URBAN CREEKS MONITORING REPORT

PART A: CREEK STATUS MONITORING IN SAN MATEO COUNTY

Water Year 2022 (October 2021 – September 2022)

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

SAN MATEO COUNTYWIDE
Water Pollution
Prevention Program

A Program of the City/County Association of Governments of San Mateo County

March 31, 2023

CREDITS

This report is submitted by the participating agencies in the

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City of Belmont	City of Half Moon Bay	City of San Carlos
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List of Acronyms

ACCWP	Alameda Countywide Clean Water Program
AFDM	Ash Free Dry Mass
AFS	American Fisheries Society
ASCI	Algae Stream Condition Index
BAMSC	Bay Area Municipal Stormwater Collaborative
BASMAA	Bay Area Stormwater Management Agencies Association
BMI	Benthic Macroinvertebrate
C/CAG	City/County Association of Governments
CCCWP	Contra Costa Clean Water Program
CDC	Center for Disease Control
CEDEN	California Environmental Data Exchange Network
COLD	Cold Freshwater Habitat
CSCI	California Stream Condition Index
DO	Dissolved Oxygen
GIS	Geographic Information Systems
GRTS	Generalized Random Tessellation Stratified
IMR	Integrated Monitoring Report
IPI	Index of Physical Habitat Integrity
MDL	Method Detection Limit
MIGR	Fish Migration
MPC	Monitoring and Pollutants of Concern
MRP	Municipal Regional Permit
MS4	Municipal Separate Storm Sewer System
MUN	Municipal and Domestic Water Supply Beneficial Use
MWAT	Maximum Weekly Average Temperature
NPDES	National Pollutant Discharge Elimination System
O/E	Observed to Expected
PHAB	Physical Habitat Assessments
pMMI	Predictive Multimetric Index
PSA	Perennial Streams Assessment
QAPP	Quality Assurance Project Plan
QAPrP	Quality Assurance Program Plan
QA/QC	Quality Assurance/Quality Control
RARE	Preservation of Rare and Endangered Species
REC-1	Water Contact Recreation
RM	Reporting Module
RMC	Regional Monitoring Coalition
RWB	Reach-wide Benthos
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists

SCCWRP	Southern California Coastal Water Research Project
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SMC	Southern California Stormwater Monitoring Coalition
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SOP	Standard Operating Procedures
SSID	Stressor/Source Identification
SWAMP	Surface Water Ambient Monitoring Program
SWPP	Surface Water Protection Program
UCMR	Urban Creeks Monitoring Report
USEPA	Environmental Protection Agency
WARM	Warm Freshwater Habitat
WQO	Water Quality Objective
WY	Water Year

1.0 Introduction

This *Urban Creeks Monitoring Report (UCMR) Part A: Creek Status Monitoring, Water Year*[1] *(WY) 2022* was prepared by the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). SMCWPPP is a program of the City/County Association of Governments (C/CAG) of San Mateo County. Each incorporated city and town in the county, OneShoreline, and the County of San Mateo share a common National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP). The MRP was first adopted by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB or Regional Water Board) on October 14, 2009 as Order R2-2009-0074 (SFBRWQCB 2009; referred to as MRP 1.0). On November 19, 2015, the Regional Water Board updated and reissued the MRP as Order R2-2015-0049 (SFBRWQCB 2015; referred to as MRP 2.0). The Regional Water Board subsequently updated and revised the MRP as Order R2-2022-0018 (SFBRWQCB 2022; referred to as MRP 3.0), which took effect on July 1, 2022.

This report fulfills the requirements of provision C.8.h.iii. of MRP 2.0 for interpreting and reporting all Creek Status monitoring data collected through July 1, 2022[2] by SMCWPPP. Data presented in this report were collected pursuant to water quality monitoring requirements in provisions C.8.d (Creek Status Monitoring) of MRP 2.0.[3] Data collected for provisions C.8.f. (Pollutants of Concern) and C.8.g. (Pesticides & Toxicity Monitoring) are presented in separate reports (i.e., Parts B and C of this UCMR) per MRP 3.0 requirements. Data presented in this report were submitted electronically to the Regional Water Board by SMCWPPP and may be obtained via the California Environmental Data Exchange Network (CEDEN).

Sections of this report are organized according to the following topics:

- **Section 1.0 –** Introduction including overview of SMCWPPP goals, background, monitoring approach, and statement of data quality
- **Section 2.0 –** Biological condition assessment and stressor analysis at probabilistic sites
- **Section 3.0 –** Continuous water quality monitoring (temperature, general water quality)
- **Section 4.0 –** Chlorine monitoring
- **Section 5.0 –** Conclusions and recommendations
- **Section 6.0 –** References cited

[1] Most hydrologic monitoring occurs for a period defined as a Water Year, which begins on October 1 and ends on September 30 of the named year. For example, Water Year 2022 (WY 2022) began on October 1, 2021 and concluded on September 30, 2022.

[2] Due to the effective date (July 1, 2022) of the newly adopted MRP, monitoring data associated with MRP 2.0 that are typically conducted after month of July were not collected. These data included pathogen indicator and continuous water quality and temperature measurements after July 1, 2022.

[3] Monitoring data collected pursuant to other C.8 provisions (e.g., Pollutants of Concern, Pesticides and Toxicity) are reported in other Parts of the SMCWPPP Urban Creeks Monitoring Report for WY 2022.

1.1 Monitoring Goals

Provision C.8.d. of MRP 2.0 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?***

The first management question is addressed primarily through the evaluation of probabilistic and targeted monitoring data with respect to the triggers defined in the MRP. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other beneficial uses and under MRP 2.0 were considered for future evaluation via Stressor/Source Identification (SSID) projects, as described in provision C.8.e. of MRP 2.0.

The second management question is addressed by assessing indicators of beneficial uses. For example, the indices of biological integrity based on benthic macroinvertebrate (BMI) and algae data are direct measures of the condition of aquatic life beneficial uses. Continuous monitoring data (temperature, dissolved oxygen, pH, and specific conductance) are evaluated with respect to COLD (cold freshwater habitat) and WARM (warm freshwater habitat) beneficial uses.

Creek Status monitoring parameters, methods, occurrences, durations, and minimum number of sampling sites are described in provision C.8.d. of MRP 2.0. The Creek Status monitoring requirements in MRP 2.0 (SFBRWQCB 2015) are similar to MRP 1.0 (SFBRWQCB 2009) requirements (which began implementation on October 1, 2011) and build upon earlier monitoring conducted by SMCWPPP. The current MRP (i.e., MRP 3.0; SVBRWQCB 2022) does not include Creek Status monitoring; therefore, WY 2022 is the final year for this type of monitoring. Creek Status monitoring is coordinated through the Bay Area Stormwater Management Agencies Association (BASMAA)[4] Regional Monitoring Coalition (RMC).

Results of Creek Status Monitoring conducted in WYs 2012 through 2021 were detailed in prior reports[5] (SMCWPPP 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022).

1.2 Regional Monitoring Coalition

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 several BASMAA (now the Bay Area Municipal Stormwater Collaborative (BAMSC)) 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. Implementation of the RMC's Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012) allows Permittees and the Regional Water Board to

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[4] The Bay Area Stormwater Management Agencies Association (BASMAA) recently dissolved as a formal non-profit organization, but its members continue to meet as an informal organization called the Bay Area Municipal Stormwater Collaborative (BAMSC).

[5] Prior monitoring reports prepared by SMCWPPP are available at https://www.flowstobay.org/data-resources/reports/urban-creek-monitoring-reports/

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 BAMSC Monitoring and Pollutants of Concern (MPC) Committee.

Table 1.1. Regional Monitoring Coalition participants.

Stormwater Programs	RMC Participants (MRP Permittees)
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; Valley Water; and Santa Clara County
Alameda Countywide Clean Water Program (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 and Sea Level Rise Resiliency District (OneShoreline); and San Mateo County
Solano Stormwater Alliance (SSA)	Cities of Fairfield, Suisun City, Vallejo, and the Vallejo Flood and Wastewater 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., Regional 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 Creek Status Monitoring is described in the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012). The strategy includes regional ambient/probabilistic monitoring and local "targeted" 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). MRP 2.0 specifically prescribes the probabilistic/targeted approach and most of the other details of the RMC Creek Status and

Long-Term Trends Monitoring Plan.[6] Table 1.2 provides a list of which monitoring parameters are included in the probabilistic versus the targeted programs. This report includes data collected in San Mateo County under both monitoring components. Data are organized into report sections that reflect the format of monitoring requirements in the MRP.

Table 1.2. Monitoring parameters of MRP 2.0 provision C.8.d. (Creek Status Monitoring) and associated monitoring component.

Monitoring Elements	Monitoring Component		Report Section
	Regional Ambient (Probabilistic)	Local (Targeted)	
Creek Status Monitoring (C.8.d)			
Bioassessment & Physical Habitat Assessment	X	X[a]	2.0
Nutrients	X	X[a]	2.0
General Water Quality (Continuous)		X	3.0
Temperature (Continuous)		X	3.0
Chlorine	X	X[b]	4.0

Notes:
[a] Provision C.8.d.i.(6) of MRP 2.0 allows for up to 20% of sample locations to be selected on a targeted basis. Subsequent communications by Regional Board staff allow for all sample locations to be selected on a targeted basis if probabilistic stations have been exhausted.
[b] Provision C.8.d.ii.(2) provides options for probabilistic or targeted site selection. In WYs 2012 - 2022, chlorine was measured at probabilistic and targeted bioassessment sites.

1.3 Monitoring and Data Assessment Methods

1.3.1 Monitoring Methods

Creek Status monitoring data were collected and reviewed in accordance with California Surface Water Ambient Monitoring Program (SWAMP) comparable methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016) and the associated Quality Assurance Project Plan (QAPP; BASMAA 2020). These documents are updated as needed to optimize applicability. Where applicable, monitoring data were collected using methods comparable to those specified by the SWAMP Quality Assurance Program Plan (QAPrP)[7], and were submitted in SWAMP-compatible format to the Regional Water Board. 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.

During WY 2022, SMCWPPP management and monitoring activities continued to be impacted by the COVID-19 public health emergency. To minimize any spread of COVID-19 during implementation of monitoring activities, SMCWPPP monitoring consultants developed SOPs based on Center for Disease Control (CDC) guidance. The SOPs consist of hygiene and social

[6] Creek Status monitoring is not included in the current MRP (i.e., MRP 3.0); however, provision C.8.h.vi requires Permittees to collectively submit a comprehensive analysis of all bioassessment monitoring conducted by the RMC during MRP 1.0 and 2.0 for Water Years 2012 through 2021. This report is due by March 31, 2024.

[7]The current SWAMP QAPrP is available at: https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/swamp-qaprp-2022.pdf

distancing practices and are updated as needed when new information regarding COVID-19 becomes available. Implementation of the COVID-19 SOPs did not impact sampling results or data quality.

1.3.2 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 samples. 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 BASMAA QAPP (BASMAA 2020). Analytical laboratory methods, reporting limits, and holding times for chemical water quality parameters are also described in the BASMAA QAPP (2020). Analytical laboratory contractors in WY 2022 included:

- BioAssessment Services, Inc. – BMI identification
- EcoAnalysts, Inc. – Algae identification
- CalTest, Inc. – Sediment chemistry, nutrients, chlorophyll a, ash free dry mass (AFDM)

1.3.3 Data Analysis Methods

Monitoring data generated during WY 2022 were analyzed and evaluated to identify potential stressors that may be contributing to degraded or impacted biological conditions, including exceedances of water quality objectives (WQOs). Creek Status Monitoring data are evaluated with respect to numeric thresholds (i.e., triggers) specified in MRP 2.0 (SFBRWQCB 2015). Under MRP 2.0, sites with monitoring data that do not meet WQOs and/or exceed MRP trigger thresholds were considered for further evaluation as part of a SSID project. SSID projects were intended to be oriented toward taking action(s) to alleviate stressors and reduce sources of pollutants. SSID projects are no longer required under MRP 3.0.

In compliance with provision C.8.e.i. of MRP 2.0, all monitoring results exceeding trigger thresholds are added to a list of that is maintained throughout the permit term.

1.4 Setting

There are 34 watersheds in San Mateo County draining an area of about 450 square miles. The San Mateo Range of the Santa Cruz Mountains runs north/south and divides the county roughly in half. The eastern half of the county ("Bayside") drains to San Francisco Bay and is characterized by relatively flat, urbanized areas along the Bay. To varying degrees, portions of all Bayside watersheds within the urban zone have been engineered or placed within underground culverts. The western half of the county ("Coastside") drains to the Pacific Ocean and consists of approximately 50 percent parkland and open space, with agriculture and relatively small urban areas.

The complete list of probabilistic and targeted monitoring sites sampled by SMCWPPP in WY 2022 in compliance with provisions C.8.d. (Creek Status Monitoring) is presented in Table 1.3. Probabilistic station numbers, generated from the RMC Sample Frame, are provided for all bioassessment locations. Targeted stations numbers, based on SWAMP station numbering methods (BASMAA 2016), are provided for all targeted monitoring sites. Monitoring locations with monitoring parameter(s) from WY 2022 are mapped in Figure 1.1.

Monitoring Station Naming Conventions

- **Regional Monitoring Coalition (RMC) Sample Frame** – Monitoring sites were probabilistically identified during the initial implementation of the MRP.
    - **Example**: 202R04736 (2 = Water Board Region, 02 = Hydrological Unit Code, 04736 = order in which the site was drawn from the sample frame)
- **Surface Water Ambient Monitoring Program (SWAMP)** – SWAMP is the State Water Board's monitoring program. Monitoring sites are "targeted or handpicked by SMCWPPP staff.
    - **Example**: 202SGR042 (2 = Water Board Region, 02 = Hydrological Unit Code, SGR = watershed abbreviation, 042 – location of sample site on creek with low numbers representing sites closer to the creek mouth)

Table 1.3. Sites and parameters monitored in WY 2022 at three coastal watersheds in San Mateo County

Station ID	Watershed	Creek Name	Latitude	Longitude	Bioassessment, Nutrients, General WQ	Chlorine	Temp[a]	Cont WQ[b]
Pescadero Creek Watershed								
202R00726	Pescadero Creek	Peters Creek	37.25662	-122.21695	X	X		
202R00806	Pescadero Creek	Pescadero Creek	37.27158	-122.27474	X	X		
San Gregorio Creek Watershed								
202SGR042	San Gregorio Creek	San Gregorio Creek	37.3116	-122.31074	X	X	X	X
202SGR066	San Gregorio Creek	San Gregorio Creek	37.31883	-122.29675	X	X	X	
202R00664	San Gregorio Creek	San Gregorio Creek	37.31341	-122.28522	X	X	X	X
202R00920	San Gregorio Creek	Alpine Creek	37.29648	-122.25832	X	X		
San Pedro Creek Watershed								
202R03404	San Pedro Creek	San Pedro Creek	37.58210	-122.48737	X	X	X	
202R03916	San Pedro Creek	San Pedro Creek	37.59184	-122.50338	X	X		
202R04568	San Pedro Creek	San Pedro Creek	37.58097	-122.47956	X	X		
202R05464	San Pedro Creek	San Pedro Creek	37.5871	-122.49567	X	X	X	

[a] Temperature monitoring was conducted continuously (i.e., hourly) April through July 1, 2022.
[b] Continuous water quality monitoring (temperature, dissolved oxygen, pH, specific conductivity) was conducted during a 10-day period in the spring.

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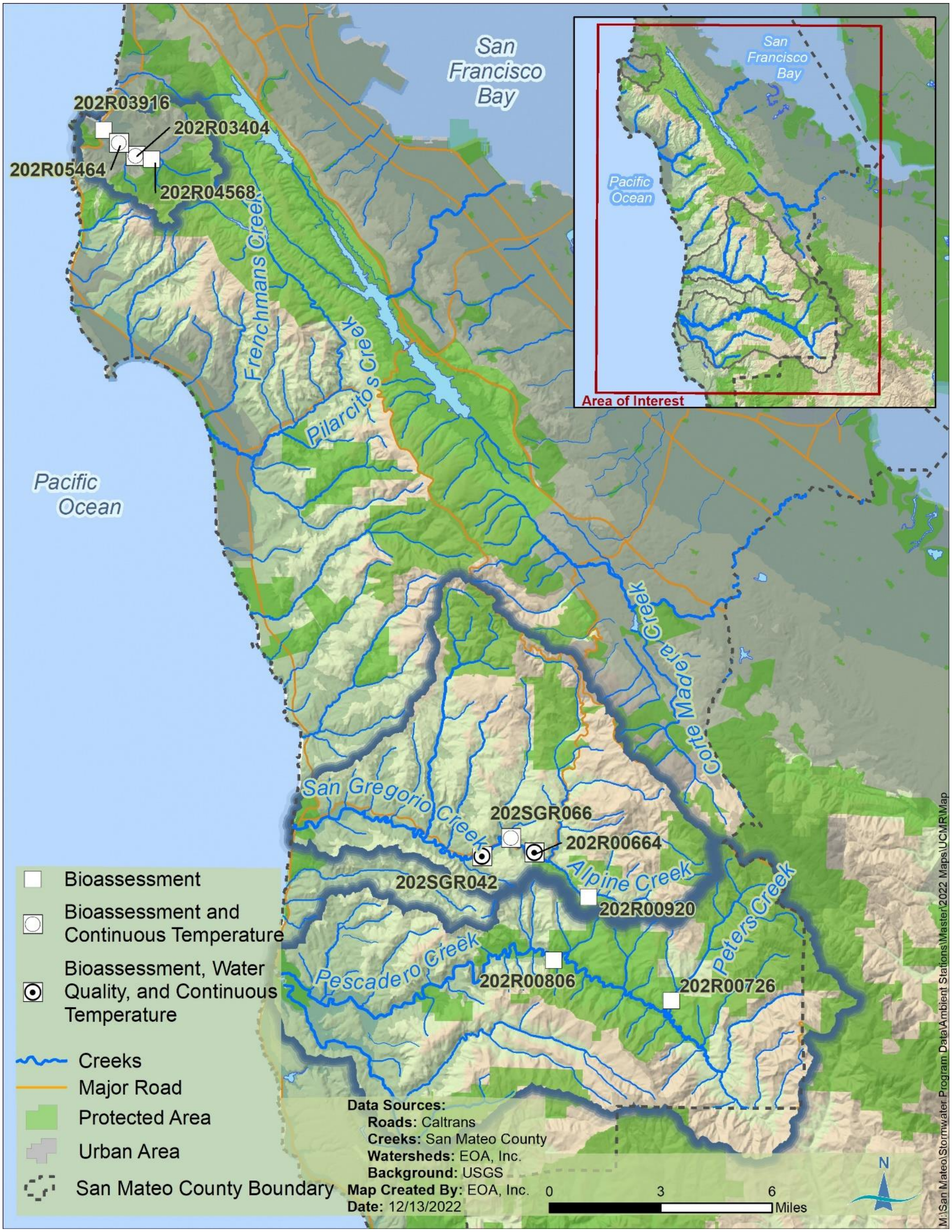

Figure 1.1. SMCWPPP Program Area, major creeks, and sites monitored in WY 2022.

1.4.1 Designated Beneficial Uses

Beneficial uses define the resources, services, and qualities of aquatic systems. Unimpaired beneficial uses are the ultimate goal for protection and achievement of high water quality. Beneficial uses in San Mateo County creeks are designated by the Regional Water Board for specific water bodies and serve as the basis for establishing WQOs designed to protect those uses (SFBRWQCB 2017). All creeks in San Mateo County, except a few coastal creeks, are designated as having the WARM beneficial use. Nearly all coastal creeks and a few bayside creeks, such as San Mateo Creek and San Francisquito Creek, are designated as having COLD beneficial use, meaning they historically or currently support trout, anadromous salmon, and/or steelhead fisheries. Dissolved oxygen (DO) WQOs are more stringent in creeks with COLD beneficial uses because these species are relatively intolerant to environmental stresses. Virtually all creeks in the region are designated as having water contact recreation (REC-1) beneficial uses, such as swimming where ingestion of water is considered reasonably possible; however, for most creeks this is a presumed use that has not been documented and may not actually exist. Fecal indicator bacteria WQOs are identified to protect the REC-1 beneficial use. Several coastal creeks, as well as Bear Gulch Creek and Crystal Springs Reservoir in the San Mateo Creek watershed, are designated as having the municipal and domestic water supply (MUN) beneficial use, due to the presence of drinking water reservoirs and/or diversions for these purposes. The Basin Plan identifies WQOs for several constituents of concern that apply only to waters with the MUN beneficial use, e.g., chloride and nitrate. Beneficial uses for creeks monitored in WY 2022 are listed in Table 1.4.

Table 1.4. Beneficial uses designated by the Regional for creeks monitored in WY 2022 in the San Mateo County (SFBRWQCB 2017).

Creek	Receiving Water	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
Pescadero Creek	Coastal	E	E							E			E	E	E	E	E	E	E	
San Gregorio Creek	Coastal	E								E			E	E	E	E	E	E	E	
Alpine Creek	Coastal									E			E	E	E	E	E	E	E	
San Pedro Creek	Coastal	E	E							E			E	E	E	E	E	E	E	

Notes:
E = Existing Use

1.4.2 Climate

San Mateo County experiences a Mediterranean-type climate with cool, wet winters and hot, dry summers. The area is characterized by microclimates created by topography, ocean currents, fog exposure, and onshore winds which can result in large differences in temperature and rainfall within short distances. The wet season typically extends from October through April with local long-term, mean annual precipitation ranging from 20 inches near the Bay to over 40 inches along the highest ridges of the San Mateo Mountain Range (PRISM Climate Group 30-year normals, 1981-2020[8]). Figure 1.2 illustrates the geographic variability of mean annual precipitation in the area based on statistical models; however, actual measured precipitation

[8] http://www.prism.oregonstate.edu/normals/

each year rarely equals the statistical average. Figure 1.3 illustrates the temporal variability in annual precipitation measured at the San Francisco International Airport (SFO) from WY 1946 to WY 2022. This record illustrates that extended periods of drought are common and often punctuated by above average years. Creek Status Monitoring in compliance with the MRP began in WY 2012 which was the first year of a severe statewide drought that persisted through WY 2016. Annual rainfall measured at SFO during subsequent years has exceeded the long-term average twice, WY 2017 and WY 2019. Rainfall at SFO was also below average in WYs 2020 through 2022, with WY 2021 the lowest in the SFO 75-year record.

The overall Bay Area climate and the specific conditions within any given year are influenced by global climate change. The most recent Climate Change Assessment report for the Bay Area highlights several impacts of climate change that are already being felt: the Bay Area's average annual maximum temperature increased by nearly 1°C from 1950 – 2005, coastal fog along the San Mateo County coast may be less frequent, and sea level in the Bay Area has risen over eight inches (Ackerly et al. 2018). These changes are projected to increase significantly in the coming decades. As a consequence, heat extremes, high year-to-year variability in precipitation, droughts, intense storms, wildfire, and other events will likely also increase.

Climate patterns (e.g., extended droughts) and individual weather events (e.g., extreme storms, hot summers) influence biological communities (i.e., vegetation, wildlife) and their surrounding physical habitat and water quality. They should therefore be considered when evaluating the type of data collected by the Creek Status Monitoring Program. For example, periods of drought (rather than individual dry years) can result in changes in riparian and upland vegetation communities. Long drought periods are associated with increased streambed sedimentation, which can persist directly or indirectly for many years, depending on the occurrence and magnitude of flushing flow events. Research has highlighted that drought periods extend the residence time of fine-grained post-fire channel sedimentation observed in southern Californian streams (Florsheim et al. 2017). Furthermore, in response to prolonged drought, the relative proportion of pool habitat can increase at the expense of riffle habitat.

It is uncertain what effect these factors have on indices of biotic integrity that are calculated using data collected by the Creek Status Monitoring Program, such as BMI or algae. A study evaluating 20 years of bioassessment data collected in northern California showed that, although BMI taxa with certain traits may be affected by dry (and wet) years and/or warm (and cool) years, indices based on these organisms appear to be resilient (Mazor et al. 2009, Lawrence et al. 2010). However, this study did not specifically examine the impact of longer *periods* of extended drought or heat on biological indices, which would require analysis of a dataset with a much longer period of record. The Herbst Lab at the Sierra Nevada Aquatic Research Laboratory, University of California Santa Barbara recently completed a study exploring how flooding and droughts vary taxa metrics in the Sierra Nevada streams. While species diversity and density remained relatively unchanged during flooding, extreme dry weather conditions significantly impacted BMI population structure. These differences were exacerbated with continued exposure to drought (Herbst et al. 2019). Similar changes to the BMI community in San Mateo County streams may have occurred during the Creek Status Monitoring period of record but have not been evaluated.

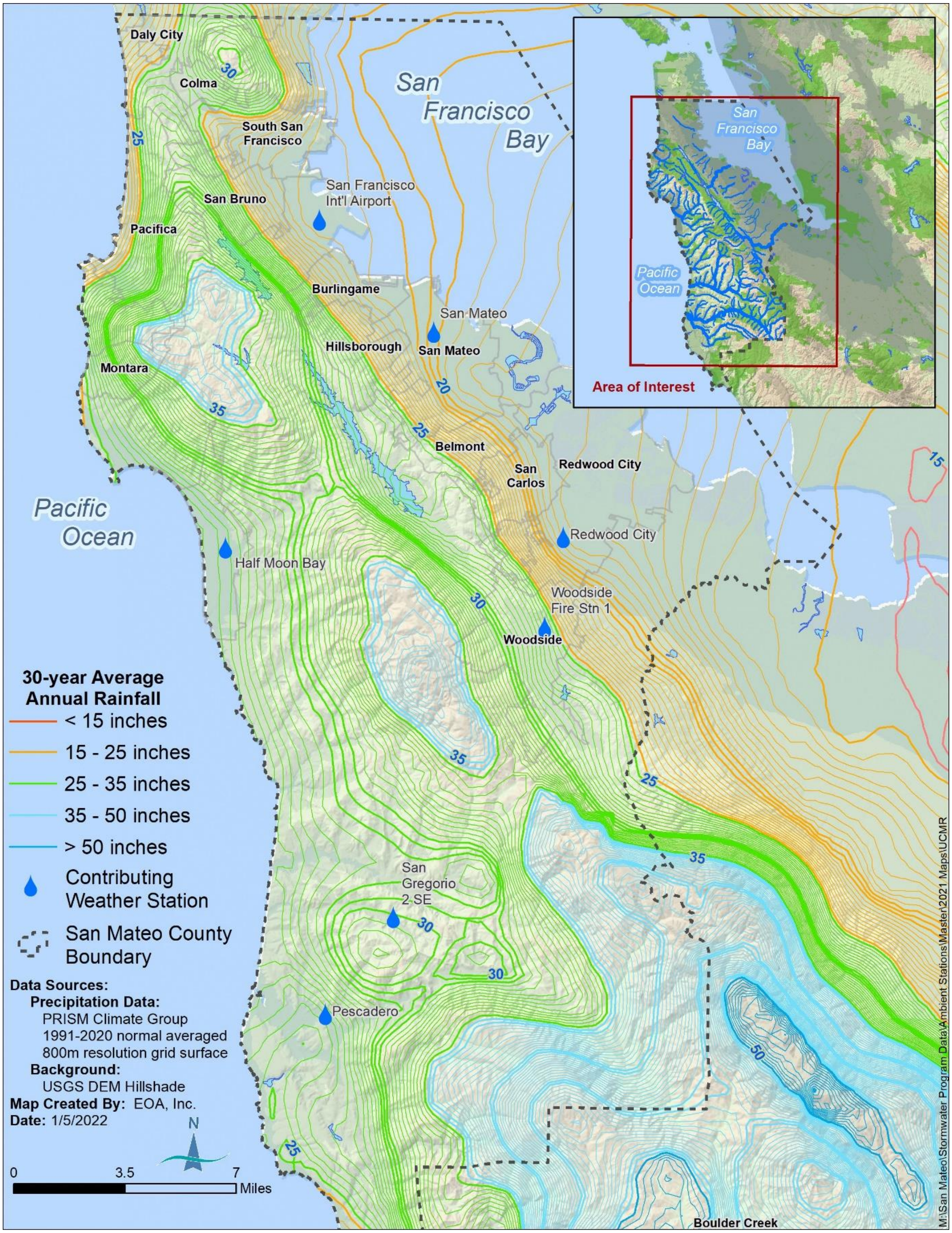

Figure 1.2. Average annual precipitation in San Mateo County, modeled by the PRISM Climate Group for the period of 1981-2020.

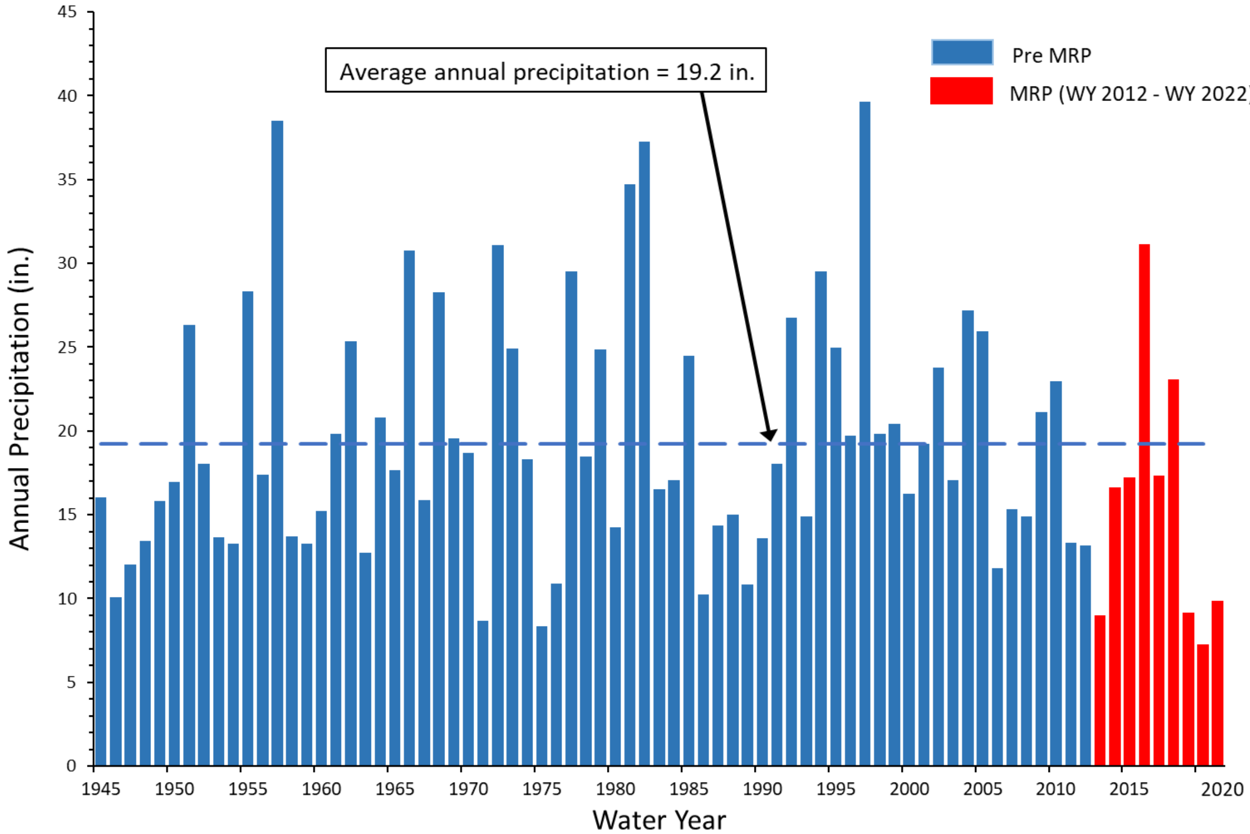

Figure 1.3. Annual rainfall recorded at the San Francisco International Airport, WY 1946 – WY 2022.

1.5 Statement of Data Quality

A comprehensive Quality Assurance/Quality Control (QA/QC) program was implemented by SMCWPPP covering all aspects of Creek Status Monitoring. In general, QA/QC procedures were implemented as specified in the BASMAA RMC QAPP (BASMAA 2020) and monitoring was performed according to protocols specified in the BASMAA RMC SOPs (BASMAA 2016). Both documents were adapted from the methods detailed in the SWAMP QAPrP.

Overall, the results of the QA/QC review suggests that the Creek Status Monitoring data generated during WY 2022 were of sufficient quality for the purposes of this monitoring program, in comparison to objectives outlined in the QAPP. Some data were flagged for accuracy and precision in accordance with QA/QC protocols, but none were rejected.

A detailed QA/QC report for WY 2022 data is included as Attachment 1.

2.0 Biological Condition Assessment

2.1 Introduction

SMCWPPP has conducted bioassessment monitoring since WY 2012 in San Mateo County creeks in compliance with Creek Status Monitoring provisions C.8.c. of MRP 1.0 and C.8.d.i. of MRP 2.0. Nearly all bioassessment monitoring has been performed at randomly selected sites using a probabilistic monitoring design. The probabilistic monitoring design allows each individual RMC participating program to objectively assess creek ecosystem conditions within its program area (i.e., county jurisdictional area) while contributing data to answer regional management questions about water quality and beneficial use condition in San Francisco Bay Area creeks. The probabilistic design provides an unbiased framework for condition assessment of ambient aquatic life uses within known estimates of precision. The monitoring design was developed to address management questions for RMC participating counties and the overall RMC area:

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?*

The first question (i.e., *What is the condition of aquatic life in creeks in the RMC area?*) is addressed by assessing indicators of aquatic biological health at probabilistic sampling locations. Once a sufficient number of samples have been collected, ambient biological condition can be estimated for streams at a regional (or countywide) scale. Over the past eleven years (WY 2012 through WY 2022), SMCWPPP and the Regional Water Board have conducted 120 bioassessment sampling events at 98 probabilistic and 22 targeted sites[9] in San Mateo County. Targeted sites include 15 resampled probabilistic sites. The number of sampled probabilistic samples sampled to date is now sufficient to estimate ambient biological condition for both urban and non-urban streams countywide[10]. However, there is still an insufficient

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[9] MRP 2.0 allows for up to 20% of bioassessment surveys at targeted sites to address other types of management questions. Subsequent communications from Regional Board staff have authorized additional monitoring at targeted sites due to exhaustion of available probabilistic sites.

[10] For each of the strata (urban and non-urban), 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 2012).

number of probabilistic samples to accurately assess the ambient biological condition for individual watersheds and smaller jurisdictional areas (i.e., cities).

The second question (i.e., *What are major stressors to aquatic life in the RMC area?*) is addressed by evaluation of physical habitat and water chemistry data collected at the probabilistic sites, as potential stressors to biological health. The stressor levels can be compared to biological indicator data through correlation and random forest models. Assessing the extent and relative importance of stressors in predicting biological condition can help prioritize stressors at a regional scale and inform local management decisions.

The third question (i.e., *What are the long-term trends in water quality in creeks over time?*) is addressed by assessing the change in biological condition over several years. Understanding changes in biological condition over time can help evaluate the effectiveness of management actions. Although, long-term trend analysis for the probabilistic survey will require more than ten years of data collection, preliminary trend analysis of biological condition may be possible for some stream reaches using a combination of historical targeted data with the probabilistic data.

All three management questions were comprehensively evaluated using eight years of bioassessment data (WY 2012 – WY 2019) and reported in SMCWPPP's WY 2019 Integrated Monitoring Report (IMR; SMCWPPP 2020). Results presented in the IMR were similar to findings from an analysis of regional probabilistic data collected during WY 2012 – WY 2016 (BASMAA 2019). Provision C.8.h.vi. of MRP 3.0 requires Permittees to collectively submit (by March 31, 2024) a comprehensive analysis of all bioassessment monitoring conducted by the RMC during MRP 1.0 and 2.0 for Water Years 2012 through 2021.

This section of the report presents bioassessment results from WY 2022. In compliance with provision C.8.d.i.(8) of MRP 2.0, WY 2022 data are compared to triggers and WQOs identified in the MRP. Sites with results exceeding trigger thresholds were added to the list of trigger exceedances maintained by SMCWPPP.

2.2 Methods

2.2.1 Site Selection

2.2.1.1 Probabilistic Survey Design

Prior to WY 2020, SMCWPPP conducted bioassessments primarily at sites selected using the RMC probabilistic design. The RMC probabilistic design was created using the Generalized Random Tessellation Stratified (GRTS) approach developed by the United States Environmental Protection Agency (USEPA) and Oregon State University (Stevens and Olsen 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 in California by several organizations 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).

Probabilistic monitoring sites were selected using the GRTS approach from a sample frame consisting of a creek network geographic information system (GIS) data set within the 3,407-square mile RMC area (BASMAA 2012). 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 (see Table 1.1). There is approximately one site for every stream kilometer in the sample frame. 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 data coordination with these programs.

Once the master draw was performed, the list of sites 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 RMC area. Some sites classified as urban fall near the non-urban edge of the city boundaries and have little upstream development. For consistency, these urban sites were not re-classified. Therefore, data values within the urban classification represent a wide range of conditions.

The RMC participants decided to partition their sampling efforts so that approximately 80% are in in urban areas and 20% in non-urban areas. In addition, between WY 2012 and WY 2015, SWAMP conducted 34 bioassessments throughout the RMC region at non-urban sites selected from the sample frame, including 10 sites in San Mateo County.

All probabilistic sites identified in the master draw are evaluated by each RMC participant in chronological order using the process described in RMC Standard Operating Procedure FS-12 (BASMAA 2016) which is consistent with the procedure described by Southern California Coastal Water Research Project (SCCWRP 2012). Each site is evaluated to determine if it meets RMC sampling location criteria (e.g., not tidally influenced, sufficient flow, safe accessibility, landowner permission to access site). Site evaluation information is stored in a database and analyzed to determine the statistical significance of local and regional average ambient conditions calculated from the multi-year dataset.

2.2.1.2 Targeted Sites

During the site evaluation process in WY 2020, the complete list of San Mateo County *urban* probabilistic sites from the RMC Sample Frame was evaluated for sampling and only four met the RMC criteria[11]. As a result, in WY 2020, six of the ten required bioassessment surveys (i.e., 60%) were conducted at targeted sites. All six targeted sites were previously sampled probabilistic sites and three of these were in San Mateo Creek. In recognition of the exhaustion of probabilistic sites in San Mateo County, Regional Water Board staff supported a monitoring approach that included more than 20% targeted sites.[12] Regional Water Board staff recommended targeted monitoring to fill spatial data gaps and/or to assess changes over time.

In WY 2021, SMCWPPP prioritized bioassessments at *non-urban* probabilistic sites to establish a sample size of 30 non-urban sites, which is a sufficient number of sites to estimate ambient biological condition for both non-urban streams countywide. All six non-urban probabilistic sites were located in San Gregorio and Pescadero Creek watersheds. In addition, one new urban probabilistic site in Corte Madera Creek was sampled in WY 2021 at a location that was

[11] A high proportion of probabilistic sites that were evaluated in WY 2020 could not be sampled due to an exceptionally dry winter wet season and a resulting lack of spring baseflow.

[12] January 26, 2021, letter from Derek Beauduy, Regional Water Board, to stormwater monitoring program managers.

previously to dry to sample. Three targeted sites were also selected[13], including two sites on San Gregorio Creek which were fisheries restoration sites managed by the San Mateo Resource Conservation District, and one probabilistic site previously sampled in Pescadero Creek in San Mateo County Memorial Park.

In WY 2022, SMCWPPP conducted bioassessments at ten targeted sites. Six of those sites were previously sampled in WY 2021, including four sites in the San Gregorio Creek watershed and two sites in the Pescadero Creek watershed. Four targeted sites were selected in San Pedro Creek; all four sites were previously sampled probabilistic sites. All three watersheds support steelhead populations.

2.2.2 Field Sampling Methods

Bioassessment survey methods were consistent with the BASMAA RMC QAPP (BASMAA 2020) and SOPs (BASMAA 2016). In accordance with the RMC QAPP (BASMAA 2020) 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 (defined as at least 0.5-inch of rainfall within a 24-hour period). The 30-day grace period allows diatom and soft algae communities to recover from peak flows that may scour benthic algae from the bottom of the stream channel.[14] In WY 2022, bioassessment sampling was conducted between May 16 and May 25, 2022. Field work began after a long dry period, with the last significant storm of the season occurring on December 25, 2021.

Each bioassessment sampling site consisted of a 150-meter stream reach that was divided into 11 equidistant transects placed perpendicular to the direction of flow. Benthic macroinvertebrate and algae samples were collected at each of the 11 evenly spaced transects using the Reach-wide Benthos (RWB) method described in the SWAMP SOP (Ode et al. 2016). The most recent SWAMP SOP (i.e., Ode et al. 2016) combines the BMI and algae methods that are referenced in the MRP (Ode 2007, Fetscher et al. 2009), provides additional guidance, and adds two new physical habitat analytes (assess scour and engineered channels). The full suite of physical habitat data was collected within the sample reach using methods described in Ode et al. (2016).

Immediately prior to biological and physical habitat data collection, water samples were collected for nutrients, conventional analytes, AFDM, and chlorophyll a analysis using the Standard Grab Sample Collection Method as described in SOP FS-2 (BASMAA 2016). Water samples were also collected and analyzed in the field for free chlorine and total chlorine residual using a Pocket Colorimeter™ II and DPD Powder Pillows according to SOP FS-3 (BASMAA 2016) (see Section 4.0 for chlorine monitoring results). In addition, general water quality parameters (dissolved oxygen, pH, specific conductance and temperature) were measured at or near the centroid of the stream flow using a pre-calibrated multi-parameter probe.

Biological and water samples were sent to laboratories for analysis. The laboratory analytical methods used for BMIs followed Woodard et al. (2012), using the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Level 1 Standard Taxonomic Level of Effort, with

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[13] In recognition of the exhaustion of urban probabilistic sites in San Mateo County, Regional Water Board staff issued a letter, dated January 26, 2021, that supported a monitoring approach that included more than 20% targeted sites.

[14] The BASMAA 30-day grace period is more conservative than the 21-day grace period described in the SWAMP SOP (Ode et al. 2016).

the additional effort of identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae). Soft algae and diatom samples were analyzed following SWAMP protocols (Stancheva et al. 2015). The taxonomic resolution for all data was compared SWAMP master taxonomic list. All BMI and algal taxa identified in samples collected over the eleven-year monitoring period were consistent with the taxa listed on the SWAMP Master List, which was then included in the data submittal each year.

2.2.3 Data Analysis

Biological condition indicator data and stressor data for all bioassessment sites surveyed in WY 2022 were compiled into a master spreadsheet for data analyses. The master spreadsheet is included with this report as Attachment 2. Benthic macroinvertebrate and algae data were analyzed to assess the biological condition (i.e., aquatic life beneficial uses) of the sampled reaches using condition index scores. Physical habitat data were used to assess biological condition and were evaluated as potential stressors. Water chemistry data were evaluated as potential stressors to biological health using triggers and WQOs identified in the MRP (see Stressor Variable section below). Data analysis methods for biological indicators and stressors are described below.

The BMI and algae data were compiled, formatted and submitted to the Moss Landing Marine Laboratory – San Jose State University Research Foundation (MLML-SJSURF) for the calculation of biological condition index scores using the RStudio statistical package and the necessary program scripts, developed by the Southern California Coastal Water Research Project (SCCWRP; Boyle et al. 2020). Drainage areas upstream of all bioassessment sampling locations were delineated in GIS and sent to MLML-SJSURF for the calculation of environmental predictor variables, which are necessary input for the calculation of biological index scores. In addition, physical habitat data were compiled, formatted and submitted to MLML-SJSURF for the calculation of physical habitat metrics using the SWAMP Bioassessment Reporting Module (SWAMP RM), a custom Microsoft Access™ application developed by the State Water Board. A subset of these metrics was then used to calculate physical habitat index scores. Detailed descriptions for each of the indices used to evaluate bioassessment data are described below.

2.2.4.1 Biological Indicators

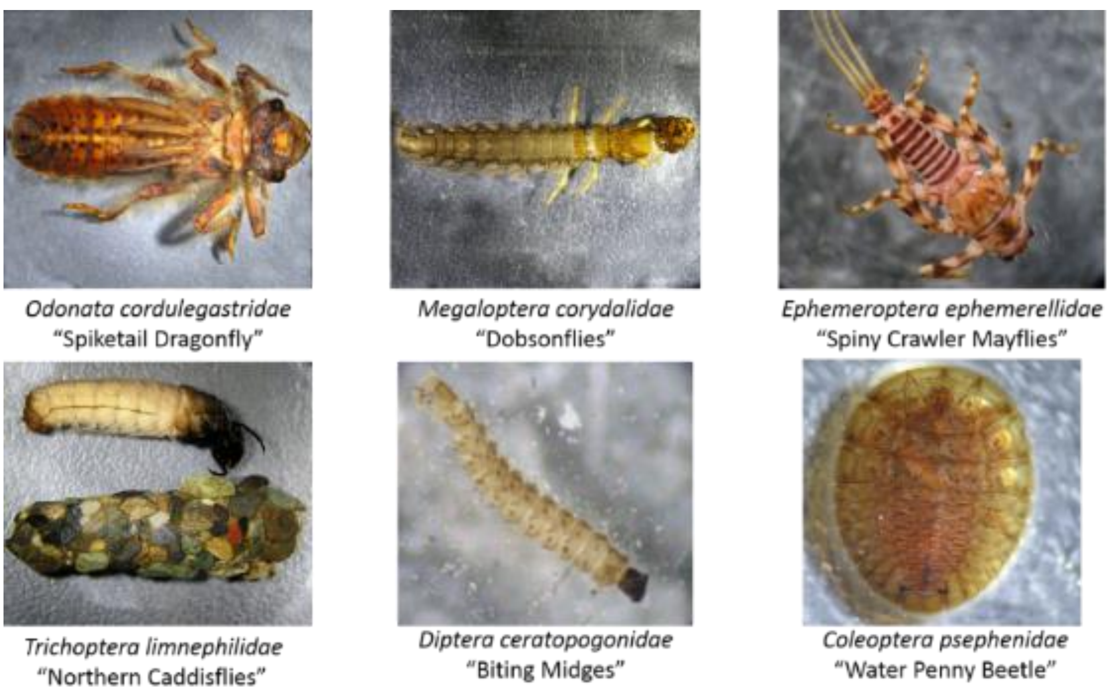
Benthic Macroinvertebrates

The benthic (i.e., bottom-dwelling) macroinvertebrates collected through this monitoring program are organisms that live on, under, and around the rocks and sediment in the stream bed. Examples include dragonfly and stonefly larvae, snails, worms, and beetles (Figure 2.1). Each BMI species has a unique response to water chemistry and physical habitat condition. Some are relatively sensitive to poor habitat and pollution; others are more tolerant. Therefore, the abundance and variety of BMIs in a stream is an indicator of the biological condition of the stream.

The California Stream Condition Index (CSCI) is an assessment tool that was developed by the State Water Board support the development of California's statewide Biological Integrity Plan[15]. The CSCI translates BMI data into an overall measure of stream health. The CSCI was developed using a large reference data set that represents the full range of natural conditions in California and site-specific models for predicting biological communities. The CSCI combines two types of indices: 1) taxonomic completeness, as measured by the ratio of observed-to-expected (O/E) taxa; and 2) ecological structure and function, measured as a predictive multimetric index (pMMI) that is based on reference conditions. The CSCI score is computed as the average of the sum of the O/E and pMMI.

The CSCI score for each station is calculated using a combination of biological and environmental data following methods described in Rehn et al. (2015) and Boyle et al. (2020). Biological data consist of the BMI data collected and analyzed using the protocols described in the previous section. Environmental predictor data are generated in GIS using drainage areas upstream of each BMI sampling location.

The State Water Board is continuing to evaluate the performance of CSCI in a regulatory context. In provision C.8.d. of MRP 2.0, the Regional Water Board defines a CSCI score of 0.795 as a trigger threshold for identifying sites with potentially degraded biological condition.



Source: http://www.dfg.ca.gov/abl/Reference/California/CA_digital_ref_familylevel_home.asp

Figure 2.1. Examples of benthic macroinvertebrates.

[15] The Biological Integrity Assessment Implementation Plan has been combined with the Biostimulatory Substances Amendment project. The State Water Board is proposing to adopt statewide WQOs for biostimulatory substances (e.g., nitrate) in freshwater along with a program of implementation.

Benthic Algae

Similar to BMI's, the abundance and type of benthic algae species living on a streambed are an indicator of stream health. When evaluated with the CSCI, biological indices based on benthic algae can provide a more complete picture of the streams biological condition because algae respond more directly to nutrients and water chemistry. In contrast, BMIs are more responsive to physical habitat. Figure 2.2 shows examples of benthic algae common in Bay Area streams.

The State Water Board and SCCWRP recently updated and finalized the Algae Stream Condition Index (ASCI)[16] which uses benthic algae data as a measure of biological condition for streams in California (Theroux et al. 2020*).* The ASCI uses predictive multimetric indices to evaluate ecological conditions. There are three versions of the ASCI pMMI: an index for diatoms, one for soft-bodied algae and a hybrid index using both assemblages. Using a statewide data set, all three indices were evaluated by Theroux et al. for precision, accuracy, responsiveness, and regional bias. The diatom and hybrid indices were found to be the most sensitive to anthropogenic stressor gradients.

There are no thresholds for ASCI scores in the MRP for identifying sites with potentially degraded biological condition. Condition categories based on reference conditions are presented in Theroux et al. (2020) and used to evaluate data in this report. Hybrid ASCI scores were primarily used to evaluate the bioassessment data.

Additional study is needed to determine the best approach to apply the ASCI tools to evaluate bioassessment data. For example, it is not clear if the ASCI should be used as a second line of evidence to understand CSCI scoring results, or if it would be more effective as an independent indicator to evaluate different types of stressors (e.g., nutrients) to which BMIs are not very responsive. The ASCI is currently under review by the Biostimulatory-Biointegrity Policy Science Advisory Panel and the State Water Board.

[16] Previously reported ASCI scores summarized in the SMCWPPP IMR (SMCWPPP 2020) have been superseded.

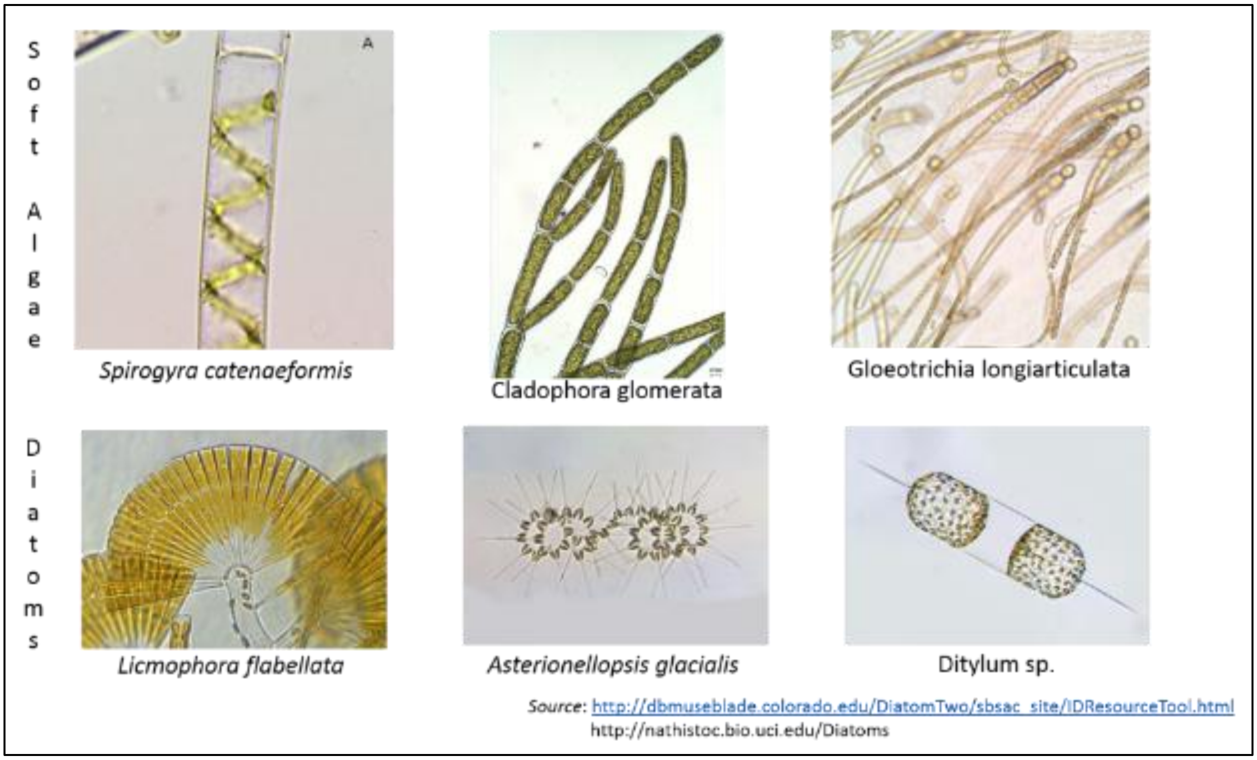


Figure 2.2. Examples of soft algae and diatoms.

2.2.4.2 Physical Habitat Indicators

The condition of the physical habitat within the riparian corridor is a major contributor to stream ecosystem health. Physical habitat components such as streambed substrate, channel morphology, microhabitat complexity, in-stream cover-type complexity, and riparian vegetation cover contribute to the overall physical and biological integrity of a stream. The physical characteristics of a stream reach are affected by both natural factors (e.g., climate, slope, geology) and human disturbance (e.g., channelization, development, stream crossings, hydromodification).

Physical habitat conditions are evaluated using two methods. Physical habitat metrics were calculated using reach-scale averages of transect-based measurements and observations. Approximately 170 different metrics were generated from the SWAMP RM using physical habitat measurements collected by SMCWPPP at bioassessment stations. The metrics are classified into five thematic groups representing different physical attributes: substrate, riparian vegetation (including structure and shading), flow habitat variability, in-channel cover, and channel morphology.

The State Water Board recently developed the Index of Physical Habitat Integrity (IPI) as an overall measure of physical habitat condition. Similar to the CSCI, the IPI is calculated using a combination of physical habitat data collected in the field and environmental data generated in GIS following the methods described in Rehn et al. (2018) and Boyle et al. (2020). The IPI is based on 12 of the metrics generated by the SWAMP RM (Table 2.1). The metrics were selected for their ability to discriminate between reference and stressed sites and provide unbiased representation of waterbodies across the different ecoregions of California. Scoring for these metrics were then calibrated using environmental variables that were associated with drainage areas for each sampling location.

Table 2.1. Physical habitat metrics calculated from bioassessment data collected in WY 2022. The 12 metrics used to calculate IPI scores are also shown.

Type/Class	Metric/Variable Name	Variables used for IPI Score
Channel Morphology	Mean Bankfull Width (SBKF_W)	x
	Mean Slope of Reach (XSLOPE)	x
	Percent Stable Banks (PBM_S)	
Flow Habitat	Evenness of Flow Habitat Types (Ev_FlowHab)	x
	Percent Pools in Reach (PCT_POOL)	x
	Shannon Diversity (H) of Aquatic Habitat Types (H_AqHab)	x
	Percent Fast Water (PCT_FAST)	
Instream Cover	Mean Filamentous Algae Cover (XFC_ALG)	x
	Natural Shelter cover – SWAMP (XFC_NAT_SWAM)	
	Mean Undercut Banks Cover (XFC_UCB)	
Riparian Cover	Mean Upper Canopy Trees and Saplings (XC)	x
	Riparian Cover Sum of Three Layers (SCMG)	x
Substrate	Percent Concrete/Asphalt (PCT_RC)	x
	Percent Sand (PCT_SA)	x
	Percent Gravel – coarse (PCT_GC)	
	Percent Substrate Smaller than Sand (<2 mm) (PCT_SAFN)	x
	Shannon Diversity (H) of Natural Substrate Types (H_SubNat)	x
	Median Particle Size (d50) (SB_PT_D50)	

Physical habitat is also assessed using the reachwide qualitative assessment (PHAB) that consists of three separate attributes: channel alteration, epifaunal substrate, and sediment deposition. Each attribute is individually scored on a scale of 0 to 20, with a score of 20 representing good condition. The total PHAB score is the sum of three individual attribute scores with a score of 60 representing the highest possible score.

2.2.4.3 Biological and Physical Habitat Condition Thresholds

Existing thresholds for CSCI scores (Mazor 2015) and ASCI scores (Theroux et al. 2020) were used to evaluate the BMI and algae data collected in San Mateo County and analyzed in this report (Table 2.2). Provisional thresholds for IPI scores (Rehn et al. 2018) were used to evaluate physical habitat conditions. The thresholds for all three indices were based on the distribution of scores for data collected at reference calibration sites located throughout California. Four condition categories are defined by these thresholds: “likely intact” (greater than 30th percentile of reference site scores); “possibly altered” (between the 10th and the 30th percentiles); “likely altered” (between the 1st and 10th percentiles); and “very likely altered” (less than the 1st percentile).

A CSCI score below 0.795 is referenced in the MRP as a threshold indicating a potentially degraded biological community. The MRP threshold is at the division between the “possibly altered” and “likely altered” condition categories described in Mazor (2015). Further investigation is needed to evaluate the applicability of this threshold to sites in highly urban watersheds and/or modified channels that are common throughout the Bay Area.

Table 2.2. Condition categories used to evaluate CSCI, ASCI Hybrid, and IPI scores.

Biological Indicator	Tool	Likely Intact	Possibly Altered	Likely Altered	Very Likely Altered
BMI	CSCI	≥ 0.92	≥ 0.79 to < 0.92	≥ 0.63 to < 0.79	< 0.63
Algae	ASCI Hybrid	≥ 0.94	≥ 0.86 to < 0.94	≥0.75 to < 0.86	< 0.75
Physical Habitat	IPI	≥ 0.94	≥ 0.84 to < 0.94	≥0.71 to < 0.83	< 0.70

2.2.4.4 Stressor Variables

Attachment 2 includes biological condition scores (CSCI, ASCI, IPI) and potential stressor data for bioassessment sites monitored in WY 2022. Stressors are conditions that affect the biological condition of a stream. They include, but are not limited to, the types of physical habitat, landscape characteristics, general water quality, and water chemistry data that are collected during bioassessment surveys.

Potential stressors included in Attachment 2 are:

- ***Physical habitat*** stressor variables include metrics developed by the SWAMP RM (described above) and physical habitat variables from the reach-wide qualitative assessments that are conducted in compliance with the BASMAA (BASMAA 2016) and SWAMP (Ode et al. 2016) SOPs.

- ***Land Use*** variables are calculated in GIS by overlaying land use and transportation layers with the drainage area upstream of the sampling location. Attachment 2 includes percent urban area, percent impervious area, and road density.

- ***Water quality*** stressor variables include the general parameters measured in the field (i.e., DO, pH, temperature, specific conductivity, free chlorine, total chlorine residual) and water chemistry analyzed at laboratories (nutrients and anions). Additional water quality variables included chlorophyll a and AFDM, both measured from filtration of the benthic algae composite samples.

  Some of the water quality stressor variables were calculated or converted from other analytes or units of measurement:

  - Unionized ammonia is calculated from measured concentrations of total ammonia, pH, temperature, and specific conductance using a formula provided by the American Fisheries Society (AFS; https://fisheries.org/wp-content/uploads/2016/03/Copy-of-pub_ammonia_fwc.xls).
  - Total nitrogen concentration was calculated by summing nitrate, nitrite, and Total Kjeldahl Nitrogen concentrations.
  - The volumetric concentrations (mass/volume) for AFDM and chlorophyll a (as measured by the laboratory) were converted to an area concentration (mass/area). Calculations required using both algae sampling grab size and composite volume.

The IMR evaluated the relationship between potential stressors and biological condition (i.e., CSCI and ASCI scores) for the WY 2012 through WY 2019 probabilistic dataset (SMCWPPP 2020) using statistical analyses such as correlation and random forest models. Those analyses were not updated to include data collected the previous three years (WY 2020 through WY 2022). A comprehensive bioassessment monitoring report including analyses of eleven years of data collected during MRP 1.0 and 2.0 will be completed in WY 2023 to satisfy MRP 3.0 requirements.

2.2.4.5 Trigger Thresholds

In compliance with provision C.8.h.iii.(4) of MRP 2.0, water chemistry data collected at the bioassessment sites during WY 2022 were compared to MRP trigger thresholds and applicable water quality standards (Table 2.3). Thresholds for pH, specific conductance, DO, and temperature (for waters with COLD Beneficial Use only) are listed in provision C.8.d.iv of MRP 2.0. Except for temperature and specific conductance, these conform to WQOs in the Basin Plan (SFBRWQCB 2017). Of the eleven nutrients analyzed synoptically with bioassessments, WQOs only exist for three: ammonia (unionized form), and chloride and nitrate (for waters with MUN Beneficial Use only).

Ammonia, specifically unionized ammonia, is toxic to aquatic life. Therefore, the Basin Plan states that discharge of wastes shall not cause receiving waters to contain annual median concentrations of un-ionized ammonia in excess of 0.025 mg/L or maximum concentrations above 0.4 mg/L in the Lower Bay, which includes creeks in San Mateo County that drain to the Bay (SFBRWQCB 2017). Conversion of measured total ammonia to the more toxic form of unionized ammonia was calculated to compare Creek Status monitoring results with the WQOs in the San Francisco Basin Water Quality Control Plan (Basin Plan) (SFBRWQCB 2017).

Table 2.3. MRP trigger thresholds and WQOs for nutrient and general water quality variables.

	Units	Threshold	Direction	Source
Nutrients and Ions				
Nitrate as N [a]	mg/L	10	Increase	Basin Plan
Unionized Ammonia, annual median [b]	mg/L	0.025	Increase	Basin Plan
Unionized Ammonia, maximum	mg/L	0.4	Increase	Basin Plan
Chloride [a]	mg/L	250	Increase	Basin Plan
General Water Quality				
Oxygen, Dissolved [d]	mg/L	5.0 or 7.0	Decrease	Basin Plan
pH	--	6.5 and 8.5	Both	Basin Plan
Temperature, instantaneous maximum [c]	°C	24	Increase	MRP
Specific Conductance [c]	µS/cm	2000	Increase	MRP

[a] Nitrate and chloride WQOs only apply to waters with MUN designated beneficial uses.
[b] This threshold is an annual median value and is not typically applied to individual samples.
[c] The MRP thresholds (or triggers) for temperature and specific conductance apply when 20 percent of instantaneous results are in exceedance. Application to individual samples is provisional.
[d] The WQO for WARM and COLD Beneficial Use is 5.0 and 7.0, respectively.

2.3 Results and Discussion

The results for bioassessment monitoring in WY 2022 are presented in the sections below.

- **Section 2.3.1** presents a summary of biological assessment data collected at ten sites in San Mateo County during WY 2022.
- **Section 2.3.2** presents a comparison of bioassessment results between WY 2022 and previous years at the sampled sites.

Conclusions and recommendations for this section are presented in Section 5.0.

2.3.1 Bioassessment Results (WY 2022)

This section documents the biological condition and stressor data collected at ten targeted sites in San Mateo County during WY 2022. The WY 2022 bioassessment sites are listed in Table 2.4 and mapped in Figure 2.4.

Table 2.4. Bioassessment sampling locations and dates in San Mateo County in WY 2022.

Station Code	Creek Name	Sample Date	Site Elevation (ft)	Latitude	Longitude	Targeted	
						Non-Probabilistic	Re-sampled Probabilistic
Pescadero Creek Watershed							
202R00806	Pescadero Creek	5/16/2022	200	37.2716	-122.27474		x
202R00726	Peters Creek	5/19/2022	420	37.2566	-122.21695		x
San Gregorio Creek Watershed							
202SGR042	San Gregorio Cr	5/17/2022	184	37.3116	-122.31074	x	
202SGR066	San Gregorio Cr	5/17/2022	230	37.3188	-122.29675	x	
202R00664	San Gregorio Cr	5/24/2022	290	37.3134	-122.28522		x
202R00920	Alpine Creek	5/24/2022	482	37.2965	-122.25832		x
San Pedro Creek Watershed							
202R03916	San Pedro Creek	5/25/2022	20	37.59184	-122.50338		x
202R05464	San Pedro Creek	5/25/2022	42	37.5871	-122.49567		x
202R03404	San Pedro Creek	5/23/2022	75	37.58210	-122.48737		x
202R04568	San Pedro Creek	5/23/2022	95	37.58097	-122.47956		x

2.3.1.1 Biological and Physical Habitat Conditions

Biological condition, as represented by CSCI and ASCI Hybrid scores, for the ten sites sampled in three watersheds by SMCWPPP in WY 2022, is shown in Table 2.5. Physical habitat condition, as represented by IPI scores, is also shown in Table 2.5. The four condition categories for the three indicators are shown as color shaded cells as defined in Table 2.2. Site characteristics related to percent impervious in the contributing watershed and total PHAB scores are also presented. Condition classes are mapped in Figure 2.4.

<u>CSCI Scores</u>

The CSCI scores ranged from 0.61 to 1.13 across the ten bioassessment sites sampled in WY 2022 (Table 2.5). Five of the ten sites (50%) had CSCI scores in the two higher condition categories: “likely intact” and “possibly altered.” The high scoring sites included all four sites sampled in the San Gregorio Creek watershed and one site in Pescadero Creek watershed.

The highest CSCI score (1.13) occurred at the two upper elevation sites for both watersheds: site 202R00920 in Alpine Creek, located in Sam McDonald County Park, and site 202R00726 in Peters Creek, located in Portola Redwoods State Park.

The remaining five bioassessment sites had CSCI scores that were in the two lower condition categories: "likely altered" and "very likely altered", which are below the MRP trigger threshold value of 0.795. These sites include site 202R00806, located in Pescadero Creek County Park, and all four sites in San Pedro Creek. Site 202R00806 (Pescadero Creek County Park) also received a low CSCI score (0.49) in WY 2021. Although this site has minimal development (1% impervious area) (Figure 2.3), physical habitat and water quality may still be impacted by the 2020 Big Basin Fire, which burned in the upper areas of the Pescadero Creek watershed. All four sites in San Pedro Creek had moderate influence from urbanization with percent impervious area ranging between 12% and 15%.

Table 2.5. Biological condition, presented as CSCI and ASCI Hybrid scores, and physical habitat condition, presented as IPI scores, for ten sites sampled in San Mateo during WY 2022. Overall condition scores (i.e., the sum of the three individual index scores) are also shown. The four sites with highest overall condition scores (≥ 3.0) are shown in bold. Site characteristics related to percent impervious area and total PHAB scores are also presented.

Station Code	Creek	CSCI Score	ASCI Hybrid Score	IPI Score	Overall Score	Total PHAB Score	Percent Impervious Area
Pescadero Creek Watershed							
202R00806	Pescadero Creek	0.69	**1.12**	**1.19**	**3.0**	50	1.0
202R00726	Peters Creek	**1.13**	**1.02**	**1.04**	**3.19**	48	1.3
San Gregorio Creek Watershed							
202SGR042	San Gregorio Creek	0.88	0.8	**1.09**	2.77	50	2.8
202SGR066	San Gregorio Creek	**0.98**	**1.2**	**1.12**	**3.30**	48	3.2
202R00664	San Gregorio Creek	**1.09**	**1.01**	**0.94**	**3.04**	50	3.1
202R00920	Alpine Creek	**1.13**	0.81	**1.02**	2.96	49	1.0
San Pedro Creek Watershed							
202R03916	San Pedro Creek	0.61	0.68	**1.11**	2.40	35	12.4
202R05464	San Pedro Creek	0.68	0.78	**0.88**	2.34	32	13.1
202R03404	San Pedro Creek	0.68	**0.94**	**1.11**	2.73	51	13.4
202R04568	San Pedro Creek	0.63	0.71	**0.88**	2.22	39	15.0

ASCI Hybrid Scores

The ASCI Hybrid scores ranged from 0.68 to 1.12 across the ten bioassessment sites sampled in WY 2022 (Table 2.5). Five sites had ASCI Hybrid scores in the two upper condition categories (≥ 0.86), three sites were in the "likely altered" condition category, and one site (202R00806), scored in the "very likely altered" condition category (< 0.75). There is no MRP trigger for the ASCI Hybrid index.

IPI Scores

Physical habitat condition, as represented by IPI scores, ranged from 0.88 to 1.19 across the ten bioassessment sites sampled in WY 2022 (Table 2.5). Eight sites had IPI scores that were in the highest condition category (≥ 0.94). Two sites in San Pedro Creek had IPI scores in the "possibly altered" condition category.

Overall Condition

The overall biological/physical condition of a site was calculated by summing the two biological condition index scores (CSCI and ASCI Hybrid) and the physical habitat condition score (IPI). The four sites with the highest overall condition scores (≥ 3.0) included two in the Pescadero Creek watershed and the two middle elevation sites in San Gregorio Creek (Table 2.5).

Figure 2.3. SMCWPPP field crew collecting benthic macroinvertebrates in Pescadero Creek (site 202R00806). The CSCI score at this site is 0.69.

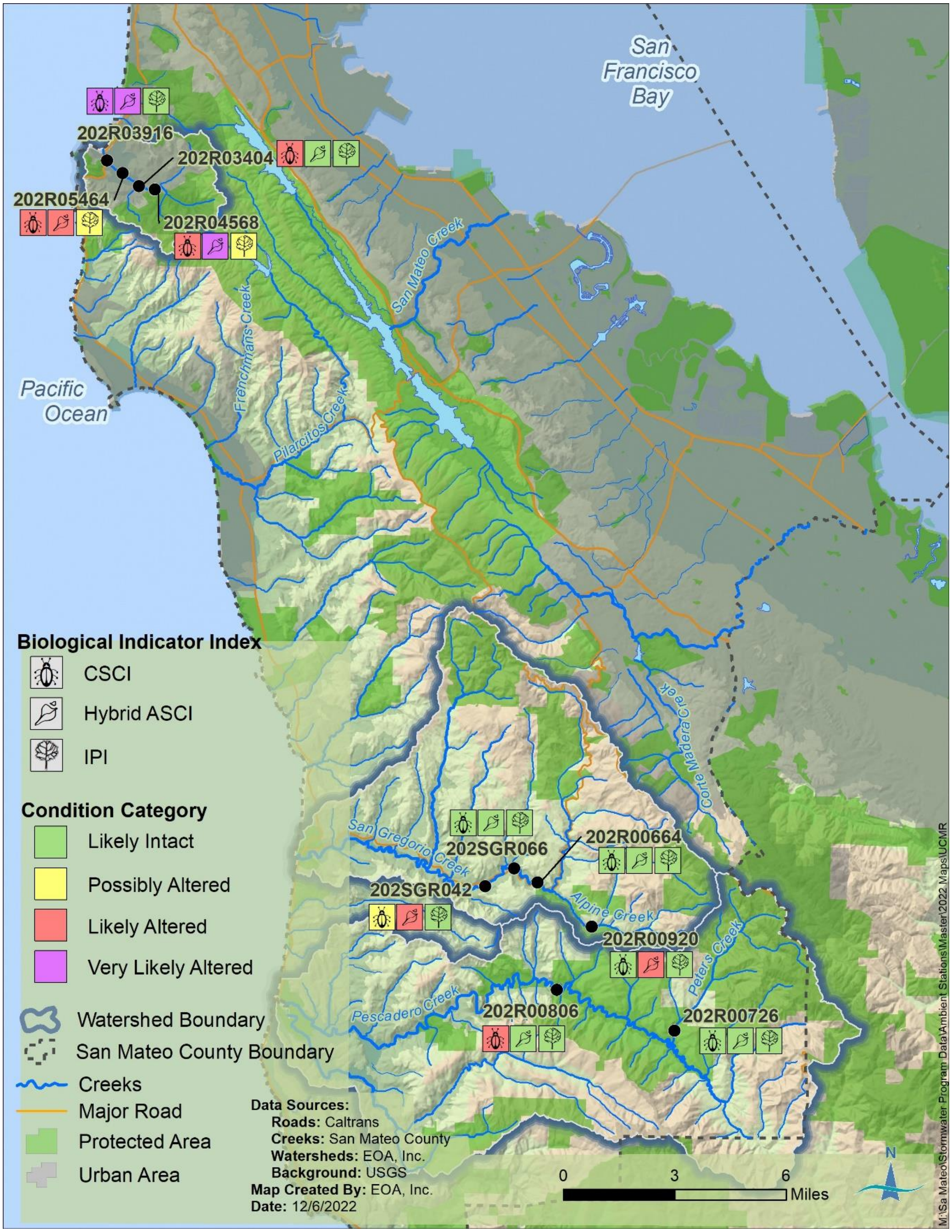


Figure 2.4. Condition category as represented by CSCI, ASCI Hybrid and IPI scores for ten bioassessment sites sampled in San Mateo County in WY 2022.

2.3.2 Bioassessment Results (WY 2018 – 2022)

All ten bioassessment sites sampled in WY 2022 were also sampled in prior years (WY 2018, WY 2020, or WY 2021). CSCI scores for WY 2022 and prior years are shown in Table 2.6. CSCI scores were relatively consistent between sampling events, with minor changes in condition category at four locations.

Table 2.6. CSCI scores at WY 2022 sites compared to scores from prior years.

Station Code	Creek	WY 2018	WY 2020	WY 2021	WY 2022
Pescadero Creek Watershed					
202R00806	Pescadero Creek	ns	ns	0.46	0.69
202R00726	Peters Creek	ns	ns	**1.11**	**1.13**
San Gregorio Creek Watershed					
202SGR042	San Gregorio Creek	ns	ns	0.91	0.88
202SGR066	San Gregorio Creek	ns	ns	**1.09**	**0.98**
202R00664	San Gregorio Creek	ns	ns	**1.03**	**1.09**
202R00920	Alpine Creek	ns	ns	**1.04**	**1.13**
San Pedro Creek Watershed					
202R03916	San Pedro Creek	0.68	ns	ns	0.61
202R05464	San Pedro Creek	ns	0.51	ns	0.68
202R03404	San Pedro Creek	0.65	ns	ns	0.68
202R04568	San Pedro Creek	ns	0.50	ns	0.63

ns = not sampled

2.3.3 Stressor Assessment (WY 2022)

This section presents results for stressor data collected at the ten bioassessment sites in WY 2022. The comparison of WY 2022 stressor data to associated MRP triggers and/or WQOs is documented for the purposes of maintaining the list of sites with trigger exceedances.

<u>General Water Quality</u>

Results of general water quality measurements collected at the ten bioassessment sites in WY 2022 are listed in Table 2.7. No WQOs or MRP triggers were exceeded at any of the sites.

Table 2.7. General water quality measurements for ten bioassessment sites in San Mateo County sampled in WY 2022.

Station Code	Creek Name	Temp (°C)	DO (mg/L)	pH	Specific Conductance (uS/cm)
Pescadero Creek Watershed					
202R00806	Pescadero Creek	13.9	9.6	8.1	607
202R00726	Peters Creek	12.0	10.0	8.4	776
San Gregorio Creek Watershed					
202SGR042	San Gregorio Creek	12.7	10.8	8.2	946
202SGR066	San Gregorio Creek	11.4	10.0	8.1	940
202R00664	San Gregorio Creek	13.6	12.0	8.3	751
202R00920	Alpine Creek	10.1	10.9	8.3	909
San Pedro Creek Watershed					
202R03916	San Pedro Creek	16.2	10.7	8.1	426
202R05464	San Pedro Creek	12.7	9.5	7.9	418
202R03404	San Pedro Creek	13.3	9.5	8.1	409
202R04568	San Pedro Creek	12.2	10.5	7.9	422

Water Chemistry (Nutrients)

Nutrient and conventional analyte concentrations measured in water samples collected at the ten WY 2022 bioassessment sites are listed in Table 2.7. No WQOs or MRP trigger thresholds were exceeded.

Total nitrogen concentrations ranged from 0.07 to 0.41 mg/L, with the highest concentration measured in Peters Creek (site 202R00726). Total phosphorus concentrations ranged from 0.024 to 0.21 mg/L, with the highest concentration was measured in Alpine Creek (site 202R00920).

Chlorophyll a and AFDM are two indicators of biomass. The highest concentrations of Chlorophyll a (74 mg/m^2) and AFDM (48 g/m^2) were measured in samples collected from site 202R00664 and site 202SGR042, respectively, in San Gregorio Creek.

Table 2.7. Nutrient and conventional constituent concentrations in water samples collected at ten sites in San Mateo County during WY 2022.

Station Code	Creek	Ammonia (as N)	Unionized Ammonia (as N)	Chloride	AFDM	Chlorophyll a	Nitrate (as N)	Nitrite (as N)	Total Kjeldahl Nitrogen (as N)	Total Nitrogen	Ortho-phosphate (as P)	Total Phosphorus	Silica (as SiO2)
		mg/L	*mg/L*	*mg/L*	*g/m2*	*mg/m2*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
	Water Quality Objective:	*NA*	*0.025* [b]	*250* [a]	*NA*	*NA*	*10*[a]	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Pescadero Creek Watershed													
202R00806	Pescadero Creek	0.096 J	0.0027	35	11	35	<0.02	0.0005	0.29	0.30	0.1	0.11	17
202R00726	Peters Creek	0.062 J	0.0029	33	19	19	0.16	0.002 J	0.25	0.41	0.17	0.18	24
San Gregorio Creek Watershed													
202SGR042	San Gregorio Creek	0.076 J	0.0024	71	48	45	0.025 J	0.0005	0.04	0.07	0.18	0.19	24
202SGR066	San Gregorio Creek	0.16	0.0036	60	6.3	20	0.031 J	0.0005	0.22	0.25	0.18	0.19	25
202R00664	San Gregorio Creek	0.12	0.0050	52	12	74	0.041 J	0.0005	0.17	0.21	0.18	0.19	24
202R00920	Alpine Creek	0.15	0.0048	28	20	12	0.13	0.002 J	0.04	0.17	0.21	0.21	28
San Pedro Creek Watershed													
202R03916	San Pedro Creek	0.089 J	0.0030	26	29	22	0.20	0.003 J	0.04	0.24	0.035	0.039	15
202R05464	San Pedro Creek	0.096 J	0.0016	24	12	29	0.22	0.003 J	0.04	0.26	0.029	0.041	15
202R03404	San Pedro Creek	0.16	0.0043	26	17	40	0.22	0.004 J	0.04	0.26	0.019	0.025	16
202R04568	San Pedro Creek	0.041 J	0.0006	26	19	9	0.22	0.007	0.04	0.27	0.015	0.024	16

AFDM = Ash Free Dry Mass, NA = Not Applicable

J = The reported result is an estimate. The value is less than the reporting limit but greater than the detection limit.

[a] Chloride and nitrate WQOs only apply to waters with MUN designated beneficial uses, i.e., Pescadero Creek and San Pedro Creek.

[b] This threshold is an annual median value and is not typically applied to individual samples.

Physical Habitat

There are no WQOs or MRP triggers associated with the physical habitat measurements collected during bioassessment surveys. However, physical habitat is an important factor that may influence biological conditions. The qualitative habitat (PHAB) scores, including individual scores for channel alteration, epifaunal substrate and sedimentation attributes[17], and total PHAB (sum of the three attributes scores) are shown in Table 2.8, with CSCI and IPI scores for comparison. Total PHAB scores ranged from 32 to 50 (highest possible score is 60).

Table 2.8. Qualitative physical habitat scores for ten bioassessment sites in San Mateo County sampled in WY 2022. CSCI and IPI scores are provided for comparison.

Station Code	Creek Name	CSCI Score	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Total PHAB	IPI Score
Pescadero Creek Watershed							
202R00806	Pescadero Creek	0.69	20	19	11	50	**1.19**
202R00726	Peters Creek	**1.13**	18	17	13	48	**1.04**
San Gregorio Creek Watershed							
202SGR042	San Gregorio Creek	0.88	19	18	13	50	**1.09**
202SGR066	San Gregorio Creek	**0.98**	19	16	13	48	**1.12**
202R00664	San Gregorio Creek	**1.09**	18	16	16	50	**0.94**
202R00920	Alpine Creek	**1.13**	19	17	13	49	**1.02**
San Pedro Creek Watershed							
202R03916	San Pedro Creek	0.61	18	9	8	35	**1.11**
202R05464	San Pedro Creek	0.68	12	10	10	32	**0.88**
202R03404	San Pedro Creek	0.68	18	17	16	51	**1.11**
202R04568	San Pedro Creek	0.63	16	12	11	39	**0.88**

[17] Channelization is measure of extent of reach that is armored/modified; Epifaunal substrate is measure of quantity and quality of physical habitat features (e.g., substrate, wood) that provide structure for colonization of biological communities; Sedimentation is a measure of the amount of sediment that has accumulated in the reach.

3.0 Continuous Water Quality Monitoring

3.1 Introduction

During WY 2022 (while MRP 2.0 was effective, i.e., through June 30, 2022) water temperature and general water quality were monitored in compliance with Creek Status Monitoring provisions C.8.d.iii. – iv. of MRP 2.0. Monitoring was conducted at selected sites using a targeted design based on the directed principle[18] 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?*

The first management question is addressed primarily through evaluation of water quality results in the context of existing aquatic life uses. Temperature and general water quality data were evaluated for potential impacts to different life stages and overall population of fish community present within monitored reaches.

The second management question is addressed primarily through the evaluation of targeted data with respect to water quality objectives and thresholds from published literature. Sites where exceedances occur may indicate potential impacts to aquatic life or other beneficial uses and are added to the table of trigger exceedances that is maintained by SMCWPPP.

The sections below summarize methods and results from continuous temperature and water quality monitoring conducted in WY 2022. Conclusions and recommendations for continuous monitoring are presented in Section 5.0.

3.2 Methods

Continuous temperature and water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016) and associated QAPP (BASMAA 2020). Data were evaluated with respect to the MRP 2.0 provision C.8.d. “Follow-up” triggers for each parameter.

3.2.1 Continuous Temperature

Digital temperature loggers (Onset HOBO Water Temp Pro V2) were programmed to record data at 60-minute intervals. The loggers were deployed at five targeted sites from April through July 2022. Procedures used for calibrating, deploying, programming, and downloading data are described in RMC SOP FS-5 (BASMAA 2016). SMCWPPP typically deploys temperature loggers at more than minimum number of sites in anticipation of field equipment being stolen or washed downstream.

[18] 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."

3.2.2 Continuous General Water Quality

Water quality monitoring equipment recording dissolved oxygen (DO), temperature, conductivity, and pH (Eureka Manta+35 water probes) were programmed to record data at 15-minute intervals. The sondes were deployed at two targeted sites during a 2-week sampling event during the spring season[19] (early June 2022). Procedures for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2016).

3.2.3 Data Evaluation

Continuous temperature and water quality data collected during WY 2022 were analyzed and evaluated to identify potential stressors that may be contributing to degraded or impacted biological conditions, including exceedances of WQOs. Provision C.8.d. of MRP 2.0 identifies trigger criteria 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 for continuous temperature and water quality data are listed in Table 3.1.

Table 3.1. Water Quality Objectives and thresholds used for continuous monitoring trigger evaluation.

Monitoring Parameter	Objective/Trigger Threshold	Units	Source
Temperature	Two or more weekly average temperatures exceed the Maximum Weekly Average Temperature (MWAT) threshold of 17.0°C for a Steelhead stream, or 20% of the results at one sampling station exceed the instantaneous maximum of 24°C.	°C	MRP 2.0 provision C.8.d.iii. Sullivan et al. 2000
General Water Quality Parameters[a]	20% of results at each monitoring site exceed one or more established standard or threshold - applies individually to each parameter		
Conductivity	2000	uS/cm	MRP 2.0 provision C.8.d.iii.
Dissolved Oxygen	WARM < 5.0, COLD < 7.0	mg/L	SF Bay Basin Plan Ch. 3, p. 3-4
pH	> 6.5, < 8.5 [b]	pH	SF Bay Basin Plan Ch. 3, p. 3-4
Temperature	Same as Temperature (See Above)		

[a] Triggers are associated with continuous general water quality data.
[b] Special consideration will be used at sites where imported water is naturally causing higher pH in receiving waters.

[19] Event 2, typically conducted during August/September timeframe, was not conducted due to the beginning of MRP 3.0 permit term in July 2022.

3.3 Study Area

In compliance with MRP 2.0, continuous temperature monitoring is conducted at a minimum of four sites[20], and continuous general water quality monitoring at two sites. The targeted monitoring design focuses on sites selected based on the presence of significant fish and wildlife resources as well as historical and/or recent indications of water quality concerns. Two coastal drainages in San Mateo County were selected for monitoring during WY 2022. San Gregorio Creek and its tributaries support migration, rearing and spawning habitat for coho salmon and steelhead (Stillwater Sciences 2010). San Pedro Creek also supports migration, rearing and spawning habitat for steelhead.

Continuous temperature monitoring was conducted at three sampling locations along a two-mile reach of San Gregorio Creek located near the town of La Honda. Temperature monitoring was previously conducted at these stations in WY 2021. Temperature monitoring was also conducted at two sampling locations in San Pedro Creek within the City of Pacifica. Continuous (hourly) temperature measurements were recorded from April 8 through July 21, 2022. Temperature monitoring stations are mapped in Figure 3.1.

Continuous (15-minute) general water quality measurements (DO, specific conductance, pH, and temperature) were recorded at two locations in San Gregorio Creek (Figure 3.1). Continuous general water quality monitoring was conducted between June 2 and June 16, 2022.

Bioassessments were conducted in WY 2022 at all five temperature monitoring stations, as well as both continuous water quality monitoring stations (Table 3.2). Bioassessment monitoring results are described in Section 2.0.

Table 3.2. Bioassessment, temperature and continuous water quality monitoring stations monitored by SMCWPPP during WY 2022.

Targeted Station Code	Creek Name	Bioassessment	Continuous Temperature	Continuous General Water Quality
202SGR042	San Gregorio Creek	x	x	x
202SGR066		x	x	
202R00664		x	x	x
202R05464	San Pedro Creek	x	x	
202R03404		x	x	

[20] SMCWPPP typically monitors water temperature at more stations than the MRP requires to mitigate for potential equipment loss.

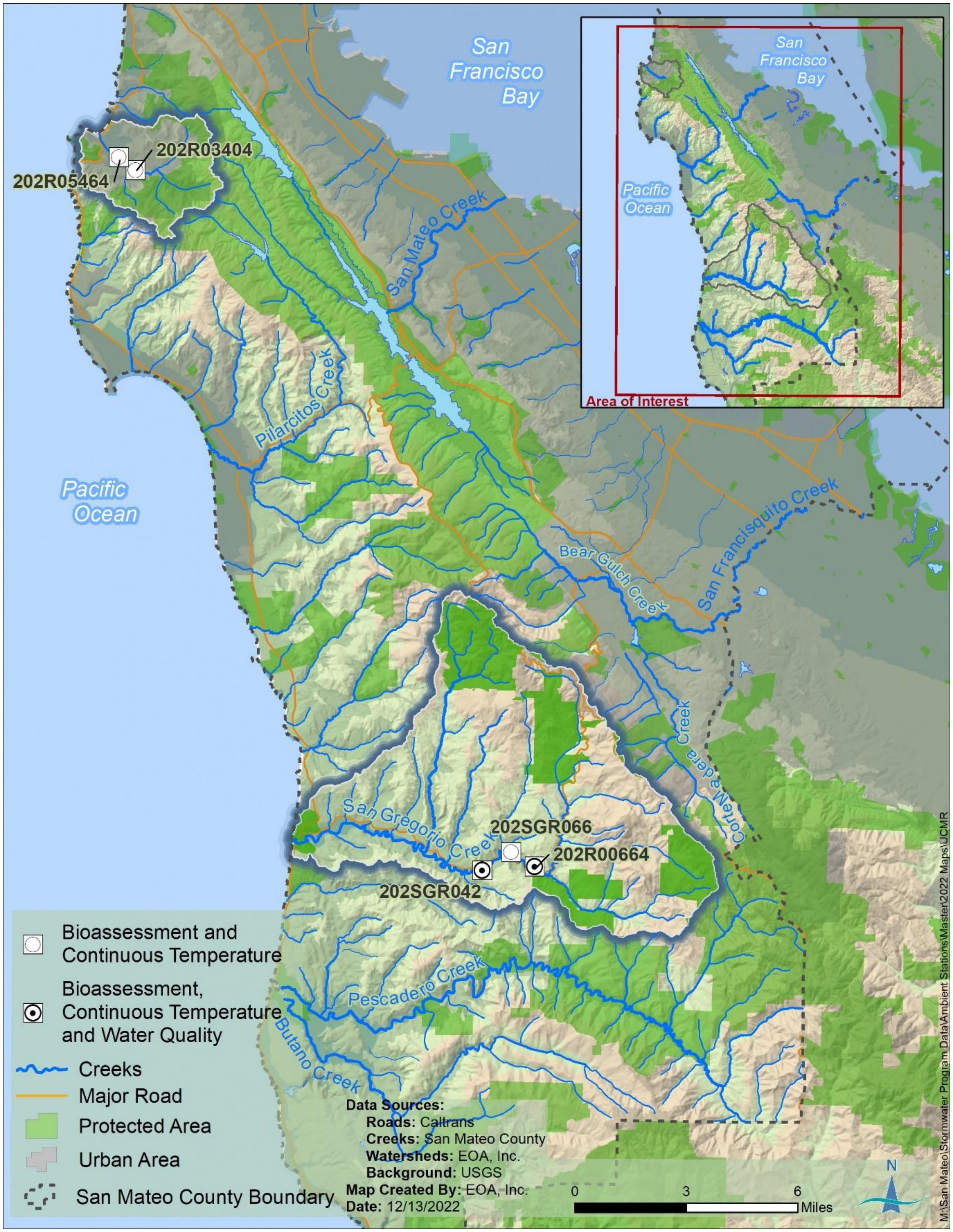


Figure 3.1. Continuous temperature (n=5) and general water quality (n=2) stations in the San Pedro Creek and San Gregorio Creek watersheds, San Mateo County, WY 2022.

3.4 Results and Discussion

The section below describes results from continuous temperature and water quality monitoring conducted during WY 2022. Conclusions and recommendations for this section are presented in Section 5.0.

3.4.1 Continuous Temperature

Summary statistics for continuous water temperature data are listed in Table 3.3. Instantaneous temperatures at the five stations ranged between 7.2°C and 20.2°C. None of the recorded temperatures exceeded the instantaneous maximum temperature trigger of 24°C.

Table 3.3. Descriptive statistics for continuous water temperature measured between April 8 and July 21, 2022 at three sites in the San Gregorio Creek watershed and two sites in San Pedro Creek, San Mateo County.

	Watershed	San Gregorio Creek			San Pedro Creek	
	Site ID	**202SGR042**	**202SGR066**	**202R00664**	**202R05464**	**202R03404**
	Start Date	4/8/2022	4/8/2022	4/8/2022	4/8/2022	4/8/2022
	End Date	7/21/2022	7/21/2022	7/21/2022	7/21/2022	7/21/2022
Temperature (°C)	Minimum	7.2	7.6	9.7	10.0	7.5
	Median	13.6	13.8	14.3	14.1	14.0
	Mean	13.4	13.7	14.3	14.2	13.8
	Maximum	19.0	18.8	20.2	19.0	19.1
	N (# individual measurements)	2506	2506	2506	2506	2506
# Measurements > 24°C		0	0	0	0	0

Weekly average temperature was calculated for each of the five monitoring sites (Table 3.4 and Figure 3.2). Consistent with MRP 2.0 requirements, the weekly averages were calculated for non-overlapping, seven-day periods. The MRP trigger is exceeded if two or more weeks exceed the Maximum Weekly Average Temperature (MWAT) threshold of 17.0°C.

The weekly average temperature values across all the sites ranged from 10.1°C to 16.6°C throughout the entire sampling period. The highest values generally occurred during the month of June and early July. The MWAT trigger was never exceeded throughout the monitoring period. As a result, none of the sites were added to the list of trigger exceedances that is maintained by SMCWPPP.

Water temperature data, calculated as a daily average, for the five monitoring sites in the San Gregorio Creek and San Pedro Creek watersheds, are shown in Figure 3.3. Temperature peaks occurred in early-June and mid-July. The increases in water temperature closely correspond to the air temperatures observed during the sampling period. Maximum daily air temperatures recorded at San Francisco International Airport are shown in Figure 3.4.

Table 3.4. Weekly average temperature values for water temperature data collected at three stations in the San Gregorio Creek watershed and at two stations in the San Pedro Creek watershed during WY 2022. Values did not exceed the MWAT threshold (17°C).

Watershed	San Gregorio Creek			San Pedro Creek	
Site ID	202SGR042	202SGR066	202R00664	202R05464	202R03404
Date	Weekly Average Temperature (°C)				
4/8/2022	10.1	10.6	10.8	12.5	12.4
4/15/2022	10.5	10.9	11.0	12.9	13.0
4/22/2022	11.3	11.8	11.9	13.3	13.4
4/29/2022	11.2	11.7	11.7	12.8	12.9
5/6/2022	11.3	11.8	11.8	13.1	13.2
5/13/2022	12.6	13.0	13.0	13.6	13.7
5/20/2022	12.9	13.2	13.1	13.7	13.9
5/27/2022	13.7	14.0	13.9	14.3	14.5
6/3/2022	14.6	14.9	14.9	15.0	15.2
6/10/2022	15.3	15.5	15.3	15.2	15.5
6/17/2022	15.2	15.4	15.2	15.2	15.5
6/24/2022	15.7	15.8	15.5	15.1	15.5
7/1/2022	15.0	15.3	15.3	15.1	15.3
7/8/2022	16.4	16.6	16.5	15.8	16.0
7/14/2022	15.8	16.0	15.8	14.8	15.0
Total Weeks	15	15	15	15	15
Number >17°C	0	0	0	0	0
> MRP Trigger	N	N	N	N	N

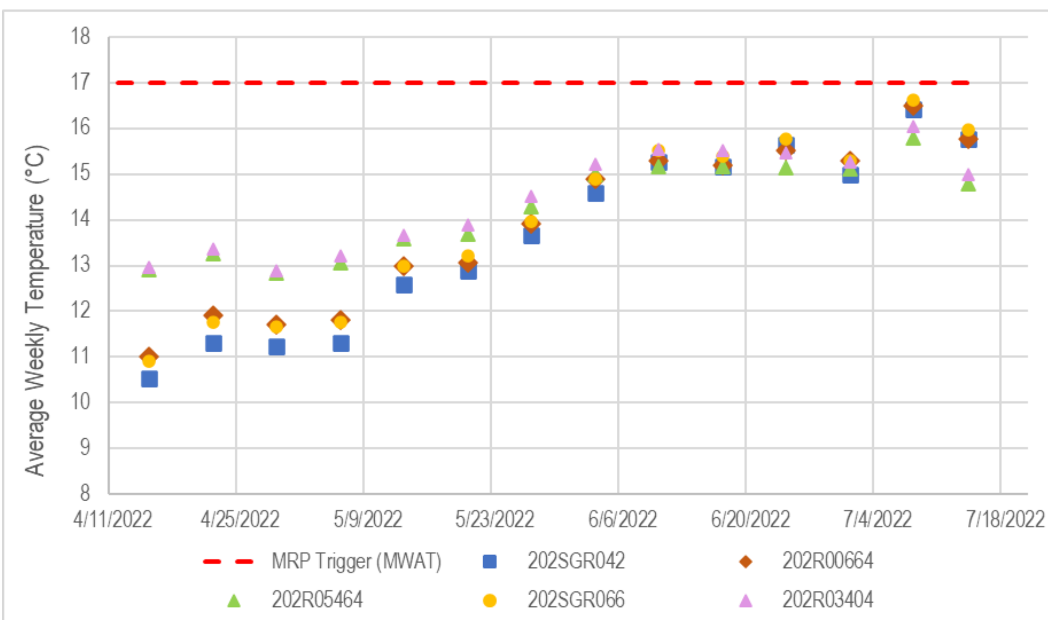


Figure 3.2. Weekly average temperature values calculated for water temperature collected at three sites in the San Gregorio Creek and two sites in San Pedro Creek over 15 weeks of monitoring in WY 2022. The MWAT threshold (17°C) is shown for comparison.

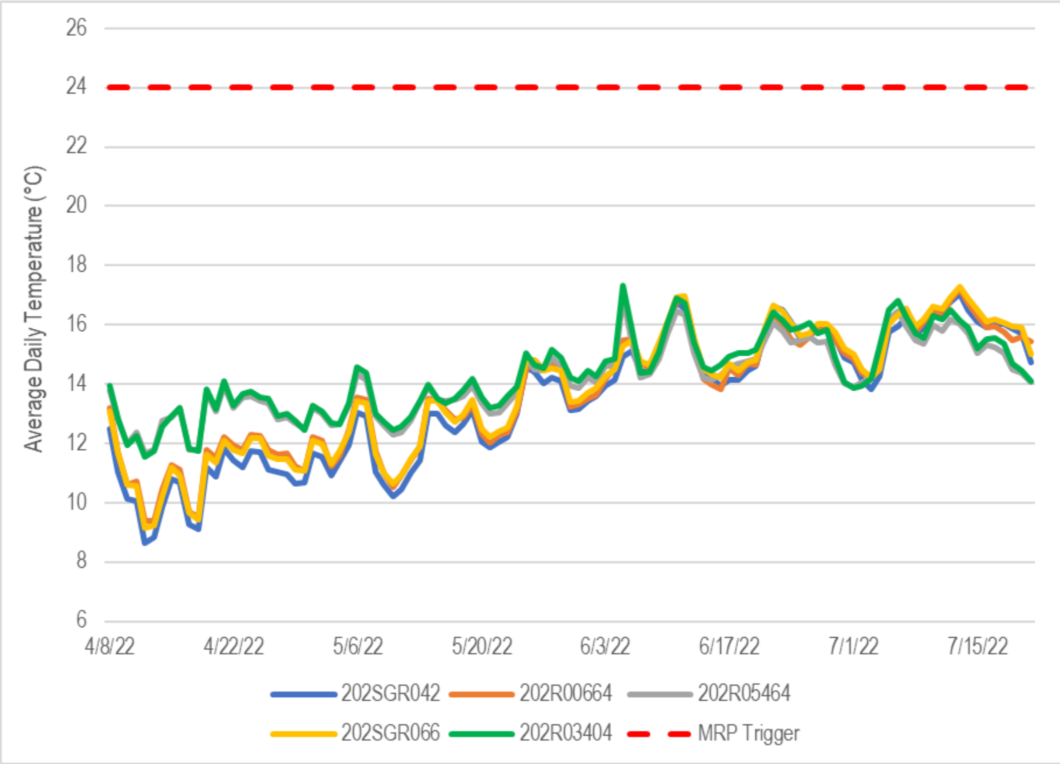


Figure 3.3 Water temperature, shown as daily average, measured at three sites in the San Gregorio Creek and two sites in San Pedro Creek watershed, San Mateo County in WY 2022. The MRP trigger threshold (24°C) is shown for comparison.

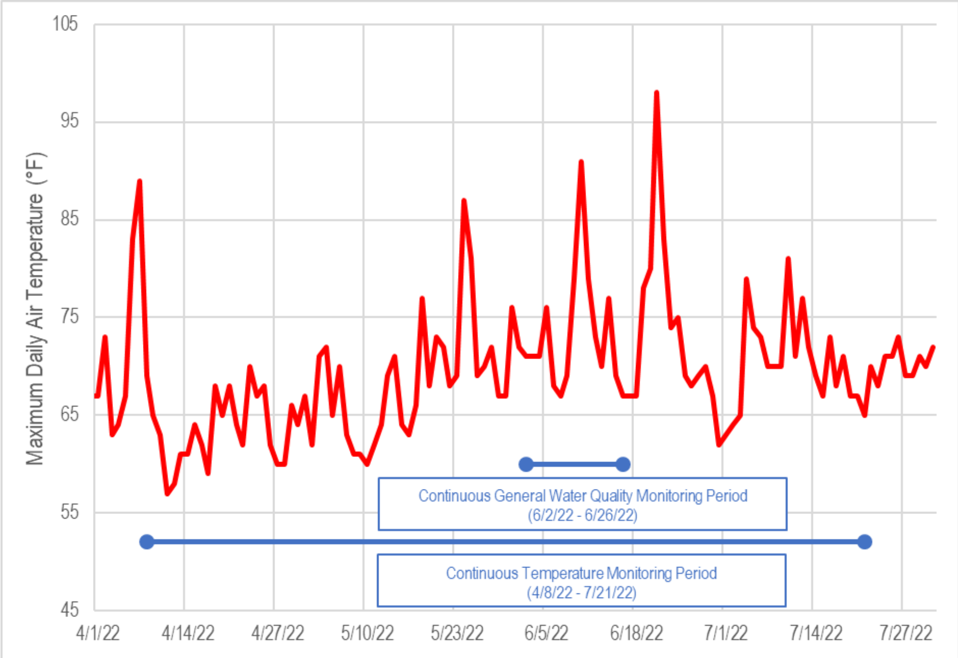


Figure 3.4 Maximum daily air temperature at San Francisco International Airport, April 1 – July 31, 2022 (NOAA station USW00023234).

3.4.2 General Water Quality

Summary statistics for continuous (15-minute) general water quality measurements (DO, pH, specific conductance, temperature) collected at two stations in San Gregorio Creek are listed in Table 3.5. Plots for all accepted water quality data measured during the June monitoring event are shown Figure 3.5. Photos of the two stations are included in Figure 3.6.

Table 3.5. Descriptive statistics for continuous (15-minute) water temperature, dissolved oxygen, pH, and specific conductance measured at two San Gregorio Creek sites during WY 2022.

Parameter	Data Type	(Downstream --------Upstream)	
		202SGR042	202R00664
	Assessment Date Range:	6/2/22 - 6/16/22	6/2/22 - 6/16/22
Temperature (°C)	Minimum	12.0	12.3
	Median	15.0	14.8
	Mean	15.0	14.9
	Maximum	18.7	18.4
	% > 24	0%	0%
Specific Conductivity (uS/cm)	Minimum	921	817
	Median	967	914
	Mean	969	915
	Maximum	983	932
	% > 2000	0%	0%
pH	Minimum	8	8.1
	Median	8.1	8.2
	Mean	8.1	8.2
	Maximum	8.3	8.4
	% < 6.5 or > 8.5	0%	0%
Dissolved Oxygen (mg/L)	Minimum	7.4	8.2
	Median	8.6	9.3
	Mean	8.7	9.5
	Maximum	10.0	11.4
	% < 7.0	0%	0%

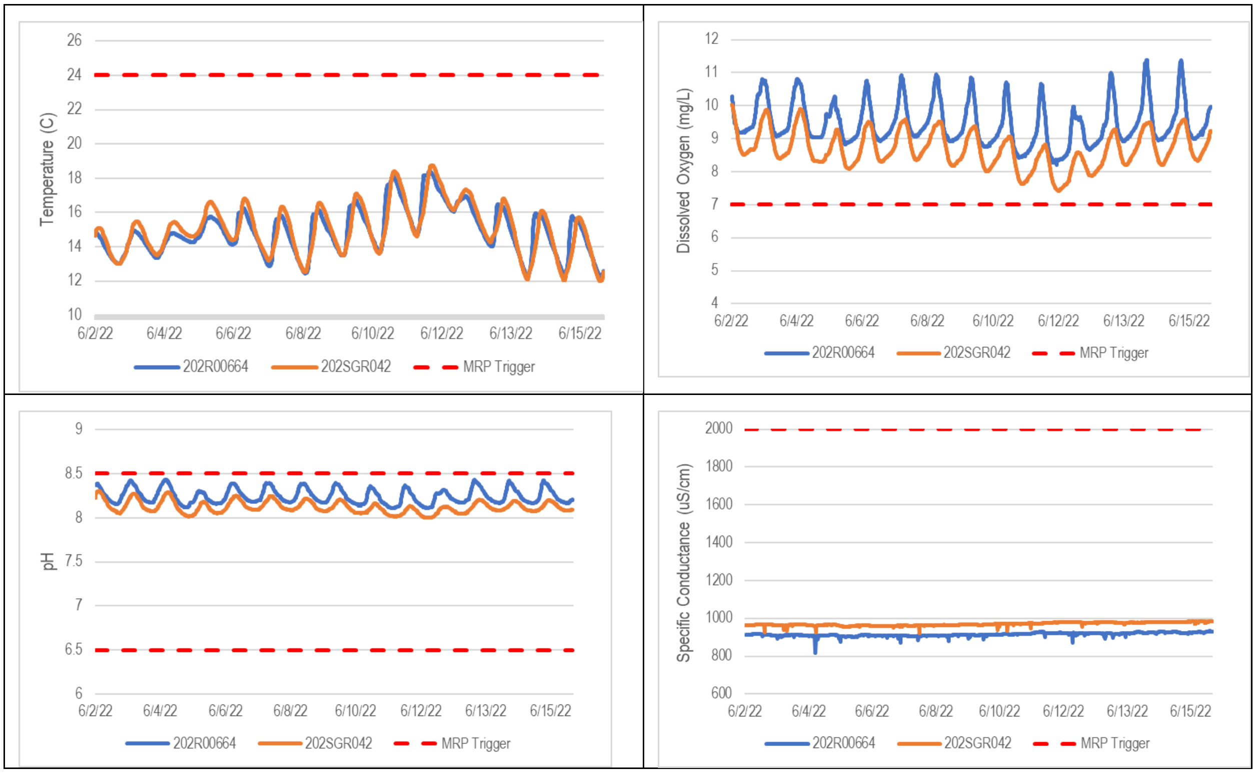


Figure 3.5 Continuous (15-minute) water quality data (temperature, specific conductance, pH, and dissolved oxygen) collected during June 2022 at two sites in San Gregorio Creek, WY 2022.

Figure 3.6. San Gregorio Creek at stations 202R00664 and 202SGR042. Photos captured summer 2022.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from 7.4 mg/L to 11.4 mg/L across both sites. There were no measurements below the WQO of 7mg/L, thus, the MRP trigger was not exceeded at either site. The DO levels were consistently higher at site 202R00664 compared to site 202SGR042 (Table 3.5). The DO concentrations at both sites followed a typical diurnal pattern with higher concentrations measured in the afternoon as a result of photosynthesis throughout the day and lower concentrations measured at night as a result of aquatic plant and animal respiration (Figure 3.5).

pH

Measured pH values ranged from 8.0 to 8.4 across both sites. None of the pH measurements exceeded the WQOs and thus, the MRP trigger was not exceeded at either site. Similar to DO, the pH values showed diurnal variability, with higher levels during the day and lower levels at night. pH levels were slightly higher at the upper site (station 202R00664).

Specific Conductivity

Specific conductance ranged from 817 µS/cm to 983 µS/cm across both sites, never exceeding the MRP trigger of 2000 µS/cm (Table 3.5). Specific conductance levels were similar at the two stations, with station 202R00664 (the upstream station) recording slightly lower specific conductance.

Temperature

Water temperature data collected with the sondes ranged between 12.0°C and 18.7°C, never exceeding the MRP trigger threshold of 24°C. The MRP trigger for MWAT was not exceeded at either station. Temperature loggers were deployed at both stations between April 8 and July 21, 2022. See Section 3.4.1 for a full discussion of the water temperature monitoring results.

Continuous Water Quality Trigger Summary

There were no exceedances of WQOs or MRP triggers for water quality measurements (pH, DO, specific conductivity) or water temperature. These do not appear to be limiting factors for salmonid fish populations in San Gregorio Creek or San Pedro Creek.

4.0 Chlorine Monitoring

4.1 Introduction

Chlorine is added to potable water supplies and wastewater to kill microorganisms that cause waterborne diseases in humans. However, chlorine can be toxic to aquatic species if left unmanaged. Chlorinated water may be inadvertently discharged to the municipal separate storm sewer system (MS4) and/or urban creeks from residential activities such as pool dewatering and over-watering of landscape, or from municipal activities such as hydrant flushing and water main breaks.

In compliance with provision C.8.d.ii. of MRP 2.0 and to assess whether chlorine in receiving waters is present at concentrations potentially toxic to aquatic life, SMCWPPP field staff measured the concentration of free chlorine and total chlorine residual in creeks where bioassessments were conducted. Total chlorine residual is comprised of “combined” chlorine and free chlorine. Combined chlorine is the chlorine that has reacted with ammonia or organic nitrogen to form chloramines, while free chlorine is the chlorine that remains unbound. Both can be toxic to aquatic life, but chlorine dissipates into the atmosphere more quickly than chloramine.

4.2 Methods

In accordance with the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), WY 2022 field testing for free chlorine and total chlorine residual was conducted at all ten bioassessment sites concurrent with spring bioassessment sampling (May). Bioassessment site selection is described in Section 2.0.

Field testing for free chlorine and total chlorine residual conformed to methods and procedures described in the BASMAA RMC SOPs (BASMAA 2016). Per SOP FS-3 (BASMAA 2016), water samples were collected and analyzed for free chlorine and total chlorine residual using a Hach Pocket Colorimeter™ II and DPD Powder Pillows, which has a manufacturer reported method detection limit (MDL) of 0.02 mg/L. If concentrations exceeded the MRP 2.0 trigger criteria of 0.1 mg/L, the site was immediately resampled. If the second sample also exceeded the trigger, the site is added to the list of sites with trigger exceedances that is maintained by SMCWPPP. Provision C.8.d.ii.(4) of MRP 2.0 also specifies that, for sites with trigger exceedances, “Permittees report the observation to the appropriate Permittee central contact point for illicit discharges so that the illicit discharge staff can investigate and abate the associated discharge in accordance with its provision C.5.e. – Spill and Dumping Complaint Response Program.”

4.3 Results and Discussion

In WY 2022, SMCWPPP monitored the ten bioassessment sites for free chlorine and total chlorine residual. These measurements were compared to the MRP 2.0 trigger threshold of 0.1 mg/L. Results are listed in Table 4.1 and mapped in Figure 4.1. The trigger thresholds for free chlorine and total chlorine residual were not exceeded at any of the sites in WY 2022.

For unknown reasons, the free chlorine result was greater than the total residual chlorine result at four stations (Table 4.1). While theoretically impossible, inverted results such as this have been occasionally noted during the WY 2012 – WY 2021 monitoring program (SMCWPPP 2021). Potential causes for inverted results include matrix interferences, colorimeter user error, and concentrations near the detection limit. According to Hach, the supplier of the equipment and reagents, the free chlorine could have false positive results due to pH (i.e., above 7.6) and/or high alkalinity (i.e., above 250 mg/L). It is unlikely that the higher free chlorine readings were caused by user error. The field crew is well-trained and aware of potential problems with this testing method, such as wait times between adding reagents and taking the readings and keeping the free chlorine and total chlorine residual samples separate. The cause of the inverted free chlorine and total chlorine residual results is unknown. However, it should be noted that colorimetric field instruments are generally not considered capable of providing accurate measurements of free chlorine and total chlorine residual below 0.13 mg/L, regardless of the MDL provided by the manufacturer (in this case 0.02 mg/L). For this reason, the Statewide General Permit for drinking Water Discharges (Order WQ 2014-0194-DWQ) uses 0.1mg/L as a reporting limit for field measurements of total chlorine residual.

Table 4.1. Chlorine testing results compared to MRP trigger of 0.1 mg/L, WY 2022.

Site ID	Date	Creek	Free Chlorine (mg/L)[ab]	Total Chlorine Residual (mg/L) [a,b]
202R00806	5/16/2022	Pescadero Creek	0.05	0.05
202R00726	5/19/2022	Peters Creek	0.03	0.02
202SGR042	5/17/2022	San Gregorio Creek	0.07	0.02
202SGR066	5/17/2022	San Gregorio Creek	<0.02	<0.02
202R00664	5/24/2022	San Gregorio Creek	<0.02	<0.02
202R00920	5/24/2022	Alpine Creek	0.04	<0.02
202R03916	5/25/2022	San Pedro Creek	0.02	0.04
202R05464	5/25/2022	San Pedro Creek	0.05	0.03
202R03404	5/23/2022	San Pedro Creek	<0.02	0.03
202R04568	5/23/2022	San Pedro Creek	0.05	0.06

[a] The MDL is 0.02 mg/L; however, the Statewide General Permit for Drinking Water Discharges (Order WQ 2014-0194-DWQ) uses 0.1 mg/L as a reporting limit (minimum level) for field measurements of total chlorine residual.

[b] The MRP trigger threshold of 0.1 mg/L applies to both free chlorine and total chlorine residual measurements.

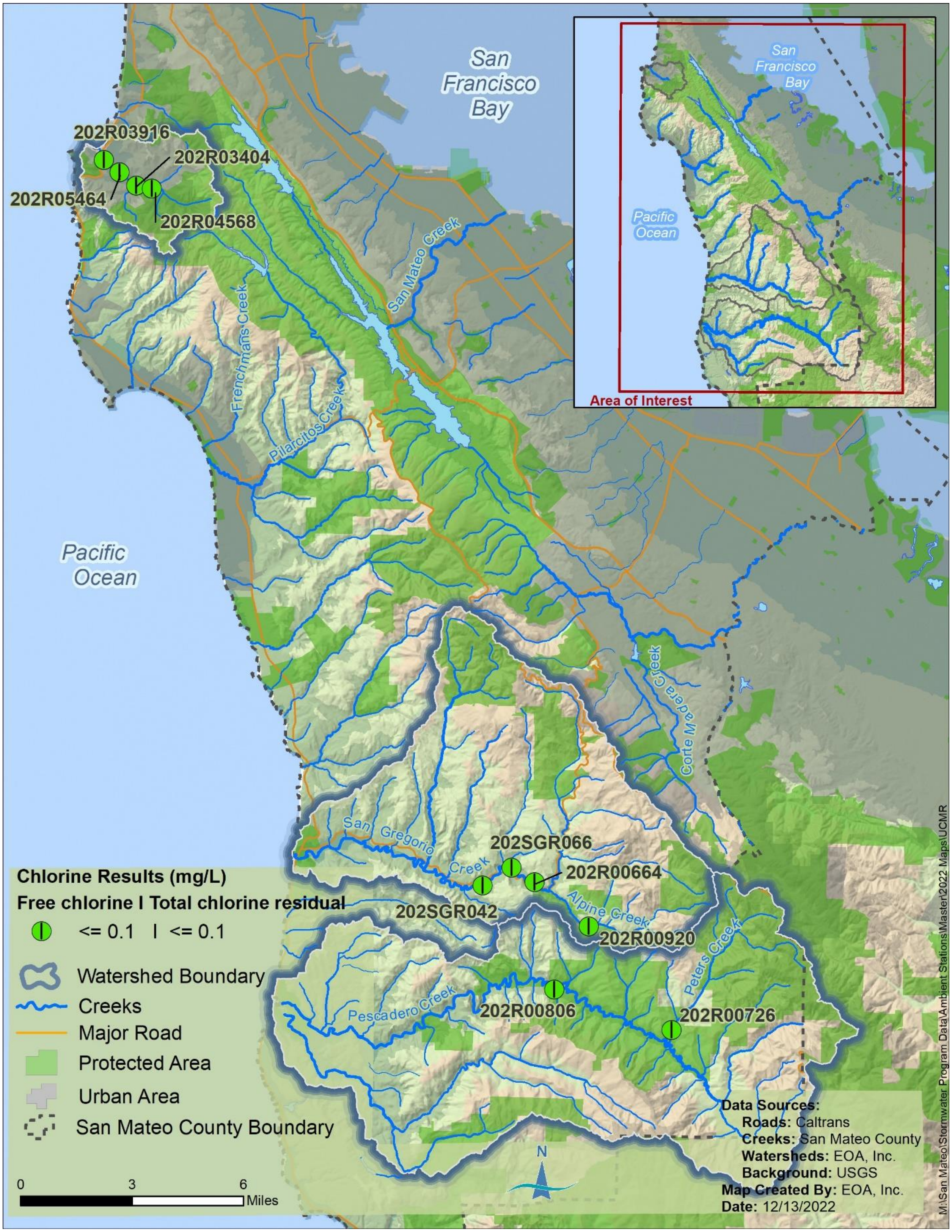


Figure 4.1 Chlorine sample stations and results in San Mateo County, WY 2022.

5.0 Conclusions and Recommendations

This section presents conclusions and recommendations from review of the WY 2022 Creek Status Monitoring data that are presented in this report.

In WY 2022, in compliance with provision C.8.d. of MRP 2.0 and the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012), SMCWPPP continued to implement a monitoring design that was initiated in WY 2012. The strategy includes a regional ambient/probabilistic bioassessment monitoring component and a component based on local targeted monitoring for general water quality parameters. The combination of these monitoring designs allows each individual RMC participating program (including SMCWPPP) to assess the status of beneficial uses in local creeks within its jurisdictional area, while also contributing data to help address management questions at the regional scale (e.g., differences between aquatic life condition in urban and non-urban creeks).

Conclusions from Creek Status Monitoring conducted during WY 2022 in San Mateo County are based on the management questions from MRP 2.0 presented in Section 1.0 of this report:

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 through the evaluation of monitoring data with respect to WQOs and triggers defined in the MRP. A summary of trigger exceedances observed for each WY 2022 site is presented in Table 5.1. In compliance with provision C.8.e.i. of MRP 2.0, SMCWPPP coordinates with the RMC to maintain a comprehensive list of all monitoring results from the region exceeding trigger thresholds. Sites where triggers are exceeded may indicate potential impacts to aquatic life or other beneficial uses and under MRP 2.0 were considered for future evaluation via SSID projects.

The second management question is addressed primarily by assessing indicators of aquatic biological health using BMI and algae data. The indices of biological integrity based on BMI and algae data (i.e., CSCI and ASCI) are direct measures of aquatic life beneficial uses. Biological condition scores are 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 biological condition scores. Continuous monitoring data (temperature, DO, pH, and specific conductance) are evaluated with respect to COLD and WARM freshwater aquatic habitat beneficial uses.

All monitoring and data validation were conducted using methods consistent with the BASMAA RMC QAPP (BASMAA 2020) and SOPs (BASMAA 2016). Recommendations for future monitoring are described in Section 5.3.

5.1 Conclusions

5.1.1 Bioassessment Monitoring

In WY 2022, bioassessment monitoring was conducted at ten sites in compliance with provision C.8.d.i of MRP 2.0. Sites were sampled for BMI, benthic algae, and nutrients. Physical habitat and general water quality parameters were also measured at each site. In WY 2022, all ten bioassessment surveys were conducted at targeted sites. Eight of the sites were previously sampled as probabilistic sites. The targeted (rather than probabilistic) approach to bioassessment monitoring was initiated in WY 2022 because the Master List from which probabilistic sites are selected was exhausted for the area in WY 2020.

Management questions associated with the probabilistic monitoring design (*What is the condition of aquatic life in creeks in the RMC area; are WQOs met and are beneficial uses supported?, What are major stressors to aquatic life in the RMC area?, What are the long-term trends in water quality in creeks over time?)* were addressed in prior reports. In particular, the WY 2019 IMR (SMCWPPP 2020) evaluated eight years (WY 2012 – WY 2019) of SMCWPPP bioassessment data, and BASMAA (2019) analyzed five years (WY 2012 – WY 2016) of regional probabilistic data. The WY 2022 targeted monitoring design focused on building multi-year datasets for bioassessment sites that were previously sampled.

CSCI scores and water quality data were compared to applicable WQOs and triggers identified in MRP 2.0. Sites with results that exceed WQOs and triggers are added to the comprehensive list of exceedances that is maintained by SMCWPPP, consistent with provision C.8.e of the MRP (see Section 5.2).

Biological Condition Assessment

Stream condition is assessed using three different types of indices/tools: the BMI-based CSCI, the benthic algae-based ASCI, and the physical habitat-based IPI. Of these three, the CSCI is the only tool with a MRP trigger threshold.

The CSCI scores ranged from 0.61 to 1.13 across the ten bioassessment sites sampled in WY 2022 (Table 2.5). Five of the ten sites (50%) had CSCI scores in the two higher condition categories: "likely intact" and "possibly altered." The high scoring sites included all four sites sampled in the San Gregorio Creek watershed and one site in the Pescadero Creek watershed. The highest CSCI score (1.13) occurred at the two upper elevation sites in both watershed: site 202R00920 in Alpine Creek, located in Sam McDonald County Park, and site 202R00726 in Peters Creek, located in Portola Redwoods State Park.

The remaining five bioassessment sites had CSCI scores that were in the two lower condition categories: "likely altered" and "very likely altered", which are below the MRP trigger threshold value of 0.795. These sites included site 202R00806, located in Pescadero Creek County Park, and all four sites sampled in San Pedro Creek. Site 202R00806 also received low a CSCI score (0.49) from the bioassessment sampling event in WY 2021 (Table 2.6). Although this site has minimal development (1% impervious area), physical habitat and water quality may still be impacted from the 2020 Big Basin Fire, which burned in the upper areas of the Pescadero Creek watershed.

Biological conditions, based on CSCI scores, were relatively consistent across the ten sites for sampling events conducted between WY 2018 and WY 2022. There were changes in condition categories “likely altered” and “very likely altered” at four of the ten sites. The remaining six sites had minimal differences in CSCI score and no change in condition category.

5.1.2 Continuous Monitoring for Temperature and General Water Quality

Continuous monitoring of water temperature and general water quality in WY 2022 was conducted in compliance with provision C.8.d.iii. – iv. of MRP 2.0. Hourly temperature measurements were recorded at five sites from April through July. Continuous (15-minute) general water quality measurements (pH, DO, specific conductance, temperature) were recorded at two sites over a 15-day period during the spring season (June 2 through 16). Monitoring was conducted to address the following management questions from the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012):

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?*

Monitoring sites were selected based on the presence of significant fish and wildlife resources as well as historical and/or recent indications of water quality concerns. In WY 2022, the San Gregorio Creek watershed was targeted for continuous temperature and water quality monitoring. San Pedro Creek was targeted for continuous temperature monitoring. Both San Gregorio and San Pedro Creek support migration, rearing, and spawning habitat for existing steelhead populations. Temperature measurements followed predictable daily and seasonal patterns, were generally consistent across sites for both watersheds, and remained below MRP trigger thresholds. Similarly, general water quality parameters (DO, pH, conductivity) do not appear to be limiting factors for coho salmon or steelhead trout in San Gregorio Creek. In WY 2022, WQOs or MRP triggers for continuous temperature and general water quality monitoring data were not exceeded.

5.1.3 Chlorine Monitoring

Free chlorine and total chlorine residual were measured at ten sites concurrent with bioassessment surveys. In WY 2022, the MRP triggers for chlorine (> 0.1 mg/L) were not exceeded.

While chlorine has generally not been a concern in San Mateo County creeks and the MRP triggers were not exceeded in WY 2022, prior monitoring results revealed occasional trigger exceedances of free chlorine and total chlorine residual in samples from creeks in the County. Trigger exceedances may be the result of one-time discharges of chlorinated water (e.g., pool dewatering), and it is generally challenging to identify the source of elevated chlorine from such episodic discharges. Furthermore, chlorine in surface waters can rapidly dissipate from volatilization and reaction with sediments and organic matter.

5.2 WY 2022 Trigger Assessment

MRP 2.0 requires analysis of the monitoring data to identify candidate sites for potential future investigations. Trigger thresholds against which to compare the data are provided for most monitoring parameters in the MRP and are described in the foregoing sections of this report. Stream condition was assessed based on CSCI scores that were calculated using BMI data. Nutrient data were evaluated using applicable water quality standards from the Basin Plan (SFBRWQCB 2017). In compliance with provision C.8.e.i. of MRP 2.0, all monitoring results exceeding trigger thresholds are added to a list of candidate SSID projects that were maintained throughout the MRP 2.0 permit term. Table 5.1 lists sites with trigger exceedances based on WY 2022 Creek Status monitoring data. Trigger and WQO exceedances from WY 2014 through WY 2021 were reported in the IMR (SMCWPPP 2020) and prior UCMRs (SMCWPPP 2015, 2016, 2017, 2018, 2019, 2021, 2022).

Additional analysis of the data is provided in the previous sections of this report and should be considered prior to selecting and defining any follow-up projects. The analyses include review of physical habitat and water chemistry data to identify potential stressors that may be contributing to degraded or diminished biological conditions. Analyses in this report also include historical and spatial perspectives that help provide context and deeper understanding of the trigger exceedances.

Table 5.1. Summary of SMCWPPP MRP trigger threshold exceedances, WY 2022. "No" indicates samples were collected but did not exceed the MRP trigger; "Yes" indicates an exceedance of the MRP trigger.

Station Number	Creek Name	Bioassessment [a]	Nutrients [b]	Chlorine [c]	Continuous Temperature [d]	Dissolved Oxygen [e]	pH [f]	Specific Conductance [g]
Pescadero Creek Watershed								
202R00806	Pescadero Creek	Yes	No	No	--	--	--	--
202R00726	Peters Creek	No	No	No	--	--	--	--
San Gregorio Creek Watershed								
202SGR042	San Gregorio Creek	No	No	No	No	No	No	No
202SGR066	San Gregorio Creek	No	No	No	No	--	--	--
202R00664	San Gregorio Creek	No	No	No	No	No	No	No
202R00920	Alpine Creek	No	No	No	--	--	--	--
San Pedro Creek Watershed								
202R03916	San Pedro Creek	Yes	No	No	--	--	--	--
202R05464	San Pedro Creek	Yes	No	No	No	--	--	--
202R03404	San Pedro Creek	Yes	No	No	No	--	--	--
202R04568	San Pedro Creek	Yes	No	No	--	--	--	--

Notes:
[a] CSCI score ≤ 0.795.
[b] Unionized ammonia (as N) ≥ 0.025 mg/L, nitrate (as N) ≥ 10 mg/L, chloride > 250 mg/L.
[c] Free chlorine or total chlorine residual ≥ 0.1 mg/L.
[d] Two or more weekly average temperatures exceed the MWAT of 17.0°C or 20% of results ≥ 24°C.
[e] Twenty percent of results = DO < 7.0 mg/L in COLD streams or DO < 5.0 mg/L in WARM streams.
f Twenty percent of results = pH < 6.5 or pH > 8.5.
[g] Twenty percent of results = specific conductance > 2000 uS.

5.3 Recommendations

The Creek Status Monitoring program (consistent with provision C.8.d. of MRP 2.0) was eliminated with the adoption of MRP 3.0 in July 2022. Biological assessments, continuous temperature and water quality monitoring, chlorine testing, and pathogen indicator monitoring are no longer required during the next permit term. As a result, there are no recommendations associated with these monitoring parameters provided in this report. However, in compliance with provision C.8.h.vi. of MRP 3.0, SMCWPPP will work with RMC partners to collectively submit (by March 31, 2024) a comprehensive analysis of all bioassessment monitoring conducted by the RMC during MRP 1.0 and 2.0 for Water Years 2012 through 2021.

Over the past eleven years (WY 2012 through WY 2022), SMCWPPP (with support from the Regional Water Board) conducted a total of 120 bioassessment surveys at over 100 unique stream locations throughout San Mateo County. Most of the monitoring stations were selected using a randomized probabilistic sample design; thus, sites were located across a wide variety of stream types in both urban and non-urban land uses. Collectively, these bioassessment data provide a comprehensive baseline dataset to evaluate biological and physical habitat conditions in San Mateo County watersheds, and throughout the Bay Area. The biological indicator data are valuable for evaluating potential support of Aquatic Life Uses.

It is recommended that bioassessments are periodically conducted at selected locations to assess changes in stream conditions over time. Additional targeted monitoring (e.g., continuous water quality) may also provide useful information to assess potential impacts to biological conditions. Targeted monitoring could be conducted in reaches downstream of water quality improvement projects (e.g., Low Impact Development) or stream restoration projects to measure changes in biological and habitat condition over time.

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ATTACHMENTS

Attachment 1

QA/QC Report

Urban Creeks Monitoring Report
Creek Status Monitoring

Quality Assurance/Quality Control Report

Water Year 2021-2022

Prepared by:

EOA inc.

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1410 Jackson Street
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SAN MATEO COUNTYWIDE
Water Pollution
Prevention Program

March 31, 2023

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LIST OF ACRONYMS

BAMSC	Bay Area Municipal Stormwater Collaborative
BASMAA	Bay Area Stormwater Management Agencies Association
BMI	Benthic Macroinvertebrates
CDFW	California Department of Fish and Wildlife
DPD	Diethyl-p-phenylene Diamine
DQO	Data Quality Objective
EDDs	Electronic data deliverables
EV	Expected Value
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MQO	Measurement Quality Objective
MRP	Municipal Regional Permit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MV	Measured Value
ND	Non-detect
NIST	National Institute of Standards and Technology
NPDES	National Pollution Discharge Elimination System
NV	Native Value
PR	Percent Recovery
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting Limit
RMC	Regional Monitoring Coalition
RPD	Relative Percent Difference
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SFRWQCB	San Francisco Regional Water Quality Control Board
SMCWPPP	San Mateo County Urban Pollution Prevention Program
SOP	Standard Operating Procedures
STE	Standard Taxonomic Effort
SV	Spike Value
SWAMP	Surface Water Ambient Monitoring Program
TKN	Total Kjeldahl Nitrogen
WY	Water Year

1. INTRODUCTION

In Water Year 2021-2022 (WY 2022; October 1, 2021 through September 30, 2022), the San Mateo County Water Pollution Prevention Program (SMCWPPP or Program) conducted creek status monitoring in compliance with Provision C.8.d of the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities, referred to as the Municipal Regional Permit (MRP; SFBRWQCB 2015). The monitoring strategy includes regional ambient/probabilistic monitoring and local "targeted" monitoring as described in the Bay Area Stormwater Management Agencies Association (BASMAA[1]) Regional Monitoring Coalition (RMC) Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2012). The Program implemented a comprehensive data quality assurance and quality control (QA/QC) program, covering all aspects of creek status monitoring. QA/QC for the data collected was performed according to procedures detailed in the BASMAA RMC Quality Assurance Project Plan (QAPP) (BASMAA 2020) and the BASMAA RMC Standard Operating Procedures (SOP; BASMAA 2016), SOP FS-13 (Standard Operating Procedures for QA/QC Data Review). The BASMAA RMC QAPP and SOP are based on the QA program developed by the California Surface Water Ambient Monitoring Program (SWAMP 2022).

Based on the QA/QC review, WY 2022 data met overall QA/QC objectives. Some data were flagged, but not rejected. Details are provided in the sections below.

1.1. Data Types Evaluated

During creek status monitoring (MRP Provision C.8.d), several data types were collected and evaluated for quality assurance and quality control. These data types include the following:

1. Bioassessment data
    a. Benthic Macroinvertebrates (BMI)
    b. Algae
2. Physical Habitat Assessment
3. Field Measurements
4. Water Chemistry
5. Continuous Water Quality (one 2-week deployment; 15-minute interval)
    a. Temperature
    b. Dissolved Oxygen
    c. Conductivity
    d. pH
6. Continuous Temperature Measurements (3-month deployment; 1-hour interval)

1.2. Laboratories

Laboratories that provided analytical and taxonomic identification support to SMCWPPP and the RMC were selected based on the demonstrated capability to adhere to specified protocols. Laboratories are certified and are as follows:

- Caltest Analytical Laboratory (nutrients, chlorophyll a, ash free dry mass)
- BioAsessment Services (benthic macroinvertebrate (BMI) identification)
- Jon Lee Consulting (BMI identification Quality Control)
- EcoAnalysts, Inc. (algae identification)

[1] BASMAA was dissolved in January 2021 and was replaced by the Bay Area Municipal Stormwater Collaborative (BAMSC)

1.3. QA/QC ATTRIBUTES

The RMC SOP and QAPP identify seven data quality attributes that are used to assess data QA/QC. They include (1) Representativeness, (2) Comparability, (3) Completeness, (4) Sensitivity, (5) Precision, (6) Accuracy, and (7) Contamination. These seven attributes are compared to Data Quality Objectives (DQOs), which were established to ensure that data collected are of adequate quality and sufficient for the intended uses. DQOs address both quantitative and qualitative assessment of the acceptability of data – representativeness and comparability are qualitative while completeness, sensitivity, precision, accuracy, and contamination are quantitative assessments.

Specific DQOs are based on Measurement Quality Objectives (MQOs) for each analyte. Chemical analysis relies on repeatable physical and chemical properties of target constituents to assess accuracy and precision. Biological data are quantified by experienced taxonomists relying on organism morphological features.

1.3.1. Representativeness

Data representativeness assesses whether the data were collected in a manner that is representative of actual conditions at each monitoring location. For this project, all samples and field measurements are assumed to be representative if they are performed according to protocols specified in the RMC QAPP and SOPs.

1.3.2. Comparability

The QA/QC officer ensures that the data may be reasonably compared to data from other programs producing similar types of data. For RMC creek status monitoring, individual stormwater programs try to maintain comparability within the RMC. The key measure of comparability for all RMC data is SWAMP.

1.3.3. Completeness

Completeness is the degree to which all data were produced as planned; this covers both sample collection and analysis. For chemical data and field measurements, an overall completeness of greater than 90% is considered acceptable for RMC chemical data and field measurements. For bioassessment-related parameters – including BMI and algae taxonomy samples/analysis and associated field measurement – a completeness of 95% is considered acceptable.

1.3.4. Sensitivity

Sensitivity analysis determines whether the methods can identify and/or quantify results at low enough levels. For the chemical analyses in this project, sensitivity is considered to be adequate if the reporting limits (RLs) comply with the specifications in RMC QAPP Appendix E: RMC Target Method Reporting Limits. For benthic macroinvertebrate data, taxonomic identification sensitivity is acceptable provided taxonomists use standard taxonomic effort (STE) Level I, as established by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT). There is no established level of sensitivity for algae taxonomic identification.

1.3.5. Accuracy

Accuracy is assessed as the percent recovery of samples spiked with a known amount of a specific chemical constituent. Chemistry laboratories routinely analyze a series of spiked samples. The results of these analyses are reported by the laboratories and evaluated using the RMC Database QA/QC Testing Tool. Acceptable levels of accuracy are specified for chemical analytes in RMC QAPP Appendix A: Measurement Quality Objectives for RMC Analytes, and for biological measurements in Appendix B: Benthic Macroinvertebrate MQOs and Data Production Process.

1.3.6. Precision

Precision is nominally assessed as the degree to which replicate measurements agree and determined by calculation of the relative percent difference (RPD) between duplicate measurements. Chemistry laboratories routinely analyze a series of duplicate samples that are generated internally. The RMC QAPP also requires the collection and analysis of field duplicate samples at a rate of 5% of all samples for all parameters[2]. The results of the duplicate analyses are reported by the laboratories and evaluated using RMC Database QA/QC Testing Tool. Results of the Tool are confirmed manually. Acceptable levels of precision are specified for chemical analytes in RMC QAPP Appendix A: Measurement Quality Objectives for RMC Analytes, and for biological measurements in Appendix B: Benthic Macroinvertebrate MQOs and Data Production Process.

1.3.7. Contamination

For chemical data, contamination is assessed as the presence of analytical constituents in blank samples, including laboratory, field, and equipment blanks. The RMC QAPP requires collection and analysis of field blank samples at a rate of 5% for orthophosphate. Field blanks are not required for other constituents.

[2] The QAPP also requires the collection of field duplicate samples for 10% of biological samples (BMI and algae). However, there are no prescribed methods for assessing the precision of these duplicate samples.

2. METHODS

2.1. Representativeness

To ensure representativeness, each member of the SMCWPPP field crew received and reviewed all applicable SOPs and the QAPP. Most field crew members also attended a two-day bioassessment and field sampling training session from the California Water Boards Training Academy. The course was taught by California Department of Fish and Wildlife, Aquatic Bioassessment Laboratory staff and covered procedures for sampling benthic macroinvertebrates, algae, and measuring physical habitat characteristics using the applicable SWAMP SOPs. As a result, each field crew member was knowledgeable of, and performed data collection according to the protocols in the RMC QAPP and SOPs, ensuring that all samples and field measurements are representative of conditions in San Mateo County urban creeks.

2.2. Comparability

In addition to the bioassessment and field sampling training, SMCWPPP field crew members participated in an inter-calibration exercise with other stormwater programs prior to field assessments at least once during the permit term. During the inter-calibration exercise, the field crews also reviewed water chemistry (nutrient) sample collection and water quality field measurement methods. To ensure comparability, there was close communication throughout the field season with other stormwater program field crews.

Sub-contractors collecting samples and the laboratories performing analyses received copies of the RMC SOP and QAPP and have acknowledged reviewing the documents. Data collection and analysis by these parties adhered to the RMC protocols and was included in their operating contracts.

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the SMCWPPP Program Quality Assurance staff, and were compared against the methods and protocols specified in the SOPs and QAPP. Specifically, staff checked for conformance with field and laboratory methods as specified in SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc.

Electronic data deliverables (EDDs) were submitted to the San Francisco Regional Water Quality Control Board (SFRWQCB) in Microsoft Excel templates developed by SWAMP, to ensure data comparability with the SWAMP program. In addition, data entry followed SWAMP documentation specific to each data type, including the exclusion of qualitative values that do not appear on SWAMP's look up lists[3] such as field crew member names and site IDs. Completed templates were reviewed using SWAMP's online data checker[4], further ensuring SWAMP-comparability.

2.3. Completeness

2.3.1. Data Collection

All efforts were made to collect 100% of planned samples. Upon completion of all data collection, the number of samples collected for each data type was compared to the number of samples planned and the number required by the MRP, and reasons for any missed samples were identified. When possible, SMCWPPP staff resampled sites if missing data were identified prior to the close of the monitoring period. Specifically, continuous water quality data were reviewed immediately following deployment for adherence to MQOs. If data were rejected, samplers were redeployed immediately.

[3] Look up lists available online at https://swamp.waterboards.ca.gov/swamp_checker/LookUpLists.aspx
[4] Checker available online at https://swamp.waterboards.ca.gov/swamp_checker/SWAMPUpload.aspx

For bioassessments, the SMCWPPP field crew made all efforts to collect the required number of BMI and algae subsamples per site; in the event of a dry transect, the samples were slid to the closest sampleable location to ensure 11 total subsamples in each station's composite sample.

2.3.2. Field Sheets

Following the completion of each sampling event, the field crew leader/local monitoring coordinator reviewed any field generated documents for completion, and any missing values were entered. Once field sheets were returned to the office or shared electronically, a SMCWPPP QA staff member reviewed the field sheets again and noted any missing data.

2.3.3. Laboratory Results

SMCWPPP QA staff assessed laboratory reports and EDDs for the number and type of analysis performed to ensure all sites and samples were included in the laboratory results.

2.4. Sensitivity

2.4.1. Biological Data

Benthic macroinvertebrates were identified to SAFIT STE Level I, with the additional effort of identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae).

2.4.2. Chemical Analysis

The reporting limits for analytical results were compared to the target reporting limits in Appendix E (RMC Target Method Reporting Limits) of the RMC QAPP. Results with reporting limits that exceeded the target reporting limit were flagged.

2.5. Accuracy

2.5.1. Biological Data

Ten percent of the total number of BMI samples collected was submitted to a separate taxonomic laboratory, Jon Lee Consulting, for independent assessment of taxonomic accuracy, enumeration of organisms, and conformance to standard taxonomic level. For SMCWPPP, one sample was evaluated for QC purposes. Results were compared to MQOs in Appendix B (Benthic macroinvertebrate MQOs and Data Production Process).

2.5.2. Chemical Analysis

Caltest evaluated and reported the percent recovery (PR) of laboratory control samples (LCS; in lieu of reference materials) and matrix spikes (MS), which were recalculated and compared to the applicable MQOs set by Appendix A (Measurement Quality Objectives for RMC Analytes) of the RMC QAPP MQOs. If a QA sample did not meet MQOs, all samples in that batch for that particular analyte were flagged.

For reference materials, percent recovery was calculated as:

$$PR = MV / EV \times 100\%$$

Where: MV = the measured value
EV = the expected (reference) value

For matrix spikes, percent recovery was calculated as:

$$PR = [(MV - NV) / SV] \times 100\%$$

Where: MV = the measured value of the spiked sample
NV = the native, unspiked result
SV = the spike concentration added

2.5.3. Water Quality Data Collection

Accuracy for continuous water quality monitoring sondes was assured via continuing calibration verification for each instrument before and after the two-week deployment. Instrument drift was calculated by comparing the instrument's measurements in standard solutions taken before and after deployment. The drift was compared to measurement quality objectives for drift listed on the SWAMP calibration form, included as an attachment to the RMC SOP FS-3.

Temperature data were checked for accuracy by comparing measurements taken by HOBO temperature loggers with NIST thermometer readings in room temperature water and ice water prior to deployment. The mean difference and standard deviation for each HOBO was calculated, and if a logger had a mean difference exceeding 0.2 ºC, it was replaced.

2.6. PRECISION

2.6.1. Field Duplicates

For creek status monitoring, duplicate biological samples were collected at 10% (one) of the 10 sites and duplicate water chemistry samples were collected at 10% (one) of the sites sampled to evaluate precision of field sampling methods. The RPD for water chemistry field duplicates was calculated and compared to the MQO (RPD < 25%) set by Table A-1 and A-2 in Appendix A of the RMC QAPP. If the RPD of the two field duplicates did not meet the MQO, the results were flagged.

The RPD is calculated as:

RPD = ABS ([X1-X2] / [(X1+X2) / 2])

Where: X1 = the first sample result
X2 = the duplicate sample result

2.6.2. Chemical Analysis

Caltest evaluated and reported the RPD for laboratory duplicates, laboratory control sample duplicates (LCSD), and matrix spike duplicates (MSD). The RPDs for all duplicate samples were recalculated and compared to the applicable MQO set by Appendix A of the RMC QAPP. If a laboratory duplicate sample did not meet MQOs, all samples in that batch for that particular analyte were flagged.

2.7. CONTAMINATION

Blank samples were analyzed for contamination, and results were compared to MQOs set by Appendix A of the RMC QAPP. For creek status monitoring, the RMC QAPP requires all blanks (laboratory, equipment, and field) to be less than the analyte reporting limits. If a blank sample did not meet this MQO, all samples in that batch for that analyte were flagged.

3. RESULTS

3.1. Overall Project Representativeness

The SMCWPPP staff and field crew members were trained in SWAMP and RMC protocols and received significant supervision from the local monitoring coordinator and QA officer. As a result, creek status monitoring data are considered to be representative of conditions in San Mateo County Creeks.

3.2. Overall Project Comparability

SMCWPPP creek status monitoring data are considered to be comparable to other agencies in the RMC and to SWAMP due to a shared QAPP and SOP, trainings, use of the same electronic data templates, and close communication.

3.3. Bioassessments and Physical Habitat Assessments

The SMCWPPP field crew collected algae and BMI taxonomic samples, as well as chlorophyll a and ash free dry mass composite samples during bioassessments.

3.3.1. Completeness

SMCWPPP completed bioassessments and physical habitat assessments at 10 of 10 planned/required sites for a 100% sampling completion rate.

3.3.2. Sensitivity

The analytical sensitivity for ash free dry and chlorophyll a analysis could not be evaluated due to analytical units differing from the unit listed in the RMC QAPP.

The BMI taxonomic identification met sensitivity objectives; the taxonomy laboratory, BioAssessment Services, and QC laboratory, Jon Lee Consulting, confirmed that organisms were identified to SAFIT STE Level I, with the exception of Chironomidae which was analyzed to SAFIT level 1a.

There is currently no protocol for evaluating the sensitivity of algae taxonomy.

3.3.3. Accuracy

The analytical laboratory analyzed laboratory control samples (LCS) and laboratory control sample duplicates (LCSD) for ash free dry mass and chlorophyll a. The percent recoveries (PRs) for all LCS and LCSD samples were within the MQO listed in the RMC QAPP (Table A-1), and no samples were flagged for accuracy exceedances.

One BMI sample was submitted to an independent QC taxonomic laboratory. There were three taxonomic discrepancies and two minor enumeration (counting) discrepancies. Two of the taxonomic discrepancies was likely due to sorting errors and the remaining discrepancy involved larvae of Tipulidae that was labeled *Limnophila* by mistake. Enumeration discrepancies were both one specimen off.

The QC laboratory calculated sorting and taxonomic identification metrics, which were compared to the measurement quality objectives in Table D-1 in Appendix D of the RMC QAPP. A comparison of the metrics with the MQOs is shown in Table 1. In WY 2022, all MQOs were met. A copy of the QC laboratory report is available upon request.

Table 1. Quality control metrics for taxonomic identification of benthic macroinvertebrates collected in San Mateo County in WY 2022 compared to measurement quality objectives.

Quality Control Metric	MQO	Error Rate	Exceeds MQO?
Absolute Recount	≤10%	0.48%	No
High Taxonomic Resolution Count	≤10%	0%	No
High Taxonomic Resolution Individual	≤10%	0%	No
Individual ID	≤10%	0.64%	No
Low Taxonomic Resolution Count	≤10%	0%	No
Low Taxonomic Resolution Individual	≤10%	0%	No
Recount Accuracy	≥95%	99.84%	No
Taxa Count	≤10%	0%	No
Taxa Identification	≤10%	6.25%	No
Taxonomic Resolution Count	≤10%	0%	No
Taxonomic Resolution Individual	≤10%	0%	No

There is currently no protocol for evaluating the accuracy of algae taxonomic identification.

3.3.4. Precision

Laboratory duplicates were analyzed for chlorophyll a and ash free dry mass samples. The RPDs for all ash free dry mass and chlorophyll a laboratory duplicates were found to be below the MQO limit.

Field blind duplicate chlorophyll a and ash free dry mass samples were collected at one site in WY 2022 and were sent to the laboratory for analysis. Due to the method used to collect duplicate algae field samples, these samples do not provide a valid estimate of precision in the sampling and are of little use to assessing precision, because there is no reasonable expectation that duplicates will produce identical data. Nonetheless, the RPD of the chlorophyll a and ash free dry mass duplicate results were calculated and compared to the MQO (< 25%) for conventional analytes in water (Table A-1 in Appendix A of the RMC QAPP). Due to the nature of chlorophyll a and ash free dry mass collection, the RPDs for both parameters are expected to exceed the MQO. Discrepancies are expected due to the potential natural variability in algae production within the reach and the collection of field duplicates at different locations along each transect (as specified in the protocol). As a result, both parameters have frequently exceeded the field duplicate RPD MQOs during past years' monitoring efforts.

The field duplicate results and their RPDs for WY 2022 are shown in Table 2. As expected, ash free dry mass exceeded the MQO, while chlorophyll a did not. Ash free dry mass samples were flagged.

Table 2. Field duplicate water chemistry results for site 202R05464, collected on May 25, 2022.

Analyte	Units	202R05464 May 25, 2022			
		Original Result	Duplicate Result	RPD	Exceeds MQO (>25%)[a]
Chlorophyll a	mg/m^2	29	26	11%	No
Ash Free Dry Mass	g/m^2	12	7.4	47%	Yes

[a] In accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable

3.3.5. Contamination

All field collection equipment was decontaminated between sites in accordance with the RMC SOP FS-8 and CDFW Aquatic Invasive Species Decontamination protocols. As a result, it is assumed that samples were free of biological contamination.

Additionally, the analytical laboratory ran several method blanks during ash free dry mass and chlorophyll a analysis and no contamination was detected in any of the blank samples.

3.4. Field Measurements

Temperature, dissolved oxygen, pH, specific conductivity, and chlorine residual were collected concurrently with bioassessments and water chemistry samples. Chlorine residual was measured using a HACH Pocket Colorimeter™ II, which uses the Diethyl-p-phenylene Diamine (DPD) method. All other parameters were measured with a YSI Professional Plus or YSI 600XLM-V2-S multi-parameter instrument. All data collection was performed according to RMC SOP FS-3 (Performing Manual Field Measurements).

3.4.1. Completeness

Temperature, dissolved oxygen, pH, specific conductivity, free and total chlorine residual were measured at all 10 bioassessment sites for a 100% completeness rate.

3.4.2. Sensitivity

Free and total chlorine residual were measured using a HACH Pocket Colorimeter™ II, which uses the DPD method. For this method, the estimated detection limit for the low range measurements (0.02-2.00 mg/L) was 0.02 mg/L. There is, however, no established reporting limit. Colorimetric field instruments are generally not considered capable of providing accurate measurements of free chlorine and total chlorine residual below 0.13 mg/L (Missouri Department of Natural Resources 2004), due to analytical noise, regardless of the method detection limit provided by the manufacturer. For this reason, the Statewide General Permit for drinking Water Discharges (SWRCB 2014) and other recently issued NPDES permits, use 0.1 mg/L as a reporting limit for field measurements of total chlorine residual.

The Program also uses this threshold as a reporting limit for MRP chlorine residual monitoring. All measurements between 0.02 and 0.1 mg/L have been flagged as “detected, not quantified” (EPA “J” flag). The adopted SMCWPPP reporting limit is still much lower than the target reporting limit of 0.5 mg/L listed in the RMC QAPP for free and total chlorine residual.

There are no reporting limits for temperature, dissolved oxygen, pH, and conductivity measurements, but the actual measurements are much higher than target reporting limits in the RMC QAPP, so it is assumed that the target reporting limits are met for all field measurements.

3.4.3. Accuracy

Data collection occurred Monday through Thursday, and the multi-parameter instrument was calibrated within 12 hours prior to the first sample on Monday, with the dissolved oxygen sensor calibrated every morning to ensure accurate measurements. Calibration solutions are certified standards, whose expiration dates were noted prior to use. The chlorine kit is factory-calibrated and is sent into the manufacturer every other year to be calibrated. The chlorine kit was not factory calibrated prior to WY 2021 monitoring, but results do not indicate any issues with the kit.

Free chlorine was measured to be higher than total chlorine at four of the ten sites sampled in WY 2022. In past years, free chlorine has also occasionally been measured as higher than total chlorine. Theoretically, the free chlorine measurement should always be less than or equal to the total chlorine measurement, as the total chlorine concentration in water encompasses the free chlorine concentration in addition to any other chlorine species. The reason for free chlorine concentrations exceeding total chlorine concentrations at a sample site has not been definitively established. Potential causes for these inverted results include matrix interferences, colorimeter user error, and uncertainty associated with low concentrations below the reporting limit. According to Hach, the manufacturer of the equipment and reagents, the free chlorine could have false positive results due to a pH exceedance of 7.6 and/or an alkalinity exceedance of 250 mg/L. It is unlikely that the higher free chlorine readings were caused by user error. The field crew is well trained and aware of potential problems with this testing method, such as wait times between adding reagents and taking the readings and separating the free chlorine and total residual chlorine samples. When free chlorine was observed to be higher than total chlorine at a sample site, the free chlorine measurement was retaken with a new water sample and recorded on the field form. It was deemed unnecessary to flag free chlorine measurements that were higher than total chlorine measurements.

3.4.4. Precision

Precision could not be measured as no duplicate field measurements are required or were collected.

3.5. WATER CHEMISTRY

Water chemistry samples were collected by SMCWPPP staff concurrently with bioassessment samples. The samples were analyzed by Caltest Analytical Laboratory within their respective holding times. 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 Tables A-1 and A-2.

3.5.1. Completeness

The Program collected 100% of planned/required water chemistry samples at the 10 bioassessment sites including one field duplicate sample. Samples were analyzed for all requested analytes, and 100% of results were reported.

3.5.2. Sensitivity

Laboratory RLs met or were lower than target RLs for all nutrients except chloride, nitrate, and ammonia. These results are similar to past years' results. Target and actual RLs are shown in Table 3. The Program has discussed the chloride and nitrate RLs with Caltest, and due the methodology, lower limits cannot currently be achieved.

While the RL for all chloride samples exceeded the target RL, concentrations were much higher than the RL, and the elevated RL did not decrease confidence in the measurements. Nitrate sample results were more variable. Four nitrate samples were reported as "not detected" since their concentrations were below the actual MDL/RL (0.05 mg/L); however, the remaining nitrate samples were detected at concentrations well above the RL.

Past ammonia concentrations were suspected of being biased high based on the theoretical relationship between ammonia and total Kjeldahl nitrogen (TKN) (i.e., ammonia concentrations should be less than TKN), but data were not flagged or rejected until this finding could be confirmed and the source identified.

Due to low confidence in ammonia concentrations analyzed[5] via a low-level analysis, the laboratory, RMC, and Regional Water Board agreed that the higher-level ammonia analysis was appropriate for RMC starting in WY 2021. To support this conclusion, in WY 2021, Caltest conducted a small-scale investigation of ammonia analytical methods using ammonia samples collected in Santa Clara County. The investigation compared the low-level, undistilled ammonia methodology (which met the target reporting limit for ammonia) against the regular-level, distilled methodology (which exceeded the target reporting limit). The laboratory found that for most of samples evaluated, the RPD between the regular-level and low-level methods exceeded the internal lab MQO of 20%. Additionally, the regular-level data typically trended higher than low-level. Caltest concluded that the low-level, undistilled methodology should be discontinued and the regular, distilled method be used for future ammonia analysis.

The regular-level, distilled methodology was used to analyze all ammonia samples collected during WY 2022.

Table 3. Target and actual reporting limits for nutrients analyzed in SMCWPPP creek status monitoring. Data in highlighted rows exceed monitoring quality objectives in RMC QAPP.

Analyte	Target RL mg/L	Actual RL mg/L
Ammonia	0.02	0.1
Chloride	0.25	10
Total Kjeldahl Nitrogen	0.5	0.1
Nitrate	0.01	0.05
Nitrite	0.01	0.005
Orthophosphate	0.01	0.01
Silica	1	0.5
Phosphorus	0.01	0.01

3.5.3. Accuracy

The RMC QAPP lists a target recovery range of 90-110% for nutrient laboratory control samples (LCS), and 80-120% for nutrient matrix spike and matrix spike duplicates (MS/MSD). For other conventional analytes (i.e., silica and chloride), both the LCS and MS/MSD MQO for recovery is 80-120%. Recoveries on all LCS and MS/MSD samples were within the MQO target range.

3.5.4. Precision

Caltest ran several LCS/LCSD and MS/MSD pairs for all target analytes, and the RPD for all pairs were consistently below the MQO target of < 25%.

In WY 2022, water chemistry field duplicates were collected at one site in San Mateo County and were compared against the original sample. The field duplicate water chemistry results and their RPDs are shown in Table 4. Because of the variability in reporting limits, RPD was not calculated when either the original or duplicate sample concentration was less than the RL. For WY 2022, none of the analytes exceeded MQO target for the duplicate sample collected at site 202R05464. Field crews will continue to make an effort in subsequent years to collect the original and duplicate samples in an identical fashion.

[5] Please see the section 3.5.1 of the WY 2020 QA/QC report for more details on the issues surrounding ammonia detection limits and analysis.

Table 4. Field duplicate water chemistry results for site 202R05464, collected on May 25, 2022.

Analyte Name	Fraction Name	Unit	Original Result	Duplicate Result	RPD	Exceeds MQO? (>25%)[a]
Ammonia as N	Total	mg/L	J 0.096	0.17	NA	NA
Chloride	None	mg/L	24	25	4%	No
Nitrate as N	None	mg/L	0.22	0.22	0%	No
Nitrite as N	None	mg/L	J 0.003	J 0.002	NA	NA
Nitrogen, Total Kjeldahl	None	mg/L	-0.08	-0.08	NA	NA
Orthophosphate as P	Dissolved	mg/L	0.029	0.032	10%	No
Phosphorus as P	Total	mg/L	0.041	0.036	13%	No
Silica as SiO2	Total	mg/L	15	15	0%	No

[a] In accordance with the RMC QAPP, if the native concentration of either sample is less than the reporting limit, the RPD is not applicable.
J = Detected, not quantified (EPA flag); Concentration between the MDL and RL.

3.5.5. Contamination

During WY 2022, Caltest analyzed three equipment blanks (orthophosphate filter blanks) and several laboratory blanks. No contamination was detected in any of the laboratory or equipment blanks. The SMCWPPP field crew takes appropriate precautions to avoid contamination, including wearing gloves during sample collection and rinsing sample containers with stream water when preservatives are not needed.

3.6. Continuous Water Quality

Continuous water quality measurements were recorded at two sites during June 2022 concurrent with bioassessments in compliance with the MRP. Temperature, pH, dissolved oxygen, and specific conductivity were recorded once every 15 minutes for approximately 10 days using a multi-parameter water quality sonde (Eureka Manta+30).

3.6.1. Completeness

The MRP requires SMCWPPP to monitor dissolved oxygen, pH, specific conductance, and temperature at two sites using sondes that record at 15-minute intervals over 1-2 weeks in the spring concurrent with bioassessment sampling and 1-2 weeks in summer at the same sites. The summer event typically occurs in August/September timeframe, and thus was not conducted in WY 2022 due to the onset of new monitoring requirements under the reissued MRP (MRP 3.0), which do not include continuous monitoring. In WY 2022, 100% of the planned data were collected.

3.6.2. Sensitivity

There are no method reporting limits for temperature, dissolved oxygen, pH, and conductivity measurements, but the actual measurements are much higher than target reporting limits in the RMC QAPP, so it is assumed that target reporting limits are met for all field measurements.

3.6.3. Accuracy

Program staff conduct pre- and post-deployment sonde calibrations for the two sondes used during monitoring events and calculate the drift during the deployments. A summary of the drift measurements is shown in **Error! Reference source not found.**. Both sondes passed the calibration drift checks for all parameters.

Table 5. Differences between pre- and post-deployment calibration readings for sondes used to measure continuous water quality.

Parameter	Measurement Quality Objectives	202R00664	202SGR042
Dissolved Oxygen (mg/L or %)	± 0.5 mg/L or 10%	0.14	-0.11
pH 7.0	± 0.2	0.01	0.05
pH 10.0	± 0.2	0.0	0.01
Specific Conductance (uS/cm)	± 10%	0%	0%

3.6.4. Precision

There is no protocol listed in the RMC QAPP for measuring the precision of continuous water quality measurements.

3.7. Continuous Temperature Monitoring

Continuous temperature monitoring was conducted from April through June 2022 at five sites in San Mateo County. Onset HOBO Water Temperature data loggers recorded one measurement per hour.

3.7.1. Completeness

The MRP requires SMCWPPP to monitor four stream reaches for temperature each year but anticipating the potential for a HOBO temperature logger to be lost during such a long deployment, SMCWPPP deployed one extra temperature logger for a total of five loggers. Since the MRP only requires four sites, SMCWPPP achieved a greater than 100% completion rate for continuous temperature monitoring.

3.7.2. Sensitivity

There is no target reporting limit for temperature listed in the RMC QAPP, thus sensitivity could not be evaluated for continuous temperature measurements.

3.7.3. Accuracy

A pre-deployment accuracy check was run on the temperature loggers in March 2022. None of the loggers exceeded the 0.2 ^{o}C mean difference threshold for either the room temperature bath or the 0.2 ^{o}C mean difference for the ice bath.

3.7.4. Precision

There are no precision protocols for continuous temperature monitoring.

4. SUMMARY

In WY 2022, sample collection and analysis followed MRP and RMC QAPP requirements. A summary of the QA/QC analysis is provided below.

Data Discrepancies

- Free chlorine measurements were greater than total chlorine measurements at four sites.

Flagged data

- Ash free dry mass result for field duplicate exceeded the MQO for RPD (<25%)

5. REFERENCES

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Attachment 2

SMCWPPP Bioassessment Data, WY 2022

Site Information						Water Quality						Nutrients														Biological and Physical Habitat Index Scores					Physical Habitat									Land Use		
StationCode	Creek Name	Latitude	Longitude	Elevation(m)	Sample Date	Dissolved Oxygen (mg/L)	Temperature (Deg C)	Specific Cond (uS/cm)	pH	Silica (mg/L)	Chloride (mg/L)	Ash Free Dry Mass (g/m2)	Chlorophyll a (mg/m2)	Ammonia (mg/L)	UIA (mg/L)	Nitrate (mg/L)	QA Flag	Nitrite (mg/L)	QA Flag	TKN (mg/L)	QA Flag	Total N (mg/L)	Ortho Phosphate (mg/L)	QA Flag	Total Phosphorus(mg/L)	CSCI Score	ASCI_D Score	ASCI_H Score	ASCI_S Score	IPI Score	Channel Alteration	Epifaunal Substrate	Sediment Deposition	Human Disturbance Index	Evenness Flow Habitat	% Substrate < 2 mm	Shannon Diversity Habitat	Sum Riparian Cover	Shannon Diversity Substrate	% Impervious (wat)	% Urban (wat)	Road Density (wat)
202R00806	Pescadero Creek	37.27158	-122.27474	62.2	16-May-22	9.6	13.9	607	8.07	17	35	11	35	0.096 J	0.0027	0.01	ND	0.0005	ND	0.29		0.30	0.10	=	0.11	0.69	1.05	1.12	0.99	1.19	20	19	11	0.3	0.7	31	2.0	190	1.8	1%	0%	1.3
202R00726	Peters Creek	37.25662	-122.21695	127.1	19-May-22	10.0	12	776	8.35	24	33	19	19	0.062 J	0.0029	0.16		0.002 J	DNQ	0.25		0.41	0.17	=	0.18	1.13	0.80	1.02	1.25	1.04	18	17	13	0.5	0.7	22	1.6	130	1.8	1%	1%	1.9
202SGR042	San Gregorio Creek	37.31160	-122.31074	61.6	17-May-22	10.8	12.7	946	8.23	24	71	48	45	0.076 J	0.0024	0.03	J	0.0005	ND	0.04	ND	0.07	0.18	=	0.19	0.88	0.72	0.8	0.00	1.09	19	18	13	1.0	0.9	26	1.8	149	1.5	3%	4%	2.0
202SGR066	San Gregorio Creek	37.31883	-122.29675	72.2	17-May-22	10.0	11.4	940	8.12	25	60	6.3	20	0.16	0.0036	0.03	J	0.0005	ND	0.22		0.25	0.18	=	0.19	0.98	0.92	1.2	1.41	1.12	19	16	13	0.5	1.0	11	1.8	163	1.1	3%	5%	2.2
202R00664	San Gregorio Creek	37.31341	-122.28522	86.6	24-May-22	12.0	13.6	751	8.3	24	52	12	74	0.12	0.005	0.04	J	0.0005	ND	0.17		0.21	0.18	=	0.19	1.09	0.81	1.01	0.72	0.94	18	16	16	0.8	0.9	11	1.5	86	1.8	3%	5%	2.2
202R00920	Alpine Creek	37.29648	-122.25832	148.1	24-May-22	10.9	10.1	909	8.3	28	28	20	12	0.15	0.0048	0.13		0.002 J	DNQ	0.04	ND	0.17	0.21	=	0.21	1.13	0.67	0.81	0.70	1.02	19	17	13	1.0	0.9	14	1.2	126	1.7	1%	0%	1.6
202R03916	San Pedro Creek	37.59184	-122.50338	0.2	25-May-22	10.7	16.2	426	8.06	15	26	29	22	0.089 J	0.003	0.20		0.003 J	DNQ	0.04	ND	0.24	0.04	=	0.04	0.61	0.77	0.68	0.16	1.11	18	9	8	1.1	0.7	30	1.6	216	1.4	15%	26%	3.5
202R05464	San Pedro Creek	37.5871	-122.49567	14.2	25-May-22	9.5	12.7	418	7.9	15	24	12	29	0.096 J	0.0016	0.22		0.003 J	DNQ	0.04	ND	0.26	0.03	=	0.04	0.68	0.87	0.78	0.09	0.88	12	10	10	3.8	1.0	27	1.9	66	1.5	13%	23%	3.1
202R03404	San Pedro Creek	37.5821	-122.48737	23.5	23-May-22	9.5	13.3	409	8.1	16	26	17	40	0.16	0.0043	0.22		0.004 J	DNQ	0.04	ND	0.26	0.02	=	0.03	0.68	0.82	0.94	1.25	1.11	18	17	16	2.1	0.8	40	1.7	226	1.5	13%	23%	2.8
202R04568	San Pedro Creek	37.58097	-122.47956	31.1	23-May-22	10.5	12.2	422	7.92	16	26	19	9	0.041 J	0.0006	0.22		0.007		0.04	ND	0.27	0.02	=	0.02	0.63	0.78	0.71	0.31	0.88	16	12	11	3.2	0.7	17	1.9	88	1.3	12%	21%	2.6

QA Flag: ND - Non-detect (used ½ value of the method detection limit), DNQ - Detected Not Quantifiable (used measured value)

NR - Not Recorded

UIA- Un-ionized Ammonia

TKN - Total Kjeldahl Nitrogen

CSCI - California Stream Index

ASCI_D - Algae Stream Condition Index (Diatoms)

ASCI_H - Algae Stream Condition Index (Hybrid)

ASCI_SA - Algae Stream Condition Index (Soft Algae)

IPI - Index Physical Habitat Integrity