



Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Pollutants of Concern Monitoring - Data Report

Water Year 2018

Submitted in compliance with Provision C.8.h.iii of NPDES Permit # CAS612008 (Order No. R2-2015-0049)

March 31, 2019

This report is submitted by the agencies participating in the



City of Campbell
City of Cupertino
City of Los Altos
Town of Los Altos Hills
Town of Los Gatos

City of Milpitas
City of Monte Sereno
City of Mountain View
City of Palo Alto
City of San Jose

City of Santa Clara
City of Saratoga
City of Sunnyvale
County of Santa Clara
Santa Clara Valley Water District

Prepared for:

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)

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LIST OF ACRONYMS

AFR	Alternative Flame Retardant
BASMAA	Bay Area Stormwater Management Agency Association
BMP	Best Management Practice
BSM	Bioretention Soil Media
CASQA	California Stormwater Quality Association
CEC	Contaminants of Emerging Concern
CEDEN	California Environmental Data Exchange Network
DQO	Data Quality Objective
ECWG	Emerging Contaminants Work Group
EDD	Electronic Data Deliverable
HDS	Hydrodynamic Separator
MRP	Municipal Regional Permit
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
NMS	San Francisco Bay Nutrient Management Strategy
NNE	Nutrient Numeric Endpoints
NPDES	National Pollution Discharge Elimination System
PBDEs	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PFAS	Perfluoroalkyl Sulfonates
PFOS	Perfluorooctane Sulfonates
POC	Pollutant of Concern
POTW	Publicly Owned Wastewater Treatment Works
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RAA	Reasonable Assurance Analysis
RMP	Regional Monitoring Program for Water Quality in the San Francisco Bay
RWSM	Regional Watershed Spreadsheet Model
SAP	Sampling and Analysis Plan
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFEI	San Francisco Estuary Institute
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SOP	Standard Operating Procedures
SPoT	Statewide Stream Pollutant Trend Monitoring
SSC	Suspended Sediment Concentration
STLS	Small Tributary Loading Strategy
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
UCMR	Urban Creeks Monitoring Report
USEPA	US Environmental Protection Agency
WMA	Watershed Management Area
WQO	Water Quality Objective
WY	Water Year

TABLE OF CONTENTS

LIST OF ACRONYMSiii

LIST OF FIGURES.....v

LIST OF TABLESv

LIST OF ATTACHMENTSv

1.0 INTRODUCTION..... 1

 1.1 POC Monitoring Requirements..... 1

 1.2 BASMAA Monitoring 4

 1.3 Third-Party Data 4

2.0 POC MONITORING RESULTS.....6

 2.1 Statement of Data Quality..... 6

 2.2 PCBs and Mercury 10

 2.2.1 Comparison with Region-wide Storm Sampling Results..... 12

 2.2.2 WMA Update 16

 2.2.3 Source Property Identification 16

 2.3 Copper 17

 2.4 Nutrients 18

 2.5 Emerging Contaminants 19

3.0 COMPARISON TO APPLICABLE WATER QUALITY STANDARDS 21

4.0 CONCLUSIONS AND RECOMMENDATIONS..... 23

5.0 REFERENCES 25

LIST OF FIGURES

Figure 1. SCVURPPP and Third-Party POC Monitoring Stations in WY 2018. (BASMAA regional project sample locations are not mapped.) 8

Figure 2. SCVURPPP current Watershed Management Area (WMA) map showing catchments sampled in WY 2018..... 11

Figure 3. PCB concentrations for water samples collected in large MS4s and receiving waters in the Bay Area..... 14

Figure 4. PCB particle ratios for water samples collected in MS4s and receiving waters (i.e., creeks/rivers) draining to the Bay. 15

LIST OF TABLES

Table 1. MRP Provision C.8.f Pollutants of Concern monitoring requirements..... 3

Table 2. SCVURPPP and Third-Party POC Monitoring Accomplishments in WY 2018. 7

Table 3. POC monitoring stations in Santa Clara County, WY 2018. 9

Table 4. PCB, mercury, and suspended sediment concentrations in water samples collected by SCVURPPP and STLS, WY 2018..... 12

Table 5. Descriptive statistics of PCB and mercury concentrations in water and particle ratios..... 13

Table 6. Total and dissolved copper concentrations in water samples collected by SCVURPPP, WY 2018.. 17

Table 7. Nutrient concentrations (mg/L) in water samples collected by SCVURPPP, WY 2018. 18

Table 8. Comparison of WY 2018 Monitoring Data to the Copper WQO..... 22

LIST OF ATTACHMENTS

Attachment 1. Pollutants of Concern Monitoring Quality Assurance/Quality Control Report, WY 2018

1.0 INTRODUCTION

This Pollutants of Concern Monitoring - Data Report (POC Data Report) was prepared by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP or Program) on behalf of its 15 member agencies (13 cities/towns, the County of Santa Clara, and the Santa Clara Valley Water District) subject to the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities, referred to as the Municipal Regional Permit (MRP). The MRP was reissued by the San Francisco Regional Water Quality Control Board (Regional Water Board) on November 19, 2015 as Order R2-2015-0049. This report fulfills the requirements of Provision C.8.h.iii of the MRP for reporting a summary of MRP provision C.8.f POC Monitoring conducted during Water Year (WY) 2018.¹

This report builds on the POC Monitoring Report that was submitted to the Regional Water Board on October 15, 2018 (SCVURPPP 2018a). In accordance with Provision C.8.h.iv, the POC Monitoring Report listed WY 2018 POC monitoring locations, number and types of samples collected, purpose of sampling (i.e., Management Questions addressed), and analytes measured (SCVURPPP 2018a). The October 15, 2018 POC Monitoring Report also described the allocation of sampling effort for POC monitoring planned for WY 2019. Similar POC Monitoring Reports and POC Data Reports describing WY 2017 and WY 2016 monitoring efforts and data results were previously submitted (SCVURPPP 2018b, SCVURPPP 2017a, SCVURPPP 2017b).

This POC Data Report is included as an appendix to the WY 2018 Urban Creeks Monitoring Report (UCMR). Consistent with MRP Provision C.8.h.ii, POC monitoring data generated from sampling of receiving waters (e.g., creeks) were submitted to the San Francisco Bay Area Regional Data Center for upload to the California Environmental Data Exchange Network (CEDEN).²

1.1 POC Monitoring Requirements

Provision C.8.f of the MRP requires monitoring of several POCs including polychlorinated biphenyls (PCBs), mercury, copper, emerging contaminants³, and nutrients. POC monitoring is conducted on a Water Year (WY) basis. Provision C.8.f specifies yearly (i.e., WY) and total (i.e., permit term) minimum numbers of samples for each POC. In addition, POC monitoring must address the five priority management information needs (i.e., Management Questions) identified in C.8.f:

1. **Source Identification** – identifying which sources or watershed source areas provide the greatest opportunities for reductions of POCs in urban stormwater runoff;
2. **Contributions to Bay Impairment** – identifying which watershed source areas contribute most to the impairment of San Francisco Bay beneficial uses (due to source intensity and sensitivity of discharge location);
3. **Management Action Effectiveness** – providing support for planning future management actions or evaluating the effectiveness or impacts of existing management actions;
4. **Loads and Status** – providing information on POC loads, concentrations or presence in local tributaries or urban stormwater discharges; and

¹ Most hydrologic monitoring occurs for a period defined as a water year, which begins on October 1 and ends on September 30 of the named year. For example, water year 2018 (WY 2018) began on October 1, 2017 and concluded on September 30, 2018.

² CEDEN has historically only accepted and shared data collected in streams, lakes, rivers, and the ocean (i.e., receiving waters). In late-2016, SCVURPPP was notified that there were changes to the types of data that CEDEN would accept and share. However, there is still some uncertainty and until the changes are clarified, SCVURPPP will continue to submit only receiving water data to CEDEN.

³ Emerging contaminant monitoring requirements will be met through participation in the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) special studies. The special studies will account for relevant Contaminants of Emerging Concern (CECs) in stormwater and will address at least PFOS, PFAS, and alternative flame retardants being used to replace PBDEs.

5. **Trends** – providing information on trends in POC loading to the Bay and POC concentrations in urban stormwater discharges or local tributaries over time.

The MRP specifies the minimum number of samples that must be collected and analyzed for each POC. For example, over the first five years of the permit, a minimum total of 80 PCBs samples must be collected and analyzed and at least eight PCB samples must be collected each year. The MRP also specifies the minimum number of samples for each POC that must address each Management Question. For example, by the end of Year Four⁴ of the permit term, each of the five Management Questions must be addressed with at least eight PCB samples. It is possible that a single sample can address more than one Management Question. POC Monitoring requirements are summarized in Table 1.

Other MRP provisions require studies or have information needs that could be addressed through Provision C.8.f (POC Monitoring) and for which related samples will count towards POC monitoring requirements. These other Permit provisions and their associated timelines are listed below.

- Provisions C.11.a.iii and C.12.a.iii require that Permittees provide a list of management areas (referred to in this report as Watershed Management Areas, or WMAs) in which new mercury and PCB control measures will be implemented during the permit term, as well as the monitoring data and other information used to select the watersheds. Progress toward developing the list was reported on April 1, 2016 and a more complete list with identified control measures is provided with each Annual Report, beginning with the 2016 Annual Report that was submitted on September 30, 2016. Provision C.8.f (POC Monitoring) is intended to support C.11/12 requirements by requiring monitoring directed toward source identification (i.e., identifying which sources or watershed source areas provide the greatest opportunities for implementing cost-effective controls to reduce loads of POCs in urban stormwater runoff).
- Provision C.12.e requires that Permittees collect at least 20 composite samples (region-wide) of the caulks and sealants used in storm drains or roadway infrastructure in public rights-of-way. To achieve compliance with this provision, MRP Permittees agreed to collectively conduct this sampling via the Bay Area Stormwater Management Agencies Association (BASMAA). The Final Study Design was approved by the BASMAA Project Management Team (PMT) in June 2017, sample collection was conducted in November and December 2017, and a report summarizing results of the study was submitted to the Regional Water Board with the 2017/18 Annual Reports on September 30, 2018. The project report, *Evaluation of PCBs in Caulk and Sealants in Public Roadway and Storm Drain Infrastructure* (EOA, SFEI, KLI 2018) is summarized in SCVURPPP's WY 2018 UCMR.
- Provisions C.11.c and C.12.c require that Permittees submit a Reasonable Assurance Analysis to demonstrate quantitatively that mercury reductions of at least 10 kg/yr and PCBs reductions of at least 3 kg/yr will be realized by 2040 through implementation of green infrastructure projects. Although these provisions will be met through modeling, POC monitoring focused on management action effectiveness may help inform the models. To learn more about the effectiveness of selected stormwater treatment controls, MRP Permittees are collectively conducting monitoring studies through BASMAA.

⁴ Note that the minimum sampling requirements addressing information needs must be completed by the end of year four of the permit; whereas, the minimum number of total samples does not need to be met until the end of year five of the permit.

Table 1. MRP Provision C.8.f Pollutants of Concern monitoring requirements.

Pollutant of Concern	Media	Total Samples ^d	Yearly Minimum	Minimum # of Samples that Must be Collected for Each Information Need by the End of Year Four				
				Source Identification	Contributions to Bay Impairment	Management Action Effectiveness	Loads and Status	Trends
PCBs	Water or sediment	80	8	8	8	8	8	8
Total Mercury	Water or sediment	80	8	8	8	8	8	8
Total & Dissolved Copper	Water	20	2	--	--	--	4	4
Nutrients ^a	Water	20	2	--	--	--	20	--
Emerging Contaminants ^b	--	--	--	--	--	--	--	--
Ancillary Parameters ^c	--	--	--	--	--	--	--	--

^a. Ammonium⁵, nitrate, nitrite, total Kjeldahl nitrogen, orthophosphate, total phosphorus (analyzed concurrently in each nutrient sample).

^b. Must include perfluorooctane sulfonates (PFOS, in sediment), perfluoroalkyl sulfonates (PFAS, in sediment), alternative flame retardants. The Permittee shall conduct or cause to be conducted a special study that addresses relevant management information needs for emerging contaminants. The special study must account for relevant Contaminants of Emerging Concern (CECs) in stormwater and would address at least PFOS, PFAS, and alternative flame retardants being used to replace PBDEs.

^c. Total Organic Carbon (TOC) should be collected concurrently with PCBs data when normalization to TOC is deemed appropriate. Suspended sediment concentration (SSC) should be collected in water samples used to assess loads, loading trends, or Best Management Practice (BMP) effectiveness. Hardness data are used in conjunction with copper concentrations collected in fresh water.

^d. Total samples that must be collected over the five-year Permit term.

⁵ There are several challenges to collecting samples for "ammonium" analysis. Therefore, samples are analyzed for total ammonia which is the sum of un-ionized ammonia (NH₃) and ionized ammonia (ammonium, NH₄⁺). Ammonium concentrations are calculated by subtracting the calculated concentration of un-ionized ammonia from the measured concentration of total ammonia. Un-ionized ammonia concentrations are calculated using a formula provided by the American Fisheries Society that includes field pH, field temperature, and specific conductance. This approach was approved by Regional Water Board staff in an email dated June 21, 2016.

1.2 BASMAA Monitoring

In WY 2018, SCVURPPP participated in the BASMAA “POC Monitoring Project for Source Identification and Management Action Effectiveness” project. This regional project includes two (somewhat independent) monitoring studies designed during WY 2017 and implemented during WY 2018. As one of four Countywide Programs subject to provision C.8.f POC Monitoring requirements, SCVURPPP’s POC monitoring accomplishments include ¼ of the total number of samples collected through this regional project (Table 2).

- The PCBs in Infrastructure Caulk Study was developed to satisfy the provision C.12.e requirement to collect 20 composite caulk/sealant samples throughout the MRP permit area and evaluate (at a screening level) whether PCBs are present in right-of-way infrastructure caulk and sealants in the Bay Area. This study also addresses Management Question #1 (Source Identification). In WY 2018, the BASMAA project team collected 54 samples of caulk/sealant materials from ten types of roadway and storm drain infrastructure. The individual samples were grouped by structure type and sample appearance (color and texture) into 20 composites and analyzed for the RMP 40 PCB congeners using a modified method EPA 8270C. The final project report was included with the Program’s Fiscal Year 2017/18 Annual Report, submitted to the Regional Water Board on September 30, 2018 (EOA, SFEI, KLI 2018).
- The Best Management Practices (BMP) Effectiveness Study was developed to satisfy provision C.8.f requirements to collect at least eight PCBs and mercury samples (per county) that address Management Question #3 (Management Action Effectiveness). A major consideration of the study was collection of data in support of conducting the Reasonable Assurance Analysis (RAA) that is required by provision C.12.c.iii.(3) and must be submitted to the Regional Water Board with the 2020 Annual Report (September 30, 2020). In WY 2018, the BASMAA project team collected a total of 34 samples. Results of the study are summarized in two reports that are submitted (as appendices) with the Program’s WY 2018 Urban Creeks Monitoring Report.
 - **Column Study Report.** Twenty-six samples consisting of influent/effluent pairs from column tests of biochar-enhanced bioretention soil media (BSM) were analyzed. Stormwater from two sites during two storm events was run through six columns with five different biochar-enhanced BSM mixes and one standard BSM as a control to evaluate which mix was most effective at removing PCBs and mercury. Dilutions were run on two columns to assess removal efficiencies with decreasing influent pollutant concentrations. Samples were analyzed for the RMP 40 PCB congeners (method EPA 1668C), total mercury (method EPA 1631E, SSC (method ASTM D3977-97), and total organic carbon (method EPA 9060). The project report is included as Appendix D to the Program’s WY 2018 Urban Creeks Monitoring Report.
 - **HDS Study Report.** Eight samples consisting of sediment and leaf debris were collected from hydrodynamic separator (HDS) unit sumps during regularly scheduled cleanouts to evaluate the PCBs and mercury load reduction effectiveness of these units. The HDS unit samples were analyzed for the RMP 40 PCB congeners (method EPA 1668C), total mercury (method EPA 1631E), and total solids⁶ (method EPA 160.4M). The project report is included as Appendix E to the Program’s WY 2018 Urban Creeks Monitoring Report.

1.3 Third-Party Data

The Program strives to work collaboratively with water quality monitoring partners to develop mutually

⁶ Samples were analyzed for total solids so that dry weight calculations could be made.

beneficial monitoring approaches. Provision C.8.a.iii of the MRP allows Permittees to use data collected by third-party organizations to fulfill monitoring requirements, provided the data are demonstrated to meet the required data quality objectives. For example, samples collected in Santa Clara County through the Regional Monitoring Program for Water Quality in the San Francisco Bay (RMP) and the State's Stream Pollution Trends (SPoT) Monitoring Program may supplement the Program's efforts towards achieving Provision C.8.f monitoring requirements. Third party monitoring conducted by the RMP and SPoT also provide context for reviewing and interpreting SCVURPPP monitoring results.

RMP STLS

The RMP's Small Tributary Loading Strategy (STLS) Team typically conducts annual monitoring for POCs on a region-wide basis. SCVURPPP is an active participant in the STLS and works with other Bay Area municipal stormwater programs to identify opportunities to direct RMP funds and monitoring activities towards addressing both short- and long-term municipal stormwater permit management questions. During WY 2013 – WY 2014 POC monitoring activities by the STLS focused on pollutant loading monitoring at six region-wide stations including two stations in Santa Clara County. In WY 2015, the loading stations were discontinued and STLS monitoring shifted to wet weather characterization in catchments of interest. In WYs 2016, 2017, and 2018, the STLS Team continued wet weather characterization sampling using a similar approach to the PCBs and mercury sampling that was implemented by the Program. In Santa Clara County, the STLS sampled two catchments for PCBs and mercury in WY 2018, two catchments in WY 2017, six catchments in WY 2016, and eight catchments in WY 2015. STLS wet weather characterization data are described in Gilbreath et al. (2019, in preparation) (Appendix F to the Program's WY 2018 Urban Creeks Monitoring Report).

SPoT Monitoring Program

The goal of the SPoT program is to monitor trends in sediment toxicity and sediment contaminant concentrations in selected large rivers throughout California, and relate contaminant concentrations and toxicity to watershed land uses. SPoT monitoring staff reported that both Coyote Creek (205COY060) and Guadalupe River (205GUA020) were monitored in June 2018. Sediment samples from both stations were analyzed for mercury, copper, pesticides, organic pollutants, and toxicity, but not PCBs. Results of the WY 2018 SPoT monitoring are not yet available. Results from these large catchment stations provide context for the monitoring conducted by the Program. The most recent technical report prepared by SPoT program staff was published in 2016 and describes seven-year trends from the initiation of the program in 2008 through 2014 (Phillips et al. 2016). An update to the report is anticipated in mid-2019.

2.0 POC MONITORING RESULTS

In compliance with Provision C.8.f of the MRP, the Program conducted POC monitoring in WY 2018 for PCBs, mercury, copper, and nutrients. The MRP-required yearly minimum number of samples was met or exceeded for all POCs. The total number of samples collected for each POC, the agency conducting the monitoring, and the Management Questions addressed are listed in Table 2. Specific monitoring stations are listed in Table 3 and illustrated in Figure 1. The sections below describe the results of the monitoring accomplished in WY 2018. Compliance with applicable water quality standards is described in Section 3.0.

2.1 Statement of Data Quality

A comprehensive Quality Assurance/Quality Control (QA/QC) program was implemented by SCVURPPP covering all aspects of POC monitoring.

Monitoring for PCBs, mercury, and copper in water was performed according to protocols specified or referenced in the WY 2016 POC Sampling and Analysis Plan (SAP) (SCVURPPP 2015). The POC SAP references the Clean Watersheds for a Clean Bay (CW4CB) Quality Assurance Project Plan (QAPP; BASMAA 2013) as the basis for (QA/QC) procedures. Monitoring for nutrients in water was performed according to protocols specified in the BASMAA Standard Operating Procedures (SOPs) (BASMAA 2016a) and QAPP (BASMAA 2016b).

Data were assessed for seven data quality attributes, which include (1) Representativeness, (2) Comparability, (3) Completeness, (4) Sensitivity, (5) Contamination, (6) Accuracy, and (7) Precision. These seven attributes are compared to Data Quality Objectives (DQOs), which were established to ensure that data collected are of adequate quality and sufficient for the intended uses. Overall, the results of the QA/QC review suggest that most of the POC monitoring data generated during WY 2018 were of sufficient quality. Although, some data were flagged in the project database, including one dissolved copper sample with a questionable value, none were rejected according to DQOs. Attachment 1 contains a report summarizing the results of the data validation.

Table 2. SCVURPPP and Third-Party POC Monitoring Accomplishments in WY 2018.

Pollutant of Concern/ Agency	Number of Samples (WY 2018)	Management Question Addressed ^a					Sample Type and Comments
		1. Source Identification	2. Contributions to Bay Impairment	3. Management Action Effectiveness	4. Loads and Status	5. Trends	
PCBs & Mercury							
SCVURPPP	8	8	8	--	8	2	Stormwater runoff samples to characterize high interest catchments
SCVURPPP via BASMAA	8 ^b	--	--	8	--	--	Regional HDS unit & biochar effectiveness study
SCVURPPP via BASMAA	5 ^b	5	--	--	--	--	Regional public infrastructure caulk/sealant samples
RMP STLS	2	2	2	--	2	--	Stormwater runoff repeat samples to characterize high interest catchments
SPoT (Mercury only) ^c	2	--	--	--	--	2	Sediment samples to assess trends at long-term monitoring station
Copper							
SCVURPPP	6	NA	NA	NA	6	6	Creek water samples collected during storm event and subsequent dry season
SPoT	2	NA	NA	NA	--	2	Sediment sample to assess trends at long-term monitoring station
Nutrients							
SCVURPPP	6	NA	NA	NA	6	NA	Creek water samples collected during storm event and subsequent dry season

NA = not applicable

a. Individual samples can address more than one Management Question simultaneously.

b. The overall total number of BASMAA BMP effectiveness samples was 32 and the overall total number of caulk samples was 20. Each participating Program is given credit for 1/4 of the total study samples.

c. The SPoT program did not analyze samples for PCBs in WY 2018.

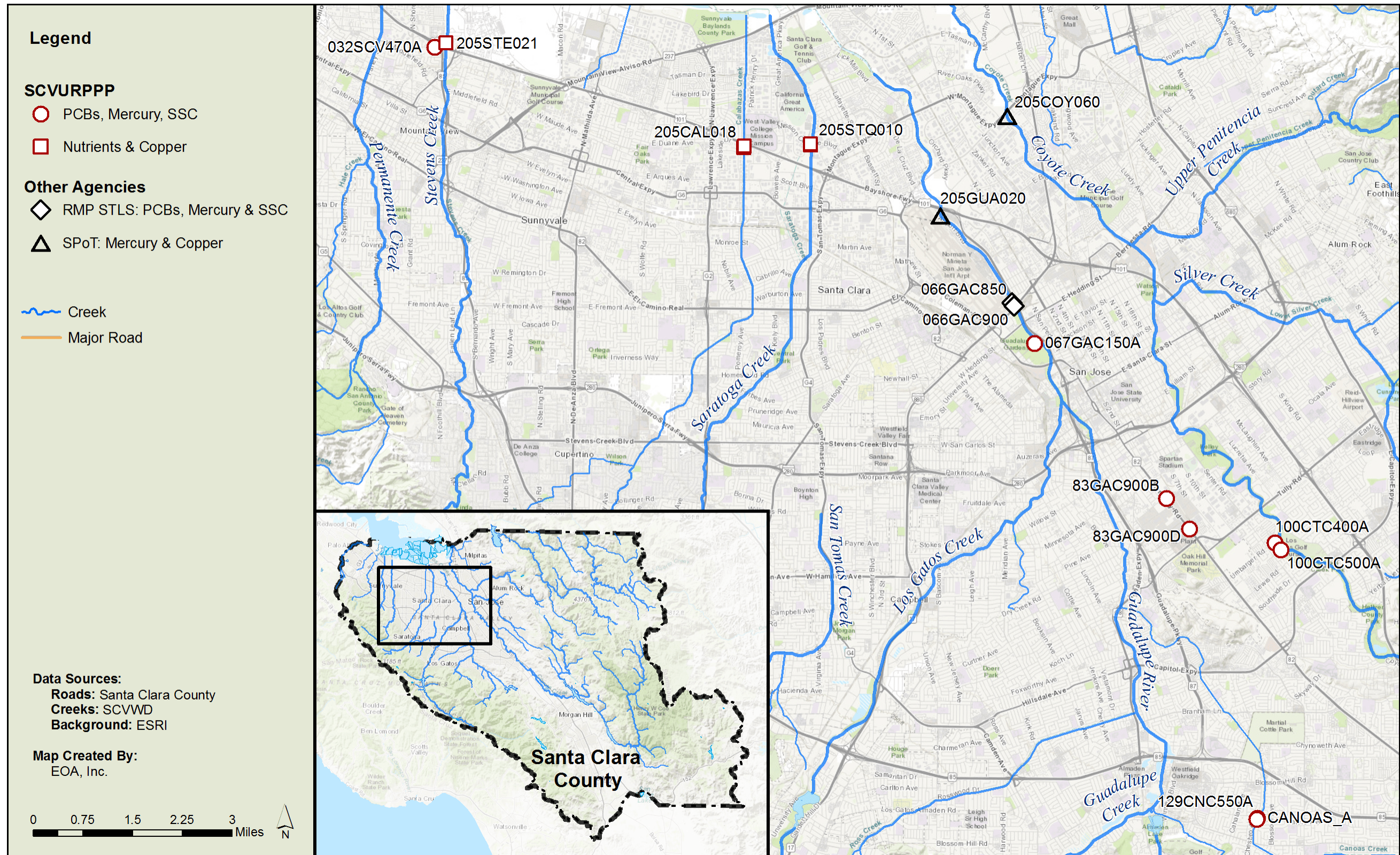


Figure 1. SCVURPPP and Third-Party POC Monitoring Stations in WY 2018. (BASMAA regional project sample locations are not mapped.)

Table 3. POC monitoring stations in Santa Clara County, WY 2018.

Agency	Station Code	Sample Date	Latitude	Longitude	Matrix	PCBs	Mercury	Suspended Sediment Concentration	Total Copper	Dissolved Copper	Hardness as CaCO3	Nutrients ^b
SCVURPPP												
SCVURPPP	032SVC470A	11/16/2017	37.40855	-122.07205	water	x	x	x				
SCVURPPP	100CTC400A	11/16/2017	37.30304	-121.83985	water	x	x	x				
SCVURPPP	100CTC500A	11/16/2017	37.30149	-121.83815	water	x	x	x				
SCVURPPP	129CNC550A	1/8/2018	37.24280	-121.84350	water	x	x	x				
SCVURPPP	CANOAS_A	1/8/2018	37.24250	-121.84370	water	x	x	x				
SCVURPPP	067GAC150A	4/6/2018	37.34586	-121.90647	water	x	x	x				
SCVURPPP	083GAC900B	4/6/2018	37.31239	-121.86973	water	x	x	x				
SCVURPPP	083GAC900D	4/6/2018	37.30583	-121.86319	water	x	x	x				
SCVURPPP	205STE021	1/8/2018	37.40950	-122.06900	water				x	x	x	x
SCVURPPP	205STQ010	1/8/2018	37.38850	-121.96860	water				x	x	x	x
SCVURPPP	205CAL018	1/8/2018	37.38760	-121.98690	water				x	x	x	x
SCVURPPP	205STE021	5/21/2018	37.40944	-122.06904	water				x	x	x	x
SCVURPPP	205STQ010	5/21/2018	37.38868	-121.96870	water				x	x	x	x
SCVURPPP	205CAL018	5/21/2018	37.38796	-121.98683	water				x	x	x	x
Third Party Organizations												
RMP STLS	066GAC850	4/7/2018	37.35469	-121.91279	water	x	x	x				
RMP STLS	066GAC900	4/7/2018	37.35392	-121.91223	water	x	x	x				
SPoT	205GUA020	June 2018 ^a	37.3734	-121.9328	sediment		x		x			
SPoT	205COY060	June 2018 ^a	37.3954	-121.9148	sediment		x		x			

a. Specific sample dates have not yet been provided by the SPoT program.

b. Ammonia (for ammonium), nitrate, nitrite, total Kjeldahl nitrogen, orthophosphate, and total phosphorus are analyzed concurrently in each nutrient sample.

2.2 PCBs and Mercury

The primary goal of the Program's WY 2018 PCBs and mercury monitoring was to identify Watershed Management Areas where cost-effective control measures could be implemented to comply with MRP PCBs and mercury load reduction requirements. This is the same goal that the Program has worked toward since WY 2015.

During WY 2018, the Program collected eight wet weather water samples from municipal separate storm sewer system (MS4) outfalls or receiving waters for PCBs and mercury analysis. An additional two samples were collected in Santa Clara County by the RMP's Small Tributary Loading Strategy (STLS) at similar types of stations using similar methods. These combined 10 samples address POC Management Questions #1 (Source Identification) and #2 (Contributions to Bay Impairment). Data may also be used to improve calibration of the Regional Watershed Spreadsheet Model (RWSM) which is a land use based planning tool for estimation of overall POC loads from small tributaries to San Francisco Bay at a regional scale (i.e., Management Question #4 – Loads and Status). Two of the SCVURPPP samples (083GAC900B and 083GAC900D) were collected in a previously sampled catchment and therefore address Management Question #5 (Trends) in addition to contributing data towards the other management questions.

WMAs are land areas where PCBs and mercury control measures are or will be implemented. These areas have been delineated mostly at the catchment level using topographic and storm drain maps. To help identify where the most cost-effective PCBs/mercury load reduction benefit can be achieved, the Program has focused monitoring efforts over the past several years on identifying WMAs where elevated PCBs and mercury concentrations are observed. These WMAs are then targeted for source investigations to identify specific source properties that can potentially be referred to the Regional Water Board for further investigation and potential abatement.

WMA prioritization monitoring conducted by the Program was performed in accordance with the *Water Year 2016 Pollutant of Concern Monitoring - Sampling and Analysis Plan* (SCVURPPP 2015). The primary goal of the monitoring, as described in the SAP, is to provide information to identify WMAs that disproportionately contribute PCBs and/or mercury to stormwater. Monitoring is focused on collection of storm composite samples from high interest WMAs that may contain PCB and/or mercury source properties. High interest WMAs were identified and prioritized for sampling by evaluating several types of data, including: PCBs and mercury concentrations from prior sediment and water sampling efforts, land use data showing old industrial parcels (especially, municipal storm drain data showing pipelines and access points (e.g., manholes, outfalls, pump stations), catchment areas delineated from municipal storm drain data, and logistical/safety considerations (SCVURPPP 2015).

Specific monitoring stations targeted in WY 2018 were selected from the prioritized list of high interest WMAs. Because a large percentage of the costs to collect storm samples is due to labor charges, paired stations are often sampled to take advantage of the presence of a field crew in the area during a storm event. The paired stations may be lower on the list of priorities and/or may characterize a different mix of land uses. For example, Canoas Creek (station CANOAS_A) was targeted due to its proximity to station 129CNC550A and to characterize the old residential land uses that comprise the majority of its catchment area. Canoas Creek is an engineered channel that was created to drain a wetland during development of the area in the 1960s.

The current WMA map is illustrated in Figure 2. This map shows the 10 catchments that were sampled in WY 2018 by the Program and RMP STLS, as well as the status of all other WMAs, including those sampled in prior years. Some WMAs contain "confirmed source properties," with two having already been referred to agency staff for follow-up abatement. Some WMAs are identified as having "known high source areas." These are WMAs with water and/or sediment sampling results showing elevated concentrations of PCBs that are currently under source property investigation or where an investigation is planned for the near future. The remainder of the WMAs/catchments delineated in Figure 2 are of interest and may have been sampled, but elevated concentrations were not observed. All other land areas within a city that do not fit into one of the "high interest catchments" are lumped into a single city-wide WMA (that is not necessarily

spatially contiguous). These city-wide WMAs are not shown in Figure 2.

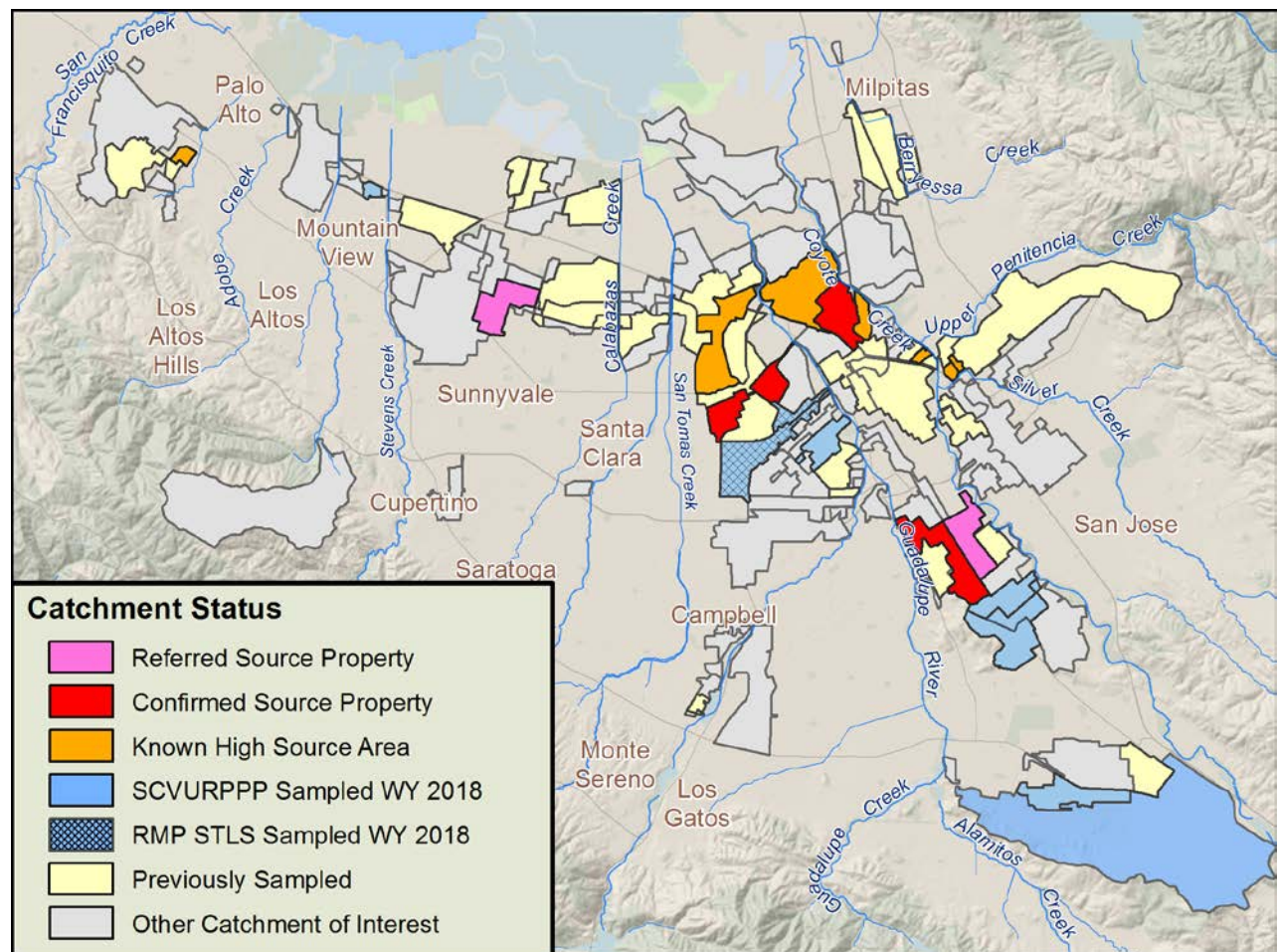


Figure 2. SCVURPPP current Watershed Management Area (WMA) map showing catchments sampled in WY 2018.

Composite samples consisting of four to eight aliquots collected during the rising limb and peak of the storm hydrograph (as determined through field observations) were analyzed for the “RMP 40” PCB congeners⁷ (method EPA 1668C), total mercury (method EPA 1631E), and suspended sediment concentration (SSC) (method ASTM D3977-97).

Table 4 summarizes PCBs, mercury, and SSC monitoring results collected by SCVURPPP and the RMP STLS in WY 2018⁸. “Total PCBs” were calculated as the sum of the RMP 40 congeners. The “PCB Particle Ratio” and “Hg Particle Ratio” are calculated by dividing Total PCBs and Total Mercury by SSC. Particle Ratios address the fact that these pollutants are generally bound to sediment. Water concentrations and particle ratios are compared to countywide and regional datasets in order to “rank” monitoring stations and the WMAs they characterize. High ranking WMAs are flagged for future source property investigations which typically include property records review, aerial photography interpretation, public right-of-way surveys, facility site visits, and sediment sampling.

⁷ The RMP 40 PCB congeners include: PCB-8, PCB-18, PCB-28, PCB-31, PCB-33, PCB-44, PCB-49, PCB-52, PCB-56, PCB-60, PCB-66, PCB-70, PCB-74, PCB-87, PCB-95, PCB-97, PCB-99, PCB-101, PCB-105, PCB-110, PCB-118, PCB-128, PCB-132, PCB-138, PCB-141, PCB-149, PCB-151, PCB-153, PCB-156, PCB-158, PCB-170, PCB-174, PCB-177, PCB-180, PCB-183, PCB-187, PCB-194, PCB-195, PCB-201, PCB-203.

⁸ RMP STLS results are also reported separately by the San Francisco Estuary Institute (SFEI) in Gilbreath et al. (2019, in preparation).

For the eight samples that were collected by SCVURPPP in WY 2018, total PCB concentrations ranged from 0.15 ng/L to 57.3 ng/L, and PCB particle ratios from 4.0 ng/g to 623 ng/g. Total mercury concentrations ranged from 1.07 ng/L to 31.6 ng/L, and mercury particle ratios from 27.6 ng/g to 344 ng/g. PCB monitoring results within the context of other water samples analyzed for PCBs in Santa Clara County and region-wide are described below.

Table 4. PCB, mercury, and suspended sediment concentrations in water samples collected by SCVURPPP and STLS, WY 2018.

Station Code	Sample Date	SSC (mg/L)	Total PCBs (ng/L) ^a	PCB Particle Ratio (ng/g) ^b	Hg (ng/L)	Hg Particle Ratio (ng/g) ^b
SCVURPPP Samples						
032SVC470A	11/16/2017	40.4	6.95	172	13.4	332
100CTC400A	11/16/2017	72.1	4.41	61	9.73	135
100CTC500A	11/16/2017	81.3	5.89	73	7.55	93
129CNC550A	1/8/2018	18.3	1.31	72	3.81	208
CANOAS_A	1/8/2018	38.8	0.15	4.0	1.07	28
067GAC150A	4/6/2018	82.2	1.87	23	5.21	63
083GAC900B	4/6/2018	92.0	57.3	623	31.6	344
083GAC900D	4/6/2018	54.9	1.60	29	7.24	132
RMP STLS Samples						
066GAC850	4/7/2018	149	6.63	45	16	107
066GAC900	4/7/2018	27	3.36	125	17	644

^a Total PCBs calculated as sum of RMP 40 congeners.

^b PCB and Hg Particle Ratios calculated by dividing Total PCBs and Hg concentrations by SSC.

2.2.1 Comparison with Region-wide Storm Sampling Results

The current available storm sample dataset now includes samples collected from 127 MS4 catchments and 28 receiving waters throughout the Bay Area.⁹ The MS4 catchment sites include storm drain manholes, outfalls, pump stations, and artificial channels.¹⁰ The 28 sites in receiving waters have watersheds ranging in size from less than 3,000 acres (i.e., Lower Penitencia Creek) to the entire Sacramento–San Joaquin River Delta watershed (i.e., Mallard Island). Many of the sites have been sampled more than once and/or have multiple sample results reported for individual storm events. A total of 15 of the 28 receiving water sites have multiple sample results (3 to 126 samples). A total of 12 of the 127 MS4 sites also have multiple sample results (2 to 80 samples). For sites with more than one sample, the particle ratio is calculated by dividing the sum of PCB concentrations by the sum of suspended sediment concentrations. Performing the calculation in this way is effectively the equivalent of compositing all the individual samples that have been collected at a site. This is consistent with the RMP STLS approach to data evaluation (Gilbreath et al. 2019, in preparation).

Table 5 lists descriptive statistics for PCB (n=155) and mercury concentrations (n=100) for the Bay Area stormwater dataset. The median concentration of PCBs in water is 6.63 ng/L, and the mean is 18.6 ng/L. The median PCB particle ratio is 114 ng/g, and the mean is 323 ng/g. As can be seen in Figures 3 and 4,

⁹ This dataset includes samples collected by SCVURPPP, the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), and the RMP's STLS.

¹⁰ Stormwater samples have also been collected from inlets and/or LID systems as part of special studies. However, those were not included in this analysis.

there are a few catchments with highly elevated samples that increase the mean (i.e., average) concentration statistic over the median (i.e., 50th percentile). Both SCVURPPP and the RMP are continuing to collect stormwater composite samples in WY 2019 in an effort to grow this dataset. In future years, it may be informative to correlate measured concentrations to various factors such as storm size, rainfall intensity, antecedent dry weather, land use characteristics, and age of development.

Table 5. Descriptive statistics of PCB and mercury concentrations in water and particle ratios.

	PCBs (ng/L) ^a	Hg (ng/L)	SSC (mg/L)	PCB Particle Ratio (ng/g) ^b	Hg Particle Ratio (ng/mg) ^b
N	155	100	155	155	100
Min	ND	0.44	3.20	ND	7.89
10th Percentile	1.56	4.10	16.0	15.5	108
25th Percentile	2.76	7.37	31.0	47.1	194
50th Percentile	6.63	15.4	55.8	114	331
75th Percentile	14.5	36.9	111	230	529
90th Percentile	41.7	70.7	266	745	772
Max	448	1,053	2,630	8,222	5,290
Mean	18.6	41.7	130	323	446

^a Total PCBs calculated as sum of RMP 40 congeners.

^b PCB and Hg Particle Ratios calculated by dividing Total PCBs and Hg concentrations by SSC.

PCB concentrations in water samples for the Bay Area dataset (n=155) are plotted in Figure 3. PCB particle ratios are plotted in Figure 4. Figures 3 and 4 symbolize samples according to three categories: collected in Santa Clara County in WY 2018 (n=10), collected in Santa Clara County in other years (n=49), and collected elsewhere in the Bay Area (n=96). Of the 59 sites in Santa Clara County, 10 were sampled by SCVURPPP in WY 2018, 17 in WY 2017, and nine in WY 2016. Two sites were sampled by RMP STLS in WY 2017 and WY 2018, nine in WY 2016, and thirteen in WY 2015. Eight sites were sampled multiple times by the RMP in prior water years.

Overall, Santa Clara County has relatively low PCB concentrations and PCB particle ratios compared to the other three counties in the region (Alameda, Contra Costa, and San Mateo). However, some of the highest water concentrations and particle ratios measured in the Bay Area to-date have been observed in Santa Clara County, including site 083GAC900B sampled in WY 2018. The highest PCB concentrations in Santa Clara County have been measured at:

- Sunnyvale East Channel (96.6 ng/L; sampled WYs 2011-14),
- 067CTC250A (Yard Court San Jose) (57.6 ng/L; sampled WY 2017),
- 083GAC900B (Monterey Road at Phelan) (57.3 ng/L; sampled WY 2018),
- 051CTC400A (Ridder Park Dr Storm Drain) (55.5 ng/L; sampled WY 2015),
- 067SCL080A (Outfall to Lower Silver Creek) (44.6 ng/L; sampled WY 2015), and
- 067SCL120A (Las Plumas Ave San Jose) (27.1 ng/L; sampled WY 2017).

The sites with the highest PCB particle ratios are:

- 031SCH250A (Hansen Way Palo Alto) (1,070 ng/g; sampled WY 2017),
- 067SCL080A (Outfall to Lower Silver Creek) (783 ng/g; sampled WY 2015),
- 083GAC900B (Monterey Road at Phelan) (623 ng/g; sampled WY 2018),
- 050GAC020A (Rincon 2 PS San Jose) (530 ng/g; sampled WY 2017),
- 051CTC400A (Ridder Park Dr Storm Drain) (488 ng/g; sampled WY 2015), and
- 067SCL120A (Las Plumas Ave San Jose) (485 ng/g; sampled WY 2017).

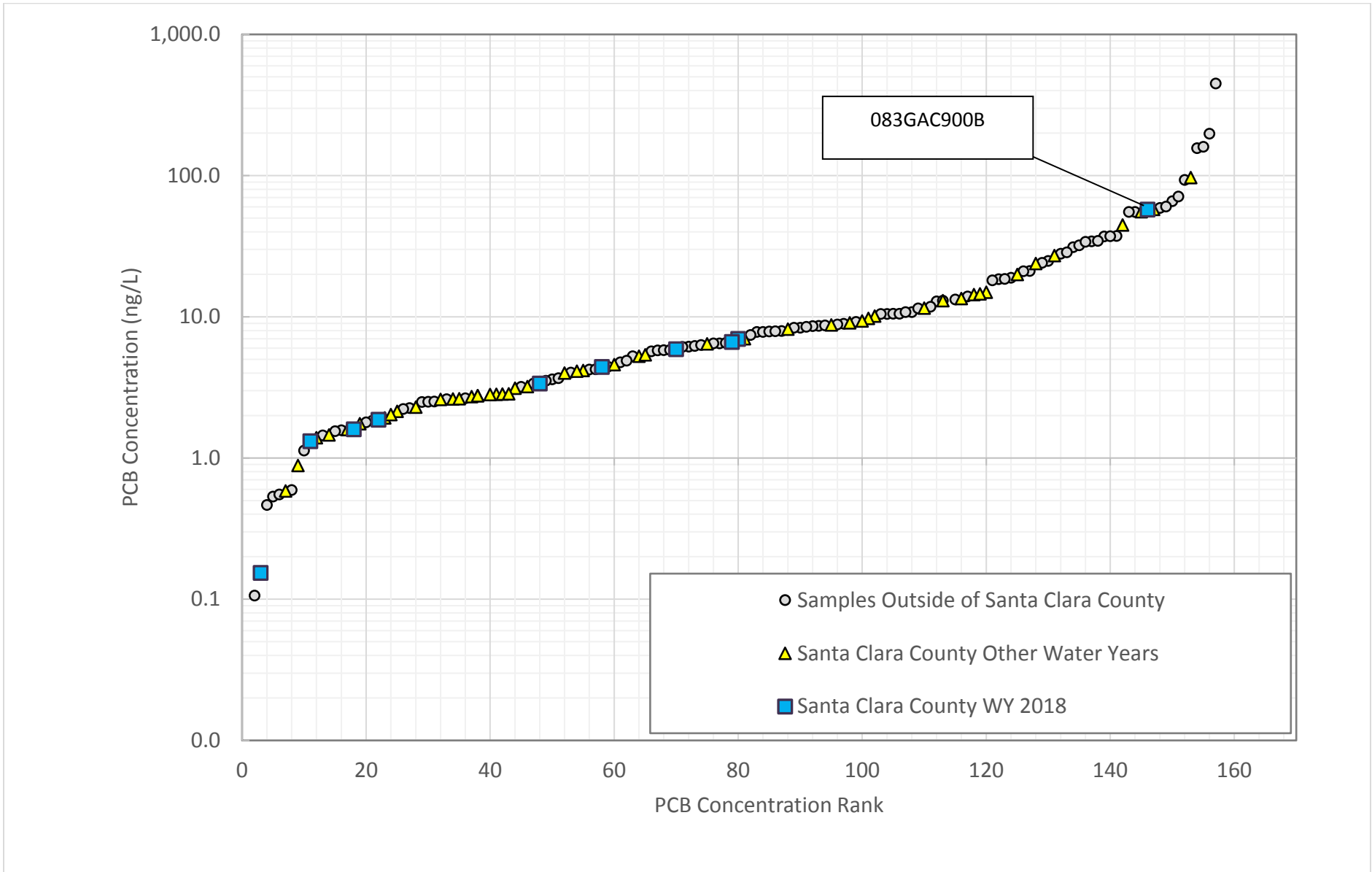


Figure 3. PCB concentrations for water samples collected in large MS4s and receiving waters in the Bay Area

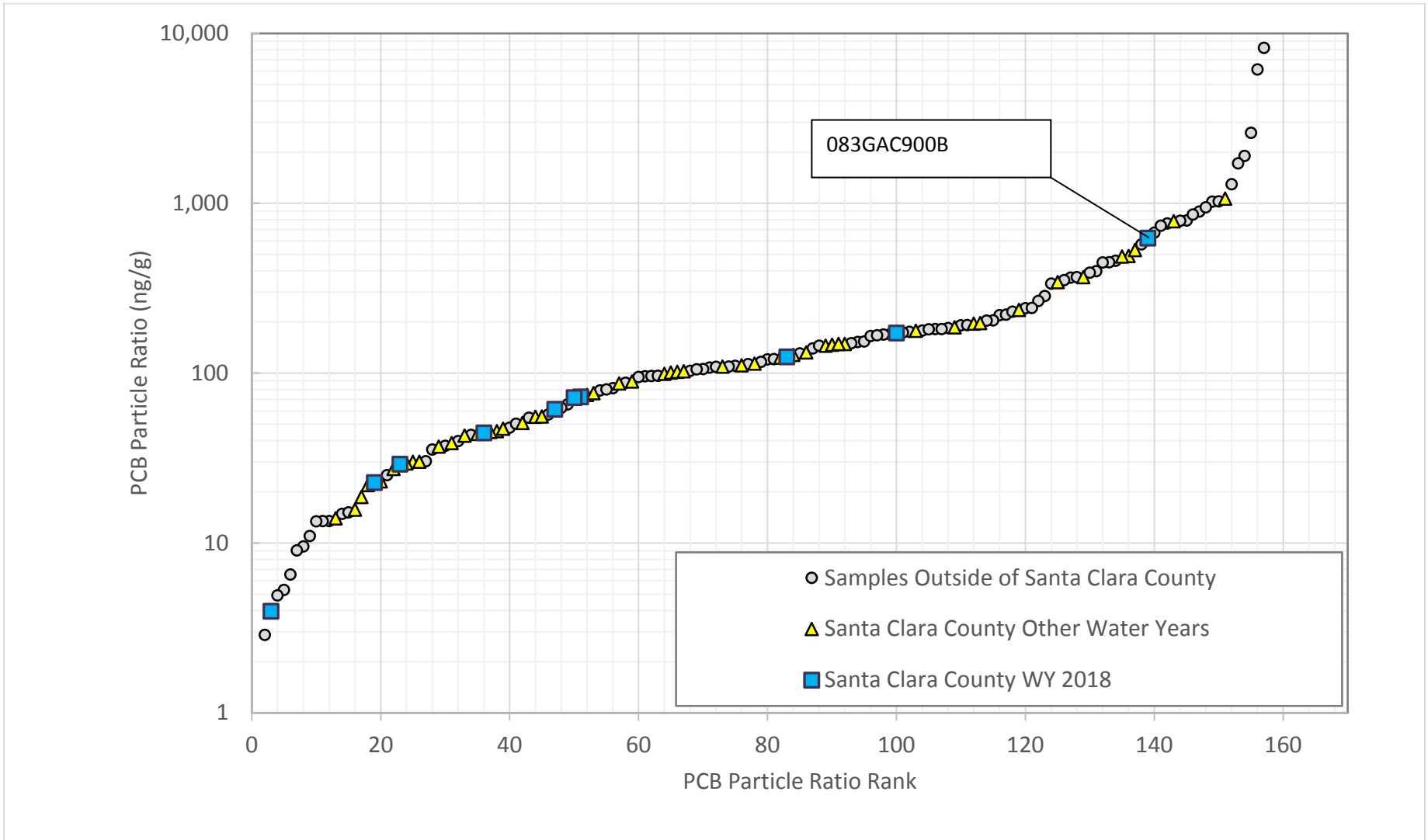


Figure 4. PCB particle ratios for water samples collected in MS4s and receiving waters (i.e., creeks/rivers) draining to the Bay.

2.2.2 WMA Update

PCB and mercury sampling data are used to identify specific source properties and/or WMAs where control measures will be implemented. There are currently no thresholds established for classifying or prioritizing PCB or mercury concentrations in stormwater. Therefore, the Program is currently focusing on PCBs and applying the BASMAA RMC sediment concentration thresholds to PCB particle ratio data which can be expressed in the same units (mg/kg). A PCB particle ratio greater than 0.5 mg/kg (or 500 ng/g) is used as a preliminary threshold for classifying water samples as high, 0.2 – 0.5 mg/kg (200 – 500 ng/g) is moderate, and less than 0.2 mg/kg (200 ng/g) is low.

Sites are also ranked within the regional dataset (n=155) based on two parameters: concentrations in water and particle ratios. The sites typically have a different ranking depending on which list is reviewed. A sample that has a relatively low concentration in water but a high particle ratio may suggest that the storm that was sampled was relatively small, and the rainfall was not enough to mobilize much sediment. A larger storm may mobilize more sediment and PCBs, so catchments with an elevated concentration or particle ratio may be considered for a source investigation.

Based on WY 2018 sampling of the eight catchments that were sampled for the first time, no additional WMAs were identified as “known high source areas” where source investigations should be considered. However, based on WY 2018 review of WY 2017 monitoring and investigations, the status of three catchments changed to “confirmed source property,” as additional source properties were identified, but not yet referred. Additionally, the status of catchment 001SFC100A, located in downtown Palo Alto, was changed from “known high source area” to “other catchment of interest” based on sampling results having low concentrations of PCBs and the high rate of redevelopment/green stormwater infrastructure (GSI) occurring in the catchment. Seven catchments remain with a status of “known high source area” and will continue to be targeted by source property investigations. Many of the catchments shown in Figure 2 with a status of “other catchment of interest” have been sampled, but the samples had low PCB concentrations, suggesting that either no PCB sources exist in the catchment or the sample is a “false negative.” False negatives could be the result of low runoff/rainfall rates failing to mobilize sources, high runoff diluting the sample, the well-known high variability of PCBs in sediments and runoff, poor sample station locations, and/or numerous other causes. As more information is gathered, many of these WMAs will be removed from further consideration.

2.2.3 Source Property Identification

One strategy to reduce PCBs and mercury loadings to the Bay is to identify properties that disproportionately contribute these pollutants to the MS4 and then refer these properties to appropriate agencies for further investigation and potential abatement. At least seven potential PCB or mercury source properties have been identified to-date in priority WMAs in Santa Clara County. Two properties have already been referred to the Regional Water Board, and at least five additional properties could potentially be referred as a result of investigations over the previous two years. If WY 2019 sampling results in the identification of additional source properties, the Program will work with local municipalities to cleanup and abate the properties, and/or refer these properties to Regional Water Board for follow up action.

Source investigations are continuing in high priority catchments including catchment 083GAC900 where two storm samples were collected in WY 2018 and many samples in the past have shown the area to have high concentrations of PCBs. Part of the investigation in this catchment and others will include a paired sampling approach where a storm sample will be collected both upstream and downstream of the suspected source area. In WY 2018, sample 083GAC900B was collected downstream of a suspected source area. This sample had a relatively high PCB concentration (57.3 ng/L); whereas sample 083GAC900A, located upstream of the suspected source area had a relatively low PCB concentration (1.60 ng/L). In spite of these findings, identifying the exact source property(ies) is challenging due to the complicated nature of the public and private storm drain network and multiple suspected source properties where the PCBs could be originating. Investigation in catchment 083GAC900 will continue in WY 2019.

2.3 Copper

In WY 2018, SCVURPPP collected a total of six samples for copper analysis. Three bottom-of-the-watershed stations (Stevens Creek, San Tomas Aquino Creek, and Calabazas Creek) were sampled during a large storm event on January 8, 2018, concurrent with nutrient monitoring and Provision C.8.g.iii Wet Weather Pesticides and Toxicity Monitoring. The three sites were sampled again on May 21, 2018 during spring baseflows. The goal of this approach is to address Management Question #5 (Trends) by comparing copper concentrations during different seasons. Management Question #4 (Loads and Status) is also addressed by characterizing copper concentrations in mixed-use watersheds. These data are supplemented by the two SPoT sediment samples collected in June 2018 from Coyote Creek and Guadalupe Creek and analyzed for copper to assess long-term trends (Management Question #5).

All Program samples were analyzed for total copper, dissolved copper¹¹, and hardness. Results are listed in Table 6. Comparisons to freshwater water quality objectives are described in Section 3.0.

Table 6. Total and dissolved copper concentrations in water samples collected by SCVURPPP, WY 2018.

Station Code	Creek	Total Copper (µg/L)	Dissolved Copper (µg/L)	Hardness as CaCO ₃ (mg/L)
January 8, 2018 (storm event)				
205STE021	Stevens Creek	12	4.3	60
205STQ010	San Tomas Aquino Creek	14	30 *	46
205CAL018	Calabazas Creek	14	4.1	50
May 21, 2018 (spring baseflow)				
205STE021	Stevens Creek	0.59	0.22	440
205STQ010	San Tomas Aquino Creek	1.2	0.85	390
205CAL018	Calabazas Creek	0.82	0.46	460

* The dissolved copper concentration from the Jan. 8, 2018 205STQ010 sample was flagged as questionable. Dissolved copper, by definition, must be ≤ total copper, which is not the case in this sample. The data validation process did not find any other concerns with the copper results. It is possible that contamination was introduced during the laboratory filtration process for this sample.

Based on the laboratory results, the following findings are noted:

- As expected, dissolved copper concentrations are lower than total copper concentrations. The dissolved portion of the total copper concentration is higher in the spring base flow samples compared to the storm samples. This finding illustrates coppers affinity to suspended sediment which is higher during storm events.
- Copper concentrations were higher in the storm samples compared to the spring baseflow samples. Conversely, hardness concentrations were lower in the storm samples compared to the spring baseflow samples.
- Copper concentrations were similar (i.e., within the same order of magnitude) in all three creeks sampled. There do not appear to be localized sources of copper.

¹¹ In order to simplify the field effort and reduce the risk of sample contamination, the analytical laboratory was asked to conduct the sample filtration required for dissolved copper analysis.

2.4 Nutrients

Nutrients were included in the POC monitoring requirements to support Regional Water Board efforts to develop nutrient numeric endpoints (NNE) for the San Francisco Bay Estuary. The “San Francisco Bay Nutrient Management Strategy” (NMS) is part of a statewide initiative to address nutrient over-enrichment in State waters (Regional Water Board 2012). Its goal is to lay out a well-reasoned and cost-effective program to generate the scientific understanding needed to fully support major management decisions such as establishing/revising objectives for nutrients and dissolved oxygen, developing/implementing a nutrient monitoring program, and specifying nutrient limits in NPDES permits. The NMS monitoring program currently focuses on stations located within San Francisco Bay rather than freshwater tributaries.

The suite of nutrients required in MRP Provision C.8.f (i.e., ammonium, nitrate, nitrite, total Kjeldahl nitrogen (TKN), orthophosphate, and total phosphorus) closely reflects the list of analytes measured by the RMP and BASMAA partners at the six regional loading stations (including Santa Clara County stations in Guadalupe River and the Sunnyvale East Channel) monitored in WY 2012 - WY 2014. The prior data collected in freshwater tributaries to San Francisco Bay were used by the Nutrient Strategy Technical Team to develop and calibrate nutrient loading models.

In WY 2018, POC monitoring for nutrients in Santa Clara County was conducted during a large storm event on January 8, 2018 at three bottom-of-the-watershed stations on Stevens Creek, San Tomas Aquino Creek, and Calabazas Creek, concurrent with copper monitoring and Provision C.8.g.iii Wet Weather Pesticides and Toxicity Monitoring. Follow up monitoring at all three stations was conducted during the dry season concurrent with spring bioassessment monitoring on May 21, 2018. Nutrient POC monitoring addresses Management Question #4 (Loads and Status). Results are listed in Table 7. Comparisons to applicable freshwater water quality objectives are described in Section 3.0.

Table 7. Nutrient concentrations (mg/L) in water samples collected by SCVURPPP, WY 2018.

Date/Station	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen (TKN)	Ammonia as N	Un-ionized Ammonia as N ¹	Ammonium ²	Total Nitrogen ³	Dissolved Orthophosphate as P	Phosphorus as P
January 8, 2018 (storm event)									
205STE021 (Stevens Creek)	0.22	0.017	1.1	0.13	0.002	0.128	1.34	0.11	0.24
205STQ010 (San Tomas Aquino)	0.23	0.017	0.97	0.20	0.003	0.197	1.22	0.18	0.34
205CAL018 (Calabazas Creek)	0.22	0.016	1.1	0.13	0.002	0.128	1.34	0.13	0.28
May 21, 2018 (spring baseflow)									
205STE021 (Stevens Creek)	1.4	0.007	0.57	0.034	0.001	0.033	1.98	0.024	0.025
205STQ010 (San Tomas Aquino)	< 0.02	0.0016	0.66	0.053	0.007	0.046	0.67	<0.006	0.16
205CAL018 (Calabazas Creek)	3.2	0.011	0.35	0.040	0.015	0.025	3.56	0.038	0.019

All constituents reported as mg/L.

¹ Un-ionized ammonia calculated using formula provided by the American Fisheries Society Online Resources (<https://fisheries.org/books-journals/online-resources/>). Formula requires field measurements of temperature, pH, and specific conductance, which were not recorded for the January 8, 2018 event. Specific conductance and pH values for Jan. 8 samples were estimated based on laboratory intake measurements reported for the concurrent toxicity samples. Temperature was estimated to be 14°C.

² Ammonium = ammonia – un-ionized ammonia.

³ Total nitrogen = TKN + nitrate + nitrite. Non-detects valued at ½ method detection limit in calculation.

Based on the laboratory results, the following findings are noted:

- Concentrations of all nutrients were similar at all three stations during the January event. In contrast, there was high variability among the stations during the May event, particularly for nitrate and phosphorus which varied by an order of magnitude.
- Inorganic nitrogen (nitrate and nitrite) concentrations were higher in May compared to the January storm event (with the exception of San Tomas Aquino Creek) and organic nitrogen (TKN) concentrations were lower in May compared to the January storm event.
- Organic nitrogen (TKN) made up a greater proportion of the total nitrogen concentration during the January storm event compared to the May event. It is likely that organically-bound nitrogen washed off surfaces during the January storm had not yet had time to cycle through the ammonification and nitrification processes before samples were collected.
- Phosphorus concentrations were higher during the January storm runoff sampling event compared to the May baseflow event. This finding is consistent with the draft conceptual model developed by the NMS which suggests that nutrient loads to San Francisco Bay from creeks are highest during the wet season, although considerably less than loads from publicly owned wastewater treatment works (POTWs) (Senn and Novick 2014). However, nitrogen concentrations (primarily nitrate) were higher during the baseflow event at two of the three stations. The nitrate patterns were not consistent with the NMS model but were consistent with SCVURPPP POC monitoring conducted in WY 2017 in Silver Creek.

2.5 Emerging Contaminants

Emerging contaminant monitoring is being addressed through the Program's participation in the RMP. The RMP has investigated Contaminants of Emerging Concern (CECs) since 2001 and established the RMP Emerging Contaminants Work Group (ECWG) in 2006. The purpose of the ECWG is to identify CECs that might impact beneficial uses in the Bay and to develop cost-effective strategies to identify, monitor, and minimize impacts. The RMP published a CEC Strategy "living" document in 2013 and completed a full revision in 2017 (Sutton et al. 2013; Sutton and Sedlak 2015; Sutton et al. 2017) and made minor updates in 2018 (Lin et al. 2018). The CEC Strategy document guides RMP special studies on CECs using a tiered risk and management action framework.

Provision C.8.f of the MRP identifies three emerging contaminants that must be addressed through POC monitoring: Perfluorooctane Sulfonate Substances (PFOS), Perfluoroalkyl and Polyfluoroalkyl Sulfonate Substances (PFAS), and Alternative Flame Retardants (AFRs). PFAS is a broad class of chemicals used in industrial applications and consumer goods primarily for their ability to repel oil and water. PFOS are a subgroup within the PFAS umbrella and are identified in the CEC Strategy as "moderate" concern due to Bay occurrence data suggesting a high probability of a low-level effect on Bay wildlife. Other PFAS and AFRs are identified as "possible" concern due to uncertainties in measured or predicted Bay concentrations or in toxicity thresholds. RMP staff recently published reports summarizing PFOS and PFAS monitoring results (Houtz et al. 2016; Sedlak et al. 2017; Sedlak et al. 2018).¹²

AFRs came into use following state bans and nationwide phase-outs of polybrominated diphenyl ether (PBDE) flame retardants in the early 2000's. They include many categories of compounds, including organophosphate esters. In 2018 the RMP STLS and ECWG worked together to conduct a special study to inform ECWG's planning activities related to AFRs. The special study compiled and reviewed available data and previously developed conceptual models for PBDE to support a stormwater-related AFR conceptual model being developed by the ECWG. Organophosphate esters were prioritized for further investigation due to their increasing use, persistent character, and ubiquitous detections at concentrations exceeding PBDE concentrations in the Bay. Limited stormwater data from two watersheds in Richmond and Sunnyvale suggest that urban

¹² The Emerging Contaminants Workgroup is also conducting monitoring on a number of other emerging contaminants that are not identified in the MRP. These include microplastics, ethoxylated surfactants, and fipronil.

runoff may be an important source of these compounds. Additional monitoring and modeling was recommended. Results of the AFR special study were published in a Technical Report in 2018 (Lin and Sutton 2018).

In 2018, the RMP's ECWG also developed a special study proposal to analyze stormwater samples collected from urban watersheds for a large suite of CECs. The list of CECs to be analyzed is based on recent work conducted in Puget Sound streams and is intended to target urban runoff constituents rather than those found in wastewater (e.g., pharmaceuticals). The list includes PFOSs, PFASs, and AFRs. Pilot sampling will begin in WY 2019 in close coordination with the STLS.

These RMP special studies satisfy the POC monitoring requirement for CECs within provision C.8.f.

3.0 COMPARISON TO APPLICABLE WATER QUALITY STANDARDS

MRP provision C.8.h.i requires RMC participants to assess all data collected pursuant to Provision C.8 for compliance with applicable water quality standards. In compliance with this requirement POC data collected in WY 2018 by SCVURPPP were compared to applicable numeric water quality objectives (WQOs) included in the SF Bay Water Quality Control Plan.

When conducting a comparison to applicable WQOs/criteria, certain considerations should be taken into account to avoid the mischaracterization of water quality data:

Discharge vs. Receiving Water – WQOs apply to receiving waters, not discharges. WQOs are designed to represent the maximum amount of pollutants that can remain in the water column without causing any adverse effect on organisms using the aquatic system as habitat, on people consuming those organisms or water, and on other current or potential beneficial uses. Five of the six PCBs and mercury samples collected by the Program were within the engineered storm drain network, not receiving waters. Dilution is likely to occur when the MS4 discharges urban stormwater (and non-stormwater) runoff into the local receiving water. Therefore, it is unknown whether discharges that exceed WQOs result in exceedances in the receiving water itself, the location where there is the potential for exposure by aquatic life.

Freshwater vs. Saltwater - POC monitoring data were collected in freshwater, above tidal influence and therefore comparisons were made to freshwater WQOs/criteria.

Aquatic Life vs. Human Health - Comparisons were primarily made to objectives/criteria for the protection of aquatic life, not objectives/criteria for the protection of human health to support the consumption of water or organisms. This decision was based on the assumption that water and organisms are not likely being consumed from the stations monitored.

Acute vs. Chronic Objectives/Criteria – All monitoring for PCBs and mercury was conducted during episodic storm events and results do not likely represent long-term (chronic) concentrations of monitored constituents. The same is true for one of the two copper and nutrient sampling events. Storm monitoring data were therefore compared to “acute” WQOs/criteria for aquatic life that represent the highest concentrations of an analyte to which an aquatic community can be exposed briefly (e.g., 1-hour) without resulting in an unacceptable effect. Spring baseflow monitoring data were also compared to “chronic” WQOs/criteria.

Of the analytes monitored by SCVURPPP at POC stations in WY 2018, WQOs or criteria for the protection of aquatic life have only been promulgated for total mercury, dissolved copper, and un-ionized ammonia. In WY 2018, there were no exceedances of applicable water quality standards for these analytes in samples collected in receiving waters. Details of the analyses are provided below.

- **Total Mercury.** All mercury concentrations measured in SCVURPPP samples in WY 2018 were well below the freshwater acute objective for mercury of 2.4 ug/L (see Table 4).
- **Nutrients.** All un-ionized ammonia concentrations calculated for SCVURPPP samples were below the annual median objective for un-ionized ammonia of 0.025 mg/L (see Table 7).
- **Dissolved Copper.** Acute (1-hour average) and chronic (4-day average) WQOs for copper are expressed in terms of the dissolved fraction of the metal in the water column and are hardness dependent¹³. The copper WQOs were calculated using the exponential functions described in the California Toxics Rule (40 CFR 131.38) which apply hardness values measured at the sample station. Dissolved copper concentrations measured at those stations were compared to the calculated WQOs. In general, dissolved copper concentrations were below calculated acute and chronic WQOs (Table 8). One dissolved copper sample (205STQ010 on Jan. 8, 2018) exceeded the calculated WQOs. Because the total copper concentration from this sample was much lower (14

¹³ The current copper standards for freshwater in California do not account for the effects of pH or natural organic matter and can be overly stringent or underprotective (or both, at different times). Therefore, the California Stormwater Quality Association (CASQA) has asked the USEPA to considering updating the California Toxics Rule for copper using the Biotic Ligand Model (BLM) which accounts for the effect of water chemistry in addition to hardness (i.e., temperature, pH, dissolved organic carbon, major cations and anions).

ug/L) than the dissolved copper concentration (30 ug/L), this result has been flagged as questionable in the electronic data deliverable (EDD). It is possible that contamination was introduced during the laboratory filtration process.

Table 8. Comparison of WY 2018 Monitoring Data to the Copper WQO.

Station Code	Sample Date	Dissolved Copper (µg/L)	Hardness as CaCO ₃ (mg/L)	Acute WQO for Dissolved Copper at Measured Hardness (µg/L)	Chronic WQO for Dissolved Copper at Measured Hardness (µg/L)
205STE021	1/8/2018	4.3	60	8.3	5.8 (NA)
205STQ010	1/8/2018	30 *	46	6.5	4.6 (NA)
205CAL018	1/8/2018	4.1	50	7.0	5.0 (NA)
205STE021	5/21/2018	0.22	440	54	31
205STQ010	5/21/2018	0.85	390	48	29
205CAL018	5/21/2018	0.46	460	57	33

NA = Not applicable. Chronic WQOs are not applicable to storm event grab samples.

* The dissolved copper concentration measured at 205STQ010 is likely the result of laboratory contamination during filtration. This assumption is based on the total copper concentration from the same sample which was much lower (14 ug/L). This result has been flagged as questionable in the electronic data files.

4.0 CONCLUSIONS AND RECOMMENDATIONS

In WY 2018, SCVURPPP collected and analyzed POC samples in compliance with Provision C.8.f of the MRP. Yearly minimum requirements were met for all monitoring parameters. In addition, SCVURPPP continued to work with the RMP's STLS to supplement WY 2018 monitoring accomplishments.

Conclusions from WY 2018 POC monitoring include the following:

- SCVURPPP collected eight wet weather samples from high interest catchments for PCBs and mercury analysis. Results from SCVURPPP monitoring were compiled with results from RMP STLS monitoring (two samples) to potentially identify new high interest WMAs in which new PCB or mercury source investigations should be considered. Based on the monitoring results, no new WMAs were added to the list of catchments warranting source property investigations.
- In WY 2018, SCVURPPP continued to review PCB monitoring data that had been collected over the past few years. Based on these review, one WMA was removed from the list of "catchments of interest" (001SFC100A). The status of three additional catchments was changed from "known high source area" to "confirmed source property" as specific source properties were identified and referrals are currently under development.
- Samples for copper analyses were collected from three bottom-of-the-watershed locations during two monitoring events: a January storm event and during spring baseflow. Copper concentrations were higher in the storm samples compared to the baseflow samples. Similar concentrations at all three sites suggest a lack of local point sources. The one dissolved copper sample that exceeded applicable water quality standards was flagged as questionable and may have been had elevated concentrations as a result of laboratory contamination.
- Samples for nutrient analyses were collected from three bottom-of-the-watershed locations during two monitoring events: a January storm event and during spring baseflow. None of the samples exceeded applicable water quality objectives.
- SCVURPPP participated in a BASMAA monitoring study that satisfied the provision C.12.e requirement to collect 20 composite caulk/sealant samples throughout the MRP permit area. The final project report was included with the Program's Fiscal Year 2017/18 Annual Report, submitted to the Regional Water Board on September 30, 2018 (EOA, SFEI, KLI 2018).
- SCVURPPP participated in a the BASMAA Regional Best Management Practices (BMP) Effectiveness Study which was developed to satisfy provision C.8.f requirements to collect at least eight PCBs and mercury samples that address Management Question #3 (Management Action Effectiveness). The study investigated the effectiveness of hydrodynamic separator (HDS) units and various types of biochar-amended bioretention soil media (BSM) at removing PCBs and mercury from stormwater. Results of the study are summarized in two reports that will be submitted by March 31, 2019 with the Program's WY 2018 Urban Creeks Monitoring Report. Findings will also be used to support development of the Reasonable Assurance Analysis (RAA) that is required by provision C.12.c.iii.(3) of the MRP and which must be submitted with the 2020 Annual Report (September 30, 2020).

Recommendations for WY 2019 POC monitoring include the following:

- SCVURPPP and the RMP STLS will continue to conduct PCB and mercury monitoring with the goal of identifying WMAs and specific source properties where new PCB and mercury control measures can be implemented during the permit term.
- SCVURPPP will continue to participate in the STLS Trends Strategy Team. Initiated in WY 2015, the STLS Trends Strategy Team is currently developing a regional monitoring design to assess trends in POC loading to San Francisco Bay from small tributaries (see Section 5.2.3). The STLS Trends Strategy will initially focus on PCBs and mercury, but will not be limited to those POCs. Analysis of

recent and historical data collected at region-wide loadings stations suggests that PCB concentrations are highly variable. Therefore, a monitoring design to detect trends with statistical confidence may require more samples than is feasible with current financial resources. The STLS Trends Strategy Team is continuing to evaluate available data from the Guadalupe River watershed to explore more economical monitoring opportunities. The Team is also considering modeling options that could be used in concert with monitoring to detect and predict trends in POC loadings. A Trends Strategy Road Map is currently being developed.

- SCVURPPP will continue to work with the SPoT Program to address Management Question #5 (Trends). The SPoT Monitoring Program conducts annual dry season monitoring (subject to funding constraints) of sediments collected from a statewide network of large rivers. The goal of the SPoT Program is to investigate long-term trends in water quality (Management Question #5 – Trends). Sites are targeted in bottom-of-the-watershed locations with slow water flow and appropriate micromorphology to allow deposition and accumulation of sediments, including two stations in Santa Clara County (Coyote Creek and Guadalupe River). In most years, sediments are analyzed for PCBs, mercury, other metals, toxicity, pesticides, and organic pollutants (Phillips et al. 2014).
- A minimum of two copper samples will be collected from old industrial catchments concurrent with PCBs and mercury storm composite samples.
- A minimum of two nutrient samples will be collected from mixed land use watersheds during baseflow to address Management Question # 4 (Loads and Status).
- SCVURPPP will continue to participate in the RMP's STLS and the RMP's CEC Strategy.

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Attachment 1

Quality Assurance/Quality Control Report

Pollutants of Concern Monitoring - Quality Assurance/Quality Control Report, WY 2018

1.0 INTRODUCTION

The Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) conducted Pollutants of Concern (POC) Monitoring in Water Year (WY) 2018 to comply with Provision C.8.f (Pollutants of Concern Monitoring) of the National Pollutant Discharge Elimination Program (NPDES) Municipal Regional Permit for the San Francisco Bay Area (i.e., MRP). Monitoring included analysis for polychlorinated biphenyls (PCBs), total mercury, total and dissolved copper, suspended sediment concentration (SSC), and nutrients (i.e., ammonia, nitrate, nitrite, total Kjeldahl nitrogen, orthophosphate, and total phosphorus).

This project utilized the Clean Watersheds for Clean Bay Project (CW4CB) Quality Assurance Project Plan (QAPP; BASMAA 2013) as a basis for Quality Assurance and Quality Control (QA/QC) procedures. Missing components were supplemented by the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) QAPP (BASMAA 2016) and the QAPP for the California Surface Water Ambient Monitoring Program (SWAMP), specifically for nutrient and copper samples, respectively. Data were assessed for seven data quality attributes, which include (1) Representativeness, (2) Comparability, (3) Completeness, (4) Sensitivity, (5) Contamination, (6) Accuracy, and (7) Precision. These seven attributes were compared to Data Quality Objectives (DQOs), which were established to ensure that data collected are of adequate quality and sufficient for the intended uses. DQOs address both quantitative and qualitative assessment of the acceptability of data – representativeness and comparability are qualitative while completeness, sensitivity, precision, accuracy, and contamination are quantitative assessments. Specific DQOs are based on Measurement Quality Objectives (MQOs) for each analyte.

The MQOs for each of the POC analytes are summarized in Table 1 for water and Table 2 for sediment. As there was no reporting limit listed in the QAPP for copper, results were compared to the SWAMP recommended reporting limits for inorganic analytes in freshwater. Overall, the results of the QA/QC review suggest that the data generated during this study were of sufficient quality for the purposes of the project. However, the copper results collected during the May sampling event at 205STQ010 were flagged as questionable due to the concentration of total copper being significantly less than the dissolved copper concentration. This scenario is not possible due to the nature of the analyte types. Additional data were flagged based on the MQOs and DQOs identified in the QAPPs, but no data were rejected. Further details regarding the QA/QC review are provided in the sections below.

Table 1. Measurement quality objectives for analytes in water from the Clean Watersheds for a Clean Bay (CW4CB) Quality Assurance Project Plan (BASMAA 2013) and BASMAA RMC Quality Assurance Project Plan (BASMAA 2016)

Sample	Nutrients ¹	Hardness ¹	SSC ²	Copper ²	Mercury ²	PCBs ²
Laboratory Blank	< RL	<RL	< RL	< RL	< RL	< RL
Reference Material (Laboratory Control Sample) Recovery	90-110%	80-120%	NA	75-125%	75-125%	50-150%
Matrix Spike Recovery	80-120%	80-120%	NA	75-125%	75-125%	50-150%
Duplicates (Matrix Spike, Field, and Laboratory) ³	RPD < 25%	RPD < 25%	RPD < 25%	RPD < 25%	RPD < 25%	RPD < 25%
Reporting Limit	0.01mg/L for all except: Ammonia (0.02mg/L) TKN ⁴ (0.5mg/L)	1 mg/L ⁵	0.5 mg/L	0.10 µg/L ⁶	0.0002 µg/L (0.2 ng/L)	0.002 µg/L (2000 pg/L)

RL = Reporting Limit; RPD = Relative Percent Difference

¹ From the BASMAA QAPP

² From the CW4CB QAPP

³ NA if native concentration for either sample is less than the reporting limit

⁴ TKN = Total Kjeldahl Nitrogen

⁵ No hardness RL listed in either QAPP. Value is from SWAMP-recommended reporting limits for conventional analytes in freshwater. (https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/tools/19_tables_fr_water/1_conv_fr_water.pdf)

⁶ No copper RL listed in either QAPP. Value is from SWAMP-recommended reporting limits for inorganic analytes in freshwater. (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/tools/19_tables_fr_water/4_inorg_fr_water.pdf)

Table 2. Measurement quality objectives for analytes in sediment from the Clean Watersheds for a Clean Bay (CW4CB) Quality Assurance Project Plan (BASMAA 2013).

Sample	Total Solids	Mercury	PCBs
Laboratory Blank	< RL	< RL	< RL
Reference Material (Laboratory Control Sample) Recovery	N/A	75-125%	50-150%
Matrix Spike Recovery	N/A	75-125%	50-150%
Duplicates ¹ (Matrix Spike, Field, and Laboratory)	RPD < 25%	RPD < 25%	RPD < 25% ²
Reporting Limit	0.1% ³	30 µg/kg 0.03 mg/kg 30,000 ng/kg	0.2 µg/kg 0.0002 mg/kg 200 ng/kg

RL = Reporting Limit; RPD = Relative Percent Difference

¹ NA if native concentration for either sample is less than the reporting limit

² Only applicable for matrix spike duplicates. Method specific for field and laboratory duplicates

³ RL for total solids in water

2.0 REPRESENTATIVENESS

Data representativeness assesses whether the data were collected so as to represent actual conditions at each monitoring location. For this project, all samples were assumed to be representative if they were collected and analyzed according to protocols specified in the CW4CB QAPP and RMC QAPP. All field and laboratory personnel received and reviewed the QAPPs, and followed prescribed protocols including laboratory methods.

3.0 COMPARABILITY

The QA/QC officer ensures that the data may be reasonably compared to data from other programs producing similar types of data. For POC monitoring, individual stormwater programs try to maintain comparability within in RMC. The key measure of comparability for all RMC data is the California Surface Water Ambient Monitoring Program.

Electronic data deliverables (EDDs) were submitted to the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) in Microsoft Excel templates developed by SWAMP, to ensure data comparability with SWAMP. In addition, data entry followed SWAMP documentation specific to each data type, including the exclusion of qualitative values that do not appear on SWAMP's look up lists¹. Completed templates were reviewed using SWAMP's online data checker², further ensuring SWAMP-comparability.

¹ Look up lists available online at http://swamp.waterboards.ca.gov/swamp_checker/LookUpLists.php.

² Checker available online at http://swamp.waterboards.ca.gov/swamp_checker/SWAMPUpload.php

All WY 2018 data were considered comparable to SWAMP data and other RMC data except for the copper results for the sample collected in May at station 205STQ010. The total copper concentration for this sample was significantly less than the dissolved copper concentration. Since dissolved copper is a component of total copper, this scenario is not possible. The total copper concentration for this sample was comparable to the other samples collected in WY 2018, while the dissolved concentration was much higher than others. Both total and dissolved copper concentrations were flagged as questionable.

4.0 COMPLETENESS

Completeness is the degree to which all data were produced as planned; this covers both sample collection and analysis. For chemical data and field measurements an overall completeness of greater than 90% is considered acceptable for RMC chemical data and field measurements.

During WY 2018, SCVURPPP collected 100% of planned samples. Six aqueous samples were collected and analyzed for nutrients (ammonia, nitrate, nitrite, total Kjeldahl nitrogen, phosphorus, and orthophosphate), copper, and hardness. A total of 8 aqueous samples were collected in WY 2018 and analyzed for PCBs, mercury, and SSC.

5.0 SENSITIVITY

Sensitivity analysis determines whether the methods can identify and/or quantify results at low enough levels. For the aqueous chemical analyses in this project, sensitivity is considered to be adequate if the reporting limits (RLs) comply with the specifications in RMC QAPP Appendix E (RMC Target Method Reporting Limits) and the CW4CB QAPP Appendix B (CW4CB Target Method Reporting Limits).

A summary of the target and actual reporting limits for each analyte is shown in Table 3. The reporting limits for all nitrate, suspended sediment concentration (SSC), copper, hardness, and mercury samples, plus the ammonia samples collected in January, exceeded their respective target reporting limits.

Table 3. Target and actual reporting limits for SCVURPPP pollutants of concern monitoring in water in WY 2018

Analyte	Unit	Target	Actual	Exceeds Target RL?
Ammonia	mg/L	0.02	0.02-0.1	Yes
Nitrate	mg/L	0.01	0.1	Yes
Nitrite	mg/L	0.01	0.005	No
Total Kjeldahl Nitrogen	mg/L	0.5	0.1	No
Phosphorus	mg/L	0.01	0.01-0.02	No
Orthophosphate	mg/L	0.01	0.01	No
Suspended Sediment Concentration	mg/L	0.5	0.99-1.1	Yes
Copper	µg/L	0.1	0.5	Yes
Hardness	mg/L	1	5-10	Yes
Mercury	ng/L	0.2	0.5	Yes
PCBs	pg/L	2000	20-250	No

6.0 CONTAMINATION

For chemical data, contamination is assessed as the presence of analytical constituents in blank samples.

Several laboratory and equipment (filter) blanks were run during the nutrient, copper, and hardness analyses. All associated blanks were non-detect. Analytes were detected in laboratory blanks for mercury and several PCBs above the method detection limit, but all values were below the reporting limit. The PCBs that were detected in laboratory blanks include the following:

- PCB 011
- PCB 52
- PCB 44/47/65
- PCB 147/149
- PCB 129/138/163PCB 153/168
- PCB 156/157
- PCB 187
- Total Di-PCB
- Total Tetra-PCB
- Total Hexa-PCB
- Total Hepta-PCB
- Total PCBs

7.0 ACCURACY

Accuracy is assessed as the percent recovery of samples spiked with a known amount of a specific chemical constituent. The analytical laboratory evaluated and reported the Percent Recovery (PR) of Laboratory Control Samples (LCS; in lieu of reference materials) and Matrix Spikes (MS)/Matrix Spike Duplicates (MSD), which were recalculated and compared to the target ranges in the RMC and CW4CB QAPPs. If a QA sample did not meet MQOs, all samples in that batch for that analyte were flagged.

All laboratory LCS and MS/MSD samples for nutrients, hardness, copper, mercury, and suspended sediment concentration were within their respective MQOs except for one total Kjeldahl nitrogen and two nitrite matrix spikes in January, in addition to two suspended sediment concentration laboratory control samples in May. The associated samples were consequently flagged. Eighty-nine (89) laboratory control samples exceeded the MQOs for PCBs, and all associated samples were flagged. No MS/MSD samples were analyzed for PCB congeners in water. However, the analytical laboratory affirmed that laboratory control and duplicate laboratory control samples were analyzed in lieu of matrix spike and duplicate matrix spike samples for the PCBs. In this case, it is acceptable to compare the percent recoveries calculated from the laboratory control samples to the MQOs for matrix spike percent recoveries. Given that the MQOs are the same in both cases, no other exceedances were found.

8.0 PRECISION

Precision is the repeatability of a measurement and is quantified by the Relative Percent Difference (RPD) of two duplicate samples. Three measures of precision were used for this project – matrix spikes duplicates, laboratory duplicates, and field duplicates. The MQO for RPD specified by both the CW4CB QAPP and the BASMAA QAPP is <25%.

8.1. Laboratory Duplicates

Matrix spike duplicates and laboratory control sample duplicates for all analytes were well below the targeted range of < 25%. As previously stated, duplicate laboratory control samples were analyzed in place of duplicate matrix spike samples to assess precision in the measurement of PCB concentrations. Given that the RPD MQOs are the same in both cases, no other exceedances were found.

8.2. Field Duplicates

Two nutrient field duplicates were collected during WY 2018 creek status monitoring and are considered representative of nutrient sampling for POC monitoring. The field duplicate samples met the MQO for RPD for all analytes except for total Kjeldahl nitrogen and ammonia. Refer to the SCVURPPP Creek Status Monitoring QA/QC Report for more information.

Field duplicates were collected for copper, nutrients, and hardness during the January event in San Mateo County on behalf of SCVURPPP and the May event in Santa Clara County. The duplicate samples collected in January met the RPD MQO for all analytes except ammonia. Similarly, the duplicate samples collected in May met the RPD MQO for all analytes except ammonia and phosphorous. Additionally, a field duplicate was collected for aqueous mercury, PCBs, and SSC during the January event in Santa Clara County. The RPDs met the MQO for all PCB congeners except PCBs 164, 190, and 195.

9.0 REFERENCES

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