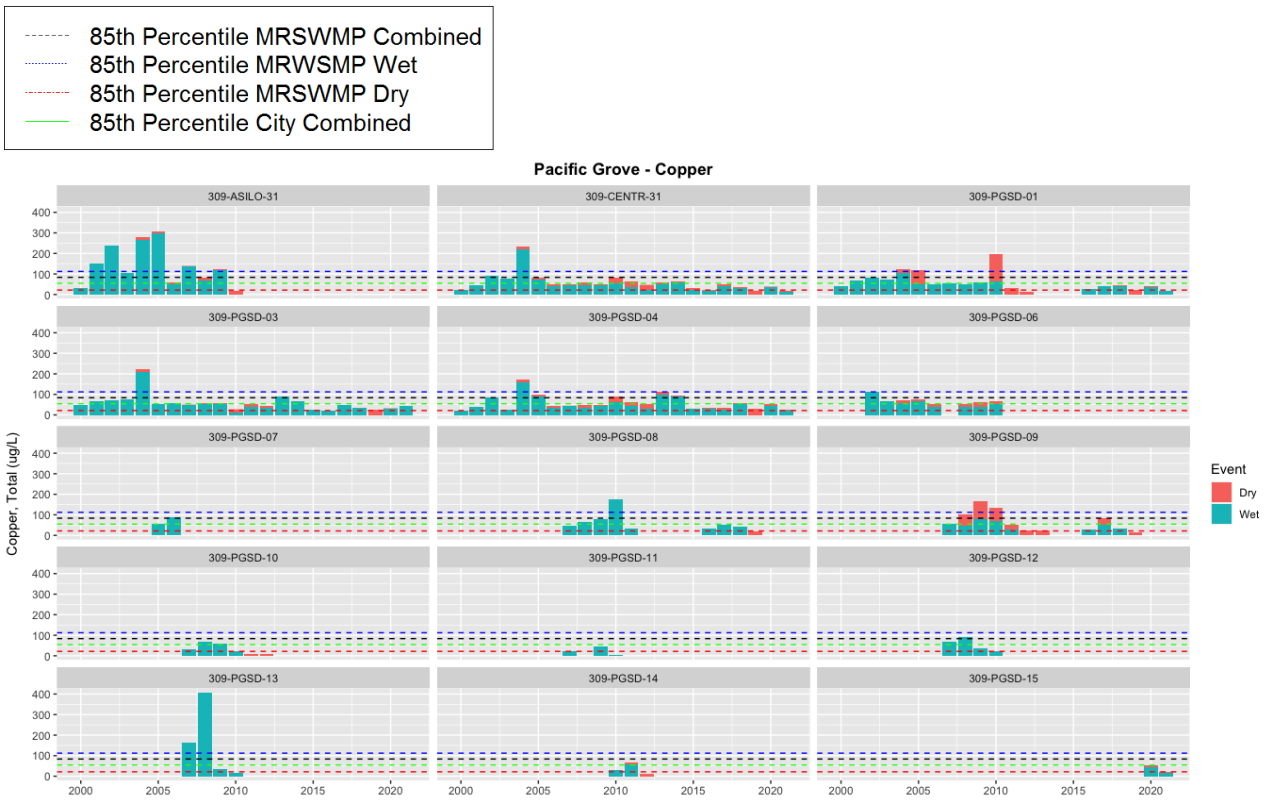

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Nitrate as N
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
Nitrate as N (mg/L)
0
10
20
30
2010
2015
2020
Event
Dry
Wet

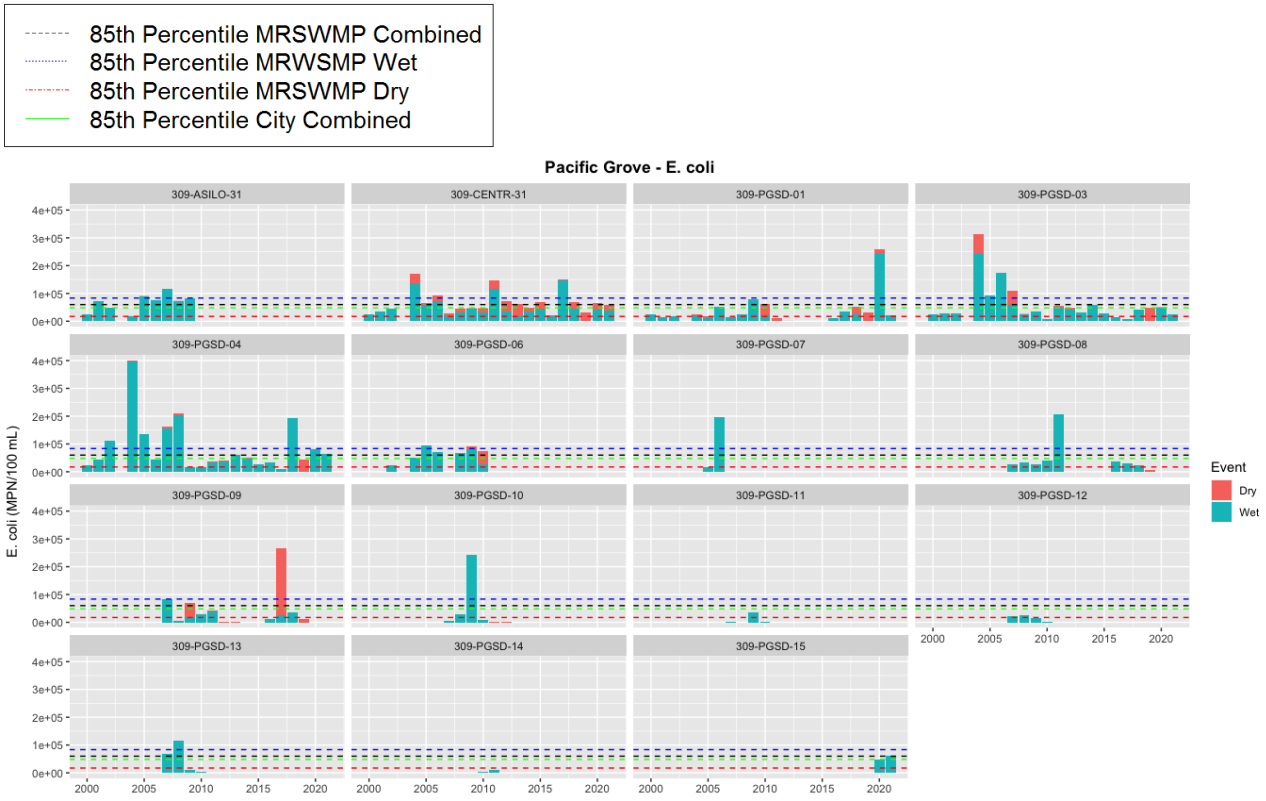

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - o-Phosphate-P
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
o-Phosphate-P (mg/L)
0
1
2
3
2010
2015
2020
Event
Dry
Wet

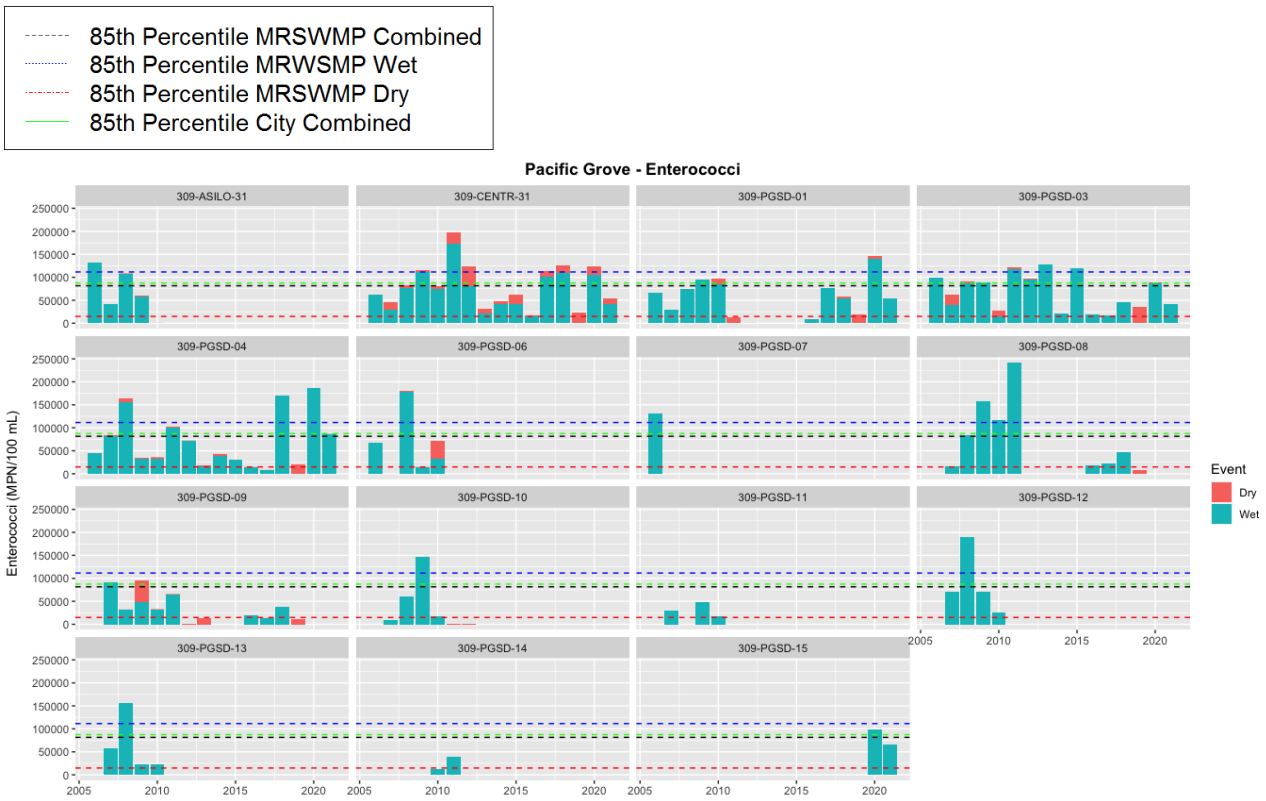

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Total Susp. Solids
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
Total Susp. Solids (mg/L)
0
200
400
2010
2015
2020
Event
Dry
Wet

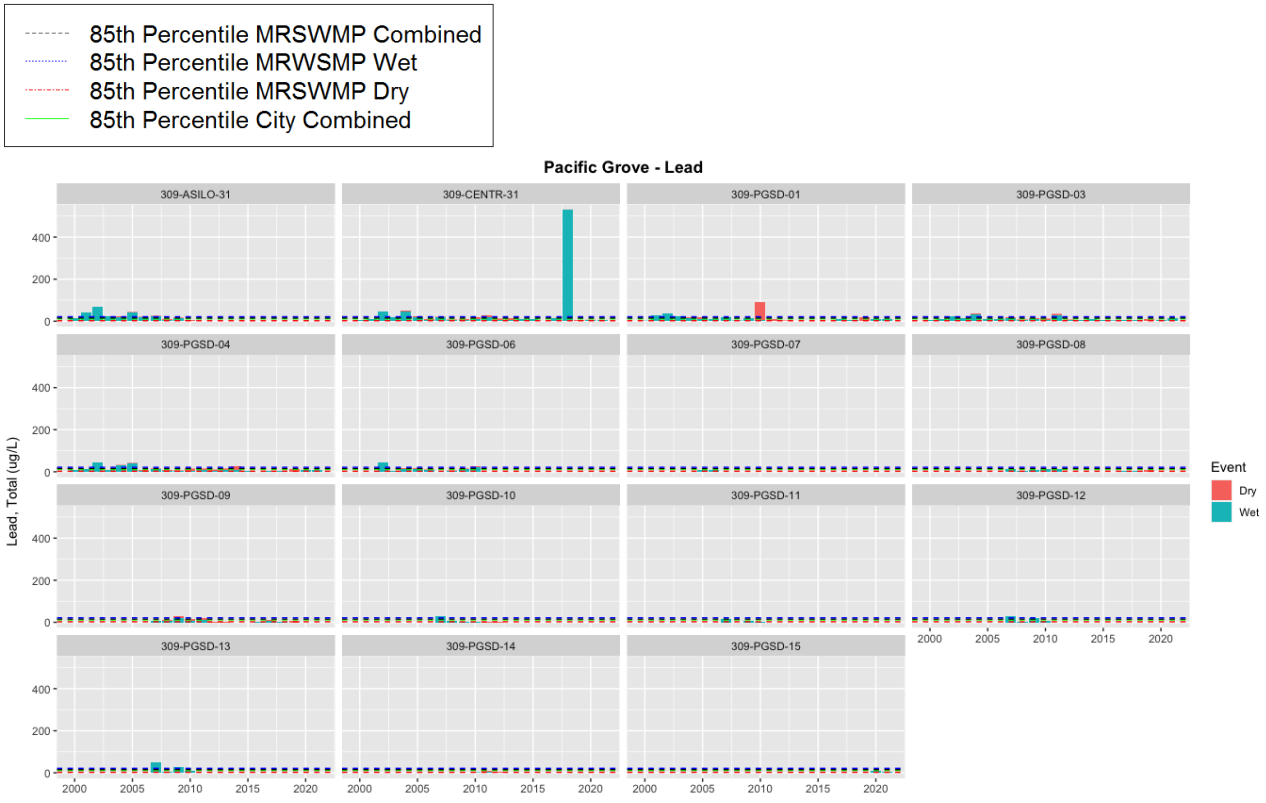

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Carmel - Zinc
307-CASD-01
307-CASD-02
307-CASD-03
307-CASD-04
307-CASD-05
307-CASD-06
Zinc, Total (ug/L)
0
200
400
600
800
2010
2015
2020
Event
Dry
Wet

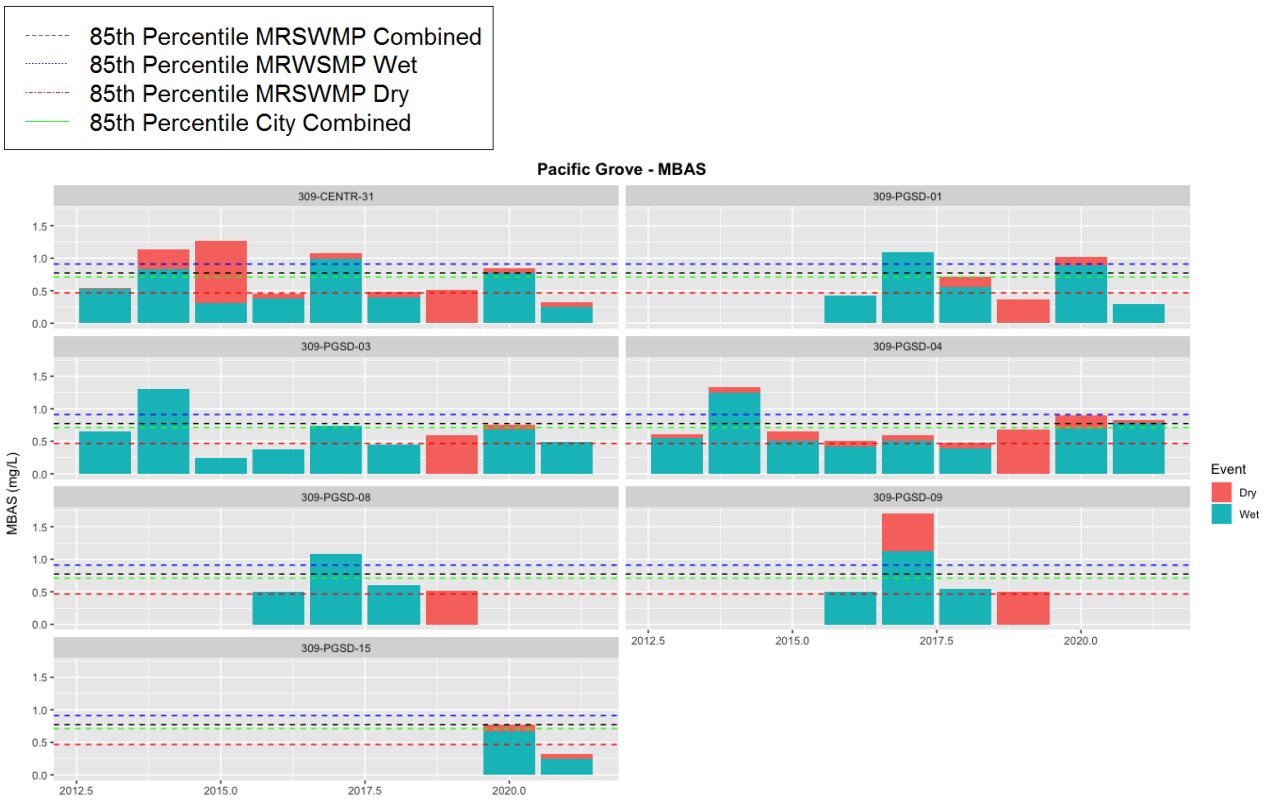

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - Ammonia-N
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-08
309-PGSD-09
309-PGSD-15
Ammonia-N (mg/L)
0
1
2
3
4
5
2014
2016
2018
2020
Event
Dry
Wet

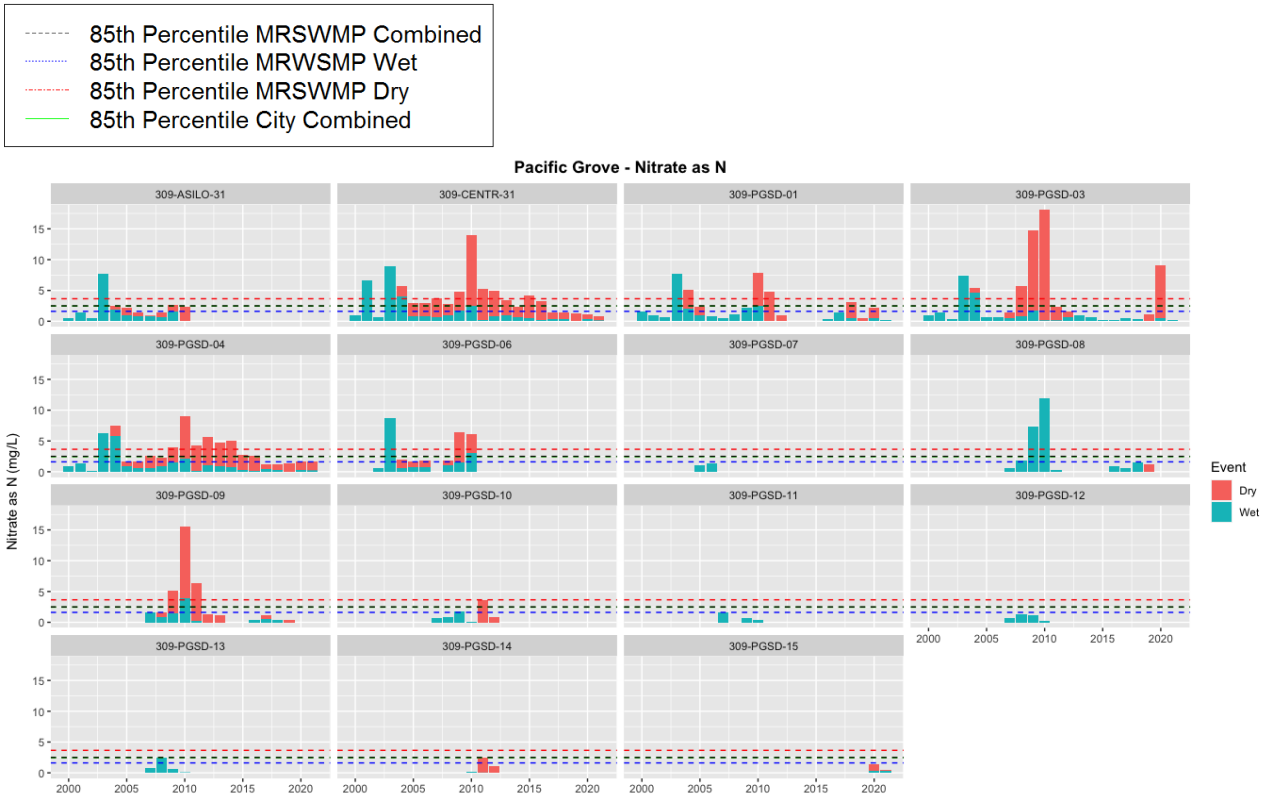

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - Copper
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
Copper, Total (ug/L)
Event
Dry
Wet


85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - E. coli
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
E. coli (MPN/100 mL)
Event
Dry
Wet

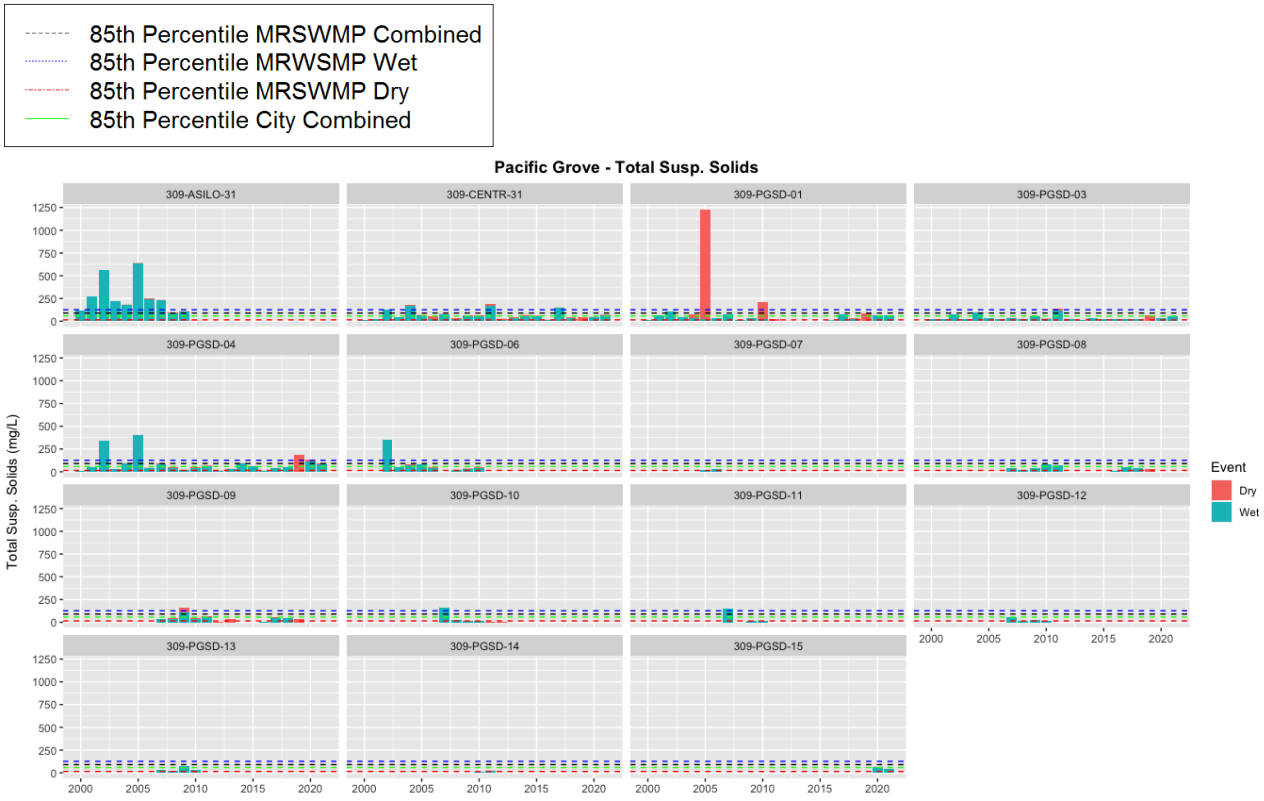

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - Enterococci
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
Enterococci (MPN/100 mL)
Event
Dry
Wet

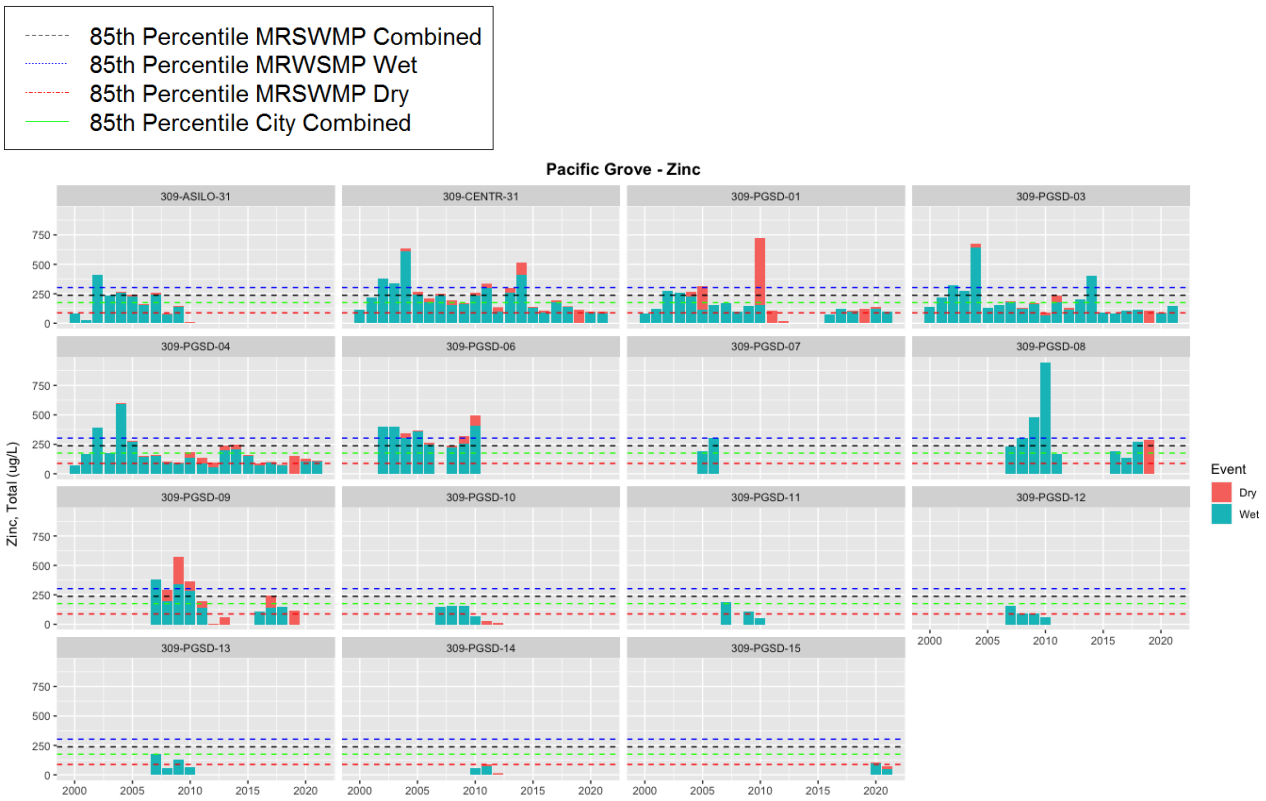

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - Lead
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
Lead, Total (ug/L)
Event
Dry
Wet

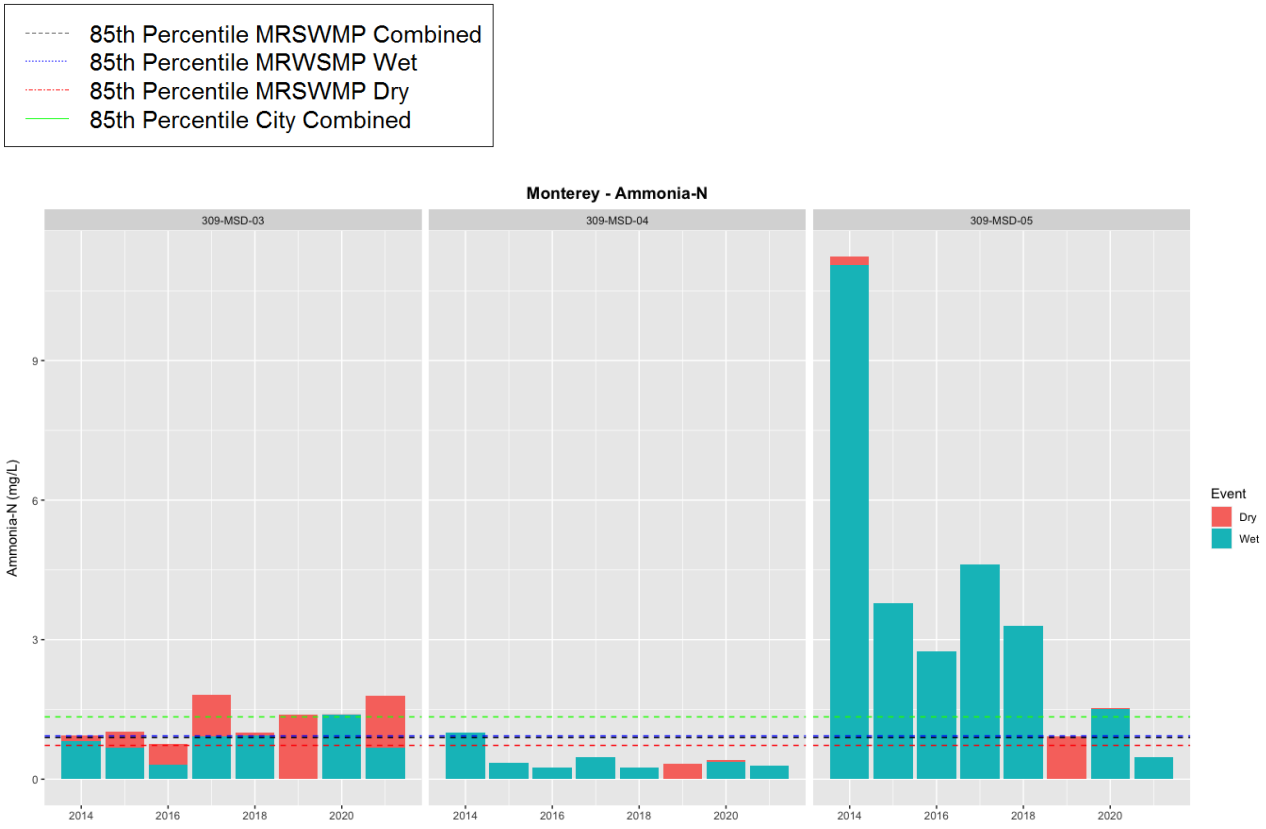

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - MBAS
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-08
309-PGSD-09
309-PGSD-15
MBAS (mg/L)
Event
Dry
Wet

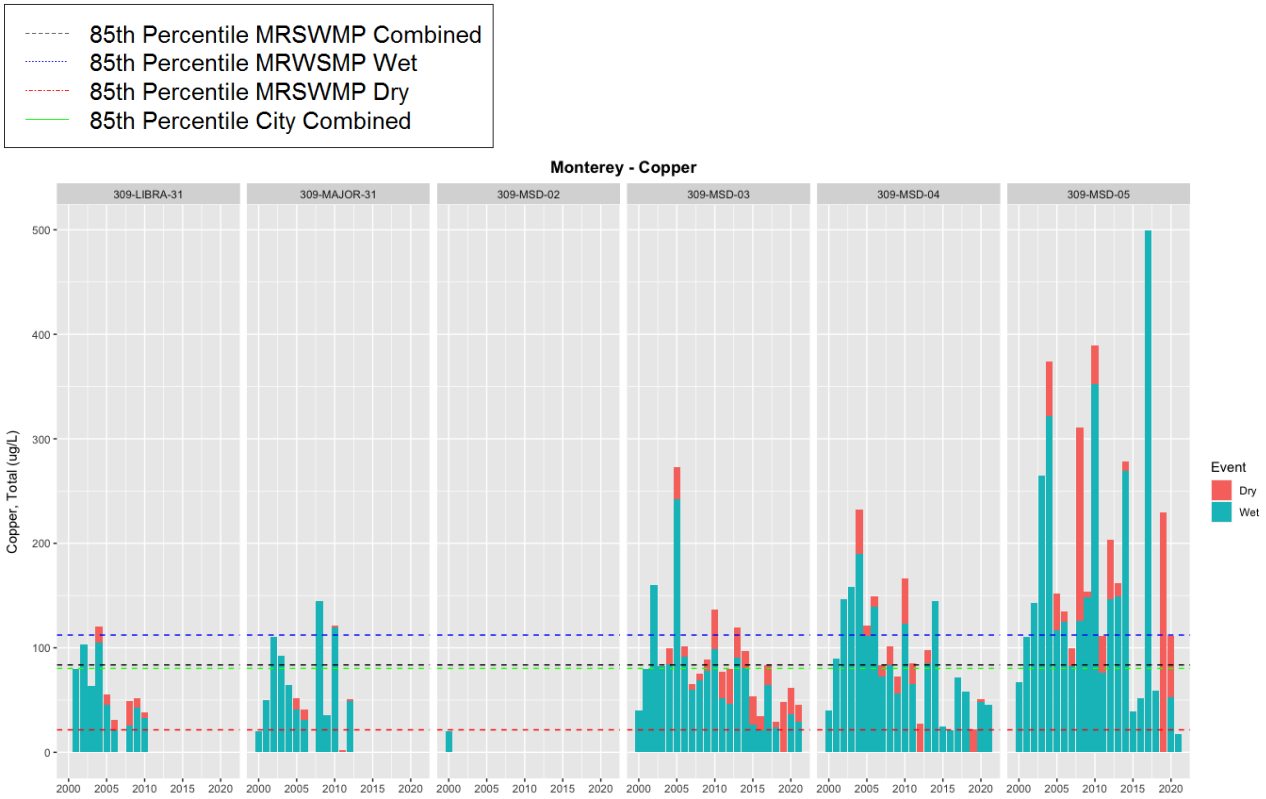

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - Nitrate as N
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
Nitrate as N (mg/L)
Event
Dry
Wet

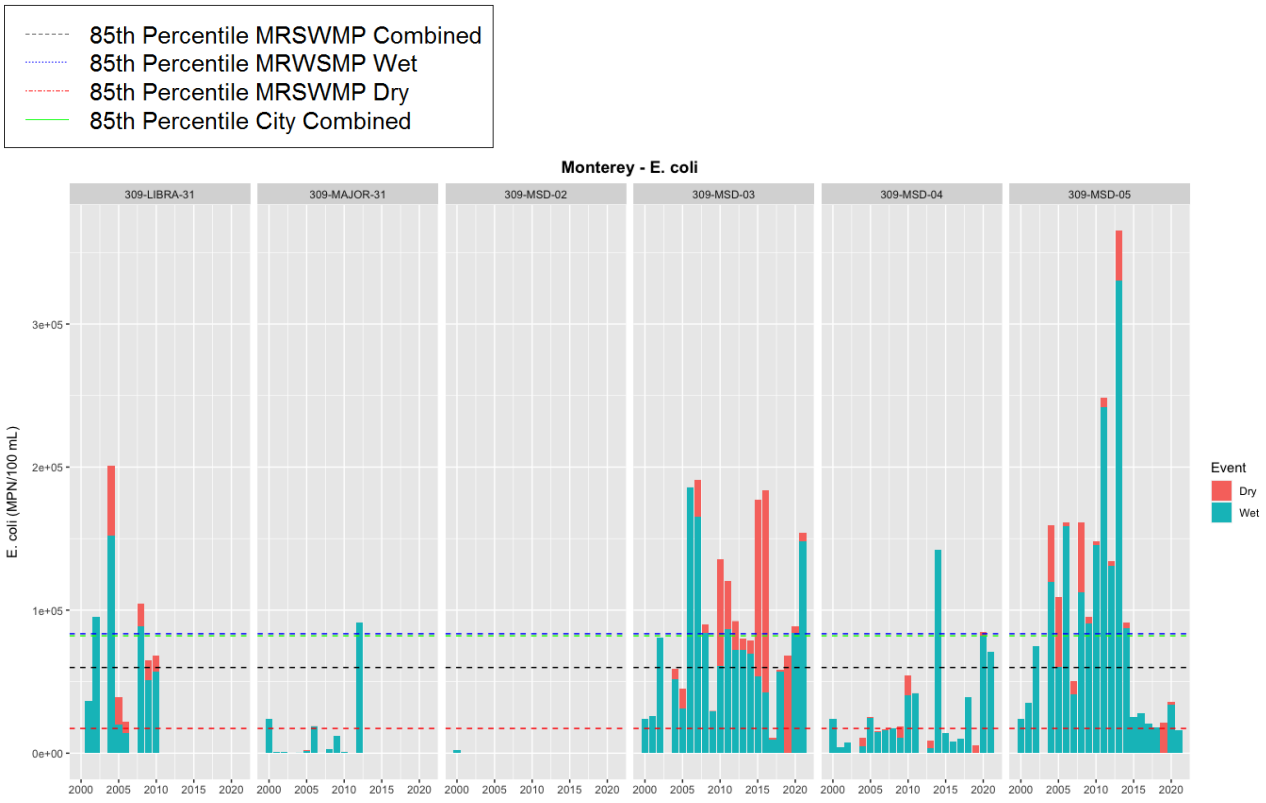

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - o-Phosphate-P
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
o-Phosphate-P (mg/L)
Event
Dry
Wet

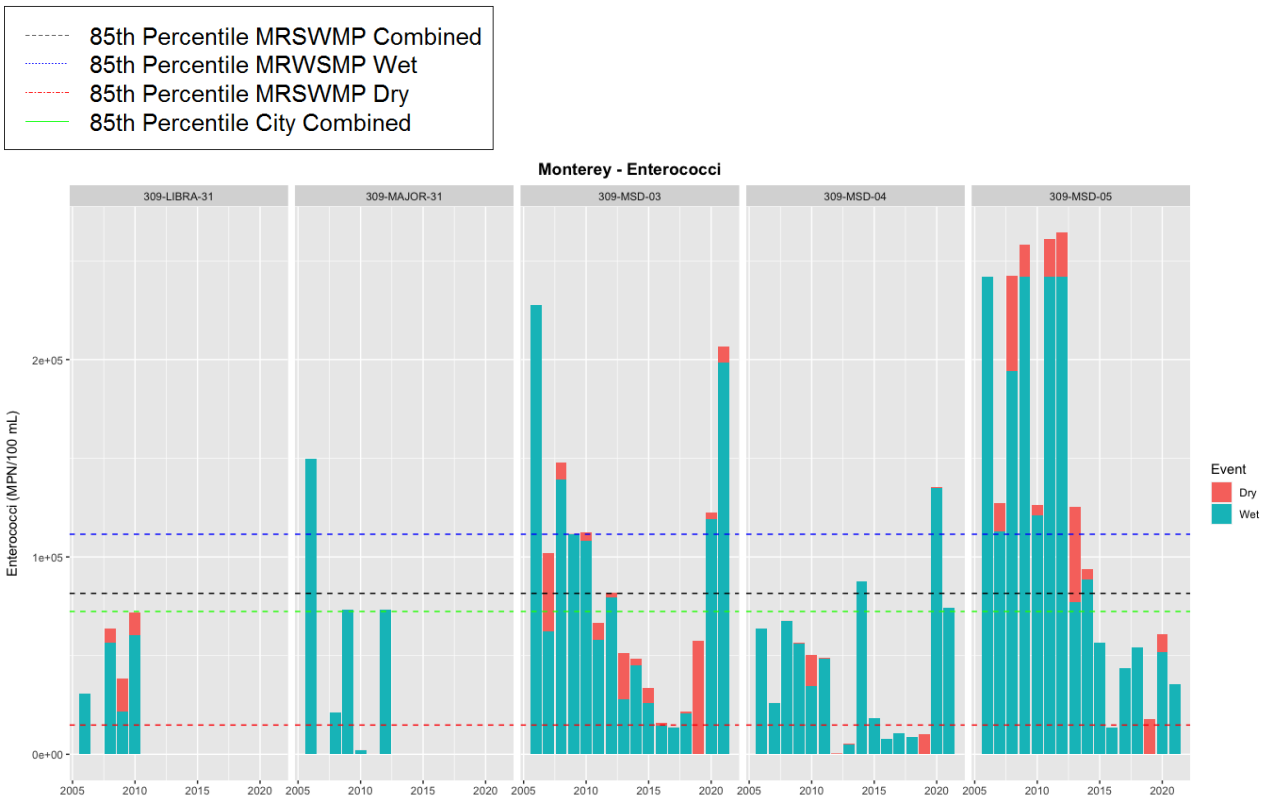

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - Total Susp. Solids
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
Total Susp. Solids (mg/L)
Event
Dry
Wet

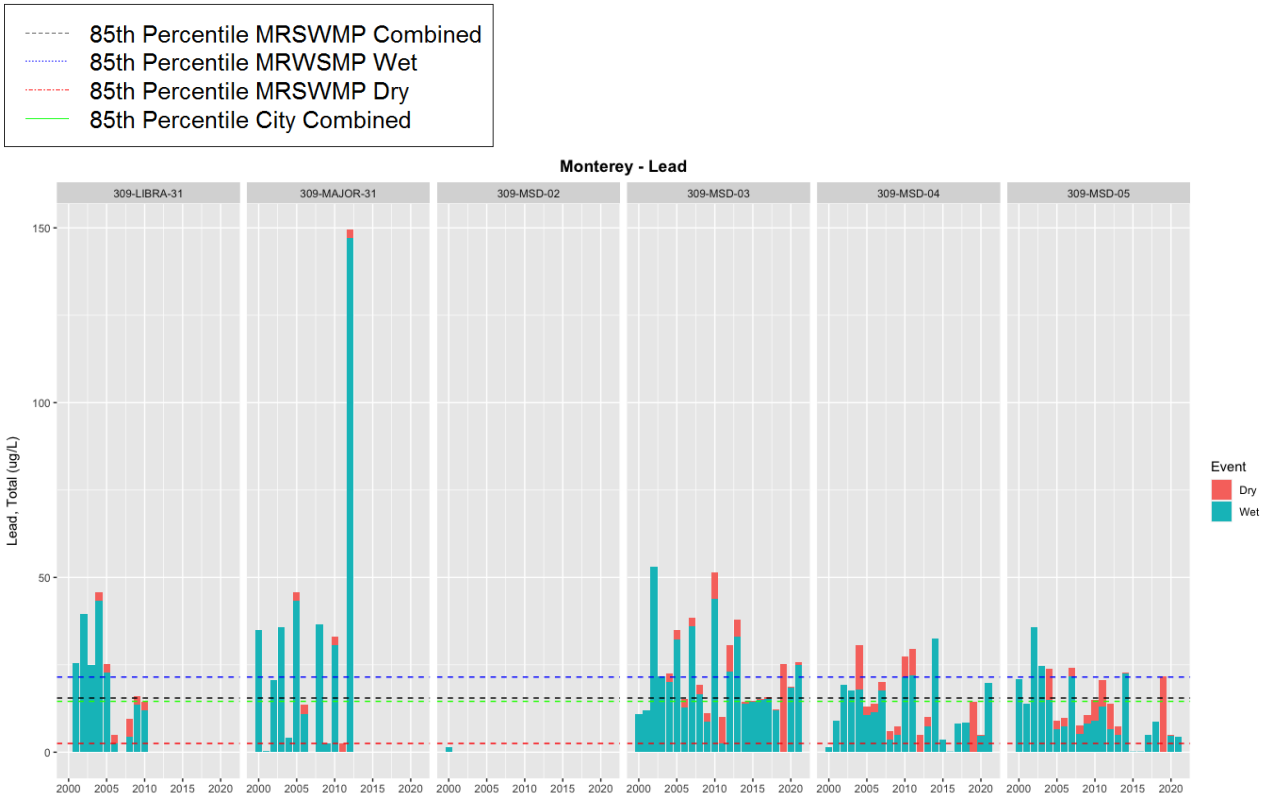

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Pacific Grove - Zinc
309-ASILO-31
309-CENTR-31
309-PGSD-01
309-PGSD-03
309-PGSD-04
309-PGSD-06
309-PGSD-07
309-PGSD-08
309-PGSD-09
309-PGSD-10
309-PGSD-11
309-PGSD-12
309-PGSD-13
309-PGSD-14
309-PGSD-15
Zinc, Total (ug/L)
0
250
500
750
2000
2005
2010
2015
2020
Event
Dry
Wet

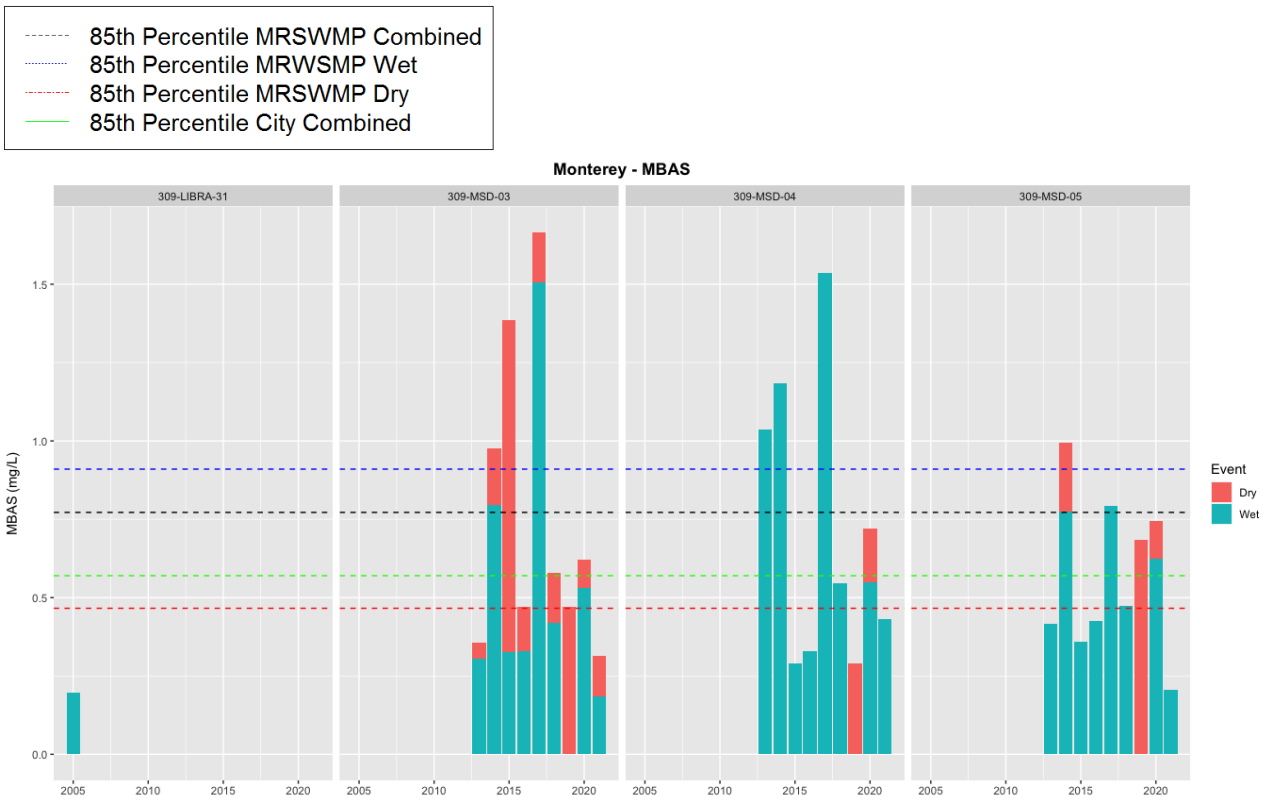

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - Ammonia-N
309-MSD-03
309-MSD-04
309-MSD-05
Ammonia-N (mg/L)
0
3
6
9
2014
2016
2018
2020
Event
Dry
Wet

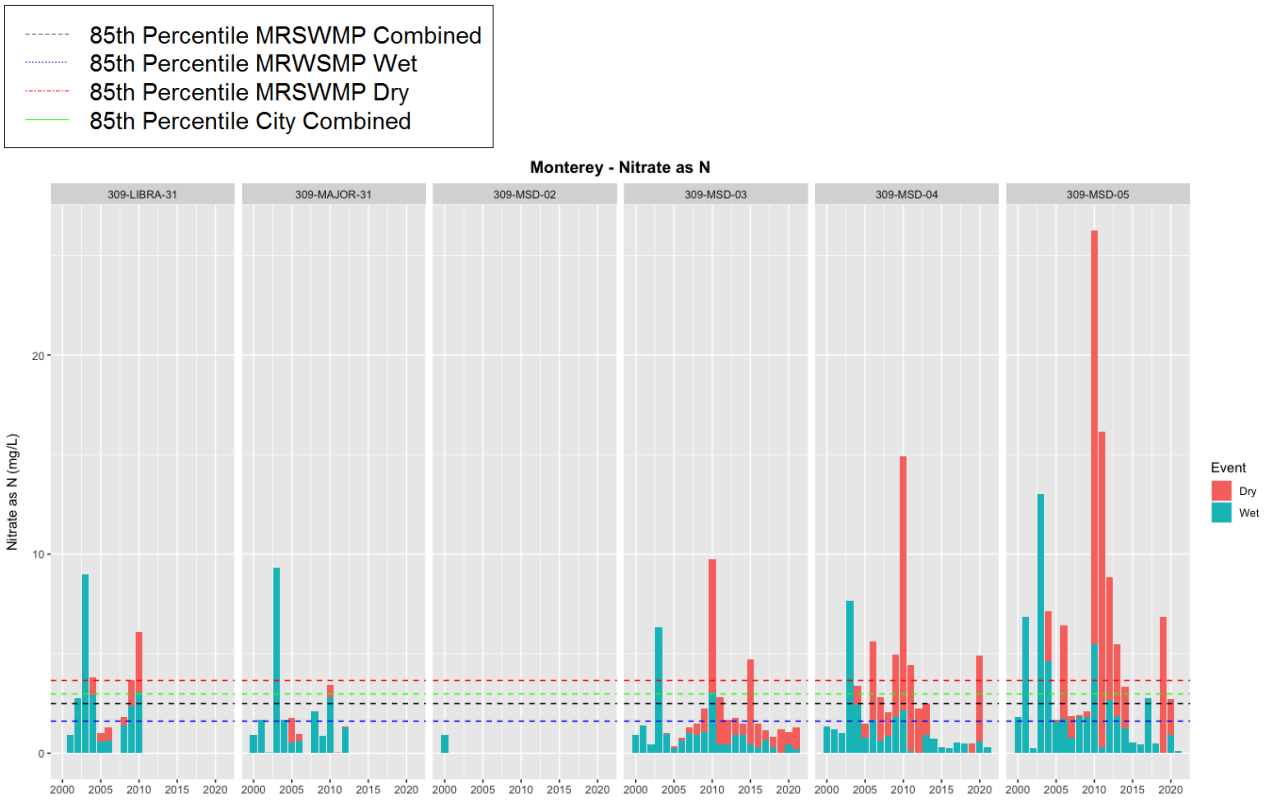

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - Copper
309-LIBRA-31
309-MAJOR-31
309-MSD-02
309-MSD-03
309-MSD-04
309-MSD-05
Copper, Total (ug/L)
0
100
200
300
400
500
2000
2005
2010
2015
2020
Event
Dry
Wet

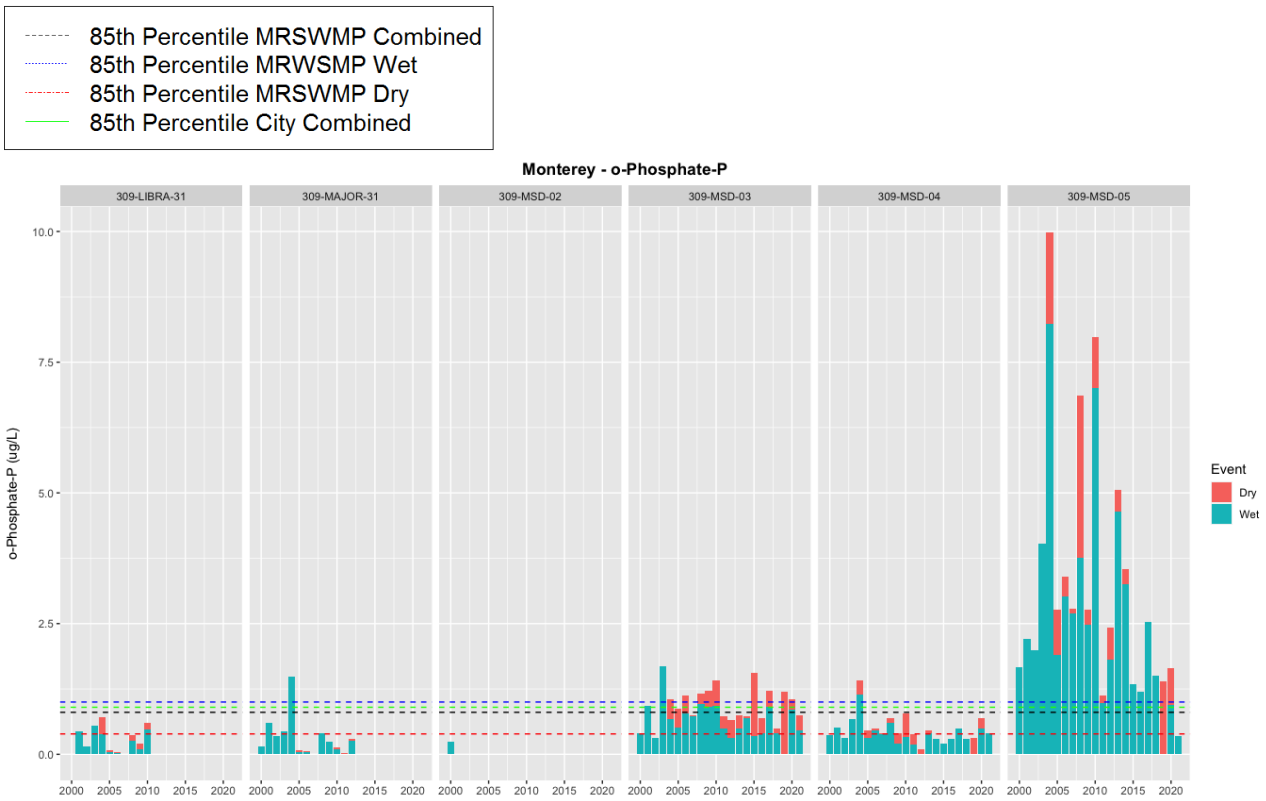

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - E. coli
309-LIBRA-31
309-MAJOR-31
309-MSD-02
309-MSD-03
309-MSD-04
309-MSD-05
E. coli (MPN/100 mL)
0e+00
1e+05
2e+05
3e+05
2000
2005
2010
2015
2020
Event
Dry
Wet

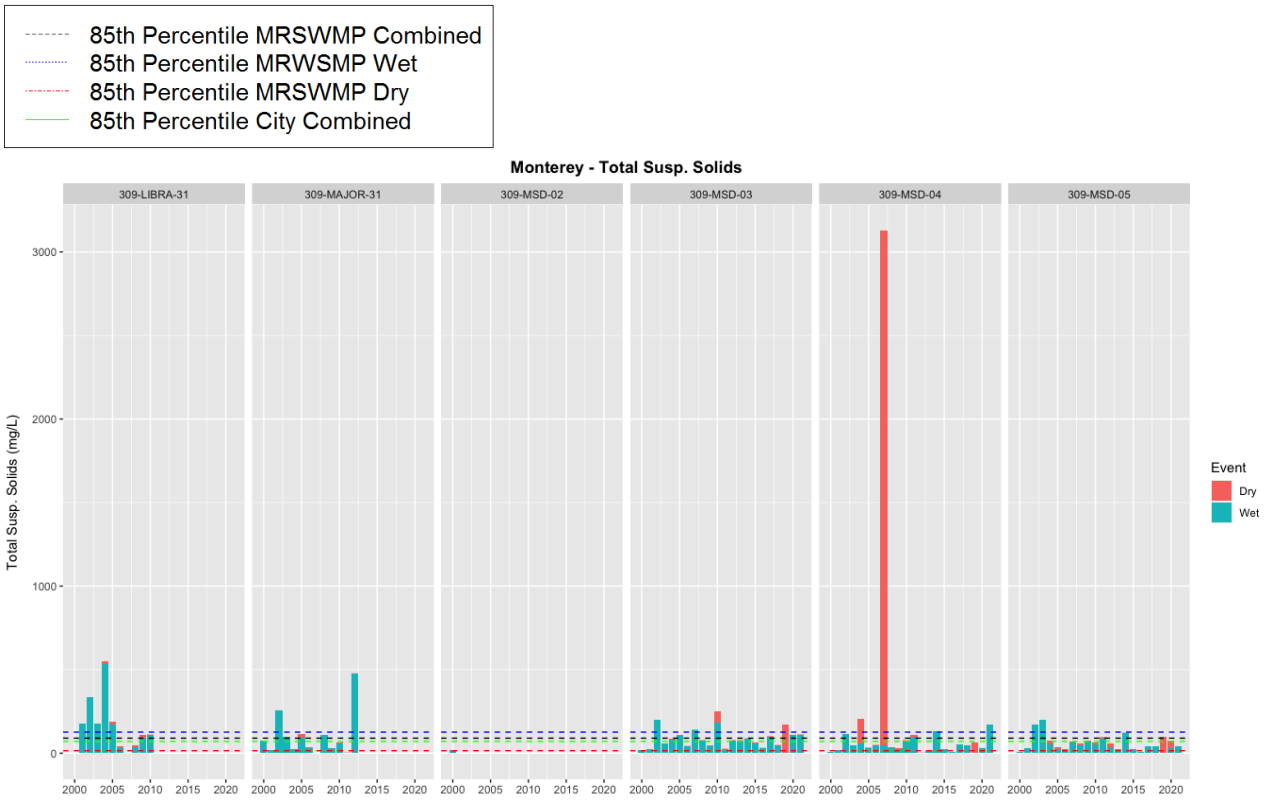

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - Enterococci
309-LIBRA-31
309-MAJOR-31
309-MSD-03
309-MSD-04
309-MSD-05
Enterococci (MPN/100 mL)
2e+05
1e+05
0e+00
2005
2010
2015
2020
Event
Dry
Wet

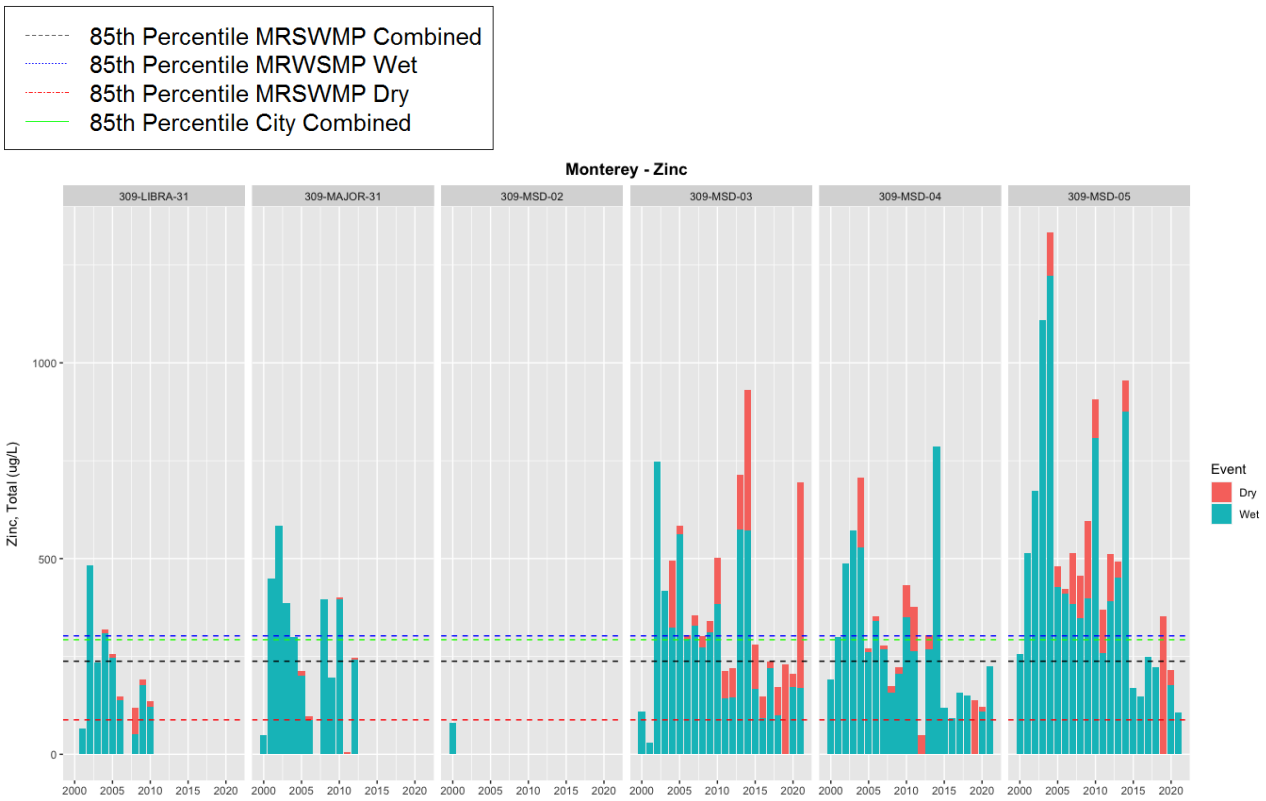

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - Lead
309-LIBRA-31
309-MAJOR-31
309-MSD-02
309-MSD-03
309-MSD-04
309-MSD-05
Lead, Total (ug/L)
150
100
50
0
2000
2005
2010
2015
2020
Event
Dry
Wet

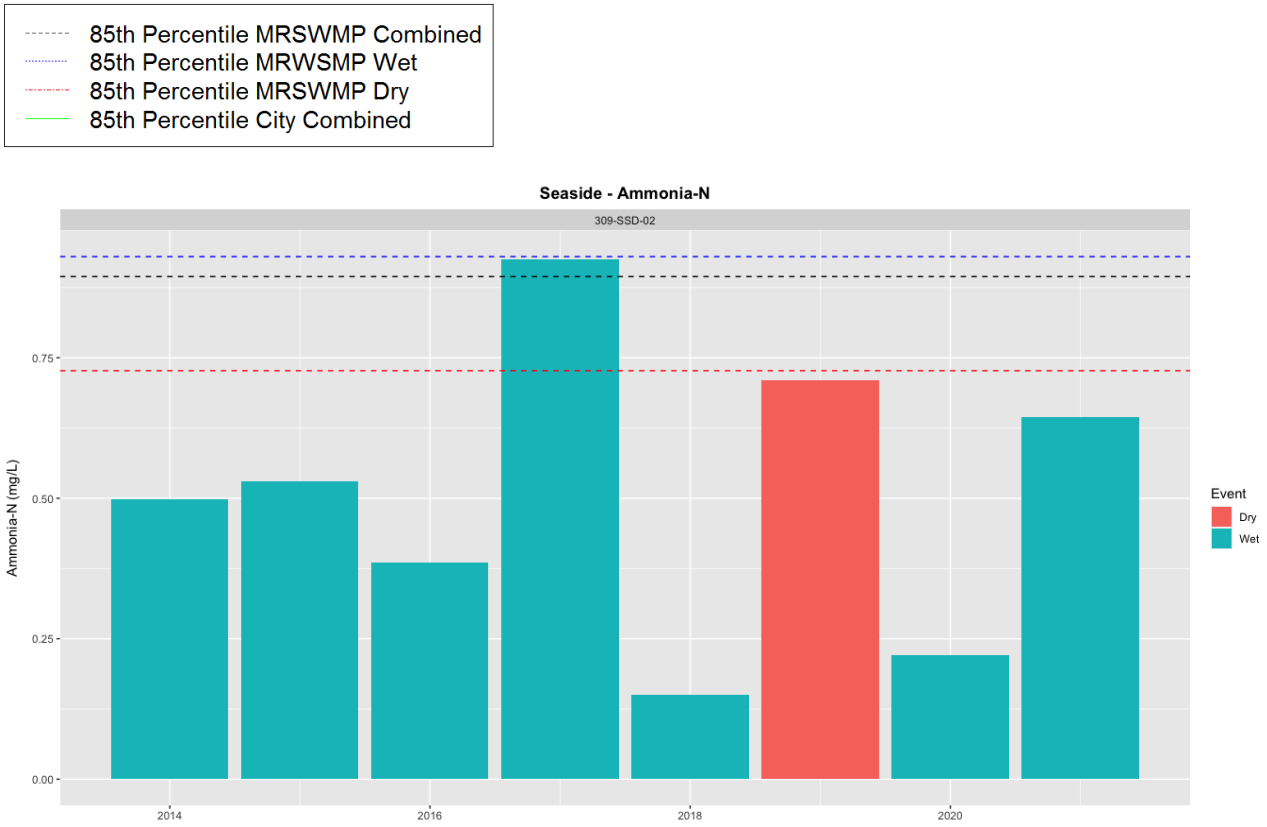

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - MBAS
309-LIBRA-31
309-MSD-03
309-MSD-04
309-MSD-05
MBAS (mg/L)
0.0
0.5
1.0
1.5
2005
2010
2015
2020
Event
Dry
Wet

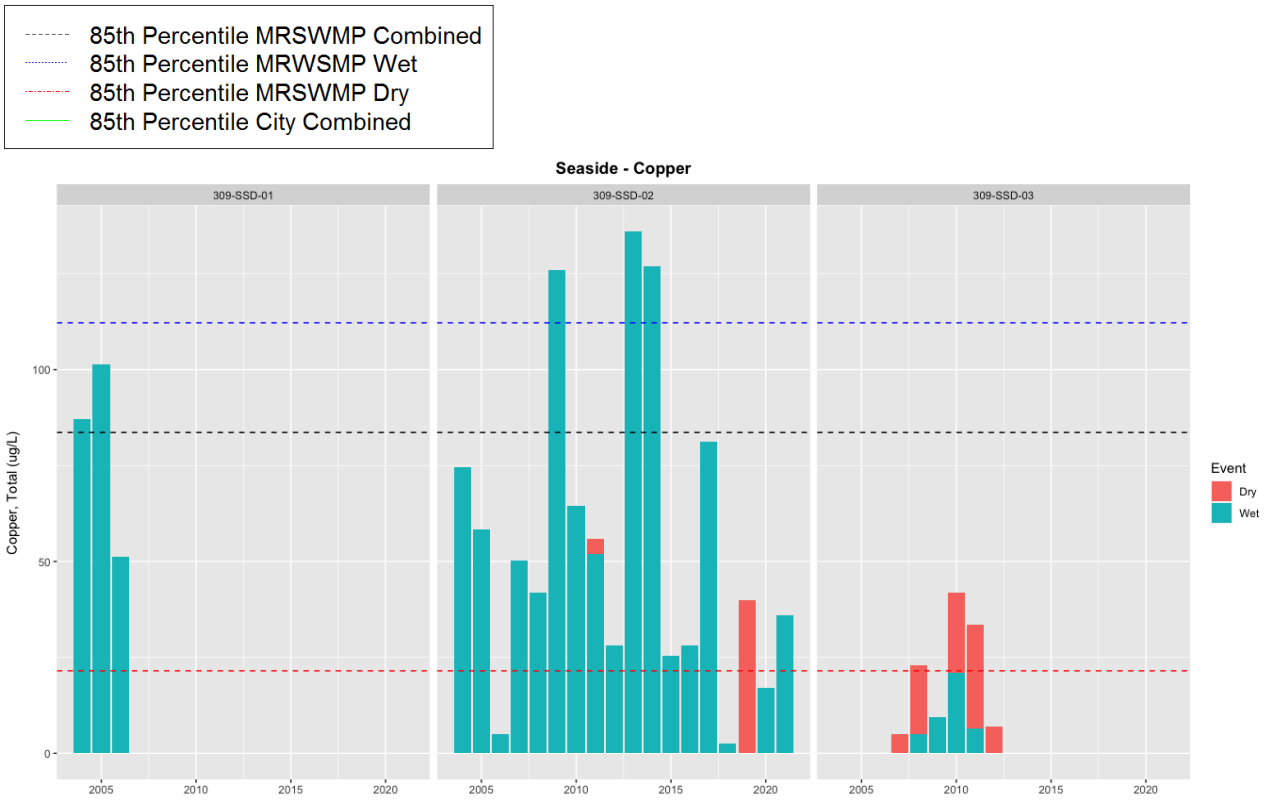

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - Nitrate as N
309-LIBRA-31
309-MAJOR-31
309-MSD-02
309-MSD-03
309-MSD-04
309-MSD-05
Nitrate as N (mg/L)
0
10
20
2000
2005
2010
2015
2020
Event
Dry
Wet

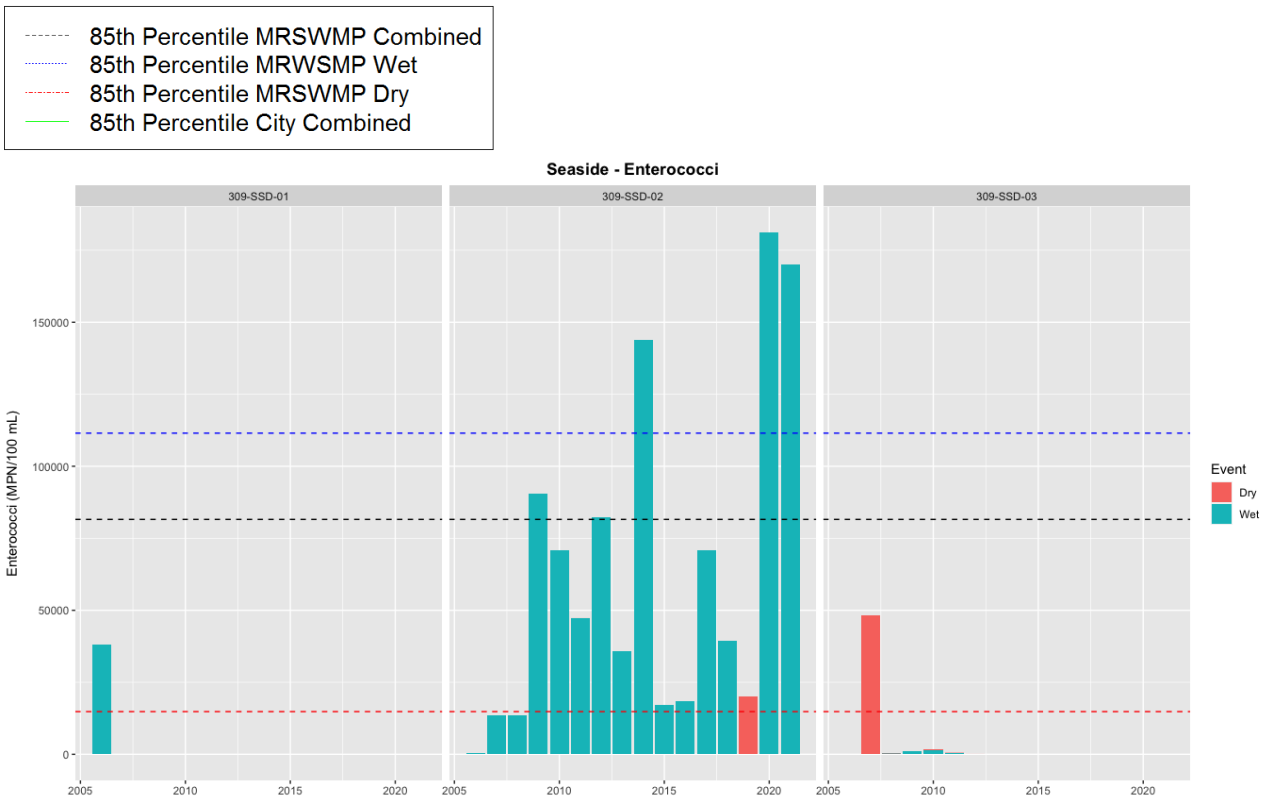

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - o-Phosphate-P
309-LIBRA-31
309-MAJOR-31
309-MSD-02
309-MSD-03
309-MSD-04
309-MSD-05
o-Phosphate-P (ug/L)
10.0
7.5
5.0
2.5
0.0
2000
2005
2010
2015
2020
Event
Dry
Wet

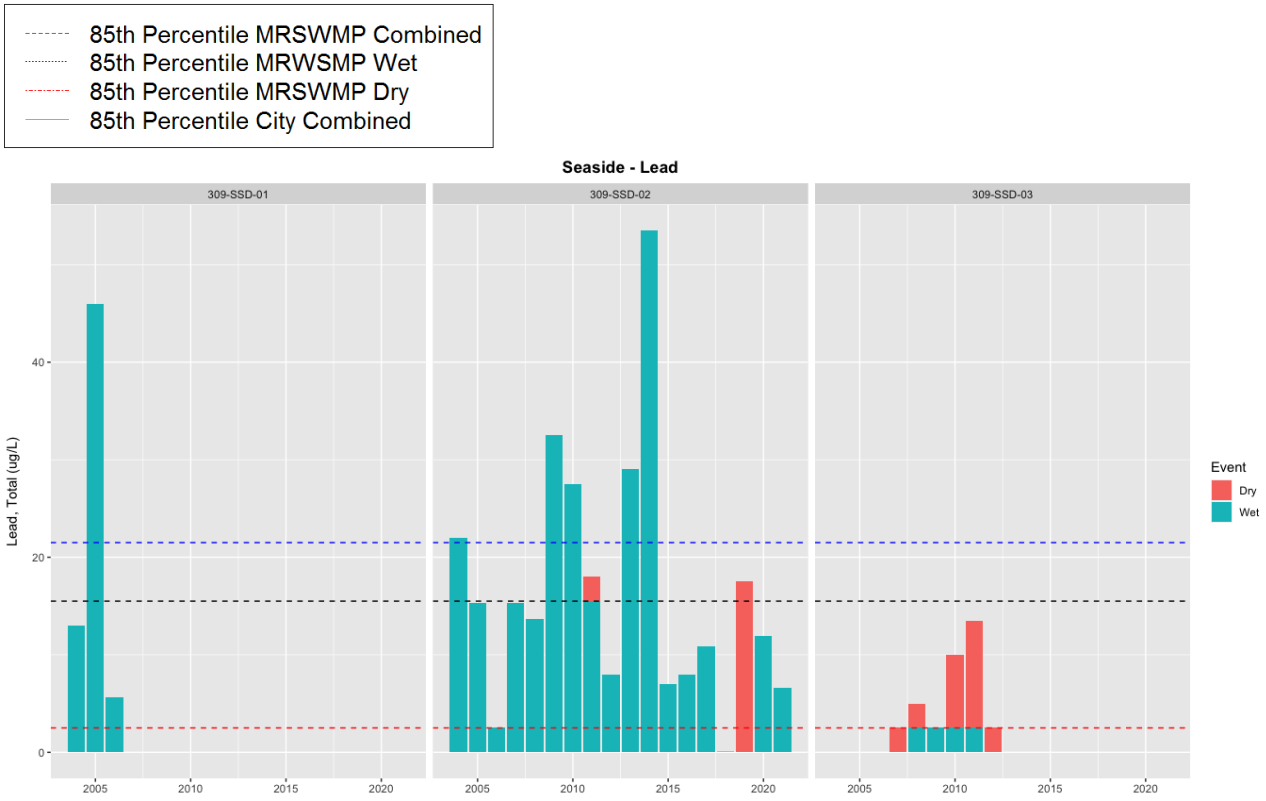

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - Total Susp. Solids
309-LIBRA-31
309-MAJOR-31
309-MSD-02
309-MSD-03
309-MSD-04
309-MSD-05
Total Susp. Solids (mg/L)
3000
2000
1000
0
2000
2005
2010
2015
2020
Event
Dry
Wet

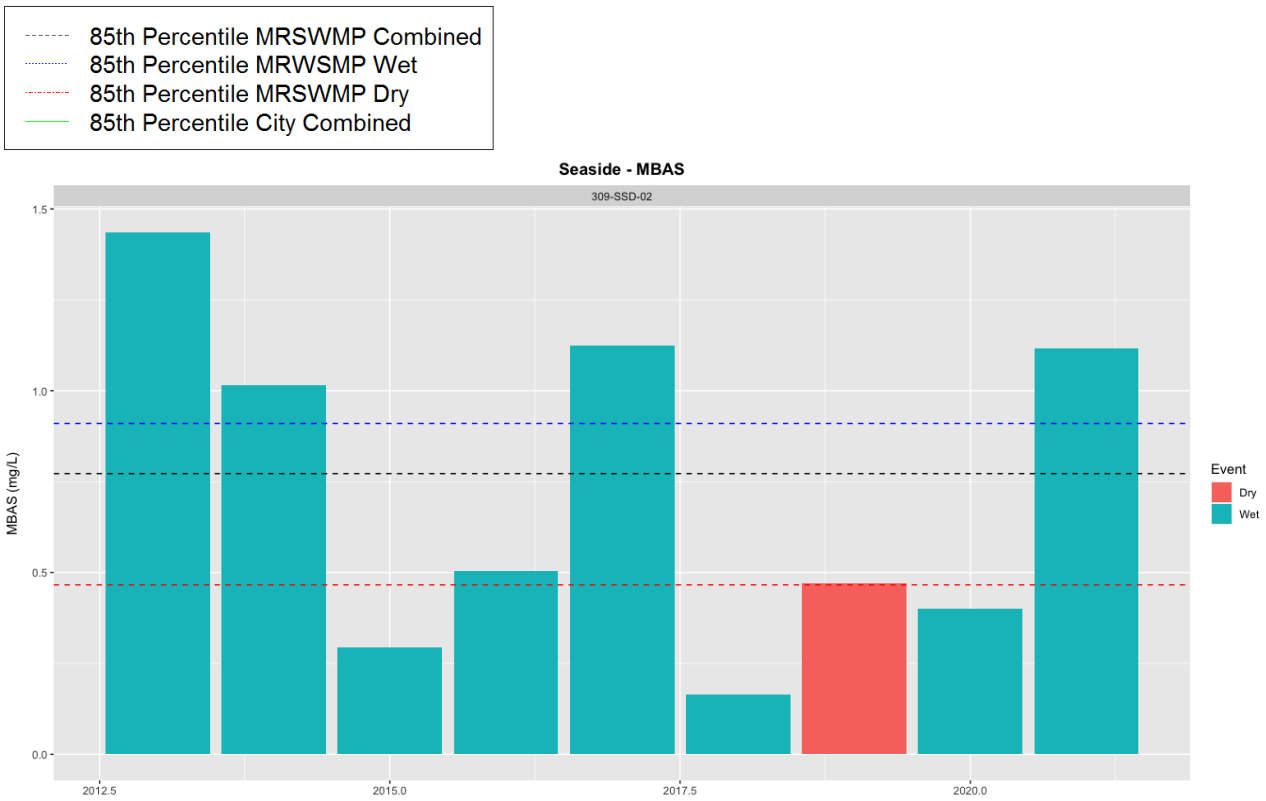

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Monterey - Zinc
309-LIBRA-31
309-MAJOR-31
309-MSD-02
309-MSD-03
309-MSD-04
309-MSD-05
Zinc, Total (ug/L)
1000
500
0
2000
2005
2010
2015
2020
Event
Dry
Wet

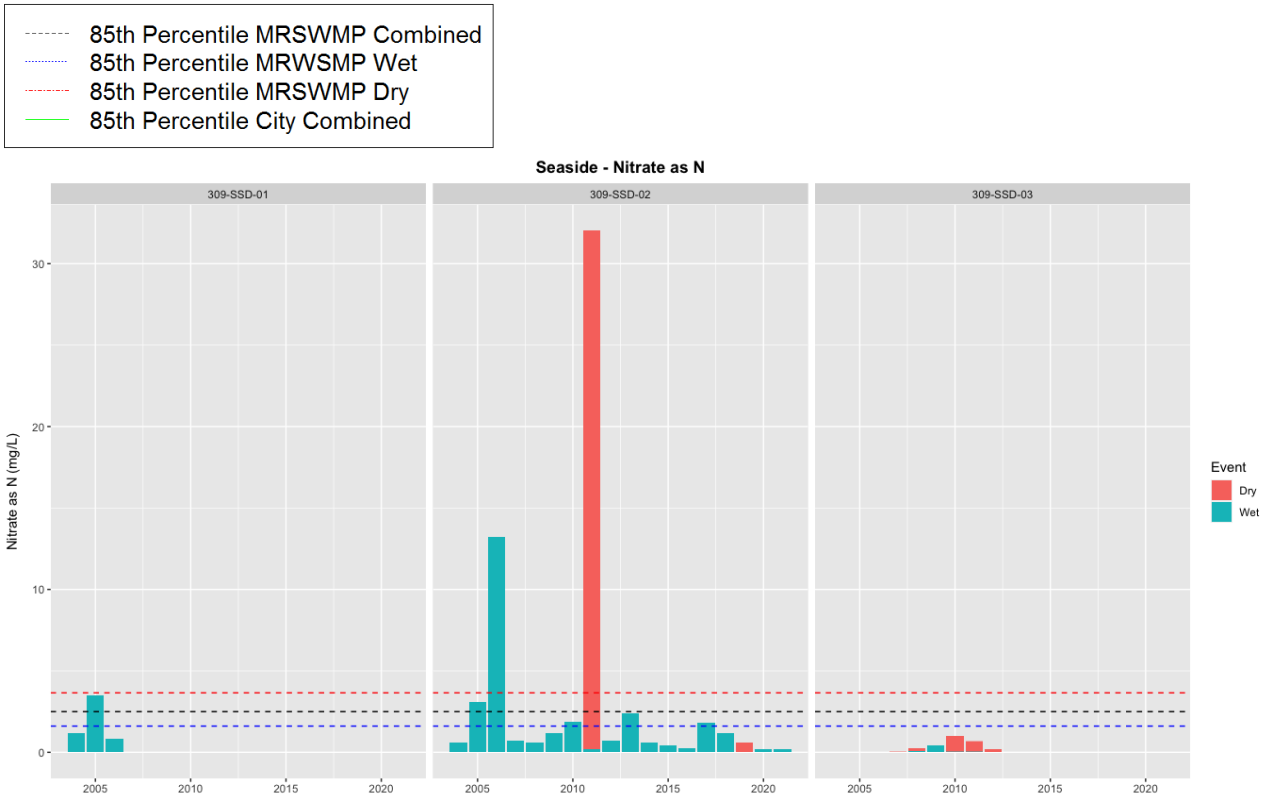

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - Ammonia-N
309-SSD-02
Ammonia-N (mg/L)
0.00
0.25
0.50
0.75
2014
2016
2018
2020
Event
Dry
Wet

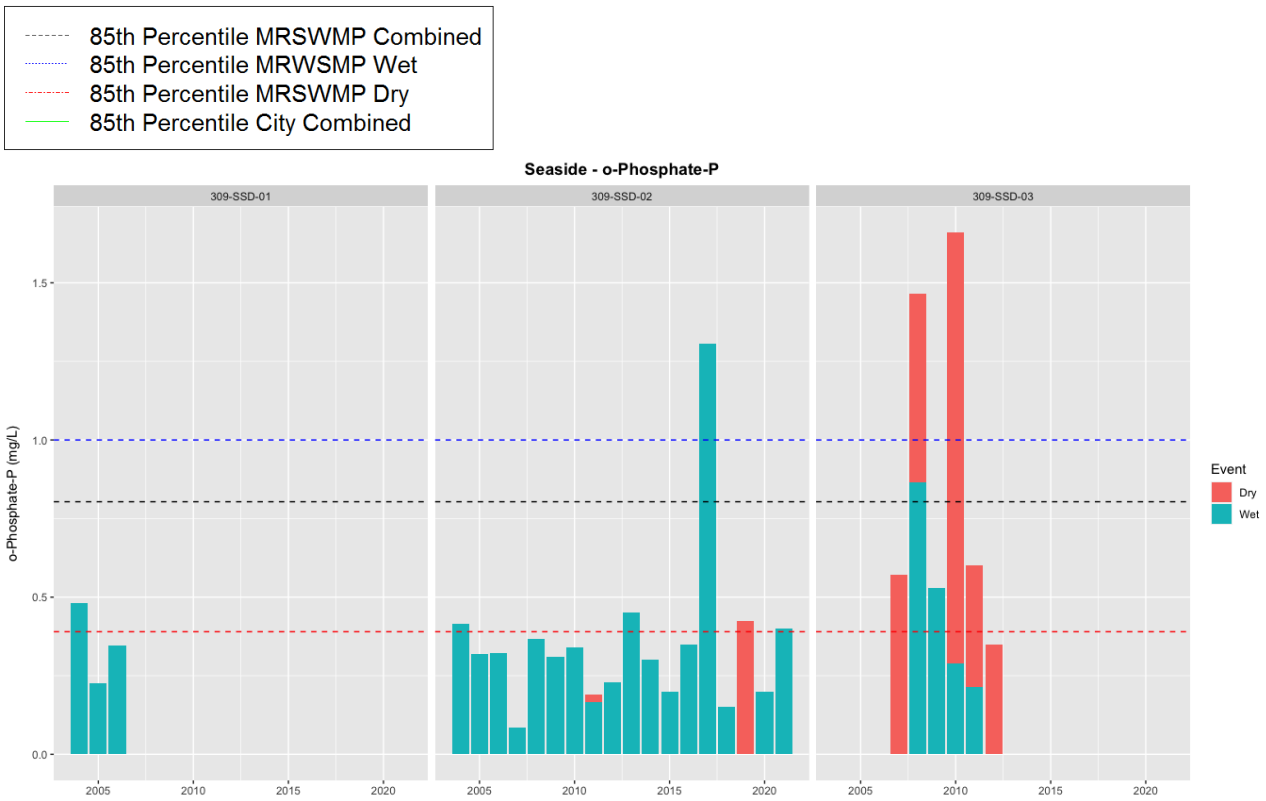

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - Copper
309-SSD-01
309-SSD-02
309-SSD-03
Copper, Total (ug/L)
0
50
100
2005
2010
2015
2020
Event
Dry
Wet

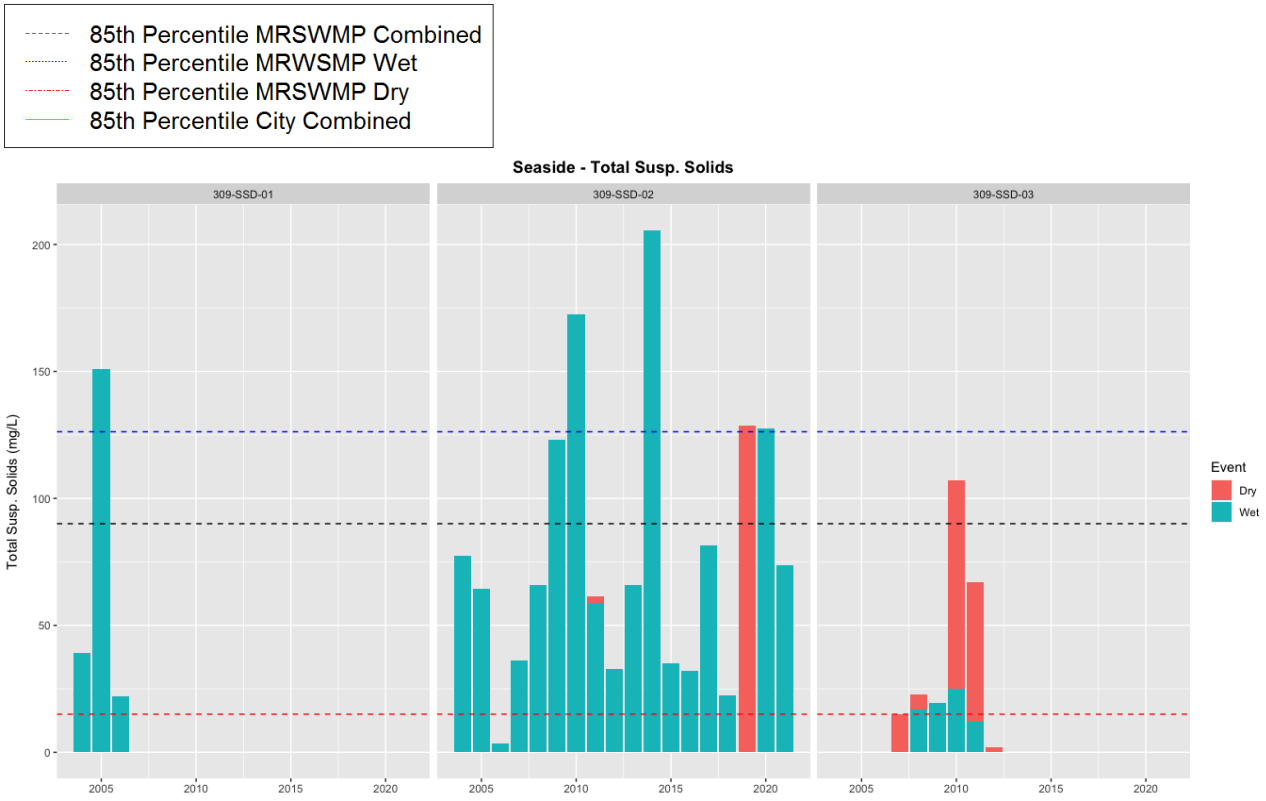

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - Enterococci
309-SSD-01
309-SSD-02
309-SSD-03
Enterococci (MPN/100 mL)
150000
100000
50000
0
2005
2010
2015
2020
Event
Dry
Wet

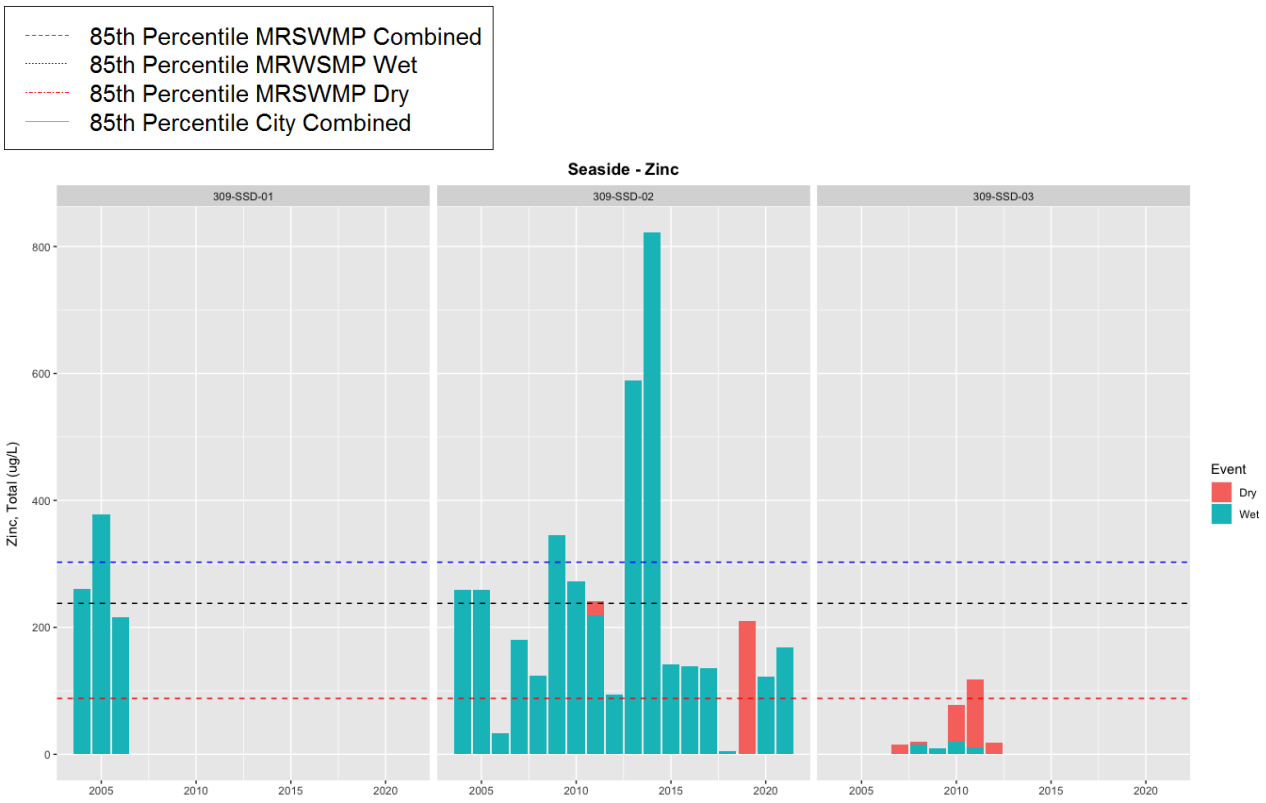

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - Lead
309-SSD-01
309-SSD-02
309-SSD-03
Lead, Total (ug/L)
40
20
0
2005
2010
2015
2020
Event
Dry
Wet

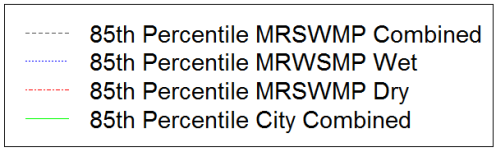

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - MBAS
309-SSD-02
MBAS (mg/L)
1.5
1.0
0.5
0.0
2012.5
2015.0
2017.5
2020.0
Event
Dry
Wet

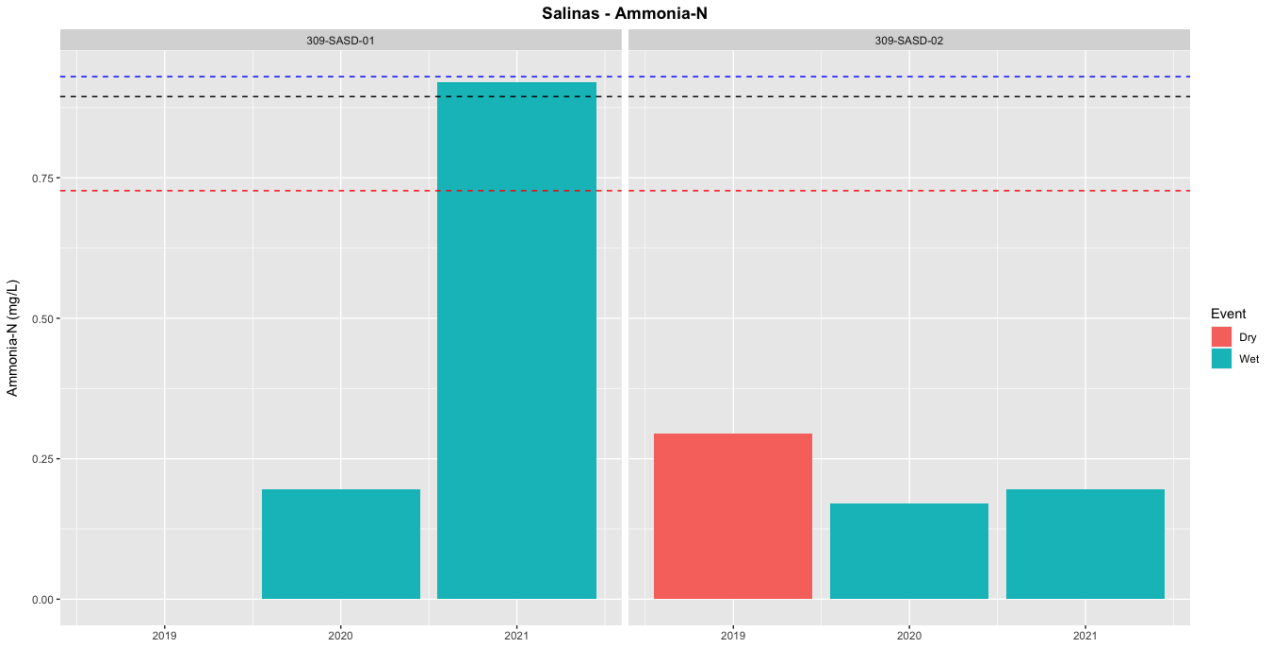

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - Nitrate as N
309-SSD-01
309-SSD-02
309-SSD-03
Nitrate as N (mg/L)
30
20
10
0
2005
2010
2015
2020
Event
Dry
Wet

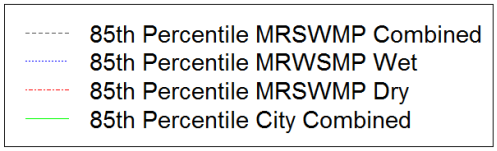

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - o-Phosphate-P
309-SSD-01
309-SSD-02
309-SSD-03
o-Phosphate-P (mg/L)
0.0
0.5
1.0
1.5
2005
2010
2015
2020
Event
Dry
Wet

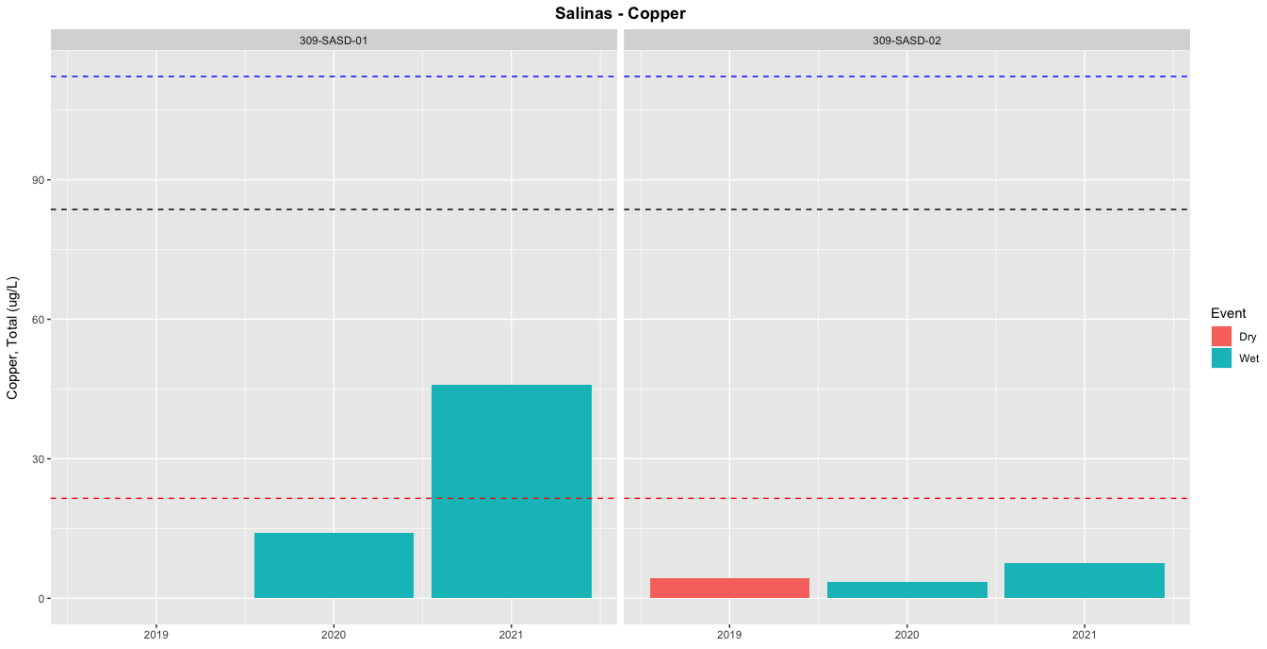

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - Total Susp. Solids
309-SSD-01
309-SSD-02
309-SSD-03
Total Susp. Solids (mg/L)
0
50
100
150
200
2005
2010
2015
2020
Event
Dry
Wet

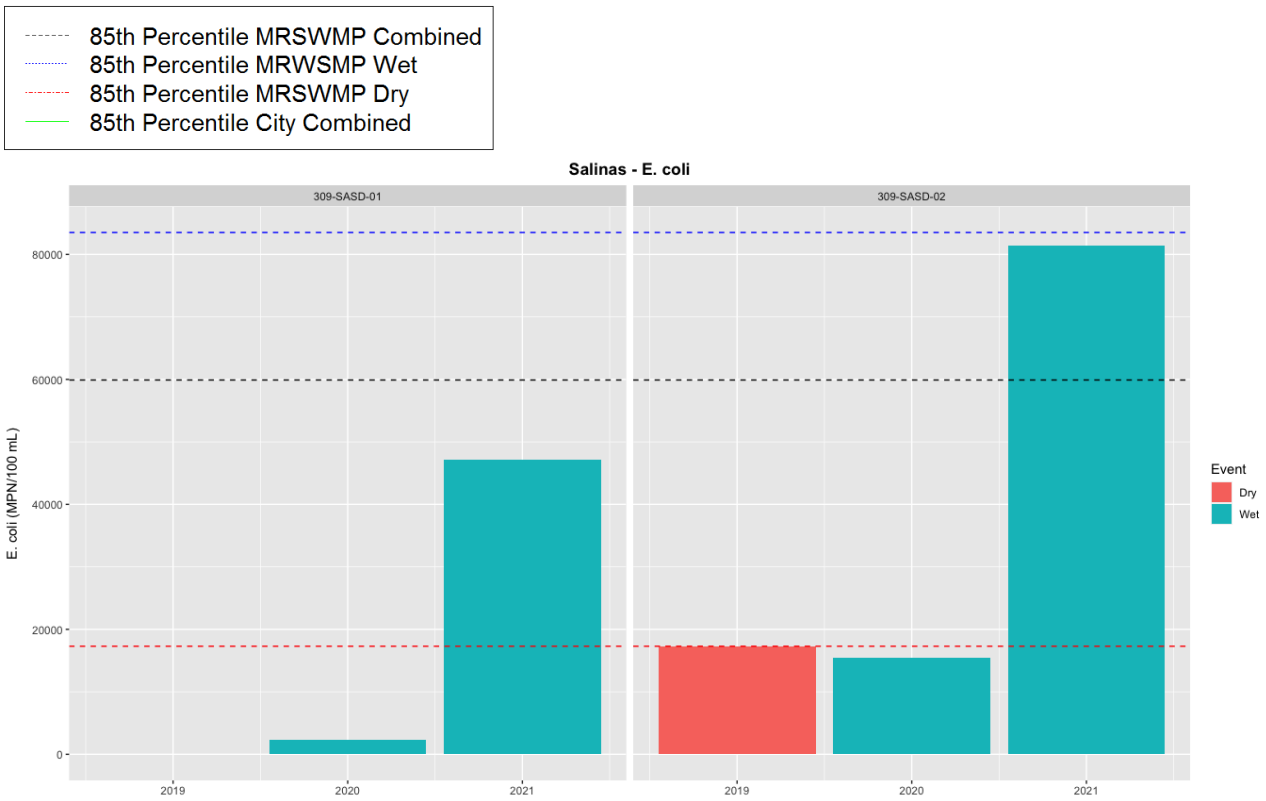

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Seaside - Zinc
309-SSD-01
309-SSD-02
309-SSD-03
Zinc, Total (ug/L)
0
200
400
600
800
2005
2010
2015
2020
Event
Dry
Wet

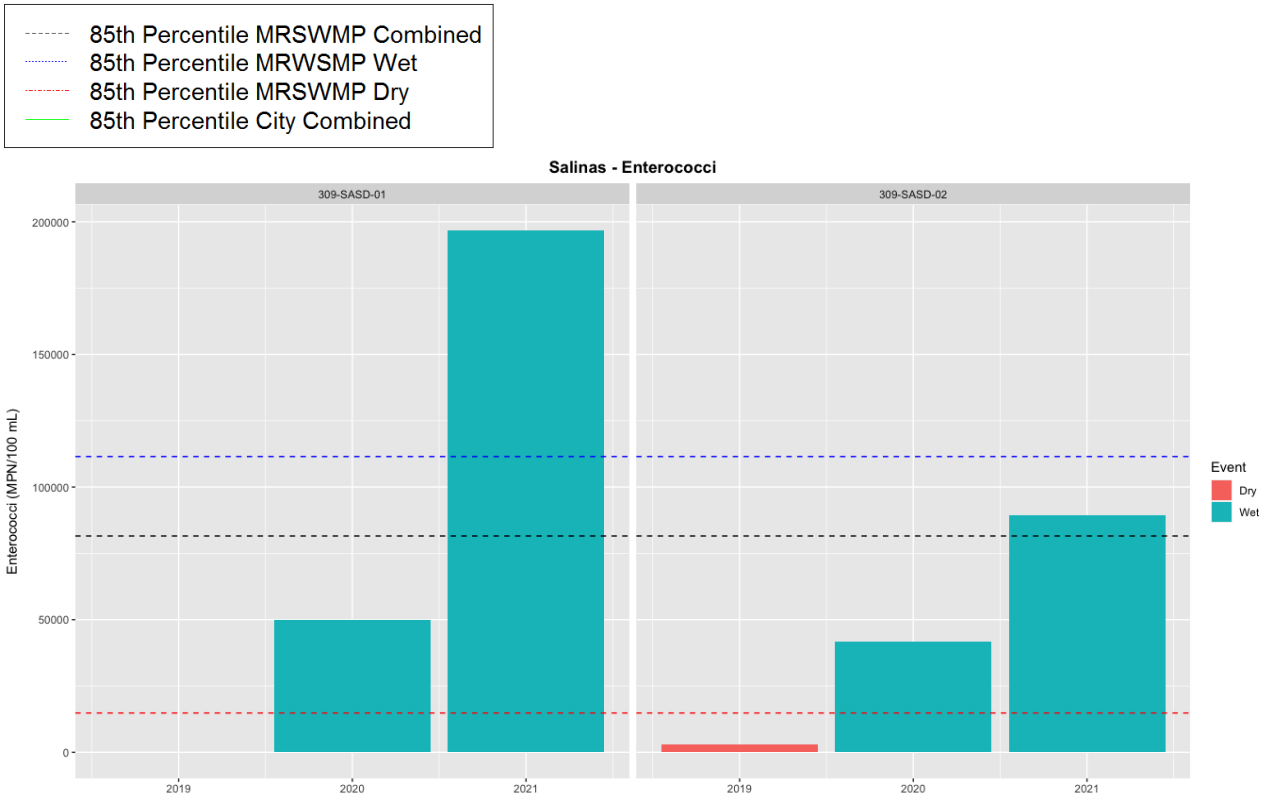

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined

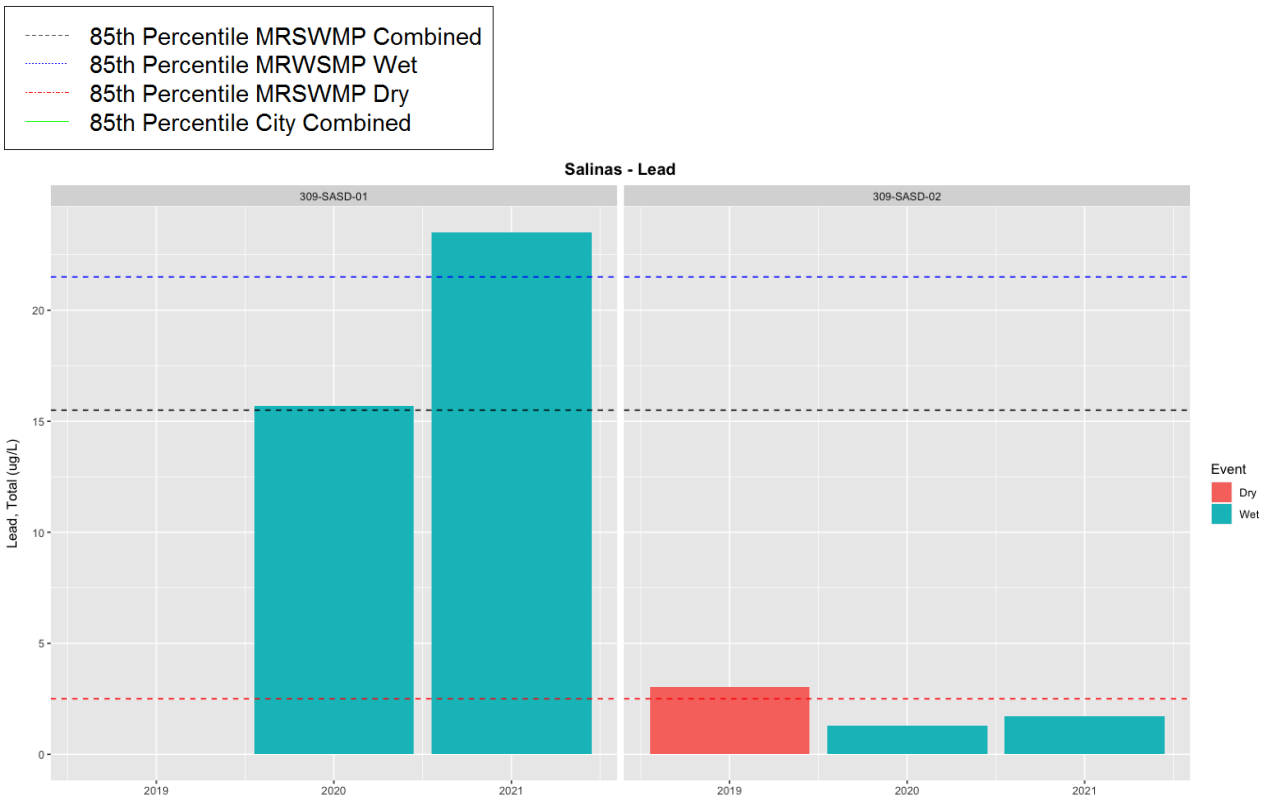

Salinas - Ammonia-N
309-SASD-01
309-SASD-02
Ammonia-N (mg/L)
0.00
0.25
0.50
0.75
2019
2020
2021
Event
Dry
Wet

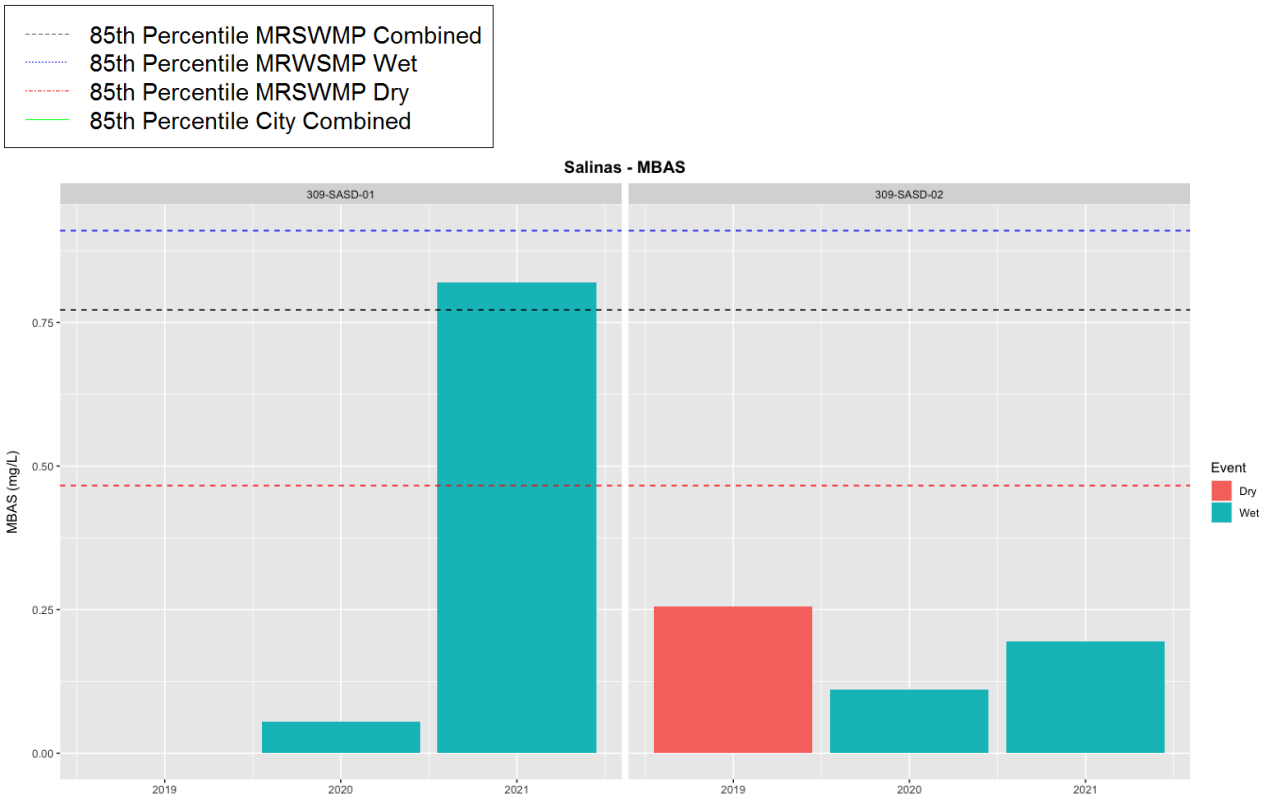

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined

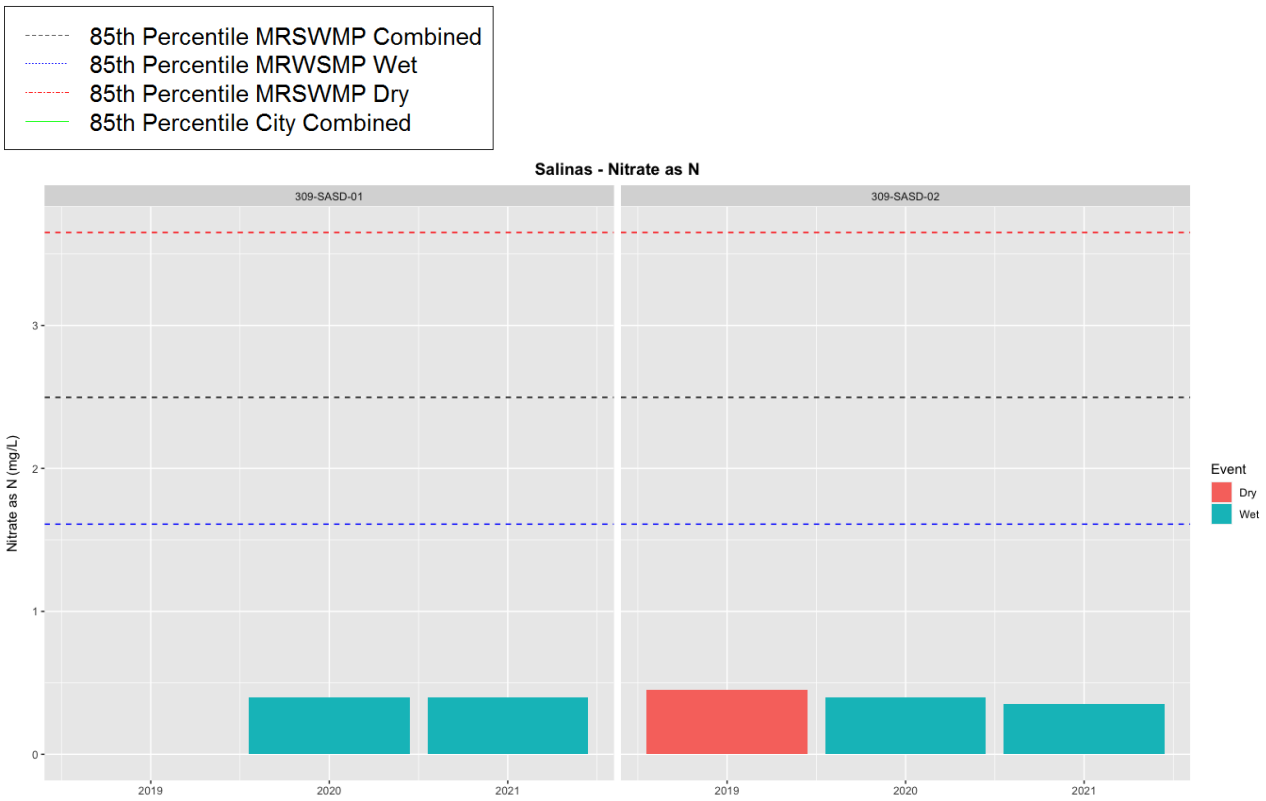

Salinas - Copper
309-SASD-01
309-SASD-02
Copper, Total (ug/L)
0
30
60
90
2019
2020
2021
Event
Dry
Wet

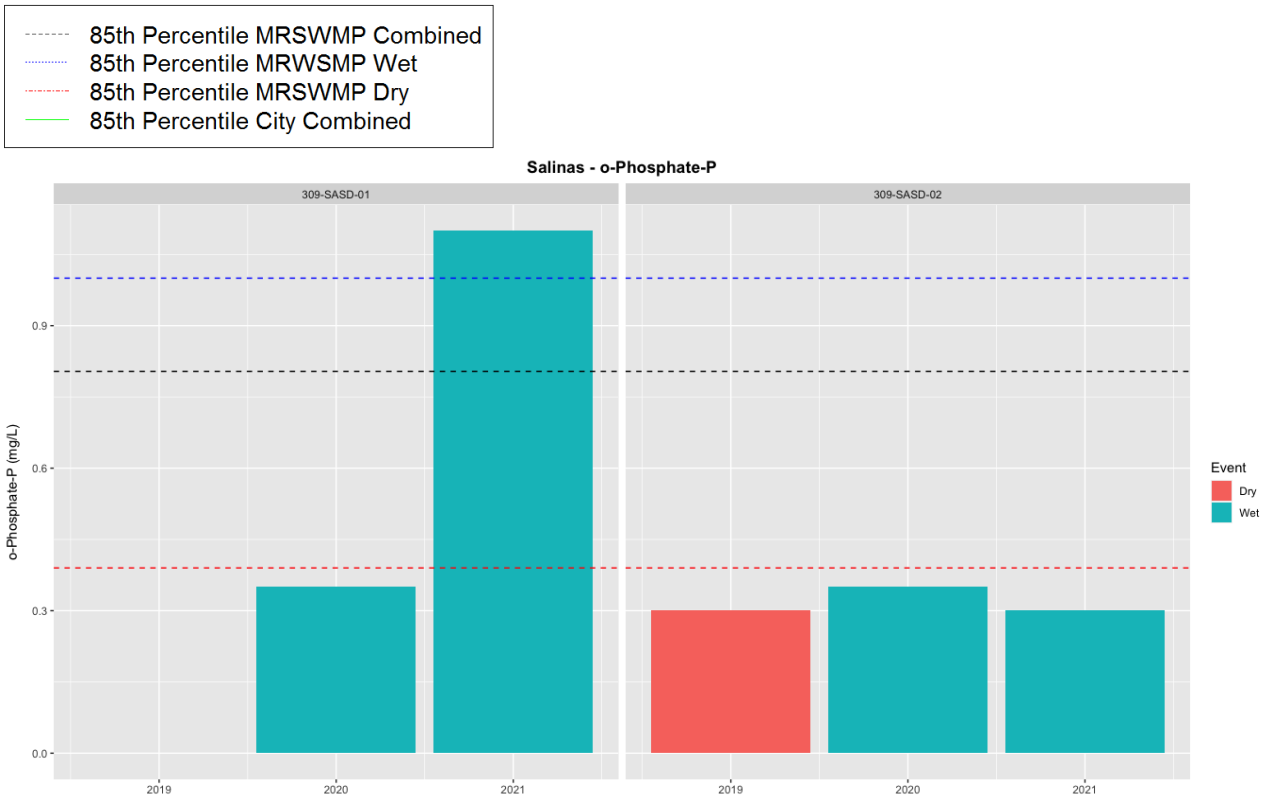

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - E. coli
309-SASD-01
309-SASD-02
E. coli (MPN/100 mL)
80000
60000
40000
20000
0
2019
2020
2021
Event
Dry
Wet

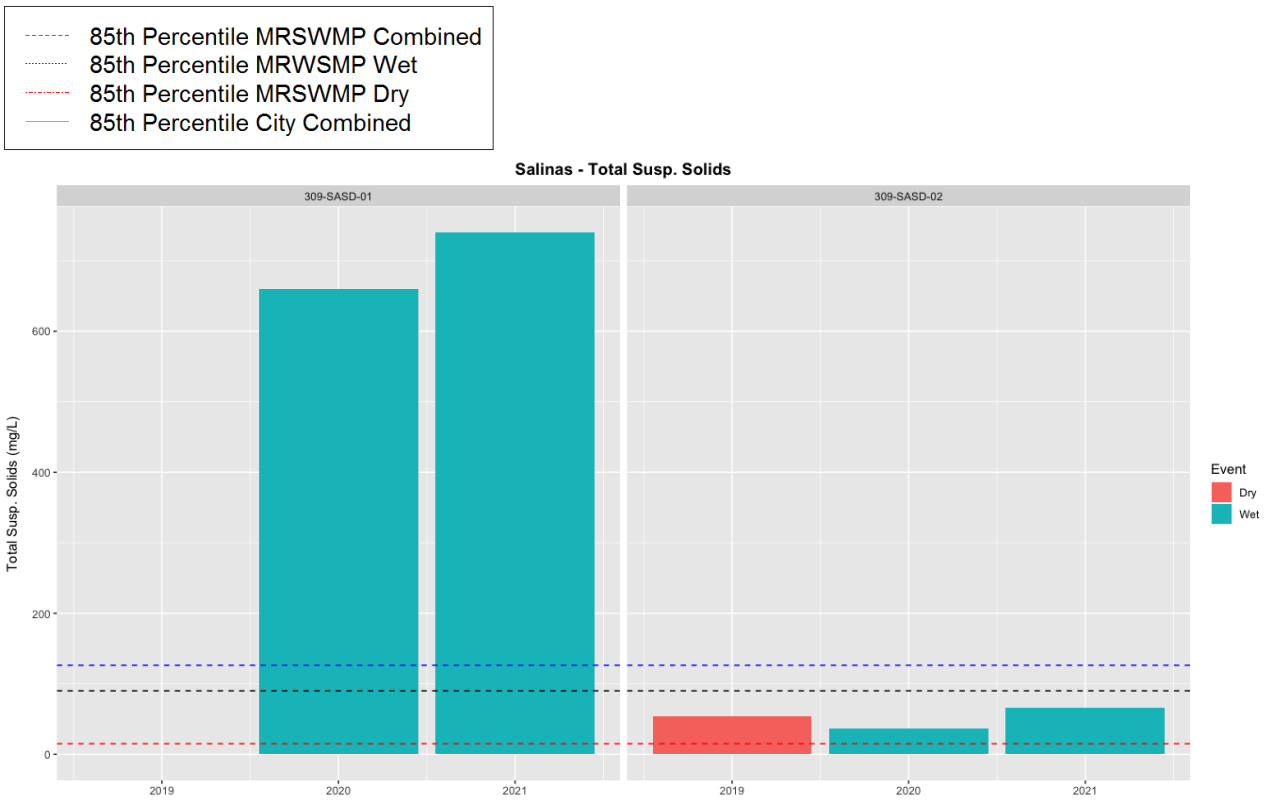

85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - Enterococci
309-SASD-01
309-SASD-02
Enterococci (MPN/100 mL)
200000
150000
100000
50000
0
2019
2020
2021
Event
Dry
Wet


85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - Lead
309-SASD-01
309-SASD-02
Lead, Total (ug/L)
0
5
10
15
20
2019
2020
2021
Event
Dry
Wet


85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - MBAS
309-SASD-01
309-SASD-02
MBAS (mg/L)
0.00
0.25
0.50
0.75
2019
2020
2021
Event
Dry
Wet


85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - Nitrate as N
309-SASD-01
309-SASD-02
Nitrate as N (mg/L)
0
1
2
3
2019
2020
2021
Event
Dry
Wet


85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - o-Phosphate-P
309-SASD-01
309-SASD-02
o-Phosphate-P (mg/L)
0.0
0.3
0.6
0.9
2019
2020
2021
Event
Dry
Wet


85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - Total Susp. Solids
309-SASD-01
309-SASD-02
Total Susp. Solids (mg/L)
600
400
200
0
2019
2020
2021
Event
Dry
Wet


85th Percentile MRSWMP Combined
85th Percentile MRWSMP Wet
85th Percentile MRSWMP Dry
85th Percentile City Combined
Salinas - Zinc
309-SASD-01
309-SASD-02
Zinc, Total (ug/L)
300
200
100
0
2019
2020
2021
Event
Dry
Wet