SAN MATEO COUNTYWIDE
Water Pollution Prevention Program

SMCWPPP Creek Status Monitoring Report

Water Year 2014 (October 2013 – September 2014)

Submitted in Compliance with

Provision C.8.g.iii, NPDES Permit No. CAS612008

March 15, 2015

Preface

In early 2010, several members of the Bay Area Stormwater Agencies Association (BASMAA) joined together to form the Regional Monitoring Coalition (RMC), to coordinate and oversee water quality monitoring required by the Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit (MRP)[1]. The RMC includes the following participants:

- Clean Water Program of Alameda County (ACCWP)
- Contra Costa Clean Water Program (CCCWP)
- San Mateo County Wide Water Pollution Prevention Program (SMCWPPP)
- Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)
- Fairfield-Suisun Urban Runoff Management Program (FSURMP)
- City of Vallejo and Vallejo Sanitation and Flood Control District (Vallejo)

This SMCWPPP Creek Status Monitoring Report complies with the MRP Reporting Provision C.8.g for Status Monitoring data (MRP Provision C.8.c) collected in Water Year 2014 (October 1, 2013 through September 30, 2014). Data presented in this report were produced under the direction of SMCWPPP using targeted and probabilistic monitoring designs as described herein.

Consistent with the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011), monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2014a) and BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2014b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[2]. Data presented in this report were also submitted in electronic SWAMP-comparable formats by SMCWPPP to the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) on behalf of San Mateo County Permittees and pursuant to Provision C.8.g.

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[1] The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) adopted the MRP on October 14, 2009 (SFRWQCB 2009). 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area are permitted under the MRP. The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley, which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

[2] The current SWAMP QAPP is available at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf

List of Acronyms

ACCWP	Alameda County Clean Water Program
AFDM	Ash Free Dry Mass
AFS	American Fisheries Society
BASMAA	Bay Area Stormwater Management Agency Association
B-IBI	Benthic Macroinvertebrate Index of Biological Integrity
BMI	Benthic Macroinvertebrate
C/CAG	City/County Association of Governments
CCC	Central California Coast
CCCWP	Contra Costa Clean Water Program
CDFW	California Department of Fish and Wildlife
CFU	Colony Forming Units
CRAM	California Rapid Assessment Method
CSCI	California Stream Condition Index
CTR	California Toxics Rule
CV	Coefficient of Variation
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DPS	Distinct Population Segment
EDD	Electronic Data Delivery
FSURMP	Fairfield Suisun Urban Runoff Management Program
GIS	Geographic Information System
GRTS	Generalized Random Tessellation Stratified
HDI	Human Disturbance Index
IPM	Integrated Pest Management
LID	Low Impact Development
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MPC	Monitoring and Pollutants of Concern Committee
MPN	Most Probable Number
MQO	Measurement Quality Objective
MRP	Municipal Regional Permit
MS	Matrix Spike
MS4	Municipal Separate Storm Sewer System

MSD	Matrix Spike Duplicate
MUN	Municipal
MWAT	Maximum Weekly Average Temperature
NIST	National Institute of Standards and Technology
NPDES	National Pollution Discharge Elimination System
NT	Non-Target
O/E	Observed to Expected
PAH	Polycyclic Aromatic Hydrocarbons
PEC	Probable Effects Concentrations
PHAB	Physical habitat assessments
pMMI	Predictive Multi-Metric Index
POTW	Publicly Owned Treatment Works
PR	Percent Recovery
PRM	Pathogen-related Mortality
PSA	Perennial Streams Assessment
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RL	Reporting Limit
RMC	Regional Monitoring Coalition
RPD	Relative Percent Difference
RWB	Reachwide Benthos
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomist
SCCWRP	Southern California Coastal Water Research Project
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFPUC	San Francisco Public Utilities Commission
SFRWQCB	San Francisco Bay Regional Water Quality Control Board
SMC	Stormwater Monitoring Coalition
SMCWPPP	San Mateo County Water Pollution Prevention Program
SOP	Standard Operating Protocol
SSID	Stressor/Source Identification
STE	Standard Taxonomic Effort
STV	Statistical Threshold Value
SWAMP	Surface Water Ambient Monitoring Program
TEC	Threshold Effects Concentrations
TNS	Target Non-Sampleable

TOC	Total Organic Carbon
TS	Target Sampleable
TU	Toxicity Unit
U	Unknown
USEPA	Environmental Protection Agency
WQO	Water Quality Objective
WY	Water Year

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1.0 Introduction

This San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) Creek Status Monitoring Report complies with Reporting Provision C.8.g.iii of the Municipal Regional National Pollutant Discharge Elimination System (NPDES) Stormwater Permit (MRP). This report summarizes Creek Status Monitoring data collected pursuant to MRP Provision C.8.c during Water Year 2014 (October 1, 2013 to September 30, 2014).

MRP Provision C.8.c requires Permittees to conduct creek status monitoring that is intended to answer the following management questions:

1. ***Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers, and tributaries?***

2. ***Are conditions in local receiving water supportive of or likely supportive of beneficial uses?***

SMCWPPP (formerly STOPPP) was established in 1990 to reduce the pollution carried by stormwater into local creeks, the San Francisco bay, and the Pacific Ocean. SMCWPPP is a program of the City/County Association of Governments (C/CAG) Each incorporated city and town in the county and the County of San Mateo share a common NPDES permit. SMCWPPP has been conducting monitoring in local creeks since 1999 to comply with requirements specified in its NPDES municipal separate stormwater sewer system (MS4) permit issued by the San Francisco Bay Regional Water Quality Control Board (SFRWQCB).

Creek status monitoring required by the current MRP builds upon monitoring previously conducted and is coordinated through the Regional Monitoring Coalition (RMC) and began on October 1, 2011. Creek status monitoring parameters, methods, occurrences, durations and minimum number of sampling sites are described in Table 8.1 of MRP Provision C.8.c. Monitoring results are evaluated to determine whether triggers are met which may require additional Monitoring Projects described in MRP Provision C.8.d.i.

Provision C.8.a (Compliance Options) of the MRP allows Permittees to address monitoring requirements through a “regional collaborative effort,” their Stormwater Program, and/or individually. The RMC was formed in early 2010 as a collaboration among a number of the Bay Area Stormwater Agencies Association (BASMAA) members and MRP Permittees (Table 1.1) to develop and implement a regionally coordinated water quality monitoring program to improve stormwater management in the region and address water quality monitoring required by the MRP. With notification of participation in the RMC, Permittees were required to commence water quality data collection by October 2011. Implementation of the RMC’s Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011) allows Permittees and the Water Board to modify their existing creek monitoring programs, and improve their ability to collectively answer core management questions in a cost-effective and scientifically-rigorous way. Participation in the RMC is facilitated through the BASMAA Monitoring and Pollutants of Concern (MPC) Committee.

Table 1.1. Regional Monitoring Coalition participants.

Stormwater Programs	RMC Participants
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, Los Altos Hills, and Los Gatos; Santa Clara Valley Water District; and, Santa Clara County
Clean Water Program of Alameda County (ACCWP)	Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, and Union City; Alameda County; Alameda County Flood Control and Water Conservation District; and, Zone 7
Contra Costa Clean Water Program (CCCWP)	Cities of Antioch, Brentwood, Clayton, Concord, El Cerrito, Hercules, Lafayette, Martinez, Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, Walnut Creek, Danville, and Moraga; Contra Costa County; and, Contra Costa County Flood Control and Water Conservation District
San Mateo County Wide Water Pollution Prevention Program (SMCWPPP)	Cities of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and, San Mateo County
Fairfield-Suisun Urban Runoff Management Program (FSURMP)	Cities of Fairfield and Suisun City
Vallejo Permittees	City of Vallejo and Vallejo Sanitation and Flood Control District

The goals of the RMC are to:

1. Assist Permittees in complying with requirements in MRP Provision C.8 (Water Quality Monitoring);

2. Develop and implement regionally consistent creek monitoring approaches and designs in the Bay Area, through the improved coordination among RMC participants and other agencies (e.g., Water Board) that share common goals; and

3. Stabilize the costs of creek monitoring by reducing duplication of effort and streamlining reporting.

The RMC's monitoring strategy for complying with MRP Provision C.8.c is described in the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011). The strategy includes local "targeted" monitoring and regional ambient/probabilistic monitoring. The combination of these two components allows each individual RMC participating program to assess the status of beneficial uses in local creeks within its jurisdictional area, while also contributing data to answer management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks). Table 1.2 provides a list of which parameters are included in the regional and local programs. This report includes data collected in San Mateo County under both monitoring components.

Table 1.2. Creek Status Monitoring parameters in compliance with MRP Provision C.8.c and associated monitoring component.

Monitoring Elements of MRP Provision C.8.c	Monitoring Component	
	Regional Ambient (Probabilistic)	Local (Targeted)
Bioassessment & Physical Habitat Assessment	X	
Chlorine	X	
Nutrients	X	
Water Toxicity	X	
Sediment Toxicity	X	
Sediment Chemistry	X	
General Water Quality (Continuous)		X
Temperature (Continuous)		X
Pathogen Indicators		X
Stream Survey (CRAM)[1]		X

Notes: 1. Stream surveys under the SMCWPPP Monitoring Program were conducted at Regional Monitoring Program sites.

1.1 Designated Beneficial Uses

There are 34 watersheds in San Mateo County draining an area of about 450 square miles. The San Mateo Range, which runs north/south, divides the county roughly in half. The eastern half (“Bayside”) drains to San Francisco Bay and is characterized by relatively flat, urbanized areas along the Bay. The western half (“coastside”) drains to the Pacific Ocean and consists of approximately 50 percent parkland and open space, with agriculture, and relatively small urban areas.

Beneficial Uses in San Mateo County creeks are designated by the SFRWQCB for specific water bodies and generally apply to all its tributaries. Uses include aquatic life habitat, recreation, and human consumption. Table 1.3 lists Beneficial Uses designated by the SFRWQCB (2013) for water bodies monitored by SMCWPPP in Water Year 2014.

The remainder of this report describes the two components of the monitoring design (targeted and probabilistic) (Section 2.0); monitoring methods (Section 3.0); data analysis and interpretation methods (Section 4.0); results and discussion, including a statement of data quality, biological condition assessment, and stressor analysis (Section 5.0), and summary conclusions (Section 6.0).

Table 1.3. Creeks Monitored by SMCWPPP in Water Year 2014 and their Beneficial Uses (SFRWQCB 2013).

Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
Bayside Creeks																			
Alambique Creek									E						E	E	E	E	
Arroyo Ojo de Agua															E	E	E	E	
Bear Creek									E			E	E	E	E	E	E	E	
Bear Gulch Creek		E							E			E	E	E	E	E	E	E	
Cherry Canyon Creek (aka Burlingame Creek)															E	E	E	E	
Cordilleras Creek															E	E	E	E	
Corte Madera Creek									E			E		E	E	E	E	E	
Laurel Creek															E	E	E	E	
Redwood Creek															E	E	E	E	
San Mateo Creek			E						E			E	E	E	E	E	E	E	
Sanchez Creek															E	E	E	E	
West Union Creek									E			E	E	E	E	E	E	E	
Coastside Creeks																			
Arroyo de en Medio									E						E	E	E	E	
Pilarcitos Creek	E	E							E			E	E	E	E	E	E	E	

Notes:

COLD = Cold Fresh Water Habitat
FRSH = Freshwater Replenishment
GWR - Groundwater Recharge
MIGR = Fish Migration
MUN = Municipal and Domestic Water
EST = Estuarine
NAV = Navigation
RARE= Preservation of Rare and Endangered Species
REC-1 = Water Contact Recreation
REC-2 = Non-contact Recreation
WARM = Warm Freshwater Habitat
WILD = Wildlife Habitat
E = Existing Use

2.0 Monitoring Design

2.1 Targeted Monitoring Design

During Water Year 2014 (WY2014; October 1, 2013 – September 30, 2014) water temperature, general water quality, and pathogen indicators were monitored at selected sites using a targeted monitoring design based on the directed principle[3] to address the following management questions:

1. What is the spatial and temporal variability in water quality conditions during the spring and summer season?

2. Do general water quality measurements indicate potential impacts to aquatic life?

3. What are the pathogen indicator concentrations at creek sites where there is potential for water contact recreation to occur?

4. What are the riparian conditions at bioassessment sampling stations? Are riparian assessments good indicators for condition of aquatic life use? Can they help identify stressors to aquatic life uses?

2.1.1 Targeted Site Selection

General Water Quality

General water quality data (dissolved oxygen, specific conductance, pH, and temperature) were collected at a total of two locations in San Mateo Creek during WY2014. Site selection was based on previous monitoring conducted by SFBRWQCB and SMCWPPP (De Anza Historical Park), and a new site (El Cerrito Ave), which was selected to represent an upstream reach with moderate urban/residential conditions where no historical data were available. Data collected from these sites were used to inform an ongoing Stressor/Source Identification (SSID) study investigating the seasonal and geographic extent of historic low dissolved oxygen conditions.

Temperature

Water temperature was monitored at five sites within the Bear Creek watershed during WY2014. Specific stations were sited in pools that have historically remained wet throughout the summer. Bear Creek drains approximately 12 square miles (25 percent) of the northwestern headwaters of San Francisquito Creek which hosts one of the last remaining wild steelhead (*Oncorhynchus mykiss*) populations among Bay Area streams. Summer water temperatures are an important factor in assessing the quality of habitat and have generally been good in the Bear Creek watershed (Smith and Harden 2001). However, due to drought conditions, WY2014 may represent a worst case scenario for summer temperatures.

[3] Directed Monitoring Design Principle: A deterministic approach in which points are selected deliberately based on knowledge of their attributes of interest as related to the environmental site being monitored. This principle is also known as "judgmental," "authoritative," "targeted," or "knowledge-based."

Pathogen Indicators

Pathogen indicator samples were collected at five sites within San Mateo Creek watershed. The decision to target this watershed was based on WY2012 Creek Status Monitoring data with results exceeding fecal coliform and *Escherichia coli* (*E. coli*) trigger thresholds (SMCWPPP 2014), and historical data (WY2003) collected as part of the SWAMP regional reference site study (SFRWQCB 2007). In addition, data collected from these sites was used to inform an ongoing SSID study investigating the extent and source of pathogen indicators in San Mateo Creek.

2.2 Probabilistic Monitoring Design

Targeted monitoring may not give an accurate view of background conditions because site selection is biased toward sites where historical or existing water quality concerns have been identified. Therefore, the RMC augments targeted monitoring designs with an ambient (probabilistic) creek status design that was developed to remove bias from site selection. This design allows each individual RMC participating program to objectively assess stream ecosystem conditions within its program area (County boundary) while contributing data to answer regional management questions about water quality and beneficial use condition in San Francisco Bay Area creeks.

The RMC regional probabilistic monitoring design was developed to address the management questions listed below:

1. What is the condition of aquatic life in creeks in the RMC area; are water quality objectives met and are beneficial uses supported?
    i. What is the condition of aquatic life in the urbanized portion of the RMC area; are water quality objectives met and are beneficial uses supported?
    ii. What is the condition of aquatic life in RMC participant counties; are water quality objectives met and are beneficial uses supported?
    iii. To what extent does the condition of aquatic life in urban and non-urban creeks differ in the RMC area?
    iv. To what extent does the condition of aquatic life in urban and non-urban creeks differ in each of the RMC participating counties?
2. What are major stressors to aquatic life in the RMC area?
    i. What are major stressors to aquatic life in the urbanized portion of the RMC area?
3. What are the long-term trends in water quality in creeks over time?

These questions will be addressed for the RMC area after a suitable number of sites have been sampled, which is expected to occur after 3 or 4 years.

Table 2.1 illustrates the total number of sites that each RMC Permittee *planned* to sample within the MRP term at the outset of the monitoring program, including sampling efforts planned by SFRWQCB (approximately 2 sites per county per year). Approximately 80 percent of the sites are in urban areas and 20 percent are in non-urban areas[4]. Table 2.1 also illustrates the number of sampling years required to establish statistically representative sample sizes (30 samples) for each of the classified strata in the regional monitoring design[5]. In San Mateo County, a statistically representative sample of urban sites is anticipated in Year 4 (WY2015) of the program; a statistically representative sample of non-urban sites is not anticipated within the 5-year program. Due to unforeseen field circumstances, the actual number of sites sampled and the percentage of urban and non-urban sites may vary. Such outcomes can be addressed in subsequent sampling years.

Table 2.1. Projected number of samples per monitoring year[a]; shaded cells indicate when a minimum sample size may be available to develop a statistically representative data set to address management questions related to condition of aquatic life.

Monitoring Year	RMC Area (Region-wide)		Santa Clara County		Alameda County		Contra Costa County		San Mateo County		Fairfield, Suisun City and Vallejo[b]	
Land Use	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*
Year 1 (WY2012)	48	22	16	6	16	6	8	4	8	4	0	2
Year 2 (WY2013)	100	44	32	12	32	12	16	8	16	8	4	4
Year 3 (WY2014)	156	66	48	18	48	18	24	12	24	12	12	6
Year 4[c] (WY2015)	204	88	64	24	64	24	32	16	32	16	12	8
Year 5 (WY2016)	256	110	80	30	80	30	40	20	40	20	16	10

[a] Assumes SFRWQCB samples two non-urban sites annually in each RMC County.
[b] Assumes: FSURMP and Vallejo only monitor urban sites; FSURMP monitors 4 sites in Year 2, 3 and 5; and Vallejo monitors 4 sites in Year 3.
[c] WY2015 is anticipated to be the final year of monitoring under the current MRP 5-Year Permit.

2.2.1 RMC Area

The RMC area encompasses 3,407 square miles of land in the San Francisco Bay Area. This includes the portions of the five participating counties that fall within the SFRWQCB boundary, as well as the eastern portion of Contra Costa County that drains to the Central Valley region (Figure 2.1). Creek status and trends monitoring is being conducted in non-tidally influenced, flowing water bodies (i.e., creeks, streams and rivers) interspersed among the RMC area. The water bodies monitored were drawn from a master list that included all perennial and non-perennial creeks and rivers that run through both urban and non-urban areas within the RMC area.

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[4] Some sites classified as urban, using the GIS may be considered for reclassification as non-urban based on actual land uses of the drainage area despite location inside municipal jurisdictional boundaries.

[5] For each of the strata, it is necessary to obtain a sample size of at least 30 in order to evaluate the condition of aquatic life within known estimates of precision. This estimate is defined by a power curve from a binomial distribution (BASMAA 2014a).

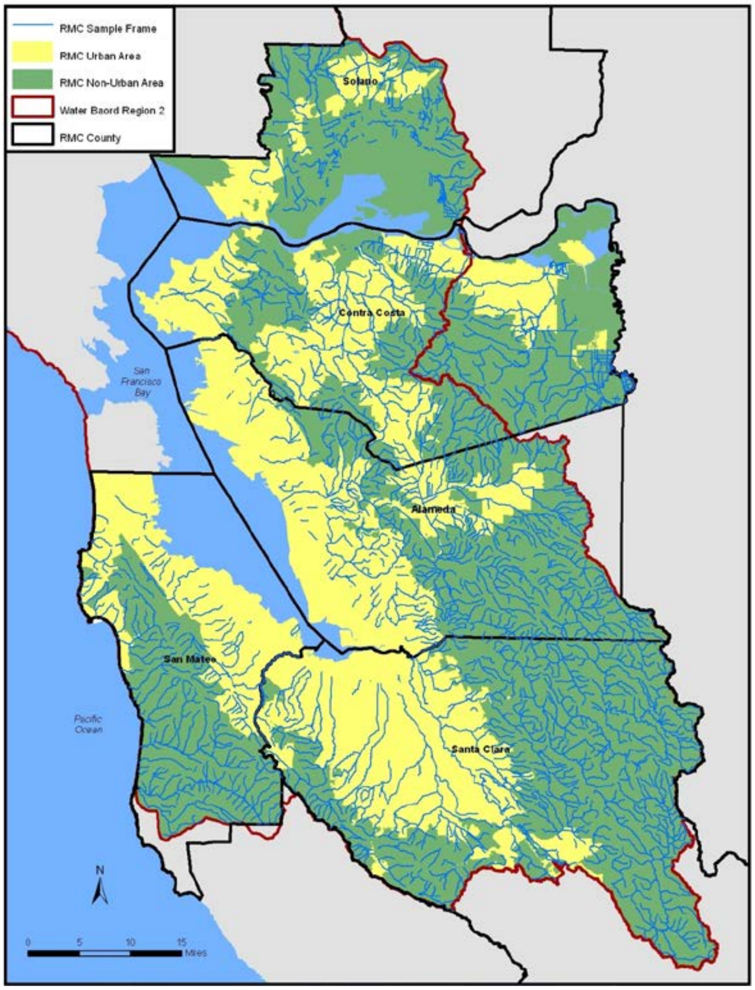

Figure 2.1 Map of BASMAA RMC area showing each member program boundary and urban and non-urban areas.

2.2.2 Probabilistic Site Selection

The regional probabilistic design was developed using the Generalized Random Tessellation Stratified (GRTS) approach developed by the United States Environmental Protection Agency (USEPA) and Oregon State University (Stevens and Olson 2004). GRTS offers multiple benefits for coordinating among monitoring entities including the ability to develop a spatially balanced design that produces statistically representative data with known confidence intervals. The GRTS approach has been implemented recently in California by several agencies including the statewide Perennial Streams Assessment (PSA) conducted by SWAMP (Ode et al. 2011) and the Southern California Stormwater Monitoring Coalition's (SMC) regional monitoring program conducted by municipal stormwater programs in Southern California (SCCWRP 2007). For the purpose of developing the RMC's probabilistic design, the 3,407-square mile RMC area is considered to represent the "sample universe."

Sample sites were selected and attributed using the GRTS approach from a sample frame consisting of a creek network geographic information system (GIS) data set within the RMC boundary (BASMAA 2011). This approach was agreed to by SFRWQCB staff during RMC workgroup meetings although it differs from that specified in MRP Provision C.8.c.iv., e.g., sampling on the basis of individual watersheds in rotation and selecting sites to characterize segments of a waterbody(ies). The sample frame includes non-tidally influenced perennial and non-perennial creeks within five management units representing areas managed by the stormwater programs associated with the RMC. The sample frame was stratified by management unit to ensure that MRP Provision C.8.c sample size requirements (SFRWQCB 2009) would be achieved.

The National Hydrography Plus Dataset (1:100,000) was selected as the creek network data layer to provide consistency with both the Statewide PSA and the SMC, and the opportunity for future data coordination with these programs. The RMC sample frame was classified by county and land use (i.e., urban and non-urban) to allow for comparisons between these strata. Urban areas were delineated by combining urban area boundaries and city boundaries defined by the U.S. Census (2000). Non-urban areas were defined as the remainder of the areas within the sample universe (i.e., RMC area). Some sites classified as urban fall near the non-urban edge of the city boundaries and have little upstream development. For the purposes of consistency, these urban sites were not re-classified. Therefore, data values within the urban classification represent a wide range of conditions.

Based on discussion during RMC Workgroup meetings with SFRWQCB staff present, RMC participants weighted their sampling efforts so that annual sampling efforts are approximately 80% in urban areas and 20% in non-urban areas for the purpose of comparison. RMC participants coordinated with the SFRWQCB by identifying additional non-urban sites from their respective counties and providing a list of sites for SWAMP to conduct site evaluations. Since 2012, the SFRWQCB has supplemented the RMC monitoring efforts with 34 additional non-urban probabilistic sites within RMC jurisdiction. The total number of sites was variable each year, with 6 sites in WY2012, 18 sites in WY2013 and 10 sites in WY2014. Information from these sampling events are included in the Site Evaluation summary (Section 2.2.3) but not included in either the results or discussion sections of this report.

2.2.3 Site Evaluation

Sites identified in the regional sample draw were evaluated by each RMC participant in chronological order using a two-step process described in RMC Standard Operating Procedure FS-12 (BASMAA 2014b), consistent with the procedure described by Southern California Coastal Water Research Project (SCCWRP) (2012). Each site was evaluated to determine if it met the following RMC sampling location criteria:

1. The location (latitude/longitude) provided for a site is located on or is within 300 meters of a non-impounded receiving water body[6];
2. Site is not tidally influenced;
3. Site is wadeable during the sampling index period;
4. Site has sufficient flow during the sampling index period to support standard operation procedures for biological and nutrient sampling.

[6] The evaluation procedure permits certain adjustments of actual site coordinates within a maximum of 300 meters.

5. Site is physically accessible and can be entered safely at the time of sampling;
6. Site may be physically accessed and sampled within a single day;
7. Landowner(s) grant permission to access the site[7].

In the first step, these criteria were evaluated to the extent possible using a "desktop analysis." Site evaluations were completed during the second step via field reconnaissance visits. Based on the outcome of site evaluations, sites were classified into one of three categories:

- **Target** – Target sites were grouped into two subcategories:
  - **Target sampleable (TS)** - Sites that met all seven criteria and were successfully sampled.
  - **Target Non-Sampleable (TNS)** - Sites that met criteria 1 through 4, but did not meet at least one of criteria 5 through 7 were classified as TNS.
- **Non-Target (NT)** - Sites that did not meet at least one of criteria 1 through 4 were classified as non-target status.
- **Unknown (U)** - Sites were classified with unknown status when it could be reasonably inferred either via desktop analysis or a field visit that the site was a valid receiving water body and information for any of the seven criteria was unconfirmed.

Table 2.2 lists the total number of sites evaluated in San Mateo County during Water Years 2012 through 2014, and their classification categories. A handful of the sites classified as non-urban were evaluated by the SFRWQCB for potential SWAMP sampling. Results of the site evaluation are illustrated in Figure 2.2 and described in further detail in Attachment A.

Table 2.2. Results of Probabilistic Site Evaluations by SMCWPPP, WY2012-WY2014.

Classification	WY2012		WY2013		WY2014		TOTAL	
	# of Sites	%	# of Sites	%	# of Sites	%	# of Sites	%
Target Sampleable (TS)	13	45	14	45	7	20	34	35
Target Non-Sampleable (TNS)	8	28	11	32	12	34	31	32
Non-Target (NT)	8	28	8	23	5	14	21	22
Unknown (U)	0	0	0	0	11	31	11	11
TOTAL SITES EVALUATED	29	100	33	100	35	100	97	100

[7] If landowners did not respond to at least two attempts to contact them either by written letter, email, or phone call, permission to access the respective site was effectively considered to be denied.

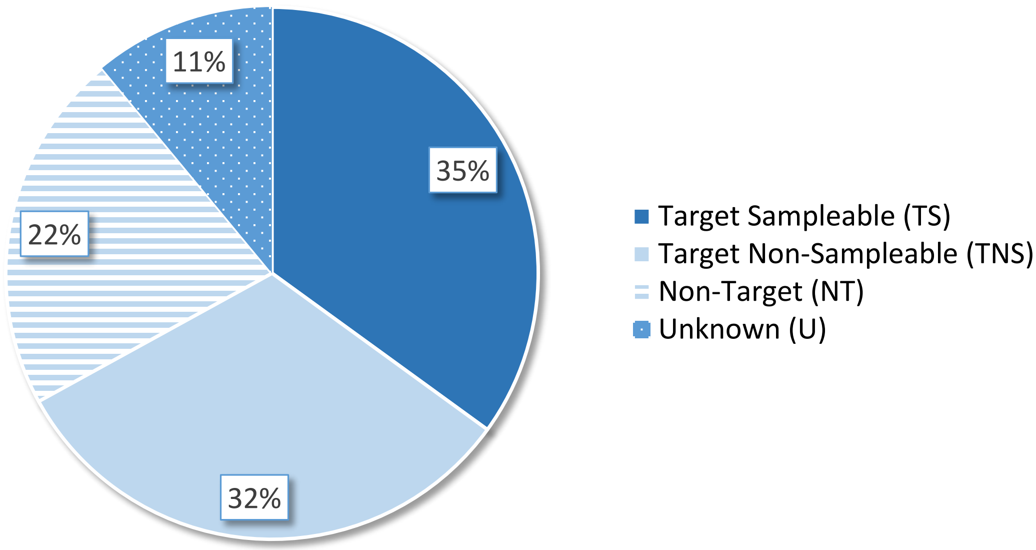

Figure 2.2. Results of San Mateo County site evaluations for Water Years 2012 - 2014.

The complete list of target and probabilistic monitoring sites sampled by SMCWPPP in WY2014 is presented in Table 2.3. Monitoring locations with monitoring parameter(s) and year sampled are shown in Figure 2.3.

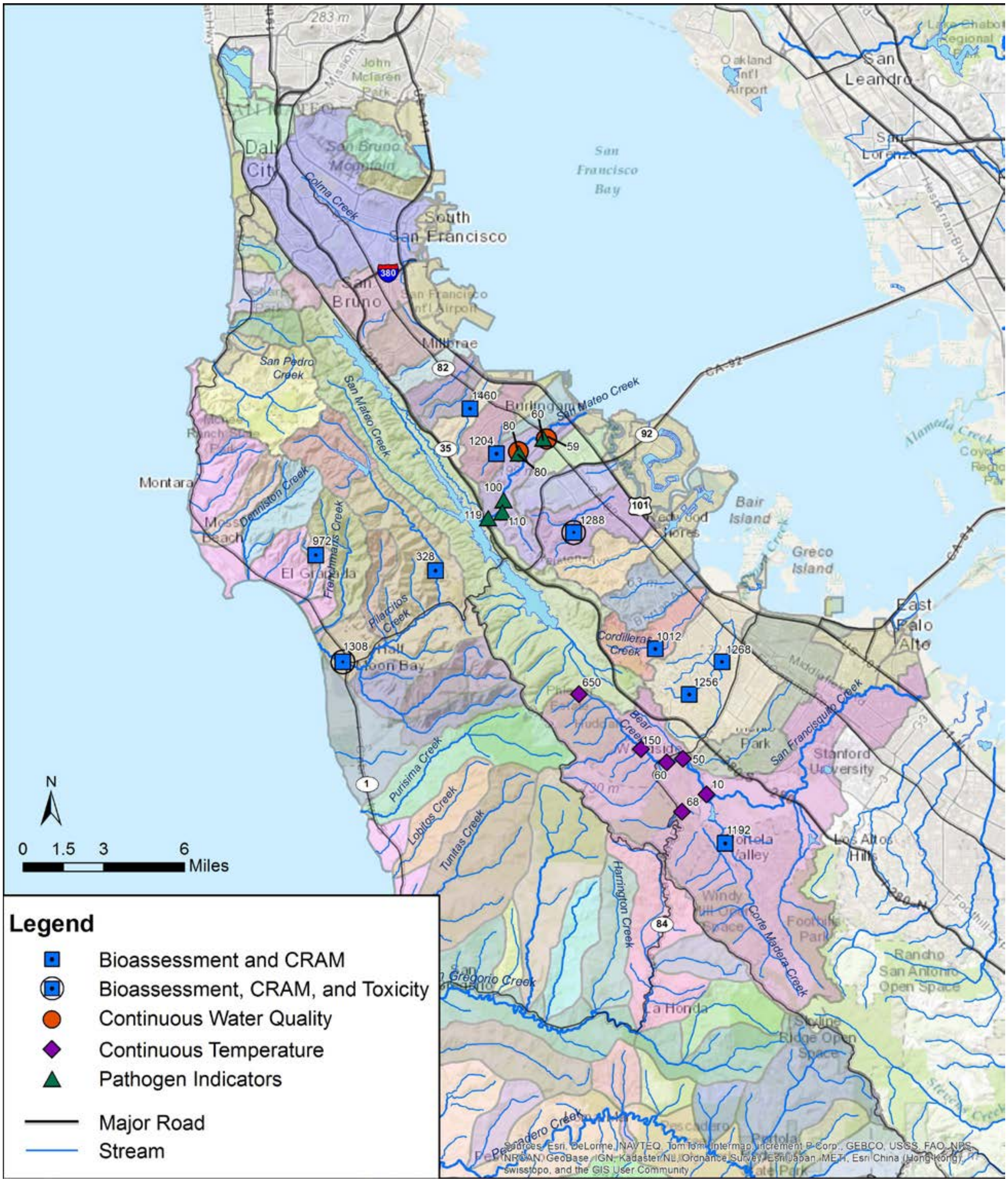

Figure 2.3. Map of SMCWPPP sites monitored in WY2014.

Table 2.3. Sites and parameters monitored in Water Years 2014 in San Mateo County.

Map ID	Station Number	Bayside or Coastside	Watershed	Creek Name	Land Use	Latitude	Longitude	Probabilistic		Targeted			
								Bioassessment, Nutrients, General WQ	Toxicity, Sediment Chemistry	CRAM	Temp	Continuous WQ	Pathogen Indicators
328	202R00328	Coastside	Pilarcitos Creek	Pilarcitos Creek	NU	37.507215	-122.38654	X		X			
972	202R00972	Coastside	Arroyo de en Medio	Arroyo de en Medio	U	37.51374	-122.45084	X		X			
1308	202R01308	Coastside	Pilarcitos Creek	Pilarcitos Creek	U	37.468314	-122.43627	X	X	X			
1012	204R01012	Bayside	Cordilleras Creek	Cordilleras Creek	U	34.473812	-122.26848	X		X			
1204	204R01204	Bayside	Burlingame Creek	Burlingame Creek	U	37.55699	-122.35379	X		X			
1256	204R01256	Bayside	Redwood Creek	Arroyo Ojo de Agua	U	37.45444	-122.25038	X		X			
1268	204R01268	Bayside	Redwood Creek	Redwood Creek	U	37.46835	-122.23277	X		X			
1288	204R01288	Bayside	Laurel Creek	Laurel Creek	U	37.523418	-122.31235	X	X	X			
1460	204R01460	Bayside	Sanchez Creek	Sanchez Creek	U	37.576703	-122.36803	X		X			
59	204SMA059	Bayside	San Mateo Creek	San Mateo Creek	U	37.56331	-122.32707					X	
60	204SMA060	Bayside	San Mateo Creek	San Mateo Creek	U	37.56244	-122.32828						X
80	204SMA080	Bayside	San Mateo Creek	San Mateo Creek	U	37.55731	-122.34204					X	X
100	204SMA100	Bayside	San Mateo Creek	San Mateo Creek	U	37.53719	-122.35001						X
110	204SMA110	Bayside	San Mateo Creek	Polhemus Creek	U	37.53235	-122.3508						X
120	204SMA119	Bayside	San Mateo Creek	San Mateo Creek	U	37.53312	-122.35073						X
68	205ALA015	Bayside	San Francisquito Creek	Alambique Creek	U	37.40443	-122.25430				X		
71	205BCR010	Bayside	San Francisquito Creek	Bear Creek	U	37.41179	-122.24106				X		
69	205BCR050	Bayside	San Francisquito Creek	Bear Creek	U	37.427017	-122.25378				X		
72	205BCR060	Bayside	San Francisquito Creek	Bear Creek	U	37.42550	-122.26243				X		
1192	205R01192	Bayside	San Francisquito Creek	Corte Madera Creek	U	37.39096	-122.23115	X		X			
70	205WUN150	Bayside	San Francisquito Creek	West Union Creek	U	37.431117	-122.27622				X		
73	205WUN650	Bayside	San Francisquito Creek	West Union Creek	NU	37.45467	-122.30986				X		

3.0 Monitoring Methods

Water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC Standard Operating Procedures (SOPs; BASMAA 2014b) and associated Quality Assurance Project Plan (QAPP; BASMAA 2014a). These documents and the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011) are updated as needed to maintain their currency and optimal applicability. Where applicable, monitoring data were collected using methods comparable to those specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[8], and were submitted in SWAMP-compatible format to the SFRWQCB. The SOPs were developed using a standard format that describes health and safety cautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples. The SOPs relevant to the monitoring discussed in this report are listed in Table 3.1.

Table 3.1. Standard Operating Procedures (SOPs) pertaining to creek status monitoring.

SOP #	SOP
FS-1	Benthic Macroinvertebrate and Algae Bioassessments, and Physical Habitat Measurements
FS-2	Water Quality Sampling for Chemical Analysis, Pathogen Indicators, and Toxicity Testing
FS-3	Field Measurements, Manual
FS-4	Field Measurements, Continuous General Water Quality
FS-5	Continuous Temperature Measurements
FS-6	Collection of Bedded Sediment Samples
FS-7	Field Equipment Cleaning Procedures
FS-8	Field Equipment Decontamination Procedures
FS-9	Sample Container, Handling, and Chain of Custody Procedures
FS-10	Completion and Processing of Field Datasheets
FS-11	Site and Sample Naming Convention
FS-12	Ambient Creek Status Monitoring Site Evaluation

[8]The current SWAMP QAPP is available at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf

3.1 Field Data Collection Methods

3.1.1 Bioassessments

In accordance with the RMC QAPP (BASMAA 2014a) bioassessments were planned during the spring index period (approximately April 15 – July 15) with the goal to sample a minimum of 30 days after any significant storm (roughly defined as at least 0.5-inch of rainfall within a 24-hour period). During WY2014, a significant storm occurred on April 1st and bioassessments were initiated during the week of April 21st 2014, approximately 20 days following the last storm event. With guidance from SFRWQCB staff, bioassessments began prior to the 30 day grace period due to rapidly declining volume of spring flows and anticipated lack of sampleable sites as the result of an extended period of drought.

Benthic Macroinvertebrates

Each bioassessment sampling site consisted of an approximately 150-meter stream reach that was divided into 11 equidistant transects placed perpendicular to the direction of flow. The sampling position within each transect alternated between 25%, 50% and 75% distance of the wetted width of the stream. Benthic macroinvertebrates (BMIs) were collected from a 1 square foot area approximately 1 m downstream of each transect (see SOP FS-1, BASMAA 2014b). The benthos were disturbed by manually rubbing coarse substrate followed by disturbing the upper layers of substrate to a depth of 4-6 inches to dislodge any remaining invertebrates into the net. Slack water habitat procedures were used at transects with deep and/or slow moving water (Ode 2007). Material collected from the eleven subsamples was composited in the field by transferring the entire sample into one to three 1000 ml wide-mouth jar(s) and preserving it with 95% ethanol.

Algae

Filamentous algae and diatoms were collected using the Reach-Wide Benthos (RWB) method described in SOP FS-1 (BASMAA 2014b). Algae samples were collected synoptically with BMI samples. The sampling position within each transect was the same as used for BMI sampling; however, samples were collected six inches upstream of the BMI sampling position and prior to BMI collection from that location. The algae were collected using a range of methods and equipment, depending on the particular substrate occurring at the site (e.g., erosional, depositional, large and/or immobile) per SOP FS-1 (BASMAA 2014b). Erosional substrates included any material (substrate or organics) that was small enough to be removed from the stream bed, but large enough in size to isolate an area equal in size to a rubber delimiter (12.6 cm^2 in area). When a sample location along a transect was too deep to sample, a more suitable location was selected, either on the same transect or from one further upstream.

Algae samples were collected at each transect prior to moving on to the next transect. Sample material (substrate and water) from all eleven transects was combined in a sample bucket, agitated, and a suspended algae sample was then poured into a 500 mL cylinder, creating a composite sample for the site. A 45 mL subsample was taken from the algae composite sample and combined with 5 mL glutaraldehyde into a 50 mL sample tube for taxonomic identification of soft algae. Similarly, a 40 mL subsample was extracted from the algae composite sample and combined with 10 mL of 10% formalin into a 50 mL sample tube for taxonomic identification of diatoms. Laboratory processing included identification and enumeration of 300 natural units of soft algae and 600 diatom valves to the lowest practical taxonomic level.

The algae composite sample was also used for collection of chlorophyll a and ash free dry mass (AFDM) samples following methods described in Fetscher et al. (2009). For the chlorophyll a sample, 25 mL of the algae composite volume was removed and run through a glass fiber filter (47 mm, 0.7 µm pore size) using a filtering tower apparatus. The AFDM sample was collected using a similar process using pre-combusted filters. Both samples were placed in whirlpaks, covered in aluminum foil and immediately placed on ice for transportation to the laboratory.

3.1.2 Physical Habitat

Physical habitat assessments (PHAB) were conducted at each BMI bioassessment sampling event using the PHAB protocols described in Ode (2007) (see SOP FS-1, BASMAA 2014b). Physical habitat data were collected at each of the 11 transects and at 10 additional inter-transects (located between each main transect) by implementing the "Basic" level of effort, with the following additional measurements/assessments as defined in the "Full" level of effort (as prescribed in the MRP): water depth and pebble counts, cobble embeddedness, flow habitat delineation, and instream habitat complexity. At algae sampling locations, additional assessment of presence of micro- and macroalgae was conducted during the pebble counts. In addition, water velocities were measured at a single location in the sample reach (when possible) using protocols described in Ode (2007).

3.1.3 Physico-chemical Measurements

General water quality parameters (dissolved oxygen, temperature, specific conductivity, and pH) were measured concurrent with BMI bioassessment sampling using multi-parameters probes according to SOP FS-3 (BASMAA 2014b). Direct field measurements or grab samples for field measurement purposes are collected from a location where the stream visually appears to be completely mixed. Ideally this is at the centroid of the flow, but site conditions do not always allow centroid collection. Measurements should occur upstream of sampling personnel and equipment and upstream of areas where bed sediments have been disturbed, or prior to such bed disturbance. Field meters are calibrated prior to use and results are recorded on the Field Meter Calibration Record form.

3.1.4 California Rapid Assessment Method for Riverine Wetlands (CRAM)

Assessments using the California Rapid Assessment Method (CRAM) were conducted at the same locations (and reach lengths) that were monitored for the RMC probabilistic design (i.e., biological and physical habitat assessments, nutrients and physical chemical water quality). CRAM assessments were conducted June 30 through July 8, 2014. CRAM was conducted at bioassessment locations to assess the utility of using CRAM data to explain the aquatic biological condition. CRAM is performed within a defined riparian Assessment Area (AA) and is composed of the following subcategories: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure. Procedures describing methods for scoring riparian attributes are described in Collins et al. (2008).

3.1.5 Nutrients and Conventional Analytes

Water samples were collected at probabilistic sites for nutrients and conventional analytes using the Standard Grab Sample Collection Method as described in SOP FS-2 (BASMAA 2014b). Sample containers were rinsed using ambient water and completely filled and recapped below water surface whenever possible. An intermediate container was used to collect water for all sample containers with preservative already added in advance by laboratory. Sample container size and type, preservative type and associated holding times for each analyte are described in

Table 1 of SOP FS-9, including field filtration where applicable. The syringe filtration method was used to collect samples for analyses of Dissolved Ortho-Phosphate and Dissolved Organic Carbon. All sample containers were labeled and stored on ice for transportation to the laboratory.

3.1.6 Chlorine

Water samples were collected and analyzed for free and total chlorine using a Pocket Colorimeter™ II and DPD Powder Pillows according to SOP FS-3 (BASMAAS 2014b). If concentrations exceed 0.08 mg/L the site was immediately resampled. Chlorine measurements in water are conducted up to twice annually: during spring bioassessments and concurrently with dry season toxicity and sediment chemistry monitoring.

3.1.7 Water Toxicity

Samples were collected at two probabilistic sites for water toxicity. The required number of 4-L labeled amber glass bottles were filled and placed on ice to cool to < 6°C. Bottle labels include station ID, sample code, matrix type, analysis type, project ID, and date and time of collection. The laboratory was notified of the impending sample delivery to meet the 24-hour sample delivery time requirement. Procedures used for sampling and transporting samples are described in SOP FS-2 (BASMAA 2014b).

3.1.8 Sediment Toxicity & Chemistry

Sediment samples were collected at two probabilistic sites in June 2014[9] for toxicity and chemical analysis. Before conducting sampling, field personnel surveyed the proposed sampling area for appropriate fine-sediment depositional areas before stepping into the stream, to avoid disturbing possible sediment collection sub-sites. Personnel carefully entered the stream and started sampling at the closest appropriate reach, continuing upstream. Sediment samples were collected from the top 2 cm of sediment in a compositing container, thoroughly homogenized, and then aliquotted into separate jars for chemical or toxicological analysis using standard clean sampling techniques (see SOP FS-6, BASMAA 2014b). Sample jars were submitted to respective laboratories per SOP FS-13 (BASMAA 2014b).

3.1.9 Continuous Temperature Monitoring

Digital temperature loggers (Onset HOBO Water Temp Pro V2) were programmed to record data at 60-minute intervals and were deployed at targeted sites from April through September 2014. Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-5 (BASMAA 2014b).

3.1.10 Continuous General Water Quality Measurements

Water quality monitoring equipment recording dissolved oxygen, temperature, conductivity, and pH at 15-minute intervals (YSI 6600 data sondes) was deployed at targeted sites for two 2-week periods: once during spring season and once during summer. Procedures used for calibrating,

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[9] Table 8-1 of the MRP specifies that sediment toxicity and chemistry parameters are collected during the dry season, defined as July 1st – September 30th. Under guidance from Regional Water Board staff, Program staff collected sediment samples approximately one month prior to the beginning of the dry season to avoid potential dry channel conditions during a drought year. This was the preferred option over potentially selecting new sampling location(s) that were not dry.

deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2014b).

3.1.11 Pathogen Indicators Sampling

Sampling techniques for pathogen indicators (fecal coliform and *E. Coli*) included direct filling of containers at targeted sites and immediate transfer of samples to analytical laboratories within specified holding time requirements. Procedures used for sampling and transporting samples are described in RMC SOP FS-2 (BASMAA 2014b).

3.2 Laboratory Analysis Methods

RMC participants, including SMCWPPP, agreed to use the same laboratories for individual parameters, developed standards for contracting with the labs, and coordinated quality assurance issues. All samples collected by RMC participants that were sent to laboratories for analysis were analyzed and reported per SWAMP-comparable methods as described in the RMC QAPP (BASMAA 2014a). Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are also reported in BASMAA (2014a). Analytical laboratory contractors included:

- BioAssessment Services, Inc. – BMI identification
- EcoAnalysts, Inc. – Algae identification
- CalTest, Inc. – Sediment Chemistry, Nutrients, Chlorophyll a, Ash Free Dry Mass
- Pacific EcoRisk, Inc. - Water and Sediment Toxicity
- BioVir Laboratories, Inc. – Pathogen indicators

4.0 Data Analysis and Interpretation Methods

This section describes methods used to analyze the monitoring data. The analyses include a preliminary condition assessment involving analysis of the biological data to characterize biological conditions within San Mateo County. The condition assessment is based upon bioassessment scores and seeks to answer management question #2 ***(Are conditions in local receiving water supportive of or likely supportive of beneficial uses?***). The physical, chemical, and toxicity data are analyzed to identify potential stressors that may be impacting water quality and biological conditions and to answer management question #1 ***(Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers, and tributaries?***). An important part of data analysis is review of all field data sheets and laboratory reports for compliance with the SOPs (BASMAA 2014b) and QAPP (BASMAA 2014a).

As the cumulative sample sizes increase through monitoring conducted in future years (Table 2.1), it will be possible to develop a statistically representative data set to address the management questions comparing urban and non-urban conditions and long-term trends. This report includes a condition assessment for individual sites using bioassessment data collected during WY2014.

4.1 Biological Condition Indicators

Assemblages of freshwater organisms are commonly used to assess the biological integrity of waterbodies because they provide direct measures of ecological condition (Karr and Chu 1999). Benthic macroinvertebrates (BMIs) are an essential link in the aquatic food web, providing food for fish and consuming algae and aquatic vegetation (Karr and Chu, 1999). The presence and distribution of BMIs can vary across geographic locations based on elevation, creek gradient, and substrate (Barbour et al., 1999). These organisms are sensitive to disturbances in water and sediment chemistry, and physical habitat, both in the stream channel and along the riparian zone. Because of their relatively long life cycles (approximately one year) and limited migration, BMIs are particularly susceptible to site-specific stressors (Barbour et al., 1999). Algae are increasingly being used as indicators of water quality as they form the autotrophic base of aquatic food webs and exhibit relatively short life cycles that respond quickly to chemical and physical changes (Fetscher et al. 2013b). Diatoms have been found to be particularly useful for interpreting some causes of environmental degradation (Hill et al. 2000).

Indices of biological integrity (IBIs) are analytical tools that calculate a site condition score based on a series of biological metrics representing taxonomic richness, composition, tolerance and functional feeding groups. IBI development in California is better established for BMIs (i.e., B-IBIs) than for algae. Benthic macroinvertebrate IBIs have been developed and tested extensively for four regions of California, including Southern California (Ode et al. 2005), Northern California (Rehn et al. 2005), Eastern Sierra Nevada (Herbst et al. 2009) and the Central Valley (Rehn et al. 2008).

A new assessment tool for BMI data is being developed by the State Water Board to support the development of the State's Biological Integrity Assessment Implementation Plan. The California Stream Condition Index (CSCI) is an assessment tool based on benthic macroinvertebrates that is designed to provide both site-specificity and statewide consistency (i.e., can be applied to all perennial wadeable streams within all ecoregions of California). The performance of the CSCI is supported by the use of a large reference data set that represents the full range of natural conditions in California and by the development of site-specific models for predicting biological communities. The site-specific model is based on two components:

1. taxonomic completeness, as measured by the ratio of observed-to-expected taxa (O/E); and
2. ecological structure, measured as a predictive multi-metric index (pMMI) that is based on reference conditions (Mazor et al. in review).

The CSCI is computed as the average of the sum of O/E and pMMI.

The State Board is continuing to evaluate the performance of CSCI in a regulatory context and SFRWQCB staff has indicated that it will be referenced as a trigger in the re-issuance of the MRP (anticipated in 2015). To further test the performance of the CSCI as a biological condition assessment tool, SMCWPPP applied the CSCI to evaluate BMI data collected for Creek Status Monitoring.

The State Water Board is developing and testing assessment tools for benthic algae data as a measure of biological condition and identification of potential stressors. A comprehensive set of stream algal IBIs that include metrics for both diatoms and soft-algae, have recently been developed and tested in Southern California (Fetscher et al. 2013a). The study evaluated a total of 25 IBIs comprising of either single-assemblage metrics (i.e., either diatoms or soft algae) or combinations of metrics presenting both assemblages (i.e, “hybrid” IBI). The study identified four high performing IBIs including three hybrid IBIs and one single-assemblage IBI for diatoms. The performance was assessed by the IBIs responsiveness to stress. The “H20” hybrid IBI was also tested in other ecoregions of the state and showed relatively good performance in the Chapparal region, which includes the San Francisco Bay Area (Fetscher et al. 2013b). As a result, the “H20” IBI (Algae IBI) was used to evaluate the algae samples collected at SMCWPPP probabilistic sites. The Algae IBI results should be considered preliminary until additional research shows that these tools perform well for data collected in San Mateo County.

4.1.1 Benthic Macroinvertebrate Data Analysis

California Stream Condition Index Score

Benthic macro-invertebrate (BMI) data collected from 10 probabilistic sites[10] in San Mateo County in WY2014 was used to calculate CSCI scores. The laboratory analytical methods identified BMIs at a Level 1 Standard Taxonomic Level of Effort, with the additional effort of identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae). The taxonomic resolution and life stage information for all BMI data was compared and revised when necessary to match the Surface Water Ambient Monitoring Program (SWAMP) master taxonomic list.

The CSCI method is dependent on a site’s position within the ecosystem (e.g., climate) and its watershed characteristics (e.g., elevation, soils) (Mazor et al. in review). Delineations for all the SMCWPPP probabilistic sites were created using existing GIS watershed/catchment data developed for San Mateo County. In most cases, the existing watershed/catchments required editing the polygon to adjust the downstream edge of the drainage area to the sampling locations.

[10] BMI data results from bioassessments conducted at two non-urban sites in 2014 by SWAMP were not available to include in the analyses.

To develop the CSCI scores, eight additional GIS datasets were compiled from the California Department of Fish and Wildlife and analyzed in ArcGIS to calculate a range of environmental predictors for each sampling location. Site elevation, temperature, and precipitation values were obtained directly at the sampling location. Elevation range was calculated from the difference in elevation in the watershed of the lowest and highest values. Summer precipitation, soil bulk density, soil erodibility, and soil phosphorus content are predictors that are averaged across each watershed, and are calculated in ArcGIS using a zonal statistics tool (http://www.arcgis.com/). The environmental predictors and BMI data were formatted into comma delimited files and used as input for the RStudio statistical package and the necessary CSCI program scripts provided by SCCWRP staff. The CSCI program includes a subsampling routine that produces a standardized number of 500 BMIs. The program output includes a summary table that averages CSCI scores over 20 iterations and calculates O/E and pMMI metrics. The output table also flags sites with inadequate numbers of unambiguous taxa (i.e., CSCI requires at least 360 unambiguous taxa).

Assessing Biological Condition

The CSCI scores were evaluated using condition categories developed by Mazor et al. (in review). Four classes were defined using a distribution of scores at reference calibration sites throughout the State of California (Table 4.1). The categories are described as “likely intact” (greater than 30th percentile of reference site scores); “possibly intact” (between the 10th and the 30th percentiles); “likely altered” (between the 1st and 10th percentiles; and “very likely altered” (less than the 1st percentile).

Table 4.1. Condition categories used to evaluate CSCI scores.

CSCI Score	Category
$\geq$ 0.92	Likely Intact
0.79 – 0.92	Possibly Intact
0.63 – 0.79	Likely Altered
$\leq$ 0.63	Very Likely Altered

4.1.2 Algae Bioassessment

The “H20” hybrid IBI (Algal IBI), developed by Fetscher et al. (2013a) for the Draft Southern California Algae IBI, was used to assess biological condition for each SCVURPPP probabilistic site. The Algae IBI is comprised of the following eight metrics (“d” indicates that a given metric is based on diatoms and “s” indicates soft algae; of the latter, “sp” indicates that the metric is based on relative species numbers):

- Proportion nitrogen heterotrophs (d)
- Proportion requiring >50% dissolved oxygen saturation (d)
- Proportion sediment tolerant (highly motile) (d)
- Proportion halobiontic (d)
- Proportion low nitrogen indicators (d)
- Proportion high Copper indicators (s, sp)
- Proportion high dissolved organic carbon indicators (s, sp)

- Proportion low total phosphorus indicators (s, sp)

The algae data were compiled, formatted and sent to the Moss Landing Marine Laboratory where "H20" scores were calculated using the SWAMP Reporting Module. No condition categories have been established for algae IBIs to date, nor has the State Water Board proposed their use in a regulatory context. However, "H20" scores may be of value in spatial and time series trends analyses.

4.2 Physical Habitat Indicators

Physical habitat indicators include measurements/assessments made during the bioassessment and during the California Riparian Assessment Method (CRAM). Physical habitat measurements were used to assess both the physical habitat condition and were evaluated as potential stressors to the biological condition as represented by CSCI and Algal IBI scores.

Riparian condition data (i.e., CRAM) were used to assess the overall condition of the health of stream ecosystem resources and to develop hypotheses regarding the causes of their observed conditions. Riparian assessment data can also supplement biological and physical habitat data collected at bioassessment sites to investigate potential stressors to aquatic health. Previous studies in Southern California (Solek et al. 2011) have demonstrated high correlation between benthic macro-invertebrate communities (as measured by IBI) and riparian condition.

<u>Physical Habitat Condition</u>
Three qualitative PHAB parameters (epifaunal substrate/cover, sediment deposition, and channel alteration) are assessed on a reachwide basis during each bioassessment. Each parameter can be scored for a range of 0-20 and the sum of the PHAB parameters result in total scores that range from 0 – 60. Higher PHAB scores reflect higher quality habitat. Physical habitat endpoints (e.g., percent algal cover, percent canopy cover, percent sands and fines) were measured at each transect and averaged to obtain a reachwide measure of physical habitat condition. Additional variables that characterize the relative amount of development within the watershed drainage areas upstream of each sampling location (e.g., percent impervious) were derived using a GIS.

CRAM is also applied to bioassessment reach. The CRAM score is based on the assessment and scoring of four different attributes: 1) Buffer and Landscape Connectivity; 2) Hydrology; 3) Physical Structure; and 4) Biotic Structure. The four attribute scores are summed and averaged to obtain the total CRAM score.

<u>Stressor Assessment</u>
Spearman rank correlation statistical tests were used to estimate the degree of correlation between PHAB parameters, physical habitat endpoints, CRAM scores, and water quality parameters with the biological condition scores (CSCI and Algal IBI).

4.3 Stressor/WQO Assessment

Water and sediment chemistry and toxicity data generated during WY2014 were analyzed and evaluated to identify potential stressors that may be contributing to degraded or diminished biological conditions, including exceedances of water quality objectives (WQOs). Per Table 8.1 of the MRP (SFRWQCB 2009), creek status monitoring data must be evaluated with respect to specified "Results that Trigger a Monitoring Project in Provision C.8.d.i." The trigger criteria listed in MRP Table 8.1 were used as the principal means of evaluating the creek status monitoring data to identify sites where water quality impacts may have occurred. The relevant trigger criteria are listed in Table 4.2. For the purposes of the stressor assessment CSCI scores below 0.79 were considered as indicators of substantially degraded aquatic communities. Additional details on selected parameters (nutrients, toxicity, sediment chemistry, temperature, dissolved oxygen and pathogen indicators) are also provided below in Table 4.2.

Table 4.2. Standards and Thresholds Used for Trigger Evaluation

Monitoring Parameter	Standard/Threshold	Units	Source
Bioassessment			
CSCI	≤ 0.795 (likely and very likely altered classes)	NA	Mazor et al. in review
Nutrients and Conventional Analytes	20% of results at each monitoring site exceed one or more established standard or threshold - applies to these parameters jointly		
Ammonia, unionized	0.025	mg/L	SF Bay Basin Plan Ch. 3, p. 3-7
Chloride	230 (4 day avg.; applies to freshwater aquatic life)	mg/L	USEPA Nat'l. Rec. WQ Criteria
Chloride	250 (secondary maximum contaminant level; MUN waters, Title 22 Drinking Waters)	mg/L	SF Bay Basin Plan Ch. 3, Table 3-5; CA Code Title 22; USEPA Drinking Water Stds. Secondary MCL
Nitrate as N	10 (applies to MUN and Title 22 Drinking Waters only)	mg/L	SF Bay Basin Plan Ch. 3, Table 3-5; CA Code Title 22; USEPA Drinking Water Stds. Primary MCL; USEPA Nat'l. Rec. WQ Criteria (Human Health)
Chlorine			
Free & Total Chlorine	> 0.08 for initial result, > 0.08 for retest result (if needed)	mg/L	USEPA 1986
Water Column Toxicity			
Selenastrum capricornutum (Growth), *Ceriodaphnia dubia* (Survival/Reproduction), Fathead Minnow (Survival/Growth) & *Hyalella azteca* (Survival)	< 50% of Control Result for initial test, < 50% of Control Result for retest (if needed)	NA	MRP Table 8.1
Sediment Toxicity			
Hyalella azteca (Survival/Growth)	Toxicity results are statistically different than, and < 20% of Control		MRP Table H-1
Sediment Chemistry			
Grain Size and Total Organic Carbon	None	NA	

Monitoring Parameter	Standard/Threshold	Units	Source
MacDonald et al. 2000 Analytes; Pyrethroids from MRP Table 8.4	Three or more chemicals exceed Threshold Effects Concentrations (TECs), mean Probable Effects Concentrations (PEC Quotient greater than 0.5, or pyrethroids Toxicity Unit (TU) sum is greater than 1.0	NA	MRP Table H-1
General Water Quality Parameters	20% of results at each monitoring site exceed one or more established standard or threshold - applies individually to each parameter		
Conductivity	None	NA	
Dissolved Oxygen	WARM < 5.0, COLD < 7.0	mg/L	SF Bay Basin Plan Ch. 3, p. 3-4
pH	> 6.5, < 8.5 [1]	pH	SF Bay Basin Plan Ch. 3, p. 3-4
Temperature	COLD water 7-day mean < 19^o; COLD and WARM shall not increase > 2.8^o above natural receiving water temp	^{o}C	USEPA 1977 & SF Bay Basin Plan, Ch. 3, p. 3-6
Temperature	Same as General Water Quality for Temperature (See Above)		
Pathogen Indicators			
Fecal coliform	≥ 400	MPN/ 100ml	SF Bay Basin Plan Ch. 3
E. coli	≥ 410	MPN/ 100ml	USEPA 2012

[1] Special consideration will be used at sites where imported water is naturally causing higher pH in receiving waters.

4.3.1 Nutrients and Conventional Analytes

A search for relevant water quality standards or accepted thresholds was conducted using available sources, including the San Francisco Basin Water Quality Control Plan (Basin Plan) (SFRWQCB 2013), the California Toxics Rule (CTR) (USEPA 2000), and various USEPA sources. Of the eleven water quality constituents monitored in association with the bioassessment monitoring (referred to collectively as “Nutrients” in MRP Table 8.1), water quality standards or established thresholds are available only for ammonia (unionized form), chloride, and nitrate (for waters with MUN beneficial use only).

For ammonia, the 0.025 mg/L standard provided in the Basin Plan applies to the unionized fraction, as the underlying criterion is based on unionized ammonia, which is the more toxic form. Conversion of monitoring data from the measured total ammonia to unionized ammonia was therefore necessary. The conversion was based on a formula provided by the American Fisheries Society (Colt internet source, Emerson et al. 1975), and includes calculation from total ammonia, as well as field-measured pH, temperature, and specific conductance.

For chloride, a Secondary Maximum Contaminant Level (MCL) of 250 mg/L applies to those waters with MUN beneficial use and Title 22 drinking water, per the Basin Plan (Table 3-5), Title 22 of the California Code of Regulations, and the USEPA Drinking Water Quality Standards. For all other waters, the water quality criterion of 230 mg/L established by USEPA (2009) (USEPA Water Quality Criteria) for the protection of aquatic life is assumed to apply. The aquatic life criterion is a four-day average value, while the Secondary MCL is a maximum value.

The nitrate Primary MCL applies to those waters with MUN beneficial use, per the Basin Plan (Table 3-5), Title 22 of the California Code of Regulations, and the USEPA Drinking Water Quality Standards.

4.3.2 Water and Sediment Toxicity

The laboratory determines whether a sample is "toxic" by statistical comparison of the results from multiple test replicates of selected aquatic species in the environmental sample to multiple test replicates of those species in laboratory control water. The threshold for determining statistical significance between environmental samples and control samples is fairly small, with statistically significant toxicity often occurring for environmental test results that are as high as 90% of the Control. Therefore, there is a wide range of possible toxic effects that can be observed – from 0% to approximately 90% of the Control values.

For water sample toxicity tests, MRP Table 8.1 identifies toxicity results of less than 50% of the Control as requiring follow-up action. For sediment sample tests, MRP Table H-1 identifies toxicity results more than 20% less than the control as requiring follow-up action.[11] Therefore, samples that are identified by the lab as toxic (based on statistical comparison of samples vs. Control at $p = 0.05$) are evaluated to determine whether the result was less than 50% of the associated Control (for water samples) or statistically different and more than 20% less the Control (for sediment samples).

4.3.3 Sediment Chemistry

Sediment chemistry results are evaluated as potential stressors in three ways, based on the following criteria from MRP Table H-1. Any sample that meets one or more of the criteria are then compared to the sediment toxicity and bioassessment results for that site. These comparisons are performed in the Sediment Triad Assessment presented in Section 5.4.5.

- Calculation of threshold effect concentration (TEC) quotients; determine whether site has three or more TEC quotients greater than or equal to 1.0;[12]
- Calculation of probable effect concentration (PEC) quotients; determine whether site has mean PEC quotient greater than or equal to 0.5; and,
- Calculation of pyrethroid toxic unit (TU) equivalents as sum of TU equivalents for all measured pyrethroids; determine whether site has sum of TU equivalents greater than or equal to 1.0.

For sediment chemistry trigger criteria, TECs and PECs are as defined in MacDonald et al., 2000. For all non-pyrethroid contaminants specified in MacDonald et al. (2000), the ratio of the measured concentration to the respective TEC value was computed as the TEC quotient. All results where a TEC quotient was equal to or greater than 1.0 were identified. PEC quotients were also computed for all non-pyrethroid sediment chemistry constituents, using PEC values from MacDonald et al. (2000). For each site the mean PEC quotient was then computed, and

[11] Footnote #162 to Table H-1 of the MRP reads, "Toxicity is exhibited when Hyallela (sic) survival statistically different than and < 20 percent of control"; this is assumed to be intended to read "…statistically different than and more than 20 percent less than control".

[12] This assumes that there is a typographical error in Table H-1 and that the criterion is meant to read, "3 or more chemicals exceed TECs".

sites where the mean PEC quotient was equal to or greater than 0.5 were identified. Pyrethroid TU equivalents were computed for individual pyrethroid results, based on available literature values for pyrethroids in sediment LC50 values.[13] Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured total organic carbon (TOC) concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid. Then for each site, the TU equivalents for the various individual pyrethroids were summed, and sites where the summed TU was equal to or greater than 1.0 were identified.

4.3.4 Temperature

Sullivan et al. (2000) is referenced in Table 8.1 of the MRP as a potential source for applicable threshold(s) to use for evaluating water temperature data, specifically for creeks that have salmonid fish communities. The report summarizes results from previous field and laboratory studies investigating the effects of water temperature on salmonids of the Pacific Northwest and lists acute and chronic thresholds that can potentially be used to define temperature criteria. The authors identified annual maximum temperature (acute) and maximum 7-day weekly average temperature (MWAT) chronic indices as biologically meaningful thresholds. They found the MWAT index to be most correlated with growth loss estimates for juvenile salmonids, which can be used as a threshold for evaluating the chronic effects of temperature on summer rearing life stage.

Previous studies conducted by USEPA (1977) identified a MWAT of 19°C for steelhead and 18°C for coho salmon. Using risk assessment methods, Sullivan et al (2000) identified lower thresholds of 17°C and 14.8°C for steelhead and coho respectively. The risk assessment method applied growth curves for salmonids over a temperature gradient and calculated the percentage in growth reduction compared to the growth achieved at the optimum temperature. The risk assessment analysis estimated that temperatures exceeding a threshold of 17°C would potentially cause 10% reduction in average salmonid growth compared to optimal conditions. In contrast, exceedances of the 19°C threshold derived by USEPA (1977) would result in a 20% reduction in average fish growth compared to optimal conditions.

The San Francisco Bay Region Water Quality Control Board (Water Board) is currently applying the temperature thresholds suggested by Sullivan et al. (2000) (i.e., MWAT of 17°C and 14.8°C for steelhead and coho salmon, respectively) to evaluate temperature data for the 303(d) listing process of impaired waterbodies (SFRWQCB 2013). The Water Board has also applied these thresholds in evaluating temperature data collected at reference sites in the San Francisco Bay Area (SFRWQCB 2012).

Several important factors should be considered when selecting the appropriate temperature thresholds for evaluating data collected from creeks that support salmonid fish communities in the San Francisco Bay Area region. The thresholds presented in Sullivan et al. (2000) are based on data collected from creeks in the Pacific Northwest region, which exhibits different patterns of temperature associated with climate, geography and watershed characteristics compared to creeks supporting steelhead and salmon in Central California. Furthermore, a single temperature threshold may not apply to all creeks in the San Francisco Bay Area due to high variability in climate and watershed characteristics within the region. .

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[13] The LC50 is the concentration of a given chemical that is lethal on average to 50% of test organisms.

Sullivan et al.'s (2000) risk assessment approach to establishing water temperature thresholds for salmonids focuses on juvenile growth rates. Several studies, however, demonstrate that Central California Coast (CCC) Steelhead Distinct Population Segment (DPS)[14] have adapted feeding behaviors and life history strategies to deal with higher water temperatures characteristic of the southern end of their range. Smith and Li (1983) have observed that juvenile steelhead will tolerate warmer temperatures when food is abundant by moving into riffle habitats to increase feeding success. Steelhead will also move into coastal estuaries to feed during the summer season when stream conditions become stressful to the fish (Moyle 2000). Sogard et al. (2012) determined that steelhead growth rates were higher during winter-spring season compared to summer fall season in Central California coastal creeks, whereas the opposite was true for steelhead in creeks of the Central Valley. Railsback and Rose (1999) concluded that juvenile growth rate during the summer season was more dependent on food availability and consumption than temperature.

These studies demonstrate that the application of temperature thresholds to evaluate steelhead growth and survival is challenging, and may promote management actions that do not improve ecological conditions. In cases where low flow conditions in concert with high temperatures during summer season are impacting steelhead populations, management actions that improve food availability (e.g., increase summer flow) may better address factors that are more critically limiting steelhead production. For monitoring, fish size thresholds at critical life stages such as smolting may be a much better indicator for understanding viability of steelhead populations (Atkinson et al. 2011).

We recommend using thresholds identified in USEPA (1977) (i.e., MWAT of 19°C for steelhead and 18°C for coho salmon) for interpretation of temperature data collected during the Creek Status Monitoring Project in WY2014. These thresholds are consistent with results from thermal tolerance studies by Myrick and Cech (2001) that demonstrated maximum growth rates for California rainbow trout population to be near 19°C. Myrick (1998) also demonstrated that growth rates for steelhead at 19°C were greatly increased when food ration level was highest.

More data and analyses of temperature and salmonid growth rates is needed from creeks in the Central California Coast and San Francisco Bay Region to better understand the effects of temperature on salmonid fish population dynamics. In addition, other indicators (e.g., fish size) should be evaluated in combination with temperature to effectively evaluate salmonid ecological conditions. For these reasons, we recommend not using thresholds identified by Sullivan et al (2000) as they are based on a risk analysis that assumes optimal growth rates for salmonids using data that are likely not applicable to local watershed conditions.

The Basin Plan's water temperature Water Quality Objective states that "temperature shall not be increased by more than 2.8ºC above natural receiving water temperature". This criterion is difficult to apply to sites where natural receiving water temperature is not known. This criterion may be applicable in situations where temperature is dramatically altered (e.g., imported water) and water temperature data is collected above and below a POTW (Publicly Owned Treatment Works) outfall. In addition, there is no recommended criterion to use for warm water fish communities, which are more adapted to higher temperatures. At this time, SMCWPPP intends

[14] CCC steelhead DPS includes all populations between Russian River and south to Aptos Creek. Also included are all drainages of San Francisco, San Pablo and Suisun Bays eastward at the confluence of the Sacramento and San Joaquin Rivers.

to continue prioritizing temperature monitoring at sites that are designated with a cold water habitat (COLD) beneficial use (SFRWQCB 2013) or that support salmonid fish communities.

4.3.5 Dissolved Oxygen

The Basin Plan (SFRWQCB 2013) lists Water Quality Objectives for dissolved oxygen in non-tidal waters as follows: 5.0 mg/L minimum for waters designated as warm water habitat (WARM) and 7.0 mg/L minimum for waters designated as COLD. Although these WQOs provide suitable thresholds to evaluate triggers, further evaluation may be needed to determine the overall extent and degree that COLD and/or WARM beneficial uses are supported at a site. For example, further analyses may be necessary at sites in lower reaches of a waterbody that may not support salmonid spawning or rearing habitat, but may be important for upstream or downstream fish migration. In these cases, dissolved oxygen data will be evaluated for the salmonid life stage and/or fish community that is expected to be present during the monitoring period. Such evaluations of both historical and current ecological conditions will be made, where possible, when evaluating water quality information.

4.3.6 Pathogen Indicators

Water Quality Objectives listed in the Basin Plan for fecal coliform are based on five consecutive samples that are collected over an equally spaced 30-day period. The WQOs for Water Contact Recreation (REC-1) include concentrations for the calculated geometric mean (< 200 MPN/100ml) and the 90th percentile (< 400 MPN/100ml). The monitoring design for pathogen indicators was to collect single water samples at individual waterbodies, which is not consistent with the sampling requirements stated in the aforementioned WQOs. As a result, the threshold for a single sample maximum concentration of fecal coliform of 400 MPN/100ml was used as the basis for analyzing which results might trigger further evaluation.

While the Basin Plan does not include adopted WQOs for *E. coli*, the EPA has recommended criteria for *E. coli* in primary contact recreational waters to protect human health (USEPA 2012). The 2012 USEPA recommendations supersede the 1986 recommendations and no longer distinguish between different levels of beach usage. USEPA recommended water quality criteria for *E. coli* consist of a geometric mean of 126 CFU/100ml for samples collected in any 30-day interval and a statistical threshold value (STV) of 410 CFU/100ml. The STV approximates the 90th percentile of data and is used as evaluation criteria. In this evaluation, the Most Probable Number (MPN) of bacteria colonies given by the analytical method is compared directly with the Colony Forming Units (CFUs) of the USEPA recommendations.

Two important issues should be considered when evaluating bacterial indicator organisms: 1) there is an imperfect correlation between bacterial indicator organisms and pathogens of public health concern; and 2) the potential for human exposure to the water bodies of interest is uncertain. Water Quality Objectives and Criteria for pathogen indicators were derived from epidemiological studies of people recreating at <u>bathing</u> <u>beaches</u> that received bacteriological contamination via treated <u>human</u> <u>wastewater</u>. Therefore, applying these thresholds to data collected from creeks where exposure via recreation is infrequent and ingestion of the water is highly unlikely, is highly questionable. Additionally, sources of fecal indicators in the watershed are likely non-human given the understanding of watershed sources. Recent research indicates that the source of fecal contamination is critical to understanding the human health risk associated with recreational waters and that the risk in recreational waters varies with various fecal sources (USEPA 2012). Thus, comparison of fecal indicator results in San Mateo County creeks to WQOs and criteria may not be appropriate and should be interpreted cautiously.

4.3.7 Quality Assurance/Quality Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA 2014a). They generally involve the following:

Data Measurement Quality Objectives (MQOs) were established to ensure that data collected are of adequate quality and sufficient for the intended uses. MQOs address both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include specifications for completeness, sensitivity (detection and quantization limits), precision, accuracy, and contamination. To ensure consistent and comparable field techniques, pre-survey field training and in-situ field assessments were conducted. Field training and inter-calibration exercises were conducted to ensure consistency and quality of CRAM and bioassessment data.

Data were collected according to the procedures described in the relevant SOPs, including appropriate documentation of data sheets and samples, and sample handling and custody. Laboratories providing analytical support to the RMC were selected based on demonstrated capability to adhere to specified protocols. Standard methods for CRAM are included in Collins et al. (2008).

Duplicate samples were collected at 10% of the sites sampled to evaluate precision of field sampling methods. Ten percent of the total number of BMI samples collected was submitted to the California Department of Fish and Wildlife (CDFW) Aquatic Bioassessment Laboratory for independent assessment of taxonomic accuracy, enumeration of organisms and conformance to standard taxonomic level.

All data were thoroughly reviewed for conformance with QAPP requirements and field procedures were reviewed for compliance with the methods specified in the relevant SOPs. Data quality was assessed and qualifiers were assigned as necessary in accordance with SWAMP requirements.

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the SMCWPPP Quality Assurance Officer, and compared against the methods and protocols specified in the SOPs and QAPP. The findings and results were evaluated against the relevant MQOs to provide the basis for an assessment of programmatic data quality. A summary of data quality steps associated with water quality measurements is shown in Table 4.5. The data quality assessment consisted of the following elements:

- Conformance with field and laboratory methods as specified in SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc.
- Numbers of measurements/samples/analyses completed vs. planned, and identification of reasons for any missed samples.
- Temperature data was checked for accuracy by comparing measurements taken by HOBOs with NIST thermometer readings in room temperature water and ice water prior to deployment.
- General water quality data was checked for accuracy by comparing measurements taken before and after deployment with measurements taken in standard solutions to evaluate potential drift in readings.

- Quality assessment laboratory procedures for accuracy and precision (i.e., laboratory duplicates, laboratory blanks, laboratory control samples, and matrix spikes) were implemented, and data which did not mean MQOs were assigned the appropriate flag.
- Field crews participated in two inter-calibration exercises prior to field assessments and attended a debriefing meeting at the end of field assessments to assess consistency among RMC field crews.

Table 4.5. Data Quality Steps Implemented for Temperature and General Water Quality Monitoring.

Step	Temperature (HOBOs)	General Water Quality (sondes)
Pre-event calibration / accuracy check conducted	X	X
Readiness review conducted	X	X
Check field datasheets for completeness	X	X
Post-deployment accuracy check conducted	X	X
Post-sampling event report completed	X	X
Post-event calibration conducted	X	X
Data review – compare drift against SWAMP MQOs		X
Data review – check for outliers / out of water measurements	X	X

5.0 Results and Discussion

In this section, following a brief statement of data quality, the biological data are evaluated to produce a preliminary condition assessment for aquatic life in SMCWPPP creeks, based on the first two years of data collection. Historical bioassessment data collected by SMCWPPP since 2002 are added to the analysis to support the condition assessment. The physical, chemical, and toxicity monitoring data are then evaluated against the trigger criteria shown in Table 4.4 (Tables 8.1 and H-1 of the MRP) to provide a preliminary identification of potential stressors. Data evaluation and interpretation methods are described in Section 4.0. The results of the stressor assessment have been used to develop source identification projects.

5.1 Statement of Data Quality

A comprehensive QA/QC program was implemented by SMCWPPP, covering all aspects of the probabilistic and targeted monitoring. In general, QA/QC procedures were implemented as specified in the RMC QAPP (BASMAA, 2014a), and monitoring was performed according to protocols specified in the RMC SOPs (BASMAA, 2014b), and in conformity with SWAMP protocols. Details of the results of evaluations of laboratory-generated QA/QC results are included in Attachment B. Issues noted by the laboratories and/or field crews are summarized below.

5.1.1 Bioassessment

Prior to sampling in WY2014, field training and inter-calibration exercises with four other field crews were conducted to ensure consistency and quality of bioassessment data While there are no quantitative methods to assess quality assurance of physical habitat conditions, it was clear from the results that measurements taken by the SMCWPPP field crew rarely deviated from those of other crews.

The field crew was audited once during the field season by a representative of SWAMP to ensure consistency with SWAMP protocols. This audit is also intended to ensure consistency among RMC participants. Audits conducted by SWAMP did not result in any notable issues needing to be addressed regarding field procedures. Field sampling protocols, sample handling, documentation and packaging/delivery of samples were all executed properly as required by the QAPP and in accordance with the RMC SOPs. All field instruments were properly calibrated and cleaned within the necessary time restrictions.

One biological assessment site had to be sampled along a shortened reach (100m instead of the standard 150 m), and in some cases, stream characterization points may have been moved along the reach due to physical limitations or obstructions. Efforts were made to minimize the distance between the target collection location and the more accessible replacement location. Collection of algae samples was difficult at several sites due to varying levels of algal growth, making it challenging to collect a distinguishable clump for analysis.

A few issues with the BMI and algae laboratory analysis were noted, as follows:

- During BMI taxonomic analysis, there were no counting discrepancies and two minor taxonomic discrepancies between the original BioAssessment Services results and the QA recount conducted by the CDFW Aquatic Bioassessment Laboratory; *Menetus opercularis* was identified by BioASsessment Services to the subfamily/tribe level (*Menetus)*, but was identified to the species level by the CDFW Aquatic Bioassessment

Laboratory. Additionally, there was one instance of a "tagalong" organism, which was accidentally included in the vial of organisms of another taxon. This was marked as a "probable sorting error."

- In accordance with the QAPP and MRP, BMIs were assessed to the Southwest Association of Freshwater Invertebrate Taxonomist (SAFIT) Standard Taxonomic Effort (STE) Level 1. BMIs from WY2014 will be re-assessed to SAFIT STE Level 2 at a later date.
- Several algae species that were found in SMCWPPP samples were not included in the SWAMP list of existing taxonomic identifications.

5.1.2 Nutrients and Conventional Analytes

Caltest Laboratories analyzed all water chemistry samples for SMCWPPP in WY2014. Caltest performed all internal QA/QC requirements as specified in the QAPP and reported their findings to the RMC. Key water chemistry MQOs are listed in RMC QAPP (BASMAA 2014a) Tables 26-1, 26-2, 26-5, and 26-7.

Several issues were noted with respect to water chemistry analyses, as follows:

- The percent recoveries (PR) for three matrix spikes (MS) and three matrix spike duplicates (MSD) exceeded the MQO (silica, chloride, and nitrite) for two batches (four sites total).
- In accordance with the QAPP, field duplicates were collected at one (10%) of the ten SMCWPPP sites sampled. Lab results of water chemistry field duplicate results are shown in Attachment B. The MQO for relative percent difference (RPD) was exceeded for two constituents (suspended sediment concentration and chlorophyll a). Due to the nature of chlorophyll a, discrepancies are to be expected and are attributed to collection of the duplicate in a different spot from the original sample. Discrepancies between the two suspended sediment concentrations are attributed to timing (i.e., not collecting the duplicate at the exact moment the original sample is collected). These results are an improvement upon previous years, and the field crew will continue to improve efforts in subsequent years to collect the original and duplicate samples in an identical fashion.
- The QAPP requires field blanks to be collected and analyzed at a frequency of 5% of all samples collected for these parameters; this equates to a total of three such samples for the RMC total of 60 samples regionwide. The 5% requirement was exceeded in WY2014. Two were collected at SMCWPPP sites, two were collected at ACCWP sites, and two were collected at CCCWP sites. Caltest analyzed these water chemistry field blank samples and detected no contaminants.
- The SMCWPPP field crew collected laboratory duplicates[15] for chlorophyll a and ash free dry mass at two sites, and RPDs for all were below the MQO listed in the RMC QAPP (25%).
- Laboratory reports list the continuing calibration verification PR range as 85-115% or 90-110% for some conventional analytes (nutrients) while the RMC QAPP lists the PR as 80-120% for all conventional analytes in water.

[15] Two filters from the same sample

5.1.3 Toxicity

One aquatic toxicity sample, taken during a storm in February 2014 at site 204R01288, was affected during testing by pathogen-related mortality (PRM), a fairly common cause of interference in aquatic sample toxicity tests with ambient surface waters. The EPA testing manual indicates that a coefficient of variation (CV) greater than 40% may be indication of pathogen interference; however, there is no mandate that the CV must be greater than 40%. Although the test CVs were not greater than 40% (survival CV was 5.13% and the growth CV was 10.3%) for this sample, it was clear from observations that one fish in one of the replicates exhibited PRM. As the PRM was limited to one test replicate and one fish, and PRM was not observed in the Laboratory Control treatment, the laboratory concluded that the PRM was not related to the source of the test organisms. The affected sample was not re-tested due to laboratory personnel's best professional judgment that the PRM observation was not associated with or indicative of stormwater toxicity.

Due to the timing of the first toxicity storm event over a weekend in February 2014, organism vendors were unable to ship larval fathead minnows in time to meet the sample holding time of 36 hours after collection. As a result, the fathead minnow test was initiated with >36-hours stormwater samples, otherwise all analyses were performed according to laboratory Standard Operating Procedures.

Reference toxicant testing results were consistent with the typical response range for each species with the exception of EC50 for *Hyalella azteca* (0.57 g/L KCl) during the first round of testing in February, which was slightly above the upper threshold of the typical response (0.54 g/L KCl). These results suggest that these organisms may have been slightly less sensitive to toxicant stress than is typical.

5.1.4 Sediment Chemistry

Caltest Laboratories performed all sediment chemistry analyses for SMCWPPP with the exception of the grain size distribution and total organic carbon (TOC) analyses, which were sub-contracted by Caltest to Soil Control Laboratories. Caltest conducted all QA/QC requirements as specified in the RMC QAPP and reported their findings to the RMC. Key sediment chemistry MQOs are listed in RMC QAPP Tables 26-4, 26-6, and 26-7. Several issues were reported by the analytical laboratory (Caltest), and the sediment chemistry data were qualified accordingly. These issues included the following:

- Chromium was detected in a laboratory blank at levels above the Method Detection Limit (MDL), but well below the Reporting Limit (RL).

- The continuing calibration verification (laboratory control sample) percent recovery slightly exceeded the MQO for zinc and three pyrethroids (benz(a)anthracene, benzo(a)pyrene, perylene).

- The laboratory report for the duplicate sediment chemistry sample taken at Pilarcitos Creek (204R01308) initially did not match the electronic data deliverable (EDD) received from the laboratory. The laboratory confirmed that the EDD was correct and the report was incorrect.

- The matrix spike and matrix spike duplicate relative percent differences for DDT (p,p'), endrin, and several polycyclic aromatic hydrocarbons (benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, chrysene, fluoranthene, and pyrene) were outside control limits for synthetic organic compounds.

In addition, the following issues with sediment chemistry were noted in 2014 and past years:

- The RMC QAPP lists the maximum RPD for inorganic analytes (metals) as 25, while the laboratory report lists the maximum as 30% for most metals and 35% for mercury.

- Synthetic organics in the sediment laboratory report lists the maximum RPD from 30 to 50% for most analytes. The maximum RPDs in the laboratory report for gamma-BHC (Lindane) and p,p'-DDT are much higher at 52% and 59%, respectively. However, the RMC QAPP lists the MQO as less than 25% RPD for all synthetic organics.

- These discrepancies in maximum RPD resulted in several PAHs not being flagged in laboratory reports when they should have been. All other analyte groups (metals, pyrethroids, etc.) had relatively low RPDs.

The RMC QAPP requires collection and analysis of duplicate sediment samples at a rate of 10% of total samples collected. For WY2014, SMCWPPP collected one sediment sample field duplicate to account for the 10 sediment sites monitored by the RMC in WY2014. The sediment sample and field duplicate were collected together using the Sediment Scoop Method described in the RMC SOP, homogenized, and then distributed to two separate containers. Of the 70 constituents analyzed, 96%, or 67, of those constituents met the RPD MQO listed in the RMC QAPP for the sediment chemistry field duplicate sample. Only cis-permethrin and three particle size results (granule, coarse clay, and medium clay) exceeded the RPD MQO for the sediment chemistry field duplicate sample.

Lab results of the sediment chemistry field duplicates are shown in Attachment B. [Note that because of the variability in reporting limits, values less than the Reporting Limit (RL) were not evaluated for sediment RPDs.] That RPDs fall outside of control limits for field duplicates should not be surprising in that the control limits associated with SWAMP-comparable programs are identical between lab duplicates and field duplicates, even though sources of variability are much larger associated with field duplicates.

5.1.5 Targeted Monitoring

Field data sheets and laboratory reports were reviewed by the local Program Quality Assurance Officer, and the results evaluated against the relevant MQOs. Results were compiled for the qualitative metrics (representativeness and comparability), as well as the quantitative metrics (completeness, precision, accuracy). The following summarizes the results of the data quality assessment:

- Temperature data (from HOBOs) were collected at six targeted site locations in WY2014, a small increase over the required five locations, and insurance in the event that field equipment is lost or damaged or that streams dried up prior to the end of the sampling period. As a result, over 100% of the expected data was captured.

- Continuous water quality data (temperature, pH, dissolved oxygen, specific conductivity) were collected at two sites during two two-week periods in the spring and summer resulting in over 100% of the expected data results.

- Continuous water quality data met MQOs (accuracy) for all parameters (see Table 5.1).
- Two laboratory duplicates were run on ACCWP and CCCWP pathogen samples. The RPDs for *E.Coli* exceeded the target ranges specified in the RMC QAPP, but only one RPD for fecal coliform exceeded the MQO. Given the nature of pathogen sampling, these results are not surprising.
- No contamination was detected in pathogen laboratory blanks.

Table 5.1. Accuracy measurements for dissolved oxygen, pH, and specific conductivity (drift) during two two-week monitoring events in WY2014

Parameter	Unit	Allowable Drift[1]	204SMA059		204SMA080	
			May	August	May	August
Dissolved Oxygen	mg/L	± 0.5 or 10%	-0.09	-0.02	-0.17	0.04
pH 7.0	---	± 0.2	-0.12	0.01	-0.06	0.05
pH 10.0	----	± 0.2	0	-0.01	-0.06	-0.09
Specific Conductivity	µS/cm	±10 %	0.6%	0%	0.5%	0%

[1]Measurement Quality Objectives from SWAMP's Quality Assurance Project Plan – Table A25.

5.2 Condition Assessment

This section addresses the core management question ***"Are conditions in local receiving water supportive of or likely supportive of beneficial uses?"*** or more specifically, ***"What is the condition of aquatic life in creeks in San Mateo County?"*** The RMC probabilistic monitoring design provides an unbiased framework for data evaluation that, with adequate sample size (n=30), will allow a conditions assessment of aquatic life within known estimates of precision. Although 30 samples have been collected and analyzed in San Mateo County, this report only evaluates the 10 sampled collected in WY2014 and therefore, a countywide condition assessment was not conducted for this report. However, a condition assessment was conducted at the site level.

Although the data set is not *yet* sufficient to develop statistically representative conclusions addressing the second core management question (***"To what extent does the condition of aquatic life in urban and non-urban creeks differ in San Mateo County?"),*** comparisons are made between the two types of sites.

5.2.1 Benthic Macroinvertebrates

Biological condition for BMI data, presented as CSCI score, for the 10 probabilistic sites sampled in San Mateo County during WY2014 are listed in Table 5.2 and illustrated in Figure 5.1. The range of CSCI scores is 0.29 to 1.12, with a median score of 0.53. Site characteristics related to land use classification, flow status, and channel modification status are presented in the table for reference.

Using the condition categories for CSCI presented in this report, one site (10%) scored as “likely intact”, one site as “likely altered” (10%), and the remaining eight sites (80%) scored as “very likely altered”. The “likely intact” site is located in Pilarcitos Creek and was the only non-urban site sampled in WY2014. Three sites were classified as having non-perennial flow; these scored as “likely altered” or “very likely altered.” Only one site (Redwood Creek) was classified as having a modified channel (i.e., concrete lined bed and/or bank, channelized earthen levee); this site scored as “very likely altered.”

Table 5.2. CSCI scores for probabilistic sites sampled in San Mateo County during WY2014 (n=10). Condition categories developed by Mazor et al. (in review) are shown for each site.

Station Code	Creek	Land Use[1]	Modified Channel	Percent Impervious	Flow[2]	CSCI	
						Score	Condition Category
202R00328	Pilarcitos Creek	NU	N	1.0%	P	1.12	Likely Intact
205R01192	Corte Madera Creek	U	N	7.1%	NP	0.67	Likely Altered
204R01012	Cordilleras Creek	U	N	16%	NP	0.61	Very Likely Altered
204R01204	Burlingame Creek	U	N	36%	P	0.57	Very Likely Altered
204R01256	Arroyo Ojo de Agua	U	N	35%	P	0.54	Very Likely Altered
202R00972	Arroyo de en Medio	U	N	1.0%	P	0.53	Very Likely Altered
204R01268	Redwood Creek	U	Y	22%	P	0.47	Very Likely Altered
204R01460	Sanchez Creek	U	N	31%	NP	0.45	Very Likely Altered
204R01288	Laurel Creek	U	N	33%	P	0.36	Very Likely Altered
202R01308	Pilarcitos Creek	U	N	2.8%	P	0.29	Very Likely Altered

[1] NU = non-urban, U = urban (as classified by the GIS-based probabilistic monitoring design)
[2] P = perennial, NP = non-perennial

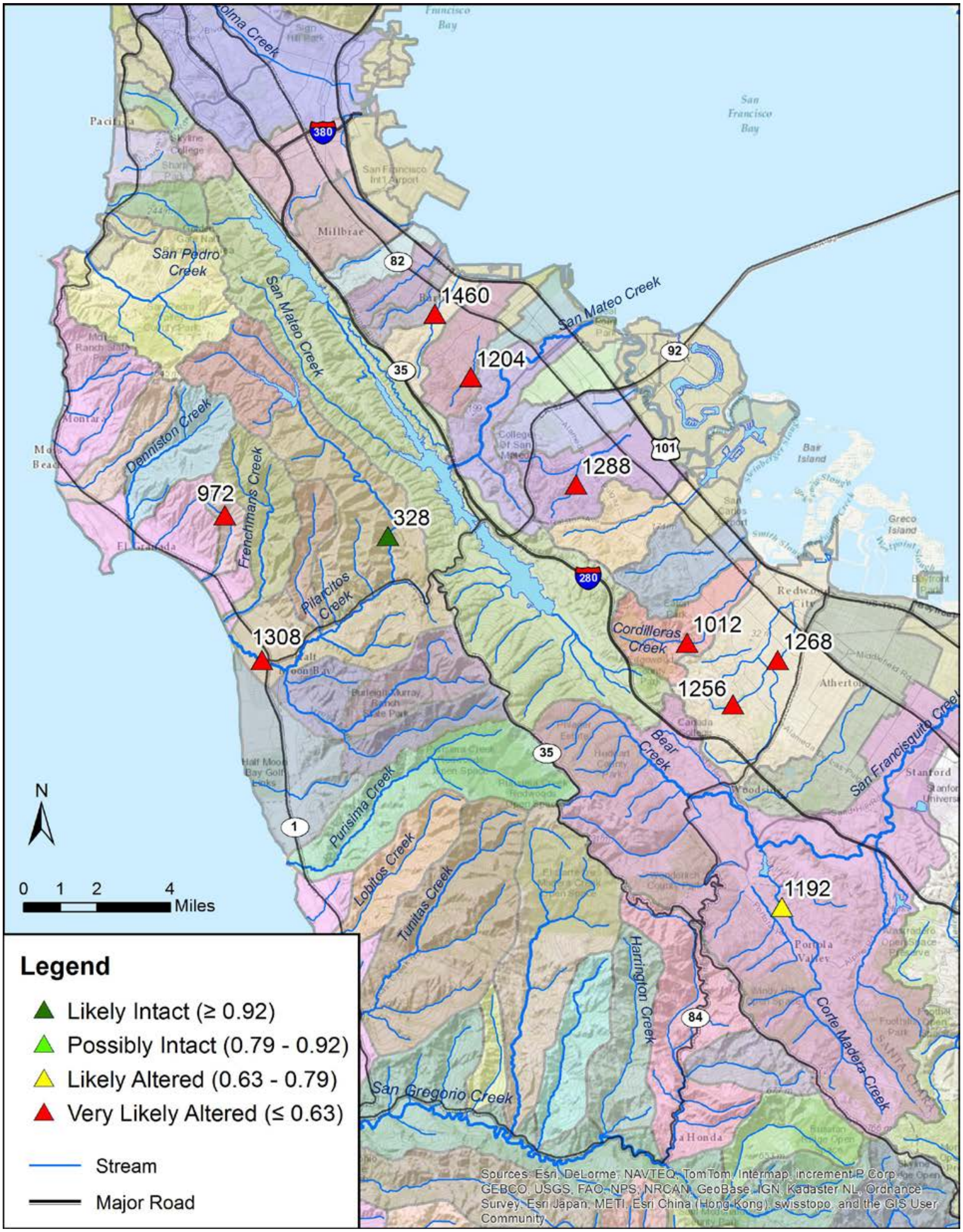

Figure 5.1. Location and CSCI condition category for 10 sites sampled in WY2014, San Mateo County.

There was very little difference in CSCI scores between sites with perennial (n=7) and non-perennial (n=3) flow (Figure 5.2) or for sites with different classes of urbanization, measured as percent impervious area (Figure 5.3). The amount of percent impervious area within the upstream watershed area for each sampling location was calculated using existing land use data in GIS. Impervious coefficients for land use classes were derived from SMCWPPP (2000). Three classes of imperviousness (<3%, 3-10%, and > 10%) were used to define the range of potential stress to biological condition at each sample location.

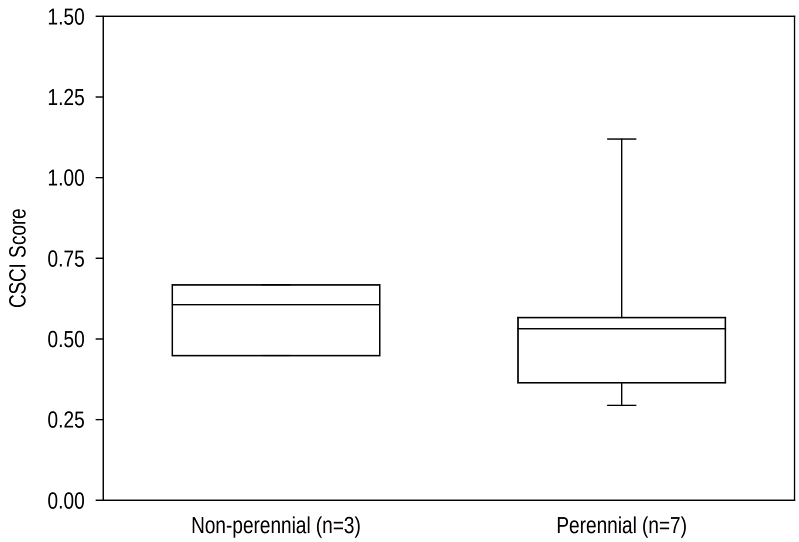

Figure 5.2. Box plots showing distribution of CSCI scores for perennial (n=7) and non-perennial (n=3) sites sampled in San Mateo County in WY2014.

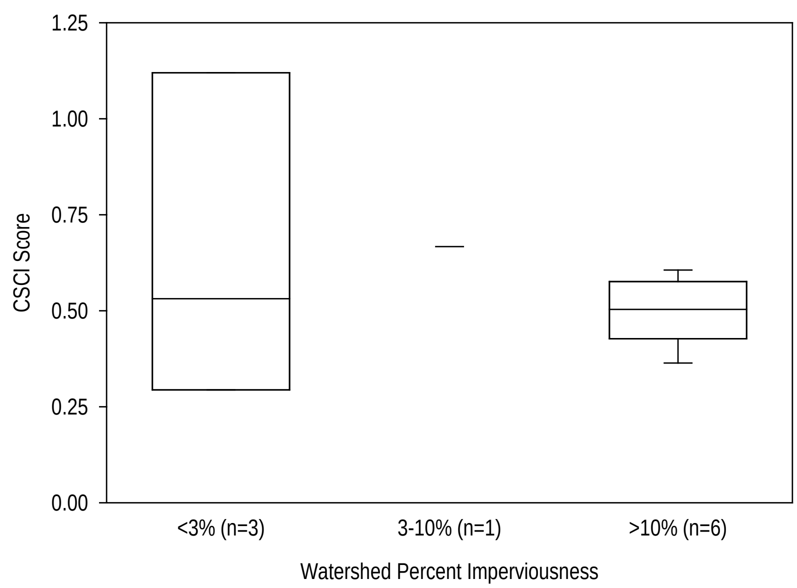

Figure 5.3. Box plots showing distribution of CSCI scores at sites sampled in San Mateo County in WY2014 for three classes of percent watershed imperviousness.

5.2.2 Algae

Biological condition, presented as the "H20" hybrid IBI (Algae IBI) score, for the 10 probabilistic sites sampled in San Mateo County during WY2014 are listed in Table 5.3 (site characteristics and CSCI scores are included for reference). The Algae IBI scores across all the sites ranged from 36 to 59. The highest Algae IBI score was measured at an urban site in Pilarcitos Creek (202R01308), which was also the site with the lowest CSCI score (0.29). Overall, Algae IBI scores were poorly correlated with CSCI scores (Figure 5.4). These results suggest that different stressors impact the algae assemblage as compared to the BMI assemblage.

Table 5.3. Algal IBI scores for 10 probabilistic sites sampled in WY2014, San Mateo County.

Station Code	Creek	Land Use[1]	Modified Channel	Percent Impervious	Flow Status[2]	Hybrid "H2O" Algal IBI Score	CSCI Score
202R01308	Pilarcitos Creek	U	N	2.8%	P	59	0.29
204R01012	Cordilleras Creek	U	N	16%	NP	55	0.61
204R01460	Sanchez Creek	U	N	31%	NP	54	0.45
204R01288	Laurel Creek	U	N	33%	P	52	0.36
202R00328	Pilarcitos Creek	NU	N	1.0%	P	51	1.12
204R01256	Arroyo Ojo de Agua	U	N	34%	P	50	0.54
204R01204	Burlingame Creek	U	N	36%	P	46	0.57
202R00972	Arroyo de en Medio	U	N	1.0%	P	44	0.53
205R01192	Corte Madera Creek	U	N	7.1%	NP	40	0.67
204R01268	Redwood Creek	U	Y	22%	P	36	0.47

[1] NU = non-urban, U = urban (as classified by the GIS-based probabilistic monitoring design)
[2] P = perennial, NP = non-perennial

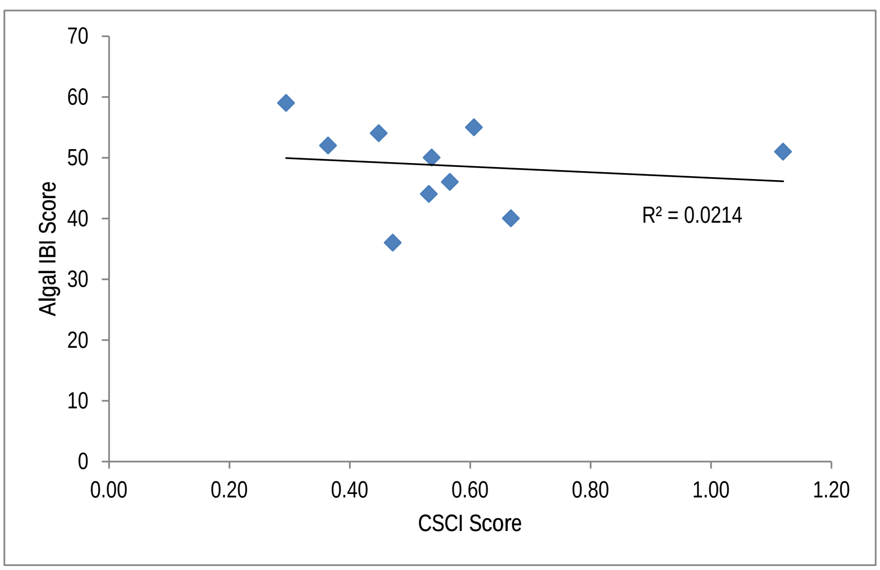

Figure 5.4. Linear regression of Algae IBI score and CSCI score for 10 probabilistic sites in San Mateo County sampled during WY2014.

Similar to the pattern observed with CSCI scores, there was minimal difference in Algae IBI scores between perennial and non-perennial sites (Figure 5.5) or urban classification (presented as percent impervious area) (Figure 5.6).

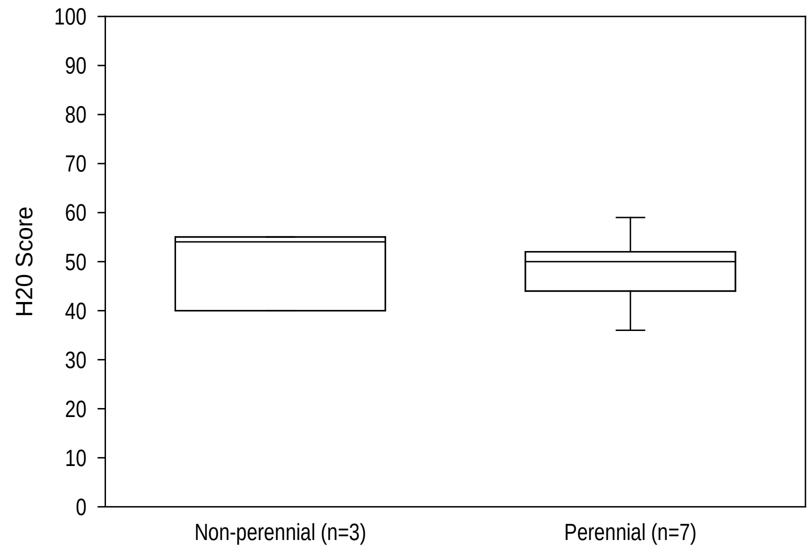

Figure 5.5. Box plots showing distribution of Algal IBI scores for perennial (n=7) and non-perennial (n=3) sites sampled in San Mateo County in WY2014.

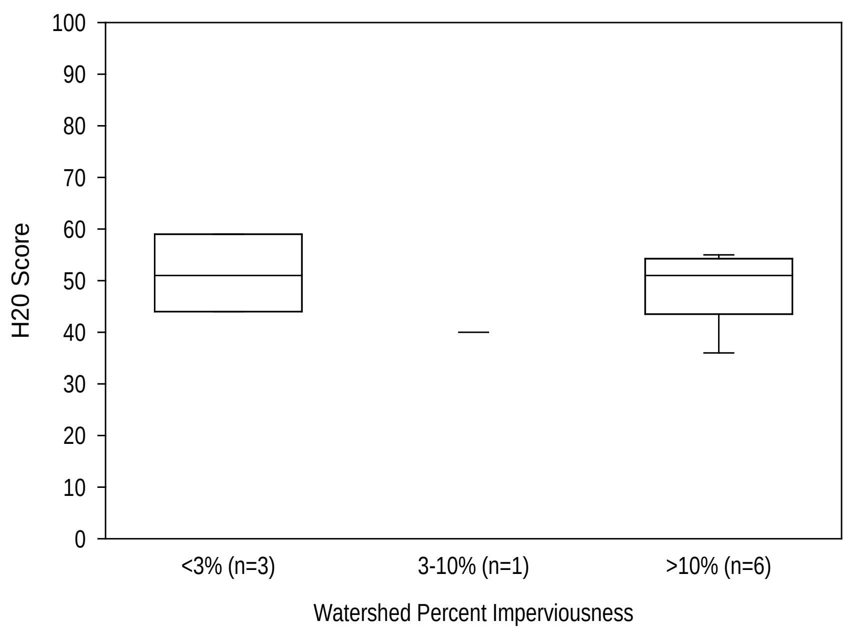

Figure 5.6. Box plots showing distribution of Algal IBI scores at sites sampled in San Mateo County in WY2014 for three classes of percent watershed imperviousness.

5.3 Physical Habitat Condition

Individual attribute and total scores for PHAB and CRAM for the 10 probabilistic sites are shown in Table 5.4. Total PHAB scores ranged from 5 to 48 (total possible score = 60) and CRAM scores ranged from 31 to 76 (total possible score = 100). Total PHAB scores and total CRAM scores were moderately correlated with each other (r^2 = 0.49) (Figure 5.7)

There were no correlations between total PHAB score or total CRAM scores with either CSCI scores or Algal IBI scores.

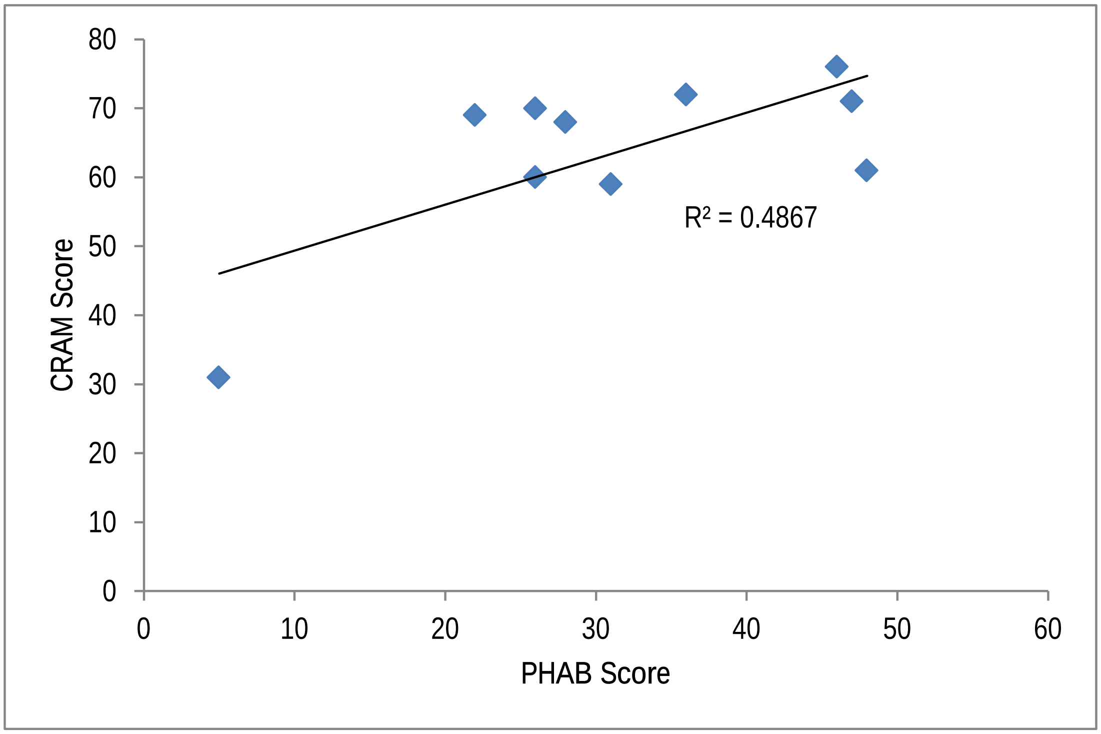

Figure 5.7. Total CRAM scores and total PHAB scores are compared for all probabilistic sites, WY2014.

The physical habitat endpoints calculated from habitat measurements conducted during bioassessments at 10 probabilistic sites are shown in Table 5.5. Stressor analysis of the habitat endpoints and biological scores is presented in the next section.

Table 5.4. PHAB, CRAM and CSCI scores at 10 probabilistic sites in San Mateo County in WY2014.

Station Code	Land Use	PHAB				CRAM					CSCI Score
		Channel Alteration	Epifaunal Substrate	Sediment Deposition	Total Score	Land	Hydro	Physical	Biotic	Total Score	
202R00328	NU	19	14	3	36	93.3	58.3	62.5	75	72	1.12
205R01192	U	11	9	6	26	75.8	50	75	80.6	70	0.67
204R01012	U	18	6	4	28	75.8	50	75	69.4	68	0.61
204R01204	U	18	15	14	47	80.6	58.3	62.5	80.6	71	0.57
204R01256	U	16	17	15	48	52.8	58.3	62.5	69.4	61	0.54
202R00972	U	20	16	10	46	62.5	83.3	87.5	72.2	76	0.53
204R01268	U	0	0	5	5	25	41.7	25	33.3	31	0.47
204R01460	U	11	8	7	26	50	58.3	62.5	69.4	60	0.45
204R01288	U	18	7	6	31	50	50	62.5	72.2	59	0.36
202R01308	U	14	5	3	22	78.5	50	62.5	83.3	69	0.29

Table 5.5. Physical habitat condition scores and endpoints calculated from habitat measurements during bioassessments at 10 probabilistic sites in San Mateo County in WY2014.

Station Code	Creek Name	Land Use	% Algae Cover	% Canopy Cover	% Sands & Fines	HDI Score	% Urban	% Impervious	CSCI Score
202R00328	Pilarcitos Creek	NU	17.0	96.3	35.2	0.67	0.0%	1.0%	1.12
205R01192	Corte Madera Creek	U	24.0	92.9	39.0	1.96	28%	7.1%	0.67
202R00972	Arroyo de en Medio	U	4.3	98.4	66.7	0.00	0.0%	1.0%	0.53
204R01204	Burlingame Creek	U	24.7	91.6	26.7	1.70	96%	36%	0.57
204R01012	Cordilleras Creek	U	26.2	93.9	18.1	1.58	60%	16%	0.61
202R01308	Pilarcitos Creek	U	12.6	97.1	60.0	1.38	3.0%	2.8%	0.29
204R01256	Arroyo Ojo de Agua	U	19.7	96.9	16.2	1.11	95%	34%	0.54
204R01268	Redwood Creek	U	38.4	54.7	7.6	2.32	95%	22%	0.47
204R01460	Sanchez Creek	U	20.3	93.7	14.3	1.41	81%	31%	0.45
204R01288	Laurel Creek	U	29.0	91.4	15.2	1.61	63%	33%	0.36

5.4 Stressor/WQO Assessment

This section addresses the core management question ***"Are water quality objects, both numeric and narrative, being met in local receiving waters, including creeks, rivers, and tributaries?"*** or more specifically, ***"What are the major stressors to aquatic life in San Mateo County?"*** Potential stressors to aquatic life (such as PHAB measures, percent impervious, and water quality) were compared to biological condition scores to evaluate their importance as major stressors to aquatic life. In addition, each monitoring category required by MRP Provision C.8.c, Table 8.1 is associated with a specification for "Results that Trigger a Monitoring Project in Provision C.8.d.i" (Stressor/Source Identification). The definitions of these "Results that Trigger…", as shown in Table 8.1, are considered to represent "trigger criteria", meaning that the relevant monitoring results should be forwarded for consideration as potential Stressor/Source Identification Projects per Provision C.8.d.i. The trigger criteria/thresholds are listed in Table 4.4 of this report. The physical, chemical, and toxicity monitoring data collected during WY2014 were evaluated against the trigger criteria. When the data analysis indicated that the associated trigger criteria were met, those sites and results were identified as potentially warranting further investigation.

5.4.1 Potential stressors to biological condition

Physical habitat, general water quality, and water chemistry (e.g., nutrients) data were evaluated as potential stressors to biological condition. These data were collected synoptically with biological data during bioassessments at probabilistic sites in WY2014. Using the Sigma Plot statistical software platform, the variables were tested for normality using the Shapiro-Wilk Test. Several environmental parameters were not normally distributed. Therefore, correlations between biological assessment tools (CSCI and Algae IBI) and environmental variables (physical habitat, water quality) were evaluated using the Spearman rank method. Spearman rank correlations greater than ±0.7 indicate a strong relationship between variables. If the p-value is ≤0.05, the correlation is considered statistically significant.

The environmental variables were poorly correlated with the biological condition scores (i.e., no correlations exceeded ±0.7) (Table 5.6). Based on these results, none of the stressor variables appeared to explain biological condition scores.

Table 5.6. Spearman Rank Correlations for biological condition scores (CSCI and Algae H20 IBI) and environmental variables.

Independent Variables	Shapiro-Wilk		CSCI		Algal IBI ("H20")	
	Normal Distribution	p-value	Spearman Correlation Coefficient	p-value	Spearman Correlation Coefficient	p-value
Bioassessment Tool						
CSCI	No	0.04	--	--	-0.33	0.33
H20	Yes	0.87	-0.33	0.33	--	--
Potential Stressor						
Algae Cover	Yes	0.98	-0.018	0.95	-0.2	0.56
Canopy Cover	No	< 0.001	0.03	0.92	0.35	0.31
Sands & Fines	Yes	0.12	0.25	0.47	0.03	0.92
HDI Score	Yes	0.60	-0.02	0.95	-0.36	0.29
Channel Alteration (PHAB)	No	0.02	0.30	0.38	0.15	0.66
Epifaunal Substrate (PHAB)	Yes	0.52	0.43	0.20	-0.29	0.40
Sediment Deposition (PHAB)	Yes	0.08	-0.018	0.95	-0.39	0.24
CRAM Total	No	0.006	0.53	0.11	-0.10	0.76
Biotic Structure (CRAM)	No	0.001	0.09	0.79	0.15	0.66
Buffer and Landscape (CRAM)	Yes	0.58	0.54	0.10	0.23	0.51
Hydrology (CRAM)	No	0.012	0.21	0.54	-0.01	0.95
Physical Structure (CRAM)	No	0.009	0.36	0.29	0.03	0.92
Impervious	Yes	0.08	-0.22	0.51	-0.05	0.87
Unionized Ammonia	No	< 0.001	-0.30	0.38	-0.32	0.35
Chloride	Yes	0.77	-0.10	0.76	0.07	0.84
Nitrate as N	Yes	0.69	-0.50	0.13	0.26	0.45
Nitrogen, Total Kjeldahl	No	0.007	-0.42	0.21	-0.34	0.31
Suspended Sediment Concentration	No	< 0.001	-0.33	0.33	-0.28	0.43
Specific Conductivity	Yes	0.06	0.19	0.58	-0.13	0.71
Temperature	No	0.004	-0.31	0.365	0.09	0.79

5.4.2 Nutrients and Conventional Analytes

Descriptive statistics for nutrient and conventional analyte concentrations measured in samples collected synoptically during bioassessments are listed in Table 5.7. Chlorophyll a and AFDM were measured in µg/L and mg/L, respectively, and were converted to volume per area units using a module developed by EOA. Trigger thresholds for chloride, unionized ammonia and nitrate are listed for reference. The unionized ammonia concentration calculated for one sample (Cordilleras Creek; 204R01012) exceeded the trigger threshold. However, this result was flagged as questionable due to an elevated field pH (9.46) used in the calculation. No other samples exceeded the thresholds.

Table 5.7. Descriptive statists for water chemistry results in San Mateo County during WY2014.

Nutrients and Conventional Analytes	Units	N	**N ≥ RL**	Min	Max	Mean[1]	Median[1]	Trigger Threshold	Trigger Exceedance
Alkalinity (as $CaCO_3$)	*(mg/L)*	10	10	96	486	259	266	--	--
Ash Free Dry Mass	*(g/m²)*	10	10	28	255	107	79	--	--
Chloride	*(mg/L)*	10	10	20	81	50	55	230/250[2]	0%
Chlorophyll α	*(mg/m²)*	10	9	<1.8	240	43	15	--	--
Dissolved Organic Carbon	*(mg/L)*	10	10	1.6	12	4.0	2.8	--	--
Ammonia (as N)	*(mg/L)*	10	3	<0.04	1.2	0.17	0.02	--	--
Unionized Ammonia (as N)[3]	*(µg/L)*	10	3	< 0.1	69[4]	8.0	0.39	25	10%
Nitrate (as N)	*(mg/L)*	10	8	<0.005	0.59	0.27	0.25	10	0%
Nitrite (as N)	*(mg/L)*	10	0	<0.006	0.03	0.006	0.003	--	--
Total Kjeldahl Nitrogen (as N)	*(mg/L)*	10	10	0.22	1.7	0.72	0.49	--	--
OrthoPhosphate (as P)	*(mg/L)*	10	10	0.021	0.31	0.13	0.09	--	--
Phosphorus (as P)	*(mg/L)*	10	10	0.024	0.32	0.13	0.1	--	--
Suspended Sediment Concentration	*(mg/L)*	10	3	<2	33	6.4	1.8	--	--
Silica (as SiO_2)	*(mg/L)*	10	10	14	67	25	20	--	--

1 Mean and median concentrations calculated using ½ the method detection limit (MDL) for samples below the detection limit (ND).

2 The nitrate and 250 mg/L chloride thresholds apply to Title 22 drinking waters and sites with MUN beneficial use only.

3 Unionized ammonia estimated from ammonia, pH, temperature, and specific conductance per Emerson et al., 1975.

4 One UIA sample exceeded the trigger, but the value is questionable due to an elevated pH (9.46) used to calculate the unionized ammonia concentration. This pH measurement was flagged as questionable.

5.4.3 Chlorine

Field testing for free chlorine and total chlorine residual was conducted at all probabilistic sites synoptic with spring bioassessment sampling and at a subset of the sites synoptic with dry season toxicity sampling. Chlorine concentrations and comparisons to the MRP Table 8.1 trigger threshold are listed in Table 5.8. The MRP trigger criterion for chlorine states, "After immediate resampling, concentrations remain >0.08 mg/L". Thus, if a repeat sample is ≤ 0.08 mg/L, the MRP trigger criterion is not met. If a repeat chlorine measurement was not conducted, the original measurement was used. Twelve measurements were collected at ten sites during WY2014. Two of the 12 samples (17 %), both collected during the spring event, exceeded the threshold for total chlorine residual. Both sites (204R01012 – Cordilleras Creek; 204R01288 – Laurel Creek) are within the urban envelope where chlorine residuals are commonly detected. Laurel Creek was resampled for chlorine during the summer toxicity sampling event and did not exceed the trigger. None of the samples exceeded the threshold for free chlorine residual. Several of the measurements were equal to but did not exceed the trigger criterion.

Table 5.8. Summary of SMCWPPP chlorine testing results in comparison to MRP trigger criteria, WY2014

Station Code	Date	Creek	Free Chlorine (mg/L)[1, 2]	Total Chlorine Residual (mg/L)[1, 2]	Exceeds Trigger?[3] (0.08 mg/L)
202R00328	5/7/2014	Pilarcitos Creek	0.02	0.04	No
202R00972	5/8/2014	Arroyo de en Medio	0.04	0.05	No
202R01308	5/7/2014	Pilarcitos Creek	0.02	0.02	No
202R01308	6/4/2014	Pilarcitos Creek	0.02	< 0.02	No
204R01012	4/29/2014	Cordilleras Creek	0.08 / 0.05	0.12 / 0.11	Yes
204R01204	4/28/2014	Burlingame Creek	0.04	0.08	No
204R01256	5/5/2014	Arroyo Ojo de Agua	0.03	0.04	No
204R01268	5/6/2014	Redwood Creek	0.04	0.12 / 0.07	No
204R01288	4/29/2014	Laurel Creek	0.11 / 0.08	0.15 / 0.10	Yes
204R01288	6/4/2014	Laurel Creek	0.03	0.04	No
204R01460	4/28/2014	Sanchez Creek	0.05	0.06	No
205R01192	5/13/2014	Corte Madera Creek	0.02	0.06	No
Number of samples exceeding 0.08 mg/L:			0	2	--
Percentage of samples exceeding 0.08 mg/L:			0%	17%	--

[1] The method detection limit for free and total chlorine is 0.02 mg/L.
[2] Original and repeat samples are reported where conducted.
[3] The trigger applies to both free and total chlorine measurements.

5.4.4 Water and Sediment Toxicity

Water toxicity samples were collected twice from a subset of the urban probabilistic sites: during a storm event and summer dry conditions. Samples were tested for toxic effects using four species: an aquatic plant (*Selenastrum capricornutum*), two aquatic invertebrates (*Ceriodaphnia dubia* and *Hyalella azteca*), and one fish species (*Pimephales promelas* or fathead minnow). Both acute and chronic endpoints (survival and reproduction/growth) were analyzed for *Ceriodaphnia dubia* and *Pimephales promelas*. *Selenastrum capricornutum* are tested only for the chronic (growth) endpoint and *Hyalella azteca* are tested only for the acute (survival) endpoint.

Table 5.9 provides a summary of toxicity testing results for water samples. Relative to the lab control, one water sample was found to be chronically toxic to *Ceriodaphnia dubia* and one sample was acutely toxic to *Hyalella azteca*. None of the water samples with toxicity relative to the lab control met the MRP Table 8.1 trigger criteria of more than 50% less than the control.

During the dry season, sediment samples were collected at the same probabilistic sites and tested for sediment toxicity and an extensive list of sediment chemistry constituents. For sediment toxicity, testing was performed with just one species, *Hyalella azteca*. Both acute and chronic endpoints (survival and growth) were analyzed. Table 5.10 provides a summary of toxicity testing results for sediment samples. One sediment sample collected at site 204R01288 was determined to be acutely toxic and one sediment sample collected at site 204R01308 was determined to be chronically toxic. Neither of these sediment samples met the MRP Table H-1 trigger criteria of more than 20% less than the control.

Table 5.11 details results for the water and sediment tests that were found to be toxic to *Ceriodaphnia dubia* and *Hyalella azteca* relative to the laboratory control (via statistical comparison at p=0.5), along with comparisons to the relevant trigger criteria from MRP Tables 8.1 and H-1.

Table 5.9. Summary of SMCWPPP water toxicity results, WY2014.

SMCWPPP Water Samples			*Test Initiation Date*	*Toxicity relative to the Lab Control treatment?*					
				Selenastrum capricornutum	*Ceriodaphnia dubia*		*Hyalella azteca*	*Pimephales promelas*	
Sample Station	*Creek*	*Sample Date*		*Growth*	*Survival*	*Reproduction*	*Survival*	*Survival*	*Growth*
204R01288	Laurel Creek	2/8/14	2/9/14	No	No	No	Yes (16% effect)	No[a]	No
204R01308	Pilarcitos Creek	2/8/14	2/9/14	No	No	No	No	No	No
204R01288	Laurel Creek	6/4/14	6/5/14	No	No	No	No	No	No
204R01308	Pilarcitos Creek	6/4/14	6/5/14	No	No	Yes	No	No	No

[a] Pathogen-related mortality observed on 2/14/14 in one fish in one of the test replicates. The EPA testing manual indicates a CV of >40% "*may be*" an indication of pathogen interference. However it is worth noting that there is no mandate that CV *must be* >40% in order to characterize mortalities as related to pathogen interference. The survival CV was 5.13% and the growth CV was 10.3%, but it was visually clear that PRM was present.

Table 5.10. Summary of SMCWPPP dry season sediment toxicity results, WY2014.

Dry Season Sediment Samples			Date of Analysis	Toxicity relative to the Lab Control treatment?	
				Hyalella azteca	
Sample Station	Creek	Collection Date		Survival	Growth
204R01288	Laurel Creek	6/4/14	6/9/14	Yes*	Yes*
204R01303	Pilarcitos Creek	6/4/14	6/9/14	No	Yes*

*The response at this test treatment was significantly less than the Lab Control treatment response at p <0.05.

Table 5.11. Comparison between laboratory control and SMCWPPP water and sediment receiving sample toxicity results (*Hyalella azteca and Ceriodaphnia dubia*) in the context of MRP trigger criteria.

Treatment/ Sample ID	Creek	Test Initiation Date (Time)	Species Tested	10-Day Mean % Survival	Mean Reproduction	Comparison to MRP Table 8.1 and H-1 Trigger Criteria
Water Samples						
Lab Control	N/A	2/9/14 (1600)	*Hyalella azteca*	100	--	N/A
204R01288	Laurel Creek			84*	--	Not <50% of Control
Lab Control	N/A	6/5/14 (1500)	*Ceriodaphnia dubia*	100	26.2[a]	N/A
204R01308	Pilarcitos Creek			100	17.6*	Not <50% of Control
Sediment Samples						
Lab Control	N/A	6/9/14 (1500)	*Hyalella azteca*	95	0.14	N/A
204R01288	Laurel Creek			77.5*	0.07*	Not <20% of Control
204R01308	Pilarcitos Creek			88.8	0.08*	Not <20% of Control

* The response at this test treatment was significantly less than the Lab Control treatment response $p < 0.05$.

[a] The test response in one of the replicates at this test treatment was determined to be a statistical outlier; the results reported above are for the analysis of the data excluding the outlier. As per EPA guidelines, analysis of the data including the outlier was also performed and is included as a supplemental appendix to the laboratory report.

5.4.5 Sediment Chemistry

Sediment chemistry results are evaluated as potential stressors based on TEC quotients, PEC quotients, and TU equivalents, according to criteria in Table H-1 of the MRP which are summarized in Section 4.3.3 of this report.

Table 5.12 lists TEC quotients for all non-pyrethroid sediment chemistry constituents, calculated as the measured concentration divided by the more sensitive TEC value, per MacDonald et al. (2000). This table also provides a count of the number of constituents that exceed TEC values for each site, as evidenced by a TEC quotient greater than or equal to 1.0. The number of TEC quotients exceeded per site ranges from a low of zero to a high of ten, out of 27 constituents included in MacDonald et al. (2000). One site (204R01288 – Laurel Creek) exceeded the relevant trigger criterion from MRP Table H-1, which is interpreted to stipulate three or more constituents with TEC quotients greater than or equal to 1.0.

Table 5.13 provides PEC quotients for all non-pyrethroid sediment chemistry constituents, and calculated mean values of the PEC quotients for each site. The PEC trigger (mean greater than 0.5) was not exceeded at either site.

High levels of naturally-occurring chromium and nickel in geologic formations (i.e., serpentinite) and soils can contribute to TEC and PEC quotients, particularly for sites located higher in the watersheds where contributing watersheds contain a higher percent of natural sources.

Table 5.14 provides a summary of the calculated TU equivalents for the pyrethroids for which there are published LC50 values in the literature, as well as a sum of TU equivalents for each site. Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the

LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured TOC concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid. The individual TU equivalents were summed to produce a total pyrethroid TU equivalent value for each site. Both sites exceed the MRP Table H-1 trigger with TU sums greater than or equal to 1.0. Bifenthrin was measured in TOC-normalized concentrations exceeding the LC50 at both sites. Bifenthrin is considered to be the leading cause of pyrethroid-related toxicity in urban areas (Ruby 2013).

Some of the calculated numbers for TEC quotients, PEC quotients, and pyrethroid TU equivalents may be artificially elevated due to the method used to account for filling in non-detect data. Concentrations equal to one-half of the respective laboratory method detection limits were substituted for non-detect data so these statistics could be computed.

Table 5.12. Threshold Effect Concentration (TEC) quotients for WY2014 sediment chemistry constituents, SMCWPPP. Bolded values indicate TEC quotient ≥ 1.0. Shaded cells indicate sum of TEC quotients ≥ 3.

Site ID, Creek	TEC	202R01308	204R01288
		Pilarcitos Creek	Laurel Creek
Metals (mg/kg DW)			
Arsenic	9.79	0.19	0.47
Cadmium	0.99	0.25	0.13
Chromium	43.4	0.25	**1.24**
Copper	31.6	0.22	0.82
Lead	35.8	0.14	0.36
Mercury	0.18	0.19	0.22
Nickel	22.7	0.48	**3.26**
Zinc	121	0.48	0.91
PAHs (µg/kg DW)			
Anthracene	57.2	0.03 [a]	0.03 [a]
Fluorene	77.4	0.04 [b]	0.02 [a]
Naphthalene	176	0.01 [a]	0.02
Phenanthrene	204	0.07	0.14
Benz(a)anthracene	108	0.03 [b]	0.11
Benzo(a)pyrene	150	0.01 [a]	0.01 [a]
Chrysene	166	0.11	0.25
Dibenz[a,h]anthracene	33.0	0.05 [a]	0.05 [a]
Fluoranthene	423	0.03	0.12
Pyrene	195	0.07	0.22
Total PAHs	1,610	0.06 [c]	0.14 [c]
Pesticides (µg/kg DW)			
Chlordane	3.24	0.20 [a]	0.20 [a]
Dieldrin	1.9	0.19 [a]	0.19 [a]
Endrin	2.22	0.17 [a]	0.17 [a]
Heptachlor Epoxide	2.47	0.13 [a]	0.13 [a]
Lindane (gamma-BHC)	2.37	0.14 [a]	0.14 [a]
Sum DDD	4.88	0.11 [c]	0.48 [c]
Sum DDE	3.16	0.45 [c]	**1.24** [c]
Sum DDT	4.16	0.08 [c]	0.08 [c]
Total DDTs	5.28	0.44 [c]	**1.25** [c]
Number of constituents with TEC quotient >= 1.0	-	0	4

a - concentration was below the method detection limit (MDL). PEC quotient calculated using 1/2 MDL.
b - PEC quotient calculated from concentration below the reporting limit (DNQ-flagged).
c - Total calculated using 1/2 MDLs.

Table 5.13. Probable Effect Concentration (PEC) quotients for WY2014 sediment chemistry constituents, SMCWPPP. Bolded values indicate individual PEC quotients > 1.0; shaded cells indicate PEC quotients > 0.5.

Site ID, Creek	PEC	202R01308	204R01288
		Pilarcitos Creek	Laurel Creek
Metals (mg/kg DW)			
Arsenic	33.0	0.06	0.14
Cadmium	4.98	0.05	0.03
Chromium	111	0.10	0.49
Copper	149	0.05	0.17
Lead	128	0.04	0.10
Mercury	1.06	0.03	0.04
Nickel	48.6	0.23	**1.52**
Zinc	459	0.13	0.24
PAHs (µg/kg DW)			
Anthracene	845	0.00 [a]	0.00 [a]
Fluorene	536	0.01 [b]	0.00 [a]
Naphthalene	561	0.00 [a]	0.01
Phenanthrene	1170	0.01	0.02
Benz(a)anthracene	1050	0.00 [b]	0.01
Benzo(a)pyrene	1450	0.00 [a]	0.00 [a]
Chrysene	1290	0.01	0.03
Fluoranthene	2230	0.00	0.02
Pyrene	1520	0.01	0.03
Total PAHs	22,800	0.00 [c]	0.01 [c]
Pesticides (µg/kg DW)			
Chlordane	17.6	0.04 [a]	0.04 [a]
Dieldrin	61.8	0.01 [a]	0.01 [a]
Endrin	207.0	0.00 [a]	0.00 [a]
Heptachlor Epoxide	16	0.02 [a]	0.02 [a]
Lindane (gamma-BHC)	4.99	0.07 [a]	0.07 [a]
Sum DDD	28	0.02 [c]	0.08 [c]
Sum DDE	31.3	0.05 [c]	0.13 [c]
Sum DDT	62.9	0.01 [c]	0.01 [c]
Total DDTs	572	0.00 [c]	0.01 [c]
Mean PEC Quotient	-	0.03	0.12

a - concentration was below the method detection limit (MDL). PEC quotient calculated using 1/2 MDL.
b - PEC quotient calculated from concentration below the reporting limit (DNQ-flagged).
c - Total calculated using 1/2 MDLs.

Table 5.14. Calculated pyrethroid toxic unit (TU) equivalents for WY2014 pyrethroid concentrations.

Pyrethroid	Unit	LC50	202R01308	204R01288
			Pilarcitos Creek	Laurel Creek
Bifenthrin	µg/g dw	0.52	1.06	5.19
Cyfluthrin	µg/g dw	1.08	0.24	1.02
Cypermethrin	µg/g dw	0.38	0.12 [a]	0.58
Deltamethrin	µg/g dw	0.79	0.22 [b]	0.66
Esfenvalerate	µg/g dw	1.54	0.03 [a]	0.03 [a]
Lambda-Cyhalothrin	µg/g dw	0.45	0.12 [a]	0.12 [a]
Permethrin	µg/g dw	10.83	0.15 [c]	0.32
Sum of Toxic Unit Equivalents per Site	-	-	1.93	7.92

a - concentration was below the method detection limit (MDL). PEC quotient calculated using 1/2 MDL.
b - PEC quotient calculated from concentration below the reporting limit (DNQ-flagged).
c - Total calculated using 1/2 MDLs.

5.4.6 Temperature

Temperature was monitored at six sites in San Mateo County from April through September 2014. Hourly measurements were recorded at one site in Alambique Creek, three sites in Bear Creek, and two sites in West Union Creek (tributary to Bear Creek). Alambique Creek is a tributary to Searsville Reservoir in the Corte Madera Creek watershed. Station locations are mapped in Figures 5.8. Loggers were deployed on April 17, 2014 and checked on August 14, 2014. Two sites (Alambique Creek and Bear Creek at Sand Hill) were completely dry during the field check, and their loggers were removed. A review of data from these loggers suggested that these sites dried up approximately one week before the field check (August 7, 2014). The other four sites remained wet during the entire sampling period and were removed September 29, 2014. Summary statistics for the water temperature data collected at the six sites are shown in Table 5.15.

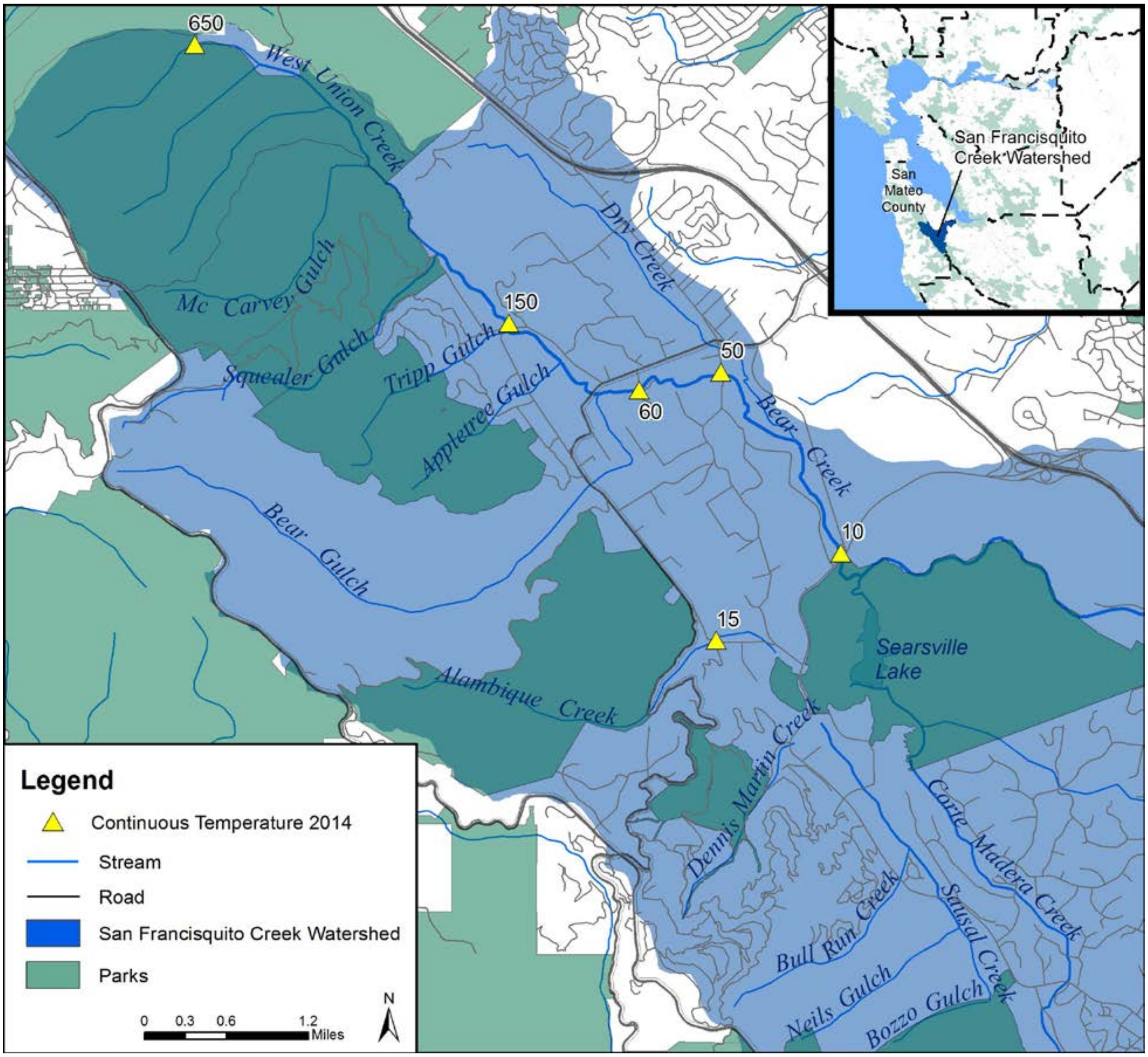

Figure 5.8. Continuous temperature stations in Alambique, Bear, and West Union Creeks, San Mateo County, WY2014.

Table 5.15 Descriptive statistics for continuous water temperature measured at six sites in San Mateo County Creeks from April 10th through September 29th, 2014.

	Creek Name	Alambique Creek	Bear Creek			West Union Creek	
	Location	Portola Rd	Sand Hill Rd	Mountain Home Rd	Fox Hollow Rd	Kings Mountain Rd	Phleger Estate
	Site ID	205ALA015	205BRC010	205BRC050	205BRC060	205WUN150	205WUN650
	Start Date	4/17/2014	4/17/2014	4/17/2014	4/17/2014	4/17/2014	4/10/2014
	End Date	8/7/2014	8/7/2014	9/29/2014	9/29/2014	9/29/2014	9/29/2014
Temperature (°C)	Minimum	9.9	11.2	10.7	10.9	11.5	9.7
	Median	13.5	16.1	15.7	15.8	15.0	14.5
	Mean	13.6	16.2	15.4	15.3	14.8	13.9
	Maximum	16.7	21.5	18.4	17.9	17.0	16.2
	Max 7-day Mean	15.8	19.4	17.7	17.2	16.7	15.8
	N	2700	2700	3964	3963	3963	4129

The results from the five sites in Bear and West Union Creeks show that temperatures were relatively consistent between sites with median temperatures ranging from 14.5 °C to 16.1 °C. Temperatures at the Alambique Creek site were slightly cooler (median temperature was 13.5 °C) during its slightly shorter deployment/wet period. Box plots showing the distribution of water temperature data at the six sites are shown in Figure 5.9 with the acute temperature threshold (24.0 °C) for reference. Temperatures were below the acute threshold at all sites.

Box plots showing the distribution of water temperature data, calculated as the 7-day mean, for the six sites are shown in Figure 5.10. The chronic (maximum 7-day mean) temperature threshold (19.0 °C) or Maximum Weekly Average Temperature (MWAT) is also shown in Figure 5.10 for reference.

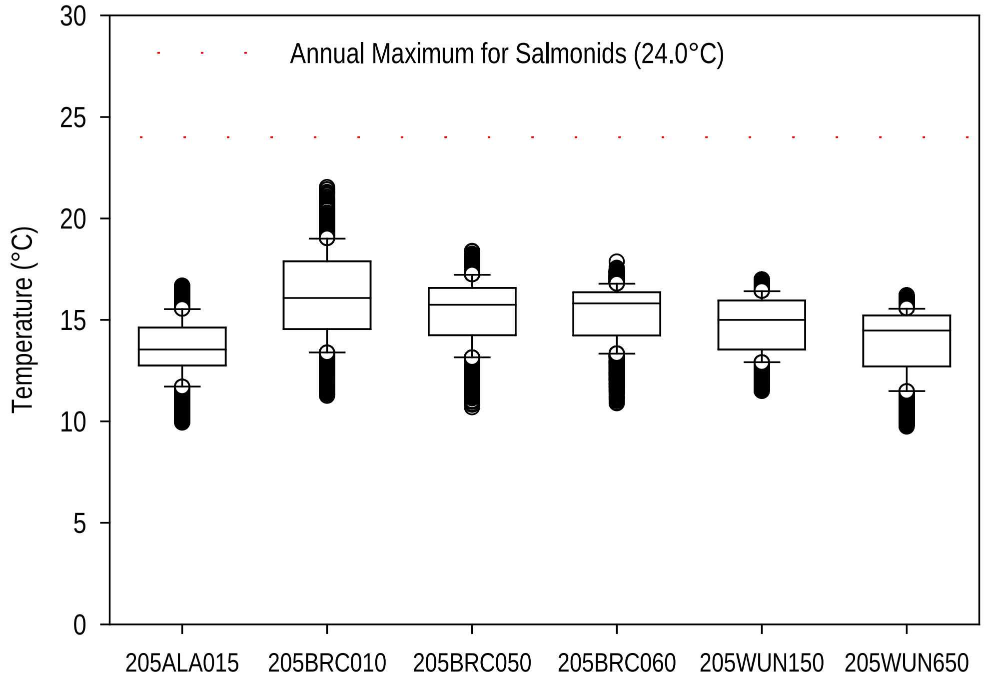

Figure 5.9. Box plots of water temperature data collected at one site in Alambique Creek, three sites in Bear Creek, two sites in West Union Creek in San Mateo County, from April through September 2014.

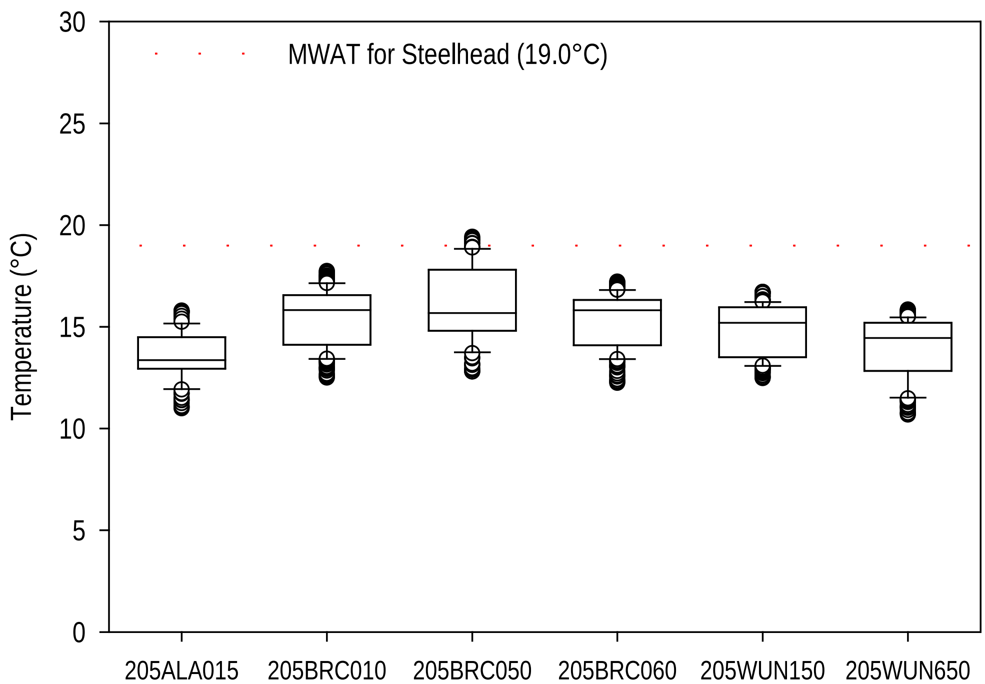

Figure 5.10. Box plots of water temperature data calculated as a rolling 7-day average, collected at one site in Alambique Creek, three sites in Bear Creek, two sites in West Union Creek, San Mateo County, from April through September 2014.

A few measurements in Bear Creek at Sand Hill Road exceeded the chronic temperature (MWAT) threshold. This may be the result of a shrinking pool prior to complete desiccation around August 7, 2014. Trigger analysis of temperature data using the MWAT threshold is shown in Table 5.16. A trigger is defined when the MWAT exceeds the threshold for more than 20% of records at a single site. No triggers were exceeded at any of the sites monitored in WY2014.

Table 5.16. Percent of water temperature data measured at six sites between April – September 2014 that exceeded the Maximum Weekly Average Temperature threshold value (19.0 °C).

Site ID	Creek	Site Name	Percentage results MWAT > 19ºC	Trigger (>20%) Exceeded
205ALA015	Alambique Creek	Portola Rd	0%	N
205BCR010	Bear Creek	Sand Hill	6%	N
205BCR050		Mountain Home Rd	0%	N
205BCR060		Fox Hollow Rd	0%	N
205WUN150	West Union Creek	Kings Mountain Rd	0%	N
205WUN650		Phleger Estate	0%	N

The Basin Plan (SFRWQCB 2013) designates several Beneficial Uses for Bear Creek that are associated with aquatic life uses, including COLD, WARM, MIGR, SPWN and RARE (Table 1.3). The Bear Creek watershed supports rearing and spawning habitat for steelhead trout throughout the Bear Creek mainstem and its major tributary, West Union Creek (Leidy et al. 2005). Recent work to improve fish passage at water diversion facilities has also provided steelhead access to portions of Bear Gulch. Fish barriers effectively block passage for steelhead in Alambique Creek, however, resident rainbow trout are supported in the lower reaches of the creek (Leidy et al. 2005).

Temperature data collected by SMCWPPP in WY2014 show that temperature does not appear to be a limiting factor for *Oncorhynchus mykiss*. A majority of the monitoring sites, however were located in pools within channels that had intermittent flow late in the dry season. As a result, the distribution of *Oncorhynchus mykiss* during the dry season of WY2014 would be limited to predominately pool habitat that provides minimal food resources due to lack of flowing water and riffle habitat upstream of the pools.

5.5 General Water Quality

Continuous general water quality measurements (temperature, dissolved oxygen, pH, specific conductance) were recorded at two stations in San Mateo Creek during two two-week sampling events in WY2014. Sample Events 1 and 2 were conducted in May and August/September 2014, respectively. Station locations are mapped in Figure 2.3. Summary statistics are listed in Table 5.17. Time series plots of the data collected during Event 1 are shown in Figure 5.11 and during Event 2 in Figure 5.12.

5.5.1 Temperature

Box plots showing the distribution of water temperature data collected at two sites in San Mateo Creek in WY2014 are shown in Figure 5.13. The chronic (maximum 7-day mean) temperature

(MWAT) threshold (19.0 °C) is shown in Figure 5.14. Trigger analysis of temperature data using the MWAT threshold is shown in Table 5.18. The MWAT threshold was never exceeded at either site during the two sampling events in WY2014.

Table 5.17. Descriptive statistics for continuous water temperature, dissolved oxygen, conductivity, and pH data measured at two sites in San Mateo Creek during WY2014. Data were collected every 15 minutes over a two week time period during May (Event 1) and August (Event 2).

Parameter	Data Type	204SMA059		204SMA080	
		May	August	May	August
Temperature (° C)	Min	12.7	16.5	12.0	15.7
	Median	15.4	17.8	14.8	17.4
	Mean	15.5	17.9	14.9	17.4
	Max	18.7	19.8	17.6	17.4
	Max 7-day Mean	15.8	18.0	15.2	17.7
Dissolved Oxygen (mg/l)	Min	8.3	5.7	8.5	8.0
	Median	9.2	7.9	9.3	8.6
	Mean	9.4	8.0	9.4	8.7
	Max	11.0	8.9	10.5	10.1
	7-day Avg. Min	8.6	7.0	8.6	8.1
pH	Min	7.6	7.5	7.4	7.5
	Median	8.0	7.7	7.8	7.6
	Mean	8.0	7.7	7.8	7.6
	Max	8.4	7.9	8.1	8.0
Specific Conductance (µS/cm)	Min	199	261	177	232
	Median	330	270	299	242
	Mean	329	271	300	243
	Max	407	290	366	310
Total number data points (n)		1729	1735	1725	1738

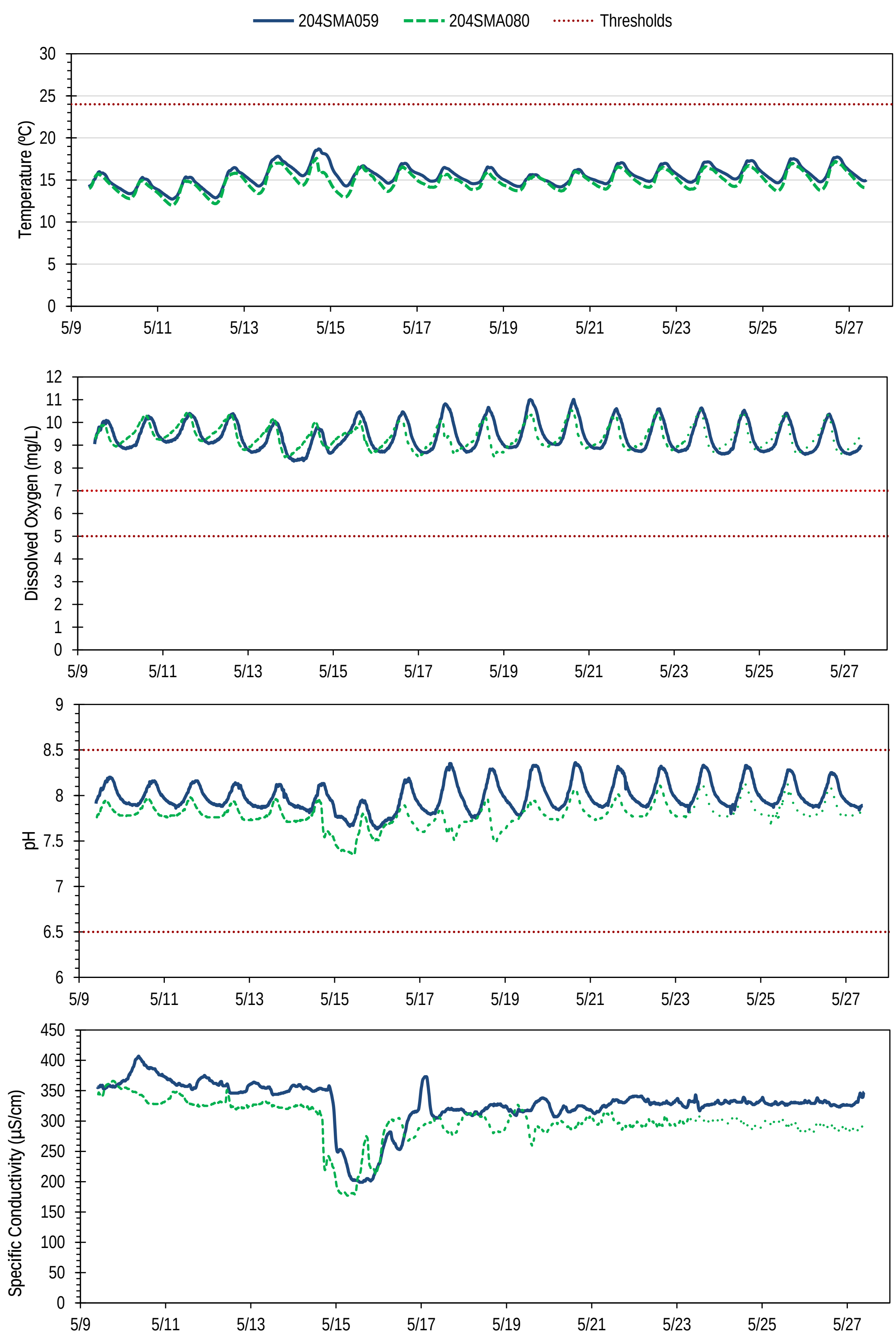

Figure 5.11 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected at two sites in San Mateo Creek during May 9-27, 2014 (Event 1).

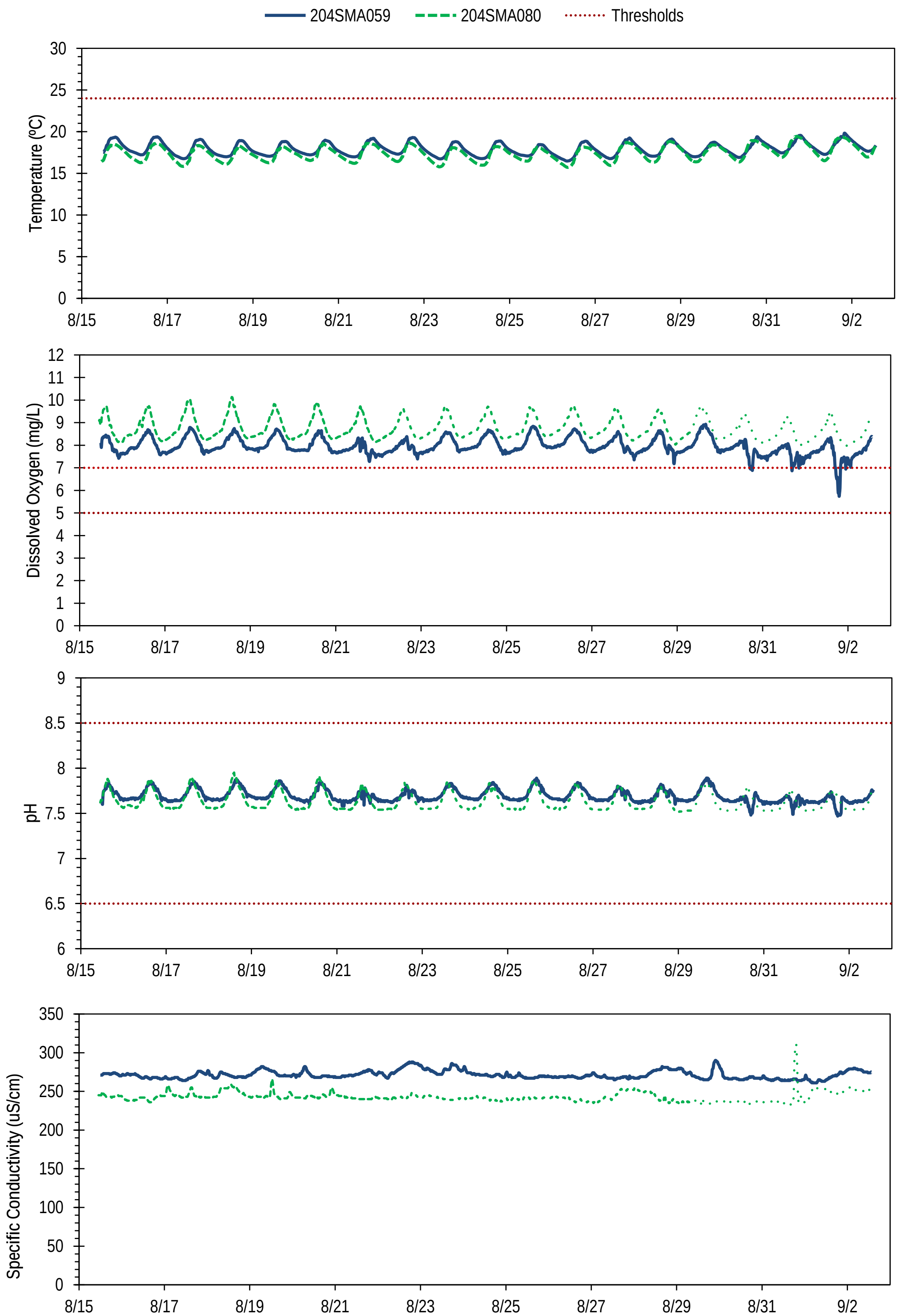

Figure 5.12 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected at two sites in San Mateo Creek during August 15th-September 2nd, 2014 (Event 2).

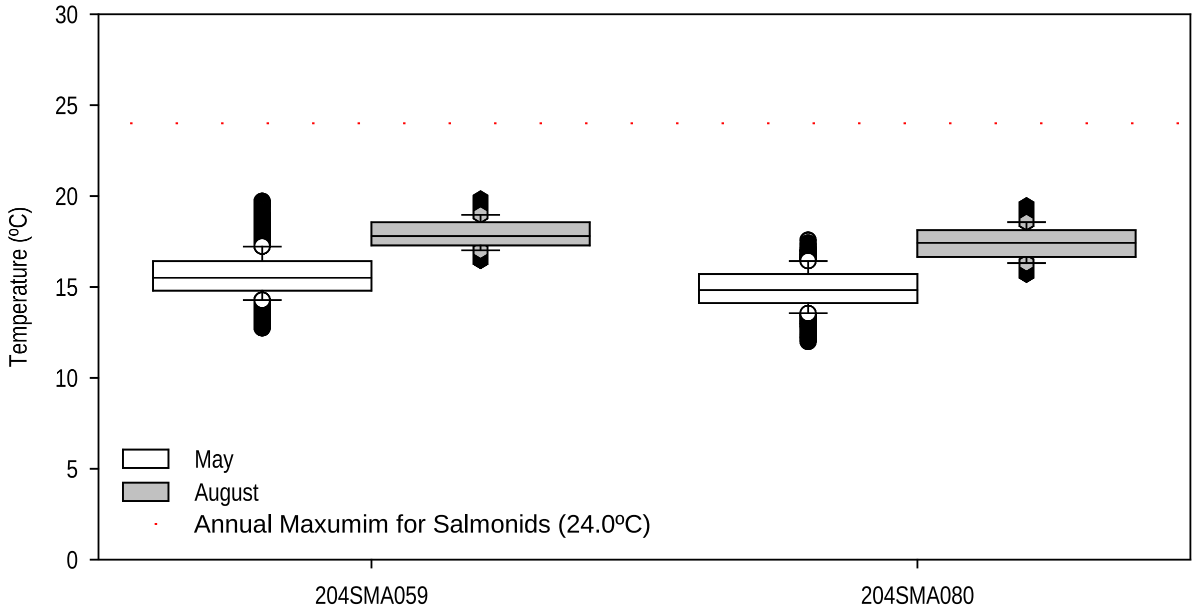

Figure 5.13. Box plots of water temperature data, measured during two sampling events in WY2014 at two sites in San Mateo Creek compared to the annual maximum temperature for salmonids.

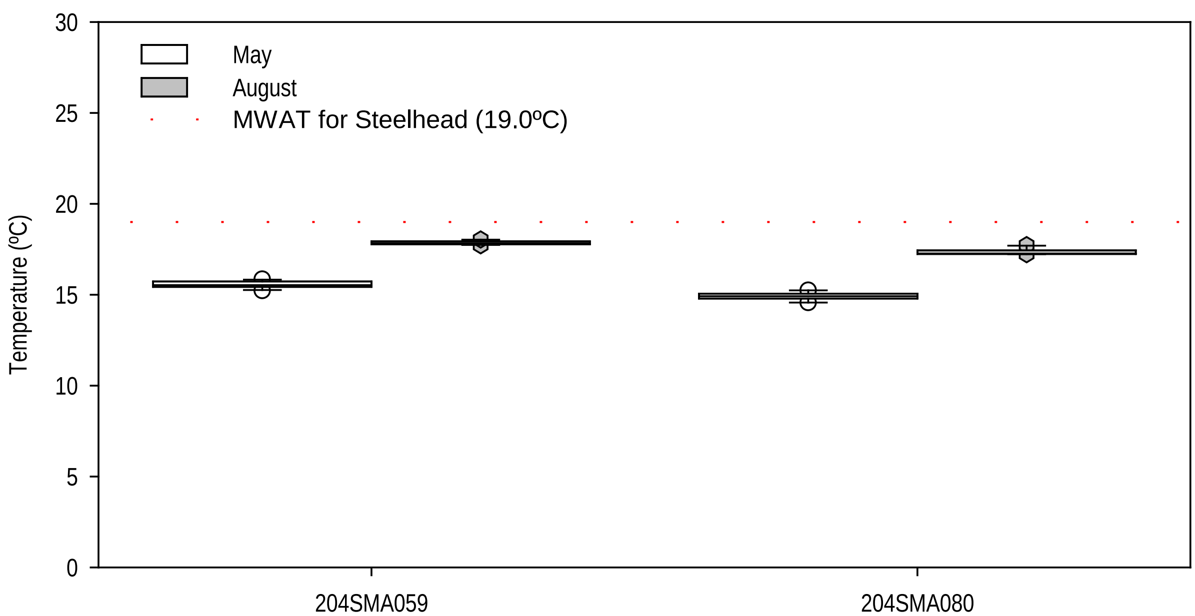

Figure 5.14. Box plots of water temperature data, calculated as a rolling 7-day average, collected during two sampling events in WY2014 at two sites in San Mateo Creek compared to the MWAT for salmonids.

Table 5.18. Percent of temperature data measured during two events at two sites in San Mateo Creek that exceed trigger values identified in Table 3.2.

Site ID	Creek Name	Site	Monitoring Event	*Percent results MWAT > 19 °C*
204SMA059	San Mateo	DeAnza Park	May	0%
			August	0%
204SMA080		Sierra & El Ceritto	May	0%
			August	0%

The Basin Plan (SFRWQCB 2013) designates several Beneficial Uses for San Mateo Creek that are associated with aquatic life uses, including COLD, WARM, MIGR, SPWN and RARE (Table 1.3). The data collected by SMCWPPP in WY2014 indicate that water temperature does not appear to adversely affect the aquatic life uses in the urban reach of San Mateo Creek between El Camino Real and Sierra Drive. Temperatures during the dry season may be controlled by increased summer discharges from Crystal Springs Reservoir that began in 2014 as a result of the dam improvements by the San Francisco Public Utilities Commission (SFPUC).

5.5.2 Dissolved Oxygen

Figure 5.15 compares dissolved oxygen (DO) levels measured during the two sampling events at the San Mateo Creek sites to the Basin Plan WQOs for WARM (5.0 mg/L) and COLD (7.0 mg/L) Beneficial Uses. In general, the DO measurements were above the WQOs for DO for both WARM and COLD; the WQO for WARM was exceeded for only 1% of the measurements taken at site 204SMA059 during Event 2. (Table 5.19).

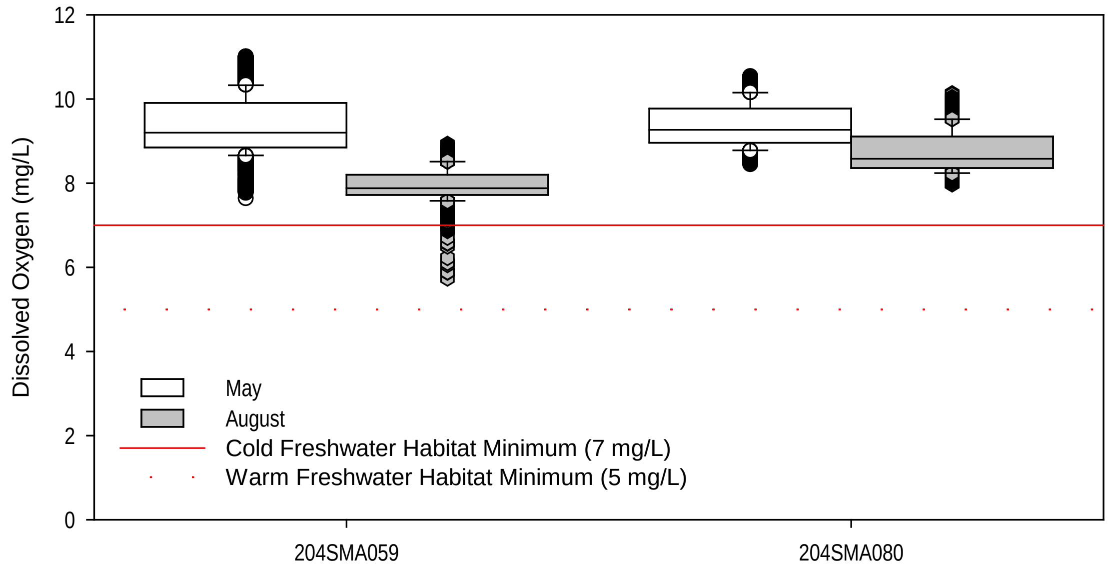

Figure 5.15. Box plots of dissolved oxygen data collected using sondes during two sampling events at sites in San Mateo Creek compared to Basin Plan Water Quality Objectives.

Table 5.19. Percent of dissolved oxygen data measured during two events at two sites in San Mateo Creek that are below trigger values identified in Table 4.2.

Site ID	Creek Name	Site	Monitoring Event	*Percent Results DO < 5.0 mg/L*	*Percent Results DO < 7.0 mg/L*
204SMA059	San Mateo	DeAnza Park	May	0%	0%
			August	0%	1%
204SMA080		Sierra Dr & El Cerrito Ave	May	0%	0%
			August	0%	0%

Juvenile steelhead rearing and spawning habitat is primarily within a two-mile reach of San Mateo Creek below the Crystal Springs Reservoir (Brinkerhoff, SFPUC, personal communication, 2013). This reach is upstream of the two monitoring locations. The water quality data collected at these locations indicate that dissolved oxygen levels would not impact aquatic life uses for either WARM or COLD Habitat Beneficial Uses. As discussed in the previous section, increased summer discharges from Crystal Springs reservoir in 2014 resulted in higher baseflows and improved water quality conditions as compared to 2013.

5.5.3 pH

Figure 5.16 compares pH levels measured during the two sampling events in WY2014 at the San Mateo Creek sites to the Basin Plan WQOs for pH (< 6.5 and/or > 8.5). The pH measurements never exceeded the WQOs at any of the sampling locations.

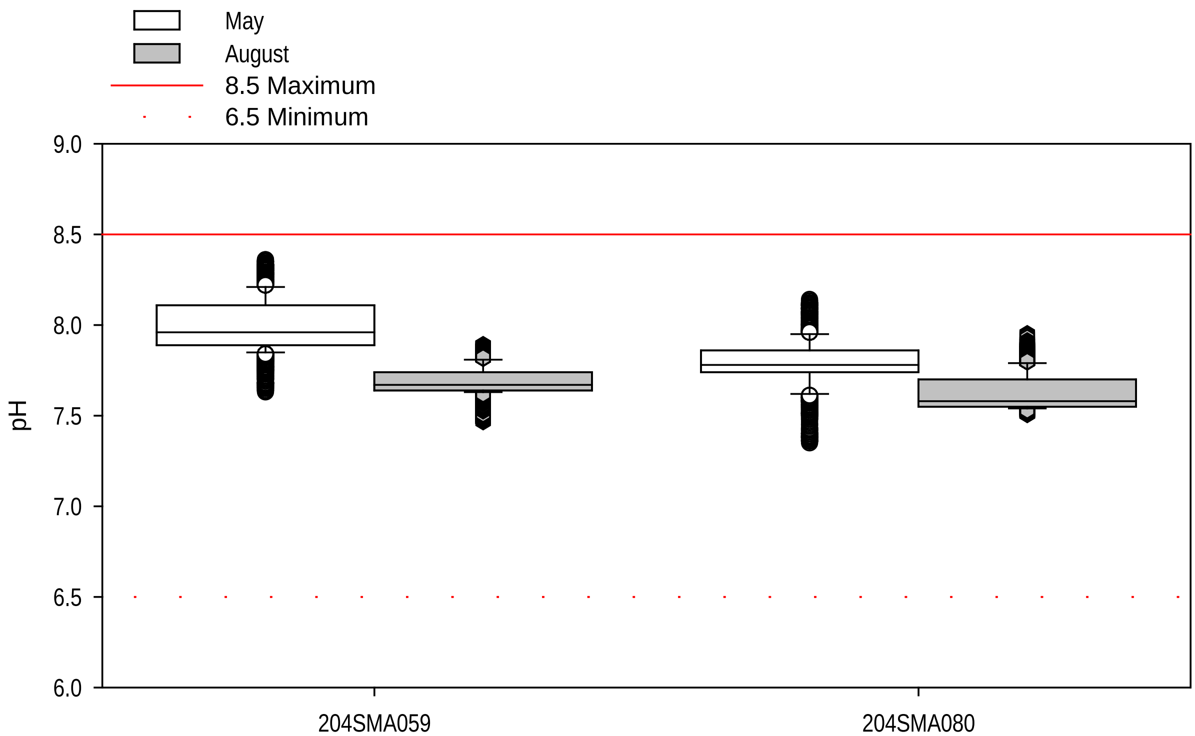

Figure 5.16. Box plots of pH data measured during two sampling events at sites in San Mateo Creek compared to Basin Plan WQOs.

5.5.4 Specific Conductivity

Box plots showing the distribution of specific conductivity measurements taken during 2014 at the San Mateo Creek sites are shown in Figure 5.17. The average concentrations and the range of concentrations recorded were lower at both sites during the August deployment, perhaps as a result of Crystal Springs reservoir releases which may comprise a greater proportion of total flow compared to local runoff and seepage which presumably decrease in late summer. There are no WQOs or thresholds for this parameter, so an evaluation of trigger exceedance was not conducted.

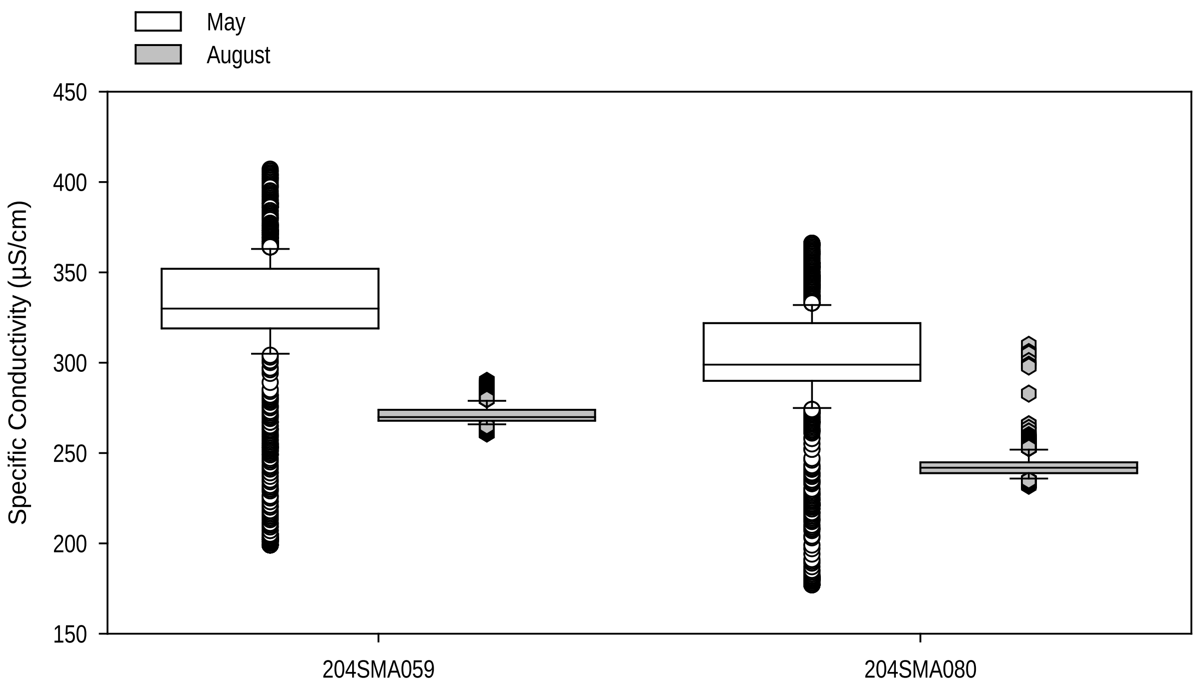

Figure 5.17. Box plots of specific conductivity measurements collected during two sampling events at sites in San Mateo Creek, WY2014.

5.6 Pathogen Indicators

Pathogen indicator densities were measured during one sampling event in WY2014 at stations along San Mateo Creek and at the mouth of Polhemus Creek. Results are listed in Table 5.20 and stations are mapped in Figure 5.18. All sites monitored for pathogen indicators are designated for both contact (REC-1) and non-contact (REC-2) water recreation Beneficial Uses, although none of the stations could be considered "bathing beaches." Only one station (204SMA060 – De Anza Park) is sited at a creekside park. Other stations were selected to characterize geographic patterns of pathogen indicator densities within the watershed. During this one grab sampling event, there is an increase in pathogen indicator densities in the downstream direction. The downstream-most station (204SMA060 – De Anza Park) exceeded the Basin Plan fecal coliform WQO and the 2012 EPA *E. coli* criterion for recreational waters. An ongoing SSID study is investigating the extent and source(s) of pathogen indicators in San Mateo Creek.

Comparison of fecal indicator results from local creeks to existing WQOs for REC-1 may not be appropriate and such comparisons should be made only with several caveats:

- The Standard Methods MPN (Most Probably Number) 95% Confidence Level range varies from approximately 1/3 to 4 times the estimated reported densities indicating a relatively high level of uncertainty regarding actual values.
- The correlation between the presence of bacterial indicator organisms and pathogens of public health concern is highly uncertain.
- The method used to derive these criteria makes their application to data from local watersheds questionable. The criteria are based upon epidemiological studies of people recreating at <u>bathing</u> <u>beaches</u> that received bacteriological contamination via treated <u>human</u> <u>wastewater</u>. Applying these criteria to data collected from creeks where ingestion of the water is highly unlikely relative to a bathing beach is highly questionable.
- Sources of fecal indicators in the watershed likely include non-human sources (e.g., wildlife and domestic animals); non-human fecal contamination may pose a lower risk to water contact recreators. Recent research indicates that the source of fecal contamination is critical to understanding the human health risk associated with its contamination of recreational waters, and that the amount of human health risk in recreational waters varies with various fecal sources (USEPA 2011).

Table 5.20. Fecal coliform and *E. coli* levels measured in San Mateo County during WY2014.

Site ID	Creek Name	Site Name	*Fecal Coliform (MPN/100ml)*	*E. Coli (MPN/100ml)*	Sample Date
		Trigger Threshold	*400*	*410*	
204SMA060	San Mateo Creek	DeAnza Park	1700	1700	7/8/14
204SMA080		Sierra Drive	300	300	7/8/14
204SMA100		Tartan Trail	50	50	7/8/14
204SMA119		USGS Gage	8	4	7/8/14
204SMA110	Polhemus Creek	At Mouth	30	30	7/8/14

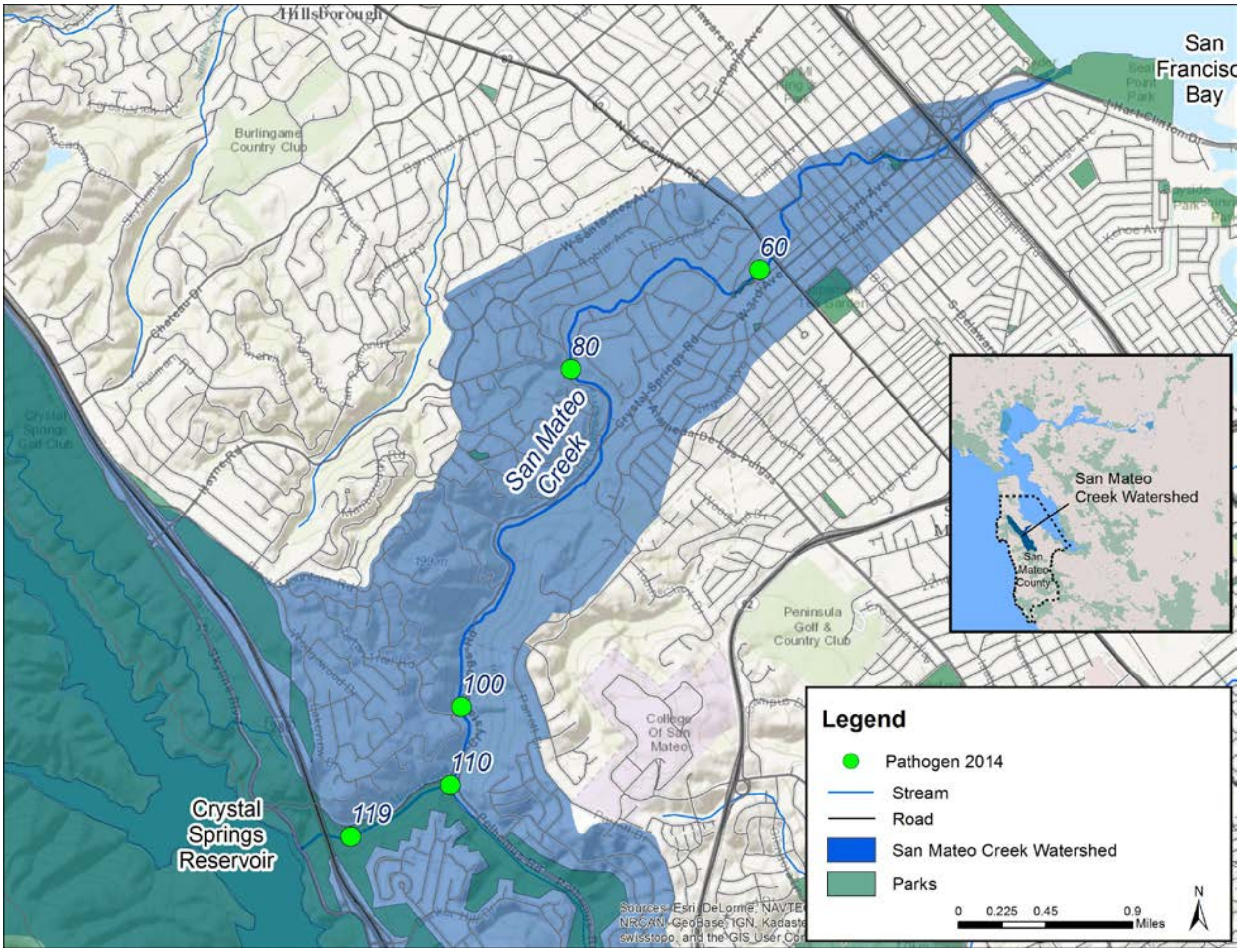

Figure 5.18. Pathogen indicator sampling stations in San Mateo Creek watershed, WY2014.

6.0 Conclusions

The following conclusions from the MRP creek status monitoring conducted during WY2014 in San Mateo County are based on the management questions presented in Section 1.0:

1) ***Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers, and tributaries?***

2) ***Are conditions in local receiving water supportive of or likely supportive of beneficial uses?***

The first management question is addressed primarily by comparison of probabilistic and targeted monitoring data to the triggers defined in Table 4.2. A summary of trigger exceedances observed for each site is presented in Table 6.1. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other Beneficial Uses and are considered for future evaluation of stressor source identification studies.

The second management question is addressed primarily through calculation of indices of biological integrity (IBI) using benthic macroinvertebrate and algae data collected at probabilistic sites. Biological condition scores were compared to physical habitat and water quality data collected synoptically with bioassessments to evaluate whether any correlations exist that may help explain the variation in scores.

Biological Condition

- The California Stream Condition Index (CSCI) tool was used to assess the biological condition for benthic macroinvertebrate data collected at probabilistic sites. There was one site rated as “likely intact” (CSCI score $\geq$ 0.92); one site rated as “likely altered” (CSCI score 0.79 – 0.92), and eight sites rated as “very likely altered” ($\leq$ 0.63).
- An Algae IBI based on a combination of soft algae and diatom metrics (referred to as “H20”) was used to evaluate benthic algae data collected synoptically with bioassessments at probabilistic sites. No condition categories have been developed for “H20” Algae IBI scores. The algae IBI results should be considered preliminary until additional data show that these tools perform well for evaluating algae data collected in San Mateo County creeks.
- Algae IBI scores ranged from 36 to 59. They were poorly correlated with CSCI scores (R^2 = 0.02), indicating different stressors may be impacting benthic macroinvertebrates compared to benthic algae.
- Physical habitat (PHAB) and riparian assessment (CRAM) scores were both poorly correlated with CSCI and Algae IBI scores. None of the environmental stressor variables were significantly correlated to CSCI or Algae IBI scores.
- There was very little difference in CSCI scores or Algae IBI scores between perennial (n=7) and non-perennial (n=3) sites. Both CSCI scores and Algae IBI scores had limited response to different levels of urbanization (calculated as percent impervious area).

Nutrients and Conventional Analytes

- Nutrients (nitrogen and phosphorus), algal biomass indicators, and other conventional analytes were measured in grab water samples collected concurrently with bioassessments which were conducted in the spring season. The unionized ammonia concentration calculated for one sample (Cordilleras Creek; 204R01012) exceeded the trigger threshold. However, this result was flagged as questionable due to an elevated field pH (9.46) used in the calculation. No other samples exceeded the MRP trigger thresholds.

Chlorine

- Free chlorine and total chlorine residual concentrations were measured using field meters during spring bioassessments at ten sites and summer toxicity and sediment sampling at two sites. Twelve measurements were collected at ten sites during WY2014. Two of the 12 samples, both collected during the spring event, exceeded the threshold for total chlorine residual. Both sites (204R01012 – Cordilleras Creek; 204R01288 – Laurel Creek) are within the urban envelope where chlorine residuals are commonly detected. Laurel Creek was resampled for chlorine during the summer toxicity sampling event and did not exceed the trigger.

Water Toxicity

- Water toxicity samples were collected from two sites at a frequency of twice per year during 2014. No water toxicity samples exceeded the MRP trigger thresholds.

Sediment Toxicity and Chemistry

- Sediment toxicity and chemistry samples were collected concurrently with the summer water toxicity samples. Neither of the sites exceeded the MRP trigger for sediment toxicity; however, both sites exceeded the trigger threshold for sediment chemistry. Sediment chemistry trigger exceedances at both sites were the result of pyrethroid concentrations exceeding LC50s. Concentrations of metals associated with serpentinite geology contributed to the TEC trigger exceedance at Laurel Creek.

Spatial and Temporal Variability of Water Quality Conditions

- There was minimal spatial variability in water temperature across the five sites in Bear Creek watershed.

- Dissolved oxygen concentrations were similar between the two San Mateo Creek sites, but were slightly lower during Event 2 compared to Event 1.

Potential Impacts to Aquatic Life

- There were no exceedances of the Maximum Weekly Average Temperature (MWAT) threshold at any of the temperature monitoring sites, with the exception of site 205BRC010 in Bear Creek where 6% of the measurements exceeded MWAT (not a trigger exceedance). Similarly, the two continuous monitoring stations in San Mateo Creek did not exceed MWAT. These results suggest that water temperature is not a limiting factor for resident steelhead population at any of the sites.

- In general, dissolved oxygen concentrations at both sites monitored in San Mateo Creek met WARM and COLD WQOs. Increased summer releases below Crystal Springs

Reservoir in 2014 may have resulted in water quality conditions more supportive for aquatic life uses.

- Values for pH met WQOs at both sites in San Mateo Creek.

Potential Impacts to Water Contact Recreation

- In WY2014, pathogen indicator sites were focused in San Mateo Creek where a bacteria SSID study is in progress. Pathogen indicator triggers were exceeded at one of the five sites.

- It is important to recognize that pathogen indicator thresholds are based on human recreation at beaches receiving bacteriological contamination from human wastewater, and may not be applicable to conditions found in urban creeks. As a result, the comparison of pathogen indicator results to body contact recreation water quality objectives may not be appropriate and should be interpreted cautiously.

Table 6.1. Summary of SMCWPPP MRP trigger threshold exceedance analysis, WY2014. “No” indicates samples were collected but did not exceed the MRP trigger; “Yes” indicates an exceedance of the MRP trigger.

Station Number	Creek Name	Probabilistic Sites						Targeted Sites			
		Bioassessment	Nutrients	Chlorine	Water Toxicity	Sediment Toxicity	Sediment Chemistry	Temperature	Dissolved Oxygen	pH	Pathogen Indicators
202R00328	Pilarcitos Creek	No	No	No	--	--	--	--	--	--	--
202R00972	Arroyo de en Medio	Yes	No	No	--	--	--	--	--	--	--
202R01308	Pilarcitos Creek	Yes	No	No	No	No	Yes	--	--	--	--
204R01012	Cordilleras Creek	Yes	Yes[a]	Yes	--	--	--	--	--	--	--
204R01204	Burlingame Creek	Yes	No	No	--	--	--	--	--	--	--
204R01256	Arroyo Ojo de Agua	Yes	No	No	--	--	--	--	--	--	--
204R01268	Redwood Creek	Yes	No	No	--	--	--	--	--	--	--
204R01288	Laurel Creek	Yes	No	Yes	No	No	Yes	--	--	--	--
204R01460	Sanchez Creek	Yes	No	No	--	--	--	--	--	--	--
204SMA059	San Mateo Creek	--	--	--	--	--	--	No	No	No	--
204SMA060	San Mateo Creek	--	--	--	--	--	--	--	--	--	Yes
204SMA080	San Mateo Creek	--	--	--	--	--	--	No	No	No	No
204SMA100	San Mateo Creek	--	--	--	--	--	--	--	--	--	No
204SMA110	Polhemus Creek	--	--	--	--	--	--	--	--	--	No
204SMA119	San Mateo Creek	--	--	--	--	--	--	--	--	--	No
205ALA015	Alambique Creek	--	--	--	--	--	--	No	--	--	--
205BCR010	Bear Creek	--	--	--	--	--	--	No	--	--	--
205BCR050	Bear Creek	--	--	--	--	--	--	No	--	--	--
205BCR060	Bear Creek	--	--	--	--	--	--	No	--	--	--
205R01192	Corte Madera Creek	Yes	No	No	--	--	--	--	--	--	--
205WUN150	West Union Creek	--	--	--	--	--	--	No	--	--	--
205WUN650	West Union Creek	--	--	--	--	--	--	No	--	--	--

[a] The unionized ammonia concentration was flagged as questionable due to an unusually high field pH used in the calculation.

6.1 Management Implications

The Program’s Creek Status Monitoring program (consistent with MRP Provision C.8.c) focuses on assessing the water quality condition of urban creeks in San Mateo County and identifying stressors and sources of impacts observed. Although the sample size from WY2014 (overall n=10) is not sufficient to develop statistically representative conclusions regarding the overall condition of all creeks, it is clear that most urban portions have likely or very likely altered populations of aquatic life indicators (e.g., aquatic macroinvertebrates). These conditions are likely the result of long-term changes in stream hydrology, channel geomorphology and in-stream habitat complexity, and other modifications to the watershed and riparian areas associated with urban development that has occurred over the past 50 plus years in the contributing watersheds. Additionally, pyrethroid pesticides are present in creek sediments at concentrations known to adversely affect sensitive aquatic organisms (i.e., LC50s), and episodic or site specific increases in temperature and decreases in dissolved oxygen (particularly in lower creek reaches) are not optimal for aquatic life in local creeks.

SMCWPPP Permittees are actively implementing many stormwater management programs to address these and other stressors and associated sources of water quality conditions observed in local creeks, with the goal of protecting these natural resources. For example:

- In compliance with MRP Provision C.3, new and redevelopment projects in the Bay Area are now designed to more effectively reduce water quality and hydromodification impacts associated with urban development. Low impact development (LID) methods, such as rainwater harvesting and use, infiltration and biotreatment are now required as part of development and redevelopment projects. These LID measures are expected to reduce the impacts of urban runoff and associated impervious surfaces on stream health.

- In compliance with MRP Provision C.9, Permittees are implementing pesticide toxicity control programs that focus on source control and pollution prevention measures. The control measures include the implementation of integrated pest management (IPM) policies/ordinances, public education and outreach programs, pesticide disposal programs, the adoption of formal State pesticide registration procedures, and sustainable landscaping requirements for new and redevelopment projects. Through these efforts, it is estimated that the amount of pyrethroids observed in urban stormwater runoff will decrease by 80-90% over time, and in turn significantly reduce the magnitude and extent of toxicity in local creeks.

- Trash loadings to local creeks are also being reduced through implementation of new control measures in compliance with MRP Provision C.10 and other efforts by Permittees to reduce the impacts of illegal dumping directly into waterways. These actions include the installation and maintenance of trash capture systems, the adoption of ordinances to reduce the impacts of litter prone items, enhanced institutional controls such as street sweeping, and the on-going removal and control of direct dumping.

- In compliance with MRP Provisions C.2 (Municipal Operations), C.4 (Industrial and Commercial Site Controls), C.5 (Illicit Discharge Detection and Elimination), and C.6 (Construction Site Controls) Permittees continue to implement programs that are designed to prevent non-stormwater discharges during dry weather and reduce the exposure of contaminants to stormwater and sediment in runoff during rainfall events.

- In compliance with MRP Provision C.13, copper in stormwater runoff is reduced through implementation of controls such as architectural and site design requirements, street sweeping, and participation in statewide efforts to significantly reduce the level of copper vehicle brake pads.

Through the continued implementation of MRP-associated and other watershed stewardship programs, SMCWPPP anticipates that stream conditions and water quality in local creeks will continue to improve overtime. In the near term, toxicity observed in creeks should decrease as pesticide regulations better incorporate water quality concerns during the pesticide registration process. In the longer term, control measures implemented to “green” the “grey” infrastructure and disconnect impervious areas constructed over the course of the past 50 plus years will take time to implement. Consequently, it may take several decades to observe the outcomes of these important, large-scale improvements to our watersheds in our local creeks. Long-term creek status monitoring programs designed to detect these changes over time are therefore beneficial to our collective understanding of the condition and health of our local waterways.

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ATTACHMENTS

Attachment A
Site Evaluation Details

Attachment A. SMCWPPP Site Evaluation Details for WY 2012 – 2014.

Station Code	Stratum	Agency Code	Evaluation Date	Target Status Code	Target Status Detail
204R00008	SM_R2_Urb	SMCWPPP	2012	TNS	TNS_PD
202R00012	SM_R2_Nonurb	SWAMP	2012	NT	NT_NLSF
202R00024	SM_R2_Nonurb	SMCWPPP	2012	T	Target
202R00028	SM_R2_Urb	SMCWPPP	2012	TNS	TNS_IA
202R00038	SM_R2_Nonurb	SWAMP	2012	T	Target
204R00040	SM_R2_Urb	SMCWPPP	2012	NT	NT_NLSF
202R00054	SM_R2_Nonurb	SWAMP	2012	TNS	TNS_PD
202R00056	SM_R2_Nonurb	SWAMP	2012	TNS	TNS_PD
202R00072	SM_R2_Nonurb	SMCWPPP	2012	T	Target
202R00076	SM_R2_Nonurb	SMCWPPP	2012	TNS	TNS_PD
202R00087	SM_R2_Urb	SMCWPPP	2012	T	Target
205R00088	SM_R2_Urb	SMCWPPP	2012	T	Target
202R00102	SM_R2_Nonurb	SWAMP	2012	NT	NT_NLSF
202R00104	SM_R2_Nonurb	SWAMP	2012	T	Target
202R00120	SM_R2_Nonurb	SMCWPPP	2013	TNS	TNS_PD
202R00136	SM_R2_Nonurb	SMCWPPP	2013	NT	NT_NLSF
202R00140	SM_R2_Urb	SMCWPPP	2012	TNS	TNS_IA
202R00150	SM_R2_Nonurb	SWAMP	2013	T	Target
202R00152	SM_R2_Nonurb	SWAMP	2013	TNS	TNS_PD
202R00166	SM_R2_Nonurb	SWAMP	2012	T	Target
205R00168	SM_R2_Urb	SMCWPPP	2012	T	Target
204R00180	SM_R2_Urb	SMCWPPP	2012	T	Target
202R00184	SM_R2_Nonurb	SMCWPPP	2013	TNS	TNS_IA
204R00200	SM_R2_Urb	SMCWPPP	2012	T	Target
202R00204	SM_R2_Urb	SMCWPPP	2012	TNS	TNS_IA
202R00214	SM_R2_Nonurb	SWAMP	2013	T	Target
202R00216	SM_R2_Nonurb	SMCWPPP	2013	TNS	TNS_PD
202R00230	SM_R2_Nonurb	SMCWPPP	2013	TNS	TNS_IA
204R00232	SM_R2_Urb	SMCWPPP	2012	T	Target
202R00243	SM_R2_Nonurb	SMCWPPP	2013	NT	NT_NLSF
204R00244	SM_R2_Urb	SMCWPPP	2012	T	Target
202R00248	SM_R2_Nonurb	SMCWPPP	2013	T	Target
202R00250	SM_R2_Nonurb	SMCWPPP	2013	TNS	TNS_PD
204R00264	SM_R2_Urb	SMCWPPP	2012	NT	NT_NC
202R00268	SM_R2_Nonurb	SWAMP	2013	T	Target
202R00280	SM_R2_Nonurb	SMCWPPP	2013	T	Target
202R00284	SM_R2_Urb	SMCWPPP	2012	T	Target
202R00294	SM_R2_Nonurb	SWAMP	2013	TNS	TNS_IA

Station Code	Stratum	Agency Code	Evaluation Date	Target Status Code	Target Status Detail
205R00296	SM_R2_Nonurb	SWAMP	2013	T	Target
205R00307	SM_R2_Urb	SMCWPPP	2012	TNS	TNS_PD
202R00312	SM_R2_Nonurb	SWAMP	2014	T	Target
202R00328	SM_R2_Nonurb	SMCWPPP	2014	T	Target
204R00332	SM_R2_Nonurb	SMCWPPP	2014	TNS	TNS_IA
202R00344	SM_R2_Nonurb	SMCWPPP	2014	NT	NT_NLSF
202R00376	SM_R2_Nonurb	SWAMP	2014	T	Target
204R00424	SM_R2_Urb	SMCWPPP	2012	NT	NT_NLSF
204R00436	SM_R2_Urb	SCVURPPP	2013	T	Target
204R00500	SM_R2_Urb	SMCWPPP	2012	NT	NT_P
204R00520	SM_R2_Urb	SMCWPPP	2013	T	Target
202R00588	SM_R2_Urb	SMCWPPP	2012	NT	NT_P
205R00616	SM_R2_Urb	SMCWPPP	2013	TNS	TNS_PD
202R00652	SM_R2_Urb	SMCWPPP	2013	TNS	TNS_IA
204R00680	SM_R2_Urb	SMCWPPP	2013	T	Target
204R00692	SM_R2_Urb	SMCWPPP	2013	NT	NT_NLSF
204R00712	SM_R2_Urb	SMCWPPP	2012	NT	NT_T
202R00716	SM_R2_Urb	SMCWPPP	2013	TNS	TNS_IA
205R00728	SM_R2_Urb	SMCWPPP	2013	NT	NT_NLSF
205R00792	SM_R2_Urb	SMCWPPP	2013	NT	NT_NLSF
204R00807	SM_R2_Urb	SMCWPPP	2013	T	Target
205R00808	SM_R2_Urb	SMCWPPP	2013	TNS	TNS_PD
205R00872	SM_R2_Urb	SMCWPPP	2013	T	Target
204R00884	SM_R2_Urb	SMCWPPP	2013	T	Target
202R00908	SM_R2_Urb	SMCWPPP	2013	T	Target
204R00936	SM_R2_Urb	SMCWPPP	2013	NT	NT_NLSF
204R00948	SM_R2_Urb	SMCWPPP	2013	NT	NT_AGDITCH
202R00972	SM_R2_Urb	SMCWPPP	2014	T	Target
205R00984	SM_R2_Urb	SMCWPPP	2013	T	Target
204R01012	SM_R2_Urb	SMCWPPP	2014	T	Target
204R01032	SM_R2_Urb	SMCWPPP	2013	NT	NT_NLSF
205R01047	SM_R2_Urb	SMCWPPP	2014	NT	NT_NC
202R01052	SM_R2_Urb	SMCWPPP	2014	TNS	TNS_IA
202R01164	SM_R2_Urb	SMCWPPP	2014	TNS	TNS_PD
205R01192	SM_R2_Urb	SMCWPPP	2014	T	Target
204R01204	SM_R2_Urb	SMCWPPP	2014	T	Target
204R01224	SM_R2_Urb	SMCWPPP	2014	TNS	TNS_IA
202R01228	SM_R2_Urb	SMCWPPP	2014	TNS	TNS_IA
204R01256	SM_R2_Urb	SMCWPPP	2014	T	Target
204R01268	SM_R2_Urb	SMCWPPP	2014	T	Target

Station Code	Stratum	Agency Code	Evaluation Date	Target Status Code	Target Status Detail
204R01288	SM_R2_Urb	SMCWPPP	2014	T	Target
202R01308	SM_R2_Urb	SMCWPPP	2014	T	Target
205R01331	SM_R2_Urb	SMCWPPP	2014	TNS	TNS_PD
202R01356	SM_R2_Urb	SMCWPPP	2014	U	U_AU
205R01384	SM_R2_Urb	SMCWPPP	2014	NT	NT_NLSF
202R01420	SM_R2_Urb	SMCWPPP	2014	TNS	TNS_IA
204R01448	SM_R2_Urb	SMCWPPP	2014	U	U_AU
204R01460	SM_R2_Urb	SMCWPPP	2014	T	Target
202R01484	SM_R2_Urb	SMCWPPP	2014	NT	NT_NLSF
204R01524	SM_R2_Urb	SMCWPPP	2014	U	U_AU
205R01560	SM_R2_Urb	SMCWPPP	2014	NT	NT_NLSF
202R01564	SM_R2_Urb	SMCWPPP	2014	U	U_AU
205R01587	SM_R2_Urb	SMCWPPP	2014	U	U_AU
202R01612	SM_R2_Urb	SMCWPPP	2014	U	U_AU
202R01676	SM_R2_Urb	SMCWPPP	2014	U	U_AU
205R01704	SM_R2_Urb	SMCWPPP	2014	U	U_AU
204R01716	SM_R2_Urb	SMCWPPP	2014	U	U_AU
204R01815	SM_R2_Urb	SMCWPPP	2014	U	U_AU
205R01816	SM_R2_Urb	SMCWPPP	2014	U	U_AU

Code	Description
TNS: target not sampleable	
TNS_PD	Access permanently denied OR no owner response, so access effectively denied
TNS_NR	No response from owners
TNS_TD	Access temporarily denied or temporarily inaccessible for other reasons
TNS_TNW	Temporarily no water due to water management activities
TNS_IA	Terrain is steep and unsafe for crews, and/or channel is too choked with vegetation to sample
TNS_DIST	Physically inaccessible - cannot hike round trip and sample in one day, and/or no good roads to access.
NT: non-target	
NT_W	Wetland
NT_NLSF	No/low spring flow
NT_H	Human hazards; unsafe for field crews
NT_NW	Non-wadable
NT_NC	Not a stream channel
NT_AGDITCH	Agricultural ditch; not natural, historic receiving water
NT_P	Pipeline
NT_T	Tidally influenced
NT_RI	Reservoir or impoundment

Attachment B
QA/QC Details

Water and Sediment Chemistry Field Duplicates

Included in this attachment are the results of water and chemistry field duplicate samples taken by SMCWPPP in 2012 and 2013. The following tables are included:

- Table B-1. 2014 Water Chemistry Field Duplicate Site 205R01308
- Table B-3. 2012 Sediment Chemistry - Field Duplicate Results and QA Results
- Table B-4. 2013 Sediment Chemistry - Field Duplicate Results and QA Results
- Table B-5. 2012 Pathogen Sample and Field Duplicate Results
- Table B-6. 2013 Pathogen Sample and Field Duplicate Results

Note for all of the above tables: In accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable.

Table B-2. 2014 Water Chemistry Field Duplicate Results and QA Results for Site 202R01308

Sample Date	SampleID	Analyte Name	Fraction Name	Unit Name	Result	DUP Result	RPD	Exceeds MQO (>25%)
7/May/2014	202R01308-W-02 202R01308-W-52	Alkalinity as CaCO3	Total	mg/L	132	132	0%	No
7/May/2014	202R01308-W-01 202R01308-W-51	Ammonia as N	Total	mg/L	ND	ND	0%	No
7/May/2014	202R01308-W-08 202R01308-W-58	Ash Free Dry Mass	Fixed	g/m^2	79.36	72.38	-3%	No
7/May/2014	202R01308-W-02 202R01308-W-52	Bicarbonate	Total	mg/L	132	132	0%	No
7/May/2014	202R01308-W-02 202R01308-W-52	Carbonate	Total	mg/L	ND	ND	0%	No
7/May/2014	202R01308-W-02 202R01308-W-52	Chloride	Dissolved	mg/L	33	32	3%	No
7/May/2014	202R01308-W-07 202R01308-W-57	Chlorophyll a	Particulate	mg/m^2	4.21	5.76	31%	Yes
7/May/2014	202R01308-W-06 202R01308-W-56	Dissolved Organic Carbon	Dissolved	mg/L	2.4	2.3	4%	No
7/May/2014	202R01308-W-02 202R01308-W-52	Hydroxide	Total	mg/L	ND	ND	0%	No
7/May/2014	202R01308-W-02 202R01308-W-52	Nitrate as N	Dissolved	mg/L	0.59	0.58	2%	No
7/May/2014	202R01308-W-02 202R01308-W-52	Nitrite as N	Total	mg/L	ND	ND	0%	No
7/May/2014	202R01308-W-01 202R01308-W-51	Nitrogen, Total Kjeldahl	None	mg/L	0.44	0.35	23%	No
7/May/2014	202R01308-W-05 202R01308-W-55	Ortho Phosphate as P	Dissolved	mg/L	0.095	0.093	2%	No
7/May/2014	202R01308-W-01 202R01308-W-51	Phosphorus as P	Total	mg/L	0.1	0.1	0%	No
7/May/2014	202R01308-W-04 202R01308-W-54	Silica as SiO2	Total	mg/L	18	18	0%	No
7/May/2014	202R01308-W-03 202R01308-W-53	Suspended Sediment Concentration	Particulate	mg/L	J2.5	4.5	57%	Yes

Note: Highlighted rows exceed MQO (>25%).

Table B-3. 2014 Sediment Chemistry Field Duplicate Results and QA Results for Site 202R01308

Method Name	Analyte Name	Unit	Sample Result	Field Duplicate Result	Relative Percent Difference	Exceeds MQO (>25%)
EPA 8270C	Acenaphthene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Acenaphthylene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Anthracene	ng/g dw	ND	ND	N/A	No
EPA 6020	Arsenic	mg/Kg dw	1.9	2	-5%	No
EPA 8270C	Benz(a)anthracene	ng/g dw	J3.2	J3.2	N/A	No
EPA 8270C	Benzo(a)pyrene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Benzo(b)fluoranthene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Benzo(e)pyrene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Benzo(g,h,i)perylene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Benzo(k)fluoranthene	ng/g dw	ND	ND	N/A	No
EPA 8270M_NCI	Bifenthrin	ng/g dw	0.55	0.65	-17%	No
EPA 8270C	Biphenyl	ng/g dw	ND	ND	N/A	No
EPA 6020	Cadmium	mg/Kg dw	0.25	0.28	-11%	No
EPA 8081A	Chlordane, cis-	ng/g dw	ND	ND	N/A	No
EPA 8081A	Chlordane, trans-	ng/g dw	ND	ND	N/A	No
EPA 6020	Chromium	mg/Kg dw	11	11	0%	No
EPA 8270C	Chrysene	ng/g dw	19	J17	N/A	No
EPA 6020	Copper	mg/Kg dw	6.8	7	-3%	No
EPA 8270M_NCI	Cyfluthrin, total	ng/g dw	0.26	0.23	12%	No
EPA 8270M_NCI	Cyhalothrin, Total lambda-	ng/g dw	ND	ND	N/A	No
EPA 8270M_NCI	Cypermethrin, total	ng/g dw	ND	J0.097	N/A	No
EPA 8081A	DDD(o,p')	ng/g dw	ND	ND	N/A	No
EPA 8081A	DDD(p,p')	ng/g dw	ND	ND	N/A	No
EPA 8081A	DDE(o,p')	ng/g dw	ND	ND	N/A	No
EPA 8081A	DDE(p,p')	ng/g dw	1.3	1.2	8%	No
EPA 8081A	DDT(o,p')	ng/g dw	ND	ND	N/A	No
EPA 8081A	DDT(p,p')	ng/g dw	ND	ND	N/A	No
EPA 8081A	Decachlorobiphenyl(Surrogate)	% recovery	91	77	17%	No
EPA 8270M_NCI	Deltamethrin/Tralomethrin	ng/g dw	J0.17	J0.18	N/A	No
EPA 8270C	Dibenz(a,h)anthracene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Dibenzothiophene	ng/g dw	ND	ND	N/A	No
EPA 8081A	Dieldrin	ng/g dw	ND	ND	N/A	No
EPA 8270C	Dimethylnaphthalene, 2,6-	ng/g dw	J3.5	ND	N/A	N/A
EPA 8081A	Endrin	ng/g dw	ND	ND	N/A	No
EPA 8270M_NCI	Esfenvalerate/Fenvalerate, total	ng/g dw	ND	ND	N/A	No
EPA 8270M_NCI	Esfenvalerate-d6-1(Surrogate)	% recovery	102	105	-3%	No
EPA 8270M_NCI	Esfenvalerate-d6-2(Surrogate)	% recovery	105	105	0%	No
EPA 8270C	Fluoranthene	ng/g dw	11	9.8	12%	No
EPA 8270C	Fluorene	ng/g dw	J3.2	ND	N/A	N/A
EPA 8270C	Fluorobiphenyl, 2-(Surrogate)	% recovery	67	70	-4%	No

Table B-3. 2014 Sediment Chemistry Field Duplicate Results and QA Results for Site 202R01308

Method Name	Analyte Name	Unit	Sample Result	Field Duplicate Result	Relative Percent Difference	Exceeds MQO (>25%)
EPA 8081A	HCH, gamma-	ng/g dw	ND	ND	N/A	No
EPA 8081A	Heptachlor Epoxide	ng/g dw	ND	ND	N/A	No
EPA 8270C	Indeno(1,2,3-c,d)pyrene	ng/g dw	ND	ND	N/A	No
EPA 6020	Lead	mg/Kg dw	4.9	4.8	2%	No
EPA 7471A	Mercury	mg/Kg dw	0.035	0.029	19%	No
EPA 8270C	Methylnaphthalene, 1-	ng/g dw	ND	ND	N/A	No
EPA 8270C	Methylnaphthalene, 2-	ng/g dw	J3.1	ND	N/A	N/A
EPA 8270C	Methylphenanthrene, 1-	ng/g dw	ND	ND	N/A	No
EPA 8270C	Naphthalene	ng/g dw	ND	ND	N/A	No
EPA 6020	Nickel	mg/Kg dw	11	12	-9%	No
EPA 8270C	Nitrobenzene-d5(Surrogate)	% recovery	71	83	-16%	No
EPA 8270M_NCI	Permethrin, cis-	ng/g dw	1.4	0.65	73%	Yes
EPA 8270M_NCI	Permethrin, trans-	ng/g dw	ND	ND	N/A	No
EPA 8270C	Perylene	ng/g dw	ND	ND	N/A	No
EPA 8270C	Phenanthrene	ng/g dw	14	12	15%	No
EPA 8270C	Pyrene	ng/g dw	13	12	8%	No
EPA 8270C	Terphenyl-d14(Surrogate)	% recovery	76	72	5%	No
EPA 8081A	Tetrachloro-m-xylene(Surrogate)	% recovery	93	79	16%	No
EPA 9060	Total Organic Carbon	%	0.96	0.96	0%	No
EPA 6020	Zinc	mg/Kg dw	58	58	0%	No
Plumb, 1981, GS	Clay, Fine <0.00098 mm	%	1.17	1.16	1%	No
Plumb, 1981, GS	Clay, Medium 0.00098 to <0.00195 mm	%	1.38	1.09	23%	No
Plumb, 1981, GS	Clay, Coarse 0.00195 to <0.0039 mm	%	0.89	1.21	-30%	Yes
Plumb, 1981, GS	Silt, V. Fine 0.0039 to <0.0078 mm	%	1.03	1.07	-4%	No
Plumb, 1981, GS	Silt, Fine 0.0078 to <0.0156 mm	%	1.52	1.6	-5%	No
Plumb, 1981, GS	Silt, Medium 0.0156 to <0.031 mm	%	2.5	2.41	4%	No
Plumb, 1981, GS	Silt, Coarse 0.031 to <0.0625 mm	%	4.12	3.76	9%	No
Plumb, 1981, GS	Sand, V. Fine 0.0625 to <0.125 mm	%	4.99	5.04	-1%	No
Plumb, 1981, GS	Sand, Fine 0.125 to <0.25 mm	%	5.75	6.17	-7%	No
Plumb, 1981, GS	Sand, Medium 0.25 to <0.5 mm	%	30.99	31.37	-1%	No
Plumb, 1981, GS	Sand, Coarse 0.5 to <1.0 mm	%	42.3	42.04	1%	No
Plumb, 1981, GS	Sand, V. Coarse 1.0 to <2.0 mm	%	3.01	2.82	7%	No
Plumb, 1981, GS	Granule, 2.0 to <4.0 mm	%	0.34	0.26	27%	Yes
Plumb, 1981, GS	Pebble, Small 4 to <8 mm	%	ND	ND	N/A	No
Plumb, 1981, GS	Pebble, Medium 8 to <16 mm	%	ND	ND	N/A	No
Plumb, 1981, GS	Pebble, Large 16 to <32 mm	%	ND	ND	N/A	No
Plumb, 1981, GS	Pebble, V. Large 32 to <64 mm	%	ND	ND	N/A	No

Notes: Highlighted rows exceed MQO (>25%).
ND: non-detect value less than the Method Detection Limit (MDL)
J: measurement was less than the Reporting Limit (RL) but above MDL
NA: Relative Percent Difference (RPD) could not be calculated

Table B-5. 2014 Pathogen Sample and Laboratory Duplicate Results

County	Parameter	Unit	Sample Result	Field Duplicate Result	Relative Percent Difference	Exceeds MQO
ACCWP	E. Coli	MPN/100mL	2200	1700	26%	Yes
ACCWP	Fecal Coliform	MPN/100mL	2200	1700	26%	Yes
CCCWP	E. Coli	MPN/100mL	1100	500	75%	Yes
CCCWP	Fecal Coliform	MPN/100m:	1100	1100	0%	No